

CAMINALCULES AND PHYLOGENETIC RECONSTRUCTION

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To prepare students to think about the data, assumptions, and interpretations that are part of a phylogenetic analysis. This exercise comes in five parts. The first part is all of the data -- all specimens and age dates for all specimens. This simulates the impossible -- a complete fossil record. The second part has 10% of the specimens randomly removed (an imperfect fossil record), but all age information is provided for the 90% given. Similarly, the third and fourth parts have 20% (different 20%*s*) of the data randomly removed, and all information is provided for the 80% of remaining specimens (a more imperfect fossil record). The fifth part has dates only for the modern forms -- all other dates are removed. This simulates the situation for a group lacking a fossil record or a situation where the fossil record is ignored.

Depending on the class size, students either individually or in groups develop a phylogeny from their data prior to class time. In class we lay everything out on tables and compare and contrast the various phylogenies and in the process discuss many of the basic assumptions, practices, biases, etc. of phylogenetic reconstruction.

You could make this more complex and have students code things into MacClade, Paup, etc.; however, I use this for the concepts of phylogenetic reconstruction only.

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EARTH SCIENCES 614 PALEOBIOLOGY

INTRODUCTION TO THE CAMINALCULE EXERCISE

Dr. Joseph T. Camin (1922-1979), Department of Entomology, University of Kansas, created the “imaginary animals” used in this exercise. Drawings and analyses of caminalcules were given in Sokal (1983a, 1983b, 1983c). These imaginary animals, “caminalcules,” were developed to test theoretical aspects of taxonomy and phylogeny. We will use five versions of this exercise A-E. In Exercise A, all available information is provided (all taxa and the ages of all caminalcules). This is of course never possible in the real world. In Exercise B the geological age of the caminalcules is given, but 10 percent of the species are missing due to “nonpreservation.” In Exercise C the geological age of the caminalcules is given, but 20 percent of the species are missing due to “nonpreservation.” In Exercise D the geological age of the caminalcules is given, but a different 20 percent of the species are missing due to “nonpreservation.” In Exercise E all caminalcules are given, but no age data is available, except for the living forms – an exercise needed for those who regard the stratigraphic record as uninformative.

In this exercise, you will analyze caminalcule phylogeny by hand and compare this to those developed by your classmates. You must make the decisions as to which characters are significant, which characters define phylogenetic transitions, and how these characters define taxonomic groupings.

As described in your version of this laboratory, come to lab with your phylogeny and classification solved and be ready to defend your decisions (based on the information that you had available) and to discuss phylogenetic methods. What is your logic for making decisions?

References Cited

- Sokal, R.R. 1983a. A phylogenetic analysis of the caminalcules. I. The data base. *Systematic Zoology*, 32:159-184.
- Sokal, R.R. 1983b. A phylogenetic analysis of the caminalcules. II. Estimating the true cladogram. *Systematic Zoology*, 32:185-201.
- Sokal, R.R. 1983c. A phylogenetic analysis of the caminalcules. III. Fossils and classification. *Systematic Zoology*, 32:248-258.

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CAMINALCULE EXERCISE – Part A

