



Natural Selection

How do traits change over time?

Version 2019

Please read before using this presentation

The following presentation is a result of a collaboration between teachers and researchers designed to support the implementation of the MBER-Biology curriculum—a student-centered sense-making classroom. You will notice there are two kinds of slides.

- (1) **Teacher Notes slides** that provide information and notes for teachers and are not meant to be shown to students. These slides are marked by the colored band in the header (as displayed above on this slide).
- (2) **Student slides** designed to facilitate student sense-making as you move through the Learning Segments and are intended for use in the classroom during instruction. In the “Presenter Notes” field you will find useful information for each particular slide.

We have combined teacher slides and student slides so you can have everything you need in one place as you explore the flow of each triangle. You will need to either hide (see note below) or delete the **Teacher Notes** slides to use it as a presentation in your classroom.

This presentation **is not meant to stand alone**, however. Instead we hope you use it in conjunction with the website. As you step through the slides, reference the table on the triangle webpage. The Learning Segments and associated resources outlined in the PowerPoint directly correspond to the Learning Segments described in the table featured on the webpage. Looking over the table as you preview the slides will help you stay oriented to the overall flow, track which resources go with the segment and access additional supports all while keeping in mind the high level goals of each learning segment and how the model is developed over the course of days.

We expect (and hope) you will modify this presentation keeping in mind the MBER philosophy. As a contributor you will be part of a community that helps improve the curriculum over time.

Thanks!

The MBER team



We use these symbols to communicate to students the following actions:



Think



Share

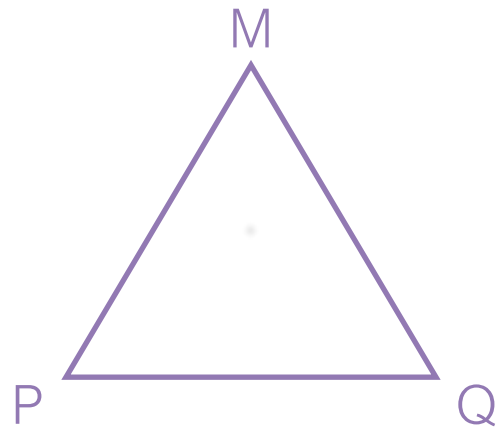


Write down



Work in research
groups

Triangle 2 Natural Selection Overview—NOT FOR STUDENTS



P: Traits change over time

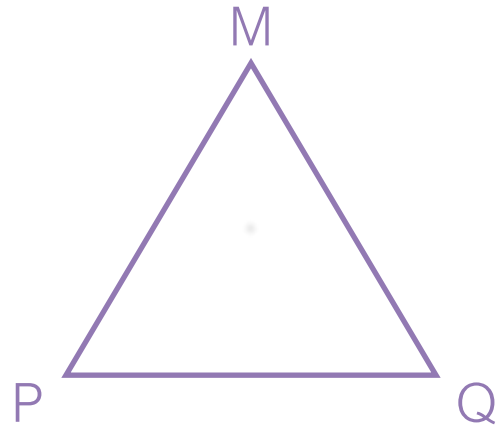
Q: How do traits change over time?

M: Natural selection model

In Unity & Diversity Part 1 (UD), students generated some ideas about the breadth of diversity of life on Earth and the remarkable similarities that we see across species. They also observed how biodiversity has changed over eons. In Population Dynamics (PD), students developed a model that begins to explain factors affecting population size.

In this triangle, natural selection (NS), students will begin to bring some of the ideas from UD and PD together to explain how traits change over time. Through observation and identification of a phenomenon—changes in traits across three unrelated species—and a data-driven activity focused on Galapagos Ground Finches, students will develop a model of natural selection that is similar to models synthesized by Charles Darwin and Ernst Mayr. They will then go on to apply and refine their model. Please refer to the website for a complete overview of all the learning segments in this triangle.

Triangle 2 Optional Set UP Activity—NOT FOR STUDENTS



P: Traits change over time

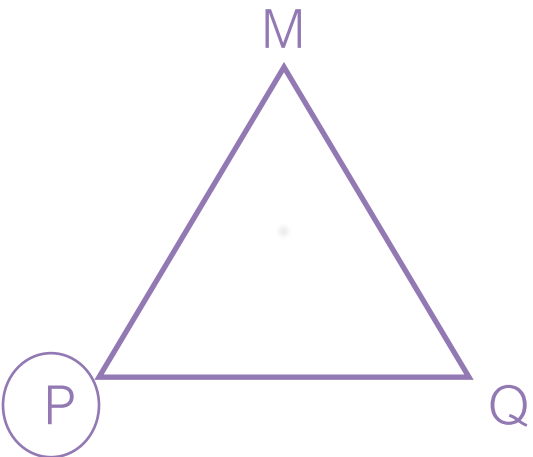
Q: How do traits change over time?

M: Natural selection model

A few days before the beginning of the unit ask students to observe birds in their community. Provide students with some ideas/questions about birds to support their observations. Such ideas/questions might include:

- What differences in abundance do you observe among species of birds?
- What types behaviors do you notice in different types of birds?
- Are different types of birds observed in of places, or are some types of birds found only in certain locations (i.e. trees, on the ground, in the underbrush, etc....)?
- Can you make out differences in feeding behavior between bird species?

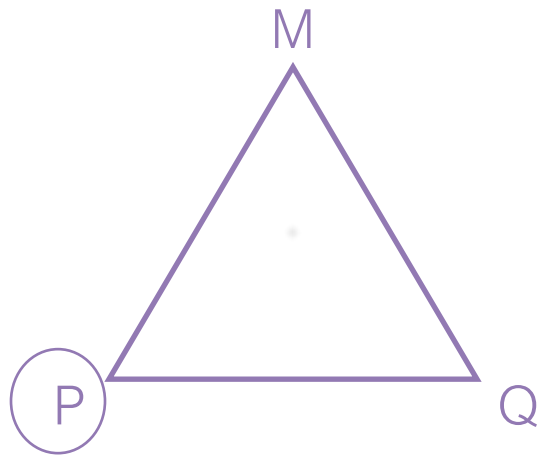
Have students record things they notice over a few days. As the NS unit starts engage in a class dialogue about what students noticed about birds. Ask some guiding questions that can serve to connect them back to the Population Dynamics (PD) unit and point them forward (or foreshadow) the NS unit content.



In learning segment 1, students will observe the **phenomenon** that **traits change over time**. The slides contain a brief overview of three stories of population change: one about changes in the frequency of certain colors variants in peppered moths over time, another about antibacterial resistance, and another about an increase in average beak depth in Galapagos Ground Finches (which students will return to in segment 3). The phenomenon in the three stories is change over time.

We encourage you to present the slides to the students without emphasizing what is happening or telling them what the phenomenon is that they are observing. The goal in this segment is for **students to observe and identify the phenomenon that will serve as a focus for their investigations and model development.**

Teacher Notes: Learning Segment 1



Resources:

NS Doodle sheet

What we've learned so far...

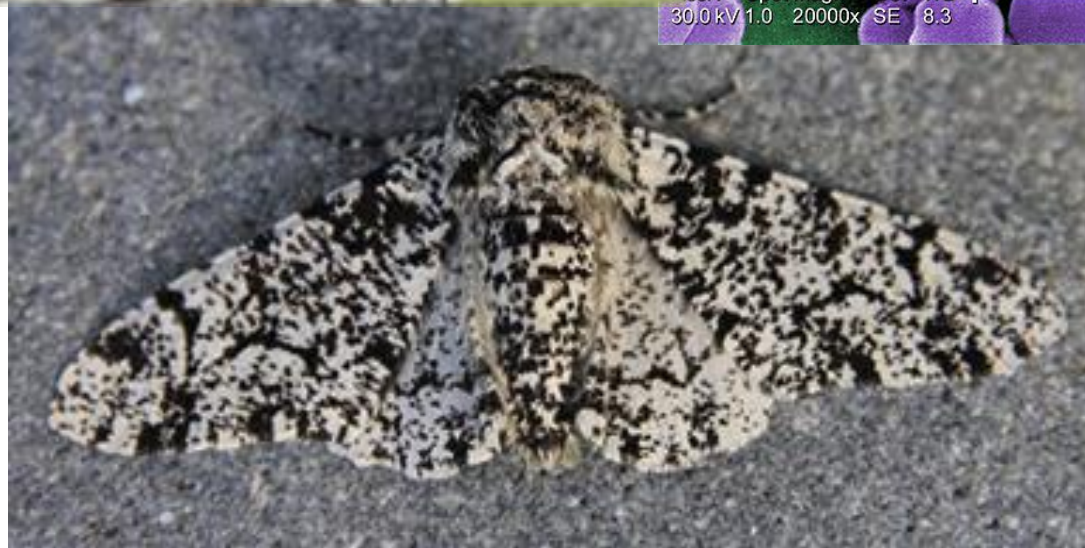
We began our exploration of biology by observing biodiversity and how it has changed over time.

Next, we observed that population sizes of some species have fluctuated and we figured out some causes for that.

Is it possible that these two ideas are connected? Can changes in population sizes play a role in species change?



Three interesting stories...



The Story of the Peppered Moth

1850



Mostly speckled, dark form is rare.

The Story of the Peppered Moth

1850



Mostly speckled, dark form is rare.

1900



Mostly dark, speckled form is rare.

The Story of the Peppered Moth

1850



Mostly speckled, dark form is rare.

1900



Mostly dark, speckled form is rare.

2000

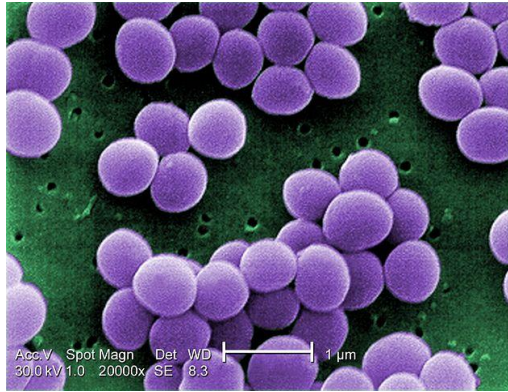


Mostly speckled, dark form is rare.

The Story of Bacteria

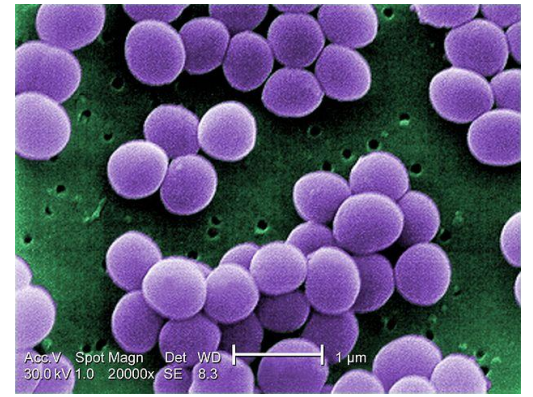
1880s

S. aureus was
first reported

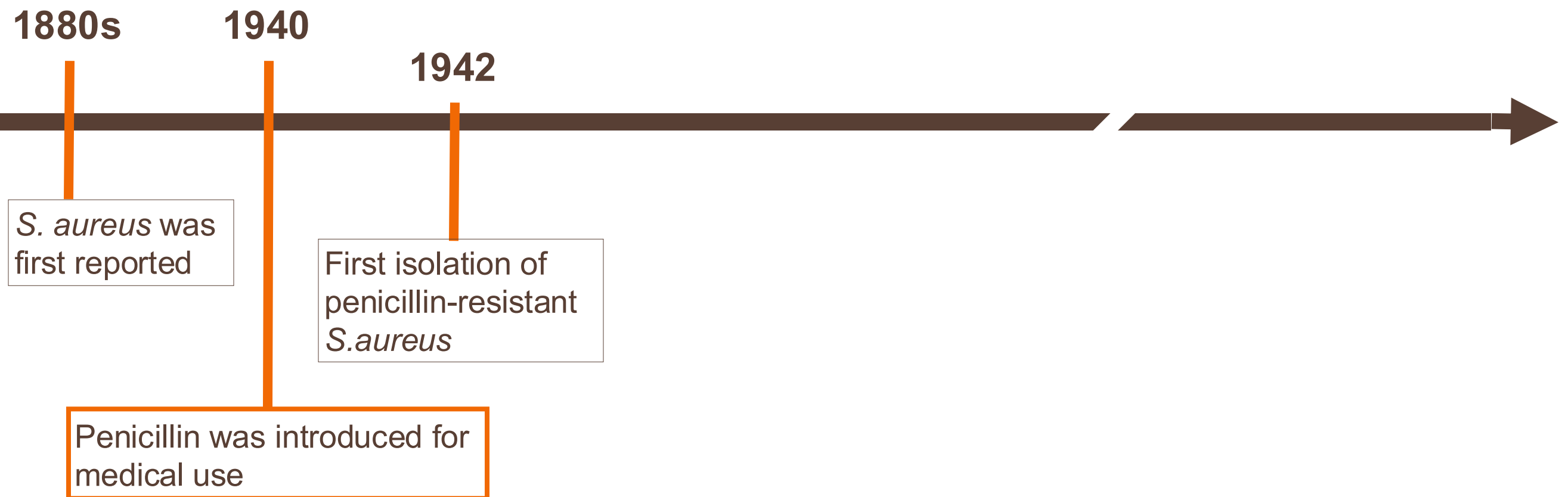
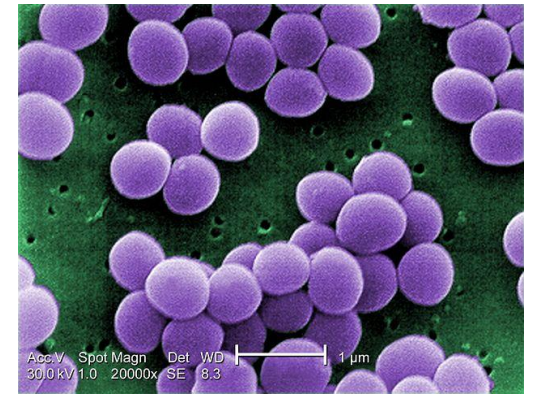


Staphylococcus aureus normally lives on our skin. It is usually harmless unless it enters our body through a wound or scrape. *S. aureus* can cause a range of illnesses from minor skin infections to life threatening pneumonia, meningitis and sepsis.

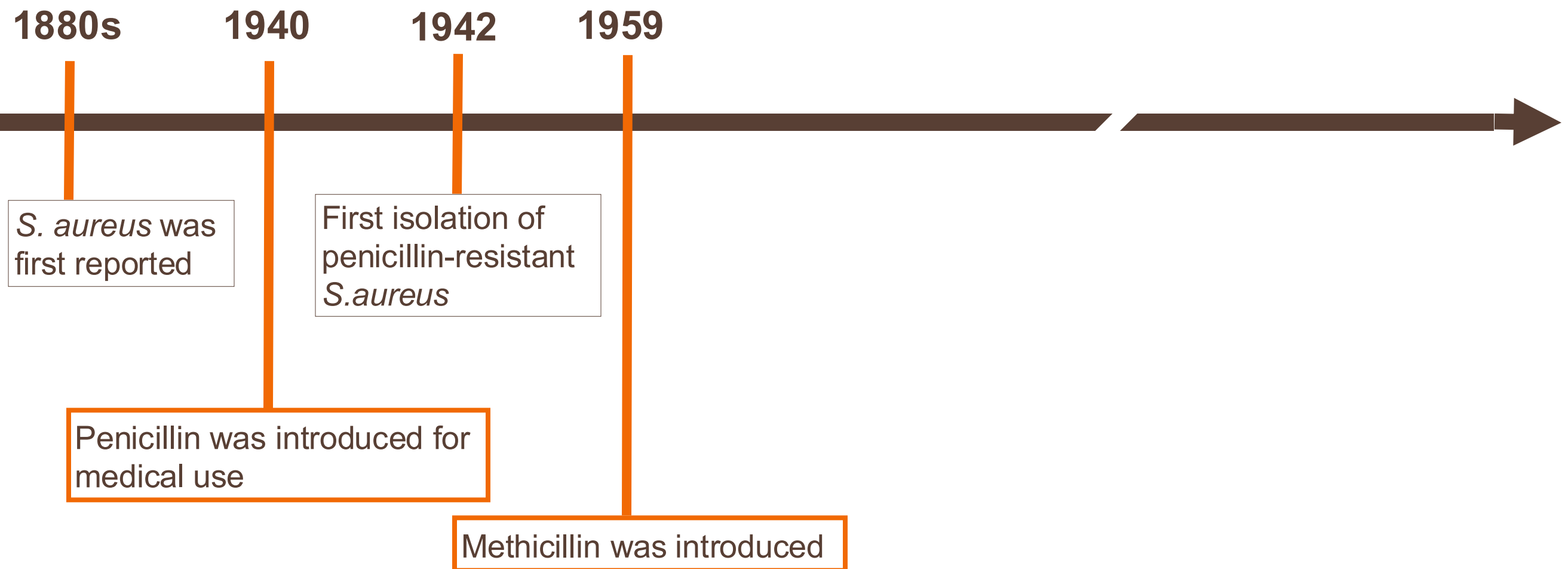
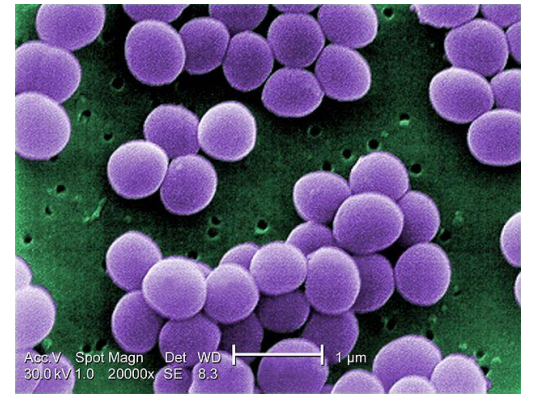
The Story of Bacteria



