Interpreting The Fossil Record

Name: ______________________ Hour: ______

How do scientist analyze the fossil record?

Materials

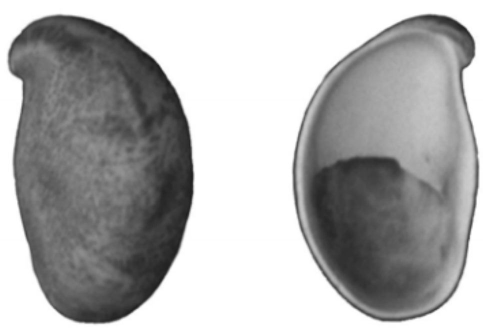
- Ruler
- Scissors
- 4 plastic sandwich bags
- Pen or pencil

Fossils are the preserved remains of once-living things. After a living thing dies, it's covered by wind or water-carried rock particles. Over time, these particles are changed into sedimentary rock. In this way, the shape of once-living things is preserved in rock as a fossil. Fossils are like a picture album of life as it once was on Earth. Unfortunately, time and events have scrambled the album. Some pages are missing and others are out of order. Paleontologists are scientists who interpret the fossil record of past living things. By studying fossils, they are able to trace how living things appeared and changed over time. In this investigation, you will see that mathematics is essential to the interpretation of fossils.

Part 1: Measuring Fossils

To explore the way paleontologists study fossils, we will use the Common Atlantic Slipper as an example. Mollusks such as clams are very old animals. They have been on Earth for hundreds of millions of years. The Common Atlantic Slipper is another old mollusk that is still around today. Slippers are mollusks with only one shell. They hold on to solid surfaces with their muscular underbodies and the single shell forms a protective shield over their backs. Here is an actual-sized picture of the front (ventral) and back (dorsal) surface of a Common Atlantic Slipper:

A Common Atlantic Slipper
(actual size)



Dorsal side Ventral side

When studying fossils, some characteristics provide better data than others. You might measure the length of the Slipper's shell. Or you might measure the roundness of the Slipper's shell. Then you would compare fossil samples from different times to see if that measurement changed as time passed.

1. Measuring the roundness of the shell provides more reliable data than measuring the length of the shell. Can you see why? Imagine that fossil shells were collected from a time when food was scarce. Scarce food means slower growth. Why might scarce food have a greater effect on the length of the shells?

Part 2: Measuring shape

To see how scientists measure the roundness of Slipper shells, use the photograph in Part 1 and follow the steps:

1. Measure the shell length along its longest dimension.
2. Turn your ruler ninety degrees and measure the shell width across the widest point.
3. Divide the width by the length.
4. The result will be a number between zero and one, called the shape index.

Shape Index

Example:

$$Shape = \frac{Width}{Length}$$

$$Shape = \frac{24\ mm}{40\ mm} = 0.6$$

Questions

1. What is the shape index value for the Common Atlantic Slipper in the photograph in Part 1? What does the number tell you about its shape?

2. Which shell is more round, one with a shape index of 0.4 or one with a shape index of 0.5?

Part 3: Representing measurements in a sample of slipper shells

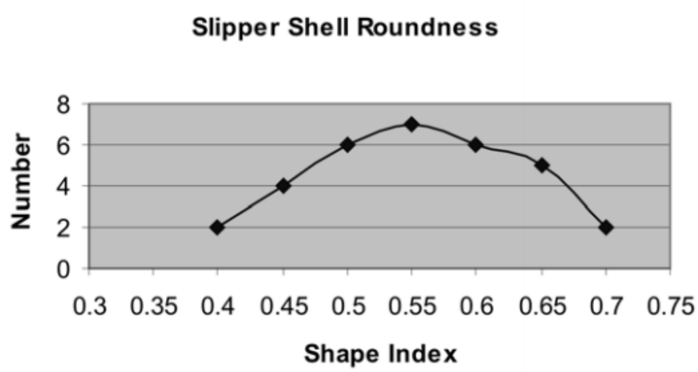
Imagine that you are a million years in the future. While digging in the side of a hill, you find the bones of an NBA basketball player. These bones belonged to a human that was much taller than earlier humans. You conclude that something caused humans to suddenly change so that they became very tall. Back at our time, we know that this conclusion is not correct. Humans did not suddenly become over six feet tall. What caused this error? What could you do to avoid this error?

