Natural Selection in Action!

Piloses Simulation Activity Guide

Funded by the National Science Foundation

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Natural Selection in Action!
Simulating Adaptation Through Natural Selection

PLEASE WATCH THE SIMULATION ACTIVITY ORIENTATION VIDEO *HERE* FIRST

***Instructional Goal*:** To help students understand the population-based mechanism of adaptation by natural selection using a simulation that focuses on how a population changes over multiple generations.

How this goal will be accomplished: By following the survival and reproductive outcomes for one member of the pilose species after the weather changes, students get to visualize differential survival and reproduction. They see how, over several generations, these processes lead to a shift in the proportion of animals with a given trait in the population.

* To assess students' understanding you can use our assessment worksheets which can be downloaded **here**. These assessments can be given to students before and after reading the book to assess growth in their understanding. They come with a manual that includes an assessment guide. This guide details the five key facts associated with an accurate understanding of adaptation by natural selection as well as details about potential misconceptions.

We highly recommend that you read the How-To Manual prior to completing this activity so you can be alert for student misconceptions and address them during the activity.

Age group: Grades 2, 3 and above

Total classroom time: Approximately 50 minutes
- Preparation: 30 minutes
- Activity: 40
- Assessment worksheet: 5-10 minutes

How do you pronounce "piloses" and "pilose"??

Piloses (pl.) = **Puh**-lo-*sez (*rhymes with "noses")
Pilose (sing.) = **Puh**-lo-*sah (*rhymes with "samosa")

Materials:

All materials for the simulation can be found here. Please note that the materials were designed for an activity involving a base of 32 student*s. For a group of 16 students, use only half the number of each type of Pilose Card. For classes with 17-32+ students, you will need to pair some of the students up so that there are still either **16 or **32** Piloses Cards in play.

(1) *How the Piloses Evolved Skinny Noses* storybook

(2) 3 Timeline Tracker Sheets:
1st Generation-Meadow
2nd Generation-Desert marked ●
3rd Generation-Desert marked ○

(3) 2 Environment Tiles

(4) 3 Millibug Tunnel Pages

(5) Piloses Cards

a. 32 Initial (1st Generation) Pilose Cards (one for each student)
16 Pilose Cards with Wider Trunks and 2 millibugs
8 Pilose Cards with Wider Trunks and 0 millibugs
8 Pilose Cards with Thinner Trunks and 4 millibugs

b. 32 2nd generation Piloses Cards (●)
8 Pilose Cards with Wider Trunks and 2 millibugs
8 Pilose Cards with Wider Trunks and 0 millibugs
16 Pilose Cards with Thinner Trunks and 4 millibugs

c. 40 3rd generation Piloses Cards (○)
4 Pilose Cards with Wider Trunks and 2 millibugs
4 Pilose Cards with Wider Trunks and 0 millibugs
32 Pilose Cards with Thinner Trunks and 4 millibugs

(6) A bag/ box

(7) 3 bins/ baskets

Optional: 32 food-based adaptation assessment worksheets

Preparation:

(1) Print PDFs of Materials for classroom setup including 2 Environment Tiles, 3 Timeline Tracker Sheets, and the 3 Millibug Tunnel Pages (we recommend that these are laminated for repeated use).

(2) Print the 32 Initial (1st Generation) Pilose Cards, cut them out, and fold them on the dotted lines. Put them in one pile.

(3) Print the 2nd generation Pilose Cards, cut them out, fold them on the dotted lines; separate them into 2 groups based on whether they have thinner or wider trunks.

(4) Print the 3rd generation Pilose Cards, cut them out, and fold them on the dotted lines; separate them into 2 groups based on whether they have thinner or wider trunks. Place these to one side for now–they will be used later in the activity.

(5) Place 3 bins or baskets in a designated area of the classroom and label them "Piloses with Thinner Trunks", "Piloses with Wider Trunks", and "Dead Piloses."

(6) Start out by putting Pilose Cards into bins that are placed side-by-side as follows:
   a. Place 16 **2nd** generation cards (●) of piloses with thinner trunks (the ones that have 4 millibugs in the tunnels) in the "Piloses with Thinner Trunks" bin
   b. Place 16 **2nd** generation cards (●) of piloses with wider trunks (the ones that have either 0 or 2 millibugs in the tunnels) into the "Piloses with Wider Trunks**"** bin
   c. The box marked "Dead Piloses" should be empty

(7) Place the Meadow Environment Tile on a table with the 32 Initial 1st Generation Pilose Cards around it
   a. 16 Cards of Adult Piloses with Wider Trunks (and 2 millibugs)
   b. 8 Cards of Adult Piloses with Wider Trunks (and 0 millibugs)
   c. 8 Cards of Adult Piloses with Thinner Trunks (and 4 millibugs)

(8) Place the 1st generation- Meadow Timeline Tracker Sheet on the board or wall so all students can see.

