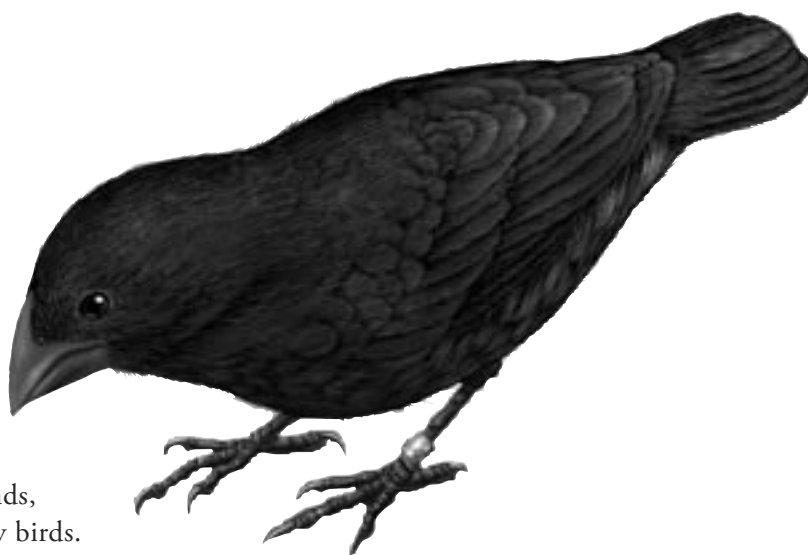


# GALÁPAGOS FINCHES: Famous Beaks

Why would anyone travel halfway around the world to a hot, rocky island to measure bird beaks? Year after year, for more than 30 years, biologists Rosemary and Peter Grant have returned to the Galápagos Islands to do just that. These aren't just any islands, and the birds aren't just any birds.



The Galápagos Islands are a cluster of active volcanic islands in the Pacific Ocean. The island chain is extremely remote. It lies hundreds of miles from the nearest landmass, South America. The plants and animals that colonized the islands evolved in unique ways. The islands, and especially a group of dull little birds known as Darwin's finches, helped inspire Charles Darwin's ideas about evolution. The finches are named in his honor.

The Galápagos Islands are home to 13 species of finches. The birds vary in size and shape, and they are about as drab looking as a sparrow—until you consider their beaks. Each species is distinguished by a different beak. The 13 beaks are often compared to a toolbox containing 13 kinds of pliers, each one suited for a different task. The cactus finch has a long thin beak that works well for crushing cactus seeds. The woodpecker finch uses its beak to dig out insects from dead wood. The sharp-beaked ground finch feeds on nectar from flowers and catches insects, but sometimes it also pecks through the skin of seabirds called boobies and feeds on their blood. While the finches on the Galápagos feed on many kinds of foods, each bird has a beak suited to certain eating habits.

When Darwin first saw the finches on his visit to the Galápagos in 1835, he didn't know how important they would be to him. Darwin was 26 years old and employed as a naturalist on a five-year voyage around the globe. One of his jobs was



Rosemary and Peter Grant study the evolution of finches on the Galápagos Islands. They are professors at Princeton University.

Photos courtesy Rosemary and Peter Grant.

to collect samples of unknown plants and animals. Darwin captured some of the Galápagos finches for his collection, but at the time, he was more interested in plants and rocks and in the islands' stranger inhabitants. In his diary he mentioned the "hideous" lizards that gathered seaweed in the ocean and giant tortoises that were big enough to ride on.

Years later, however, it was the collection of little finches that puzzled and inspired him most. Darwin wondered why there were so many species of finches on the Galápagos Islands, and why they were as different and as similar as they were. Finches don't migrate, so the birds he collected must have evolved on the islands. He speculated that the first birds blew to the Galápagos from the coast of South America, evolving in a dozen directions on different islands.

The finches' beaks gave Darwin a clue about how a species could evolve. The size and shape of a bird's beak determine the kinds of food the bird can eat and the kinds it can't. A slight difference might give one bird an advantage over another in surviving and reproducing, and the advantaged offspring, in turn, would be more likely than others to survive and reproduce. Darwin called this process natural selection. Others described it as "survival of the fittest." Darwin thought that natural selection worked too slowly to be seen in one's lifetime.

More than a hundred years after Darwin's visit, Rosemary and Peter Grant traveled to the Galápagos Islands to take a closer look at the finches. The Grants wondered: If they took careful measurements of the finches and the foods they ate, would they be able to see the changes that Darwin imagined?

The Grants and their students set up a research camp on Daphne Major, an island in the center of the Galápagos. Daphne Major is a biologist's dream because

of its small size, isolation, and harsh weather. The island is like a giant petri dish, a science experiment set up by nature.

Daphne Major has a resident population of finches commonly known as medium ground finches. Their scientific name is *Geospiza fortis* (geo-SPEEZA-fort-iss). They are distinguished from other finch species by their medium-sized bodies and their beaks. When the Grants started their research, they took a head count of the finches on Daphne Major. To do this, they put up mist nests to catch the birds, picking them out one by one with their hands and placing numbered bands on their legs. Sometimes the finches watched, perching on the researchers' wrists and arms as they worked.

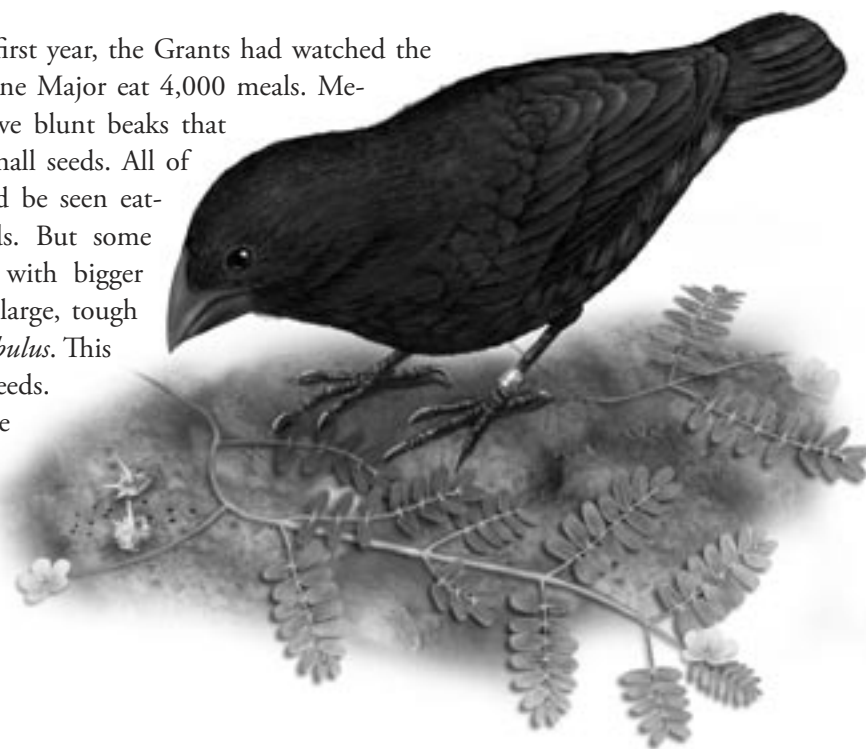
After banding the birds, the researchers took careful measurements. They weighed each bird with a spring balance and then measured it from head to hallux (big toe) with a set of calipers. They kept a record of the bird's wing length, leg length, toe length, and, most important of all, its beak size. The Grants were struck by the variation in beak sizes. To us, a fraction of an inch seems insignificant. But was it important to a finch? Did it make a difference in the food the finch ate? Did it matter to its survival?

