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Michael Comet, New York

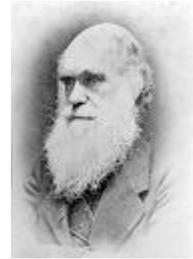
“What’s the Score?”

Using a Virtual Point System for the Beaks of Finches Activity

(A Modification of the NYSED Laboratory Activity #3: The Beaks of Finches)

*“It is not the strongest of the species
that survives, nor the most intelligent
that survives. It is the one that is the
most adaptable to change.”*

Charles Darwin



ABSTRACT

Students will simulate an activity in natural selection, survivability, and biological fitness by determining which beaks, represented by different tools, are most well-adapted for picking up seeds that will give the bird a numerical score that allows them to survive under a variety of conditions. Each tool will be randomly assigned, just as the forces of nature and evolution dictate. The food source will have high value seeds that are difficult to eat and low value seeds that are easy to obtain. Those birds that obtain a high enough score will survive and participate in increased competition and those who do not will have their genetic traits perpetuated on a different island where they will either survive or perish to the whims of evolution.

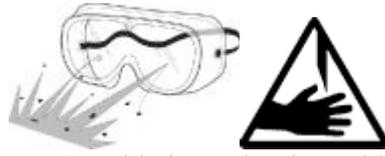
Purpose: The purpose of this laboratory investigation is to:

- learn and demonstrate how different physiological characteristics, specifically beak structure, affect the survivability of a species.
- simulate feeding with no competition, feeding with mild competition, and feeding with a high level of competition and demonstrate the effect on survivability of a species.
- more adequately understand that there is a selecting pressure exerted on a species with regard to food source availability.
- reinforce that evolution acts on populations not on an individuals within their lifetime.
- demonstrate that if a species fails to obtain the necessary food it will be removed from the gene pool and not reproduce as result.
- appropriately introduce the terms variation, competition, struggle for survival, adaptation, environment, and selecting agent as they applied to the Galapagos Finches that Darwin studied so diligently.

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Laboratory Safety Precautions: The following symbols represent the precautions that are required for this lab:



NYS Learning Standards Addressed: This investigation addresses the following MST Learning Standards. Biology: Living Environment Core Curriculum: Std. 4, Key Idea 3: 3.1f, 3.1g, 3.1h; lab Process Skills v, x, xiv, xv, xvi, and xvii

Materials: The following materials are needed to perform this investigation:

Square baking sheet (with edges)	Petri Dishes
20 ounce bag of bean soup mix	Chopsticks (pair)
Binder Clip	Clothespin
Forceps	Pliers
Laboratory tongs	Other tools (as per your teacher)
Dice (tool selection)	Pen or pencil
Calculator	

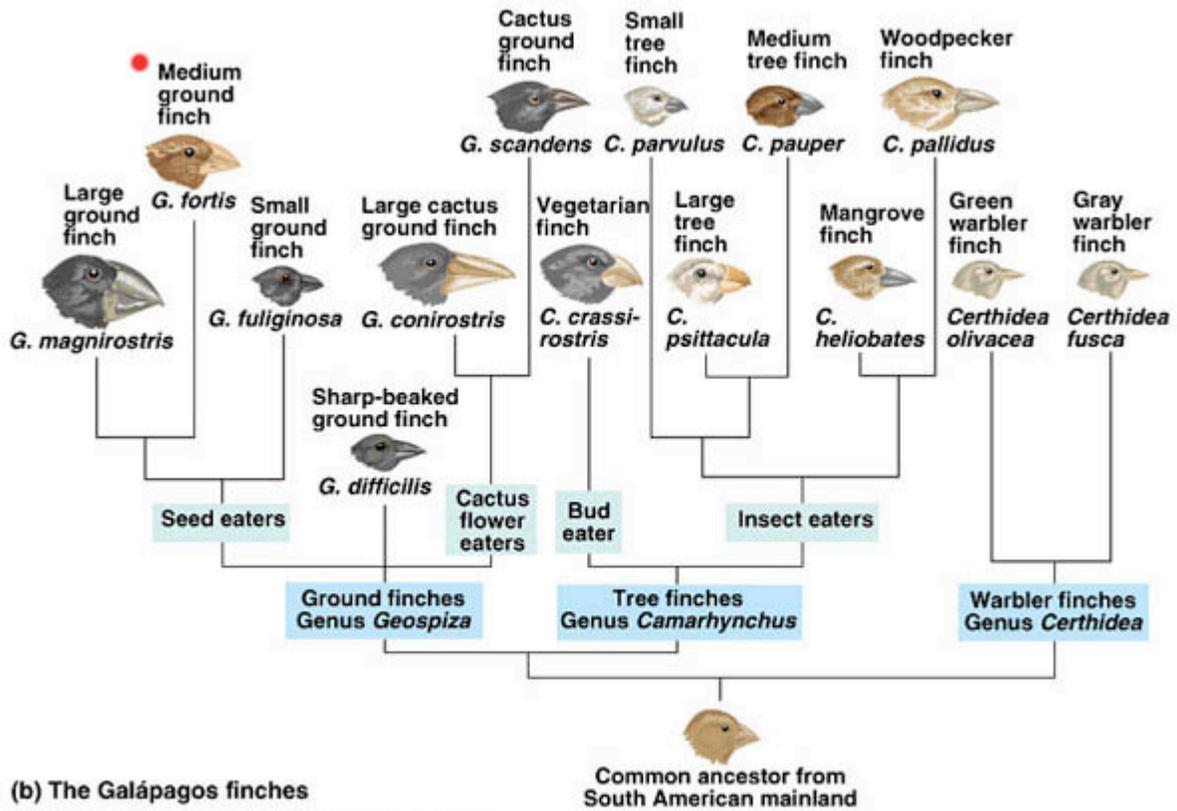
Time Required: This activity requires approximately 80 minutes of laboratory time to complete, but may require more time should results necessitate.

