The Great Fossil Find

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Overview:
Students are taken on an imaginary fossil hunt. Following a script read by the teacher, students "find" (remove from envelope) paper "fossils" of some unknown creature, only a few at a time. Each time, they try to reconstruct the creature, and each time their interpretation may change as new pieces are "found".

Lesson Concepts:

- Science is uncertain; as new evidence is revealed, ideas may change.
- Scientists working together can be more effective.
- Provides experience in the hypothesizing and testing of hypotheses.
- Scientists use "fair test" criteria to determine the "best" solutions.
- Provides some experience working with "fossils," as preparation for work with human fossils.

Grade Span: 5–12

Materials:

- One envelope of fossils, cut from Fossil Sheet* per group
- One Great Fossil Find worksheet per student
- One Skeletal Resource Manual per group (or student)
- One script The Great Fossil Find narrative and follow-up (for teacher)

* The Fossil Sheet: The original version of this page can be found in the *Laboratory Manual* for Scott, Foresman's text *Biology* (by Irwin L. Slesnick), 1985, page 75 (ISBN 0-673-22303-6).

Advance Preparation:

- Cut up the Fossil Sheet and place one set of fossils in each envelope. Leave a bit of white paper around each fossil to facilitate cutting. This can be quite time-intensive, so you may want to seek the help of lab assistants, relatives, and friends. Get together and have fun "cutting up!"
- Make one copy of the Great Fossil Find worksheet for each student.
- Reproduce back-to-back (or staple) copies of the Skeletal Resource Manual — enough for one per student (or one per group).

Time: One class period

Grouping: 3-4 per group

Teacher Background:
The "fossils" are based on the real fossil bones of *Scaphognathus crassirostris*, a ptersosaur ("flying reptile") that lived in the late Jurassic (around 150 mya) in the vicinity of present day Germany. Adults had a wingspan of about one meter.

Teacher Resources:
Do a web search for *Scaphognathus* and ptersosaurs. For elements of the nature of science that this lesson illustrates, go to the Nature of Science: General Background Information for the teacher. This will help you to dispel some of the common popular myths about science.

Teaching Tips:
This lesson provides an excellent biological alternative (or additional) example of the nature of science, in contrast to many other lessons for doing this, which are taken from the physical sciences. For this reason, you might want to include this in your introduction to the nature of science early in your course.

The lesson would also provide an engaging (and novel) introduction to fossil studies or anatomy. If you have students compare samples of hominid skulls, this lesson would be a useful preliminary experience, where you can discuss examples of structure and function suggested by the bones and teeth.

Build anticipation by announcing that the class will be going on a big fossil dig the next day. Be dramatic! The next day, if possible, come dressed in what you have that comes closest to what you might wear going to a dusty, hot, fossil dig, e.g., a grungy safari hat, sunglasses, geological hammer, camera, etc. When you do the lesson, be as dramatic as you can about your shared adventure. Be sure to snap some pictures of students working on fossils during the lesson.

The Great Fossil Find Worksheet is suitable for 6-12th grade students. For younger students, plan to engage in some follow-up discussion, e.g., "What do you think it was?" And, "How can you tell?"

Be sure to remind students to return all fossils back into the envelopes when they finish.

Vocabulary: fossil, skeleton, paleontologist, hypothesis

Procedure:

