Canon Paleo Curriculum
Unit: 3 Evolution
Lesson Plan 6

Procedure: Part B

1. Figure 2 shows fossil caminalcules. Each drawing is a separate species and each species has a number. The number in parentheses is the age of the fossil in millions of years ago. Assume the following about the fossil caminalcules

- There is as much information about each fossil caminalcules as about the living specimens.
- The exact age of each fossil is known to the closest 1 million years.

2. To determine the evolutionary relationships of the caminalcules, construct a phylogenetic tree. Use the meter stick to make 20 equally spaces horizontal lines about 5 cm apart on the large sheet of paper. Label the bottom line 19 and number upward so the top line is labeled 0. These numbers represent time intervals of one million years.

3. Cut out the fossil caminalcules in Fig. 2 and put them in piles according to their age (the number in parentheses). Beginning at the bottom of the tree, place the species on the line that match their age. Place the living caminalcule species cut out from Fig. 1 on the 0 line. Use a small piece of removable transparent tape to hold each caminalcule temporarily in place.

4. Determine the most likely relationships of the fossil caminalcules to other fossil or living caminalcules. Start your phylogenetic tree by placing the oldest fossil at the bottom of the paper on the 19 million years line. Arrange the caminalcules to reflect their relationships. Some fossils have the same species number as other fossil or living species; place these vertically above and below each other. Place the other fossil species near those that match as closely as possible newer fossil and/or living caminalcules.

5. Draw lines that indicate the relationships. A fossil species can be the ancestor or none, one or two other species at a branching point, but not of three. Sometimes there is no branching and the transition from one species to another is direct. Connect species that evolved from another species by slanted lines, not vertical ones. Use vertical lines only when the species has not evolved into a new species.

6. Because of the incomplete nature of the fossil record and different ways of interpreting the available fossils, more than one phylogenetic tree is possible. Compare your tree with that of another team. After discussing the differences and each team's rationale for its decisions, produce a revised tree.

