Name________________________________ Date___________________

Stanford Earth Young Investigators: Biodiversity
Fossil Lab 01 – Cambrian Fossils and Microfossils
Modified from GS 123 Lab by Will Gearty

Objective: The goals of this lab are 1) to become familiar with microfossils and representative fossils of the Cambrian Period, 2) to think about how we classify fossil organisms, and 3) to explore how what is preserved and how things are preserved in the fossil record influences our understanding of ancient life.

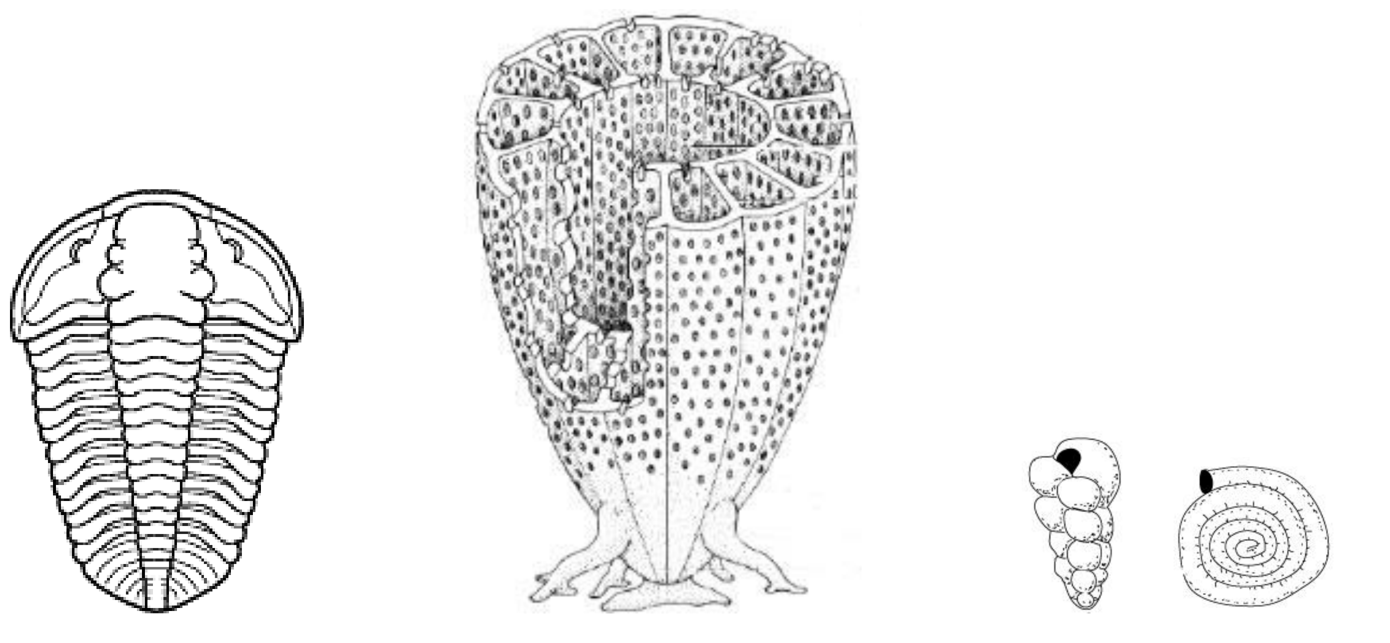

Fig. 1. Diagrams of a trilobite, archeocyathid, and a representative of the group of microfossils. Diagrams are not to scale.

Tasks:

1. Look at the fossil specimens provided to.

2. Answer the included questions.

3. Answer the questions on the Lab Feedback sheet.

The Cambrian Explosion

The oldest fossils of nearly all (well-preserved) phyla occur in the Cambrian Period. This phenomenon is often described as the **"Cambrian Explosion"** for the rapid appearance and diversification of metazoan life. The chart in fig. 2 shows the first appearances of phyla during the Proterozoic and Paleozoic Eras. The only phylum with skeletonized forms appearing after the Cambrian was the Bryozoa during the Ordovician.