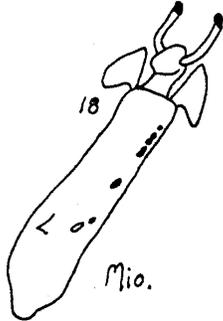
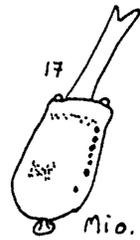
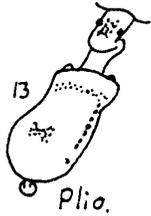
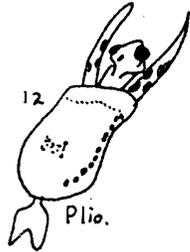
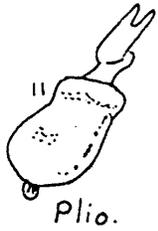
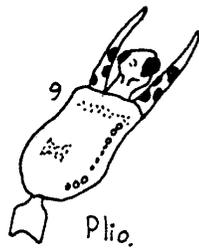
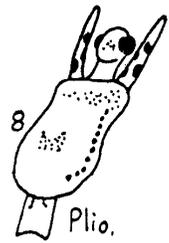
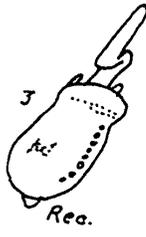
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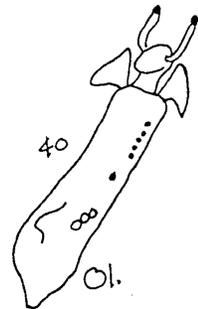
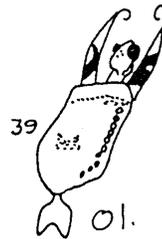
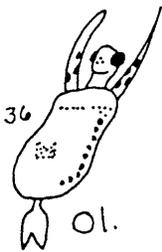
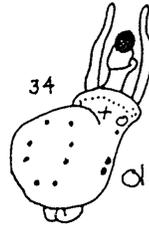
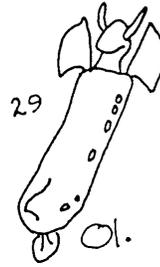
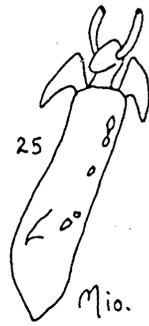
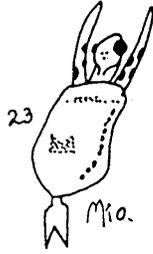
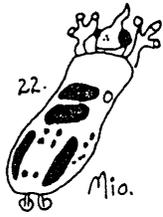
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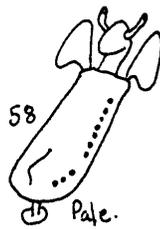
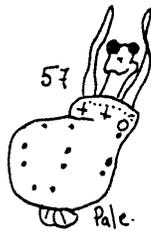
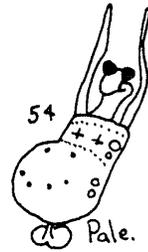
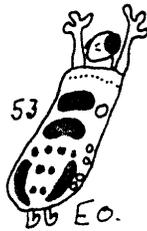
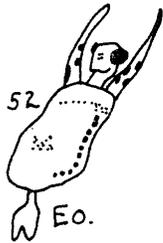
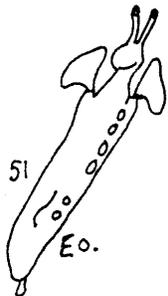
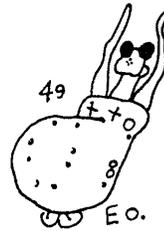
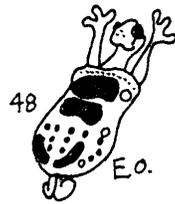
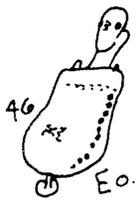
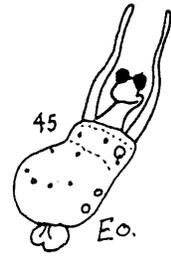
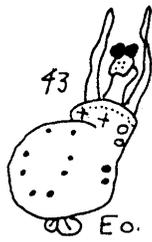
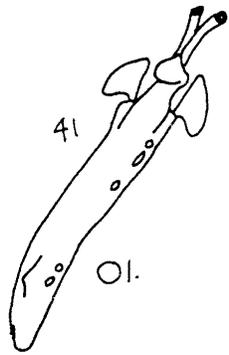
1. Cut out the individual caminalcules.
2. Construct a phylogeny of caminalcules, and summarize this on the ruled sheet of paper using the numbers of each animal.
3. Observe the following rules:
 - A. All of the caminalcules are descendants from the single Triassic form.
 - B. No ancestor-descendant relationship exists among caminalcules of any single Mesozoic period or Cenozoic epoch.
 - C. Each caminalcule in each time interval must have an ancestor in the immediately preceding period (or epoch).
 - D. Each branch in the phylogenetic tree must be a single branch (with one exception).
 - E. You have the most information of any group – don’t share it!
4. Assume that the caminalcules belong to a single class of organisms and that each specimen represents a single species. With colored pencils, illustrate Linnean classification of genera, families, and orders. Remember that this should be a nested classification.