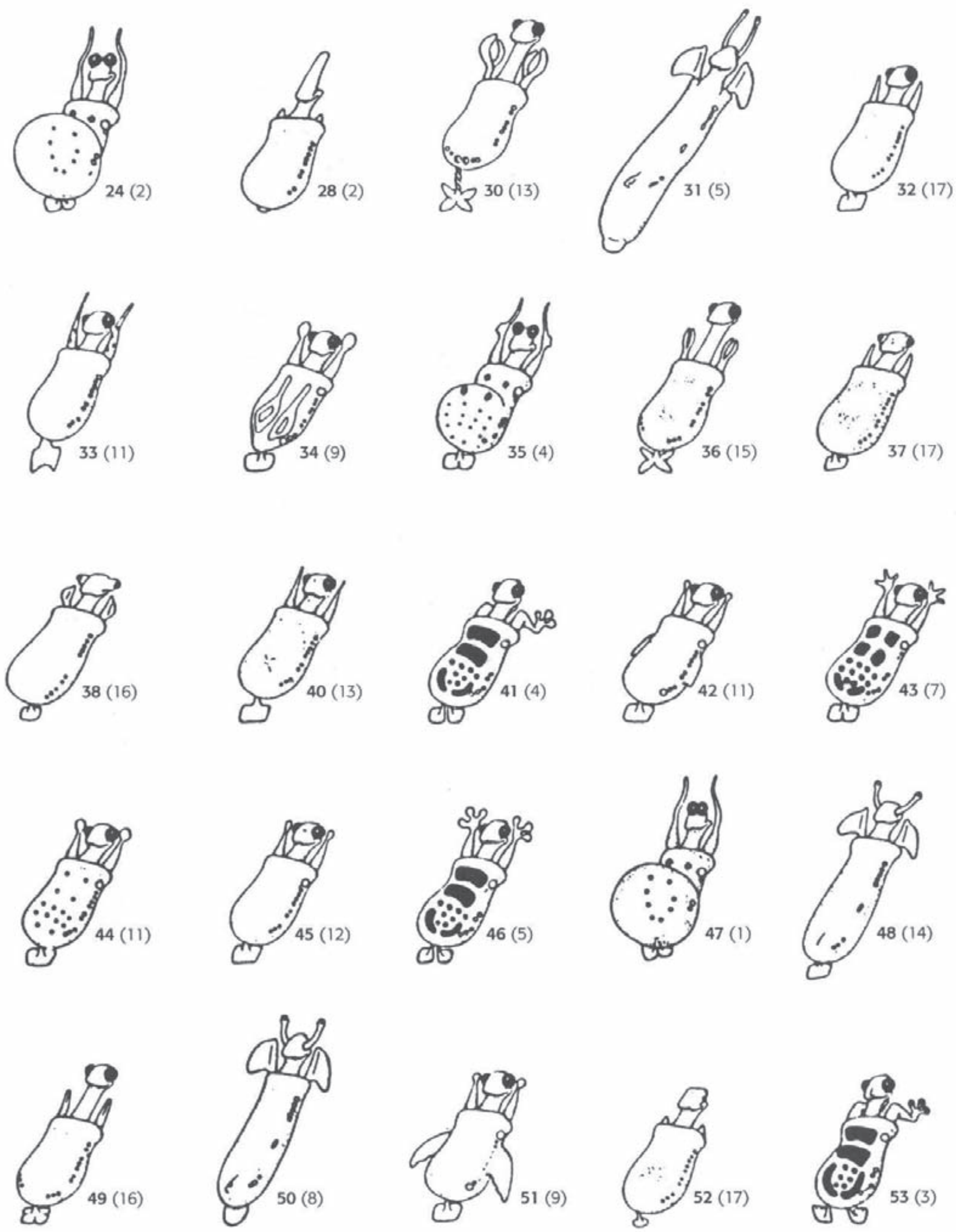


Figure 2. Fossil Caminalcule

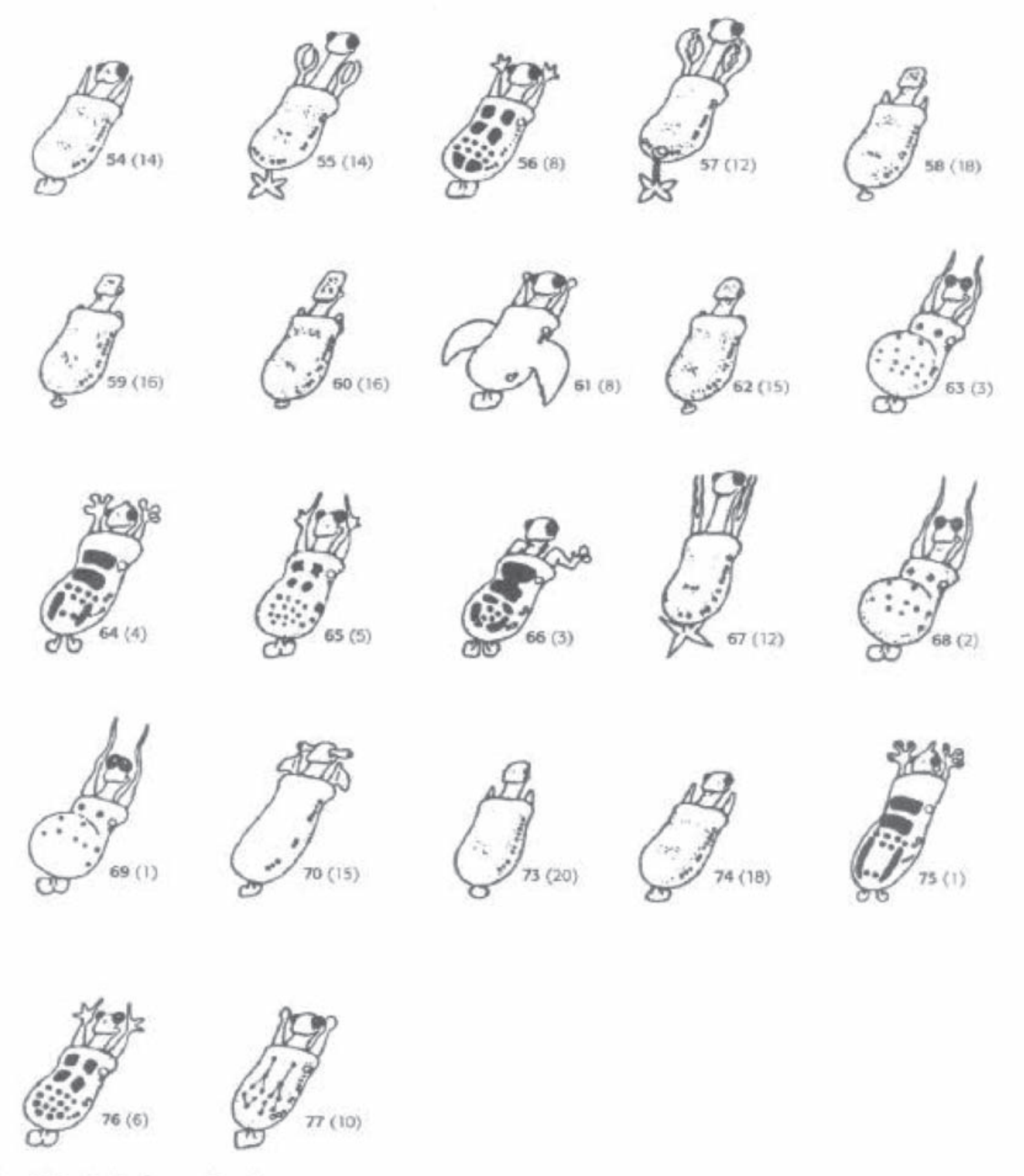