1. Make a grand entrance into your room (wearing fossil-digging gear).
2. Hand out worksheets and envelopes with fossils to all groups (or have them ready in trays for groups to get when ready). WARNING: ask students to NOT open the envelopes until instructed to do so.
3. Begin reading with enthusiasm from the narrative script. Eventually, you may want to recount the "story" from memory, with a more natural and dramatic flair. Feel free to substitute other names for those used in the script. For example, for the "field in Montana, near the town of Randak" you can substitute "field in Germany, near the town of Solnhofen," which is actually more accurate. For "Kimmel College Five and Dime", you could substitute your school's name — as a college or university.
4. At the appropriate time, hand out the Skeletal Resource Manuals to all groups, so they can begin to get clues about their creature.
5. AFTER THE STORY: When all fossils are back in their envelopes, follow these directions described in AFTER THE STORY to reinforce how the students were essentially following the process of science in their search for an answer. They should recognize that their provisional identifications were essentially "hypotheses" — tentative and testable explanations to a question (what WAS this creature?). Also, point out that this was a simulation of one kind of real science: a search for answers about past events, in contrast to most science they've studied, which are usually the experimental type.
6. As mentioned elsewhere, totally resist telling the class (or student) what the creature was. This is for two reasons: (1) in real science, we never really KNOW the ANSWER with finality. Scientists try to come sufficiently close enough to reality for all practical purposes. (2) don't spoil the adventure for later periods (word does get around!).

Extensions:

1. For an interesting variation, cut apart the fossil bones in the sheet of the early 4-legged fossil whale skeleton *Pakicetus*. See the *Pakicetus* Fossil Sheet for this.
2. Another similar experience (trying to reconstruct the past from clues) is the Checks Lab, or the Dogs and Turnips lesson. Also consider doing a forensic science lesson, e.g., ENSI's "Crime Scene: The Case of the Missing Computer Chip", which involves the same kind of science.
3. Another variation you can try is *Xenosmilus* (adapted by Al Janulow).

Acknowledgements:

From The Great Fossil Find on the ENSI website.
The *S. crassirostrus* Fossil Sheet used here is adapted from the *Laboratory Manual* for Scott, Foresman's text *Biology* (by Irwin L. Slesnick), 1985, page 75 (ISBN 0-673-22303-6).

The Great Fossil Find

[READ TO STUDENTS with ENTHUSIASM!]

In this activity, you and the members of your team will play the roles of paleontologists working in the field in Montana, near the town of Randak. One clear crisp afternoon in October, you find four well-preserved and complete fossil bones.

(Withdraw **four** fossil bones from your envelope. Make sure you take them out **without** looking at the ones remaining in the envelope!)

It is too late in the day to continue with the dig, so you return to camp with your find.

A. That night, in camp, after dinner, around a Coleman lantern, you and your colleagues begin to assemble the 4 bones you found earlier. Since the bones were all found together and in an undisturbed layer, you assume that they are all from the same animal. You spend the rest of the evening trying different arrangements of the bones in hopes of identifying the animal.

(Use the next 3-5 minutes to try various combinations.)

As the night wears on, you get weary and decide to retire and begin anew in the morning. (Before you go to bed, jot down on your worksheet the type of animal you **think** it might be.)

B. Montana mornings are marvelous. They are clear, cool, and clean. Just the kind of day you need to get work done at the dig. The rock layers that hold your fossils are very hard and only grudgingly give up **three** more specimens. With the day at an end, you make your way back to camp for another try at assembling this mystery animal.

(Withdraw 3 more bones from the envelope. Use the next 3-5 minutes to incorporate your new finds in your fossil reconstruction.)

It's getting late, and you are getting weary. Maybe tomorrow you will find the answer to the puzzle. (Be sure to record on your worksheet your latest suspicion of the type of animal suspected.)

C. The next day is cold. It is the last day of the digging season. Winter lurks behind the mountains, and you must leave. Just as the day is about to end in disappointment and defeat, one member of the group cries out "I've got them! I'VE GOT THEM!"

(Withdraw 3 more bones from the envelope. Use the next 3-5 minutes to incorporate these latest finds. Record what you think it is now.)

D. Back in the lab at Randak, you go searching in the resource library, and you find some partial skeleton drawings from another group working at a different location but dealing with the same geological period. They have found a skeleton similar to yours, but with some additional bones that you don't have. You use this information to add to your own data.