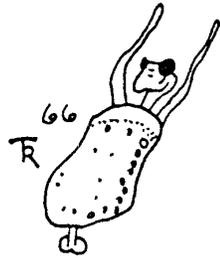
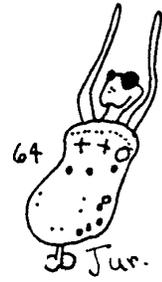
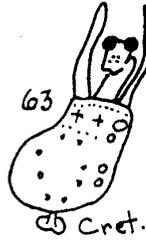
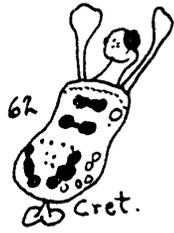
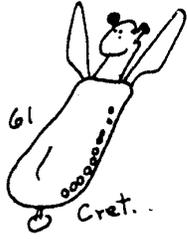
5. Questions to discuss:

- A. What additional information would have been helpful.
- B. Is your classification based on morphological similarities, on branching, on time, on innovation of new morphology, or some combination of these?
- C. Do your classification scheme and possible life habits of caminalcules have any correlation? Can you imagine any relationship to the real world.
- D. Consider how would this be different if you had all of the information available, versus only morphological information, versus taxa missing, etc.









Recent

Pleistocene

Pliocene

Miocene

Oligocene

Eocene

Paleocene

Cretaceous

Jurassic

Triassic

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PALEOBIOLOGY

CAMINALCULE EXERCISE – Part B

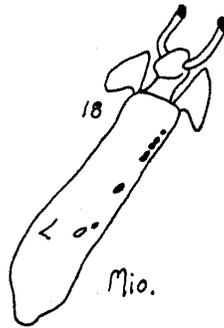
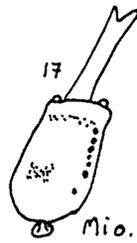
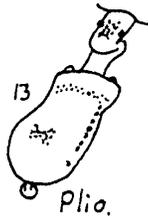
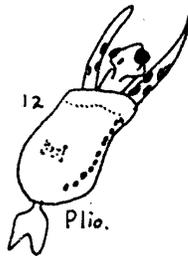
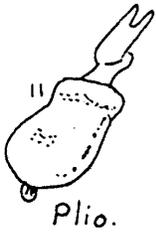
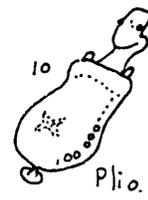
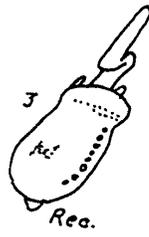
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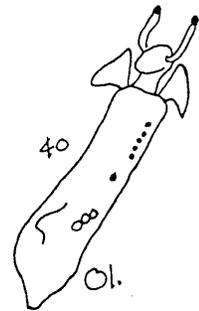
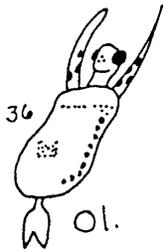
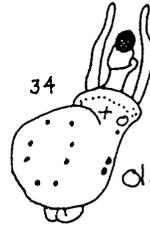
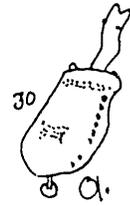
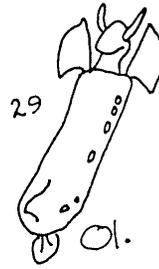
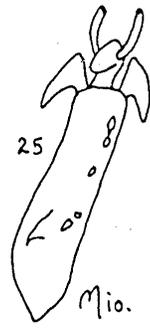
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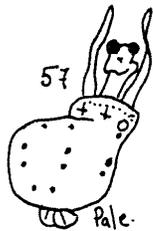
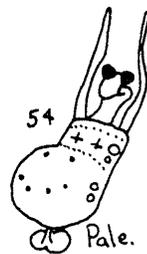
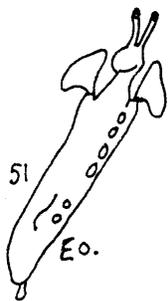
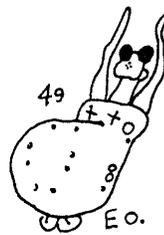
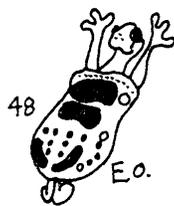
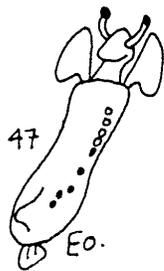
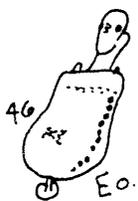
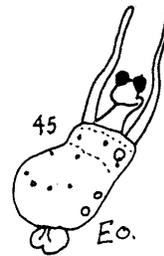
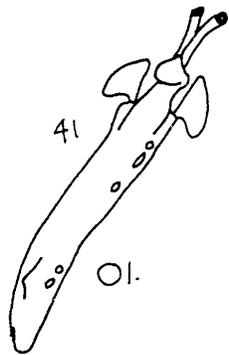
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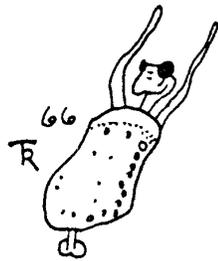
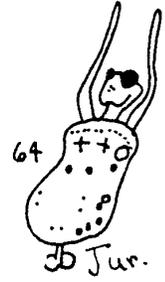
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CAMINALCULE EXERCISE – Part C

