

Yet Another Exercise on Relationship Tree Building

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This workshop emphasized the differences among relationship trees built using a Phylogenetics or Cladistics approach or a more Traditional or Classic Systematics approach. Books still mix the two approaches. This is a simple 30-45 minute exercise where groups of students construct a relationship tree using the assumptions of one or the other school.. The exercise challenges and motivates students who start only with a base diagram of an ancestor and the outline of a relationship tree. Students have responded quite positively to this exercise and their ability to correctly answer questions on exams related to clade building certainly has increased.

Keywords: cladistics, classification, synapomorphy

Introduction

The objective is to have students engage in an activity that focuses on the primary differences between phylogenetics (cladistics) and what is now referred to as traditional, classic or evolutionary systematics approach to classification. This activity then involves distinguishing a synapomorphy or derived trait from a character used in traditional classification and emphasizing the importance of nodes.

The activity is designed to use the simplest tree that forces the students to make these distinctions. A tree containing, six living species (ends of branches), two main branches and five nodes (forks as indicated by circles) was deemed suitable (Fig. 1).

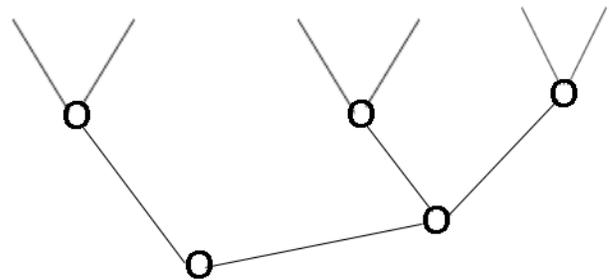


Figure 1. Basic tree used in activity.

Student Outline

General instructions should include some introduction to the tree itself. In most classes, since students have already been exposed to the tenets of the phylogenetics and evolutionary schools the following instructions would suffice.

“You are to construct a relationship tree for critters you design. It must be based on a phylogenetic (cladistic) or evolutionary scheme. You are to use the tree provided which clusters living specimens into two main groups. The focus for either classification is the four living species that are grouped together. The group consisting of two species represents for any cladistic scheme, the outgroup. Any evolutionary scheme must be constructed so any group of two living species represents a different "lifestyle". If you build a cladistics tree you should include characteristics that are and are not synapomorphies.”

Often I hand out boxes of colored pencils and of course a basic diagram of the model organism and “tree” for their use. I will allow 10-15 minutes for groups of 3-4 students to construct their tree.

The level of difficulty of the activity varies with my audience or the class in which I am using this particular activity. For example in my invertebrate zoology class I only lecture for about 20 minutes on phylogenetics. My invertebrate biology class is a senior level class on invertebrate diversity, one of two classes students can take to fulfill the diversity requirement for a Zoology major. The focus of the course is the diversity found among invertebrates and with 36 clades to discuss, I really have little time to spend on different classifications schemes. I want students to realize how different this scheme may be than the one they were introduced to in high school (usually the evolutionary or traditional or classic school). Then I simply want them to understand how the tenets of this scheme or school can be used to build trees. Often I challenge them to simply build a cladistics tree for imaginary creatures that could possibly be related to nudibranchs (Fig. 2). In my introductory lecture about the importance as well as sheer beauty of the organisms they will learn about in class this term I often use nudibranchs as one example of simply beautiful animals.