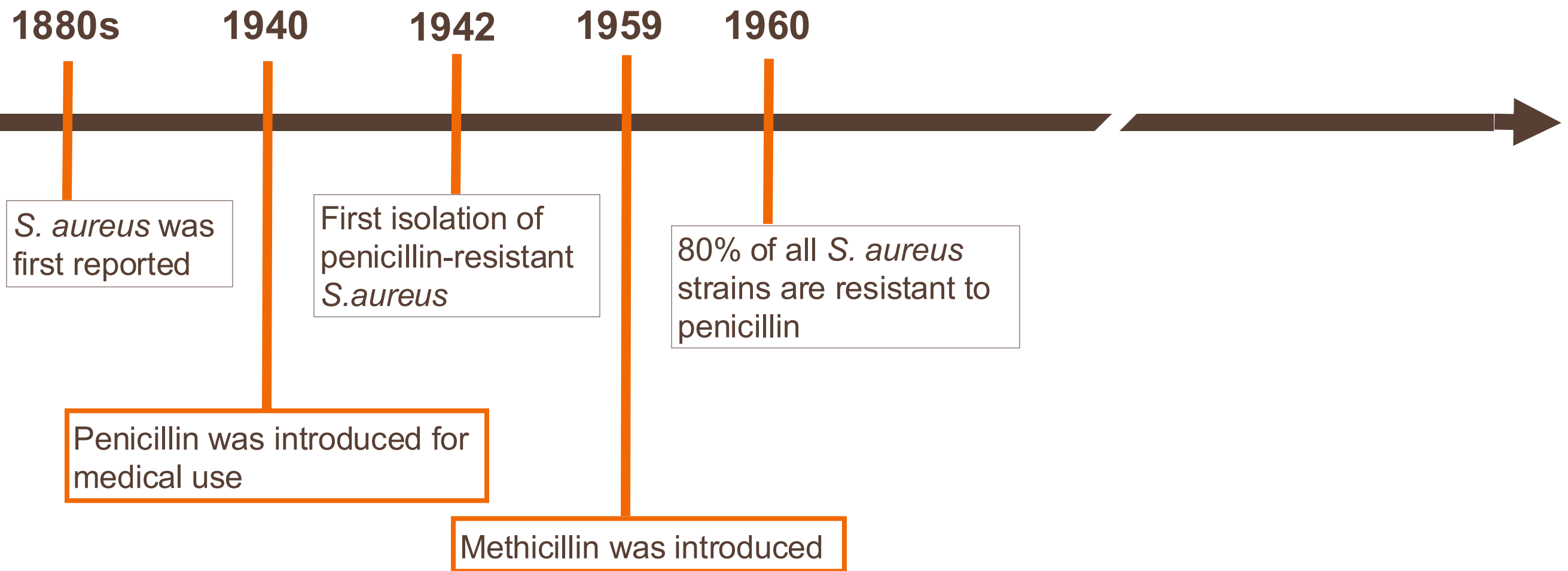
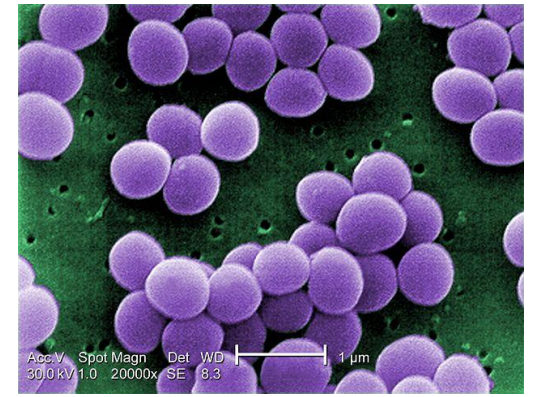
The Story of Bacteria



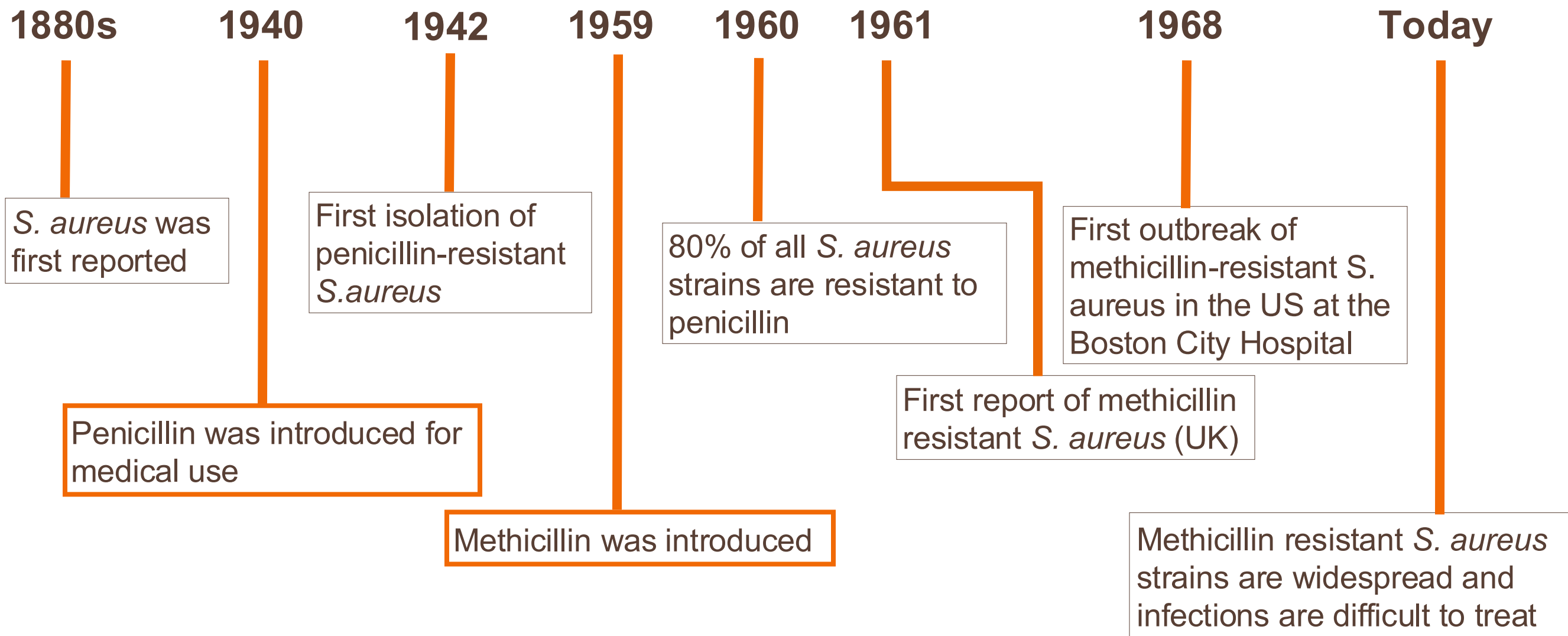
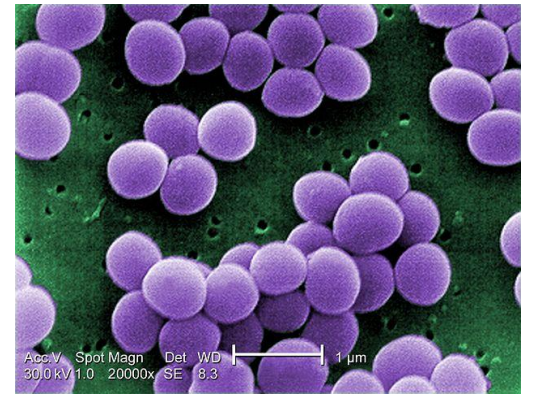
The Story of Bacteria