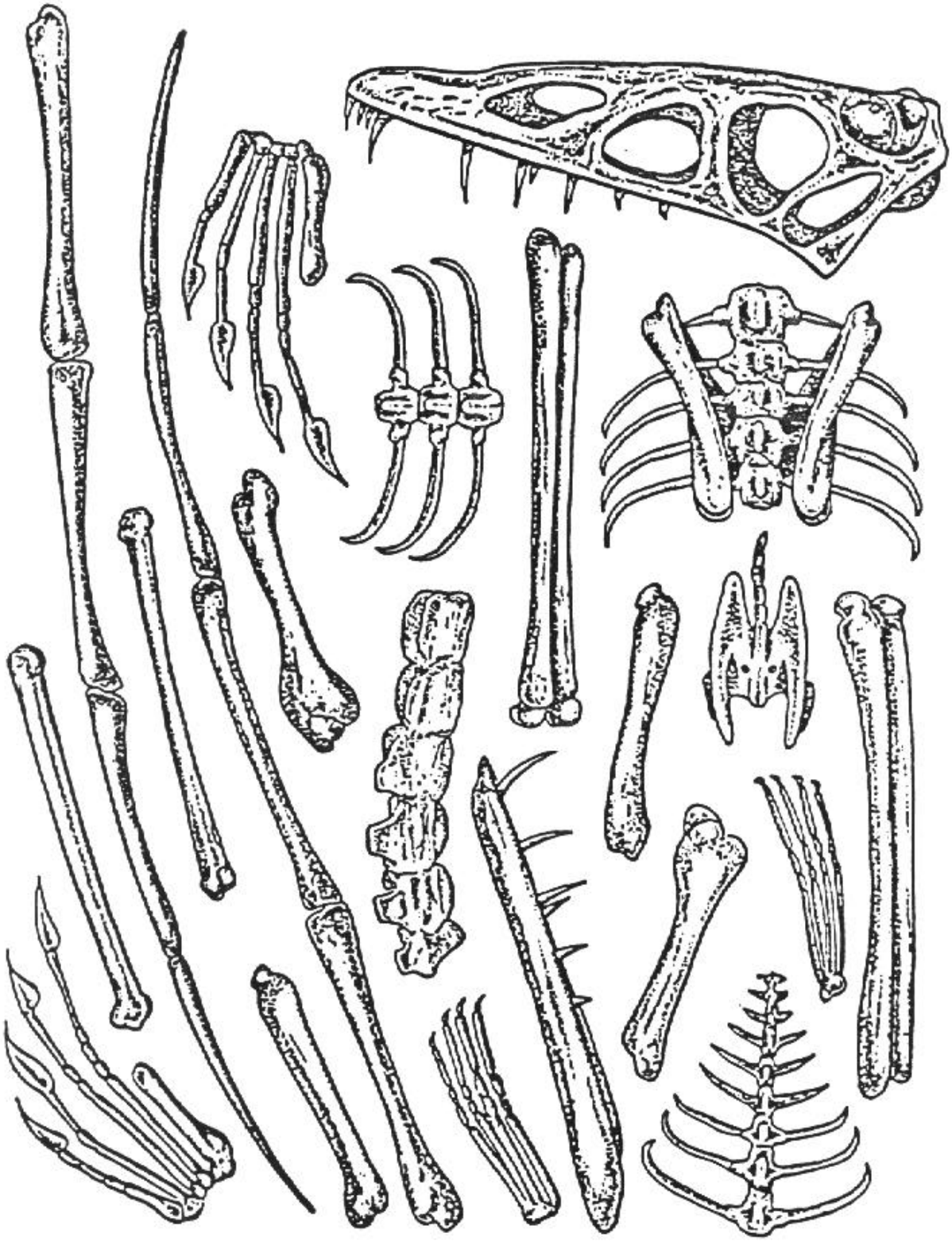
(Take the next 3-5 minutes to compare your findings with those of a team near you, looking for clues that might help you in your reconstruction, and possibly even suggest an entirely different animal than your earlier ideas. Apply these latest clues to the assembly of your skeleton as best you can Record the type of animal suspected now Be as specific as you can.)