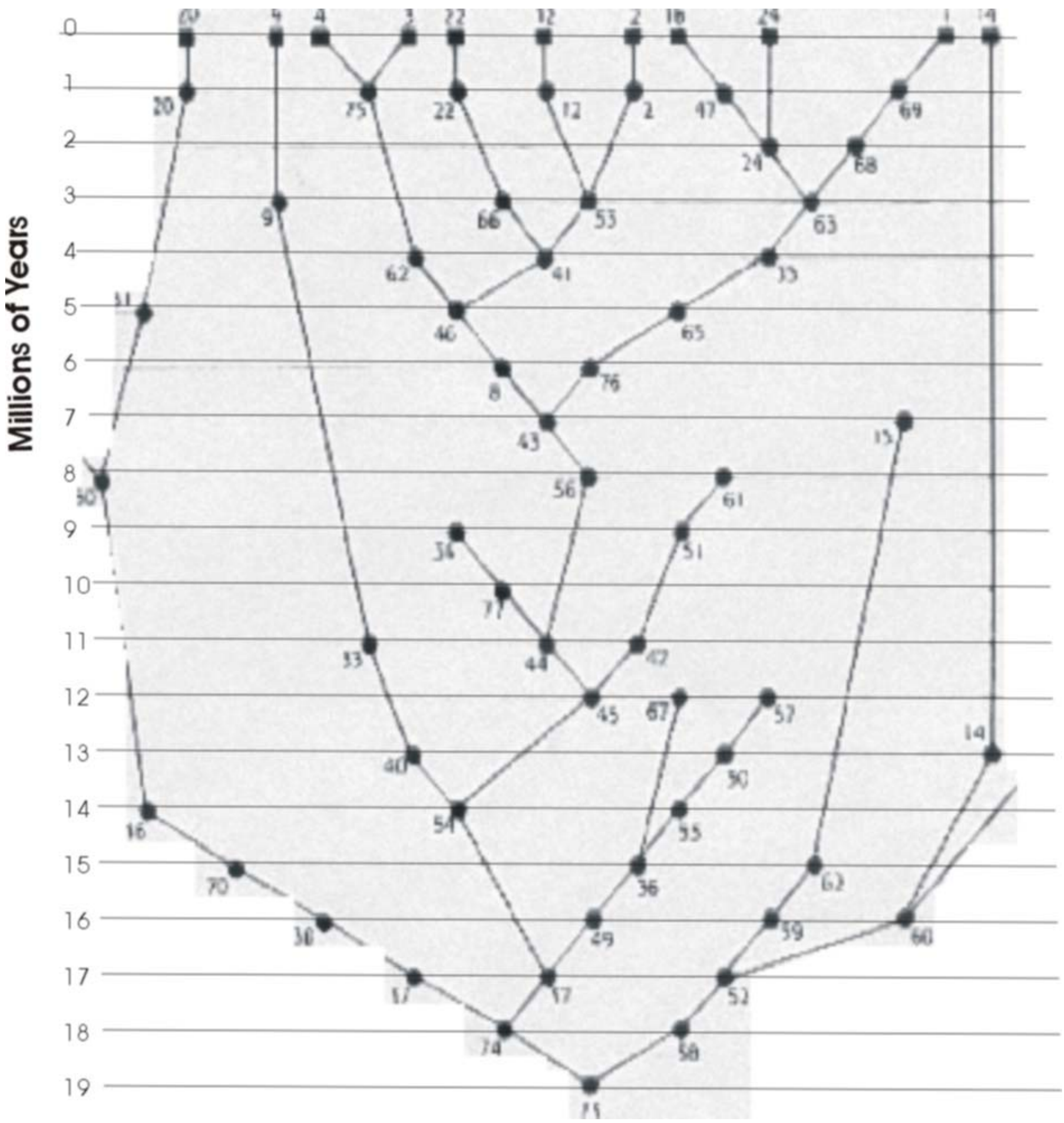


Figure 2. Fossil Caminalcule (cont.)

