

GER Project Report 2003, ZO 150 Animal Diversity

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GER Objectives

As a course in the Natural Sciences category of the General Education Requirements, ZO 150 will provide instruction and guidance that help students to:

1. use the methods and processes of science in testing hypotheses, solving problems, and making decisions; and,
2. articulate, make inferences from, and apply to solving problems, scientific concepts, principles, laws, and theories.

GER Student Learning Outcomes (condensed for inclusion in Course Objectives)

Upon successful completion of ZO 150, students will be able to:

1. explain how a cladogram (phylogenetic tree) can be constructed and supported with appropriate evidence, using the principles and terminology of cladistics;
2. compare and evaluate anatomical evidence, then use it to construct cladograms; and,
3. analyze examples of ambiguity in cladograms, and apply techniques that can resolve those ambiguities.

Means of Instructing and Evaluating GER Outcomes

Part I. Key terms in cladistics and their applications to evolutionary relationships among animals will be introduced by assigned textbook readings and a lecture. Definitions of the terms and recognition of their correct application to specific cases will be tested in multiple choice format on lecture tests.

Part II. An exercise added to the 4th laboratory meeting will challenge teams of three students to describe and evaluate anatomical characteristics from illustrations, microscope slides, and preserved specimens for use as cladistic evidence. This exercise will be guided and supported by a new handout supplemental to the Laboratory Guide.

Students will distinguish derived (more complex, advanced) from ancestral (simpler, older) conditions of each anatomical character, and explain their reasoning. They will apply their conclusions to construct a provisional cladogram for selected animals. The exercise will include a deliberately ambiguous set of characteristics, with which instructors will lead students into a discussion of techniques for resolving ambiguities using other data. Revised cladograms will be submitted as part of the lab grade.

Part III. A homework assignment later in the semester, weighted equally to a lecture test, will determine the ability of each student to apply these concepts to produce and justify a cladogram for a new set of animal taxa, using class informational resources.

Part IV.. A final exam discussion question will require students to explain a case in which application of cladistic principles has resulted in a major change in accepted taxonomic hierarchies of animals. For example: "Why is the former class Reptilia considered to be paraphyletic by cladistic standards? In your discussion, explain, with examples from this case, how the confusion of ancestral and convergent characteristics with derived characteristics led to the older classification. Finally, describe the newer classification and explain how derived characteristics support it."

Summary of Results

A four-part program of lectures, exercises, homework, and testing was instituted in ZO 150 in Fall 2003 to emphasize the general concept of cladistics, a procedure for determining the evolutionary relationships of living animals. Cladistics involves hypothesis composition, application of data to make decisions, and scientific reasoning, and incorporates repetitive, beneficial study of difficult animal names and anatomical and embryological attributes. Its findings have always been a central part of ZO 150 content, but the application of the method has never been given this level of emphasis.

There are five, contemporaneous versions of ZO 150 every fall, but the two distance education versions had small enrollments and relied on lectures videotaped before Fall 2003, so were not included in analyses. The honors section had other requirements that substituted for the homework assignment, but were included in evaluations by tests, since they attended the special lecture on cladistics (**Appendix I**). The remaining two, regular lecture sections enroll non-Zoology majors (about 160) and Zoology majors (about 70). The non-majors section is predominantly life science majors taking ZO 150 as an advised elective. Unfortunately, I forgot to download and save the majors of the enrolled students last semester, but fall 2003 was probably little different from the previous fall term, in which about 25% were from majors outside the life science or natural resource areas, or in undesignated, first year college, post-baccalaureate or undergraduate special categories.

There was no detectable improvement in responses to questions based on cladistics concepts in multiple-choice tests given during the semester, although similar questions were given before and after a special laboratory exercise (**Appendix II**) and a homework assignment (**Appendix III**) based on cladistics. However, the average proportion of correct responses to cladistics-related, multiple choice questions on the final exam in Fall 2003 was much better than responses to similar questions on the Fall 2002 final exams.

Lecture tests also involved more elaborate tests of cladistics concepts (**Appendix IV**), but in the press of class management, I neglected to keep results from those types of questions separate and could not analyze responses for improvements.

The homework assignment had been used in distance education versions of the class in previous semesters, but the sample sizes and support structures for the exercise were so different in previous versions that I do not consider a comparison to be valid.