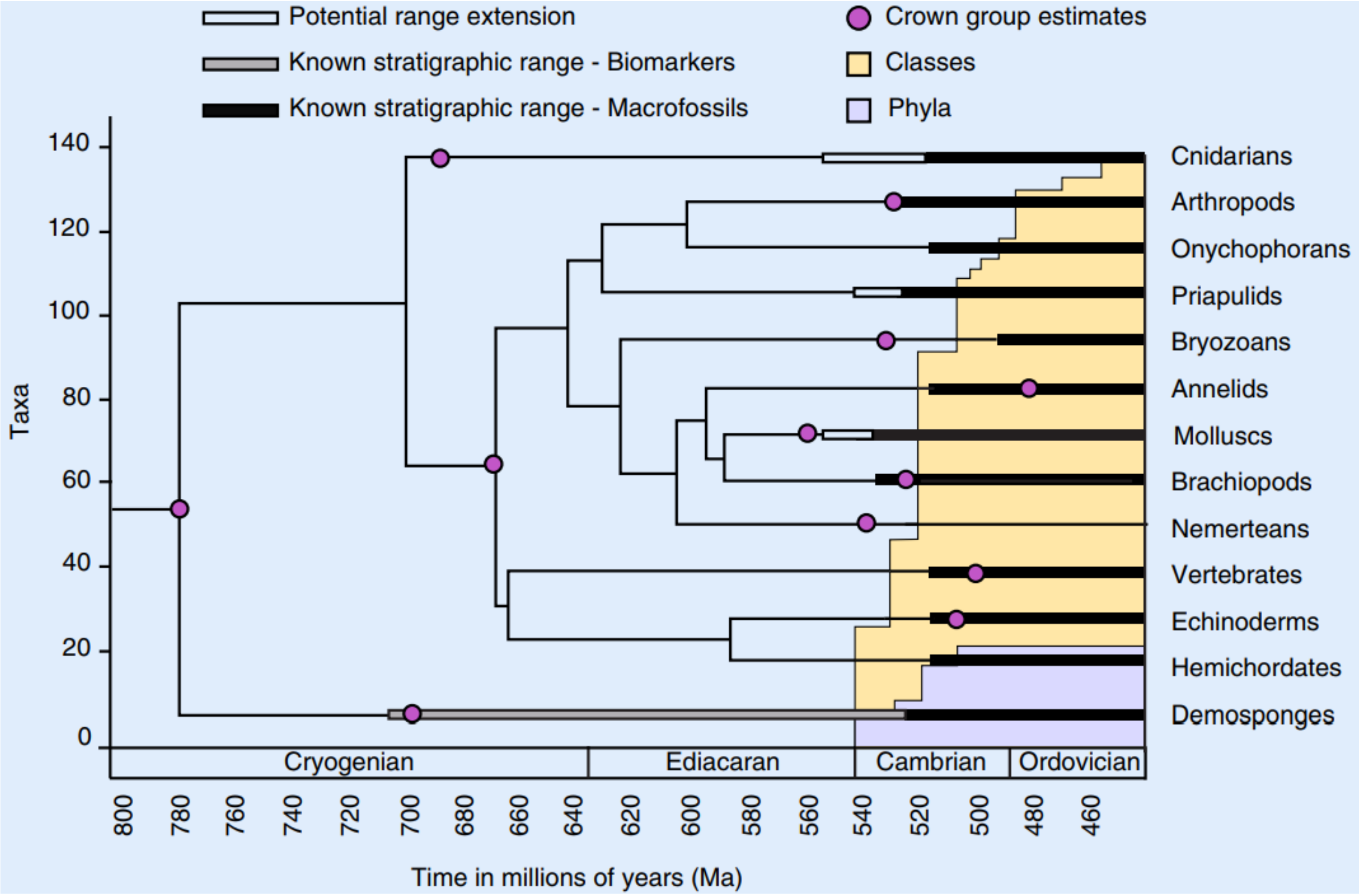

Fig. 2. First appearances of metazoan phyla during the Proterozoic and Paleozoic Eras.