The Story of Bacteria



The Story of Bacteria

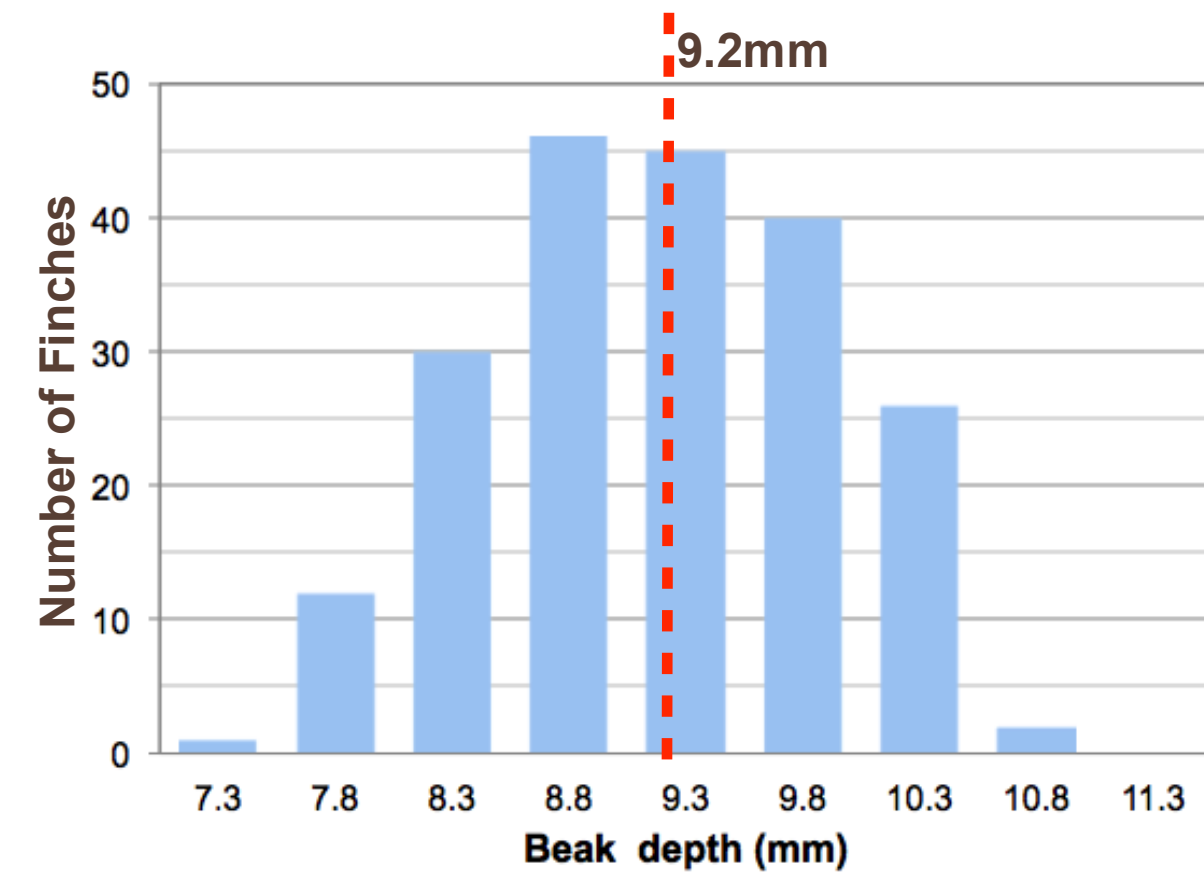


The Story of the Finches

Finches borne
1976



Beak depth average:
9.2mm



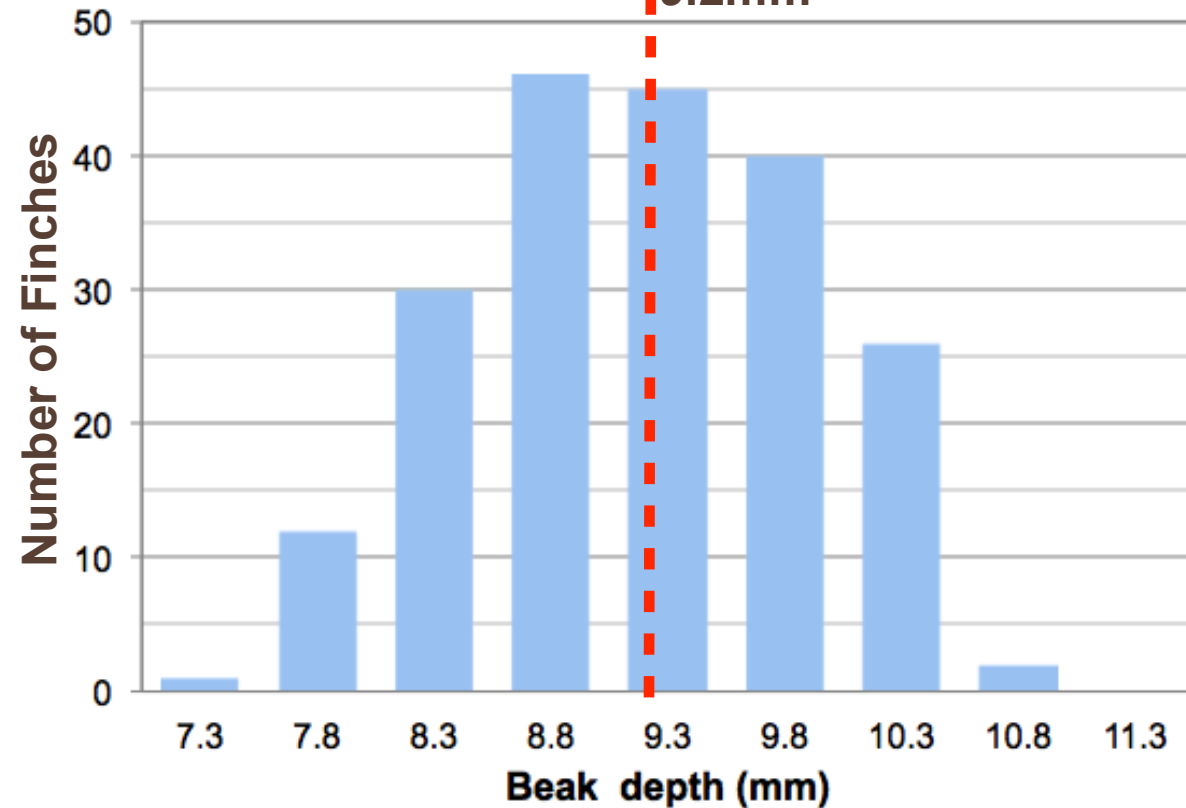
The Story of the Finches

Finches born
1976



Beak depth average:
9.2mm

9.2mm

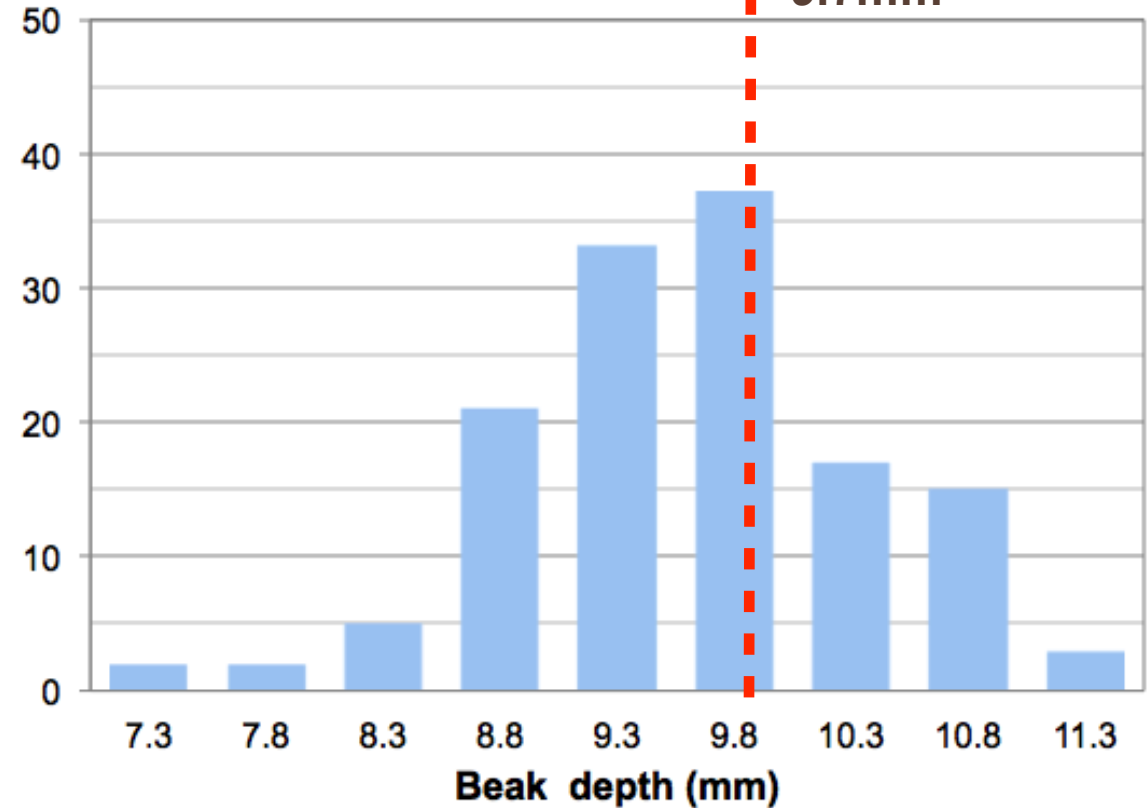


Finches born
1978

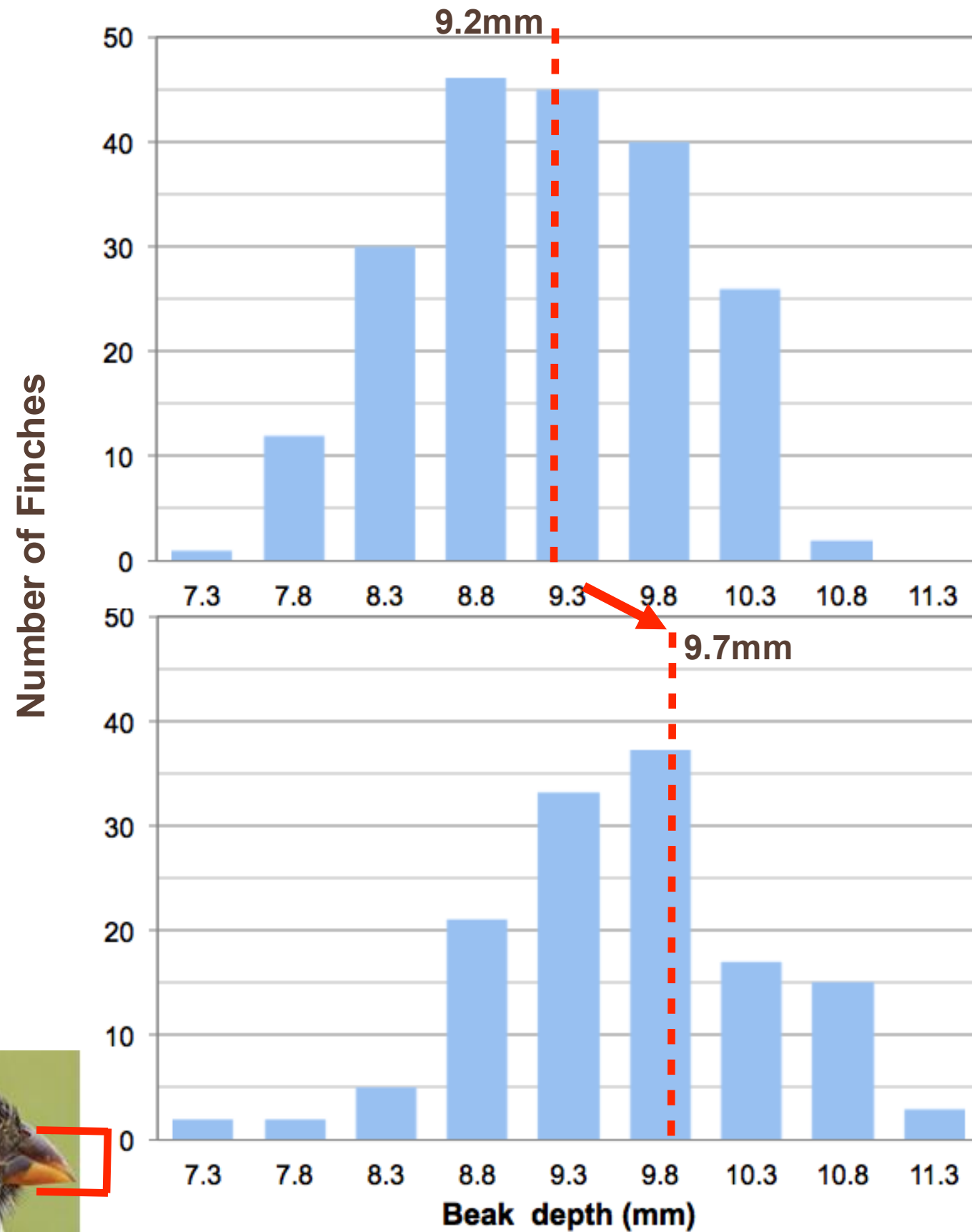


Beak depth average:
9.7mm

9.7mm



The Story of the Finches



Finches born
1976

Finches born
1978

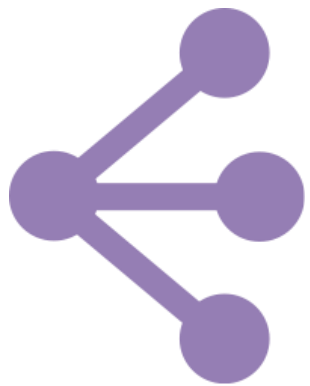


The Three Stories: What did you notice?

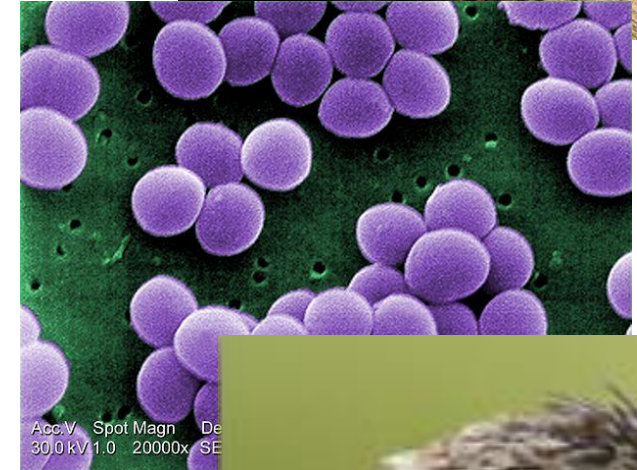
What do the three stories have in common?



Take a minute to write your thoughts down on your doodle sheet (Box A).



Share with a partner. Are there any similarities or differences in what you observed?



The Three Stories: What did you notice?

Class discussion: Share out some ideas from your partner conversation.

1.

The Three Stories vs. Geologic Time



How are the stories of species change different from the kind of change shown in the fossil record?



Discuss with your partner.

We just identified a naturally occurring
PHENOMENON

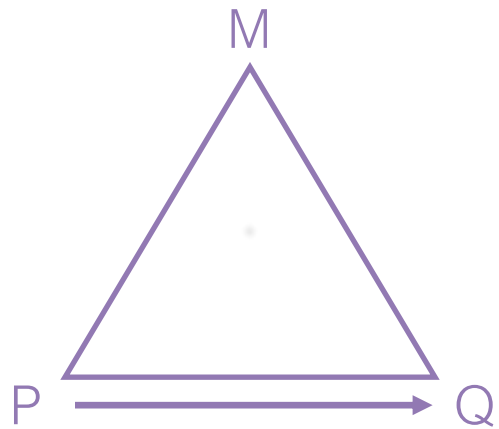


[insert your class wording for the phenomenon here]

Write the phenomenon in Box B of your doodle sheet 

What did we figure out in this learning segment?

We explored the idea of changes within a population over relatively short periods of time and identified this as a phenomenon that we want to try and explain. We generated a shared way to describe this phenomenon.



In learning segment 1, students listened to three stories and observed and identified the **phenomenon** that **traits change over time**. In this segment, students will have opportunities to generate some questions they have about their observations of the three stories. **The goal is for students to identify a question that allows them to explore the underlying mechanism causing the change in traits.**

The question can be similar to "how do traits/species/characteristics change over time?"

The final question should be posted somewhere in the classroom and written on the students' doodle sheet so that they have a constant reminder of what they are investigating.

Traits Change Over Time



What does this make you wonder about?
What questions do you have about the phenomenon?



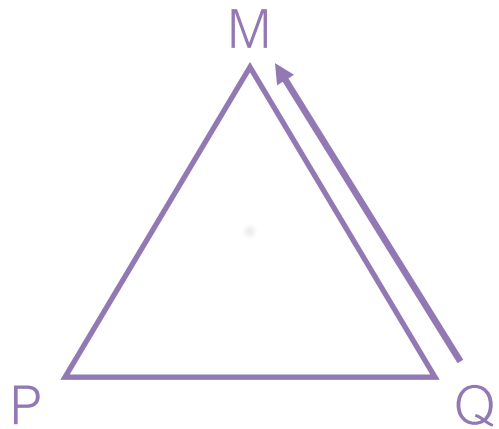
In box C on your doodle sheet, write down any questions you may have, and then share with a partner.

Questions about trait change over time:

- 1.

What did we figure out in this learning segment?

After examining the the phenomena in learning segment 1 we spent some time generating a question that will guide our work as we move through the triangle.



In learning segment 2 students identified a question about the phenomenon that they could explore. All students have ideas about what might be causing this sort of change, and this is a great opportunity to have students to begin to develop a model that can answer the question. In this segment, they generate an initial model that will continue to be revised as they proceed further into their investigations of the phenomena.

Giving students an opportunity to write down their initial models is helpful because it can serve to activate students' prior knowledge, and it gives them a set of ideas to build on as they proceed further into their investigations of the phenomena and generation of their model.

It also helps you to see their thinking so that you can draw it out and use it in the classroom.

What ideas do we have that might help us answer our question?

[place your class version of question here]



1. Write down any ideas you have that might help us to answer our question in box E on the doodle sheet.



2. Share your ideas with the class.

Our Initial Class Model:

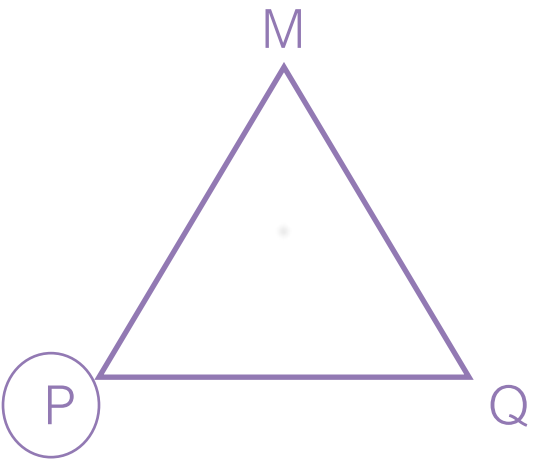
- 1.

What did we figure out in this learning segment?

We explored our initial ideas about how traits change in populations over time and put our ideas in writing so we can refer to them as we learn more.

Suggestion for Formative Assessment

- As students have completed learning segments 1, 2, and 3 as well as learned about some trait changes in populations (slide 32 in this PPT), there is an opportunity for a formative assessment at this time.
- Provide students with half sheets of paper and have them individually list what they consider to be the “Most Important Points” (MIPs) of the unit so far. You can conveniently do this as an “Exit Ticket” in the last 5 -10 minutes of a period.
- By skimming over what students have written you can assess the degree to which students are grasping important ideas in the development of a model of natural selection.
- Using a formative assessment of this sort also affords students the opportunity to do some informal writing (in preparation of formal writing to come).

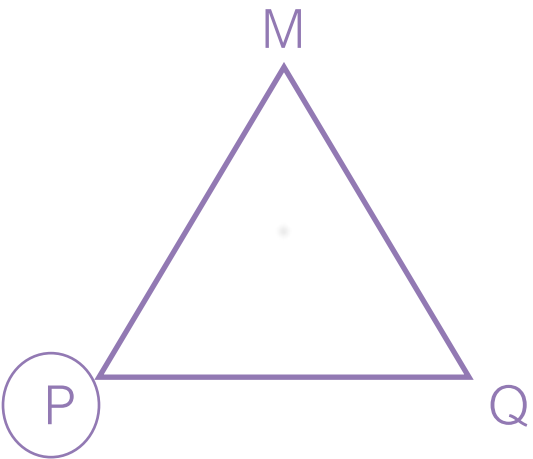


In learning segment 3, students generated an initial model that might help them to answer their question about the phenomena presented in learning segment 1. In this segment, they will build on or set aside these ideas by further exploring one phenomenon in depth. They do so by returning to the story of the Galapagos Ground Finches.

The goal of the finch investigation is for students to analyze and interpret a dataset that can help them to gather evidence and generate ideas that can explain why beak depth changed over time. The model will be made explicit in learning segment 5.

See **Teacher Notes for Finch Task** in resources for more detailed information about how to facilitate this learning segment.

Teacher Notes: Learning Segment 4



Resources for this learning segment include:

- Finches of the Galapagos reading
- Finch graphs (black/white or color)
- Finch activity teachers notes

Here we provide slides with the background information for the finch activity. If you decide to use these slides, allow students to read the background info beforehand.

We provide the slides for the graphs in case you decide to project them for discussion. Color and black & white slides for printing can be found under resources.

See Finch Activity Teachers Notes for more detailed information.

To refine our model and answer our question,
let's take a closer look at the finches.

Read the background information
about the finches.



We already noticed that the beaks
changed over time. What specific
question can we ask about the
finches that can help us answer our
big question?



Use one of the following reading strategies or use one you are more familiar with that works with your students

- **Paired Reading Protocol** in which students pair up (A and B). Partner A reads the first paragraph, partner B listens – then partner B summarizes the main point(s) of the paragraph. Switch roles for the next paragraph. Repeat until all paragraphs are read and processed.
- **Summary Protocol** – students form groups of 3 or 4. They all read the first paragraph silently to themselves. Then they dialogue about what they think are the main idea(s) or important point(s) of the paragraph. Then they come to consensus about how to write the main idea(s) of the paragraph. Each student writes their notes on that paragraph. Repeat for each paragraph of the reading.

The Medium Ground Finches of Daphne Major



The Medium Ground Finches of Daphne Major

Tiny island in the
Galapagos (Ecuador)

Terrain: Rocky, two
craters in center, very dry.



Daphne Major: 1/8sq. mile, uninhabited by humans other than a few scientists working there.

Living things: no trees, some plants that can survive dry climate, insects, finches that feed on seeds of the plants, occasional owls and hawks.

Climate: Jan-May hot wet season with heavy rains producing 90% of annual rainfall, June-Dec dry cooler season with only light mists producing small amounts of water.