(9) Place the Millibug Tunnel Pages in 3 separate areas of the classroom. Students will be asked to move to these areas if the number of millibugs on their pilose card matches the number of millibugs in the tunnel on the page.

***Instructions*:**

PRE-READING:

(1) Teacher should watch the orientation video (**link**), the pointing video (**link**), and read over the provided orientation manual (**link**).
(2) Give students an optional pre-test worksheet before book reading (recommended assessment: Tardons) (**link**).

BOOK READING:

(1) Tell students that after hearing the book they will do a class activity that will ask them to use information from the book. They should therefore pay close attention to the book so that they know what to do next.

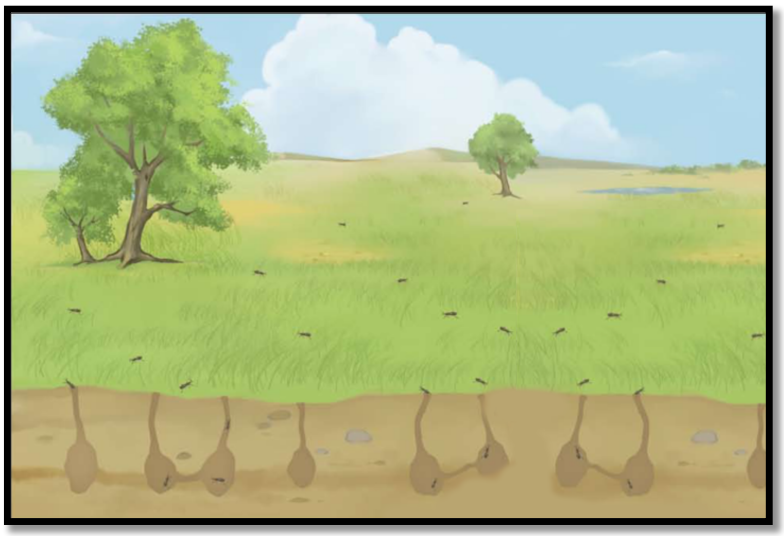
(2) Read *How the Piloses Evolved Skinny Noses* with your classroom.

    a. Refer to our pointing guide to emphasize points in the story that will help children attend to and understand the book.

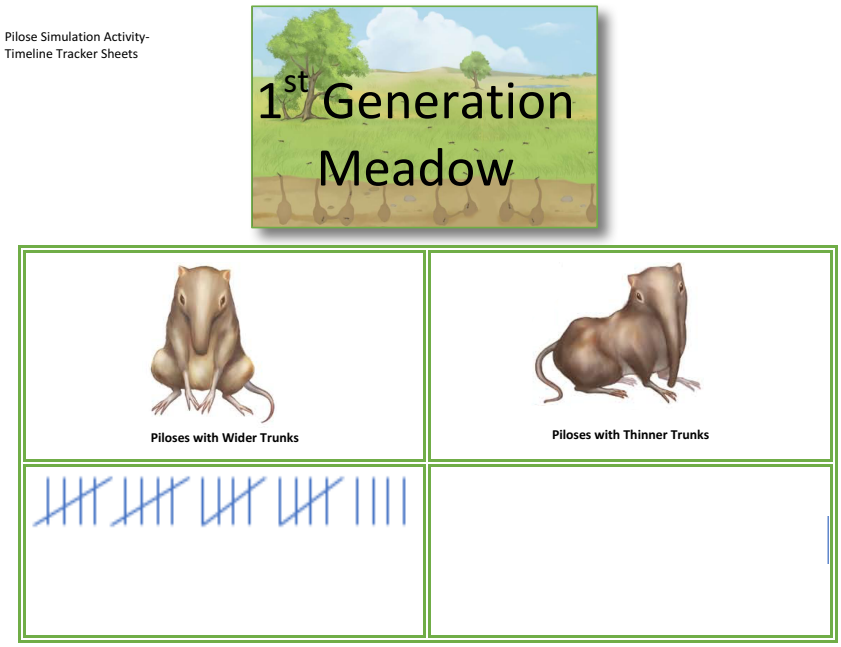
SIMULATION ACTIVITY:

INITIAL POPULATION – 1st generation

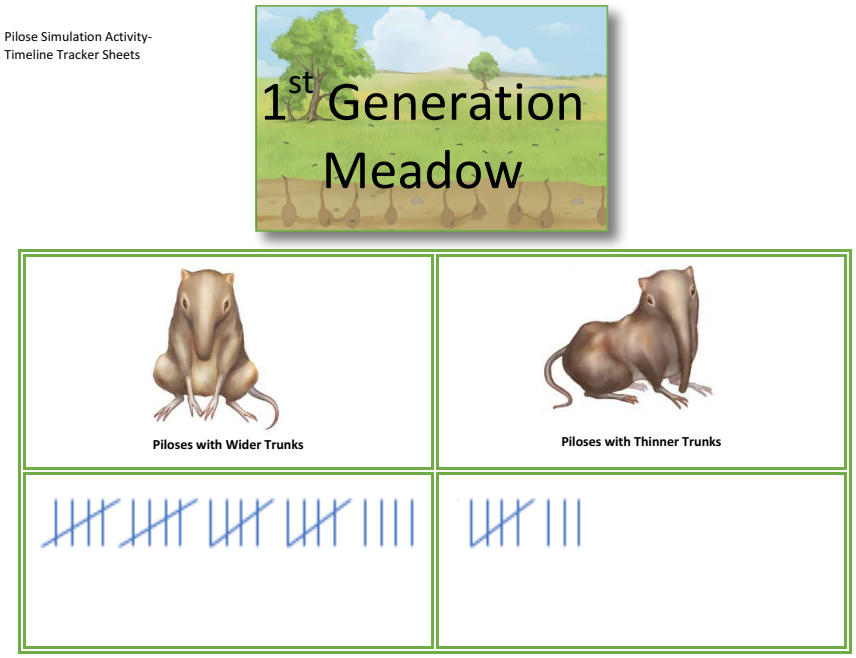
(1) Start out with students around the main table where 32 initial pilose cards are laid out around the first Environment Tile, the meadow. Introduce the environment to the students. Highlight that the millibugs – the food the piloses eat – move about all over the meadow and under the ground.



(2) Ask students to silently count how many piloses there are with wider trunks. Then ask them to report how many they found and record the number from this 1st generation on the Meadow Timeline Tracker Sheet under the column for "Piloses with Wider Trunks". (If you complete the activity with 32 students, **there should be 24 piloses with wider trunks**). **Drawing a tally mark is preferable to writing a number because it helps young students visualize the number of piloses.**



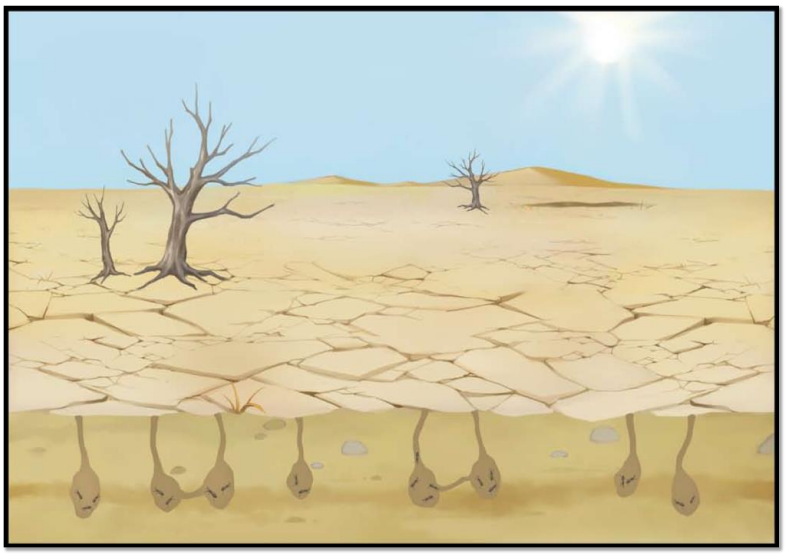
(3) Ask students to silently count how many piloses there are with thinner trunks and report how many they found. Then record this number for the 1st generation on the Meadow Timeline Tracker Sheet under the column for "Piloses with Thinner Trunks". (If you complete the activity with 32 students, **there should be 8 piloses with thinner trunks**).



(4) Ask students, “Can all of the piloses get food in this environment? Why?”

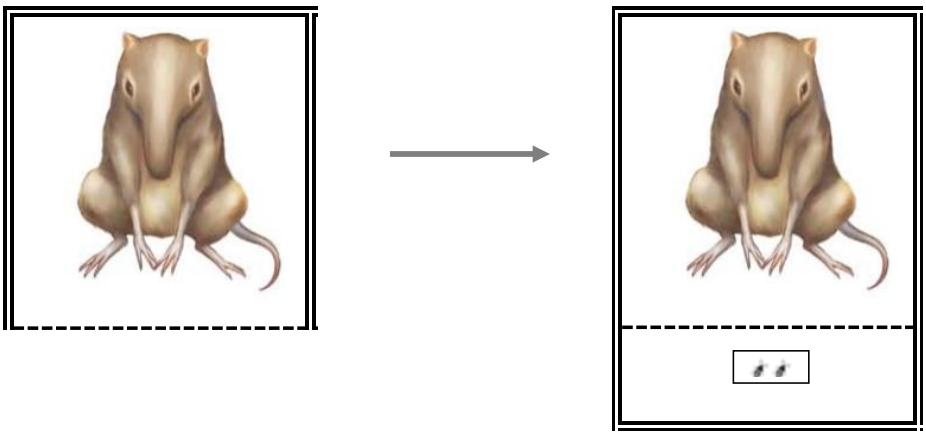
- Suggested answers: Yes, because there is food everywhere; Yes, because bugs are found above ground and below ground.