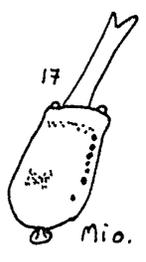
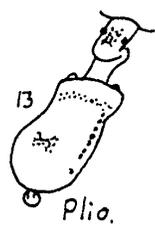
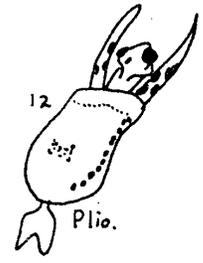
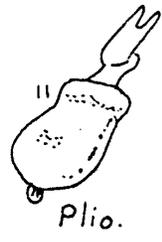
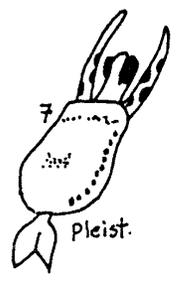
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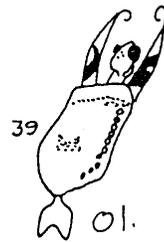
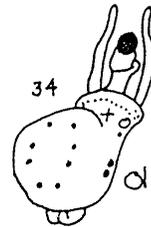
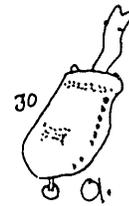
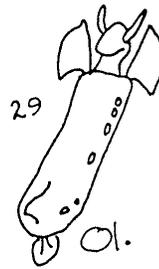
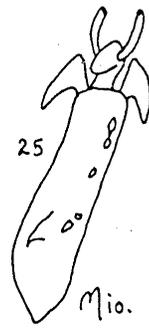
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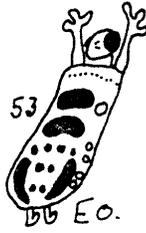
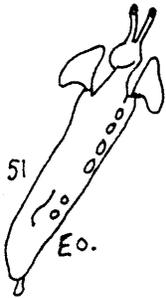
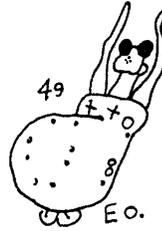
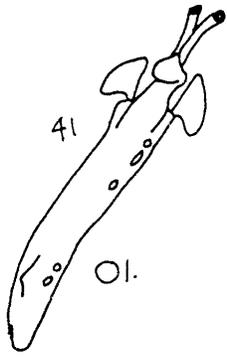
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3. Observe the following rules:
 - A. All of the caminalcules are descendants from the single Triassic form.
 - B. No ancestor-descendant relationship exists among caminalcules of any single Mesozoic period or Cenozoic epoch.
 - C. Each caminalcule should have an ancestor in the immediately preceding period (or epoch), but some will not due to nonpreservation
 - D. Each branch in the phylogenetic tree must be a single branch (with perhaps one exception).
 - E. Don not share your data with others!
4. Assume that the caminalcules belong to a single class of organisms and that each specimen represents a single species. With colored pencils, illustrate Linnean classification of genera, families, and orders. Remember that this should be a nested classification.