Our story takes place during the years of
1976-1978

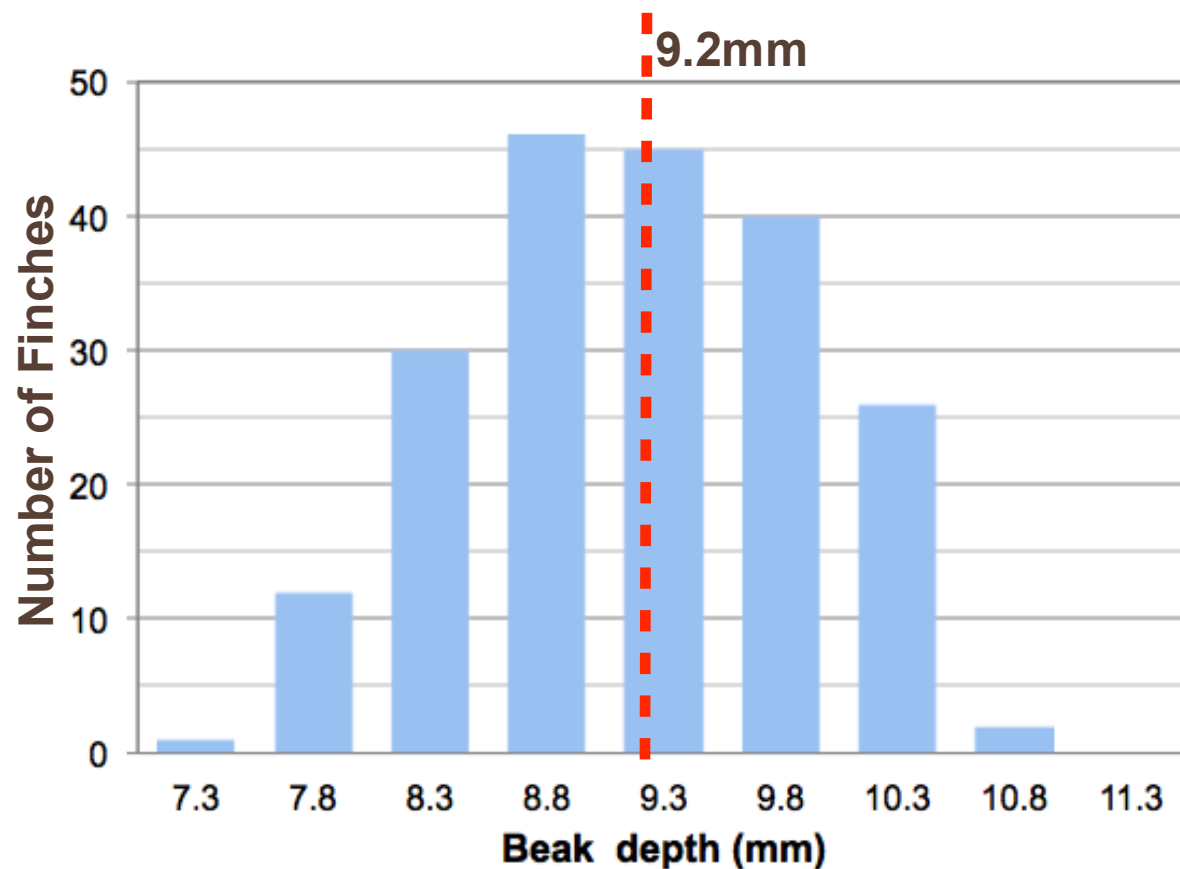


The Medium Ground Finches of Daphne Major

Finches borne
1976



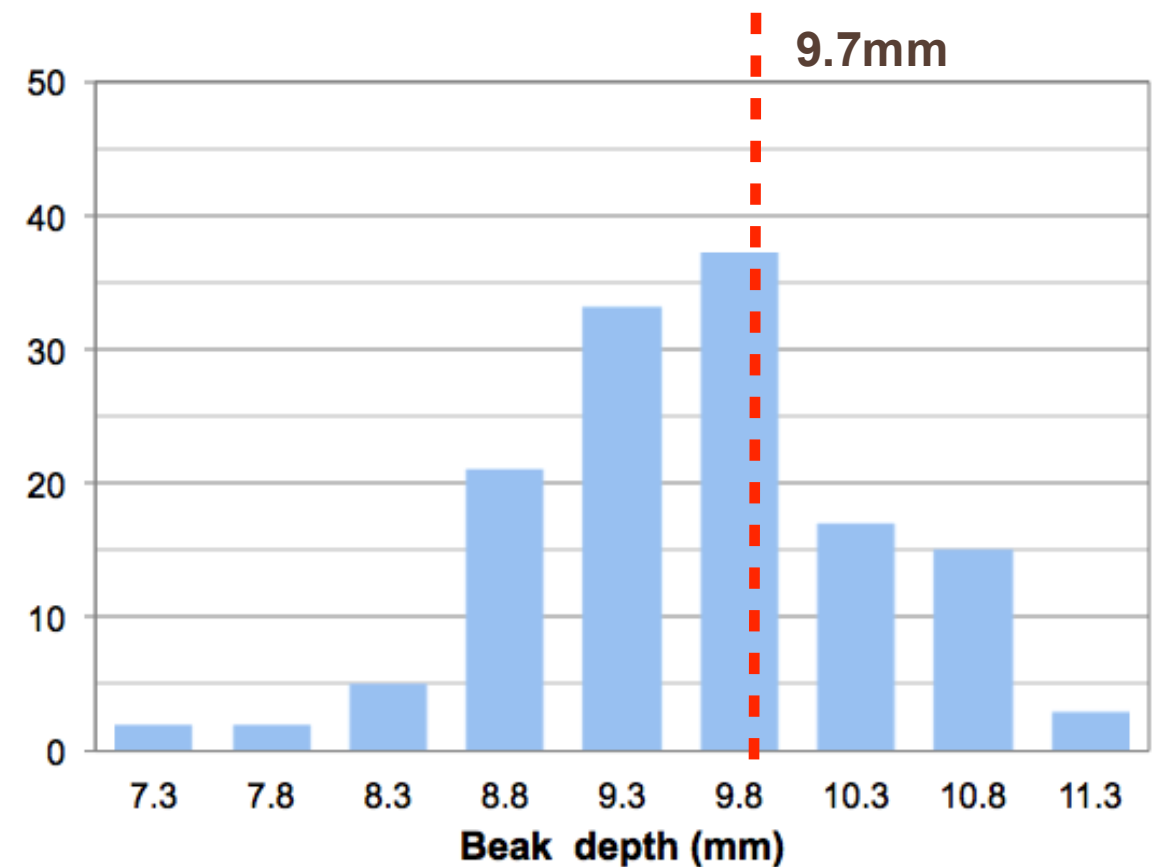
Beak depth
average:
9.2mm



Finches borne
1978



9.7mm

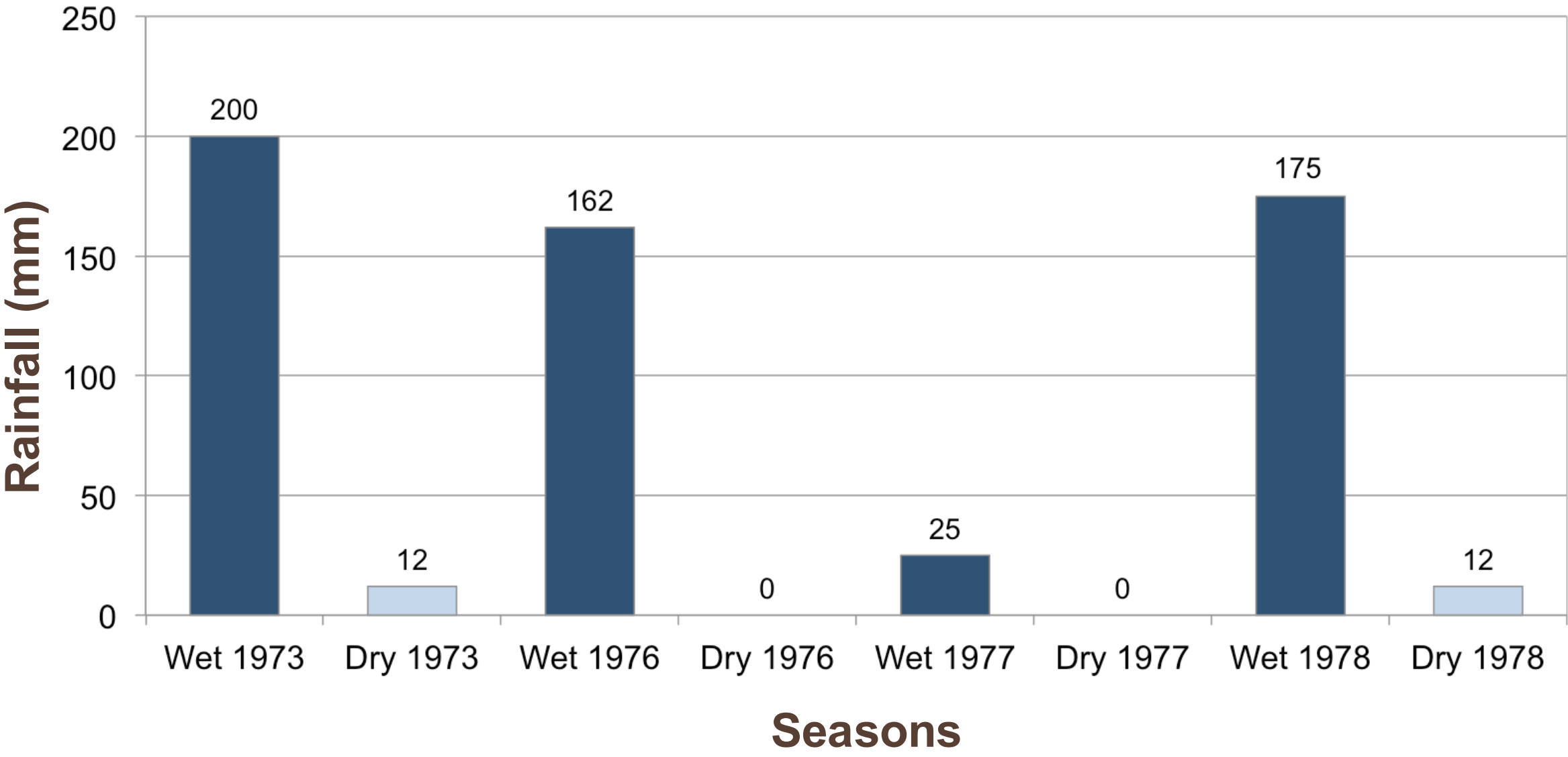


Let's look at some data for clues:

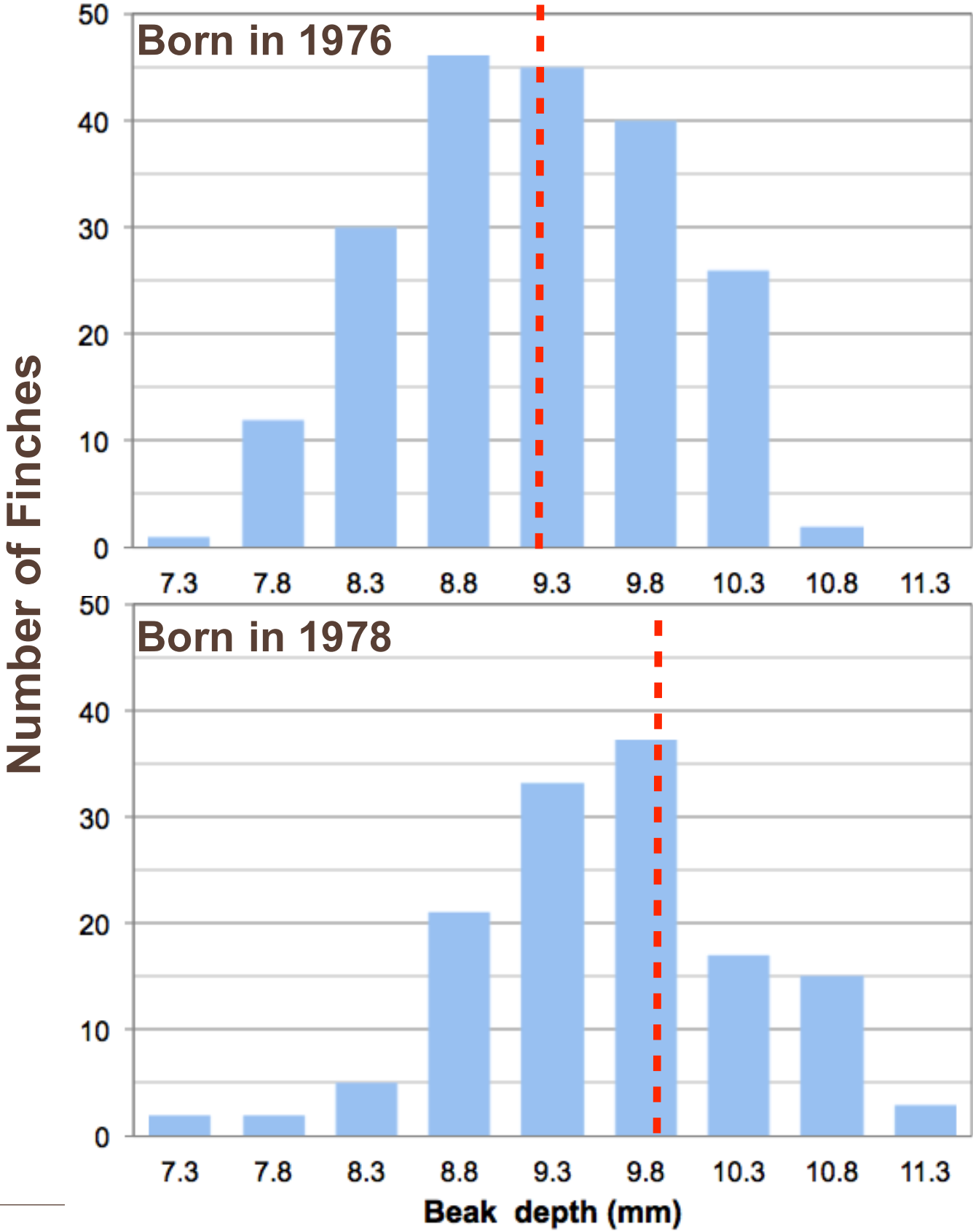
1. Look over each graph.
2. It might help to organize the data in the order of events.
3. You may use the timeline provided to help you. The worksheet is to help you organize your thoughts, but feel free to organize it differently if it makes more sense to you.
4. Look for patterns that might reveal how their beaks changed.



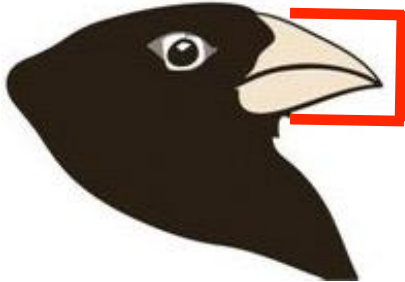
Seasonal Rainfall in Daphne Major



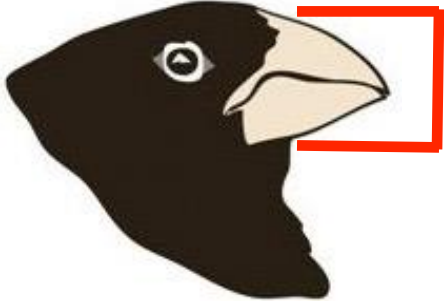
Distribution of beak depth for finches born in 1976 and 1978



