Your Name:_______________________________________ Per_____

Lab Group Names:____

Part A: Taxonomy of Living Caminalcules

1. Examine the drawings of living caminalcules. Start your classification by placing them in the animal kingdom. What characteristics make them (and any other animal) belong in Kingdom Animalia? (Hint: use a book)

2. Your answer above is based on some assumptions about caminalcules. Also assume the following:
   a) the pictures all show adults of separate species, shown at life size. Adults do not vary in size.
   b) you have no information about what is on their ventral surface, internal structures or the functions of their structures
   c) there is no gender differentiation in the caminalcules
   d) there is no information about their young, which may be quite different
   e) each caminalcule depicted is a separate species.
3. Each team member should open the BSCS Green textbook to the "Catalog of Living Things", Appendix 4, starting on page 729. Look through the organisms. These species were just discovered. Do you think the caminalcules would belong in an existing Phylum or, rather, to a new one?
   Name the Phylum (either give it an existing name or make one up) ____________________
   Describe the characteristics of the Phylum (i.e. what makes them belong in it)

4. Cut out the individual living caminalcules from Fig. 15.1. Look carefully at all the distinguishing characteristics of each.
   - Based upon your study, group similar species into Genera (plural for Genus).
   - Name each Genus and describe its characteristics.
   - Identify the species within each Genus by using its number, and then include a scientific name using Binomial nomenclature (be sure to use the Proper format!)
   - Identify your Genera and species below:

5. Now group the Genera into one or more Families. Name each Family and describe its characteristics:

6. Assume they all belong to the same order and class (of your choice). Using the BSCS Appendix again, assign them to an existing class or create and name a new order and class.

Class: ______________________________

Order: ______________________________

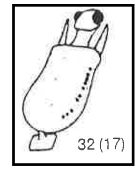
You are now ready to continue on to Part B, where your careful classification will get challenged by new information! But don't start until you hear the scintillating introduction by your teacher...

(Staple this sheet in front of Part B and then turn it in)

 Your Name:____ Per_____

Part B: Evolutionary Relationships

10. Observe the figures of the fossil caminalcules that you and your team excavated. Each creature depicted is a full grown adult that is a separate species, designated by a number. The number in parentheses is the age of the fossil in millions of years ago. For example, the fossil depicted to the right, #32, is evidence of a species that was living 17 million years ago.



11. Keeping your large sheet of paper oriented vertically, use a meter stick to make 20 equally-spaced horizontal lines along the long side of the paper. The distance between the lines should be approximately 5cm apart. Label the bottom line “19 mya” and count down as you go up so that the top line is labelled “0 mya” (present day). Each of these lines represents intervals in a time sequence from 19 million years ago until now.

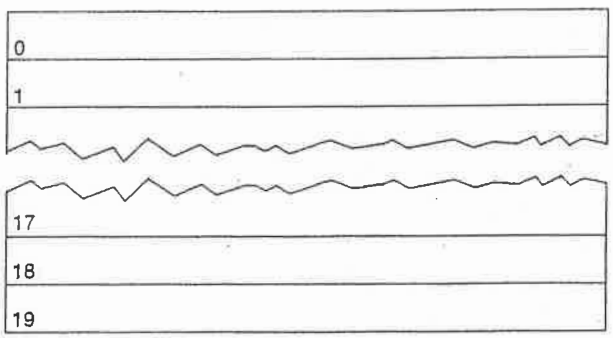


Figure 15.3 Form for making phylogenetic tree.

12. Cut out the fossil caminalcules and organize them by the age of the fossil (the number in parentheses). Place the species on the lines that match their age but do not attach them to the paper yet.

13. Next is the most important part: the relationships between the species. To determine the evolutionary relationships between the fossil species, construct a “phylogenetic tree.” Start your tree like Fig 15.4 below, which shows that the oldest fossil, species 73, evolved into both species 74 and 58. (The species are numbered at random and the numbers give no clues to the relationships)

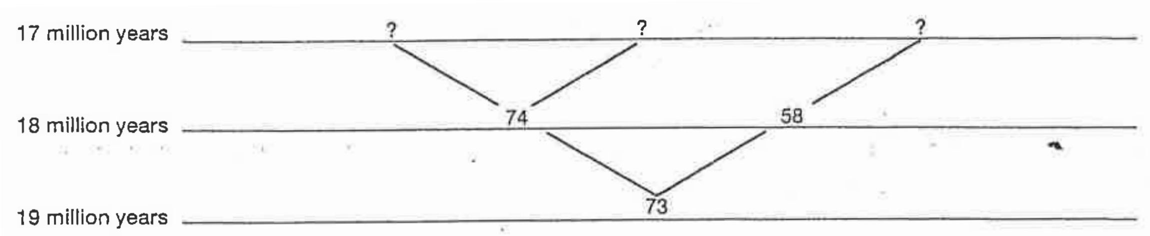


Figure 15.4 Beginning of caminalcule phylogentic tree.