An unquantified indication of the value of the project was the on-line class discussion activity concerning the homework assignment (**Appendix V**). This venue gave me a chance to see what parts confused students most, and to answer their questions or clarify procedures and concepts while they were actively engaged in the assignment. This is not easy to do in large classes, and I am most pleased with that aspect. It is a form of real-time course evaluation that will be very helpful in future adjustments of the exercises and assignments.

What I Have Learned About the Effectiveness of the Course as a GER Course

I believe that the project resulted in a substantial improvement in students' learning about animal phylogeny, as well as a better insight into current scientific thought processes for non-science majors in the field of evolution and phylogeny.

Intended Changes Based on Assessment

I discovered that students misunderstood two of the assignments somewhat. I plan to modify both the lab activity and the homework assignment for greater clarification.

Appendix I. Lecture Introduction of Concepts

This is the text of my Powerpoint presentation in lecture. References to figures are for the required textbook, Campbell, N. A., and J. B. Reece 2002. Biology (6th ed.) Benjamin Cummings, Inc.

Taxonomy According to Cladistics

Phylogenetic Classification

- Taxa defined according to phylogeny
- = evolutionary history, genetic relationships
- New evidence leads to revision of higher classification
- Many intermediate “groups” are created

Cladistics Text, p. 494-505

- Logical procedure for arranging taxa of organisms into cladograms
- = phylogenetic trees
- Based strictly on **derived homologies**
- Result: hypotheses about kinship

Amniote Cladogram Based On Observable Characters Fig. 25.12

Basic Cladogram (compare Fig. 25.9a)

Clades and Sister Groups

Monophyletic Taxon Fig. 25.9a

- Common ancestor and all its descendants are included.

Paraphyletic Taxon Fig. 25.9b

- Some of the descendants (D, E, C) of the most recent, common ancestor (A) of G, H, J, and K are excluded
- Often based on ancestral similarities

Polyphyletic Taxa Fig. 25.9c

- Common ancestors, and also descendants, excluded
- Often based on **convergences**

Criteria for Monophyly

- Only **monophyletic** groups are valid
- Must include the most recent, common ancestor and all its descendants
- Only **homologous, derived** features are acceptable evidence
 - But similar features may be homologous and **ancestral**, or analogous (**convergent**)
- Comparative Cladistic Data
 - Anatomical, cytological, and biochemical features of the adult stage
 - Patterns of embryonic and larval development
 - Statistical similarities among selected, nuclear and mitochondrial genes

Evaluating Similar Features

- Homologous features - evolved from same, basic structure; . . . may be:
- **Ancestral** - also present outside the group
- *or* **Derived** - present only in the group
- Analogous - similar, advanced features that evolved independently in different ancestors = **Convergent**

Homology of Mammal Forelimbs Fig. 22.14

- Basic bones are **ancestral** - evolved in ancestor shared with frogs and lizards
- Special modifications are **derived** for each order

Convergent Wings compare Fig. 34.20, 34.25

- Bones that support wings are **homologous**
- But differences in bones show that wings are **convergent**
 - evolved independently from different ancestors

To Tell Derived from Ancestral:

- Choose an “outgroup” - related to “ingroups” being compared, but shares an earlier, common ancestor
- Features that are similar among the ingroup that also occur in the outgroup are considered ancestral

To Tell Derived from Convergent

- Convergent characters usually follow different pathways of embryonic development
- If a greater number of features support a different clade, then the feature is likely convergent
- If taxa have very similar ecologies, we expect convergences

Convergence Due to Similar Ecology Fig. 22.15

Convergence Recognized by Stronger Evidence for Other Clade Fig. 25.16

Genetic Evidence Helps

- “Conservative” parts of genome compared by statistics
- Computers generate cladograms based on assumptions about matching sections of code and insertion or deletion processes
- New data can cause major changes in computer cladograms

Example of Code Analysis

Appendix II. ZO 150L Cladogram Exercise Handout

In teams of 3, prepare a tentative (hypothetical) cladogram of the following taxa now, during lab meeting. At the end of 15 minutes, your instructor will call the lab to order, ask for progress reports from teams, and lead a class discussion about how to proceed with the assignment.

List of taxa for this assignment:

- Hydrozoa
- Turbellaria
- Trematoda
- Cestoda
- Bivalvia

Tasks to complete:

Justify each branch with one visible, shared (or unique, for individual classes), derived feature.