(5) **The environment changes:** Now, switch out the Meadow Environment Tile for a Desert Environment Tile. Describe how the environment changed and became very hot and sunny all of the time so that the ground went from being green and soft to being dry and hard. It may be useful to insert language from the book: “because of the heat, the millibugs went from moving about all over to moving about only underground where it was cool. Most of the bugs stayed at the very ends of thin underground tunnels”.



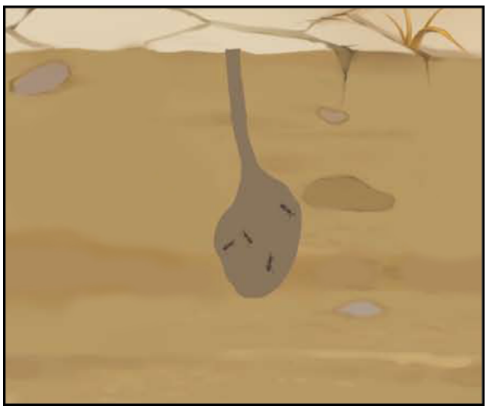
(6) Place the Pilose Cards on the table into a box/ bag and shuffle them. Instruct each student (or pair) to pick one Pilose Card.

(7) Ask each student to unfold the bottom of their card to reveal the number of millibugs that their pilose could eat.

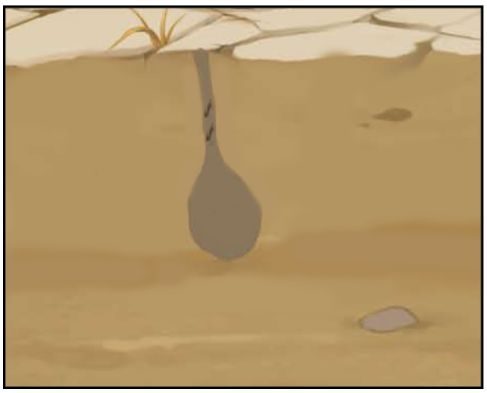


(8) Direct students to move to the area of the room where the Millibug Tunnel Page matches the number of millibugs that their pilose could eat.

- Students with pilose cards that are unfolded to reveal 4 millibugs should stand by the area with the Millibug Tunnel that contains 4 millibugs.



- Students with pilose cards that are unfolded to reveal 2 millibugs should stand by the area with the Millibug Tunnel that contains 2 millibugs.



- Students with pilose cards that are unfolded to reveal 0 millibugs should stand by the area with the Millibug Tunnel that contains 0 millibugs.

(9) Direct students to turn and talk to a partner about what kind of pilose they received and how many millibugs it could eat. Ask them to address why they think their pilose got to eat as many millibugs as it could.

(10) After discussing, bring students back to share what they discussed with their partner. Ask them about what kind of trunk their pilose has and how many millibugs it could eat.

- Make sure to clarify that piloses with thinner trunks could eat 4 millibugs by referring to the logic in the text: "their trunks could fit all the way to the bottom of the holes where most of the millibugs lived" (page 10).
- Also address that there are piloses with wider trunks who could eat either 0 millibugs or 2 millibugs.
- Address the question of why some piloses with wider trunks could eat 0 millibugs and others could eat 2 millibugs with an explanation from the text: "Piloses with wider trunks had trouble getting food. They could only fit the tips of their trunks into the holes. Some piloses with wider trunks got to eat when they found millibugs that were moving about near the top. But other piloses with wider trunks did not eat anything at all" (page 11).

(11) Discuss with students what would happen to each type of pilose.

- "Are the piloses who got to eat 4 millibugs strong and healthy? Why?"
  - Suggested answer: Yes, because they got to eat a lot of millibugs, they had a lot of energy.
- "Are the piloses who got to eat 2 millibugs strong and healthy?"
  - Suggested answer: They were kind of healthy. They had less energy than the piloses with thinner trunks who could eat 4 millibugs, but they were still able to survive.
- "What about the piloses who didn't get to eat any millibugs?"
  - Suggested answer: No, they weren't strong and healthy; They were weaker and had less energy.