An important question in paleobiology relates to this sudden appearance in the fossil record of many diverse forms of life. That question is: Was the Cambrian Explosion driven by evolutionary changes (new and diverse forms of life appeared or gained hard parts suddenly) or by preservational changes (these forms of life existed long before the Cambrian but were not preserved)? You should keep this question in mind as you work through this lab and become familiar with some of the important representatives of the Cambrian.

A. Archeocyathans

Archeocyathans were one of the earth's first multicellular, reef-building organisms. They appeared in the Early Cambrian and quickly spread around the world. The reef complexes built by archeocyathans occasionally reached tens of meters in thickness and covered several square kilometers. They went extinct in the early Middle Cambrian, and their ecological role was later filled by sponges and corals.

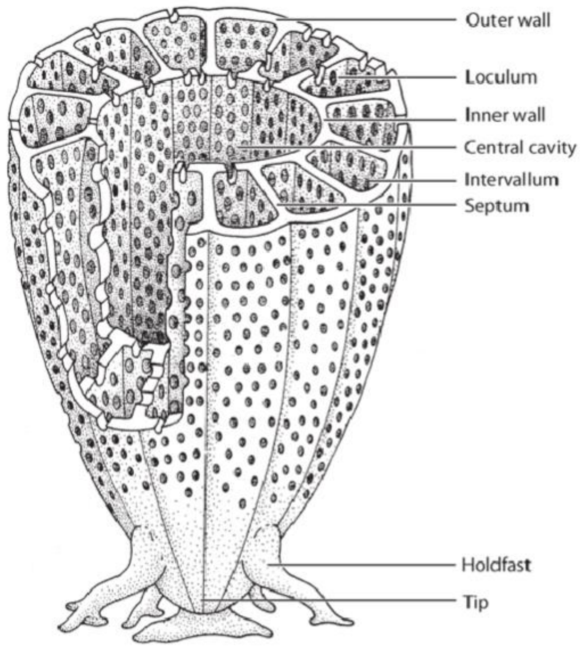

Figure 3. A labeled diagram of an Archaeocyathan (Prothero 2013).

1. Sketch two archeocyathan specimens of your choice. You should choose specimens that show the most complete and detailed morphology. Use the diagram above as references to label your sketches with important anatomical features. Make a note of any features that are not preserved in your specimens next to your diagrams. Include a scale with your sketches. If a genus and species name are provided with your specimens, be sure to include this information with your sketches.

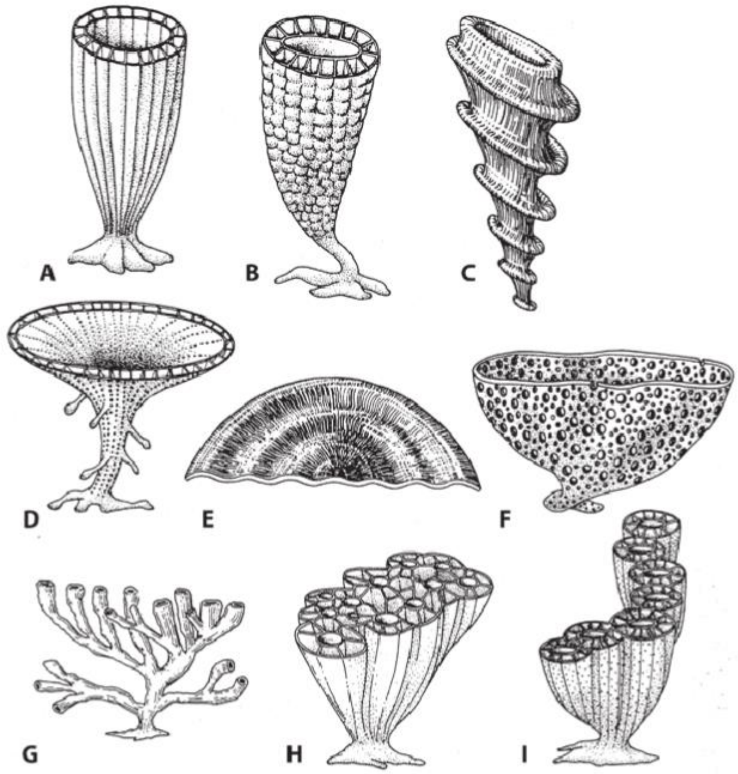

Figure 4. The many forms of archaeocyathans (Prothero 2013).