To find out, the Grants and their students also measured finch food. Every morning they scoured the island with binoculars to see what the birds ate for breakfast. They got to know the food as well as they knew the birds, though it wasn't half as much fun. It required sifting through the dirt, counting the seeds, and measuring their size and hardness. They gave each seed a score based on how hard a bird had to struggle to crack it open.

By the end of their first year, the Grants had watched the ground finches on Daphne Major eat 4,000 meals. Medium ground finches have blunt beaks that are suited to crushing small seeds. All of the ground finches could be seen eating the small, soft seeds. But some of the birds—the ones with bigger beaks—could tackle the large, tough seeds of a plant called *Tribulus*. This plant is as tough as its seeds. It can withstand extreme conditions such as long droughts.

**The Medium Ground Finch, *Geospiza fortis***

UNSM Angie Fox illustration.





These two male medium ground finches, *Geospiza fortis*, were on the same Galápagos Island at the same time. Notice the variation in beak depth.

Photo courtesy Peter Boag.

The Grants measure the size of finch beaks with great precision. Even small changes in beak size can influence the survival of the birds.

Photo courtesy Rosemary and Peter Grant.

The Grants and a graduate student, Peter Boag, returned to Daphne Major in the years following to measure the finches and their food. Nothing much changed. Then one year, a severe drought turned Daphne Major into the science experiment of a lifetime. The drought prevented many of the plants from producing seeds that year, so the finches were dependent on the seeds left over from the previous year. Once the finches ate all of the abundant small seeds that had been produced the year before, they were left with big tough seeds. Then a life-and-death struggle took place. When the Grants and Peter Boag returned to the island the next year, they were shocked by what they found.

Discover for yourselves whether variations in beak size can make a difference in finch survival and evolution. In this activity you'll meet some medium ground finches, measure their beaks, become a beak yourself and test your food-gathering skills, graph the finches and seeds on Daphne Major, and see whether changes in the environment can push the finches toward a different beak.

## PART ONE

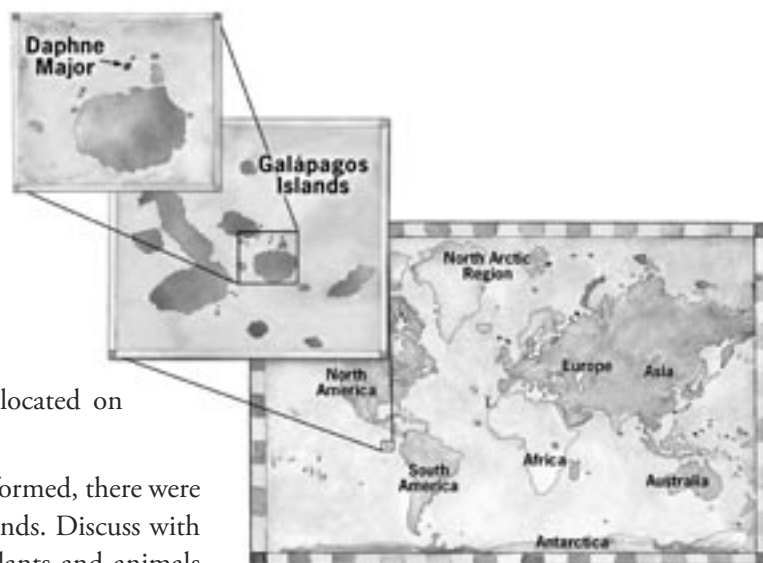
# Islands & finches

The Galápagos are strange and wonderful islands. This string of volcanic mountaintops rise out of the Pacific Ocean floor about a thousand kilometers (600 miles) off the coast of South America at the equator. When these islands first emerged from the sea floor, they were simply lifeless piles of lava rocks. About three million years ago, new species began to arrive. The barren lava soils, equatorial heat, sparse rain, and isolation make this a very harsh world to survive in. Only some species have the equipment to live in these tough conditions, making it home to some unique plants and animals. These extreme conditions make the Galápagos very interesting to biologists.

### Work with a partner

Each team will need:

- 6 Finch Beak sheets (10x larger than life size)
- Finch Beak Measurement Chart
- compass
- a ruler (cm & mm)



Lonnie Broden illustration.

## 1 Find the Galápagos

- a Find where Daphne Major is located on each of the maps.
- b When the Galápagos were first formed, there were no plants or animals on the islands. Discuss with your partner some ways that plants and animals from South America could have found their way to these rocky islands.