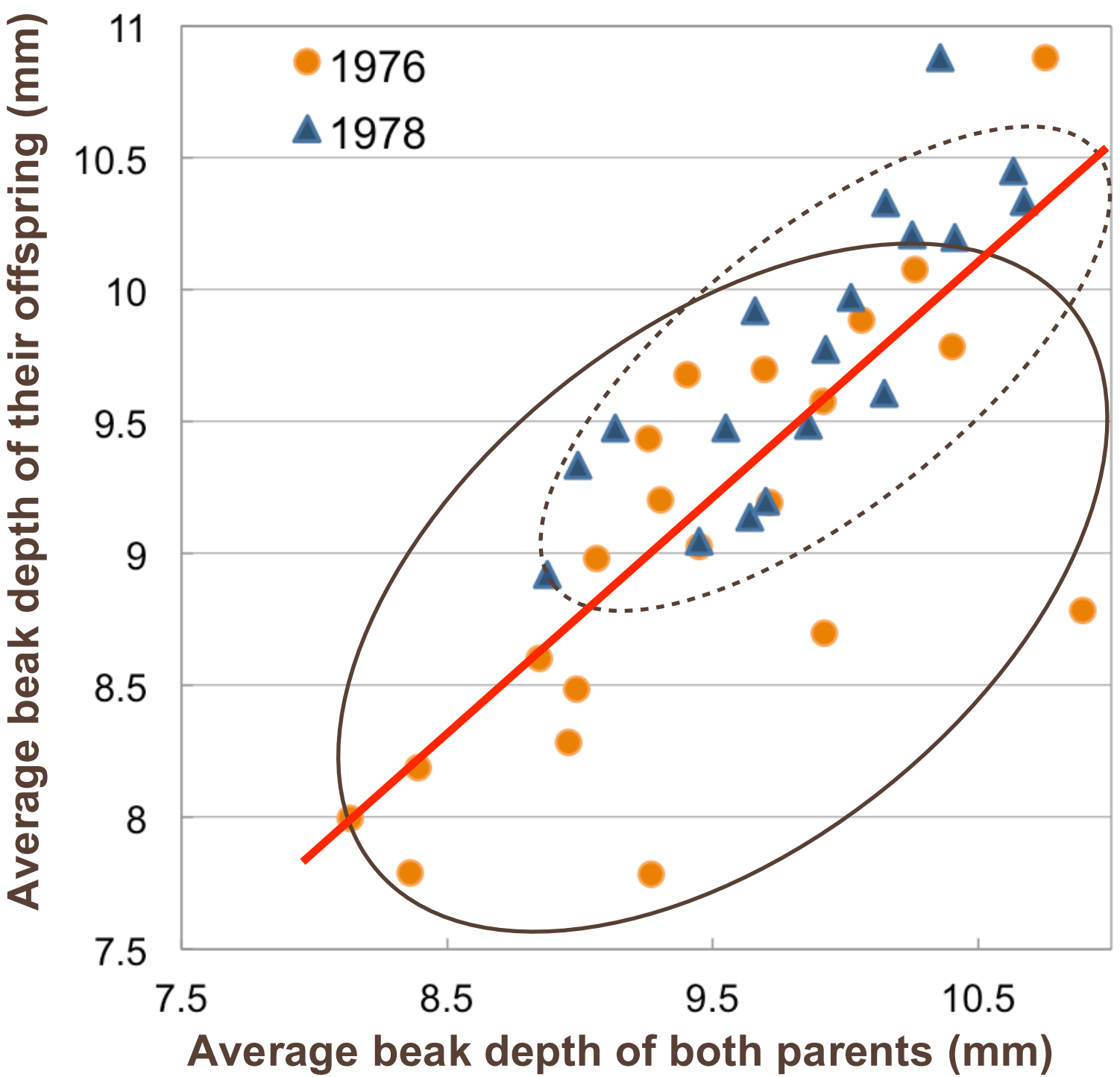
1976
Beak depth
average=9.2mm



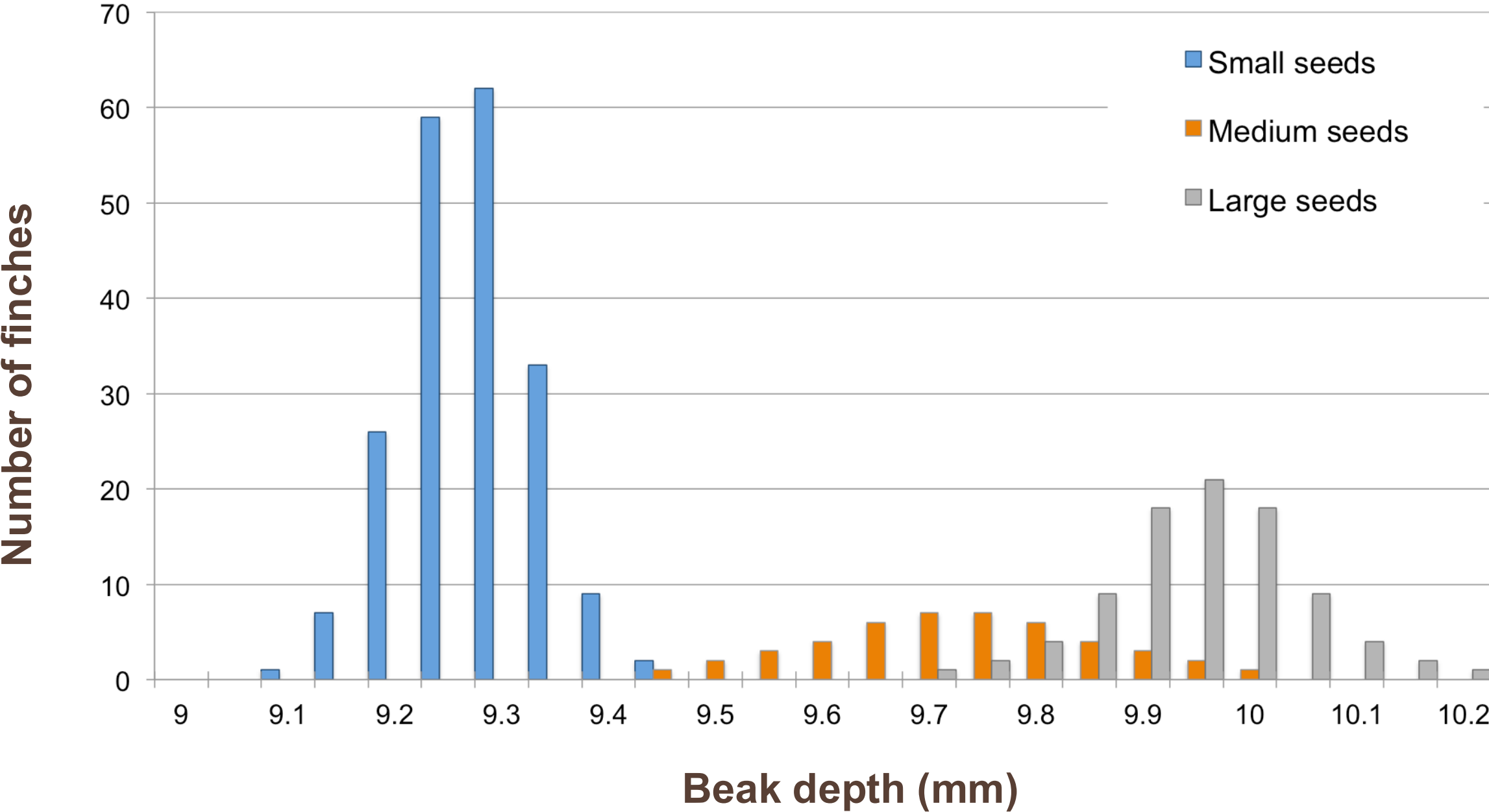
1978
Beak depth
average=9.7mm



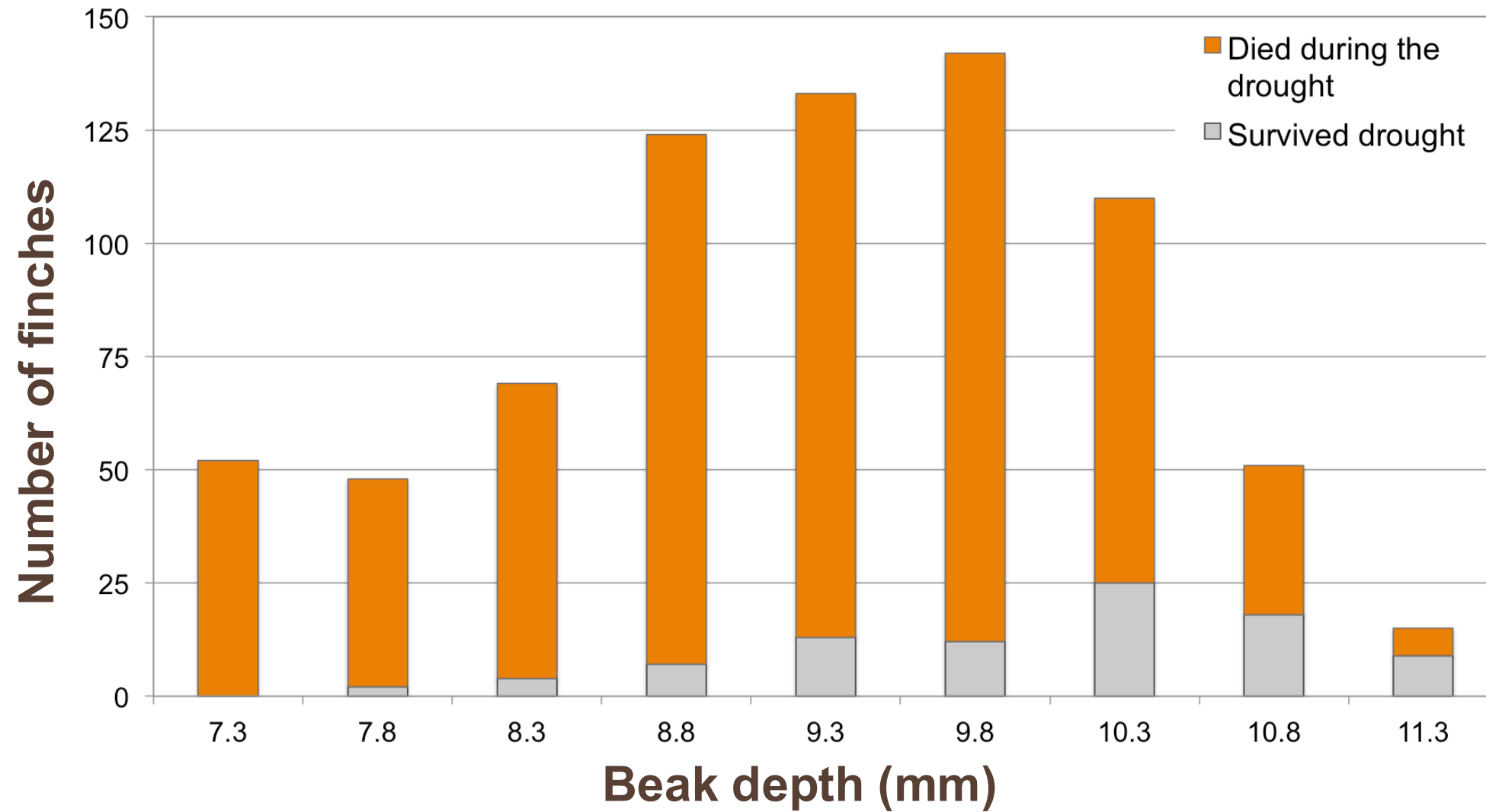
Beak depth of parents and their offspring



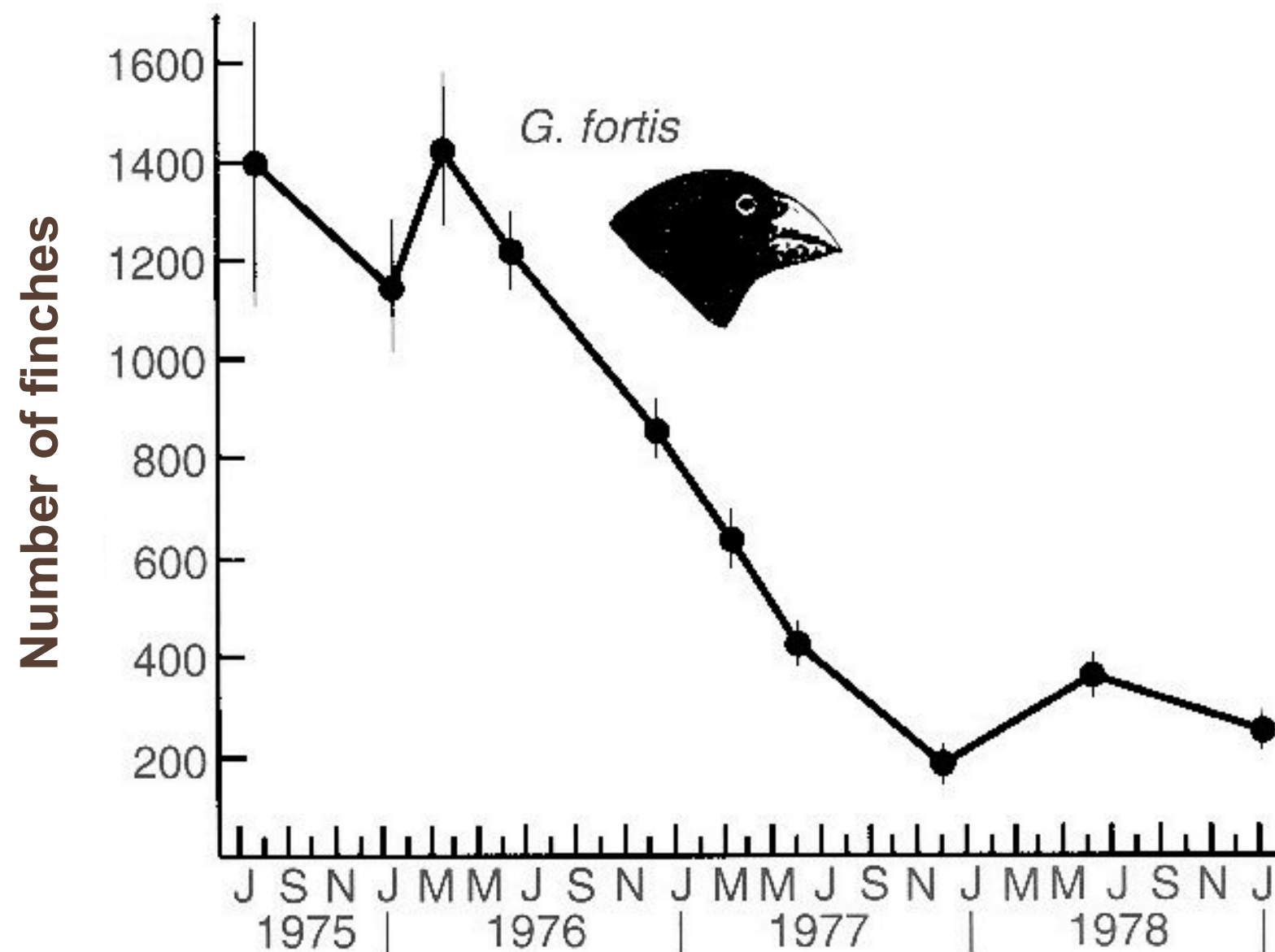
Seed size chosen by finches of different beak depths (1976)



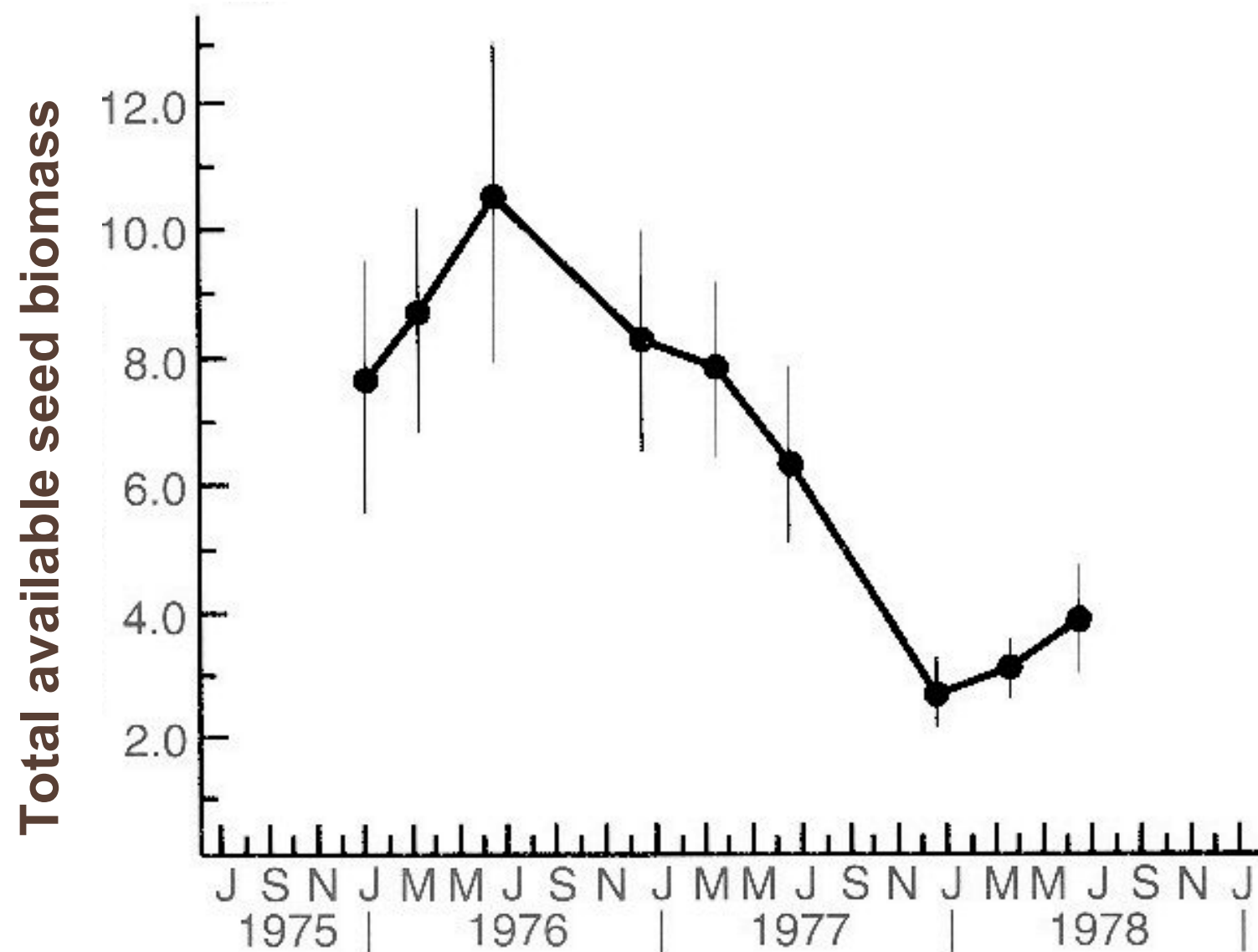
Distribution of beak depth of finches born in 1976



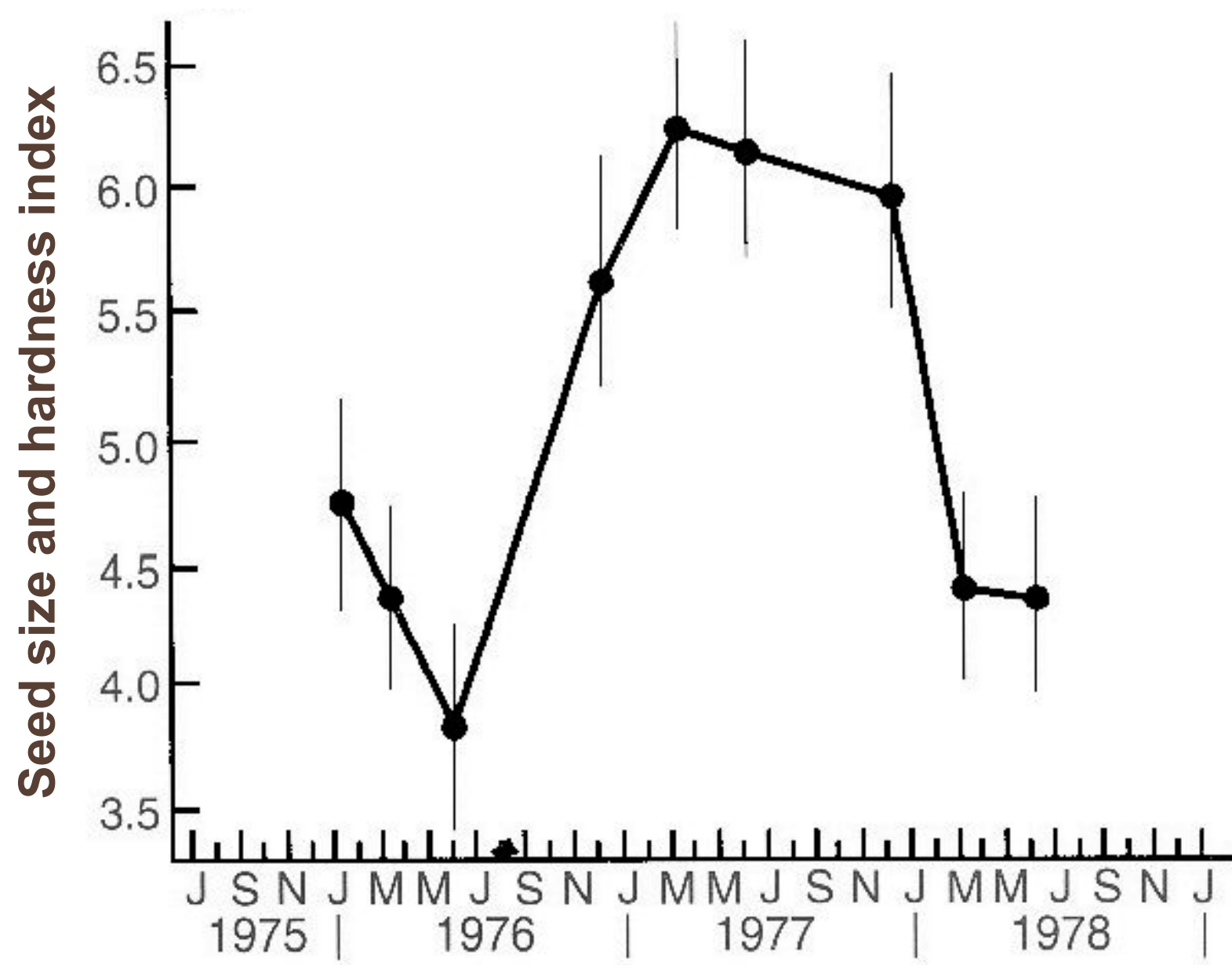
Population Size of Finches Between 1975-1978



Total seed biomass available for finches to eat 1976-78



Average Size and Hardness of Available Seeds (1975-78)



Research on Galapagos Ground Finches

The originals of the following graphs and data can be found in these references:

- Boag P.T. and P.R. Grant. 1984. Darwin's Finches (Geospiza) On Isla Daphne Major, Galapagos: Breeding and Feeding Ecology in a Climatically Variable. Ecological Monographs 54: 463–489
- Grant R.B. and P.R. Grant. 1989. Natural Selection in a Population of Darwin's Finches. The American Naturalist 133(3): 377-393
- Grant R.B. and P.R. Grant. 2003. What Darwin's Finches Can Teach Us about the Evolutionary Origin and Regulation of Biodiversity. BioScience 53(10): 965-975

Some of the graphs were modified to simplify or make more easily readable.

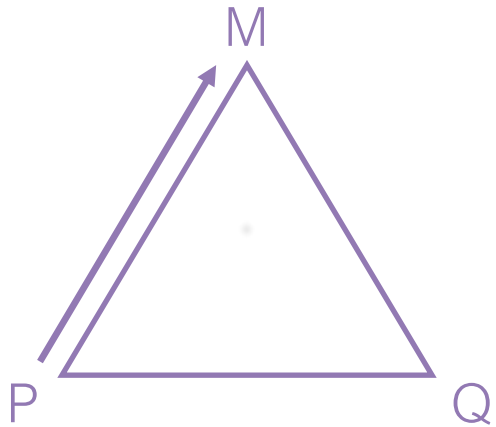
Teacher Notes: Learning Segment 4 Wrap up

What did we figure out in this learning segment?

We explored a comprehensive dataset related to the change in the distribution of finch beak size on the Galapagos in the 1970s. We organized the data so that we could see what happened with regard to rainfall, distribution of the trait, seed availability, etc. Next we will discuss what all this might mean and how we can use these ideas to continue to refine our ideas about trait change over time.

Suggestions for additional assessments

1. This may be an opportune time for a brief summative assessment.
2. Options might include multiple choice, matching, short essay (see the Assessments section of the web pages), or one of the following two less traditional types of assessment:
 - a) Use “Justified T or F Statements”. Construct several True or False Statements with spaces below for students to justify in writing their selection of T or F.
 - b) “Fact First Questioning”. Example: On islands where grazing has been heavy and sustained over very long periods of time some species of ground plants have developed flowers that are small and under leaves. This is an example of natural selection at work. Why is it an example of NS? Teacher choice as to where to place this.



In learning segment 4, students analyzed a dataset and began to generate evidence that will either support, refute, or build on their initial model ideas generated in learning segment 3.

Now in segment 5, they first construct an explanation (or “story”) explaining what happened with the finches. They will make those ideas public and utilize evidence to support their claims, compare their ideas to those of other groups and then return to the initial model they developed in Segment 3. The class will work together to refine general model ideas based on the specific case of the finches.

At the end of this segment students might feel that they have a “finished model”. Remind them that there is no such a thing as a “finished model”. **Models get continuously tested and as new observations are made, and as new evidence arises, models get revised and refined.**

Let's Review What We've Done So Far...

1. We are trying to figure out how traits change over time. To figure that out, we are studying finches to determine what may have caused the average beak depth in the population to change over time.
2. You just analyzed a dataset to try and uncover evidence that will help us answer that question.
3. Now, we want to consider what we've learned through analysis of the data and see how it relates to the initial model we already developed.



In your groups...



