Assignment Preview

Title: Modern Cladistic Analysis

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Learning Goals

Scientists who study cladistics are concerned with depicting a TREE of LIFE - often using computer technologies. Cladograms are a way to portray relationship (genealogy) between taxa. We commonly call such diagrams trees. This assignment will help you become familiar with cladograms.

- Identify a group of related organisms that were examined in a paper with original research that was published within the last 15 years.

- Notice how carefully words are used in the publication to indicate that some biological knowledge is tentative or uncertain while other biological knowledge is well established.

- You may also discover how and why biological knowledge changes over time.

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Source Materials

Scientists combine molecular evidence, biochemistry, anatomy, morphology, behavior, and fossils as evidence for the history of life on earth. Relationships among different organisms are portrayed using phylogenetic trees or cladograms where the branches relate to the predicted or hypothetical evolutionary relationships.

Consider birds. Do you know which groups of organisms are most closely related to birds? Scientists use shared and divergent traits to infer hypothetical common ancestors. Print a cladogram, The Consensus Phylogenetic Tree of All Life at http://www.talkorigins.org/faqs/comdesc/phylo.html#fig1, and refer to it as you read the following description.

Start with some cladogram terminology and basic definitions of terms such as node and branch. A node corresponds to a hypothetical ancestor. A terminal node is the hypothetical last common ancestral interbreeding population of the taxon labeled at a tip of the cladogram. An internal node is the hypothetical last common ancestral population that speciated (split) to give rise to two or more daughter taxa, which are thus sister taxon to each other. For example, in Figure 1. The Consensus Phylogenetic Tree of All Life at http://www.talkorigins.org/faqs/comdesc/phylo.html#fig1, the node marked red dot A represents an ancestral population to crocodiles and birds. Each internal node is also at the base of a clade, which includes the common ancestral population (node) plus all its descendents. A clade can arise
from an ancestral population that is hierarchically nested within another clade. To use an example, mammals are nested hierarchically within the clade of all Metazoans (animals). The common ancestor of all animals lived before the common ancestor for all mammals. There are animals that are not mammals, but all mammals are animals. Mammals are a particular subgroup or part of the whole animal clade.

A cladogram is only a hypothesis of the relative order of branching; it does not indicate how much absolute time past between branching events.

Sister taxa are any taxa derived from a common ancestral node. For a given set of taxa under consideration, a taxon is always most closely related to its sister taxon (or taxa). For any terminal or internal node giving rise to a taxon, the sister taxon is determined by, first, finding the node (common ancestor) for a taxon, then tracing along the branch leading to this node, back toward the root, until another deeper (more ancient) node is encountered. For example, tracing birds back to an ancestor that was shared by crocodiles shows that crocodiles are related to birds. The node marked A represents the next most recent common ancestor of the bird taxon, and this ancestor is also shared by the sister taxon (crocodiles). If the node is dichotomous (i.e., there are only two branches emerging directly from it), the taxon has only one sister taxon (birds and crocodiles). If there are more than two branches emerging from the node, the node is a polytomy, and the taxon has multiple sister taxa.

The terminal nodes snakes and lizards are also sister taxa. The branches leading to them meet at a node to form a clade. Likewise, bird and crocodile are sister taxa. They are members of another clade who share a different common ancestor, node A, that lived more recently than their last common ancestor shared with snakes and lizards. According to this cladogram, a bird and a crocodile are equally closely related to a lizard (or a snake), because they are related by way of the same common ancestor. One way to think about this is to consider the snip rule for dividing a large clade into the daughter lineages derived from the common ancestor. Imagine traveling up each branch from a node and then snipping. What falls off are the sister taxa.

To review and extend your understanding, spend 10 minutes with a tutorial from the University of California in Berkeley at http://evolution.berkeley.edu/evolibrary/article/phylogenetics_01 to investigate and interpret how scientists currently use evidence to establish evolutionary relationships between diverse group of organisms like the birds and dinosaurs.

Find a research paper that presents current evidence for a tree diagram portraying relationships among organisms that are relevant to your future career interests. For example, a future research biologist may choose to study the major clades of all organisms to find out about model organisms like Arabidopsis, yeast or Drosophila, a vet student could choose to learn about a clade that includes the domestic dog, fox, coyote, and wolf, a future ecologist could find out about birds, and a future medical doctor could find out about a clade that relates the rats commonly used to test drugs to humans. Be creative but start early and prepare to consult a librarian for assistance with the first step, deciding on a topic for your essay. Start early so you have time to review Tutorials for Biology Students Searching the Scientific Literature or to consult a librarian for help finding and using a scholarly primary source of scientific research.

Guidance for Studying Source Materials
Find a research paper that presents a surprising or interesting cladogram. Be creative in choosing an interesting group of organisms that is related to your future career.

- Your primary research article with tree-thinking must be published within the past 15 years.
- Identify the organisms that were examined.
- List five variables or traits that were used to interpret how the organisms are related.
- Record statements that explain about why scientists think these organisms are related.
- Critically evaluate whether the conclusions from the scientific study are warranted. Consider alternative cladograms and how convincing the current evidence is for this particular version.
- Think about the cladogram using these terms: ancestor, node, branch, divergence, clade, lineage.
- Document all references.

CAUTION 1: A cladogram that shows possible relationships among organisms is not the same as a gene or protein tree diagram.

CAUTION 2: Do not consider branch lengths on a cladogram to represent time.

CAUTION 3: Remember that a tree does not show "progress" because all existing species are equally modern.

**Guidance for Writing Your Text**

1. Write a short essay about a primary research article with tree-thinking that was published recently. Identify the source.
2. Explain how you know that the source literature is primary research.
3. Explain how specific variables or traits were examined to infer how the organisms are related.
4. Consider why some groups are thought to be more closely related than others within the tree.
5. Provide examples and clearly explain what is known about the history of specific organisms that are members of the tree. Choose your words to indicate degrees of certainty based on evidence.
6. Use the terms ancestor, node, divergence, and lineage to show correct relationships between groups.
7. Remember that related distance depends upon shared ancestors and not on time.

**Writing Prompt**

Do not just answer the questions. Organize your ideas into a short essay about a family tree cladogram diagram based on some current research. Use a scholarly primary source published within the past 15 years and written by scientists who conducted the original research. Write with logical organization and use the spelling, grammar, and word count functions of software like MSWord to shorten your essay to within the word limit. Identify your source at the end of the essay, and then paste it into the CPR textbox and submit (don't just save) it. If you decide to edit your work, you can resubmit more than once before the deadline.