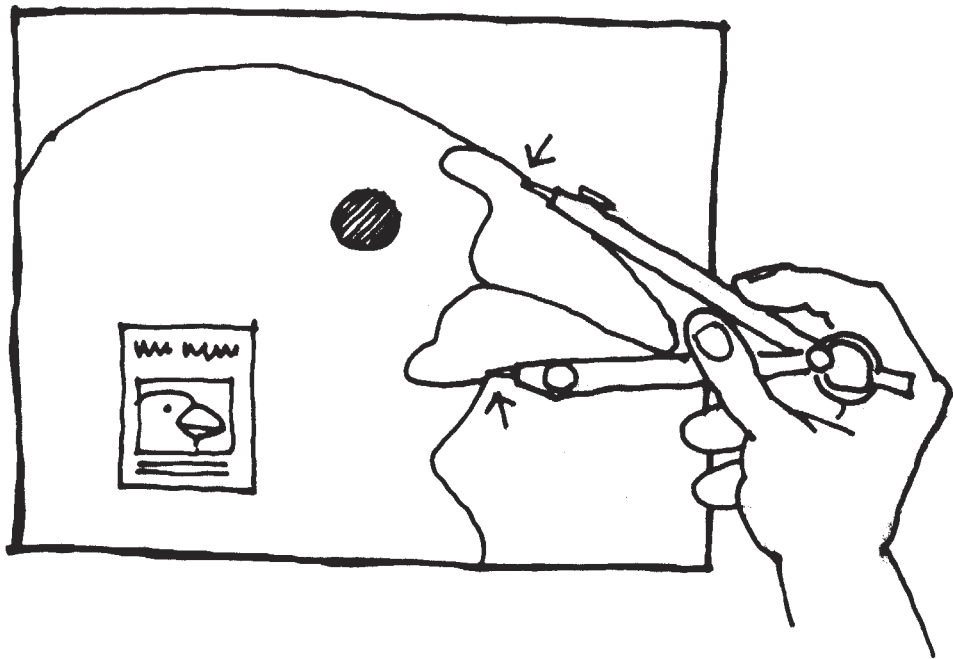
## 2 Measure Bird Beaks

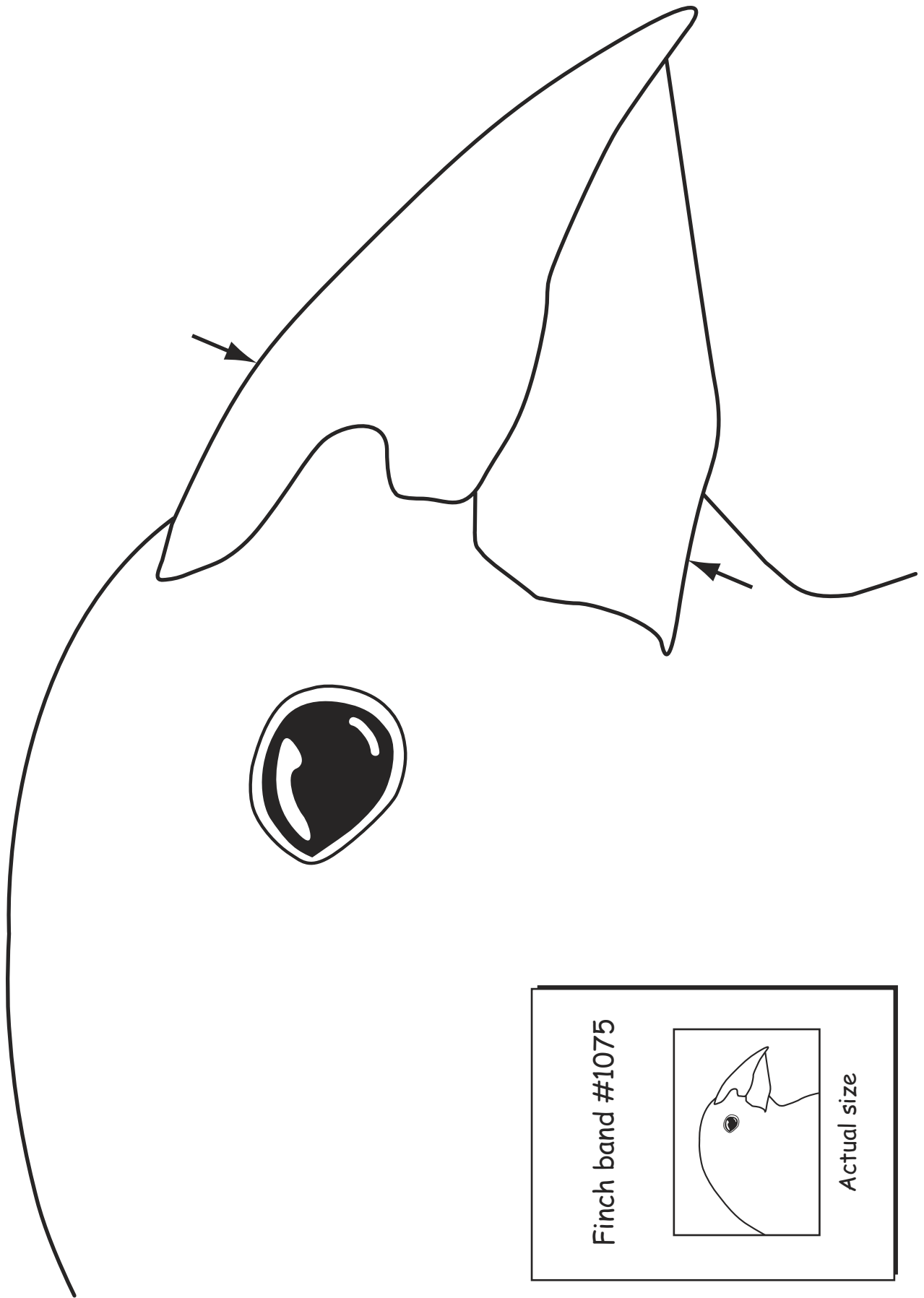
No two animals are exactly alike. Differences between organisms of the same species in features like size, color, and abilities are called variations. Usually variations are slight and don't make much difference. Sometimes a variation will give one creature an advantage over another.

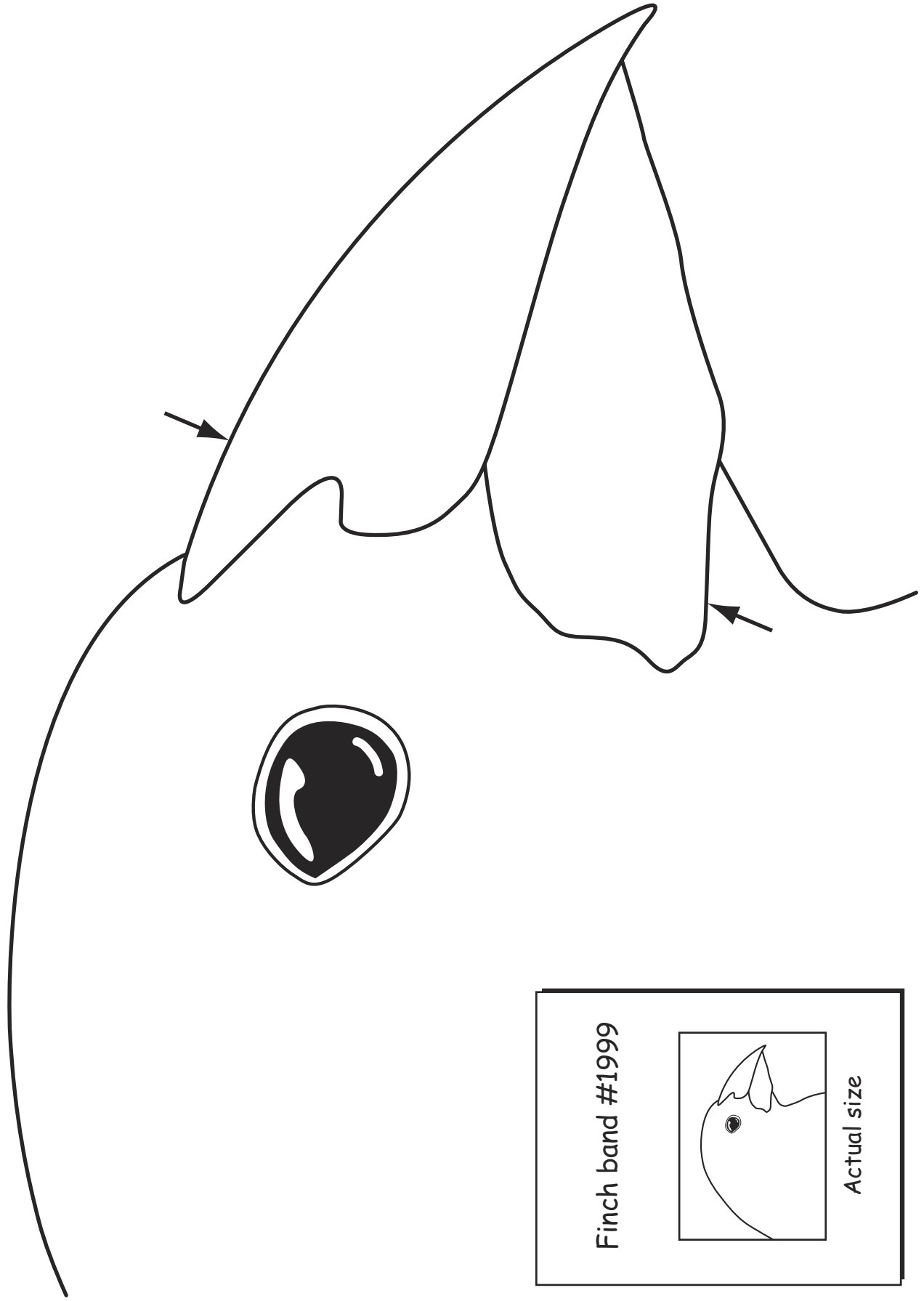
Rosemary and Peter Grant have visited the Galápagos every year for more than 30 years. They return to the island of Daphne Major to count the finches and band newly hatched birds. This puts them on a first-name basis with the finches that live on Daphne Major. The Grants pay attention to variations between each finch on the island. Learn how they measure finch beaks and discover some variations for yourself.

The Grants take precise measurements of their favorite finch, the medium ground finch, *Geospiza fortis*. You will be using a compass and ruler to measure beaks from pictures of medium ground finches that are 10 times larger than life.