2. Observe the various forms of archaeocyathans in the figure above. In what ways do archeocyathans resemble sponges? Cnidarians? How do they differ from these groups?

3. The placement of archeocyathans on the Tree of Life has been controversial. At different times, they have been grouped with sponges, corals, foraminifera, and calcareous algae. Why do you think their classification has been so contentious?

B. Trilobites

Trilobites were the most common and diverse group of fossilizable Cambrian invertebrates. They are placed in the phylum Arthropoda along with crustaceans and insects. They are so abundant in Cambrian rocks that they have become a standard tool for biostratigraphers working in that period. They reached the height of their diversity in the Late Cambrian, when they exhibited over 300 genera.

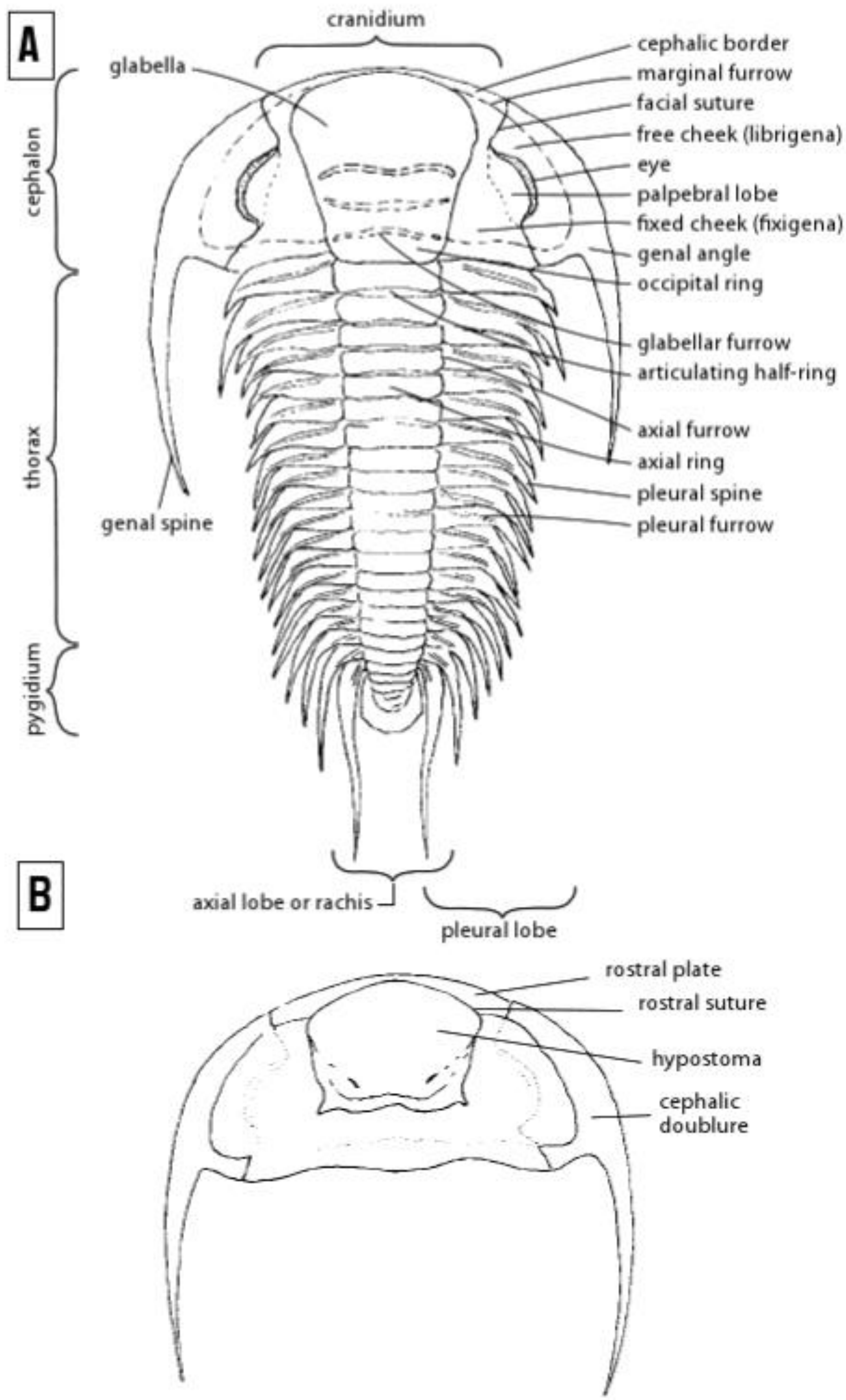

Figure 5. A labeled diagram of a trilobite (Prothero 2013).

4. Sketch a trilobite specimen of your choice. You should choose a specimen that shows the most complete and detailed morphology. Use Figure 5 as a reference and label your sketch with important anatomical features. Make a note of any features that are not preserved in your specimen next to your diagram. If a genus and species name is provided with your specimen, be sure to include this information with your sketch. Don't forget to include a scale on your sketches.

Molting in Trilobites

Arthropods possess a relatively hard, inelastic exoskeleton. In order for arthropods to grow they must shed this exoskeleton and grow another when their growth cycle is completed. The shedding of the exoskeleton is referred to as “molting” or “ecdysis.”