Background Information: The following information will prove useful as you conduct this laboratory investigation and answer the required questions:

1. Darwin identified fourteen different finches and their characteristic beaks and inferred relationships of each based upon their feeding style and nutritional requirements.
2. Darwin's Finches of the Galapagos were:
 - i) Large Ground-finch , (*Geospiza magnirostris*)
 - ii) Medium Ground-finch (*Geospiza fortis*)
 - iii) Small Ground-finch (*Geospiza fuliginosa*)
 - iv) Sharp-beaked Ground-finch (*Geospiza difficilis difficilis*, *Geospiza difficilis debilirostris*, *Geospiza difficilis septentrionalis*)
 - v) Common Cactus-finch (*Geospiza scandens scandens*, *Geospiza scandens intermedius*, *Geospiza scandens abingdoni*, *Geospiza scandens rothschildi*)
 - vi) Large Cactus-finch (*Geospiza conirostris*, *Geospiza conirostris propinqua*, *Geospiza conirostris darwini*)
 - vii) Vegetarian Finch (*Camarhynchus [Platyspiza] crassirostris*)
 - viii) Large Tree Finch (*Camarhynchus psittacula psittacula*, *Camarhynchus psittacula habeli*, *Camarhynchus psittacula affinis*)
 - ix) Medium Tree Finch (*Camarhynchus pauper*)
 - x) Small Tree Finch (*Camarhynchus parvulus*, *Camarhynchus parvulus salvini*)

- xi) Woodpecker Finch (*Camarhynchus pallidus pallidus*, *Camarhynchus pallidus productus*, *Camarhynchus pallidus striatipectus*)
- xii) Mangrove Finch – (*Camarhynchus heliobates*)
- viii) Warbler Finch - (*Certhidea olivacea* - eight subspecies – *becki*, *mentalis*, *fusca*, *olivacea*, *bifasciata*, *luteola*, *cinarens*, *ridgwayi*)
- xv) Cocos Island Finch - (*Pinaroloxias inornata*)

3. Several diagrams are available that will help to answer the questions at the end of this laboratory. However, the most “classical” image of relationships is shown below.



Procedure: The following procedure is used to perform this investigation:

Initial Requirement

1. Each time needs to be “assigned” a beak. Roll a single die to determine what kind of “beak” you will have. Use the chart below to determine which beak you will receive.

<u>Roll of</u>	<u>Beak to use</u>
1	Chopsticks
2	Clothespin

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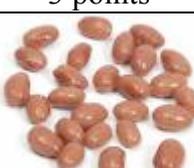
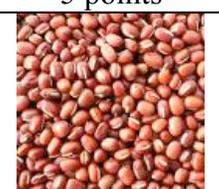
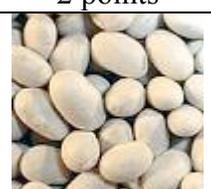
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- 3 Pliers
- 4 Binder clip
- 5 Laboratory tongs
- 6 Forceps

My group will use a _____ as our beak.

