

Cladistics



Reading for this topic:
 Worobey et al. 2004. Contaminated polio vaccine theory refuted. *Nature* 428: 820.

[note: when requesting this, request a color copy]

I. Terms & Concepts

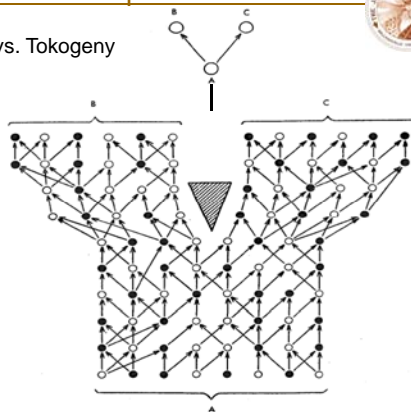


A. Phylogeny vs. Cladogram

I. Terms & Concepts



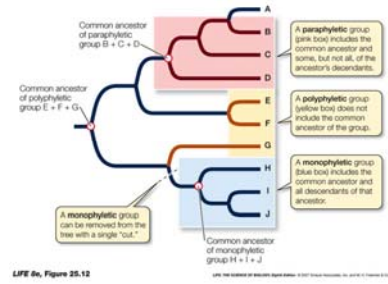
B. Phylogeny vs. Tokogeny



I. Terms & Concepts



C. Clades & Monophyletic groups



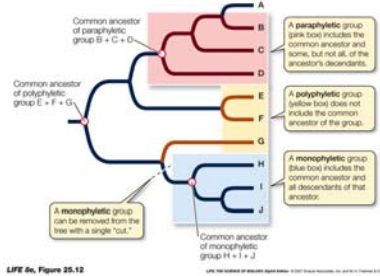
LIFE 6e, Figure 25.12

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I. Terms & Concepts



D. Sister groups



LIFE 6e, Figure 25.12

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I. Terms & Concepts



E. Phylogenetic Evidence

1. Characters & Character states

Morphological Characters

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

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

I. Terms & Concepts



E. Phylogenetic Evidence

1. Characters & Character states

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. Terms & Concepts



E. Phylogenetic Evidence

1. Characters & Character states

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., Position 36 in *rbcl* gene: 0 = A; 1 = G; 2 = C; 3 = T.

or

e.g., Position 36 in *rbcl* gene: A; G; C; T.

I. Terms & Concepts



- E. Phylogenetic Evidence
1. Characters & Character states

Molecular Characters

(e.g., amino acid sequence characters)

e.g., Position 5 in rubisco: 0 = glutamine; 1 = proline; etc.

I. Terms & Concepts



- E. Phylogenetic Evidence
2. Apomorphies vs. plesiomorphies

- a. autapomorphy vs. synapomorphy
- b. synapomorphy vs. symplesiomorphy
- c. hashmarks

I. Terms & Concepts



- E. Phylogenetic Evidence
3. Homology, analogy, and homoplasy

I. Terms & Concepts



- E. Phylogenetic Evidence
3. Homology, analogy, and homoplasy

Homology = similarity due to common descent

- e.g., plicate leaves in *Cocos* and *Serenoa*
- e.g., petals in *Magnolia* and *Liriodendron*
- e.g., 5 stamens in *Solanum* and *Capsicum*
- e.g., flippers in whales and arms (forelimbs) in terrestrial mammals.
- e.g., lack of vertebrae in bacteria, plants, snails

I. Terms & Concepts



- E. Phylogenetic Evidence
3. Homology, analogy, and homoplasy

Analogy = similarity due to similar function
(usually only superficial)

- e.g., wings in birds and bats and insects
- e.g., reduced to absence petals in
Poaceae and Fagaceae
- e.g., succulence in *Aloe* and *Crassula* leaves
- e.g., tendrils in grapes and bean plants

I. Terms & Concepts



- E. Phylogenetic Evidence
3. Homology, analogy, and homoplasy

Homoplasy = confound phylogenetic inference b/c
it creates similarity that is not homologous