14. Here comes the tricky part: *lightly* draw lines in pencil that indicate the relationships. A fossil species can be the ancestor of none, one, or two other species at a branching point, but not of three. The branching may be like that shown in Figure 15.5a but not like that shown in Figure 15.5b. Sometimes there is no branching and the transition from one species to another is like that shown in Figure 15.5c. Connect species that evolved from another species by slanted lines, not vertical lines. Use vertical lines only when the species has not evolved into a new species (ahem, species 13 and 14).

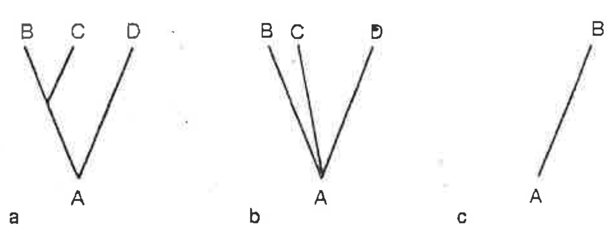


Figure 15.5 Branching can occur as shown in *a*, but *not* as shown in *b*. Sometimes there is no branching, as shown in *c*.

15. Because of the incomplete nature of the fossil record and different ways of interpreting the available fossils, more than one phylogenetic tree is possible. After you have finished, compare your tree with those of other teams. You may choose to finalize your own tree afterwards and permanently attach your fossils and darken the lines.

16. You may now compare your tree with the key provided by the teacher. Note any differences.

 Your Name:____ Per_____

Discussion after Part B

1. Do the evolutionary relationships shown in your phylogenetic tree require any changes in your original classification of living caminalcule genera? Compare the grouping on Line 0 with the way you classified the caminalcules in Part A. Revise your classification so it agrees with your phylogenetic tree. (**note** This is kinda the whole *point* of the lab). All members of a genus should have the same genus name and should share a common ancestor that is not shared by members of a different genus. The same rule applies to families, orders, classes, etc.
   ** Is revision required? (hint: it should be) Explain below.

   Describe the changes (including old and new names)

2. Define "convergent evolution," then list and describe examples of convergent evolution:

4. Define "vestigial structure," then list and describe examples of vestigial structures:

5. Is a "Successful lineage" one that has branched many times and is represented by many closely related species? Or is a lineage successful if it has changed very little through time? Defend your answer below, citing examples:

6. Define "gradualism," then describe evidence of gradualism:

7. Define "punctuated equilibrium," then describe evidence of punctuated equilibrium:

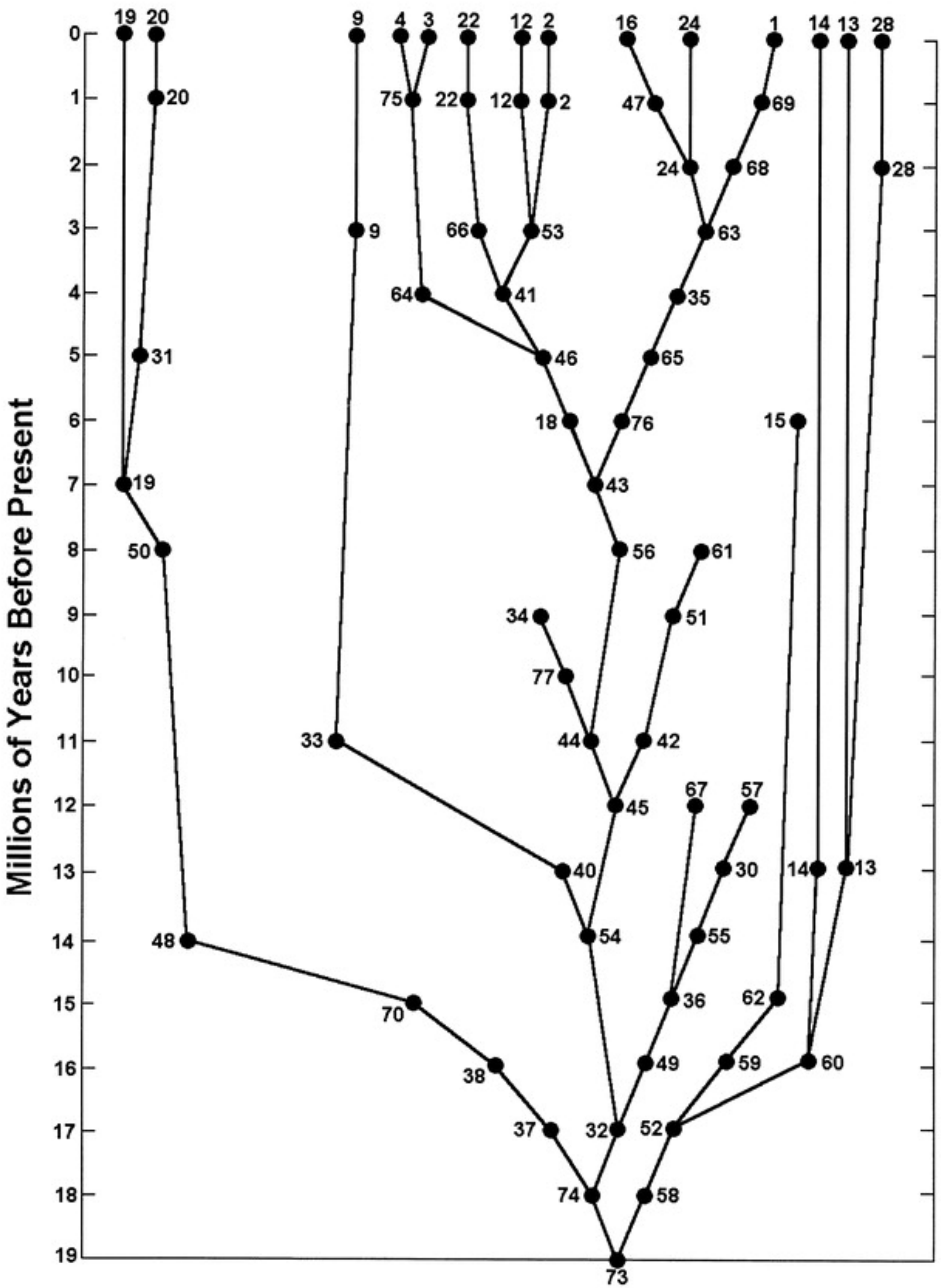
8. Propose a biological or environmental explanation for periods of time during which there was little or no change in the fossil record of caminalcules.