Bean Description/Feeding & Scoring Chart

This diagram represents the possible bean types you may encounter on your “island”. You may see some of these and not others. Make certain you are scoring correctly by determining the type of beans that you have eaten. After each round, separate the beans by variety and determine your score. Broken or crushed seeds or pebbles will reduce your score by the point value of the damaged seed. Return ALL beans and pebbles to the feeding area as directed in the lab. Seed “point” values are determined by the size of the whole seed.

				
Northern beans	Pinto beans	Lima beans	Blackeye beans	Garbanzo beans
1 point	2 points	1 point	3 points	1 point
				
Baby lima beans	Green Split peas	Red Kidney beans	Cranberry beans	Small white beans
3 points	5 points	2 points	3 points	2 points
				
Small Pink beans	Small red beans	Yellow Split Peas	Lentil (red or green)	Navy bean
4 points	4 points	5 points	5 points	2 points

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White Kidney bean	Black bean	Pearl barley	Whole dried pea	Pebbles/stones
2 points	4 points	5 points	1 point	- 1 point

Round A – Feeding with No Competition for Resource

1. You and your partner will have 4 trials of 30 seconds each to try and “eat” enough seeds to survive. After performing the 4 trials, you need to calculate your average “feeding score”. Use the attached chart to determine the value of the seeds.
2. Each partner will take turns as either the timer or the bird. After each trial record the total of each type of seed and calculate the total points scored to determine if you have survived that round.
3. If you survive, you will “move on” to the next round where you will compete with one other bird in the same sized feeding area.
4. If you do not survive, consider yourself lucky that you have laid eggs on a neighboring island that has larger seeds predominantly. Your newly hatched chicks will learn to eat there (even though you are not there to watch them). Record their results in Round B.
5. If you are the offspring of those that were unsuccessful in Round A, you will be competing against others who were unsuccessful (or your partner if necessary) for seeds in Round B-2 – Consolation Round.

Round B-1 – Feeding with Mild Competition for Resource

1. You and your partner will have 4 trials of 30 seconds each to try and “eat” enough seeds to survive. After performing the 4 trials, you need to calculate your average “feeding score”. You will compete against one other bird, whose beak style is the same as before. This “competition” will necessitate one of two things: compete and defend the seeds aggressively, but eat less OR compete much less and cooperate and eat more seeds. Use the attached chart to determine the value of the seeds.
2. Each partner will take turns as either the timer or the bird. After each trial record the total of each type of seed and calculate the total points scored to determine if you have survived that round.
3. If you survive, you will “move on” to the next round where you will compete with many other birds in the same sized feeding area.
4. If you do not survive, you will not move on as you have starved. You are essentially taken out of the gene pool. You will become “helper birds” that will assist the rest of the class in their clean up and calculations.

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5. Round B-2: If your parents were unsuccessful in Round A, you will be competing in a “Consolation Round” at this point and trying to make it back into the population to compete in Round C. Record your results appropriately.

Round C – Feeding with Intense Competition for Resource

1. You and your partner will have 4 trials of 30 seconds each to try and “eat” enough seeds to survive. After performing the 4 trials, you need to calculate your average “feeding score”. Use the attached chart to determine the value of the seeds.
2. You will compete against several other birds, whose beak style is the same as before. This “competition” will necessitate one of two things: compete and defend the seeds aggressively, but eat less OR compete much less and cooperate and eat more seeds.
3. Each partner will take turns as either the timer or the bird. After each trial record the total of each type of seed and calculate the total points scored to determine if you have survived that round.
4. If you survive, you will survive the rigors of evolution as a well-adapted bird.

Data: The following data was recorded during this investigation:

Round A – Feeding with No Competition for Resource

Trial #	1 point	2 point	3 point	4 point	5 point	TOTAL
1						
2						
3						
4						

Average total = _____

<p>SURVIVE</p> <p>(If so, move on to Round B and skip the question below.)</p>	<p>DID NOT SURVIVE</p> <p>(If not, you are now out of the gene pool, but your newly hatched chicks may have a chance. They will compete in Round B-2 – the consolation round.)</p>
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Why did you not survive? What could you do to improve your “fitness” and survive if you were to perform these trials again?

