

Intro to Cladistic Analysis



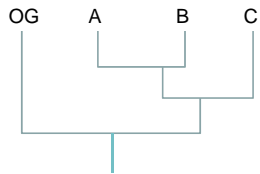
I. Overview



A. Scope

1. Ingroup vs. outgroup

e.g., angiosperms vs. non-angiosperms
e.g., primates vs. non-primates



I. Overview




B. Phylogenetic evidence

1. Characters & Character states

a. Morphological Characters

e.g., Phyllotaxy: 0 = alternate; 1 = opposite; 2 = whorled.


e.g., Carpel Presence: 0 = absent; 1 = present.

I. Overview 

B. Phylogenetic Evidence
1. Characters & Character states

b. Molecular Characters
(e.g., DNA sequence characters)

Protein coding genes (e.g., *cox1* or *rbcl*)
Structural RNA genes (e.g., 18S or 26S rDNA)


I. Overview 

B. Phylogenetic Evidence
1. Characters & Character states

b. Molecular Characters
(e.g., DNA sequence characters)

Protein coding genes (e.g., *cox1* or *rbcl*)
Structural RNA genes (e.g., 18S or 26S rDNA)

e.g., Positions 1-1436 in *rbcl* gene: A; G; C; T.

I. Overview 

B. Phylogenetic Evidence

c. Primary Homology Assessment
(during character coding and scoring)

e.g.,
PETAL COLOR:
0 = red; 1 = blue

Position 4 in *rbcl*
A; G; C; or T

I. Overview



B. Phylogenetic Evidence

c. Primary Homology Assessment (during character coding and scoring)

e.g.,
PETAL COLOR:
0 = red; 1 = blue

Position 4 in rbcL
A ; G; C; or T

I. Overview



B. Phylogenetic Evidence

c. Primary Homology Assessment (during character coding and scoring)

Bad
WINGS
0 = present; 1 = absent



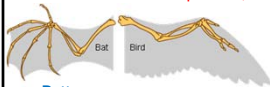
I. Overview



B. Phylogenetic Evidence

c. Primary Homology Assessment (during character coding and scoring)

Bad
WINGS
0 = present; 1 = absent



Better
Forelimb
0 = Unwinged;
1 = membranous wing;
2 = plumose wing



d. Data Matrix

	VERTICAL	LIMBS WITH DIGITS	ENDOXYHERM Y	FUR	MAMMARY GLANDS	OPPOSABLE THUMB ON FORELIMB	TAIL
Snail	0	0	0	0	0	-	-
Fish	1	0	0	0	0	-	1
Lizard	1	1	0	0	0	0	1
Bird	1	1	1	0	0	0	1
Cow	1	1	1	1	1	0	1
Monkey	1	1	1	1	1	1	1
Gorilla	1	1	1	1	1	1	0
Human	1	1	1	1	1	1	0

*Note: a "-" denotes that the character is inapplicable—i.e., not relevant—for that species.

I. Overview



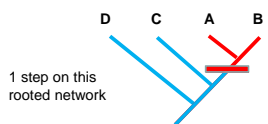
C. Recognizing synapomorphies to resolve cladogram

1. Use of parsimony

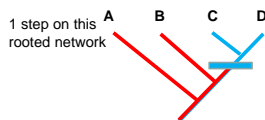



Leaf shape

- IG Sp. A cordate
- IG Sp. B cordate
- IG Sp. C elliptic
- IG Sp. D elliptic



Problem: These are equally parsimonious

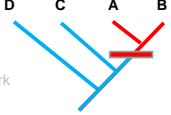




Leaf shape

IG Sp. A **cordate**
 IG Sp. B **cordate**
 IG Sp. C **elliptic**
 IG Sp. D **elliptic**

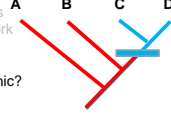
D C A B



1 step on this rooted network

Problem: These are equally Parsimonious


A B C D



1 step on this rooted network

Which state is apomorphic and which is plesiomorphic?