(12) Ask students what eventually happened to the piloses who could not eat. Explain that they eventually died. Direct the students who had piloses with 0 millibugs to place their pilose in the Dead Piloses bin, go back to their Millibug Tunnel Page, and watch what would happen to the other piloses.

(13) Discuss with the students that the piloses who got to eat a little food—the ones with 2 millibugs— were healthy enough to have <u>only one child</u>.

(14) Ask students about inheritance, "What kind of trunk would the child of a pilose with a wider trunk usually have? Why?"

- Suggested answer: A child with a wider trunk because children are usually born with the same kind of trunk that their parents were born with.

(15) Discuss with the other students how the piloses with thinner trunks were very healthy and could live for a long time. These piloses who could eat the most millibugs—4 millibugs—and were healthy enough to have many children.

(16) Ask students about inheritance, “what kind of trunk would the child of a pilose with a thinner trunk usually have? Why?”

- Suggested answer: Children with thinner trunks because children are usually born with the same kind of trunk that their parents were born with

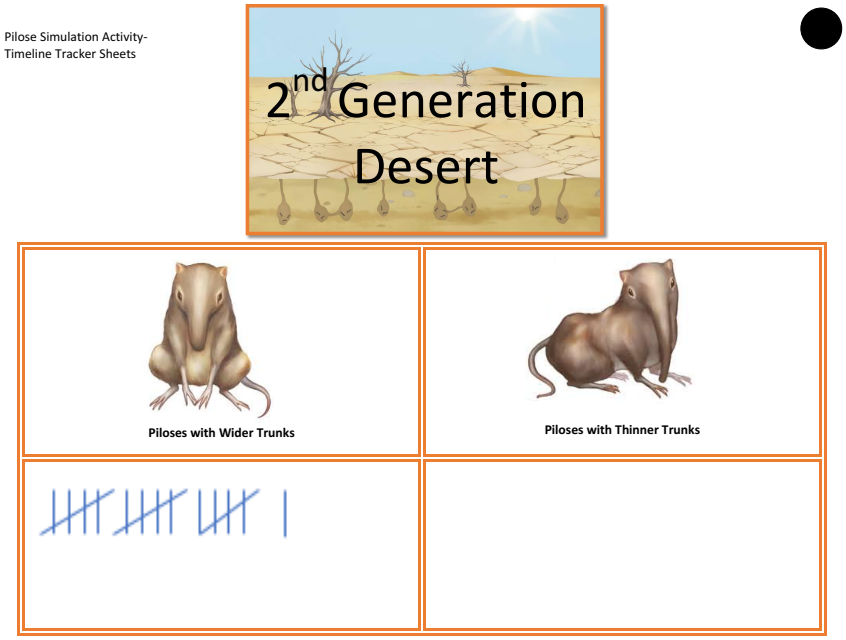
(17) Direct students to go to the designated bin and pick up the children that their pilose had. Students with a pilose that has 2 millibugs should pick up **one** pilose with a wider trunk. Students with a pilose that has 4 millibugs should pick up **two** piloses with thinner trunks.

2nd Generation

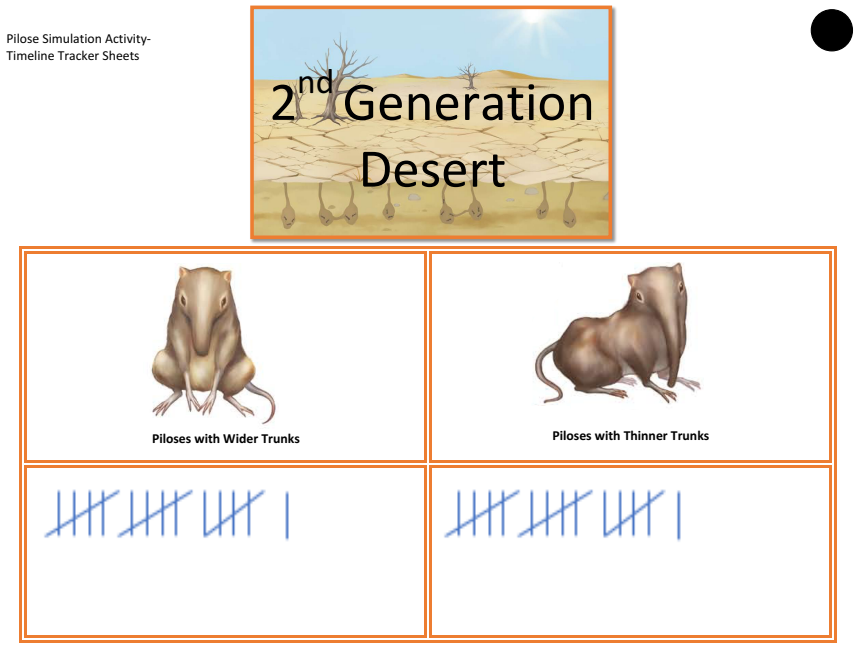
NOTE: For both the 2nd Generation and 3rd Generation, many of the discussions points and suggested answers are repeated in the text. This information shows up more than once for your convenience in case you wish to flip through the guide page-by-page during the activity.