Develop a story for what happened to the finches on Daphne Major during the years you examined. You are trying to answer the question you generated earlier: [insert question from Doodle F here]



Common ideas that came up across groups:

From the Finches to a general model:

- [insert bulleted finch story here]

- [insert initial model here]

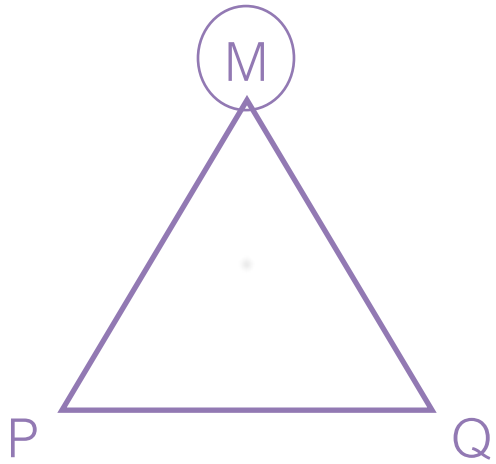


Use the finch story to refine the model ideas on the right.

What did we figure out in this learning segment?

We used our detailed exploration of the finches on Daphne Major to first develop a causal account for what happened to them over time and then we used these ideas to revise our initial model for how populations change over time.

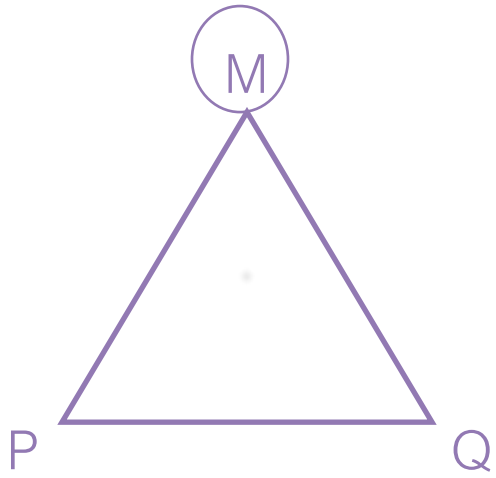
Teacher Notes: Lesson Segment 6



The goal of this segment is for students to further explore phenomena in service of evaluating and revising their model. This segment consists of a series of activities that will help students to explore and deepen their ideas about trait change to see if they are also seen across other species.

Compared to other segments in this triangle, this is a relatively long segment and is slide intensive. Try not to fall into the trap of direct instruction. Student ideas should continue to be foregrounded as they proceed through these activities. Also, at the beginning of each task, it's a good idea to remind them of the driving question for this triangle, and for the finches—during this segment they are generating/revising/testing model ideas that will help them to answer both. Restating these questions can serve as a reminder of what they are trying to figure out. Please remember to refer the important information on the Presenter Notes for each slide.

Teacher Notes: Learning Segment 6

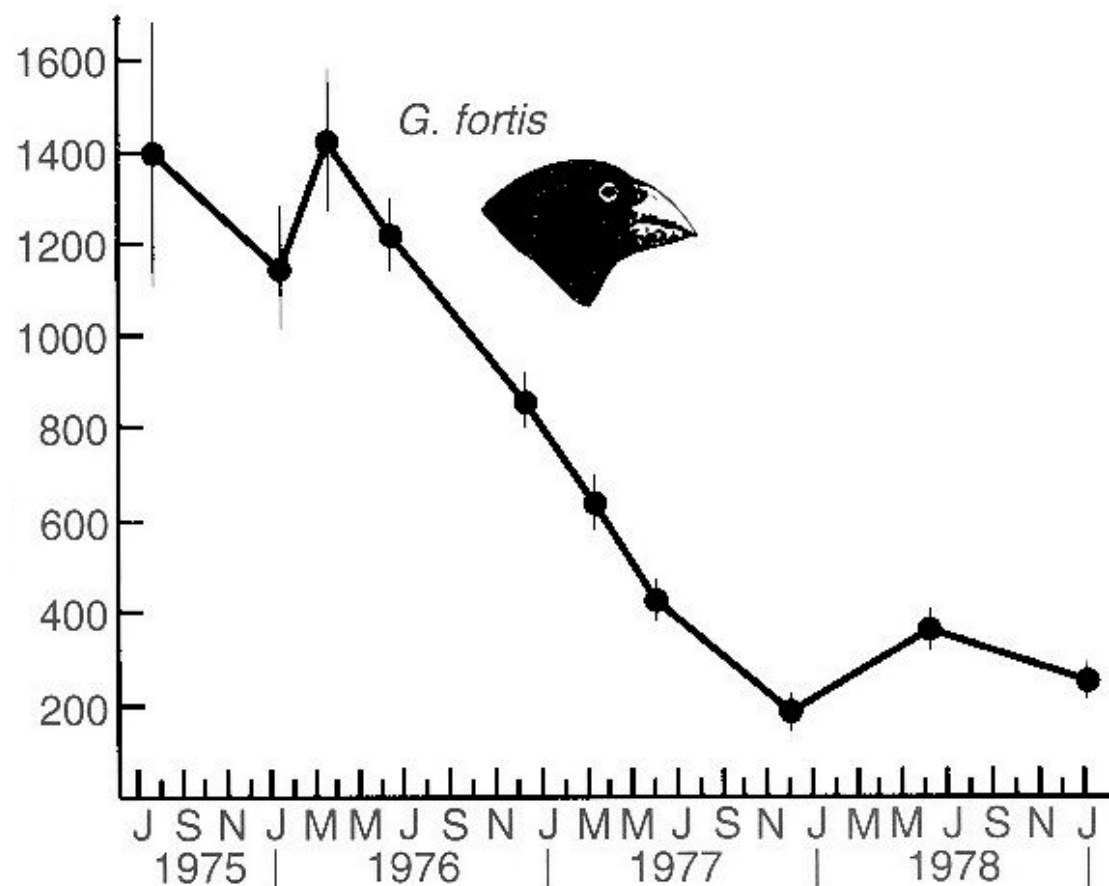


Resources for this learning segment include:

- Net logo
- "Oh Deer" Teacher notes
- Variation Lab and Teacher Notes
- Wormeaters Activity and Teacher Notes

Now that we have our model, let's further explore our ideas and see if we can find additional evidence that supports or refutes them.

We'll start with our ideas related to the change in the population size of the finches.

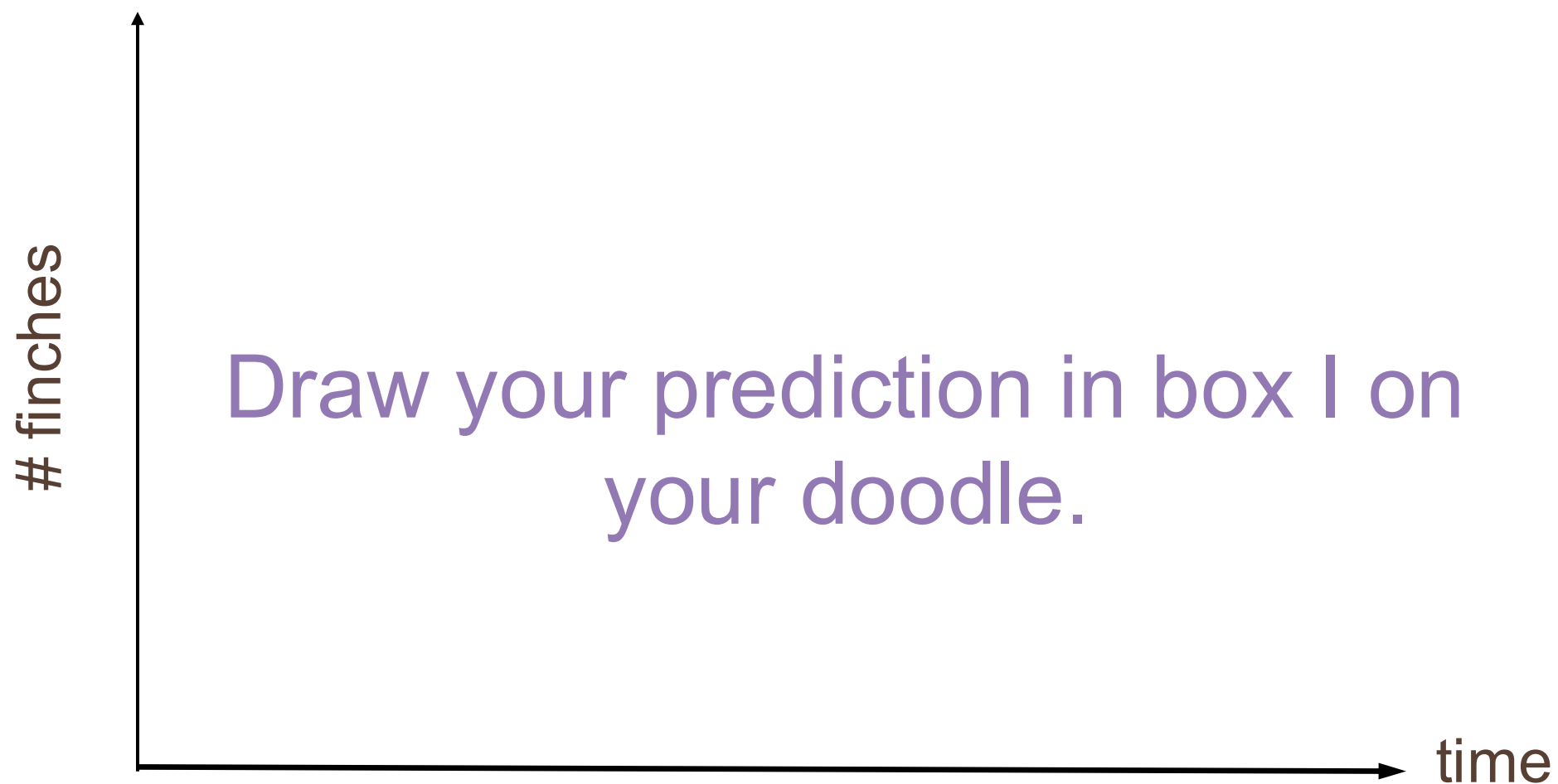


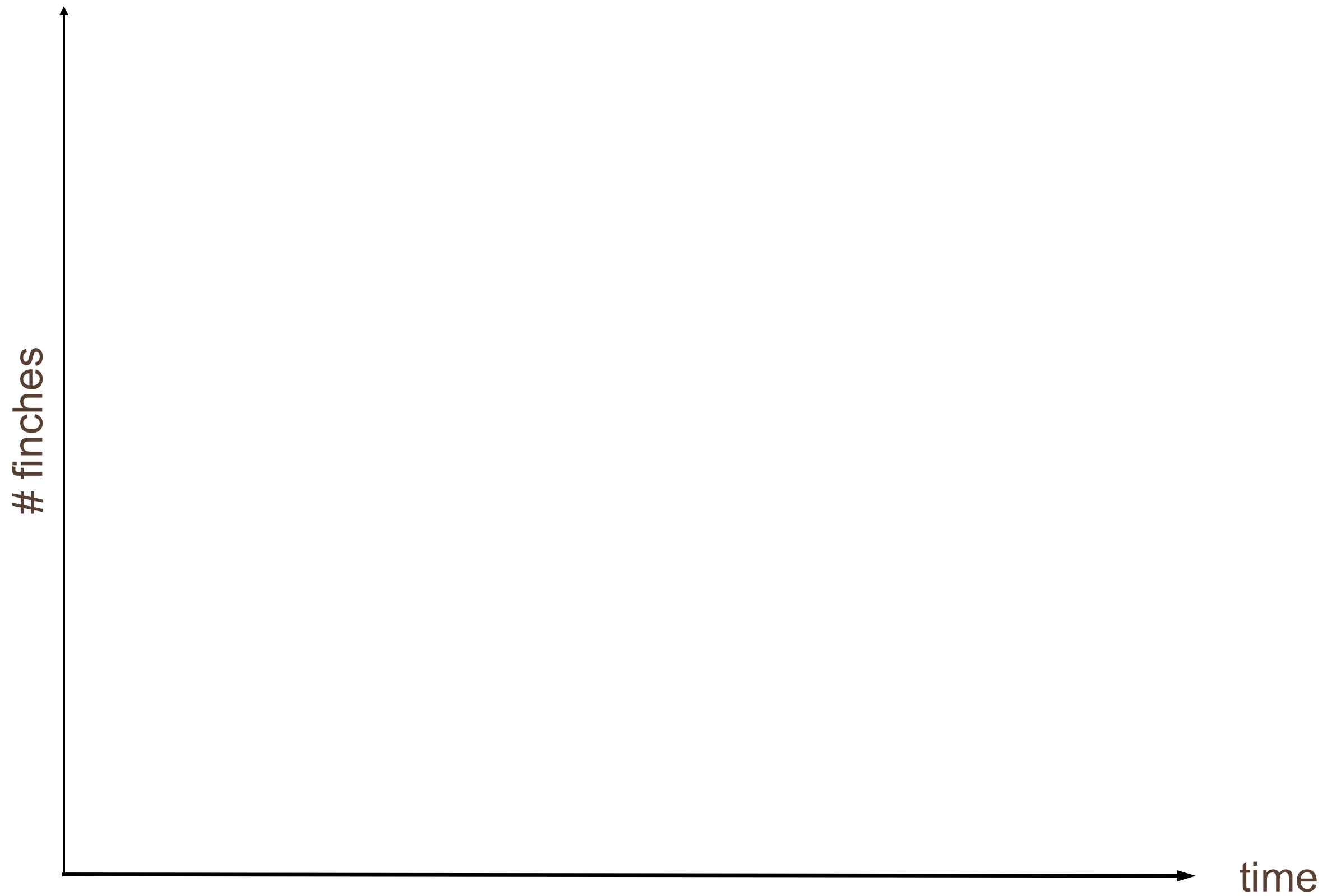
Where else have we observed changes in population sizes?

Let's consider the following question...

What if there was no starvation in the finches?

What if all the parents and offspring had survived? What would happen to the population?





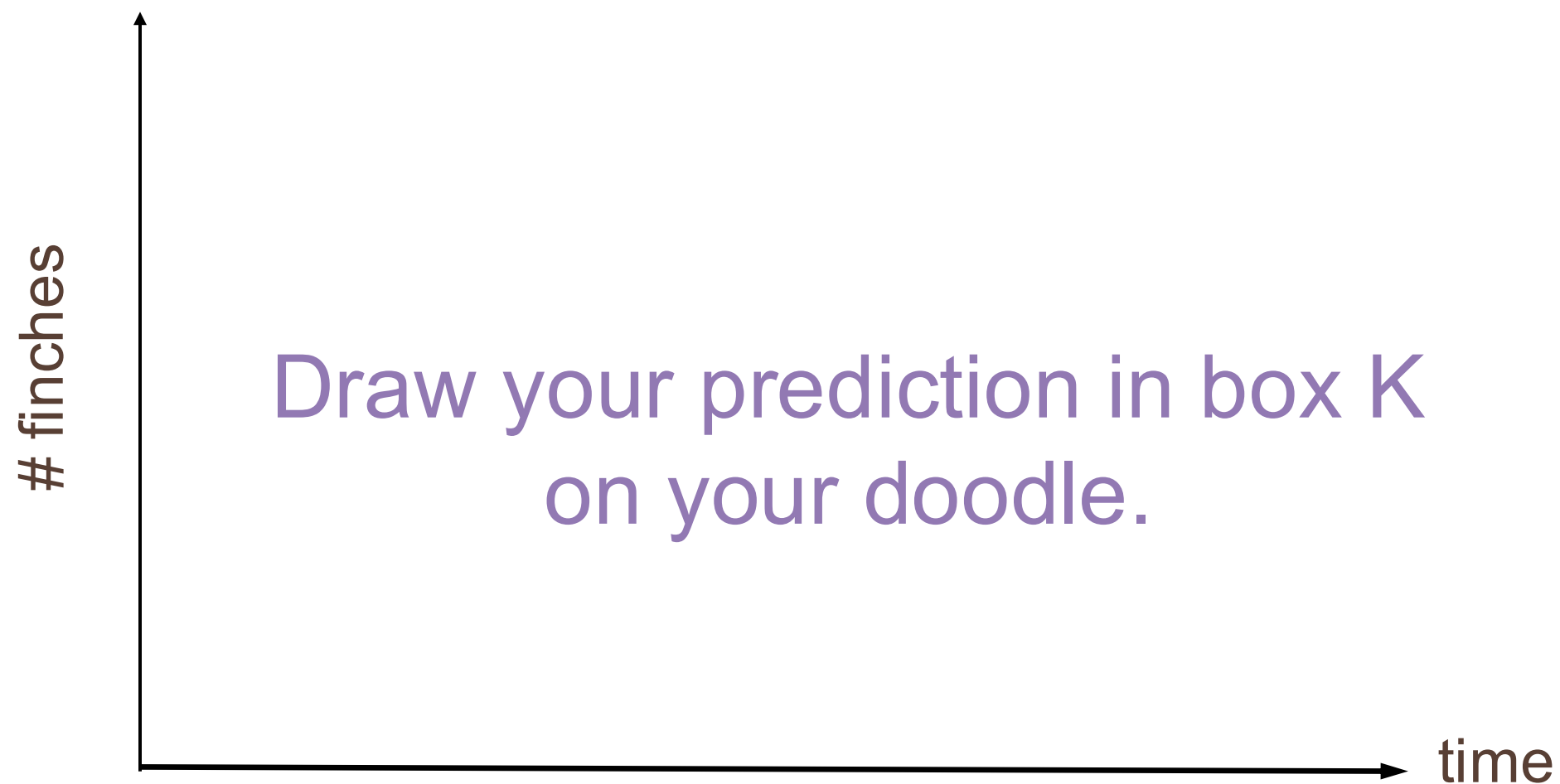
Let's Test Our Ideas Using a Simulation

What happened? Is this what you predicted?

Why or why not? What caused this to happen?

Let's consider another question...

Would we observe this kind of pattern in nature, in a real population? Why or why not?



Let's Test Our Prediction Using a Simulation

But, now we will turn the switch “on”.

What happened? Is what what you predicted?

Why or why not? What caused this to happen?

[Need to make some graphs of abundance over time]

What is the pattern in these graphs?

[Need to insert some graphs of abundance over time]

What is the pattern in these graphs?

So, what does the switch represent? In other words, what might be preventing populations from growing exponentially?