E. Once you are back in your own laboratory at Kimmel College Five and Dime, you find a **Skeletal Resource Manual** with drawings of the skeletons of some existing animals. You notice some interesting similarities between some of the drawings and your unknown fossil.

(Use the drawings to assist you in your final assembly of the fossil skeleton. Record your final interpretation)

[**To teacher**: note any resourcefulness as you circulate amongst your students, e.g. using their texts, supply catalogs, etc.]

F. Answer the questions on your worksheet. When done, be sure to return all of the "fossil bones" to the envelope.



NAME_____ S.N. .____ DATE_____ PER.___

THE GREAT FOSSIL FIND

WORKSHEET

A. Day 1 (4 bones): Type of animal suspected:_____

B. Day 2 (7 bones): Type of animal suspected:_____

C. Day 3: (10 bones): Type of animal suspected:_____

D. Day 4: (collaboration with another team): Type of animal suspected:_____

E. Day 5: (after consulting resource booklet)): Type of animal suspected:_____

QUESTIONS

1. Did you make any assumptions or inferences at the beginning of the activity that kept you from assembling the "right" skeleton (i.e. your final interpretation)? _____ Explain:

2. Did the discovery of new bones cause any conflict within your group? _____ Explain:

3. Did any of your group members resist changing in light of the new information? _____ Explain:

4. Did the information from another group influence your assumptions? _____ If so, what info?

5. Did the resource booklet **confirm** your group's ideas, or did it cause you to rework your arrangement of the fossil parts? _____Explain.

6. If this "Fossil Find" scenario is typical of the work of scientists, what features of the nature of science does it demonstrate?

7. From looking at the fossil and the resource manual, what could you say about how and where this animal lived?

8. Is it possible for scientists to do studies about things that happened millions of years ago? _____ Explain.

9. Below, or on the back of this sheet, list what you see as the 3 goals of this experience.

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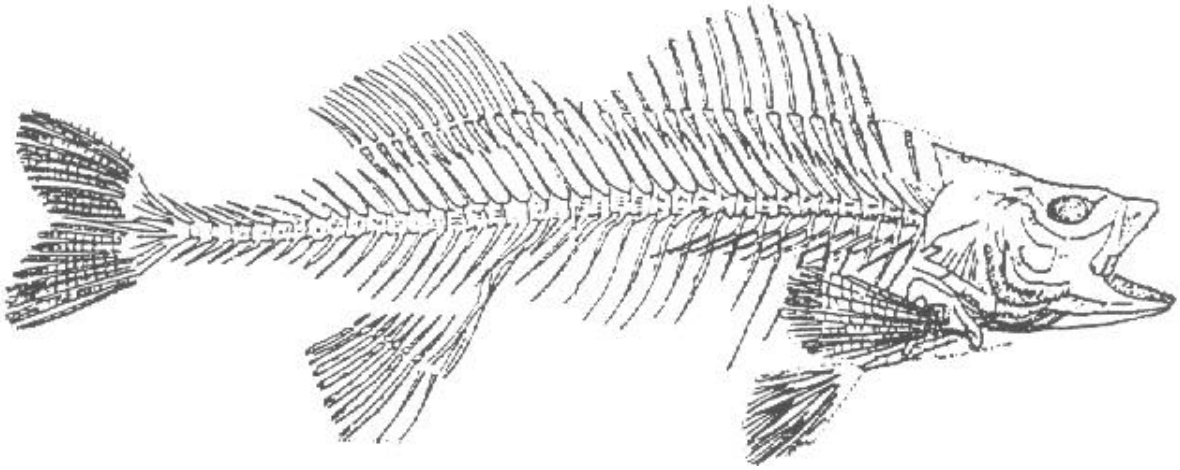
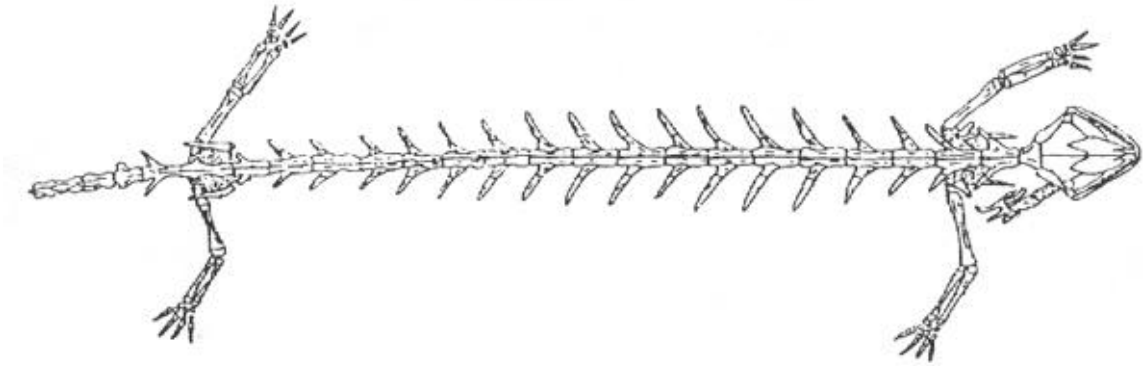
SKELETAL RESOURCE MANUAL