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Part B – Feeding with Mild Competition for Resource

Explain how you got to this round. _____
(Successful in previous round? Consolation round? Etc...)

Trial #	1 point	2 point	3 point	4 point	5 point	TOTAL
1						
2						
3						
4						

Average total = _____

SURVIVE (if so, move on to Round B)	DID NOT SURVIVE (If not, you are now out of the gene pool.)
--	--

Mark each of the following rounds a “NOT SURVIVE” and Explain why you did not complete those rounds.

Part B-2 – Consolation Round

Explain how you got to this round. _____
(Successful in previous round? Consolation round? Etc...)

Trial #	1 point	2 point	3 point	4 point	5 point	TOTAL
1						
2						

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3						
4						

Average total = _____

SURVIVE (if so, move on to Round B)	DID NOT SURVIVE (If not, your species is now entirely out of the gene pool.)
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Why did you not survive? What could you do to improve your “fitness” and survive if you were to perform these trials again?

Part C – Feeding with Intense Competition for Resource

Explain how you got to this round. _____
 (Successful in previous round? Consolation round? Etc...)

Trial #	1 point	2 point	3 point	4 point	5 point	TOTAL
1						
2						
3						
4						

Average total = _____

Circle one of the following.

SURVIVE (if so, move on to Round B)	DID NOT SURVIVE (If not, you are now out of the gene pool.)
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Mark each of the following rounds a “NOT SURVIVE” and Explain why you did not complete those rounds.

Why did you not survive? What could you do to improve your “fitness” and survive if you were to perform these trials again?

Questions: Answer the following questions regarding this investigation in the space provided.

1. Define the following terms AS THEY PERTAIN TO THIS EXPERIENCE.

- a. variation

- b. competition-

- c. struggle for survival-

- d. adaptation-

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e. environment-

f. selecting agent-

g. evolution-

h. survival of the fittest-

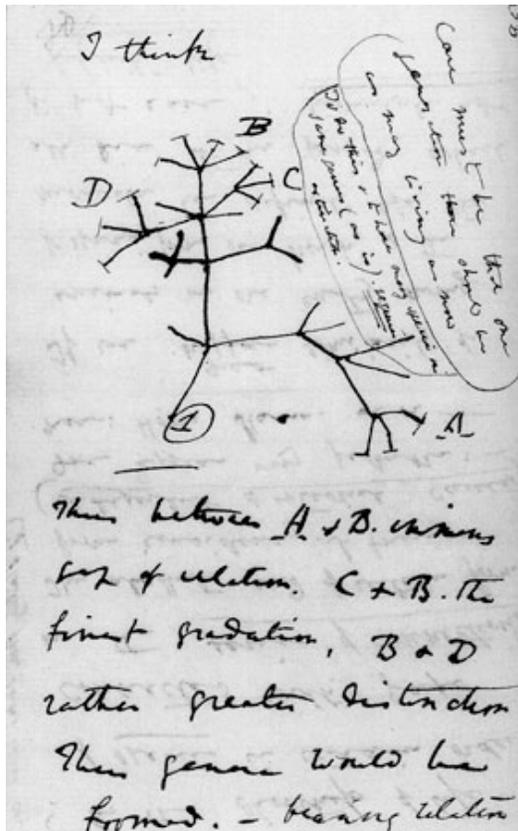
i. common ancestry-

j. variation

2. This is a page from Darwin's many notebooks over the years. Why did he write simply "I think" at the top of this page? What does this diagram represent? Be specific about what exactly Darwin was trying to demonstrate.

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Note: Questions 1, 2, and 3 are requirements as put forth in the NYSED Beaks of Finches laboratory and are not the work of this author.

1. What characteristics of your “beak” interfered with your feeding success on the original island?
2. Name three traits other than beak characteristics that could contribute to the ability of a finch [species] to compete successfully.
3. It is very unlikely that all the beaks within a species of finch are exactly alike. Random mutations and new gene combinations resulting from sexual reproduction are the source of beak variations. Describe at least three beak variations that could randomly appear to further improve your species’ chance of survival when feeding on small seeds.

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4. Why did the chicks that survived from those that were eliminated in Round A prove to be successful on the neighboring island when their parents were not?