(1) Explain that much time has passed, their initial piloses have died and the children are now adults. Instruct students to place those initial piloses in the Dead Piloses Bin but hold on to the children that they just picked up. They should place them around the Desert Environment Tile. **Make sure that they are discarding the pilose cards from the first generation –the ones without dots; every student should have placed down at least one card with a dot that looks like this (●).**

(18) Ask students how many piloses there are with wider trunks. Record this number for the 2nd generation on the Desert Timeline Tracker under the column for piloses with wider trunks. (This number may vary, but if the activity is completed with 32 students, **there should be 16 with wider trunks**).



(19) Ask students how many piloses there are with thinner trunks. Record this number for the 2nd generation on the Desert Timeline Tracker under the column for piloses with thinner trunks. (This number may vary, but if the activity is completed with 32 students, **there should be 16 with thinner trunks**).

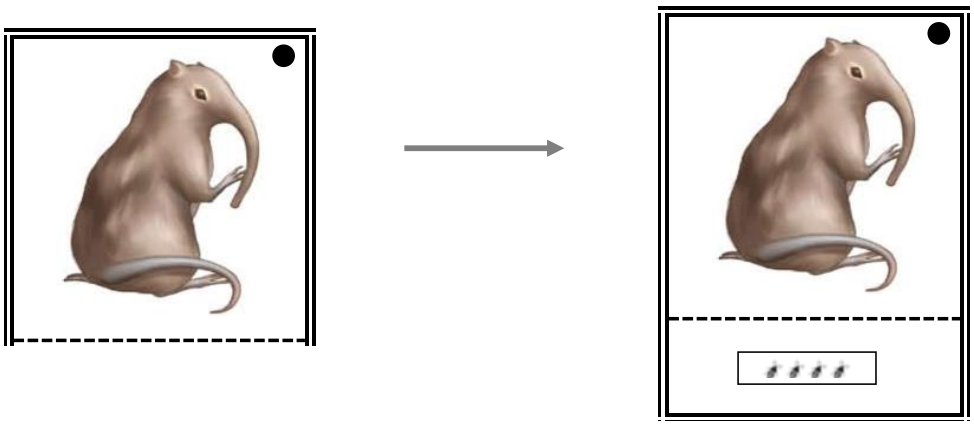


(20) Ask students, "Can all of the piloses get food in this environment? Why?"

- Suggested answers: No, because the food is far underground and not all the piloses can reach; No, because only the piloses with thinner trunks can reach.

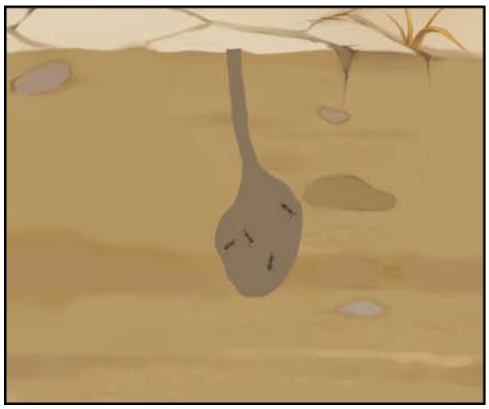
(21) Place the pilose cards on the table into a box/ bag and shuffle them. Instruct each student to pick a pilose card.

(22) Ask each student to unfold their card to reveal the number of millibugs that their pilose could eat.

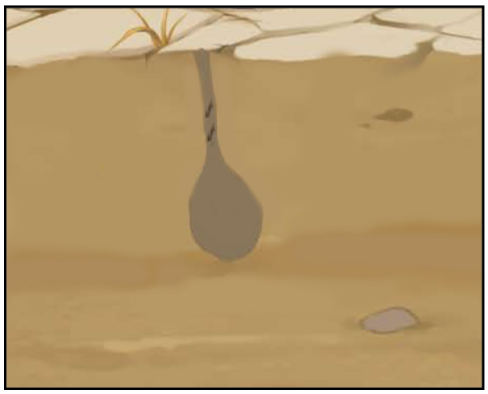


(23) Direct students to move to the area of the room where the Millibug Tunnel Page matches the number of millibugs that their pilose could eat.

- Students with pilose cards that are unfolded to reveal 4 millibugs should stand by the area with the Millibug Tunnel Page for 4 millibugs.



- Students with pilose cards that are unfolded to reveal 2 millibugs should stand by the area with the Millibug Tunnel Page for 2 millibugs.