The human height error was caused by having only one set of bones to measure. Look at your classmates around you. Would it be reasonable to pick a classmate and declare that everyone in your class stood that tall? Clearly many individuals must be measured. Then all of the measurements must be mathematically changed into a single height that represents your class.

How do we change many class heights into a single height? This process belongs to the branch of mathematics called statistics. We will look at two statistical ways to represent a group of measurements, as a graph and as a number.

Representing sample measurements as a graph

A graph is a picture of all of the members of a fossil sample. There are 32 individual shells in this sample. They range from narrow shells with a shape index of 0.4 to more rounded shells with a shape index of 0.7. The graph allows you to see the number of each shape in the sample.



1. How many shells have a shape index of 0.6?

2. What shape index number is the most common?

Representing sample measurements as a number

Showing measurements as a graph gives a lot of information about a single sample. But graphs can be difficult when you want to compare many samples, each with many measurements. Comparing many samples is much easier if the measurements in each sample can be converted into a single number. Then comparing the samples is as easy as comparing their numbers. There are many different statistical methods for changing a group of measurements into a single number, but we will use an easy one that you may already know, averaging. Finding an average is easy. You add all of the measurements and divide the total by the number of measurements.

$$Average = \frac{Sum\ of\ measurements}{Total\ number\ of\ measurements}$$

3. Calculate the average Slipper shell given the data in the table below. Show your work (equation)

Table 1: Shape Index For a Sample of Common Atlantic Slippers

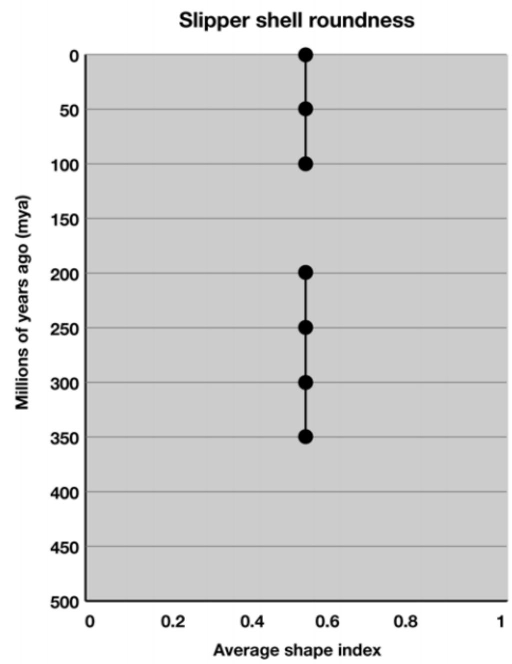
Shell no.	Shape	Shell no.	Shape	Shell no.	Shape	Shell no.	Shape
1	0.4	9	0.5	17	0.55	25	0.5
2	0.45	10	0.6	18	0.65	26	0.55
3	0.55	11	0.55	19	0.5	27	0.55
4	0.6	12	0.65	20	0.55	28	0.7
5	0.5	13	0.6	21	0.65	29	0.6
6	0.5	14	0.4	22	0.5	30	0.45
7	0.45	15	0.65	23	0.7	31	0.65
8	0.6	16	0.55	24	0.6	32	0.45

Part 4: Stop & Think

1. Why is roundness used as a measurement instead of length for analyzing Slipper shell fossils?
2. Why is a graph a good way to compare the shape index of all of the Slipper shells in a single sample?
3. Why do we use an average value for comparing the shape index of many Slipper shell samples?