Author’s Key of the Caminalcules Phylogenetic Tree



Discussion Questions

1. Answers will vary with how closely the students’ trees agree with the key. Students should compare their original classification of the living Carninalcules and see if their genera share a common ancestor. If not, they will need to rename their living species or revise their tree.

2. Students should identify which living species would need to be renamed based on their phylogenetic tree.

3. Examples of convergent evolution include the following:

- The claws of species 3 and 12 (their most recent common ancestor, species 46, did not have claws) The wings of 61 and 51 and of 19 and 20
- The single (fused) eye of species 16 and I (their shared common ancestor is species 63)
- The forelimb of species 16, 24, and I looks like that of species 9, but actually is a modified digit The head ornaments of species 12 and 3

4. Examples of vestigial structures include the following:

- The reduced digits of species 35
- The reduced feet of species 22.
- The small digit of species 66

5-6. Answers will vary, depending on whether students judge success to be long times of evolutionary stability or short times of evolutionary change. Students should justify their answers with their rationale of why one would be better than another.

7. The evolution of species 46 to 19 and 20, of 33 to 9, and of 52 to 14, 13, and 28.

8. The evolution of species 43 to 4, 3, 22, 12, 2, 16, 42, and 1. Relatively rapid environmental change might account for rapid changes in structure.

9. Lineages 13, 14, 40 and 46. Relatively unchanging environmental conditions might account for stability in structural characteristics.

Discussion

1. Do the evolutionary relationships shown in your phylogenetic tree require any changes in your original classification of living caminalcules? Compare the grouping on line 0 with the way you classified the caminalcules in Part A. If necessary, revise your classification so it agrees with your phylogenetic tree. All members of a genus should have the same genus name and should share a common ancestor that is not shared by members of other genera. The same rule applies to families, orders, classes, etc.

2. Does this revision make necessary a change in the genus and species names you gave some of the caminalcules? If you had to revise your phylogenetic tree and the scientific names you gave the living caminalcules, that does not necessarily mean your first tree or your original names were incorrect. Biologists continually revise their classification as they obtain more data on both living and extinct (fossil) organisms.

3. In your phylogenetic tree, the vertical distance represents time. The horizontal distance is an indication (in a general way) of how different the species are from one another. In other words, two species of the same genus should appear closer together on the tree than species of different genera. Two species that evolved from a common ancestor will be closer together on the tree than genera that did not evolve from a common ancestor. As you go back in time, the lines of relationship become closer to each other than the

4. Comparing living species also helps determine evolutionary relationships between organisms. In general, the greater the difference between the organisms, the longer ago they presumably diverged from a common ancestor. Some species, however, resemble each other because similar structures evolved independently in response to similar environments or ways of life, and not because they share a recent common ancestor. This type of evolution is called convergent evolution because unrelated species seem to converge (become more similar) in appearance. Examples of convergent evolution include the wings of bats, birds, and insects, or the streamlined shapes of whales and fishes. Thus, in classifying organisms, you must consider a number of characteristics rather than just a single one. List all the examples of convergent evolution you can identify in the fossil and living caminalcules. Look for two living species with a shared characteristic, such as similarly shaped forelirnbs, whose common ancestor did not have that characteristic.

5. Sometimes in the evolution of organisms, unused structures become reduced to the point where they are virtually useless. Examples of such vestigial structures in our species are the ear muscles and the tail bones. Compare the structures of the living caminalcules with their ancestors and list any examples of vestigial structures you can identify. These are structures that appear to be getting smaller and eventually disappear.

6. Is a successful lineage one that has branched many times and is represented by many species, or is it one that has changed the least through time? Explain your answer.

7. Are some lineages more successful than others? What are the characteristics of these lineages?

8. What evidence in caminalcule evolution indicates that evolution was relatively gradual?

9. What evidence in caminalcule evolution indicates that evolution was relatively *rapid? What might account for periods of rapid evolution?

10. What evidence in caminalcule evolution indicates long periods of stability when little evolution took place? What might account for long periods of stability?