9. Propose a biological or environmental explanation for when there was relatively rapid changes in the evolution of caminalcules.

(staple this sheet after Part A and then turn it in)

Your Name:____ Per_____

Phylogenetic Tree Key



Discussion Questions - Key

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. 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.
6. The evolution of species 46 to 19 and 20, of 33 to 9, and of 52 to 14, 13, and 28.
7. 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. Or early part of 58, 52 lineage ending with stability in 13/14.
8. Lineages 13, 14, 40 and 46. Relatively unchanging environmental conditions might account for stability in structural characteristics.
9. Relatively rapid environmental change or perhaps mutations.

Teacher Introduction - Part A

You and your lab group are taking a group cruise through the treacherous but fascinating waters of the South Pacific Ocean. Late one night, just as you are about to call an end to your heated debate about the relative merits of Ducks vs Beavers, the ship's radio crackles to life:
"ATTENTION ALL HANDS! TSUNAMI APPROACHING! PUT ON LIFEJACKETS, SCRAMBLE ABOVE DECKS AND BRACE FOR IMPACT!"

You might think that chaos would break loose with such news, but you have all been well-drilled by the captain and crew for emergency situations like this. You and the rest of your shipmates calmly but quickly don a lifejacket and head up to the deck. You assemble near your assigned lifeboat and await the big wave.

What you see approaching from the horizon is daunting: a massive wave 30 feet high!

The ship is a wonderful ship, but it can't handle the power of this natural disaster. You, your team, and the rest of the shipmates are all swept overboard as the ship is capsized. Fortunately, every single person on the ship is saved by the lifejackets, many salvaged lifeboats, and a helpful pod of dolphins. You and your lab group all end up in the same boat. You are confident about getting rescued, and everything is going well until a storm comes along and scatters everybody's lifeboats.

Your lifeboat is separated from everyone else by the storm. You drift for a day and then find yourself close to an island. You row ashore. In the life boat you have plenty of food and water for weeks, but you find the island has lots of delicious tropical fruit and fresh water just in case. You know that someone will find you soon because the lifeboat has been broadcasting a homing signal since the cruise ship went down. You decide to relax and enjoy your unplanned island vacation.

Because you are all inquisitive scientific minds you begin to get curious about your surroundings. Among the fascinating things on this beautiful island are several small creatures. You find some crawling around in the undergrowth and others in the shallow water along the sandy shore. They are unlike anything you've seen before. Only about two inches long, they have a variety of shapes and features.

After a few days of blissful relaxation you see a rescue ship approaching. You consider staying on the island for awhile, but decide to head home because you miss the beautiful Oregon weather. Before you leave you catch several of the different types of the strange creatures to bring back to the lab for study.

You will now regather your lab group again for the first time since your return from the shipwreck adventure. Your team will investigate and try to classify the creatures you brought back with you.

Teacher Introduction - Part B

After you and your team have successfully classified the new creatures you brought back from the island, you apply for and get a huge research grant that is sufficient to fund years of study at the island. You decide to go back and search for fossils. The amount of the grant is great enough to build a sweet research facility on the island and you move in for the next five years.

Your excavations are quickly successful. You unearth dozens of fossils on the island in several sites around the island.

The specimens are all transported back to the states and now, after five years of work, you assemble them on the lab table in front of you. You have an instruction guide that will teach you how to organize them, and a team of brilliant fellow scientists to help you finish the task.

Go earn your Nobel Prize and lifelong international fame as the group that discovered and classified a completely new and unknown class of organisms!