Teacher Guide: Rainfall and Bird Beaks

Learning Objectives

Students will …

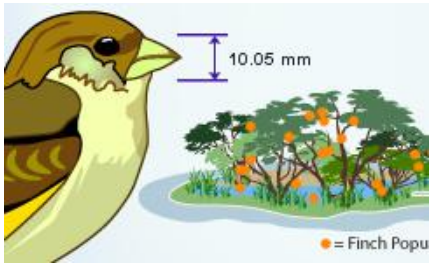
- Observe finch populations and beak shapes during normal years.
- Understand how annual rainfall affects the amount and types of available seeds.
- Explore how finch populations change in times of drought and excess rainfall.
- Identify examples of directional and stabilizing selection.
- Explain how new species of finches could arise.

Vocabulary

adaptation, beak depth, directional selection, drought, evolution, natural selection, range, stabilizing selection

Lesson Overview

The finches of the Galápagos Islands show a remarkable variety of beak shapes, diets, and lifestyles. Some finches eat small seeds, others eat large seeds, and still other finches specialize in unusual foods including cacti, insects, and even blood! The finches are so diverse that when Charles Darwin originally collected them in 1835, he didn't realize that in fact they were all closely-related species.



Recent studies have shown that Darwin's finches face enormous selective pressures as the climates of the Galápagos Islands vary from extremely dry to relatively wet. The *Rainfall and Bird Beaks* Gizmo™ allows students to explore how climate affects population size and the distribution of beak shapes within a population of seed-eating finches.

The Student Exploration sheet contains three activities:

- Activity A – Students explore the dynamics of finch populations in normal conditions.
- Activity B – Students explore how drought conditions affect the finches.
- Activity C – Students explore how plentiful rainfall affects the finches.

Suggested Lesson Sequence

1. **Pre-Gizmo activity: Eat like a bird** (5 – 15 minutes)
   Pass out a variety of "beaks" to your students. These should include delicate beaks such as tweezers and sturdy beaks such as pliers. Distribute a variety of small seeds, such as sunflower seeds, and large seeds, such as almonds in their shells. Ask which beaks are better adapted for a diet of small seeds and which are better adapted for the large nuts.

   Next, project an image of Darwin's finches to the front of the class. Discuss how the beak shapes of the different finches may be related to their diet. Explain how rainfall affects the amounts and varieties of available seeds, and challenge your students to describe the implications of this on the beak shapes of the seed-eating finches.

2. **Prior to using the Gizmo** (🕒 10 – 15 minutes)
Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations. Demonstrate how to take a screenshot and paste the image into a blank document.

3. **Gizmo activities** (🕒 15 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Discussion questions** (🕒 15 – 30 minutes)
As students are working or just after they are done, discuss the following questions:
    - What causes the yearly fluctuation in the finch population?
    - How does the amount of rainfall affect the amount and types of seeds present on the Galápagos Islands?
    - Why does the selection of available seeds favor some beaks more than others?
    - How, exactly, does the average beak depth change over time?
    - Why do you think the finches of the Galápagos Islands were so important in convincing Darwin that evolution explained the origin of species? [For Darwin, it was clear that the finches had evolved and diversified from a small group of mainland finches that had colonized the islands long ago.]

5. **Follow-up activity: Hunting for seeds** (🕒 45 – 60 minutes)
Divide your students into three teams, each representing a group of finches. Give each member of the “small beak” team a pair of tweezers. Give each member of the “medium beak” team a pair of needle-nosed pliers, and give each member of the “large beak” team a pair of regular pliers. (Implements can be borrowed from other teachers or your students.)