- e.g., reversals
- e.g., convergence

I. Terms & Concepts



- E. Phylogenetic Evidence
3. Homology, analogy, and homoplasy

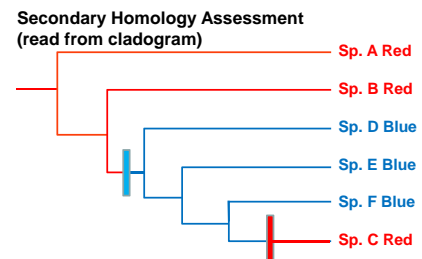
Primary Homology Assessment
(during character coding and scoring)

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

I. Terms & Concepts



- E. Phylogenetic Evidence
3. Homology, analogy, and homoplasy

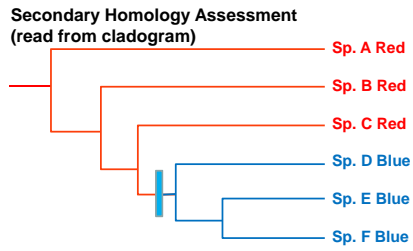


I. Terms & Concepts



E. Phylogenetic Evidence

3. Homology, analogy, and homoplasy



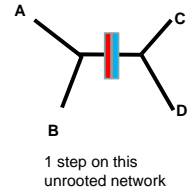
II. Cladogram Construction



A. Scope

Ingroup vs. outgroup

Leaf shape
IG Sp. A cordate
IG Sp. B cordate
IG Sp. C elliptic
IG Sp. D elliptic



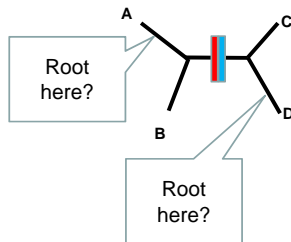
II. Cladogram Construction



A. Scope

Ingroup vs. outgroup

Leaf shape
IG Sp. A cordate
IG Sp. B cordate
IG Sp. C elliptic
IG Sp. D elliptic



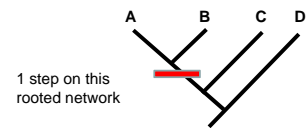
II. Cladogram Construction



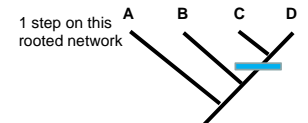
A. Scope

Ingroup vs. outgroup

Leaf shape
IG Sp. A cordate
IG Sp. B cordate
IG Sp. C elliptic
IG Sp. D elliptic



Problem: These are equally parsimonious



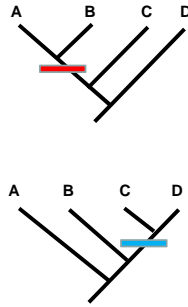
II. Cladogram Construction



A. Scope

Ingroup vs. outgroup

- Leaf shape
- IG Sp. A **cordate**
 - IG Sp. B **cordate**
 - IG Sp. C **elliptic**
 - IG Sp. D **elliptic**
 - OG Sp. **elliptic**



II. Cladogram Construction



B. Data Matrix

total 2017s.nex

File Edit Characters TaxaTrees Matrix Select Analysis Window Help

Project of total_2017s.nex

Character Matrix "Character Matrix"