Refer to your lab guide, Photo Atlas, textbook, lecture notes, and specimens you have studied in the lab to recognize shared, derived features. Absence of some feature is usually ancestral, but in parasitic animals, for example, absence of a structure or organ may be derived, because structures that are not needed are often lost in evolution.

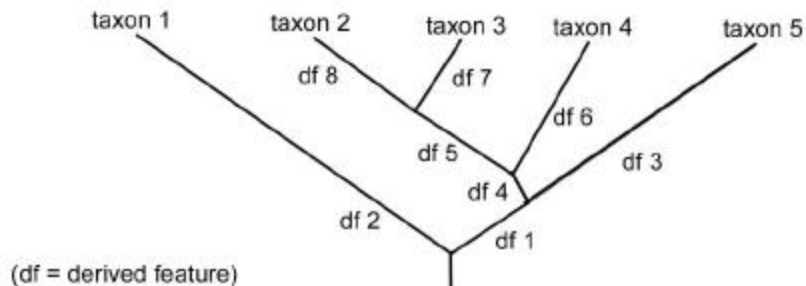
Find (and list) one convergent and two ancestral features. Convergent features must occur on two or more of the taxa in this list and you must argue that they were developed independently by different ancestors. Ancestral features are likely to include those which are recognizably simpler than the alternative, or which also occur in animals outside the major phylogenetic groups represented by the taxa in this list.

Take home your notes and continue working as a team to produce a final version of your cladogram, one per team, to hand in at lab time next week.

Format:

1. (cover page) "ZO 150L Cladogram Fall 2003, (names and signatures of team members)
2. Cladogram of 5 taxa, drawn, with a derived feature listed beside each branch
3. Brief explanation of your choices of ancestral and convergent features

Completed cladograms will earn up to 40 points to supplement your lab grade as extra credit. All members of a team who sign the cover page will receive the same grade.



Appendix III. ZO 150 Cladogram Homework Assignment for Fall 2003

The taxa (in no particular order) for this assignment are:

Bryozoa
Scyphozoa
Tardigrada
Crocodilia
Gastropoda
Echinoidea
Carnivora

Your cladogram paper must have at least three pages:

1. A title page, with "ZO 150 Cladogram Assignment, Fall 2003," your name, and the signed statement: "I prepared the final version of this cladogram assignment myself."
2. A cladogram, prepared in the same format as the team cladogram you did in laboratory, except that you will label branches with numbers and letters instead of writing characteristics directly on the chart. An example of format for this page is shown below.
3. A page listing the derived characteristics, keyed by a system of numbers similar to that illustrated in the diagram below. Items in this list may be only one or a few words long, each. A complete character list will have 2, derived characteristics for each side of each branching point in the chart, for a total of 24 characteristics.
 - The number is exact, because seven taxa will be linked by six branching points with two branches, each. Since you must find two characteristics per branch, the total is $6 \times 2 \times 2 = 24$. Notice that in the example below, there are only 6 taxa and therefore five branching points and 10 branches, which with two characteristics each would require a total of 20 characteristics).
 - In the sample cladogram, the 6 taxa are represented by letters Q and V-Z, and branches by numbers with "A" on the right and "B" on the left. You would have two characteristics for branch 1A, two others for 1B, two more for 2A, etc., through the two for 5B, for a total of 20.
 - Characters listed for any branch must apply to all the taxa farther out on that branch.
 - In the example, the two characteristics at 1A should be both derived and shared by the five taxa, X, Y, Z, Q, and W, and not shared by taxon V.
 - Similarly, the two characteristics for 3A should be derived and shared by taxa Z and Q but not by taxon W, nor by any other taxon in the diagram (except in the unlikely case of a convergence).
 - The two characteristics at 5B should be unique to taxon Q among all those in the diagram.

Additional suggestions

Read the material at <http://www.cals.ncsu.edu/course/zo150/mozley/cabvid/HowtoPhy.html> for and links to a list of suggested characteristics. Use of these materials is helpful but not entirely necessary for a good cladogram.

Appendix IV. Cladistics Discussion Questions from Exams and Tests

Students were given similar questions in advance on line as study aids, about 12 per test, then given a choice of three (for each lecture test) or five (for the comprehensive final exam) of the questions on which to write essays based on memory of their work on similar questions.

Unfortunately, I did not keep a record of which students selected these questions to answer, nor the average grades on each question option. The questions are appended to illustrate what I expected students to be able to do as a result of lectures, laboratory exercises and homework assignments.