I. Overview



C. Recognizing synapomorphies to resolve cladogram

1. Use of parsimony
2. Use of outgroup method

I. Overview



C. Recognizing synapomorphies to resolve cladogram

1. Use of parsimony
2. Use of outgroup method
 - a. Score OG taxon/taxa

Leaf shape

IG Sp. A **cordate**
 IG Sp. B **cordate**
 IG Sp. C **elliptic**
 IG Sp. D **elliptic**
 OG Sp. **elliptic**

I. Overview



C. Recognizing synapomorphies to resolve cladogram

1. Use of parsimony
2. Use of outgroup method
 - a. Score OG taxon/taxa
 - b. Root possible cladograms btwn OG and IG

Leaf shape

IG Sp. A **cordate**

IG Sp. B **cordate**

IG Sp. C **elliptic**

IG Sp. D **elliptic**

OG Sp. **elliptic**



I. Overview



C. Recognizing synapomorphies to resolve cladogram

1. Use of parsimony
2. Use of outgroup method
 - a. Score OG taxon/taxa
 - b. Root possible cladograms btwn OG and IG
 - c. Choose most parsimonious tree

Leaf shape

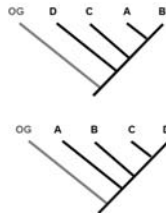
IG Sp. A **cordate**

IG Sp. B **cordate**

IG Sp. C **elliptic**

IG Sp. D **elliptic**

OG Sp. **elliptic**



I. Overview



C. Recognizing synapomorphies to resolve cladogram

1. Use of parsimony
2. Use of outgroup method
 - a. Score OG taxon/taxa
 - b. Root possible cladograms btwn OG and IG
 - c. Choose most parsimonious tree

Leaf shape

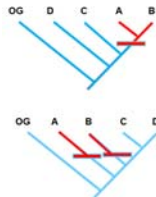
IG Sp. A **cordate**

IG Sp. B **cordate**

IG Sp. C **elliptic**

IG Sp. D **elliptic**

OG Sp. **elliptic**



I. Overview

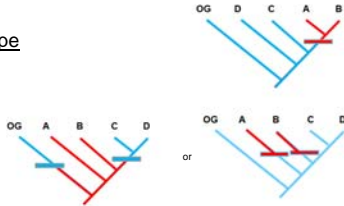


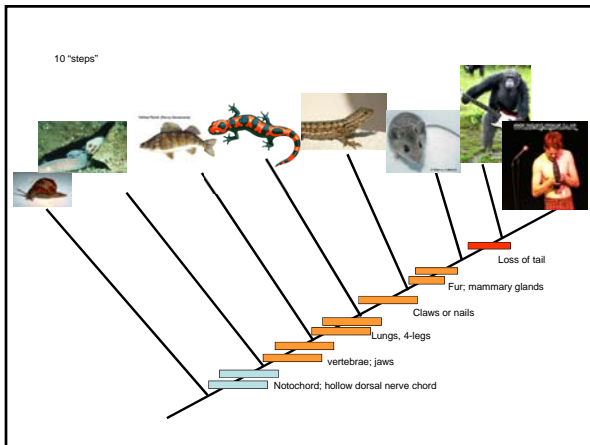
C. Recognizing synapomorphies to resolve cladogram

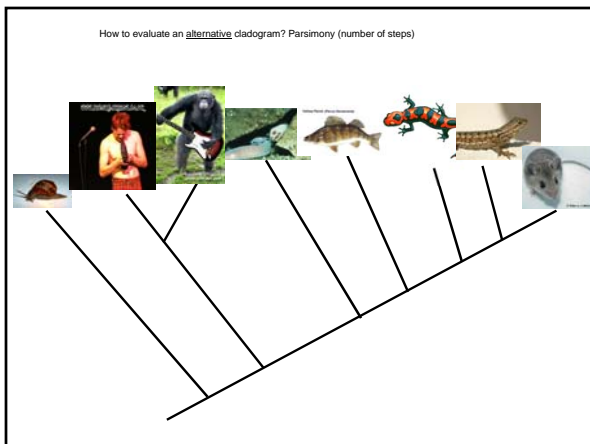
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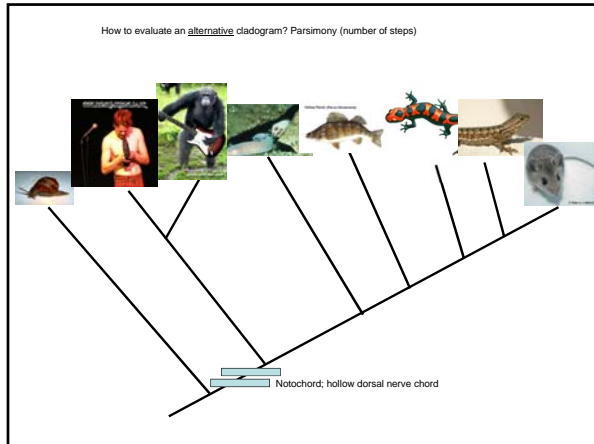
Leaf shape