5. Why did some species fail to survive Round A? In Round B? In Round C?

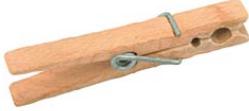
6. Why were pebbles given a negative point value? Why were seeds that were broken given a negative point value?

7. Compare each of the “tools/beaks”. What specific species do you believe is represented by each of the beaks? Include their genus and species in the table provided below.

Tool	Possible species represented
Chopsticks 	
Binder Clip 	
Clothespin	

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Forceps 	
Laboratory tongs 	
Pliers 	

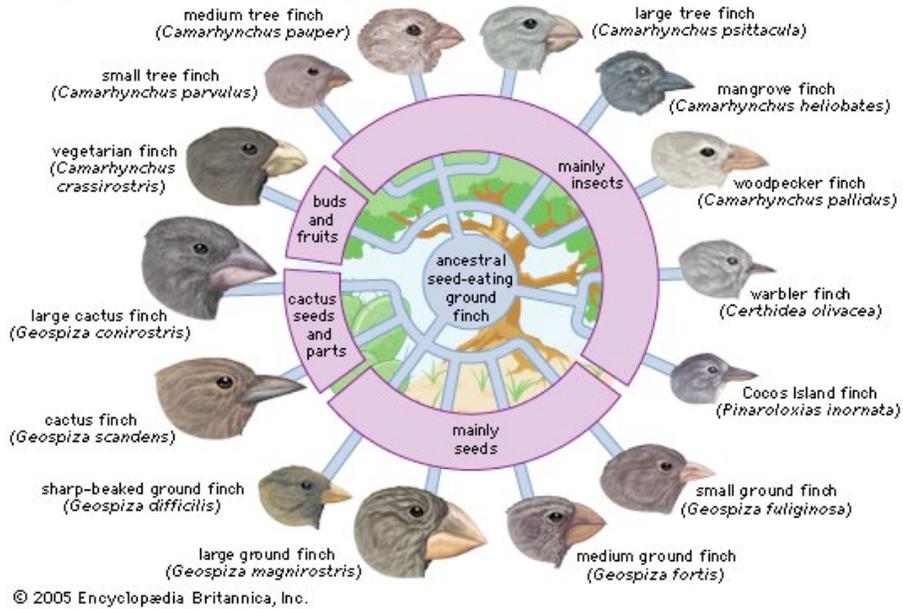
Extended Activity: Complete this activity in the space provided.

Complete this extended activity designed to help you to better understand the feeding behaviors/beak structures of the Galapagos (Darwin's) Finches. Using small circles, draw a Venn Diagram which shows the food preferences of the Galapagos Finches in the space provided below. Make sure to include the Genus and species names as well as their food preference and interlink the finches that share characteristics.

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Adaptive radiation in Galapagos finches



Bibliography of Images and Information Used

1. Charles Darwin image:
http://bbsnews.net/bbsn_images_2005_summer/undated_charles_darwin.jpg
2. Charles Darwin Signature image:
<http://www.plantexplorers.com/explorers/biographies/darwin/darwin-signature.gif>
3. Eyewear Symbol: <http://www.utexas.edu/cons/safety/equipment/eyewear.html>

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4. Sharp Instrument Safety Symbol:

<http://www.beckman.com/customersupport/images/sharpobj.gif>

5. Darwin's Notebook Image:

http://www.amnh.org/exhibitions/darwin/images/exhibit/gallery/lg/darwin_tree_lg.jpg

6. Information on species of Ground Finches:

<http://www.surfbirds.com/Features/darwinfinches/mediumgrfinch.html>

7. Darwin's Finches tree Diagram:

<http://fig.cox.miami.edu/~cmallery/150/unity/c1x17b-finches.jpg>

8. Galapagos Finches Wheel Chart

http://www.greenclub.bc.ca/Green_Club_Activity/GVRD_Parks_Events/Finches.jpg

9. Chopstick Image

<http://www.fukuoka-h.tym.ed.jp/en/04wp/5/33/4.png>

10. Binder clip image

<http://www.genesisartsupplies.com/alvin/images/2583.jpg>

11. Pliers image

<http://static.howstuffworks.com/gif/pliers-1.jpg>

12. Laboratory tongs

<http://www.2spi.com/catalog/tools/images/1266.jpg>

13. Clothespin image

<http://images.jupiterimages.com/common/detail/12/42/22844212.jpg>

14. Lab forceps image

<http://www.bio-world.com/images/200500.jpg>