Test 3 (two cladistics-related options)

Draw a phylogenetic tree that includes all the following taxa: Annelida, Nematoda, Tardigrada, Onychophora, Arthropoda, Echinodermata. At appropriate places on the branches, write the following terms: metameres, external cilia, shedding cuticle, lobopods, jointed appendages, schizocoelous, enterocoelous, spiral cleavage, non-spiral/non-radial cleavage, radial cleavage, determinate cleavage, regulative cleavage, mouth from blastopore, anus from blastopore, water vascular system. Also write the following terms along the branches: Protostomia, Spiralia, Ecdysozoa, Deuterostomia. For a character that shows up on two, separate branches, state whether it is convergent or ancestral and explain your choice.

Which two of the phyla three, deuterostome phyla that we are studying in ZO 150 are most similar, and probably most closely related? In what anatomical and life-cycle ways are these two similar? Which of these similarities also occur on the third phylum? How do these two differ from each other? Are there any closer similarities between either of these two and the third, generally less similar, phylum? What differences in the evolution of each group into particular habitats or modes of feeding might explain these differences

Test 4 (on only one of the two test versions)

Describe embryological, larval, and adult characteristics in which adult cephalochordates more similar to fish than larval urochordates are. In each case, also describe how Urochordata differ from the Cephalochordata and Craniata. Describe two characteristics of Urochordata that also occur in Craniata but NOT in Cephalochordata. Do you think these characteristics are convergent or ancestral? Why

Final Exam Version 1

Prepare a cladogram for the following phyla: Porifera, Cnidaria, Platyhelminthes, Rotifera, Mollusca, Annelida, Bryozoa, and Nematoda. At appropriate places on the branches, write the following phylogenetic terms: Parazoa, Eumetazoa, Radiata, Bilateria, Protostomia, Spiralia, Ecdysozoa. Also write the following terms: blind gut, complete gut, spiral cleavage, ecdysis, ciliated larva, cellular level of organization, tissue level of organization, organ system level of organization, primary radial symmetry, bilateral symmetry, choanocytes, cnidocytes, acoelomate, pseudocoelomate, eucoelomate, mastax, trochophore, lophophore, mantle, metameres, chaetae. Some of these terms must be written beside more than one branch. Choose and explain an example of an ancestral characteristic shared by two or more of these phyla, and an example of a convergent characteristic shared by two or more of these phyla.

Final Exam Version 2

Prepare a cladogram for the following phyla: Porifera, Cnidaria, Platyhelminthes, Rotifera, Mollusca, Annelida, Bryozoa, and Nematoda. At appropriate places on the branches, write the following phylogenetic terms: Parazoa, Eumetazoa, Radiata, Bilateria, Protostomia, Spiralia, Ecdysozoa. Also write the following terms: blind gut, complete gut, spiral cleavage, ecdysis, ciliated larva, cellular level of organization, tissue level of organization, organ system level of organization, primary radial symmetry, bilateral symmetry, choanocytes, cnidocytes, acoelomate, pseudocoelomate, eucoelomate, mastax, trochophore, lophophore, mantle, metameres, chaetae. Some of these terms must be written beside more than one branch. Choose and explain an example of an ancestral characteristic shared by two or more of these phyla, and an example of a convergent characteristic shared by two or more of these phyla.

Appendix V: WebCT “Discussions” Related to Cladogram Ssignment.

Fall 2003 ZO 150 Sections. Fourteen different students posted questions, but student names have been deleted.

Posted Thursday, September 25, 2003 11:33am

Subject Early Start on Cladogram

Dr. Mozley, I was wondering if we should start looking for information on the cladogram assignment's taxa now before we actually have done the group cladogram in the labs, if so what types of information might we search for in order to narrow down useful data? One other question regarding the cladograms is my confusion as to the final format of the assignment, are we supposed to include a paper that outlined what we found and how we believe it relates to the actual final product?

RESPONSE

You may start your individual cladogram assignment any time. It is not tied closely to the lab assignment, except that getting feedback on the lab assignment week after next will probably help you with the individual cladogram. Information in the textbook and lecture notes will help you with the lecture cladogram. Much of that information will come from future lectures. There is no narrative section to the lecture cladogram assignment. You need a title page, a cladogram page, and a list of shared, derived features in outline format. If you want to explain your reasoning about why a particular feature is derived and/or shared, you may, but that is not required.