- Students with pilose cards that are unfolded to reveal 0 millibugs should stand by the area with the Millibug Tunnel Page for 0 millibugs.

(24) Direct students to turn and talk to a partner about what kind of pilose they received and how many millibugs it could eat. Ask them to address why they think their pilose got to eat as many millibugs as it did.

(25) After discussing, bring students back to share what they discussed with their partner. Ask them about what kind of trunk their pilose has and how many millibugs it could eat.

- If needed, remind students that there are piloses with thinner trunks who could eat 4 millibugs by quoting the text: "their trunks could fit all the way to the bottom of the holes where most of the millibugs lived" (page 10).
- Also address that there are piloses with wider trunks who could eat either 0 millibugs or 2 millibugs.
- Address the question of why some piloses with wider trunks could eat 0 millibugs and others could eat 2 millibugs with an explanation from the text: "Piloses with wider trunks had trouble getting food. They could only fit the tips of their trunks into the holes. Some piloses with wider trunks got to eat when they found millibugs that were moving about near the top. But other piloses with wider trunks did not eat anything at all" (page 11).

(26) If desired, again discuss with students what would happen to each type of pilose.

- "Are the piloses who got to eat 4 millibugs strong and healthy? Why? Did they have enough energy?"
  - Suggested answer: Yes, because they got to eat a lot of millibugs. They had a lot of energy.
- "Are the piloses who got to eat 2 millibugs strong and healthy?" "Did they have as much energy as the piloses who could eat 4 millibugs?"
  - Suggested answer: They were kind of healthy. They had less energy, but they were still able to survive.
- "What about the piloses who didn't get to eat any millibugs?"
  - Suggested answer: No, they weren't strong and healthy; They were weaker and had less energy.

(27) Ask students what eventually happened to the piloses who could not eat. Explain that they eventually died. Direct the children who had piloses with 0 millibugs to place their pilose in the Dead Piloses bin and watch what would happen to the other piloses.

(28) Discuss with the students that the piloses who got to eat a little food—the ones with 2 millibugs— were healthy enough to have only one child.

(29) Ask students, "what sort of child would a pilose with a wider trunk have? Why?"

- Suggested answer: A child with a wider trunk because its parent had a wider trunk.

(30) Discuss with the other students how the piloses with thinner trunks were very healthy and could live for a long time. These piloses who could eat the most millibugs—4 millibugs—were healthy enough to have many children.

(31) Ask students, "what sort of children would a pilose with a thinner trunk have? Why?"

- Suggested answer: Children with thinner trunks because its parent had a thinner trunk.

(32) Change the pilose cards in the pilose bins; switch out the remaining 2nd generation pilose cards (●) for the 3rd generation pilose cards (○).

(33) Direct students to go to the designated bins and pick up the children that their pilose had. Students with a pilose that has 2 millibugs should pick up one pilose with a wider trunk. Students with a pilose that has 4 millibugs should pick up two piloses with thinner trunks.

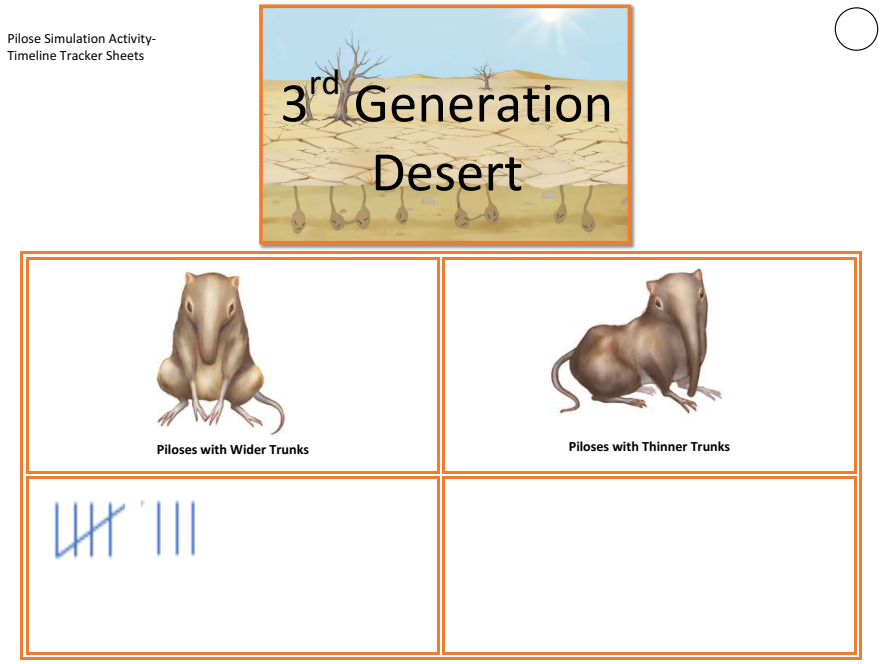
3rd Generation

NOTE: For both the 2nd Generation and 3rd Generation, many of the discussions points and suggested answers are repeated in the text. This information shows up more than once for your convenience in case you wish to flip through the guide page-by-page during the activity.