Part 5: Interpreting the Fossil Record

Congratulations! You now have all the skills needed to interpret imaginary fossil records. At the beginning, we said that fossils are like a picture album of life with missing and out of order pages. Your task is to reconstruct that picture album and interpret the changes that took place. Paleontologists have a specific way that they represent each album page. It looks like the graph shown to the right.



This graph is unusual in that time is shown on the left side. Usually time is shown along the bottom. Paleontologists use this method because it reflects the way they find fossils. Older fossils are normally deeper in the ground than younger fossils.

The oldest fossils are very old! Scientists who deal with deep time use the Geological Time Scale to represent large amounts of time. The divisions of the scale have names that correspond to millions of years ago, abbreviated *mya*.

This fossil record shows the plotted data from seven samples of our Common Atlantic Slipper. Here are the original data that were used to prepare the graph:

Table 2: Average Slipper Shape Index for Samples

Millions of years ago (mya)	Shape Index	Millions of years ago (mya)	Shape Index
0 (now)	0.55	300	0.54
50	0.56	350	0.55
100	0.55	400	No sample
150	No sample	450	No sample
200	0.55	500	No sample
250	0.56		

Now we can make some interpretations about the history of the Common Atlantic Slipper. Here are some guide questions to help you. You should be able to give specific reasons for your answers. Write down your answers before you read the para-graph below. Then compare your answers to the ones given on the class sheet.

1. Is there evidence for change in the shape of the Slipper, or has its shape been the same through time?
2. Is the Slipper extinct?
3. There is no sample from 150 million years ago. Where on the graph would you expect the missing point to appear? Explain your answer.
4. When did the Slipper first appear?

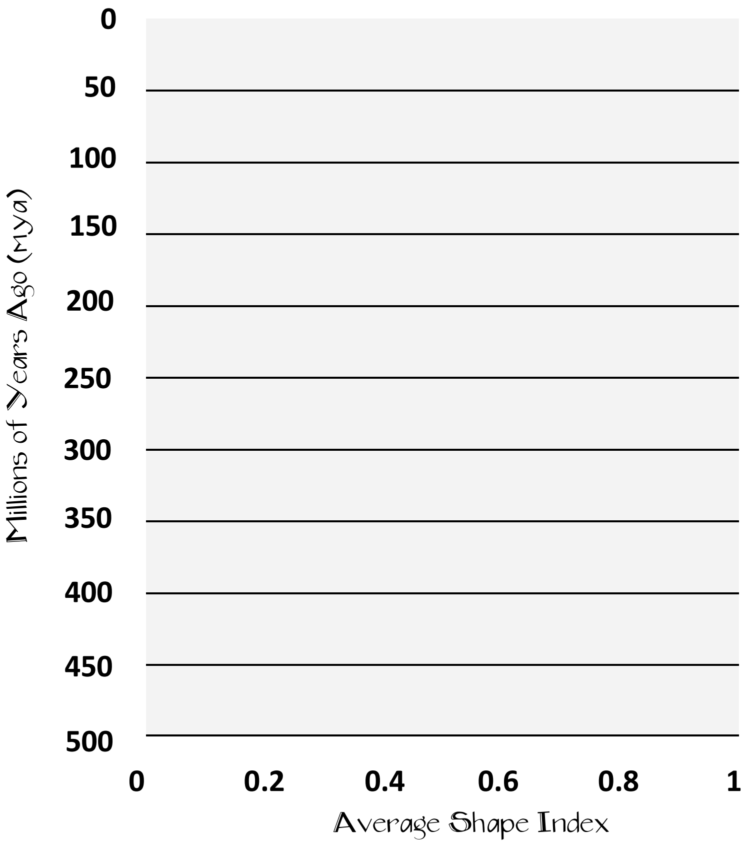
Name: ___________________________________