Posted on Monday, October 27, 2003 9:31pm

Subject Platyhelminthes

When working on a cladogram, should we treat the acoelomate condition of Platyhelminthes as a derived characteristic (as in they had it but lost it) or as an ancestral one (as in they never acquired it)?

STUDENT RESPONSE

I believe it is an ancestral characteristic b/c when you do the cladogram nothing else is an acoelomate...hope this helps

MOZLEY RESPONSE

You're not going to like this, but the answer is, "either." Acoelomate condition has previously been treated as an ancestral or primitive condition, but recent genetic studies show that Platyhelminthes and Mollusca are more closely related than Platyhelminthes and any deuterostome phylum. That means that Platyhelminthes evolved after the split of Protostomia from Deuterostomia. Since some protostomes and all deuterostomes are eucoelomate, we might conclude that the eucoelomate condition is ancestral, and Platyhelminthes must have lost the coelom as they evolved small size and flat body shape; that is, acoelomate is derived. On the other hand, the coeloms in the two groups, protostomes and deuterostomes, form by different mechanisms in the embryo, so it is also conceivable that the coeloms in the two groups are convergent. In that case, acoelomate condition would be ancestral. The good news is, I can't count it wrong, whichever way you use the condition of

acoelomate in your cladogram!

Posted on Tuesday, November 4, 2003 1:47pm

Subject branching

Should we branch the Protostomia off of the Deuterostomia? Or may we just make one large branch and designate the area in which the deuterostomes come into play?

RESPONSE

Look at a rough example of both versions. In one, the sister group of the deuterostomes might be just one protostome phylum. That means that that one, protostome phylum and the deuterostomes had a more recent, common ancestor than that protostome phylum had with other protostome phyla. In the other, all protostome phyla are equally related to all deuterostomes, and each is more closely related to another protostome phylum or group of protostome phyla than to any deuterostome phylum. Which is more correct?

Posted on Monday, November 10, 2003 8:30am

Subject Character Check

A student asks: QUESTION 1: Are tardigrades considered eucoelomate? I was wondering because our notes say that they have a small coelom in the gonads, but the main cavity is an unlined hemocoel.

ANSWER 1: Yes, tardigrades are eucoelomate, based on the vestigial coelom in or near the gonads. Yes, the main body cavity is an unlined hemocoel, which is derived from the blastocoel in a manner similar to the pseudocoelom of nematodes.

QUESTION 2: Also, I was wondering how to spell "zoecium." I have seen it spelled two different ways, "zooecium" in the lab guide and "zoecium" in a cladogram you had on the class website.

ANSWER 2: The correct spelling is zoecium. I sometimes get this word confused in my memory with the word for an individual bryozoan, "zooid," and add the extra "o" to zoecium by mistake.

Posted on Monday, November 10, 2003 7:36pm

Subject trochophore larvae

Is the presence of a trochophore larval stage a derived characteristic?

RESPONSE

Most references assume that it is a shared, derived characteristic uniting Annelida and Mollusca (plus a few phyla we are not considering) into a monophyletic group. However, recent molecular comparisons suggest that Bryozoa are more closely related to Annelida than Mollusca are, which would make the trochophore (which is not present in Bryozoa) an ancestral similarity

between mollusks and annelids.

Posted on Wednesday, November 12, 2003 9:25pm

Subject PAIN

For Scyphozoa in the cladogram, can medusa be used as a characteristic? Also what about gastrovascular cavity and actinopharynx? For Bryozoa and Gastropoda - characteristics for both - could we use spiral cleavage and also maybe cuticle epidermis (some life stages have it)?

RESPONSE

Scyphozoa characters look okay, except that Turbellaria have a gastrovascular cavity of sorts. Cuticle epidermis is a vague term and I'm not sure what you are getting at. Shell and zoeium are not the same character. Bryozoa have radial and regulative cleavage, but this must be assumed to be convergent with deuterostomes, based on molecular data. Since they cluster with the other Spiralia in molecular analyses, I would accept spiral cleavage as a shared, derived character for that group. The origin of the coelom is obscure, but shows some similarity to schizocoely.

Follow-up, Posted on Wednesday, November 12, 2003 9:51pm

Subject PAIN #2

I accidentally typed cuticle epidermis and I know there is no such word. So instead it is actually called ciliated epidermis for Gastropoda and Bryozoa.