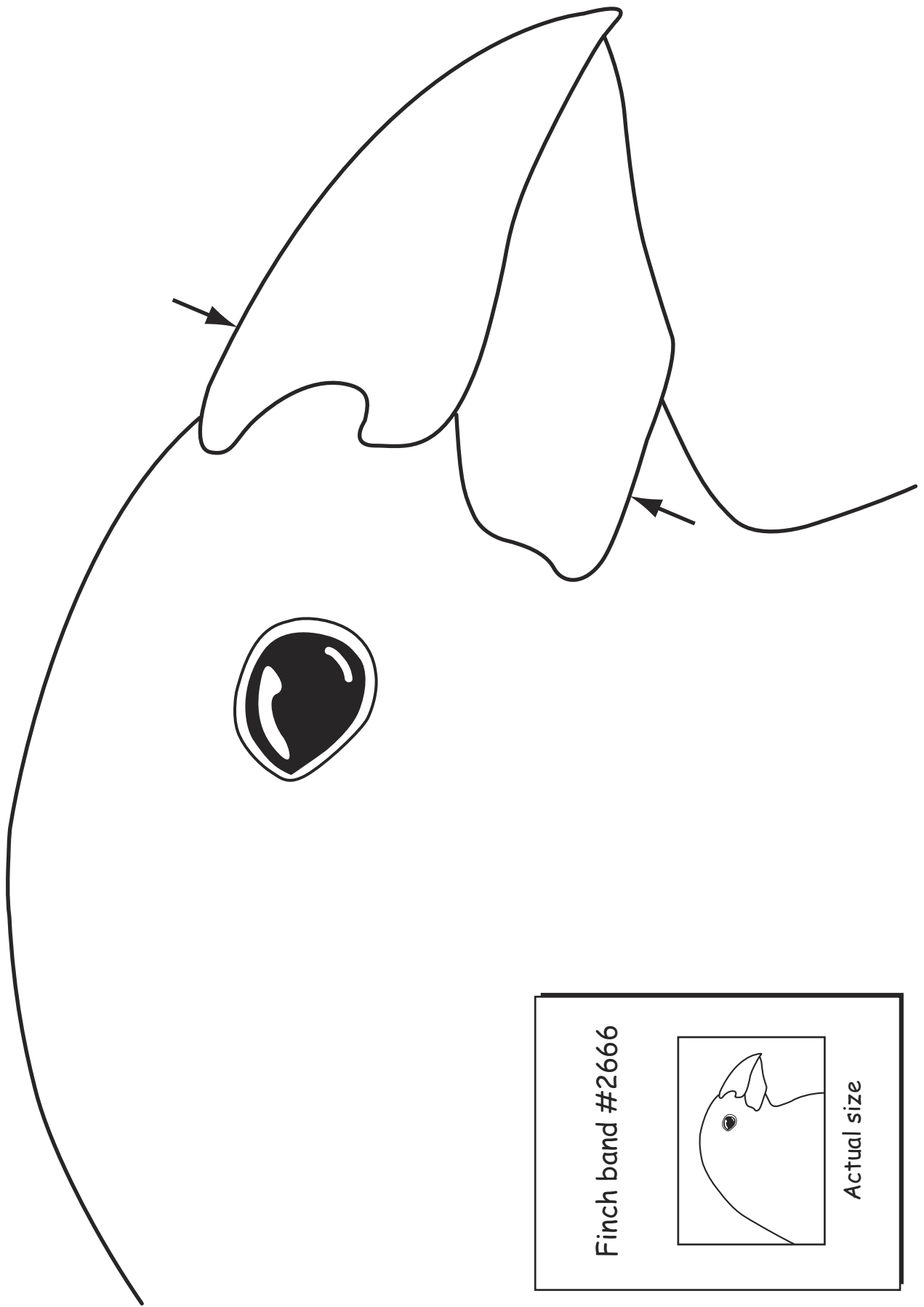
- a** Collect your compass and ruler.
- b** How to measure beak depths: Measure the beak depth by putting it between the tips of a compass. Measure from the arrow at the top of the beak to the arrow just under the chin.
- c** Transfer the tips of the compass to the ruler without changing its opening. Measure in centimeters the space between the tips. If the compass tips have moved in the process, then re-measure the beak.
- d** Record the measurements for this bird on the Finch Beak Measurement Chart. You can identify each bird by its band number.
- e** Measure each of the six finch beaks and record your data on the chart. Then calculate the average beak size and write it on the chart.