Hour: __________

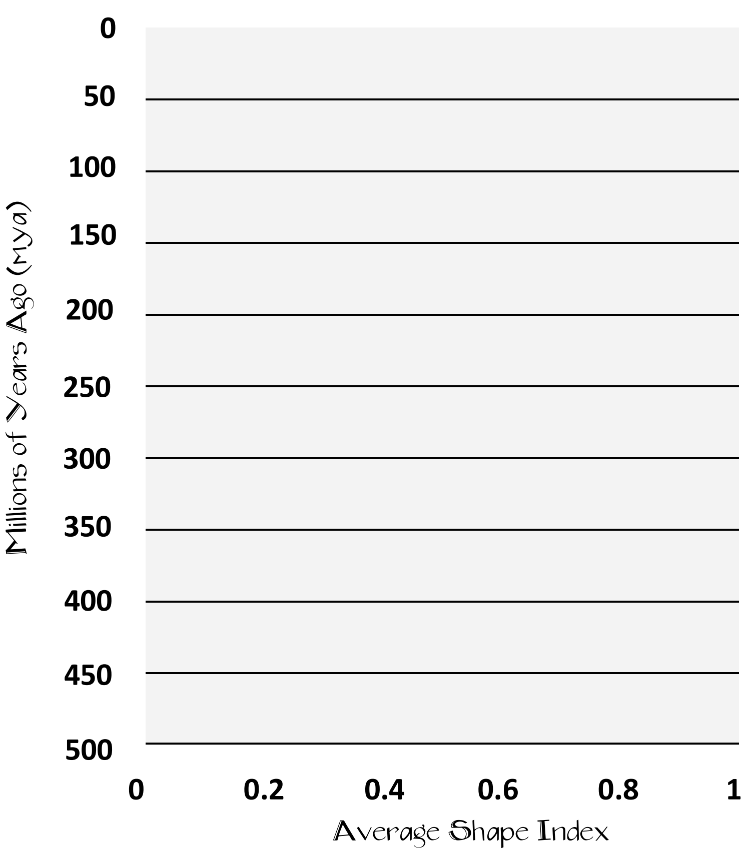
Part 6: Fossil Record Interpretations:

Sketch a graph for each set of data.

Data Set A



Data Set B



Part 7: Applying your Knowledge:

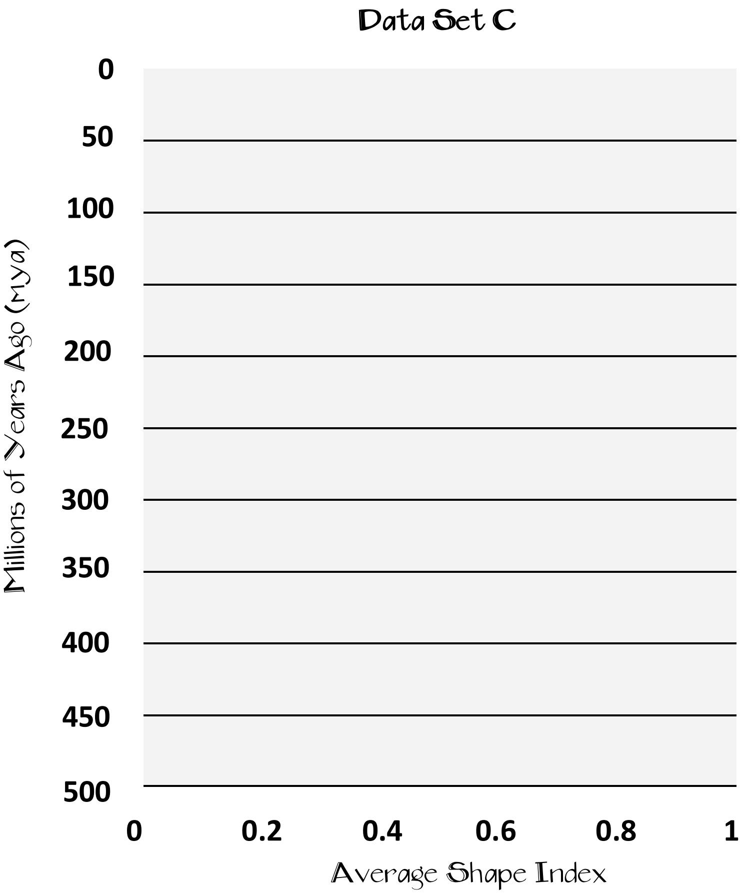
Answer the following questions below.