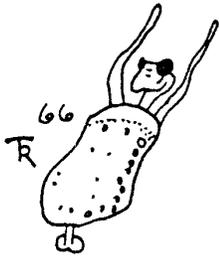
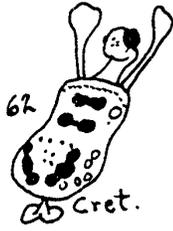
5. Questions to discuss:

- A. What additional information would have been helpful.
- B. Is your classification based on morphological similarities, on branching, on time, on innovation of new morphology, or some combination of these?
- C. Do your classification scheme and possible life habits of caminalcules have any correlation? Can you imagine any relationship to the real world.
- D. Consider how would this be different if you had all of the information available, versus only morphological information, versus taxa missing, etc.









Recent

Pleistocene

Pliocene

Miocene

Oligocene

Eocene

Paleocene

Cretaceous

Jurassic

Triassic

EARTH SCIENCES 614
PALEOBIOLOGY

CAMINALCULE EXERCISE – Part D

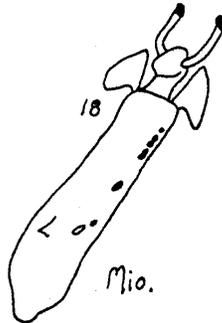
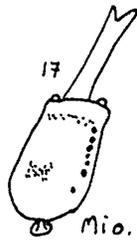
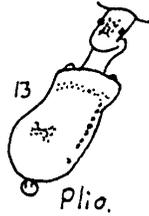
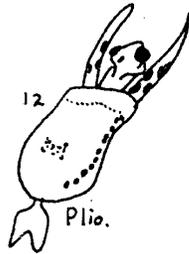
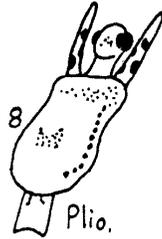
Dr. Joseph T. Camin, Department of Entomology, University of Kansas, created the “animals” used in this exercise. These imaginary animals, “caminalcules,” were developed in order to test certain theoretical aspects of taxonomy and phylogeny. We will use the caminalcules as an introduction to the decision making and options that are part of the development of phylogenies and classifications. This is Part D, in which students are given the geological age of the caminalcules but twenty percent of the species are missing – nonpreservation. Other students have different rules and perhaps somewhat different data for construction their caminalcule phylogeny.

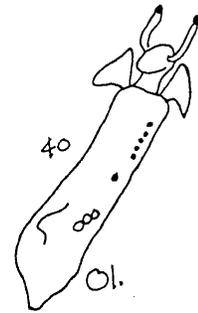
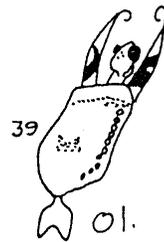
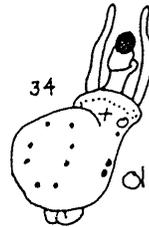
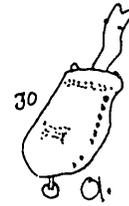
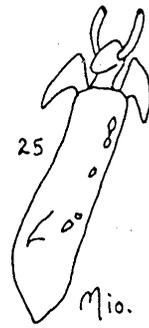
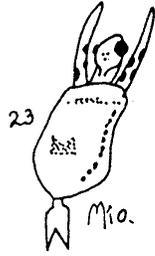
Procedure:

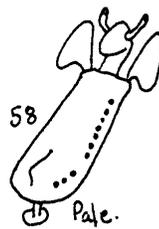
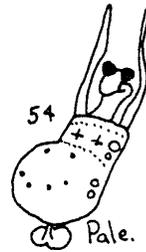
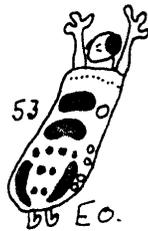
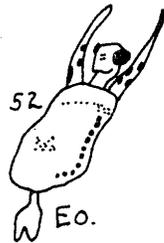
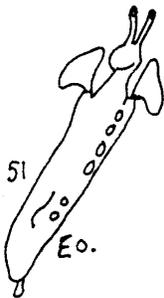
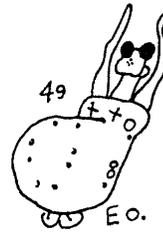
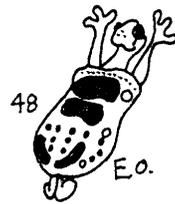
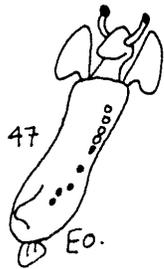
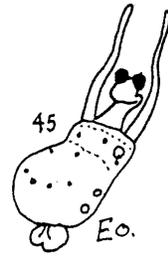
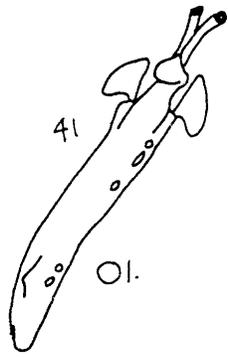
1. Cut out the individual caminalcules.
2. Construct a phylogeny of caminalcules, and summarize this on the ruled sheet of paper using the numbers of each animal.
3. Observe the following rules:
 - A. All of the caminalcules are descendants from the single Triassic form.
 - B. No ancestor-descendant relationship exists among caminalcules of any single Mesozoic period or Cenozoic epoch.
 - C. Each caminalcule should have an ancestor in the immediately preceding period (or epoch), but some will not due to nonpreservation
 - D. Each branch in the phylogenetic tree must be a single branch (with perhaps one exception).
 - E. Don not share your data with others!
4. Assume that the caminalcules belong to a single class of organisms and that each specimen represents a single species. With colored pencils, illustrate Linnean classification of genera, families, and orders. Remember that this should be a nested classification.

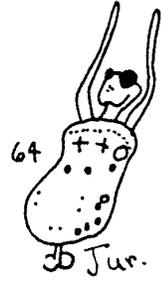
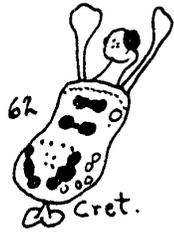
5. Questions to discuss:

- A. What additional information would have been helpful.
- B. Is your classification based on morphological similarities, on branching, on time, on innovation of new morphology, or some combination of these?
- C. Do your classification scheme and possible life habits of caminalcules have any correlation? Can you imagine any relationship to the real world.
- D. Consider how would this be different if you had all of the information available, versus only morphological information, versus taxa missing, etc.









Recent

Pleistocene

Pliocene

Miocene

Oligocene

Eocene

Paleocene

Cretaceous

Jurassic

Triassic

EARTH SCIENCES 614
PALEOBIOLOGY

CAMINALCULE EXERCISE – Part E

Dr. Joseph T. Camin, Department of Entomology, University of Kansas, created the “animals” used in this exercise. These imaginary animals, “caminalcules,” were developed in order to test certain theoretical aspects of taxonomy and phylogeny. We will use the caminalcules as an introduction to the decision making and options that are part of the development of phylogenies and classifications. This is Part E, in which students are given all of the caminalcules, but no age data is available, except for the living forms. Other students have different rules and perhaps somewhat different data for construction their caminalcule phylogeny.

Procedure:

1. Cut out the individual caminalcules.
2. Construct a phylogeny of caminalcules, and summarize this on an unruled sheet of paper using the numbers of each animal.
3. Observe the following rules:
 - A. All of the caminalcules are descendants from one form – you need to decide which form is the ancestor of all caminalcules.
 - B. Each branch in the phylogenetic tree must be a single branch (with one exception).
 - E. You have the least information of any group – don’t ask for more!
4. Assume that the caminalcules belong to a single class of organisms and that each specimen represents a single species. With colored pencils, illustrate Linnean classification of genera, families, and orders. Remember that this should be a nested classification.

5. Questions to discuss:

- A. What additional information would have been helpful.
- B. Is your classification based on morphological similarities, on branching, on time, on innovation of new morphology, or some combination of these?
- C. Do your classification scheme and possible life habits of caminalcules have any correlation? Can you imagine any relationship to the real world.
- D. Consider how would this be different if you had all of the information available, versus only morphological information, versus taxa missing, etc.