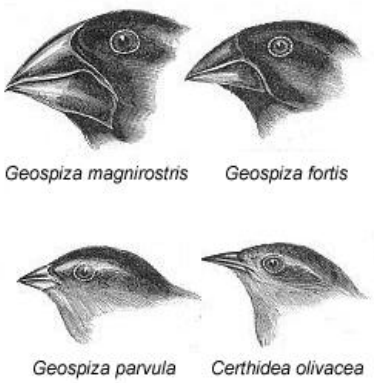
    Next, bring the class outside and scatter an even mixture of sunflower seeds, whole peanuts (in shells), and whole almonds (also in shells) on the grass. Provide each student with a paper cup. To “eat” seeds, students have to pick up seeds using their beak, use the beak to remove the seed from its shell, and drop it into the cup. Allow students two minutes to forage, and then compare the results for each team.

    You can alter the number and distribution of seeds to model drought or plentiful rainfall. For drought, scatter only almonds and a few peanuts. This will cause the small-beaked finches and most of the medium-beaked finches to starve. For plentiful rainfall, scatter lots of sunflower seeds as well as normal amounts of peanuts and almonds. The small-beaked finches will probably get the most food but the other finches will survive as well. These results should closely mirror what students observed in the Gizmo.

    To conclude this activity, discuss the results of each experiment, as well as the similarities and differences between this simulation and the real world. What would happen if the finches colonized nearby islands that had different distributions of seeds? What would happen if only tiny seeds and very large seeds were available?

Scientific Background

Among the thousands of biological specimens collected by Darwin during the voyage of the HMS *Beagle* were a group of birds from the Galápagos Islands. The birds were distinguished by a variety of beak shapes and differing lifestyles and diets. Some of the birds are seed eaters and live on the ground, some eat insects and live in trees, and one species actually feeds on the blood of other birds! Yet another species uses cactus spines to pry grubs from trees, a rare example of avian tool use.



Four of Darwin's finches

Darwin didn't pay much attention to the birds at the time, but he was later surprised to learn that all the birds were closely related finches. Darwin soon understood the implications of this fact.

He imagined a small group of finches that were lost at sea, perhaps blown off course by a storm. These finches eventually landed on the desolate Galápagos Islands, an environment completely different from the lush forests of their homeland. Over the years, the finches adapted to take advantage of new food sources. Through the finches, Darwin visualized how the process of evolution and the formation of new species could occur. Today, Darwin's finches are considered a classic example of an adaptive radiation leading to the formation of new species.

In 1973, the husband and wife team of Peter and Rosemary Grant began a remarkably detailed study of the medium ground finch, *Geospiza fortis*. In four decades of visiting the islands, they and their colleagues have observed the finches in times of normal rainfall, above-average rainfall, and extreme drought.

On the island of Daphne Major, less than three centimeters of rain fell in 1977. The Grants discovered that the finches did not breed that year, and few seeds were produced by the plants on the island. The smaller seeds were quickly consumed, leaving behind only the toughest, hardest seeds. The medium ground finch population decreased drastically that year, but finches with the smallest beaks were hit hardest. As a result the average beak depth increased.

Two years later came a period of heavy rains. Vines overgrew much of the island and produced massive numbers of small, soft seeds. The finches had multiple clutches of eggs that year and their population increased rapidly. Although medium ground finches with all beak sizes flourished, the finches with the smallest beaks underwent the greatest increase in population. Thus, the average beak depth decreased. These and other discoveries are described in the Pulitzer Prize winning book *The Beak of the Finch* by Jonathan Weiner.

Selected Web Resources

Darwin's finches: http://people.rit.edu/rhrsbi/GalapagosPages/DarwinFinch.html, http://facstaff.uwa.edu/jmccall/Finches.htm
Finch beak demo with tweezers and pliers: http://www.darylscience.com/Demos/BeekThing.html
Another bird beak lab: http://www.accessexcellence.org/AE/AEC/AEF/1996/sprague_beaks.php
The Grants: http://wps.prenhall.com/esm_freeman_evol_3/0,8018,849374-,00.html

Related Gizmos:
Natural Selection: http://www.explorelearning.com/gizmo/id?447
Evolution: Mutation and Selection: http://www.explorelearning.com/gizmo/id?554
Rabbit Population by Season: http://www.explorelearning.com/gizmo/id?380