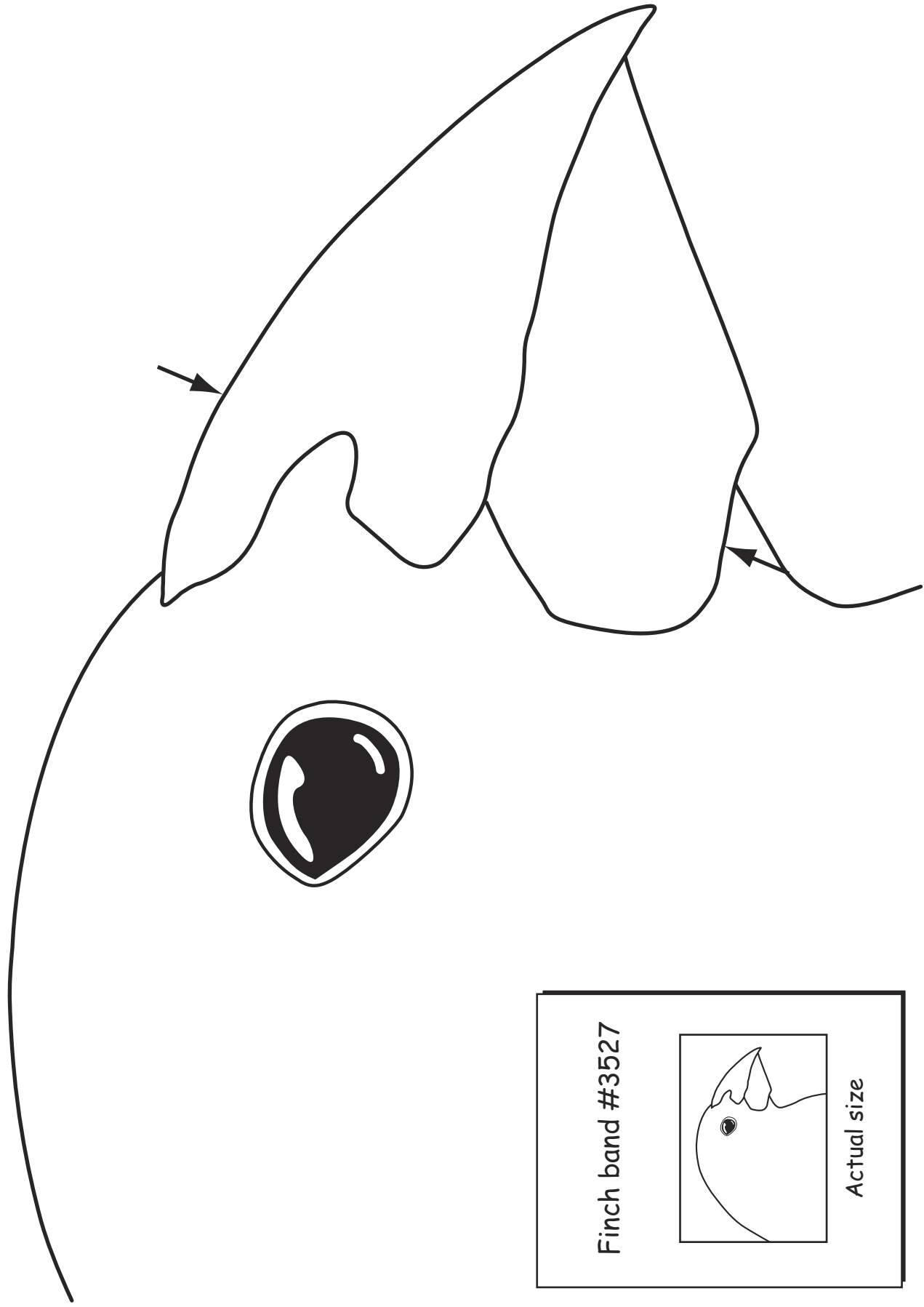


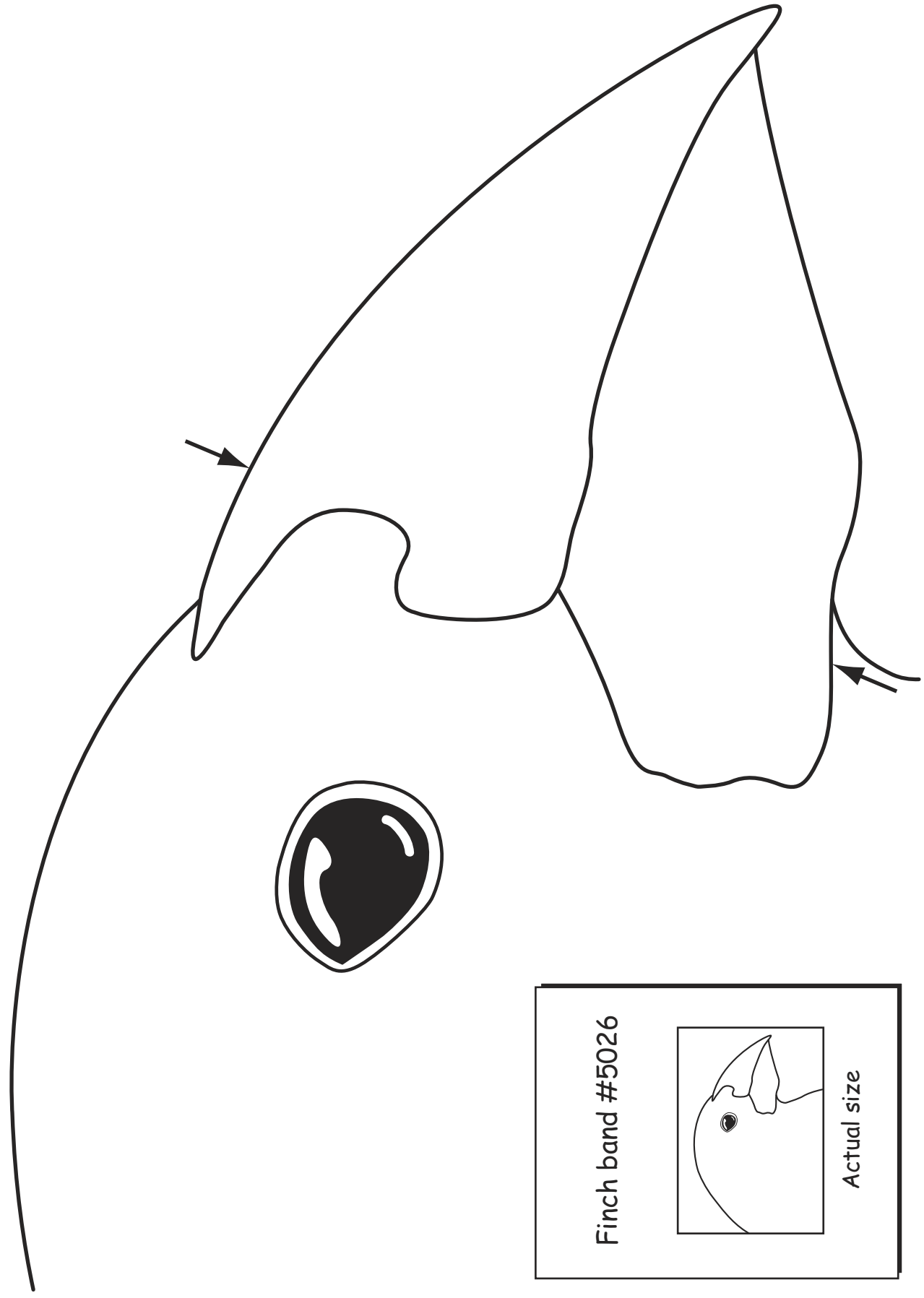


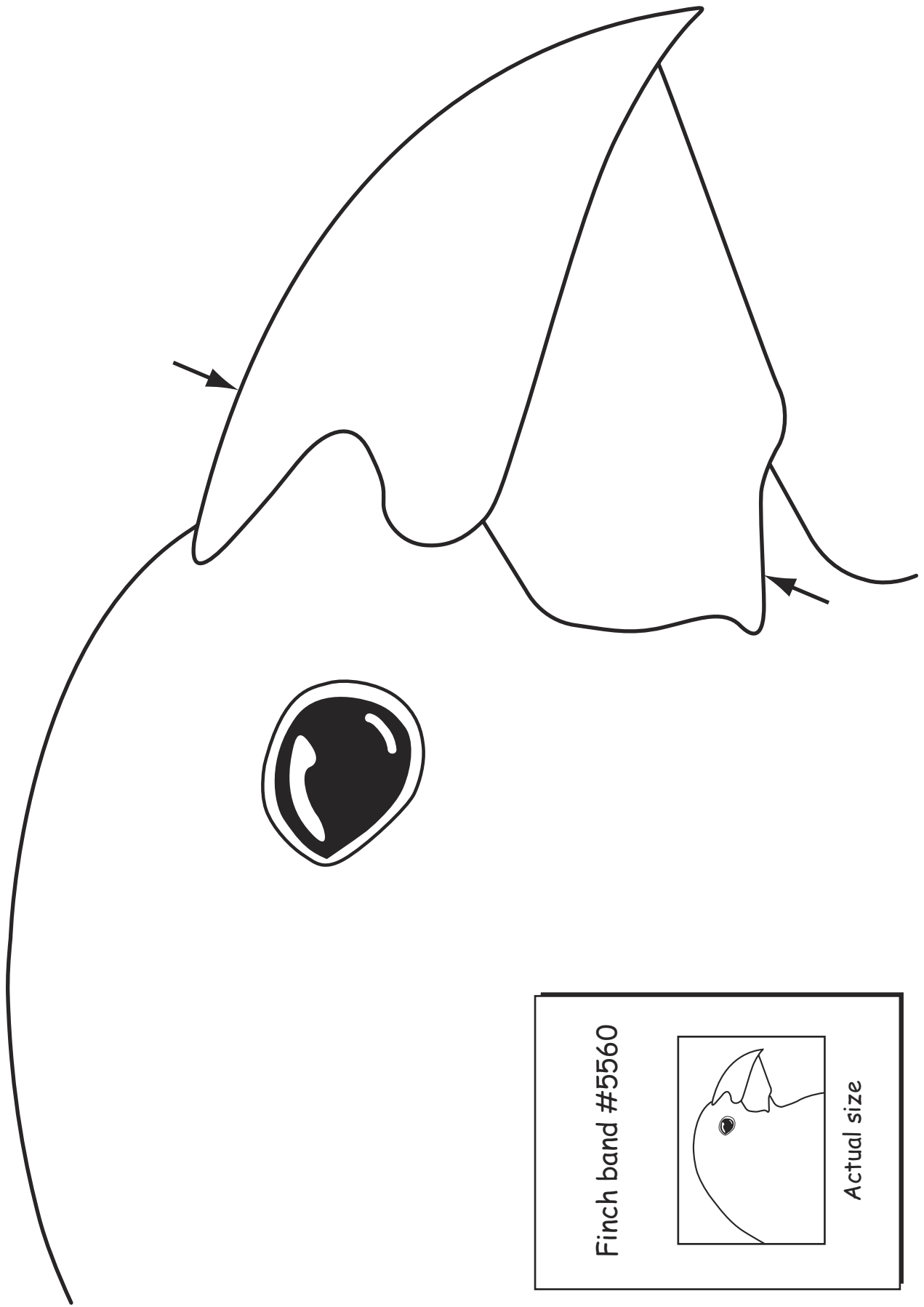












**Finch Beak Measurement Chart**

MEDIUM GROUND FINCH BAND NUMBER	BEAK DEPTH IN CENTIMETERS	BEAK DEPTH IN MILLIMETERS
Finch 1075		
Finch 2666		
Finch 5560		
Finch 3527		
Finch 5026		
Finch 1999		