1	2	3	4	5					
1	2	3	4	5					
1	Palmsa brachiosa	yes	indeterminate	-	cauline	-	-	-	-
2	Taxanta pinget	yes	indeterminate	-	cauline	prothala_m_lan-erect	-	-	foliate
3	Trachosandra ellamontana	yes	indeterminate	-	cauline	prothala_m_lan-erect	-	-	foliate
4	Sideroxylon hirtella	yes	indeterminate	-	cauline	-	-	-	foliate
5	Dichosandra aculea	yes	indeterminate	-	cauline	-	-	-	foliate
6	Dichosandra hexandra	yes	indeterminate	-	cauline	prothala_m_lan-erect	-	-	foliate
7	Dichosandra hypoleuca	yes	indeterminate	-	cauline	-	-	-	foliate
8	Cochlidocarya subulatumum	absent	indeterminate	-	cauline	-	-	-	foliate
9	Cochlidocarya rotundum	absent	indeterminate	-	cauline	-	-	-	foliate
10	Gongonanthus brevipedunculatus	yes	determinate	Loose	cauline	-	-	-	foliate
11	Gongonanthus chosrovianus	yes	determinate	Unit Planes	cauline	-	-	-	foliate
12	Gongonanthus bilobatus	yes	determinate	Unit Planes	cauline	-	-	-	foliate
13	Gongonanthus ciliatus	yes	determinate	-	cauline	prothala_m_lan-erect	-	-	foliate
14	Gongonanthus rizzanthus	yes	determinate	Loose	cauline	erect/prostrate_m_lan-erect	-	-	foliate
15	Gongonanthus pappipii	yes	determinate	Loose	cauline	prothala_m_lan-erect	-	-	foliate
16	Phymatopteris pectinata	absent	indeterminate	-	cauline	-	-	-	foliate
17	Phymatopteris grandifolia sp. grandifolia	absent	indeterminate	-	cauline	-	-	-	foliate
18	Phymatopteris pectinata	absent	indeterminate	-	cauline	-	-	-	foliate
19	Phymatopteris grandifolia sp. robusta	absent	indeterminate	-	cauline	-	-	-	foliate
20	Phymatopteris grandifolia sp. robusta	absent	indeterminate	-	cauline	-	-	-	foliate