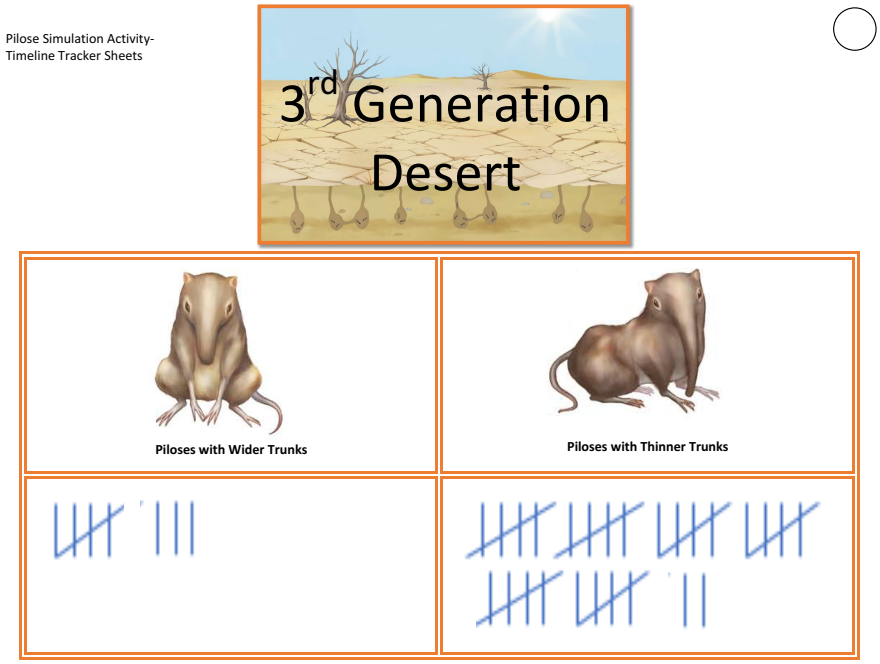
(1) Explain that much time as passed, and their initial piloses have died and the children are now adults. Instruct students to place the parent piloses in the Dead Piloses bin but hold on to the pilose children they just picked up and place them around the desert environment tile. **Make sure that they are disregarding the pilose cards from the second generation with black dots; every student should have placed down at least one card with a dot that looks like this** (○).

(2) Reiterate what the piloses' environment is like. Describe that the weather is still very hot and sunny nowadays and that the ground is still dry and hard. Mention that the millibugs are still moving about only underground where it is cool.

(3) Ask students how many piloses there are with wider trunks. Record the number of piloses with wider trunks in the 3rd generation on the Desert Timeline Tracker sheet under the column for piloses with wider trunks. (This number may vary, but if the activity is completed with 32 students, **there should be 8 with wider trunks**).



(4) Ask students how many piloses there are with wider trunks. Record the number of piloses with wider trunks in the 3rd generation on the Desert Timeline Tracker sheet under the column for piloses with thinner trunks (This number may vary, but if the activity is completed with 32 students, **there should be 32 with thinner trunks**).



(5) Look at all three timeline tracker sheets. Ask students what happened on this round and why there are now more piloses with thinner trunks than piloses with wider trunks. Ask them to come up with an explanation for how over time, the number of piloses with wider trunks decreased over time. Make sure to prompt for explanations that encompass these 5 points: differential survival, differential reproduction, multiple generations, trait constancy (trait type staying the same during an entire life), and inheritance.

- Suggested answer: Over time, the group went from mostly having wider trunks to mostly having thinner trunks. This was because piloses with wider trunks could not reach their food and stay healthy (**differential survival**), but piloses with thinner trunks could, and they had lots of energy to have many children (**differential reproduction**). Piloses with wider trunks usually had children with wider trunks and those children also had trouble getting food because their trunks stayed the same their entire lives (**trait constancy**). Piloses with thinner trunks usually had children who were born with thinner trunks because children are usually born with the same trunks their parents are born with (**inheritance**). These children grew up and were very healthy because they could reach the millibugs and so they had lots of energy to also have many children (**multiple generations**). So, over time, there came to be more piloses with thinner trunks than wider trunks in the group because piloses with thinner trunks were healthier and had more babies.

Assessment

If time permits, and as an extension of this activity give students one of the food-based adaptation assessment worksheets (recommended: Orpeds, **link**).