- f** The finch beaks you measured were enlarged 10 times. The actual range of beak variation measured by the Grants is in millimeters, not centimeters. We enlarged the finch pictures so the differences would be more visible to you. Now you need to multiply by 10 (this shows them in millimeters). Calculate the beak sizes in millimeters and insert them in the chart above.
- g** Now sum up your findings: How many different beak sizes did you find?
- h** What was the size in millimeters of the largest beak that you measured?
- i** What was the size in millimeters of the smallest beak that you measured?
- j** What is the difference in millimeters between the size of the largest and the smallest beaks that you measured?

#### 4 Consider This

Do you think that tiny variations in beak size matter for survival? Why or why not?

## PART TWO

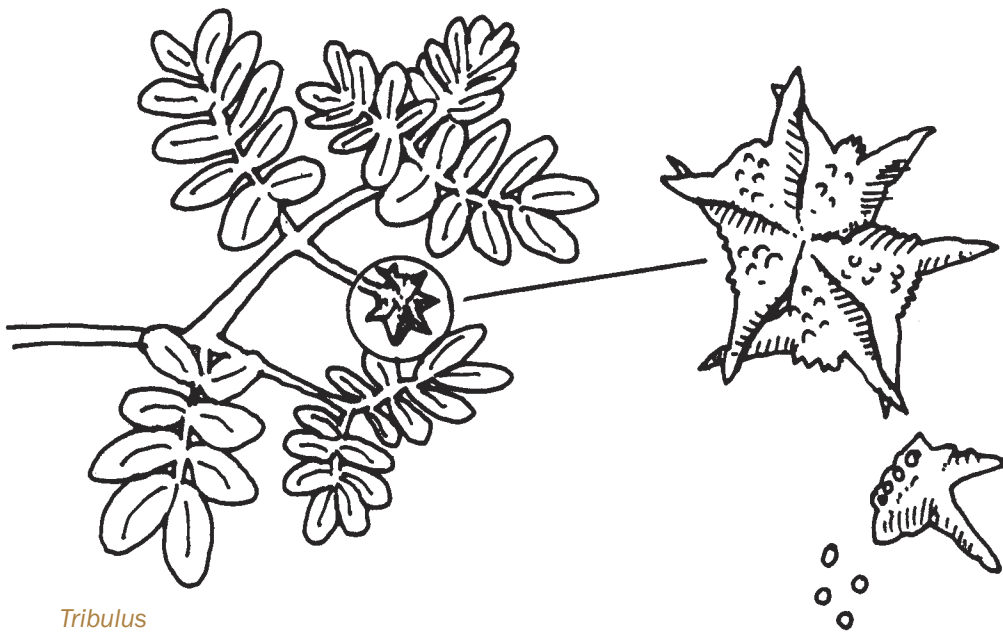
# Battle of the beaks

Medium ground finches eat a range of food including about two dozen kinds of seeds. These seeds range from small soft ones to seeds in hard shells that are tough to open. One of the toughest seeds on Daphne is from a plant called *Tribulus*. The seeds from *Tribulus* are about eight times harder to open than the soft seeds that finches also eat.

In North America *Tribulus* is a common weed that produces some of the toughest, meanest seeds around. Sometimes it is called puncture vine because the seeds have a talent for jamming themselves into bare flesh and bicycle tires.

Finches eat the easy food first. When soft seeds are plentiful the finches dine on those. When soft seeds are not available, the finches resort to the harder-to-open seeds. The scientists on Daphne Major observed that only finches with bigger beaks are able to crack open the tough seeds like *Tribulus* to get the food inside.

In this activity you will build two different types of beaks and test their food-nabbing effectiveness. Find out in the game of survival whether beak size matters.



*Tribulus*  
Linda Allison illustration

## Work with a partner

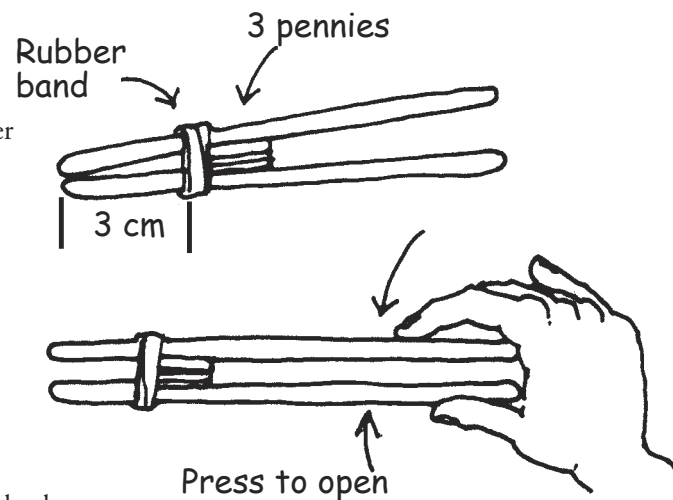
Each team will need:

- Battle of the Beaks: Normal Year Chart
- Battle of the Beaks: Drought Year Chart
- beak materials: 4 popsicle sticks, 2 rubber bands, 9 pennies
- food supply: 1 teaspoon large seeds (e.g., garbanzos) and 1 teaspoon small seeds (e.g., mustard seeds)
- cm ruler
- tape
- sheet of paper (“stomach”)
- paper plate (“island”)
- timer

### 1 Build a Small Beak

Use popsicle sticks to test the difference between big beaks and small beaks.

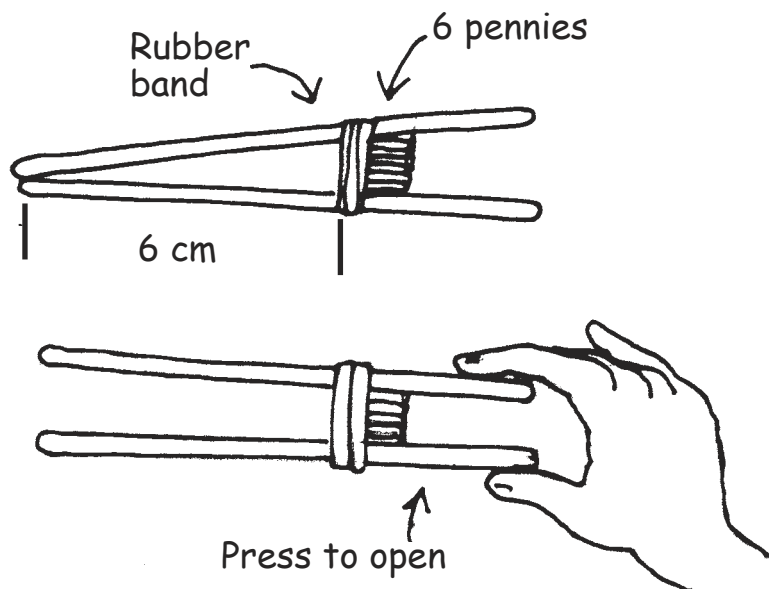
- a** To build a small beak, you will need two popsicle sticks, a rubber band, and three pennies.
- b** Measure and mark a stick with a line 3 centimeters from the tip.
- c** Rubber band the two sticks together just past the 3 centimeter line.
- d** Make a stack of three pennies. Hold the stack together with a skinny piece of tape.
- e** Slide the stack of pennies between the two sticks. Position them just behind the rubber band.
- f** Press on the open ends to open the beak.