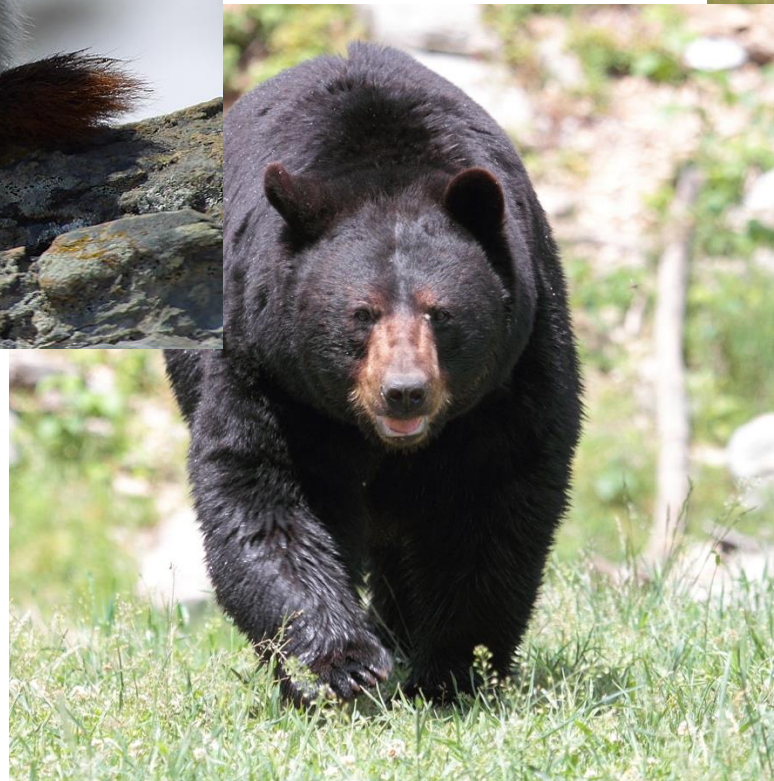
Let's return to our model ideas...

How can we incorporate these ideas into our model statement about population size?

[write idea here]

Let's consider another question:

What might it be like for organisms in nature trying to survive when resources are limited?



OH DEER!

1. Even student #'s are **DEER**, odds are **RESOURCES** .
2. Signs for resources: **FOOD** = *both hands over belly*, **WATER** = *both hands over mouth*, **SHELTER** = *make a tent over head*.
3. Groups stand with backs to each other. Everyone picks a resource by making the appropriate sign. You must display your sign the whole time!
4. On signal, turn and face each other. **DEER** must find someone showing the same resource on the other side.
5. Each deer can only claim one resource.
6. No changing once you turn around!
7. If a deer finds a resource it gets to “reproduce”. The resource it caught becomes a deer for the next round.
8. Resources not claimed stay a resource.
9. Deer not able to find their resource die and become a resource for the next round.



OH DEER!

1. Was it always easy to be a deer in the game? Why or why not?
2. Does it matter which resource is limited? For example, what if there's lots of food and shelter but no water?
3. Is there anything the deer can do when they run out of a resource?
4. If there is a shortage of resources, what might be affected?
5. On a day to day basis, when resources are limited, what is it like to be a deer?

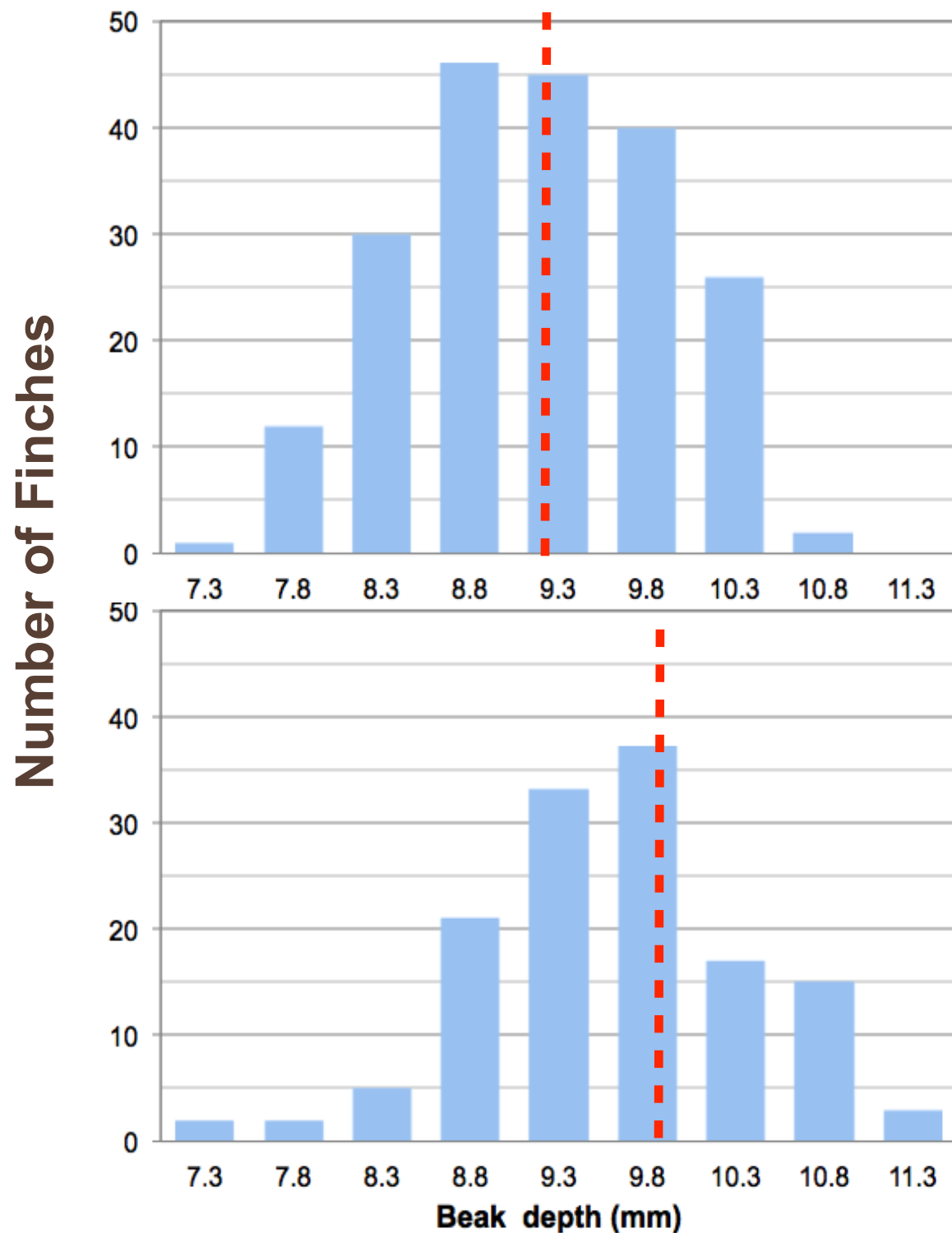


Let's return to our model ideas...

[Place current model here]

Based on what we learned in the game, do we
need to change our model?

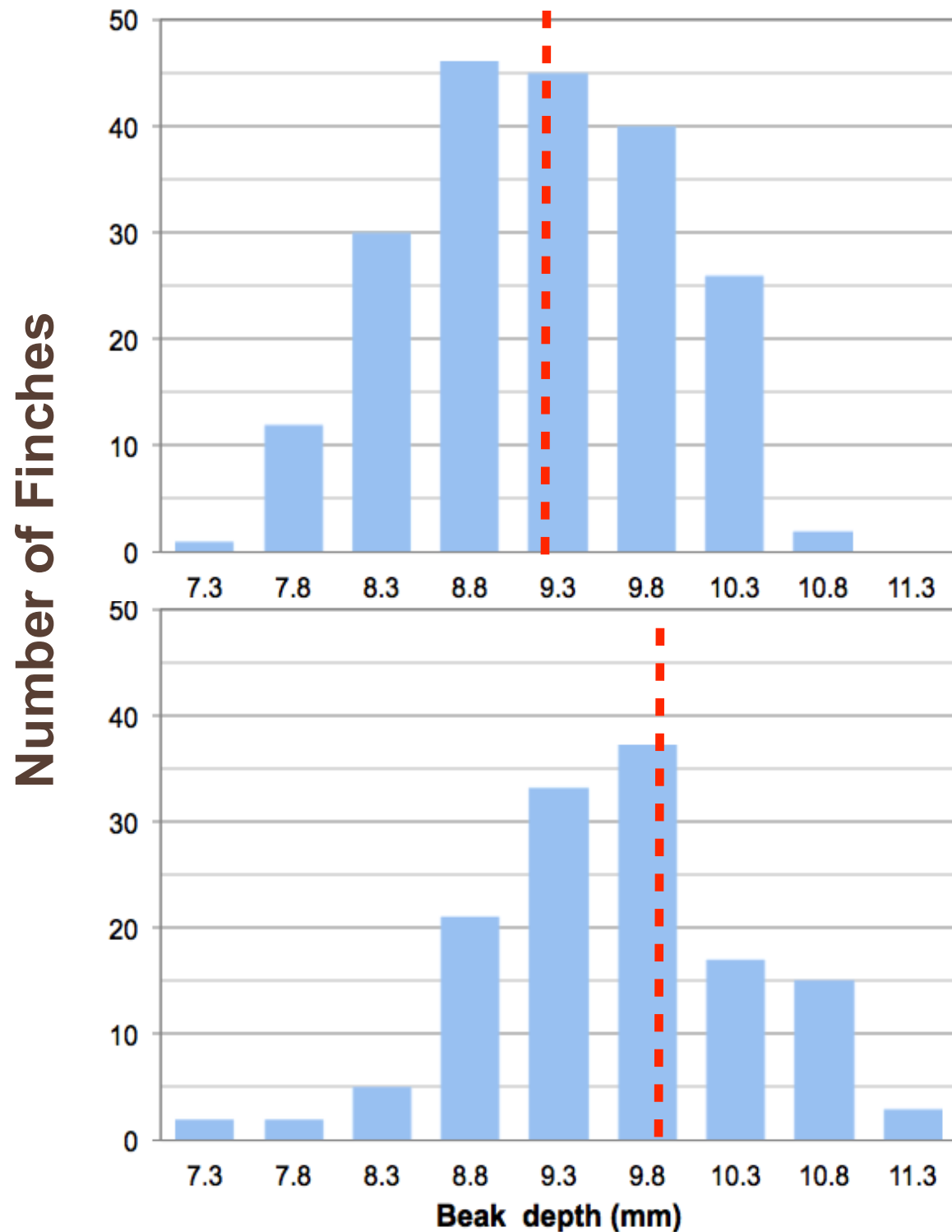
In your model, you also said that there were different beak sizes in the finch population



Let's explore this idea some more...

Is this kind of variation unique to finches, or do we find it in all species?

What can we conclude about variation from the evidence we collected in this lab?



Consider another model statement...

You mentioned that larger beaks had an advantage during the drought.

Let's explore this idea that some variations can help members of a species survive.



Observations:

Beak variation	GENERATION				
	1	2	3	4	5
Forky					
Sporky					
Spoony					
Sporticus					
Forktunis					
Offspring of 1st gen.:					
Offspring of 2nd gen.:					
Offspring of 3rd gen.:					
Offspring of 4th gen.:					
# <i>remaining after 5 generations:</i>	Forky	Sporky	Spoony	Sporticus	Forktunis
On your island →					
TOTAL remaining on all islands: →					

What patterns did you notice?



Another example of an advantageous and disadvantageous trait.



What do you predict will happen to the caribou on the left? Why?

So, what will happen if an individual with an advantageous trait gets to reproduce?



What will the offspring look like?

If more individuals with advantageous traits survive and reproduce, what do you predict will happen to the number of individuals born with the advantageous trait in the population?

What about the number of individuals with the disadvantageous trait?

Let's return to our model ideas...

[Place current model here]

Based on what we learned about advantageous and disadvantageous traits, do we need to change our model?

Are there any other ideas that we need to discuss?

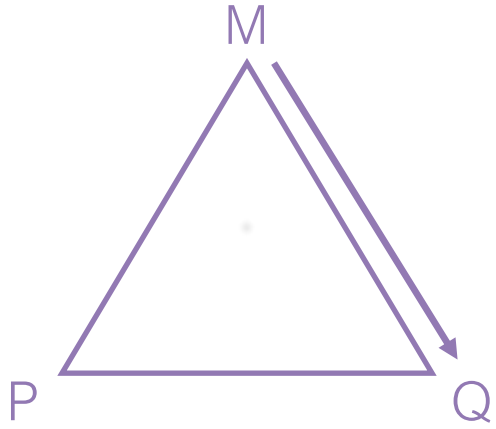
[Place current model here]

Do our ideas only apply to finches?

What did we figure out in this learning segment?

We continued to refine our model for trait change over time in populations by using some simulations and investigations. We now have a complete model that we are ready to apply and refine by returning to the finches.

Teacher Notes: Learning Segment 7



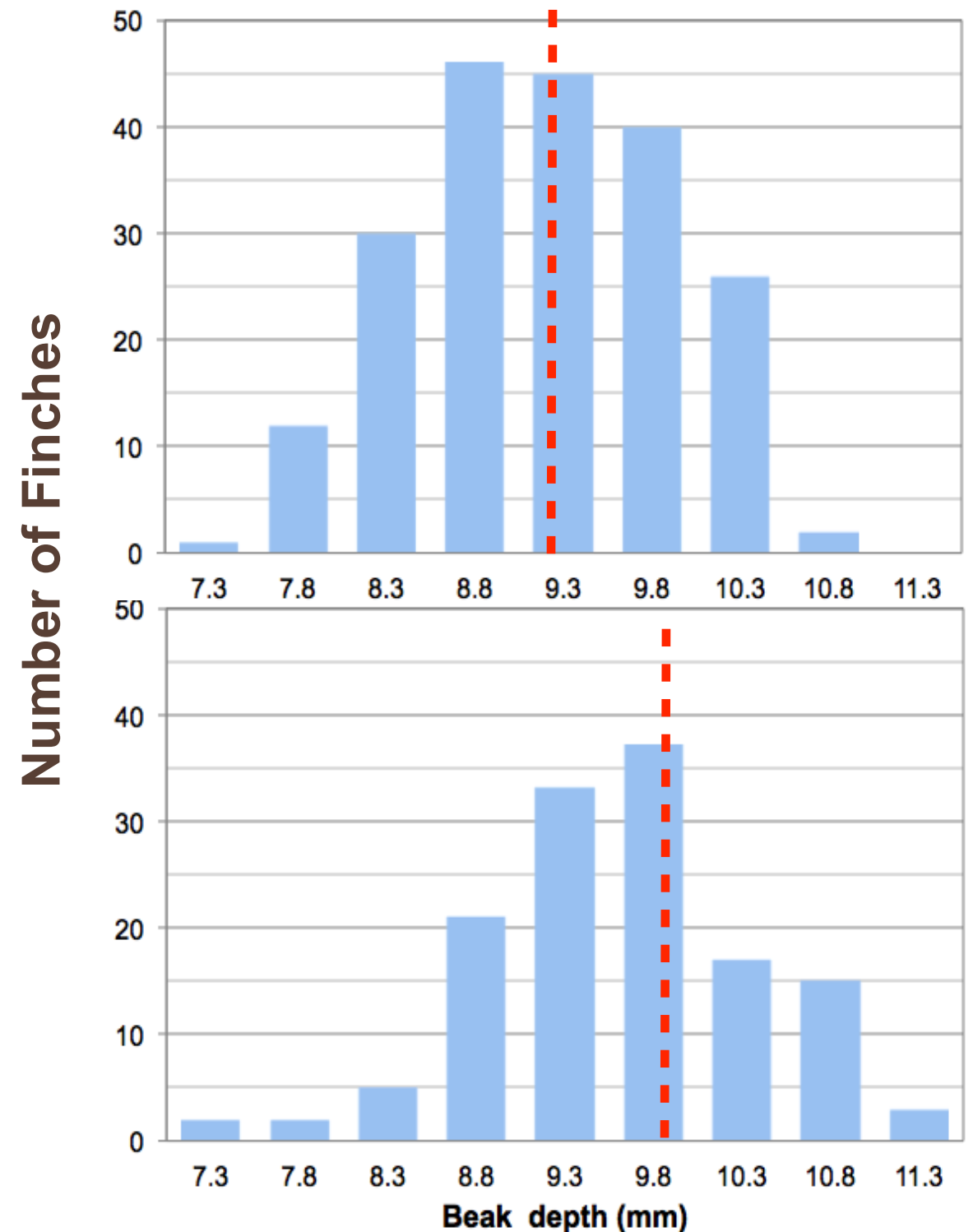
At the end of segment 6, students had a revised model that could help them to explain trait change over time. In this segment, students use their model to create a new and improved model-based explanation to answer their question about the finches.

Students' explanations may contain language such as “the birds had to change in order to survive.” This language is fine for now. Once students have completed their explanations, they will go through an activity focused on the differences between Darwin's and Lamarck's models of trait change and then will go back and finalize their explanations.

Let's review what we've done so far...

1. We observed the phenomenon that traits change over time and wondered *how* this happens.
2. We turned to the finches to seek evidence that may help us answer our question.
3. Based on evidence, we developed a model to explain trait change over time.
4. We further investigated our ideas, revising our model.

Now, we will use our model to answer our question!



Writing a Model-Based Explanation

Using your model and other information you gathered during the investigation, you will re-write your finch story so that it is a full explanation—basically an answer to our question.

First, re-write your answer individually.

Then, in your groups, compare your draft with the ones written by your group members. Write a complete explanation together.

Copy your explanation onto poster paper.

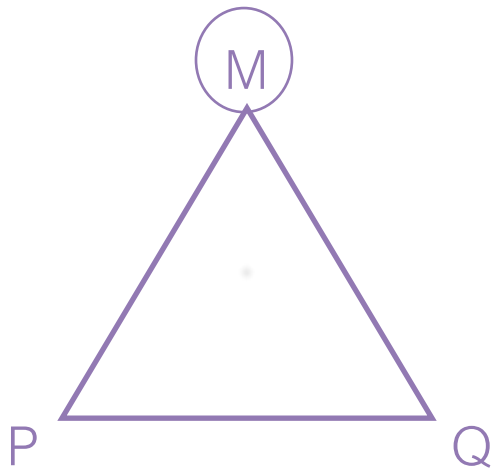


Why did the average beak depth change over time?

What did we figure out in this learning segment?