1. **Data Set A**

   How would you rate your confidence in your interpretation? Strong, fair, or weak?

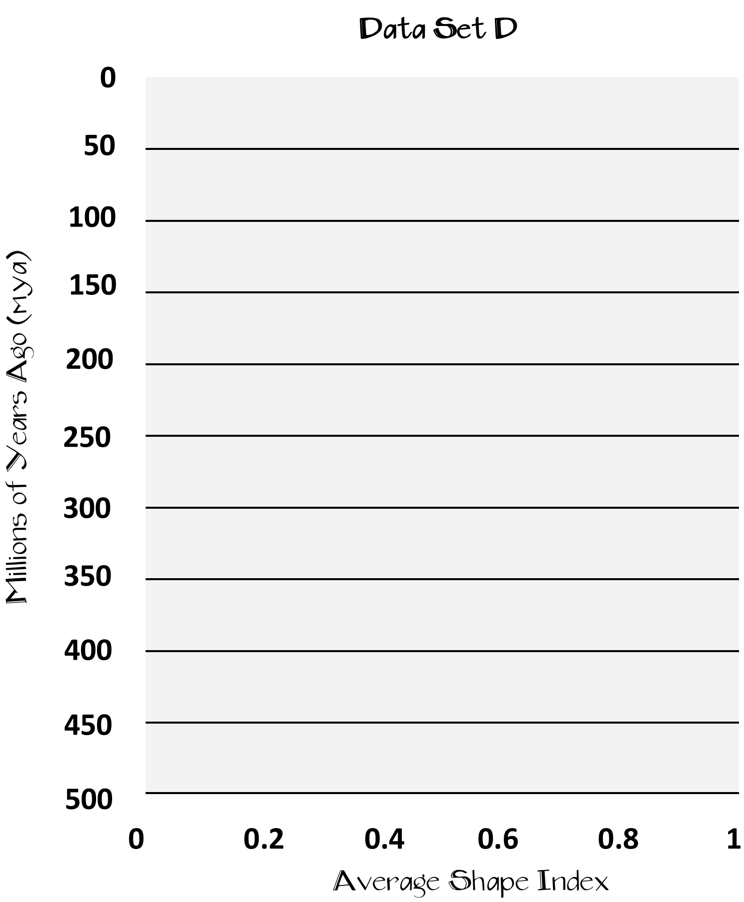
2. **Data Set B**

   What is special about Set B after 250 mya? Use your imagination to create and describe an environment that might explain this. A good starting point might have to do with predators or food availability.



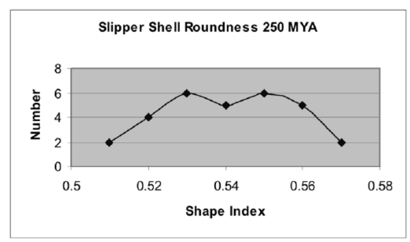
3. Data Set C

Sometimes this is all that paleontologists have to work with. What interpretations can you make confidently?



4. Data Set D

To the right is a good example of why data are displayed as graphs as well as numbers. This is a graph of all of the Slipper Shells from 250 mya in Data Set D. Although the average Shape Index is 0.54, the graph gives a hint about an important change in progress.



Explain how this graph shape relates to the Data Set D twin lines after 250 mya.

What biological event do you think produced the twin lines after this date?