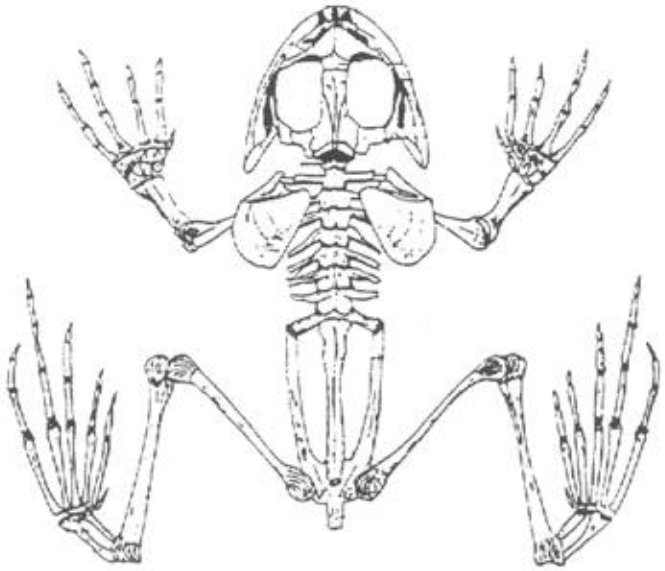
FISH (Perch)



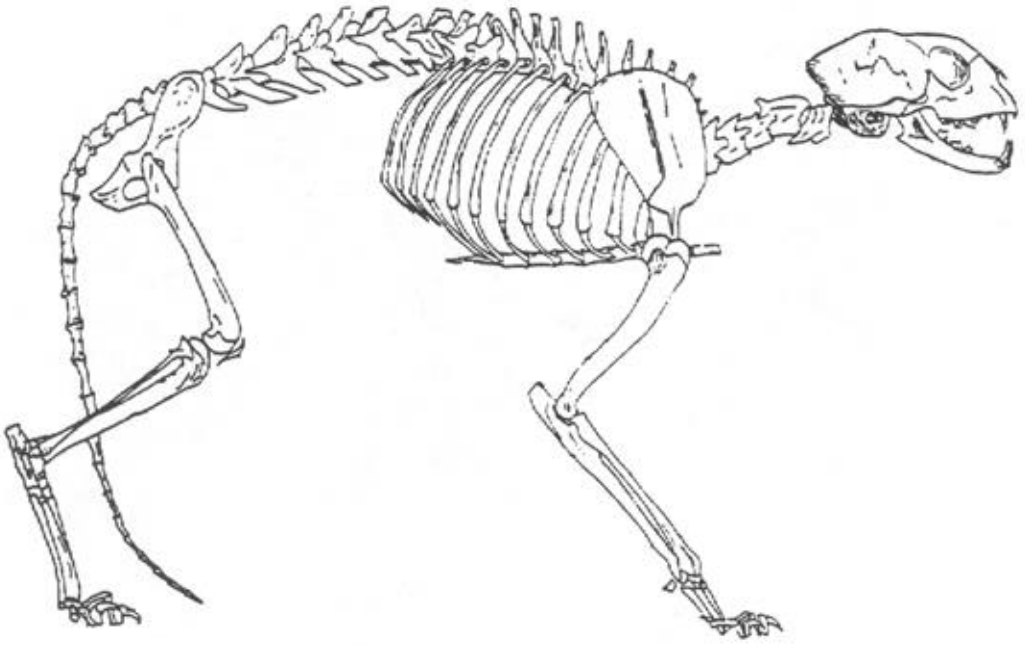
SALAMANDER (Necturus)



