CLASSIFICATION AND EVOLUTION
Phylogenetic Tree Instructions

Caminalcules are imaginary animals invented by the evolutionary biologist Joseph Camin. In this lab exercise you will construct an evolutionary tree of the Caminalcules using both the "living" species and the additional 57 "fossil" species. This illustrates how modern classification schemes attempt to reflect evolutionary history. In the process of doing this exercise you will be introduced to concepts such as convergent evolution and vestigial structures.

The Phylogeny of Caminalcules

Using a large sheet of paper, construct a phylogenetic tree for the Caminalcules. Use a meter stick to draw 20 equally spaced horizontal lines on the paper. Each line will be used to indicate an interval of one million years. Label each line so that the one at the bottom of the paper represents an age of 19 million years and the top line represents the present (0 years).

1. Cut out all the Caminalcules (including the living species).
2. Put them in piles according to their age (the number in parentheses). Beginning with the oldest fossils, arrange the Caminalcules according to their evolutionary relationship. Figure 4 shows how to get started.

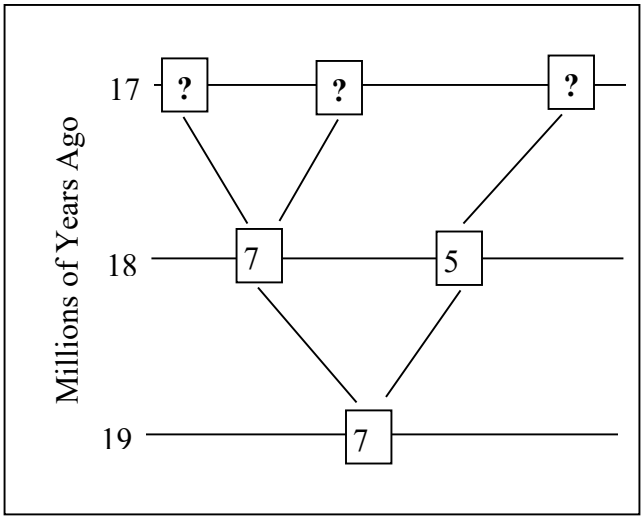
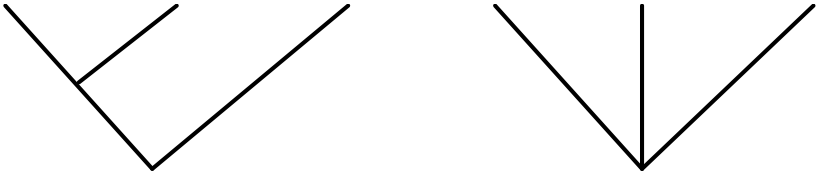


Figure 4

Hints, Suggestions and Warnings

a. Draw lines faintly in pencil to indicate the path of evolution**. Only after** I have checked your tree should you glue/tape the figures in place and darken the lines.

b. Branching should involve only two lines at a time:



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c. Some living forms are also found in the fossil record.

d. There are gaps in the fossil record for some lineages. Also, some species went extinct without leaving any descendants

e. The Caminalcules were numbered at random; the numbers provide no clues to evolutionary relationships.

f. There is *theoretically* only one correct phylogenetic tree in this exercise.

Analysis & Conclusions

1. You will notice that some **lineages** (e.g. the descendants of species 56) branched many times and are represented by many living species. Discuss the ecological conditions that you think might result in the rapid diversification of some lineages (A real world example would be the diversification of the mammals at the beginning of the Cenozoic, right after the dinosaurs went extinct.)

2. Some lineages (e.g. the descendants of species 58) changed very little over time. A good example of this would be "living fossils" like the horseshoe crab or cockroach. Again, discuss the ecological conditions that might result in this sort of long-term evolutionary stasis.

3. Some Caminalcules went extinct without leaving descendents. In the real world, what factors might increase or decrease the probability of a species going extinct?

4. Find two additional examples of **convergent evolution** among the Caminalcules. This means finding cases where two or more species have a similar characteristic that evolved independently in each **lineage**. The wings of bats, birds and bees is an example of convergence since the three groups did not inherit the characteristic from their **common ancestor**. Write your answers in complete sentences (e.g. "Species *x* and *y* both have ____ but their most recent common ancestor, *z*, did not").

   List two additional real-world examples of convergent evolution (ones that we have not already talked about in class) and discuss what might have caused the convergence.

5. Describe two examples of **vestigial structures** that you can find among the Caminalcules. These are structures that have been reduced to the point that they are virtually useless. Ear muscles and the tail bones are examples of vestigial structures in our own species.

   Explain how vestigial structures provide clues about a species' evolutionary past. Illustrate your argument with vestigial structures found in humans or other real species.