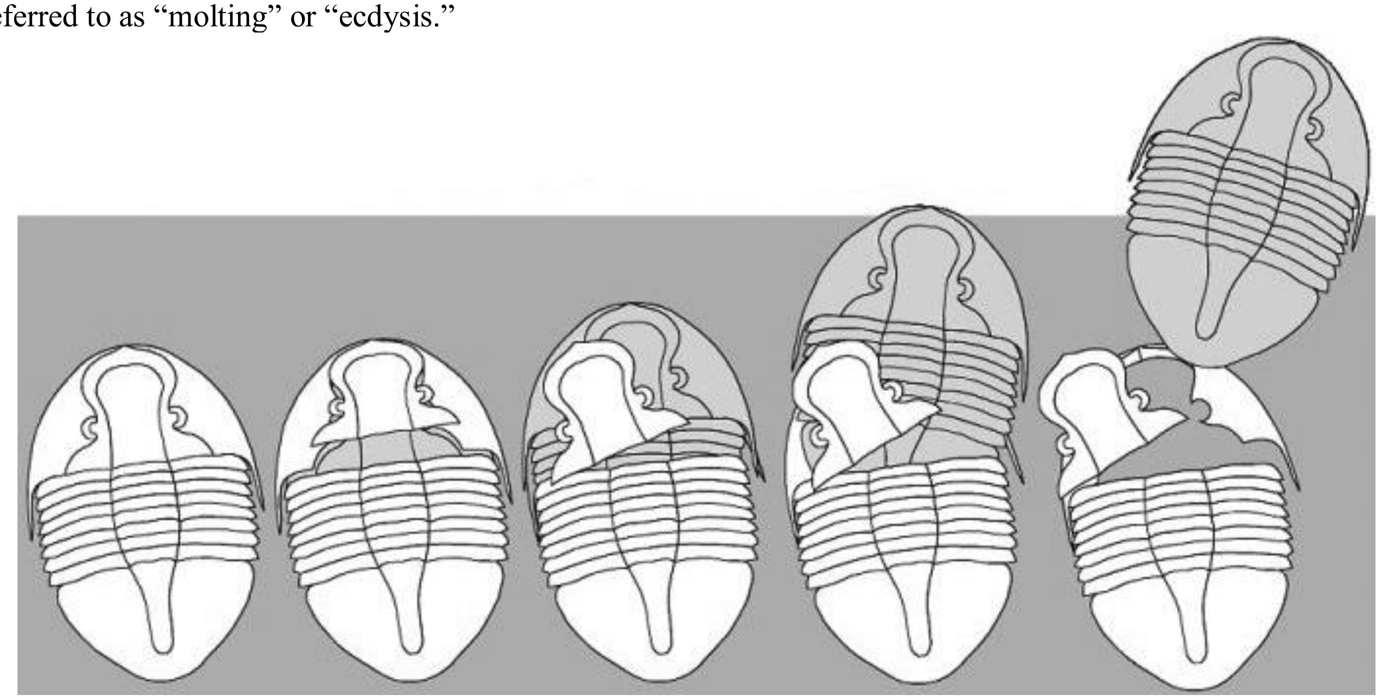

Figure 6. Trilobite molting sequence. Modified from the Guide to the Orders of Trilobites website (www.trilobites.info), created and maintained by Sam Gon III. Originally appeared in: Ludvigsen, Rolf. 1979. Fossils of Ontario. Part 1: The Trilobites: Royal Ontario Museum Life Sciences Miscellaneous Publications, 96 p.

5. What effect has the growth cycle of trilobites had on their fossil record?

6. Look at the trilobite specimens. Identify one (by genus/species name and geologic period) that is likely a piece of molted exoskeleton and one that most likely represents the death of the animal. For each, explain the evidence for your conclusion.

C. The Burgess Shale

You have learned that most fossils include only the hard parts of organisms because of the high durability and low nutrient value of these hard parts. In some cases, however, extraordinary preservation has resulted from favorable environmental conditions in depostional environments. Preserved features in these deposits may include soft tissues, skin textures, and