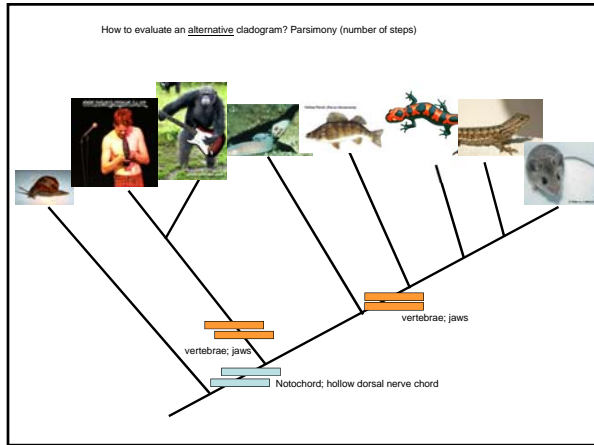
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- IG Sp. B **cordate**
- IG Sp. C **elliptic**
- IG Sp. D **elliptic**
- OG Sp. **elliptic**

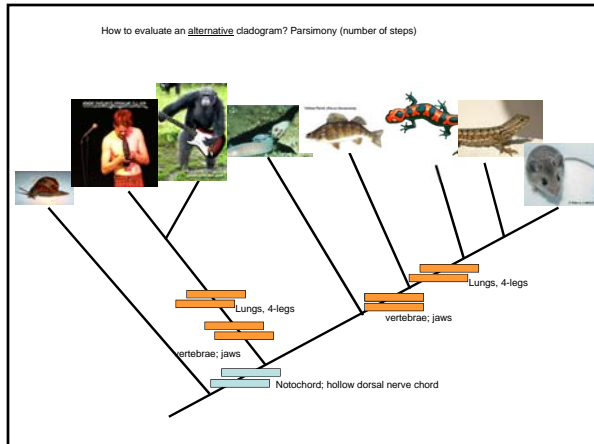


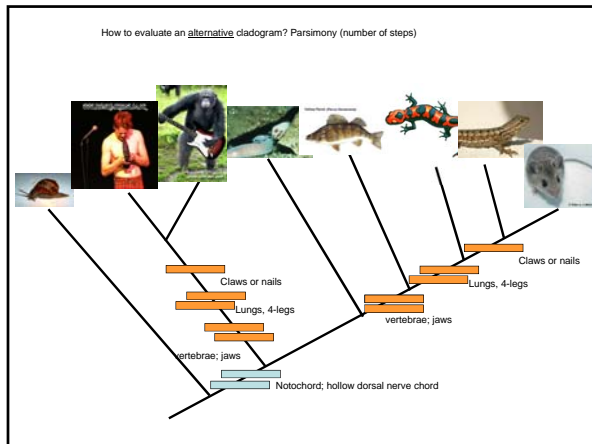


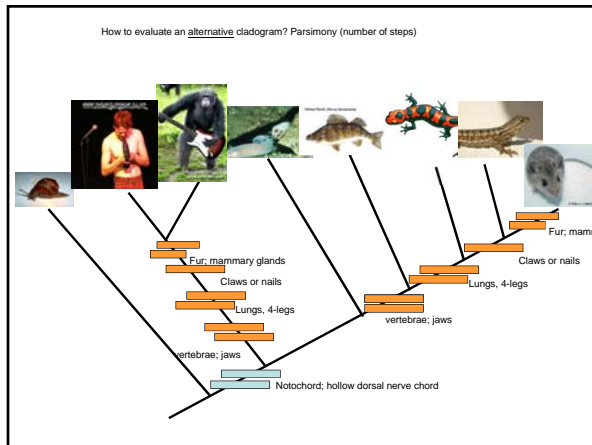


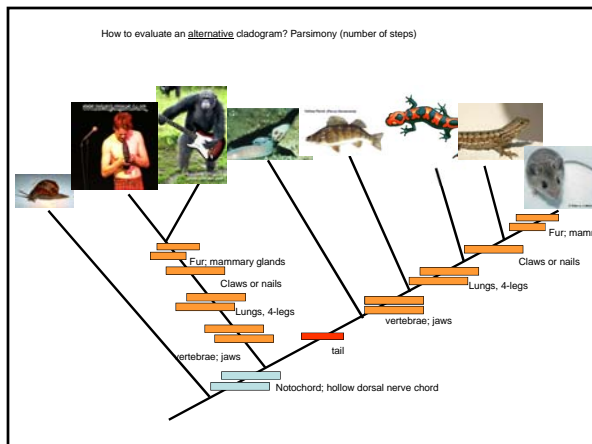










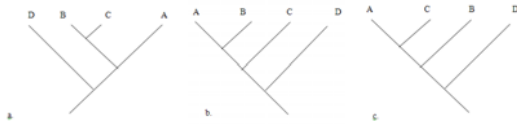


II. Cladogram Construction



2. Use parsimony to map characters

	char 1	char 2	char 3	char 4
Species A	0	0	1	1
Species B	1	1	0	0
Species C	1	0	1	1
Species D (outgroup)	1	1	1	0

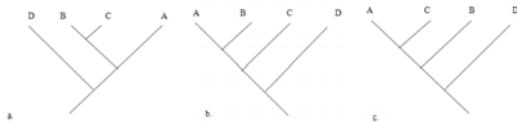


II. Cladogram Construction



3. Choose cladogram with fewest steps

	char 1	char 2	char 3	char 4
Species A	0	0	1	1
Species B	1	1	0	0
Species C	1	0	1	1
Species D (outgroup)	1	1	1	0



Dr. Anne Hardy

Tutorial:
Character State Optimization for Choosing Most Parsimonious Cladograms and Reconstructing Ancestral States.

The method we will use here is called Fitch Optimization.

- Score terminal species for character of interest.

Downward Pass

- Starting at the tips of the cladogram, start with two sister species and assign the intersection or union of the two to the node below them.