Originally we wrote our stories about what happened to the finches as a way to generate some model ideas. Then we spent some time testing and revising those ideas and in this learning segment we took our more formalized model and used it in a more explicit way to re-visit our finch stories. Our goal was to make sure we addressed all the elements of our model in our finch explanation. Next we'll take a look at some other ideas and see if they seem to be present in our explanations and do one final round of revisions to our explanations.

Lesson Segment 8: Comparing Models



Now that students have generated a model-based explanation, we turn to the models that Charles Darwin and Jean-Baptiste Lamarck created so that students can compare and contrast their own models with those of Darwin and Lamarck.

The following slides are intended for students to realize that their model and/or explanation may or may not contain Lamarckian language (e.g., “needed to adapt to their environment”). It also helps them to see that they’ve developed a model similar to that of Darwin’s.

This is a little bit more of a direct instruction style segment; however, there are places where students can be given a chance to discuss potential problems with other historical models. We’ve marked those places in the slides notes.

We are now going to investigate how our model and our explanation compares to other models that have been proposed to explain trait change over time.

But first, a brief history lesson...

~400 B.C.

1700s

1800s

The earth was ~7,000 years old.
Species were created separately and organized into an **unchanging** hierarchy, with humans positioned just below the angels.

Over many years,
scientists have used
evidence available to
them to explain how
life on earth has
changed over time.

Evidence emerged and proved that:

- Earth was older than 7,000 years
- **Life had changed over time**
- Many species had become extinct
- Organisms though different, share many characteristics and seem to have a common ancestor

If life has changed then a question emerged:
Why do traits change in populations over time?
Several models were proposed.

~400 B.C.

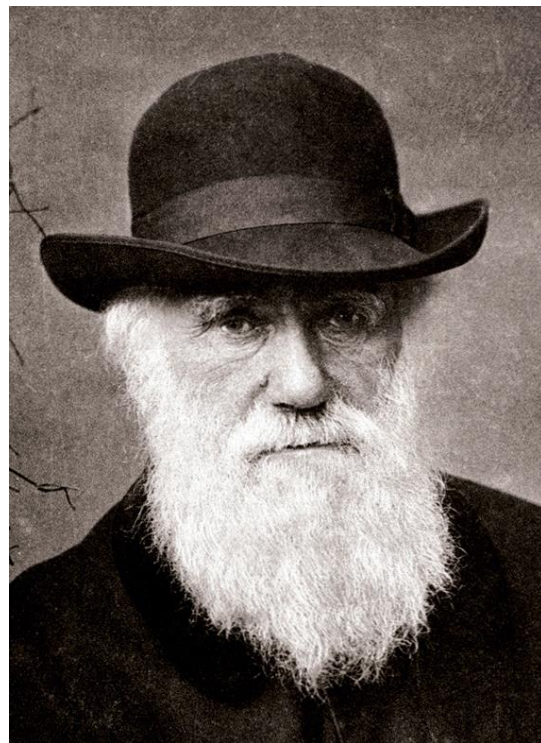
1700s

1800s

The earth was ~7.000 years old.
Species were created separately and organized into an **unchanging** hierarchy, with humans positioned just below the angels.



Jean-Baptiste
Lamarck



Charles
Darwin

Evidence emerged and proved that:

- Earth was older than 7.000 years
- **Life had changed over time**
- Many species had become extinct
- Organisms though different, share many characteristics and seem to have a common ancestor

If life has changed then a question emerged:
Why do traits change in populations over time?
Several models were proposed.

We will now explore
two of these models.



Nearly 2400 years after the Greeks first proposed a hierarchy of life...

Lamarck proposed a model that explained trait-change over time

**Jean-Baptiste
Lamarck**

1. More individuals are born than the environment can support - there is a struggle to survive.
2. All individuals in the species are alike initially, but some respond to the pressure by developing new traits that give them a better chance to survive.
3. When they reproduce, their offspring inherit the new traits they developed during their lifetimes.
4. Eventually all members of the species have the favorable trait.



Based on his model, let's see how Lamarck explained a specific phenomenon:

How did giraffes with long necks evolve from ancestors with shorter necks?

1. All early giraffes had the same (short) necks.
2. As the giraffe population increased, there wasn't enough food within reach for all so some began stretching their necks to reach food higher in the trees.
3. The more they stretched, the longer their necks grew.
4. When they reproduced they passed their longer necks on to their offspring who stretched their necks even more.
5. Eventually all giraffes had long necks.





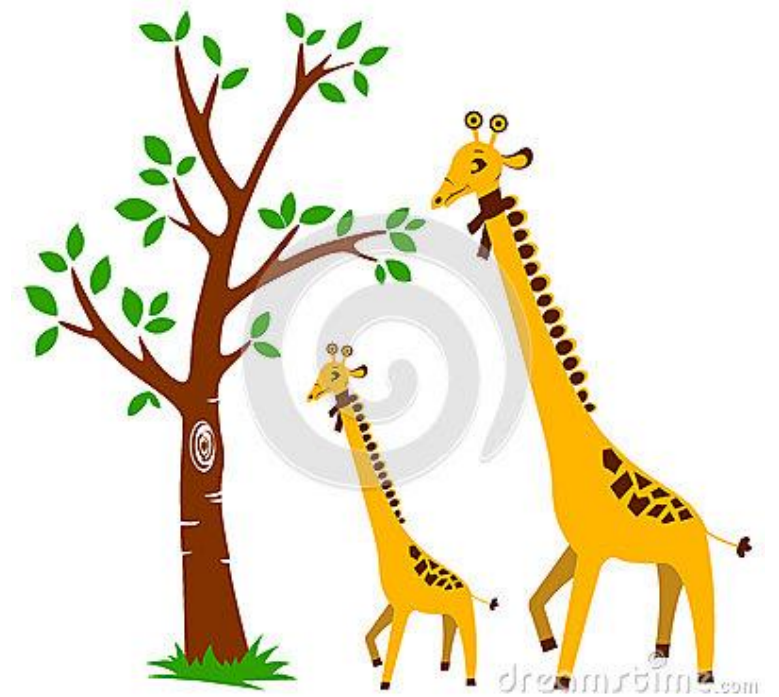
What are your thoughts about Lamarck's model and his explanation?

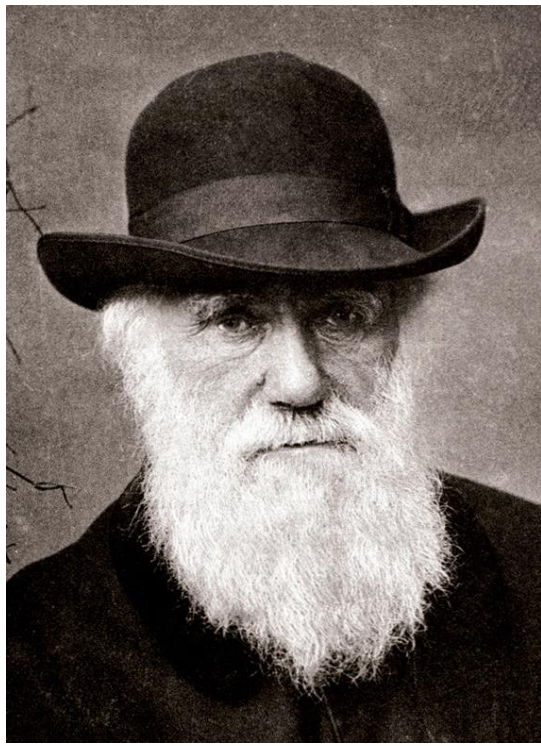
How does it compare to your model and explanation?

On your finch explanation, underline (using a red crayon/pen/marker/pencil) any statements you made that are similar to those Lamarck might have made about the finches.

Do you notice any differences?

What do you think about his model?





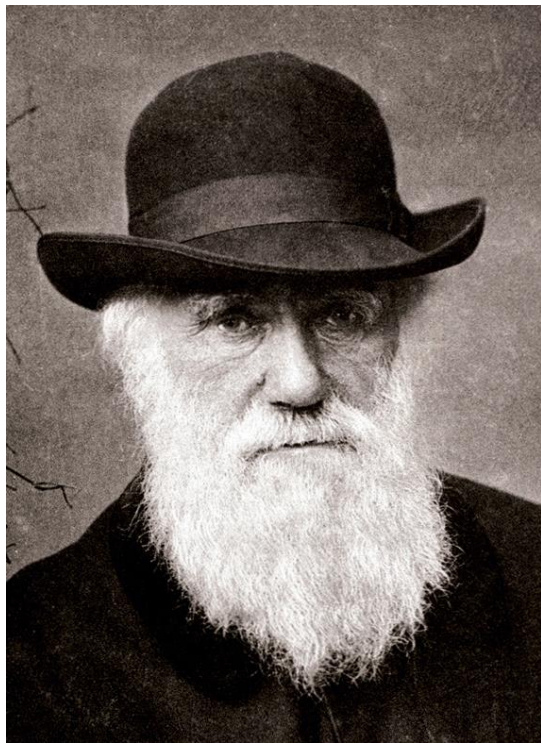
**Charles
Darwin**

The next model we will discuss is one proposed by Charles Darwin.

He also proposed a model to explain trait-change over time.

1. More individuals are born in a species than the environment can support. There is a struggle to survive.
2. Within every species there is naturally existing variation.
3. Variations of some give them an advantage over others in the struggle to survive.
4. More of these individuals will survive and reproduce than will those with less favorable traits.





**Charles
Darwin**

1. More individuals are born in a species than the environment can support. There is a struggle to survive.
2. Within every species there is naturally existing variation.
3. Variations of some give them an advantage over others in the struggle to survive.
4. More of these individuals will survive and reproduce than will those with less favorable traits.

5. Many traits are passed from parents to offspring.

6. More individuals with favorable traits reproduce, so the number of individuals with favorable traits increases in each generation. The number with less favorable traits decreases.

7. Eventually the favorable trait becomes the most common form, but variation still exists.





What are your thoughts about Darwin's model and his explanation?

How does it compare to your model and explanation?

On your finch explanation, underline (using a blue crayon/pen/marker/pencil) any statements you made that are similar to those Darwin might have made about the finches.

Do you notice any differences?

What do you think about Darwin's model?



Darwin's ideas were consistent with all observations and evidence at that time and continue to be supported by all evidence (hundreds of thousands of experiments, studies, archeological finds and facts) gathered in the 150 years since.

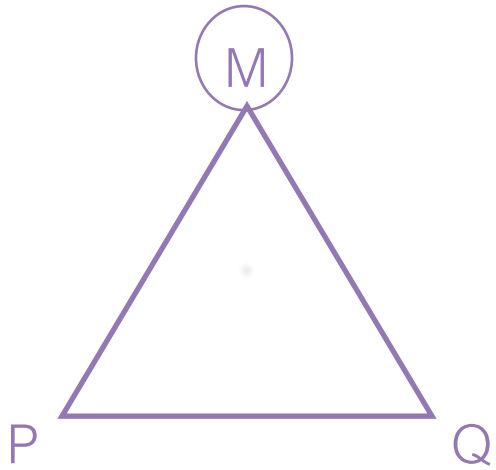
Let's return to our finch explanations one more time to make sure that our models and explanations are consistent with Darwin's!



What did we figure out in this learning segment?

We compared historical models for trait change to our model and to each other. We can now use our refined ideas to take one more pass at our finch explanations.

Lesson Segment 9: Revising our Finch Explanation



Now that students recognize that they have generated Darwin's model, they should revisit their finch explanations to remove any statements or ideas that may be Lamarckian and/or not consistent with Darwin's theory of natural selection. We will also return to our general model statements and revise them, if necessary.

Let's return to our finch explanations one more time to make sure that our models and explanations are consistent with Darwin's!

Based on what we know about Darwin and Lamarck, in groups, revise your finch explanations, if needed.

Now, let's go back to our model summary and see if we want to refine or revise any of the ideas there based on what we have just learned.

Congratulations on your scientific thinking!

You successfully proposed the model of why traits in populations change over time. This is also called the model of **Natural Selection**, one of the **most important** models in modern biology.

Two videos that can give you insight in the process of formulating the theory:

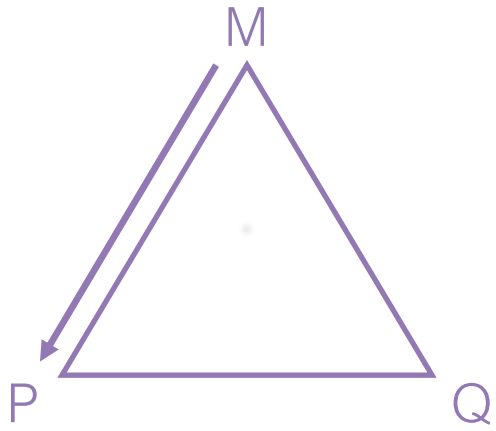
[Who was Charls Darwin](#)

[The life of Alfred Russel Wallace](#)

What did we figure out in this learning segment?

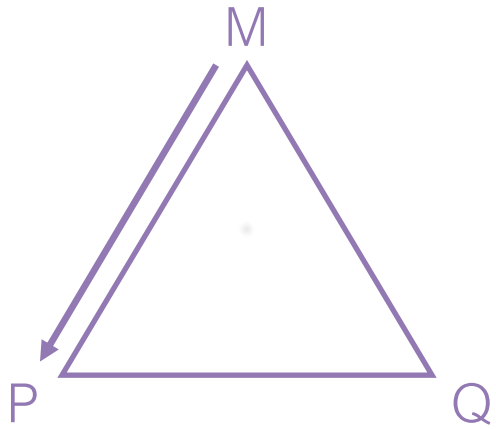
Just like scientists, we revisited our explanations to tune them and make sure everything we said is consistent with a Darwinian viewpoint. Next we see if our model is useful when explaining phenomena other than the finches.

Lesson Segment 10: Assessing Understanding



Now that students have experience in applying their model to a phenomenon (the finches beaks), choose between the two scenarios presented on the next slides about different phenomena for students to explain using their model of natural selection. Or, this would be a good opportunity to add in a socially relevant scenario that is geared toward your students in more specific ways.

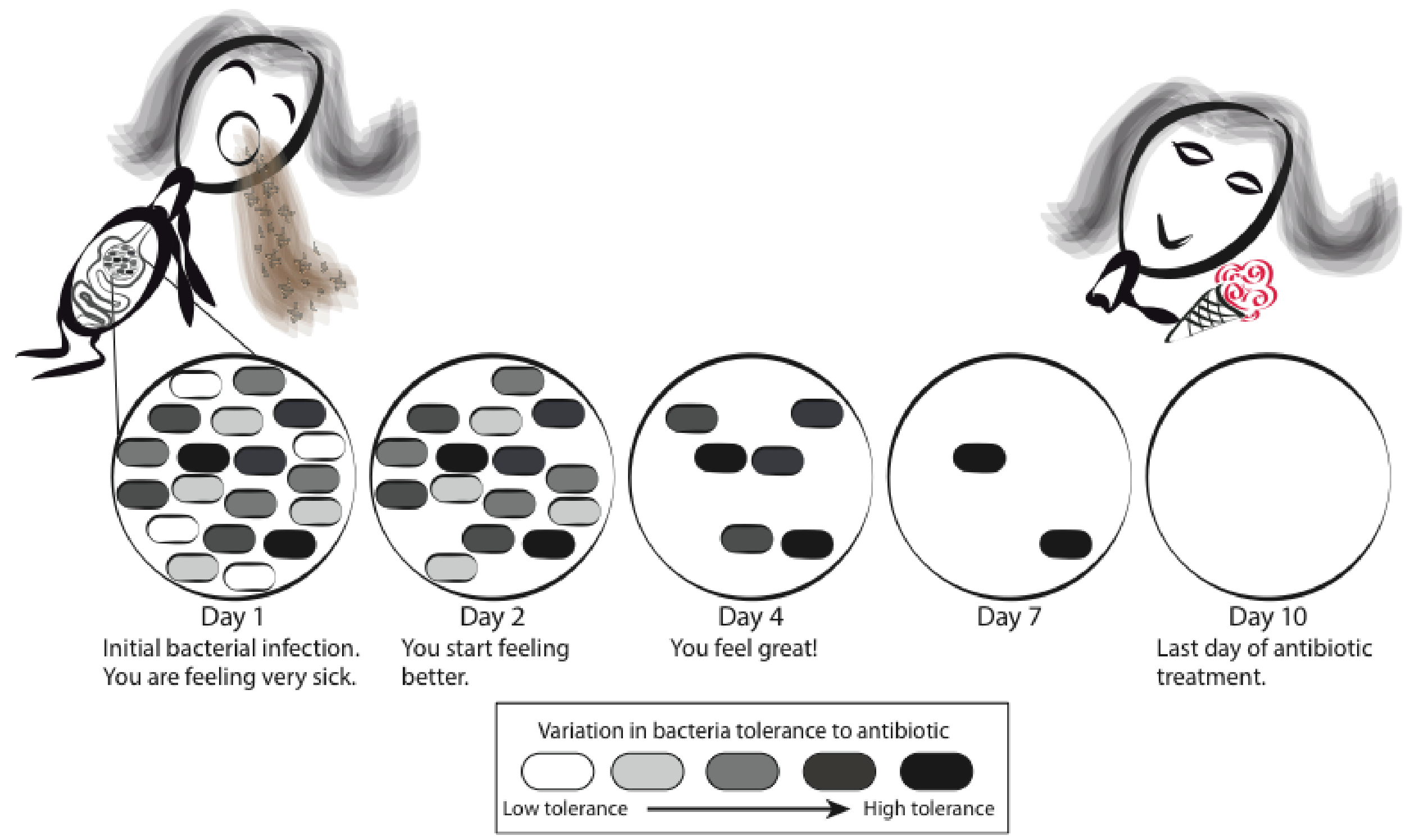
Lesson Segment 10: Assessing Understanding



Peter and Rosemary Grant have made enormous contributions to the field of evolution. They have demonstrated that natural selection can drive rapid changes in the distribution of traits in a population. The following HHMI video beautifully shows their work in the Galapagos. A version with an embedded quiz is also available.

You can use the video to connect it to the MBER process your students just went through: observation of a phenomenon leading to questions and proposed models based on evidence.

Misuse of antibiotic can put you and others at risk



The Peppered Moth Story



What did we figure out in this learning segment?

We had an opportunity to apply our model of natural selection to at least one other scenario.