RESPONSE

Oh, I understand. Remember that ciliated epidermis also occurs in echinoderms and planula larvae of cnidarians, so it is not a very good candidate for a derived character in more complex animals.

Posted on Thursday, November 13, 2003 4:54pm

Subject Protostomia

Could you possibly direct me to where I could find more characteristics that describe Protostomia? I have searched in the book, notes, and online, and have only found characteristics that deal with embryonic development (the same things everywhere: blastopore becomes the mouth, determinate cleavage, schizocoelous).

RESPONSE

While there are adult, anatomical trends across the Protostomia, none is present in all protostome phyla. Things like a dorsal heart and ventral nerve cord are included in those trends. I don't think you will find other characters in the textbooks.

Follow-up, Posted Sunday, November 16, 2003 4:15pm

Subject Re: Protostomia

I'm confused on how there can be anything then that is not ancestral for the Protostomia/Deuterostomia division. .if we can't use the embryonic development for protostomes since they are all ancestral, is there anything we can use? Or do I need to look for something other than

Protostome characters to unite Bryozoa, Gastropoda and Tardigrada?

RESPONSE

Mouth from blastopore is only one protostome character. Some of the other embryonic characters are not ancestral. It may help to know that Cnidaria cleavage is radial and regulative.

Posted on Saturday, November 15, 2003 1:42pm

Subject Spiralia

I'm having trouble finding a derived characteristics for the group Spiralia. I have spiral cleavage, but I feel like characteristics such as terminal anus and ciliated epidermis are ancestral features.

Can anyone give me some pointers to where I could find other derived features?

RESPONSE

So far, your chosen feature is fine, and the other two are indeed ancestral. There are more features available.

Posted on Saturday, November 15, 2003 3:55pm

Subject questions

1) I'm having trouble finding a derived characteristic for Gastropoda - can anyone direct me to where I might find this?

2) Is the absence of organs and organ systems in Bryozoa a derived characteristic, and if so, can it still be in the bilateral group, where a characteristic is "organs and organ systems"?

3) Can parthenogenesis be considered a derived characteristic for Tardigrada even though it is convergent (shows up in Rotifera)?

STUDENT RESPONSE

The absence of something (i.e. an organ system) is a negative feature and therefore cannot be used on the cladogram. And as long as something is shared derived, it should be able to be used, as for parthenogenesis in Tardigrada. There are a few characteristics that only Gastropods have-- check your notes from that section of lecture.

MOZLEY RESPONSE

1) There are numerous derived characteristics for Gastropoda, and remember, that since it is the only mollusk in the cladogram, molluscan characters are also usable.

2) Absence of features CAN be a derived characteristic. (Kristen) Remember that the loss of the gut in tapeworms was a derived characteristic in your lab cladogram. And even if the lost feature was a fundamental one for the clade (group), it may still be used at later levels.

3) Parthenogenesis also shows up in Arthropoda (Branchiopoda - Daphnia), Nematoda, and Chordata. Using it as a derived characteristic is a bit risky – its occurrence in so many animals suggests that it may be ancestral rather than convergent.

Posted on Sunday, November 16, 2003 11:29am

Subject labeling

For the taxa names, can we put them directly on the cladogram or do we need to letter the cladogram and put the key with the derived features key?

STUDENT RESPONSE

Put them directly on the cladogram.

MOZLEY RESPONSE

Put the names directly on the cladogram. Only the characteristics go on a separate page.

Posted on Sunday, November 16, 2003 3:54pm

Subject Cladogram Question

So for the cladogram we put the taxa on each branch, and then the characteristics represented by the numbers and letters? For Tardigrada can we use cryptobiosis for a character? or should we stick with shedding of a cuticle in order to grow? Also do we capitalize all the characters that we list or only the ones that are suppose to be?

STUDENT RESPONSE

You can use cryptobiosis, since it is convergent with another phyla, but not an ancestral feature of those two phyla.

MOZLEY RESPONSE

Since they are the only Ecdysozoa in the cladogram, either character is usable for Tardigrada. Capitalization of taxonomic names is graded, but not capitalization of characters. Names are not characteristics.

Posted on Sunday, November 16, 2003 4:01pm

Subject deuterostomes

Deuterostomes have a dorsal nerve cord and a ventral heart, but do echinoderms fit this even though they have no ventral/dorsal surfaces? In other words, can I use "dorsal nerve cord" or "ventral heart" for the deuterostome branch even though Echinodermata doesn't quite fit?