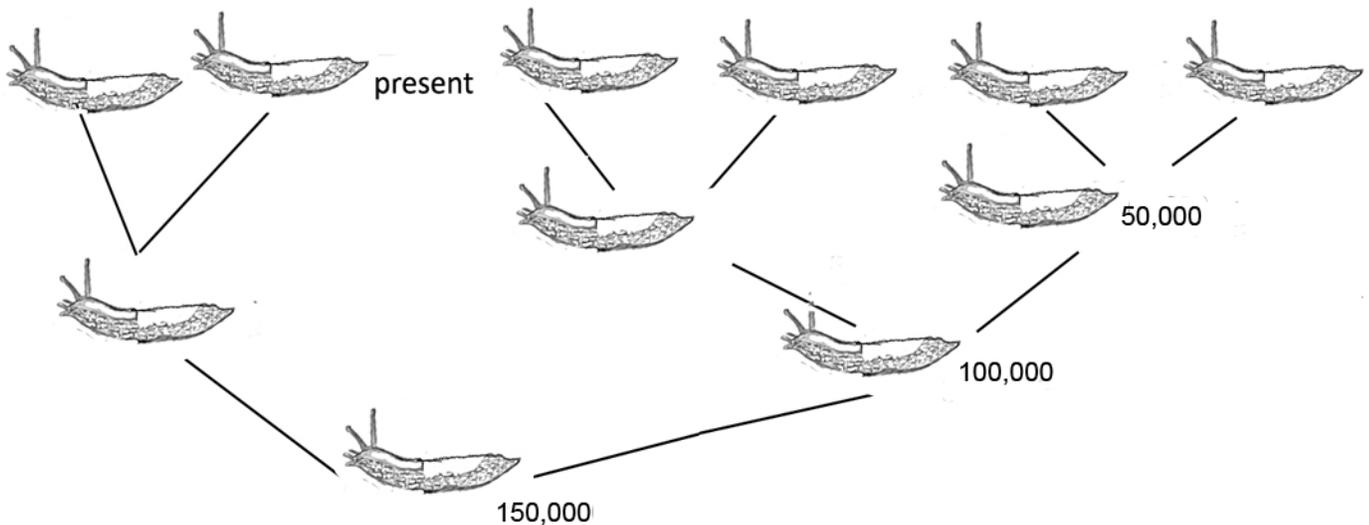


Figure 2. Diagram used by students to construct a cladistics relationship tree for nudibranch relatives. Numbers indicate ancestors existing 150,000, 100,000 or 50,000 years ago.

To their instructions I add the following.

“Come up to the front once you have finished and share your tree with the class. Tell us about the characters you used, but not which characters are synapomorphies. The class will determine what traits are synapomorphies and if you have truly built a cladistics tree.”

It is a small class and it usually takes another 15-20 minutes to discuss the trees constructed by the different groups.

My Introduction to Evolution class, is a junior-senior level course that emphasizes theory and includes examination concepts such as, the relative role of selection versus drift in shaping diversity, the unit of selections and the relationship between macro and micro evolution. Students read about various schemes of classification. I lecture a bit and we even construct a table that compares the tenets of the different schools discussed in their readings. Then they construct their trees

in small groups in class. I have used lizards and sharks as subjects. Sometimes I have let the class vote on the animal they would like to use as a model. The activity on tree building for this class is more challenging.

“Once you have completed your tree, you will give to another group your tree however with one of your ancestors missing. All of the extant species must be present. The group receiving your tree must determine whether your tree is a cladistics or phylogenetic tree and what the missing fossil may have looked like.”

It is very interesting to note that at least half the class, even in my introduction to evolution class makes a mistake in initially constructing a cladistics tree. To my surprise every term, this is the choice of most groups. I suspect students feel they do not have to discuss/write as much about the different lifestyle of clusters of imaginary organisms. In my invertebrate zoology class because they have simply learned definitions and tenets of phylogenetics from a short lecture often eighty percent of the trees fail as properly constructed examples of cladistics trees. Students can learn definitions and principles well enough to discuss them properly and still lack the understanding needed to use them properly. The benefits of this exercises is that it provides the test drive needed to master these basic concepts after readings and lecture have provided the basic introduction and relevant comparisons.

Notes for the Instructor

Workshop participants asked for some examples of trees drawn by students, so I have included two examples in this paper.

Figure 3 is one from my Darwinian Medicine class. They use the online website EVO 101 to learn about phylogenetics and tree building. They take a quiz in class about what they have learned and then I may lecture a bit before they do the tree building activity. This tree is one of the simplest drawn and could be a cladistics tree. The group gave a good discussion about camouflage in various habitats (green dots in wet habitat and orange dots and stripes in desert habitat), warning

purple coloration, flat tails for climbing vegetation and whipped tails for defense. However, the group failed to get full credit for their tree because they did not include traits that were not synapomorphies. The synapomorphies distinguishing clades or nodes are flat tail, whipped tail (outgroup), dots and stripes.