even color. Fossil deposits such as these have been given the name **Lagerstätten**, which is German for "mother lode." Perhaps the most famous of these Lagerstätten is the Middle Cambrian Burgess Shale in Yoho National Park, British Columbia.

The Burgess Shale has produced over 65,000 specimens of mostly soft-bodied organisms and includes at least 93 identifiable species. Most are preserved on the bedding planes of the shale in the Burgess Shale Formation. The organisms were apparently transported into deep, anoxic waters by submarine landslides originating from a nearby shallow-water carbonate bank. The organisms were buried quickly in the fine mud, and the combination of the anoxic conditions and rapid burial prevented decay. The importance of the Burgess Shale is that it preserves a wide variety of bizarre and unusual soft-bodied organisms that we would have been completely unaware of, if not for the unique circumstances that led to their preservation.

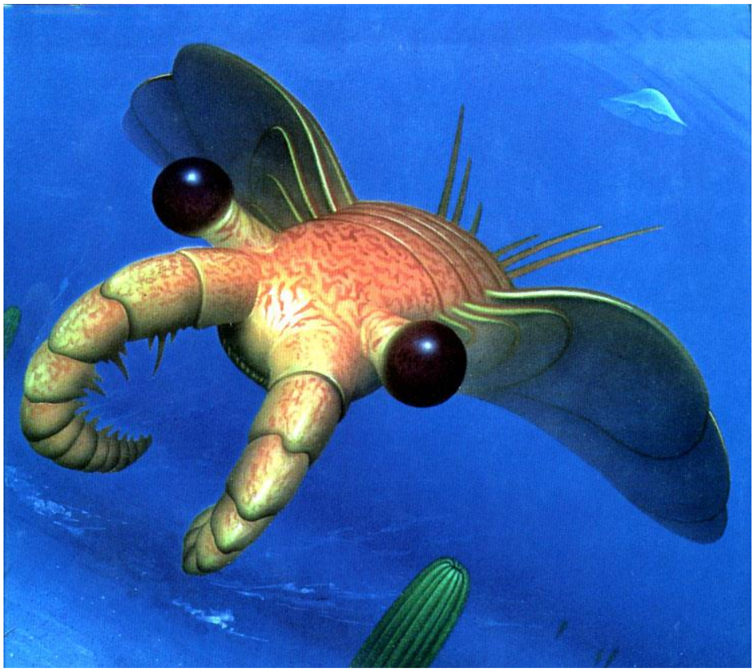

Figure 7. A reconstruction of *Anomalocaris* from fossil evidence.