STUDENT RESPONSE

It evolved away from bilateral symmetry, don't forget this. The common ancestor did have these characteristics, it just evolved away from them.

MOZLEY RESPONSE

Subject Re: deuterostomes

The student response is correct. I want to add that this is hard to answer definitively, but I won't count off if you use those characters. They work better at the Chordata level.

Posted on Sunday, November 16, 2003 7:39pm

Subject Gastropoda and Echinoidea

What do Gastropoda and Echinoidea have in common a shell? What else?

RESPONSE

To answer your question, both are Bilateria, with all that implies. Echinoids have a calcareous endoskeleton, not a shell in the same sense as gastropods, and gastropods have an external shell secreted by the mantle. But I hope this doesn't mean that you are trying to fit them together as sister groups in your cladogram! Gastropods are protostomes and echinoids are deuterostomes.

Posted on Sunday, November 16, 2003 8:34pm

Subject Cladogram "completeness"

Do we limit what we looked for in characteristics to ONLY the taxa in our list? IE: for one of my characteristics I have 4 chambered heart with the Carnivora - Crocodilia line but I know that some of the Chordata within that line that's not part of our list have only a 2 or 3-chambered heart IE: Actinopterygii and Amphibia...do we worry about anything that wasn't on the list basically?

RESPONSE

Complicated question! The four-chambered heart in Carnivora and Crocodilia must be convergent, because their most recent, common ancestor (one of the first amniotes) must have had a three-chambered heart. "Worrying about" taxa not on the list is not exactly how I would put it, but you may be able to expand the features you use as derived by using taxa that are on the same branch as these after the last branching point. For example, Carnivora are the only mammals, so you may use mammalian features on their branch. FYI: Actinopterygii do NOT have a three-chambered heart.

Posted on Sunday, November 16, 2003 8:47pm

Subject Limits on characteristics

Can we use the opposing characteristics as one of our branches, what I mean is if for instance I chose to use the characteristic of endothermous for the Carnivora branch for say 1A, can I turn around and put ectothermous for the Crocodilia branch as 2A?? This would also apply to something like the usage of triploblastic as one of the characteristics and also diploblastic as one of the other characteristics??

STUDENT RESPONSE

Dr. Mozley said more than once that we can't use opposing characteristics for two branches, you can use only one and you should choose the more advanced between them.

MOZLEY RESPONSE

Those are two good examples of parallel (or opposing) features that you should NOT use on adjacent branches. The most recent common ancestor of diploblastic and triploblastic animals must have been either diplo- or triplo-blastic. Once you decide which it probably was (unless you know otherwise, assume the simpler design is the one displayed by the common ancestor), then you may not use that "ancestral" condition on a branch farther out. For example, if you decided that the common ancestor was probably diploblastic, then triploblastic would be an advanced, derived characteristic and suitable for use on a branch, but diploblastic would

ancestral and should not be used on your cladogram.

Posted on Monday, November 17, 2003 8:55am

Subject convergent/ derived/ shared.

When labeling each characteristic are we only to compare the taxa with each other, or are we allowed to use an out-group not included in the cladogram? For example I used cryptobiosis as a Tardigrada feature. Should this be labeled convergent since Nematoda also displays this feature? Also for Gastropoda I used trochophore larva as a feature, since this shows up in Annelida and Platyhelminthes would this be convergent also....? Thanks for any help, I am just thoroughly confused

RESPONSE

It IS appropriate to use out-groups in your thinking about the cladogram, but be sure to use them correctly. Cryptobiosis (notice spelling!) does occur in both Nematoda and Tardigrada, but since both are ecdysozoans and Tardigrada is the only ecdysozoan in the list, one could make a reasonable argument that it is a derived characteristic in that branch of the cladogram. In this case, Nematoda is not an out-group, since it is within one of the branches, not outside both of them. The trochophore character works all right for gastropods because you could argue that Gastropoda and Annelida are more closely related to each other than either is to Bryozoa. There are molecular/genetic data to contradict that, but they are not as definitive as other molecular data. My own opinion is that some annelids are more closely related to Bryozoa than to Mollusca, so I think that the trochophore is ancestral in that line (Bryozoa larvae are not trochophores). But I won't hold you to that opinion for the cladogram. FYI: Some turbellarian Platyhelminthes have a ciliated, planktonic, marine larva but it is not a trochophore. It does not have a complete gut, for example, whereas trochophores do.