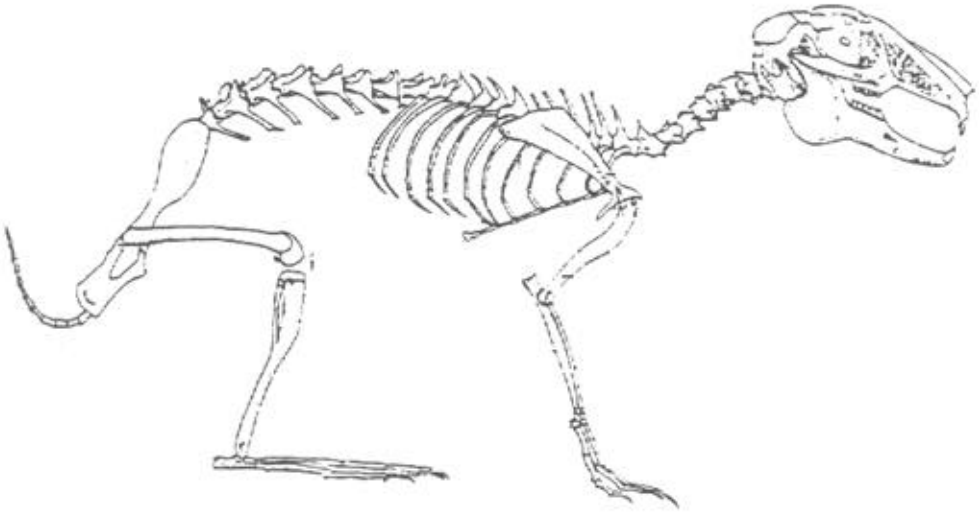
FROG



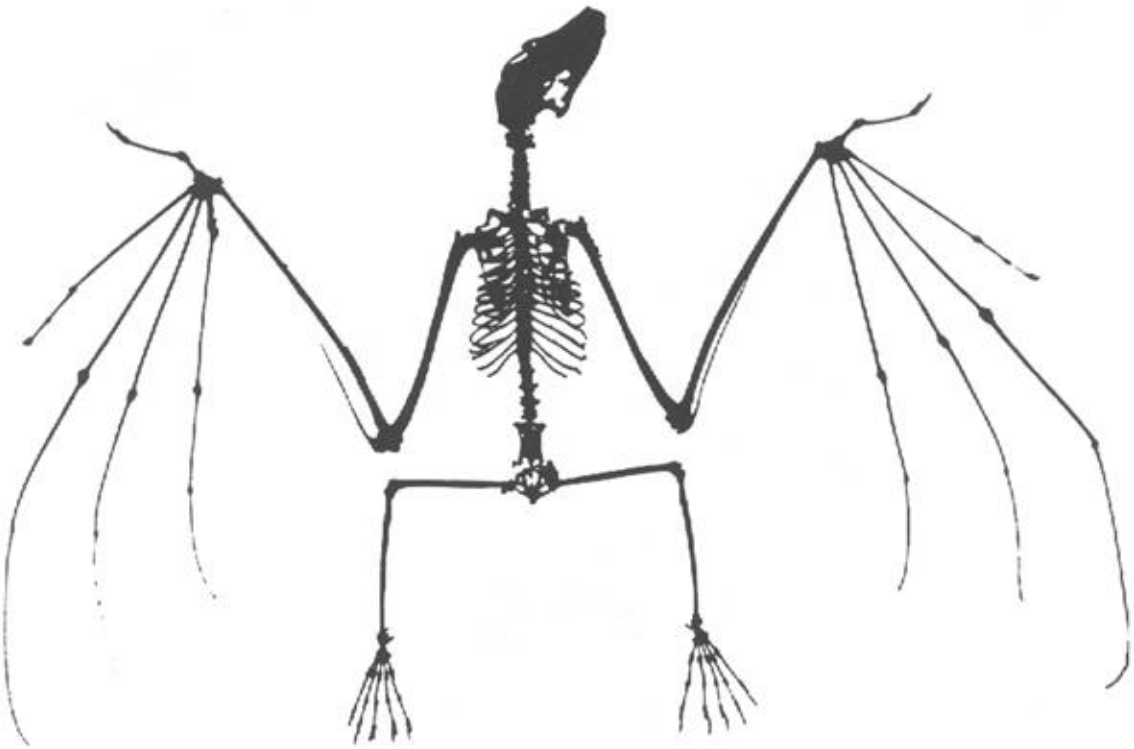
CAT



RABBIT



BAT



BIRD

AFTER THE STORY

Be sure that all envelopes (with their bones) and Skeletal Resource Manuals get returned to the team tray (or other holding site).

Now have every team share with the whole class what they figured the creature to be, and see how many were the same, and how many different interpretations were made. This lesson is, in this way, very similar to the "Palpating Pachyderms" lesson which they may have done earlier, and if so, it might be interesting to see if anyone remembers what past activity this lesson brings to mind (a little re-cycling never hurts!).

You may want to discuss their answers to the questions at this time. Is there general concensus on what the creature was? If so, discuss what the most telling clues were, and what influenced them most. (Did the conclusions of others have any influence???) Is this the way that scientists work?

If there is NOT concensus, discuss what solution seems "best", and why it seems best; what criteria are being used? What factors are influencing this decision? This would be a good place to consider what would make a "fair test", and discuss the elements of what is involved in how scientists select the "best" hypothesis out of competing ones (see the General Information" page on this site).

In any case, if you happen to know, or even suspect, what the creature was, do NOT tell your students! They will clamor to know, but you have to tell them that science is NOT in the business of KNOWING; just coming as close as we can to the MOST LIKELY solution is