### 2 Build a Big Beak

- a** To build a big beak you need two popsicle sticks, a rubber band, and six pennies. Measure and mark a stick with a line 6 centimeters from the tip.
- b** Rubber band the two sticks together just past the 6 centimeter line.
- c** Make a stack of six pennies. Hold the stack together with a skinny piece of tape. Slide the stack of pennies between the two sticks. Position them just behind the rubber band.
- d** Press on the open ends to open the beak.

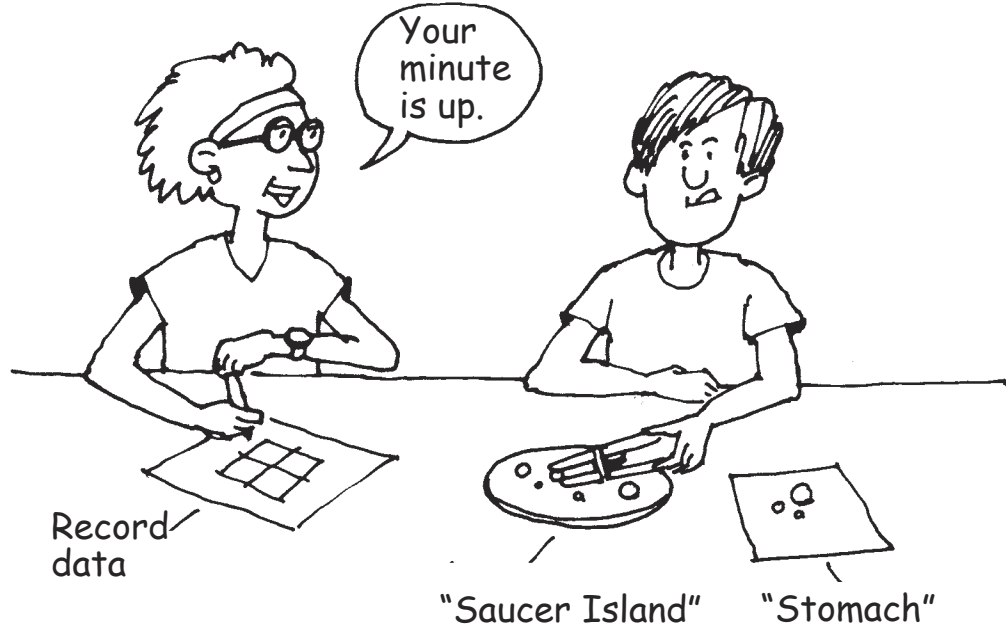




### 3 Beak Testing: A Normal Year

In this test your finch stays alive by gathering seeds on the “island” and collecting them in your “stomach.” You will have one minute to gather up as much food as you can.

- a** Decide who will use the big beak and who will use the small beak. Write each name on the Battle of the Beaks: Normal Year Chart.
- b** Before you start, predict which beak will be the better tool for gathering seeds:
- c** In a normal year, there is a mix of large and small seeds. Prepare a seed supply for a normal year grabbing an equal pile of large and small seeds then scattering them on the island (the paper plate). Each beak needs a sheet of paper to act as a stomach for its seeds.
- d** Grab a few seeds and practice with your beak.
- e** Decide who will be the timer and who will be the beak tester.
- f** Ready to test? When the timer says go the tester will have one minute to use the beak to put as many seeds as possible in the stomach.
- g** When the minute is up, count the seeds that you gathered. Record the performance for your beak on the Battle of the Beaks: Normal Year Chart. Repeat the exercise for test #2.



**Battle of the Beaks: Normal Year Chart**

Beak Type	Normal Year (A Mix of Seeds)	
<b>Small Beak</b> Name of tester:	Test # 1	
	Test # 2	
	Total	
<b>Big Beak</b> Name of tester:	Test # 1	
	Test # 2	
	Total	

- h** Switch places and have your partner complete Test 1 and Test 2 for the other beak size.
- i** Add up the totals and record them on the Battle of the Beaks: Normal Year Chart. Which beak size gathered the most seeds?

## 4 Beak Testing: A Drought Year

One year no rain came to the island. Many plants failed to bloom and produce new seeds. All the medium ground finches ate the small, soft seeds first, leaving mostly large, tough seeds, so now big seeds dominate the menu.

- a** Prepare a seed supply for a drought year by leaving mostly large seeds and only two or three small seeds on the island.
- b** Repeat the steps you did for the Normal Year. You and your partner should complete Test 3 and 4 for both beak sizes. Record your data under Battle of the Beaks: Drought Year Chart.

### Battle of the Beaks: Drought Year Chart

Beak Type	Drought Year ( Mostly big, tough seeds)	
<b>Small Beak</b> Name of tester:	Test # 3	
	Test # 4	
	Total	
<b>Big Beak</b> Name of tester:	Test # 3	
	Test # 4	
	Total	

- c** Add up the totals and record them on the Drought Year Chart. Which beak size gathered the most seeds?

## 5 Review the Data

- a** Which beak size gathered the most seeds in a normal year?
  
- b** Which beak size gathered the most seeds in a drought year?
  
- c** Review your prediction under 3b (page 137) (Beak Testing: A Normal Year). Was your prediction correct or not?
  
- d** How does a change in environment (drought) affect which beak size gathers the most seeds?

## 6 Consider This

“Natural selection” occurs when the environment favors or selects some variations over others. You have tested two variations of beaks, large and small. In the drought environment, which beak variation is favored? Why?

## PART THREE

# Survival on Daphne Major

The scientists on Daphne Major observe everything on the island, and they keep a careful record of their data. In 1977 and 1978 they recorded a spell of over 500 days in which no rain fell. During this extremely dry period, many plants failed to produce seeds.

Investigate some measurements from the scientists' field notes. Turn their data into graphs to get a picture of what happened to the food supply and the finch population after the drought.