Figure 4 is a tree from my Invertebrate Zoology class. The group did a great job with characteristics. This group even handed in DNA sequence data on a separate sheet for some nodes. They unfortunately intended their synapomorphies to be terrestrial “legs”, slime, yellow-green coloration, and head gills. They forgot to add slime as designated by the gray and blue coloration under the animal to the relevant ancestral node designated by the red X.

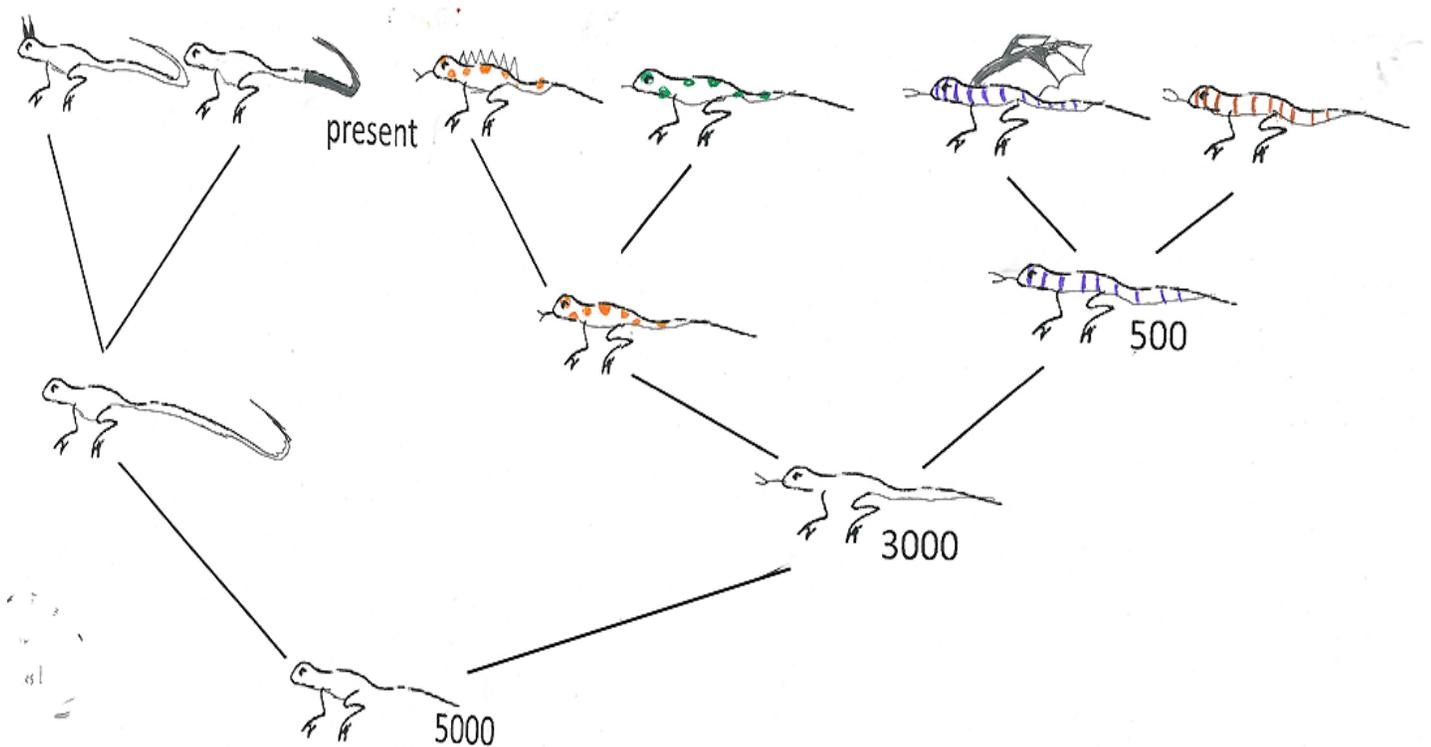


Figure 3. A tree of lizards drawn by students in a Darwinian Medicine class.

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