 - An **intersection** is where both descendants of the ancestral node have the same state; therefore, that state is assigned to the ancestral node.
 - A **union** is where the two descendants of the ancestral node have different states; therefore, both are temporarily assigned to the node.
- Work the same way from another pair of taxa, down the tree until all nodes have been assigned an intersection or union.

Upward pass

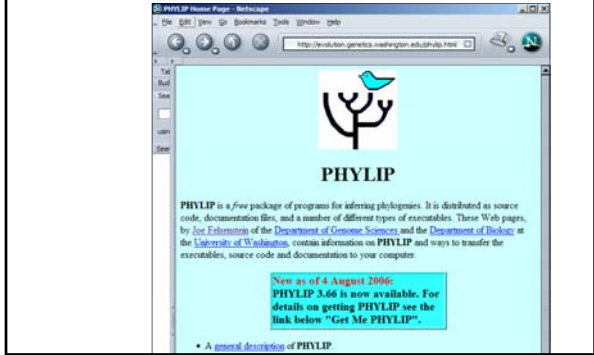
- Moving up the tree from the basal-most node (for simplicity-sake, assume that the state possessed by the most distant outgroup taxon is the state at the basal-most node), resolve any unions based upon the intersection with the lower node. If there is not intersection for a particular node on the up-pass, then your data are ambiguous for that node.

[THE STATES ASSIGNED TO NODES are one (not necessarily the only one) most parsimonious reconstruction of the state possessed by the hypothetical ancestor of that node's immediate descendants.]

II. Cladogram Construction



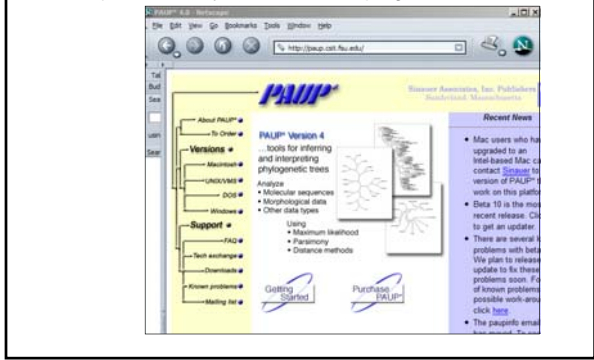
C. Major Parsimony-based cladistic programs



II. Cladogram Construction



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II. Cladogram Construction



C. Major Parsimony-based cladistic programs