## Work with a partner

Each team will need:

- Seed Abundance Graph
- Finch Population Graph

### 1 Tracking the Seed Supply

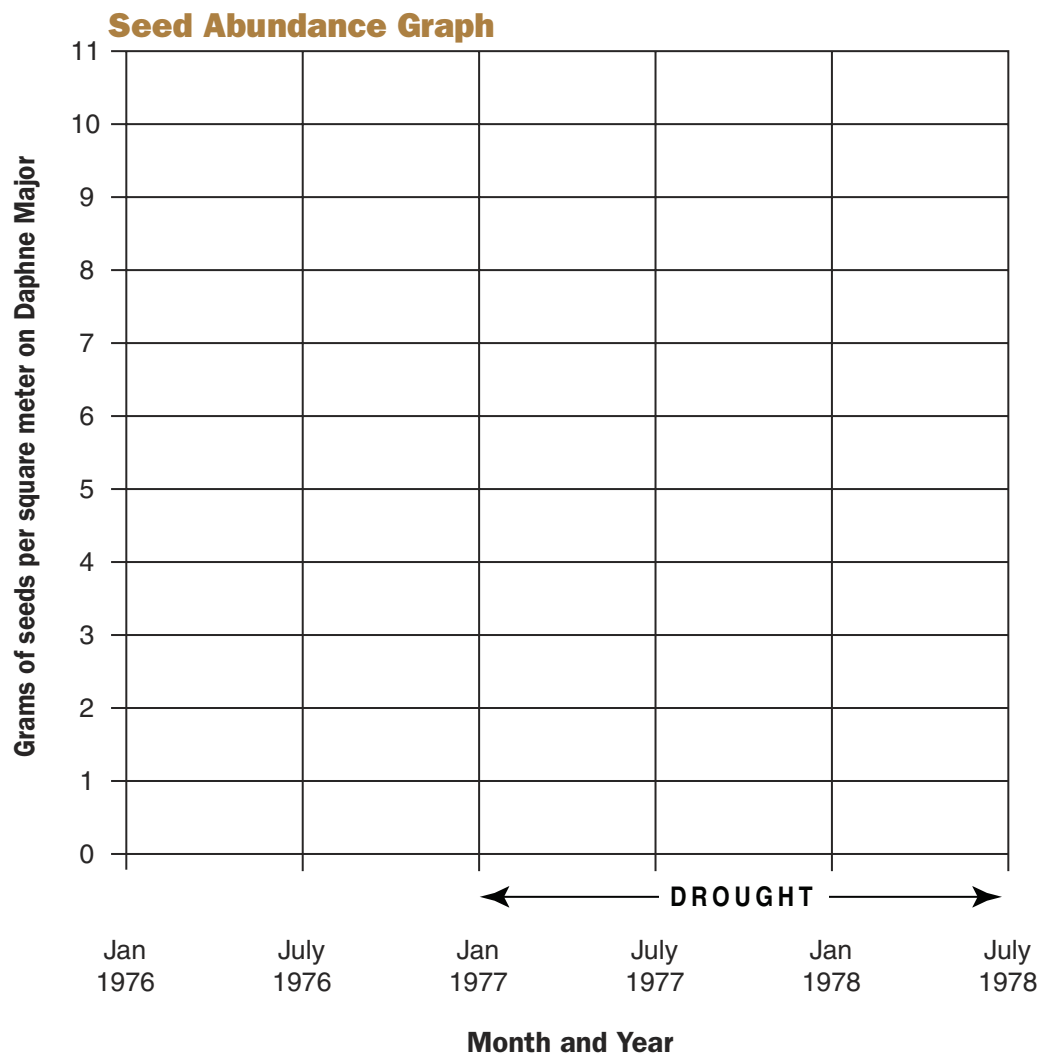
The observers on Daphne Major tracked seed abundance by first measuring a square meter area of ground and then sifting through the soil to count every seed.

This was done at many different places to get an accurate count. They repeated the count every six months. Here are their data:

#### Field notebook seed count (measured in grams per square meter)

January 1976	<b>7.5</b>	January 1977	<b>8.0</b>	January 1978	<b>2.0</b>
July 1976	<b>10.5</b>	July 1977	<b>5.5</b>	July 1978	<b>3.5</b>

- Using the entries from the field notes, enter the data as a dot on the graph for each date. Connect the dots to complete the graph.
- Review the Seed Abundance Graph. During what month and year did the seed supply shrink to its lowest amount?
- During what month and year was the seed supply most abundant?

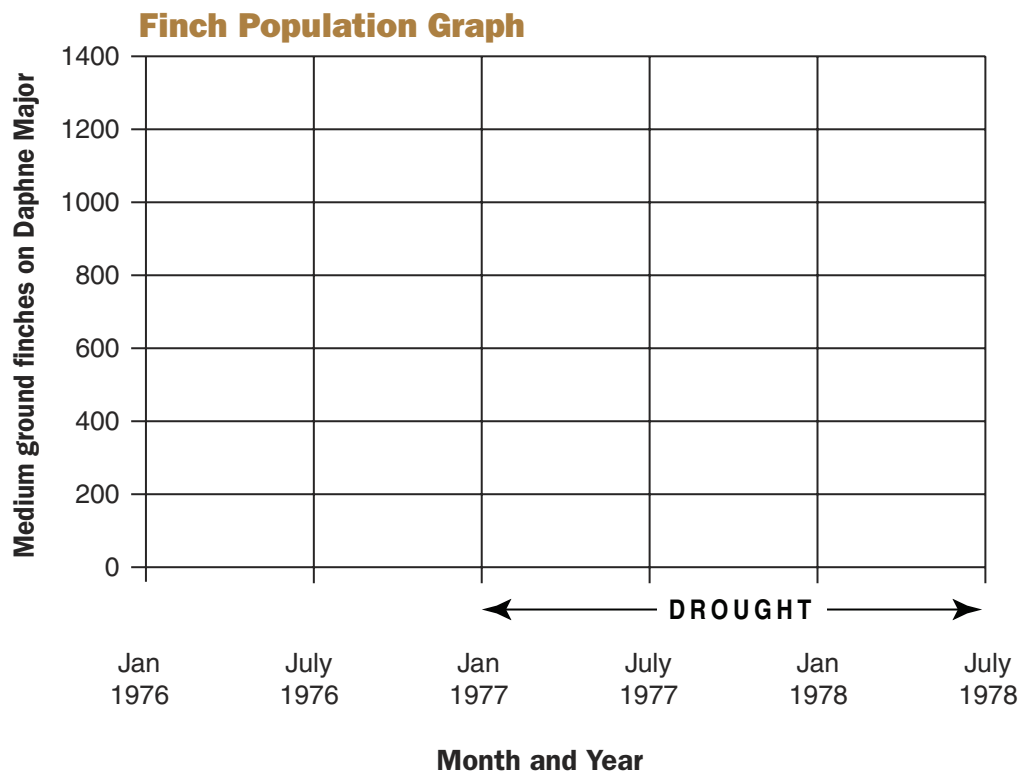


## 2 Counting the Finch Population

The finches were counted every six months. Here are the data for the same period of time as the seeds were measured.

### Field notebook finch count:

January 1976	<b>1100</b>	January 1977	<b>850</b>	January 1978	<b>200</b>
July 1976	<b>1400</b>	July 1977	<b>400</b>	July 1978	<b>357</b>



- Using the entries from the field notes, enter the data as a dot on the graph for each date. Connect the dots to complete the graph.
- Review the Finch Population Graph. When was the finch population the lowest?
- When was the finch population the highest?

### 3 Think About Seeds and Finches Together

Compare the graphs side by side.

- a What happened to the finch population when the seed supply shrank to its lowest amount? How do you account for this?
  
- b When the seed supply increased, what happened to the finches? How do you account for this?

### 4 Bigger Beaks, But Why?

When the team returned to Daphne Major, they found only one in seven finches survived the drought. When they measured the survivors, they found that most were finches with big beaks. Why do you think bigger-beaked birds survived better than the smaller-beaked birds?

### 5 Consider This

Beak size is a variation that is passed from parents to offspring. When the new generation of young finches was measured in 1978, there were many more young birds with larger beaks. What happened?



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## PART FOUR

# Be a science reporter

Write a short news story about the medium ground finches on the island of Daphne Major. Tell your readers about how the drought of 1977 led to changes in the characteristics of the finch population there. Based on what you have learned, explain why you think the finch population in the next generation had larger beaks after the drought.

**P.S.** Don't forget the headline.