the best we can do. (We have purposely not told you what the creature is for this very reason.) Tell them this is what really happens in science...we often don't have all the pieces, and may never ever find them, so we simply rely on our "best" interpretation based on the clues we do have. Leave them with whatever they figured out (just as in the "Mystery Boxes" lesson, and the "Great Volume Exchanger" lesson). An incidental product of this mystery is that word does not reach other classes as to what the unknown creature is, and spoil the experience for them.

Below are some reasonable answers to the last few questions on the worksheet:

6. If this "Fossil Find" scenario is typical of the work of scientists, what features of the nature of science does it demonstrate?
   ANS. its uncertainty, and that teamwork is more efficient.

7. From looking at the fossil and the resource manual, what could you say about how and where this animal lived?
   ANS. probably on land, perhaps able to fly.

8. Is it possible for scientists to do studies about things that happened millions of years ago? Explain.
   ANS. Yes. All sorts of clues, from fossil bones, pollen, leaves, ripple marks in sandstone, volcanic rocks, etc., scientists can do an amazingly accurate reconstruction of life and activity in the distant past.

9. On the back of this sheet, list what you see as the 3 goals of this experience.
   ANS. a. Show the uncertainty of science.b. Show how it helps to work together to solve problems.c. To see how scientists develop hypotheses from observation, then test those hypotheses.d. Gave us some "experience" working with "fossil bones".