7. You are provided with fossil specimens of *Anomalocaris*, which is a fossil collected from the Burgess Shale. Sketch one of the specimens. Based on the image above, what part of *Anomalocaris* is preserved in the fossils? Why do you think that this part is preserved in these specimens while others are not?

Figure 8. A fossil specimen of *Wiwaxia*.

8. You have a plastic model of *Wiwaxia* (the fossil shown above). Notice that the model displays a very dome-like shape for the organism. The Burgess Shale fossils are preserved on the flattened surfaces of bedding planes in the shale, which means that the fossils are nearly two-dimensional in nature. How can paleobiologists reconstruct a three-dimensional shape for an organism that is only preserved in two dimensions? Can you think of some methods? It may help to remember that these organisms are represented by numerous fossil specimens.

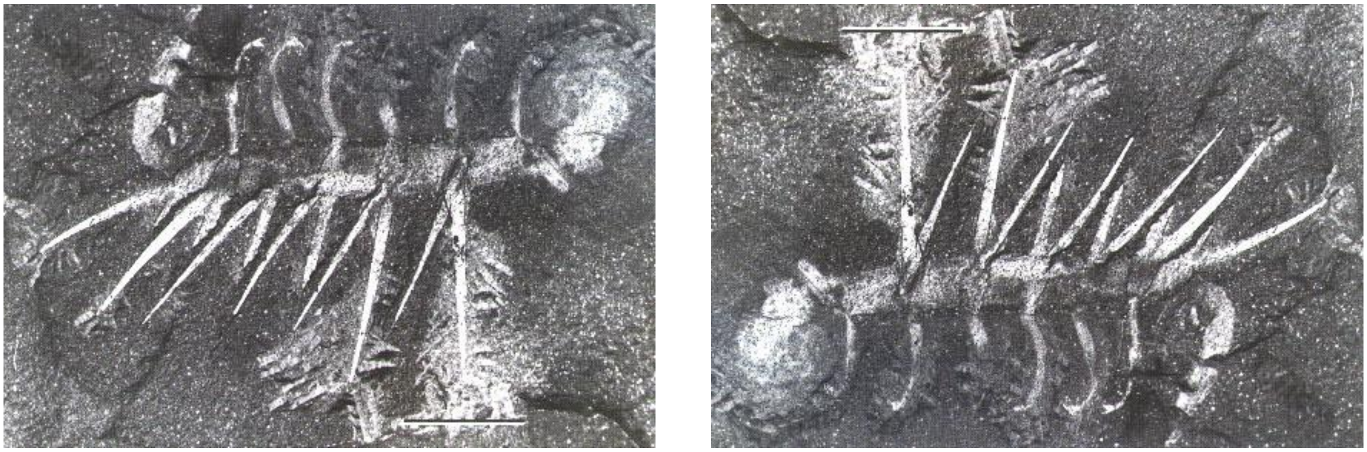

Figure 9. Two identical images of a fossil specimen of *Hallucigenia*, shown in opposite orientations.

9. The organism shown above is named *Hallucigenia*, for its bizarre appearance. The orientation of the organism has been contentious, in part because of its very unusual morphology. The main question is: What are the long, pointy structures on the organism? Are they spines for defense, or are they legs for walking? Using the images above as your sole evidence, reconstruct (make a sketch) of what you think *Hallucigenia* looked like in life position. Explain why you chose the orientation that you did. What further evidence would you like to have to be sure of the accuracy of your reconstruction? How does the two-dimensional preservation affect your ability to interpret this specimen?

<u>Fossil Lab 01 Feedback</u>

Please help me improve this lab by answering the following questions.

1. Which activity, question, or instruction was the most unclear for you? How can I improve it?

2. Which part of this lab was most helpful in improving your understanding of the diversity of life on Earth and the ways that paleobiologists interpret and classify it?

3. Would you say this lab was a) too short, b) too long, or c) just the right length? Explain.

4. Do you have any general comments or suggestions?