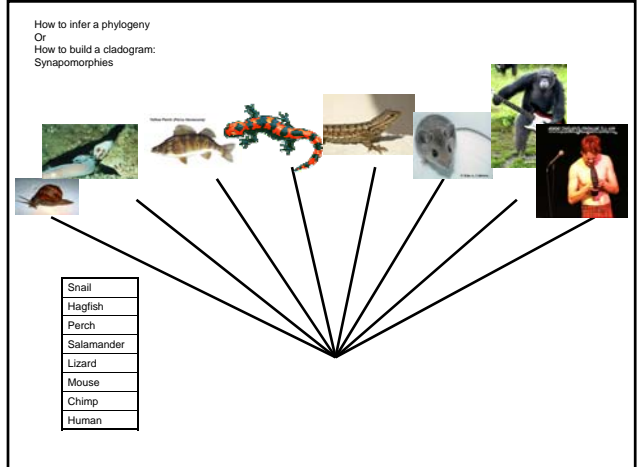
II. Cladogram Construction



C. Parsimony

in cladogram construction / phylogenetic inference

1. For one character at a time

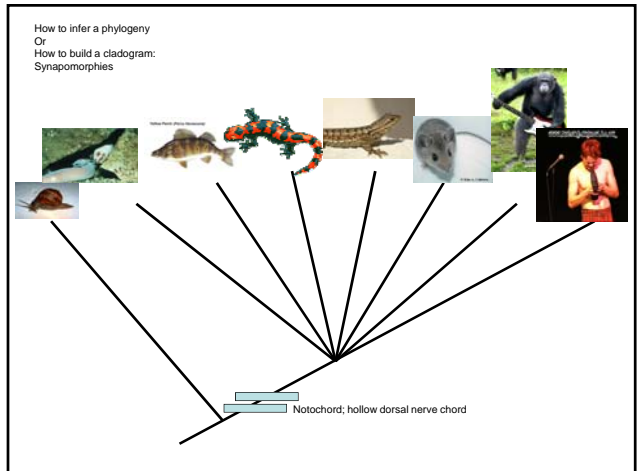
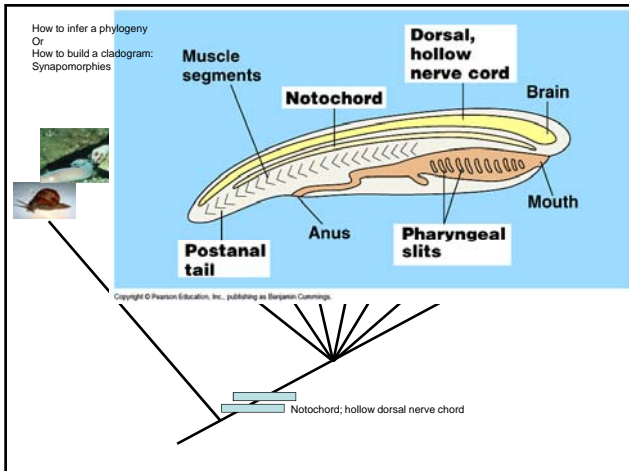
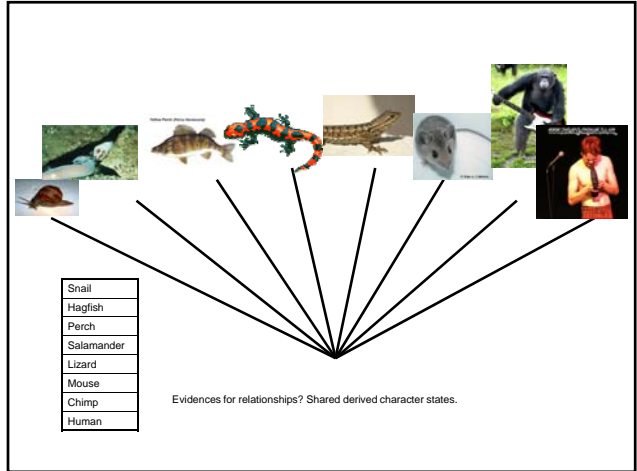


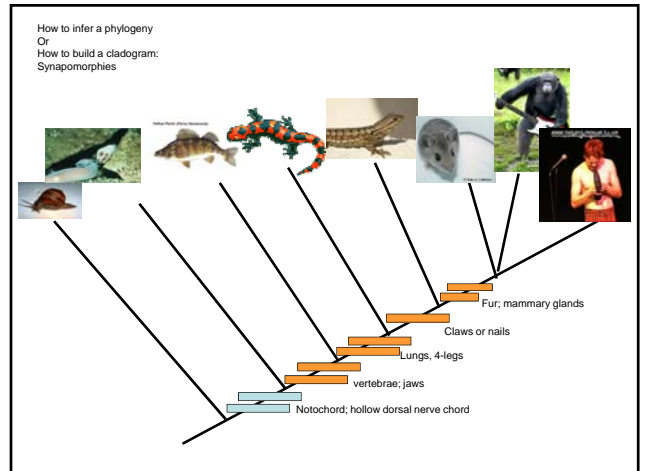
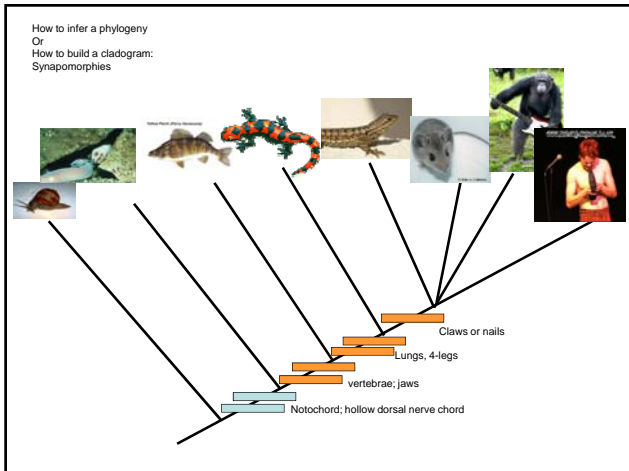
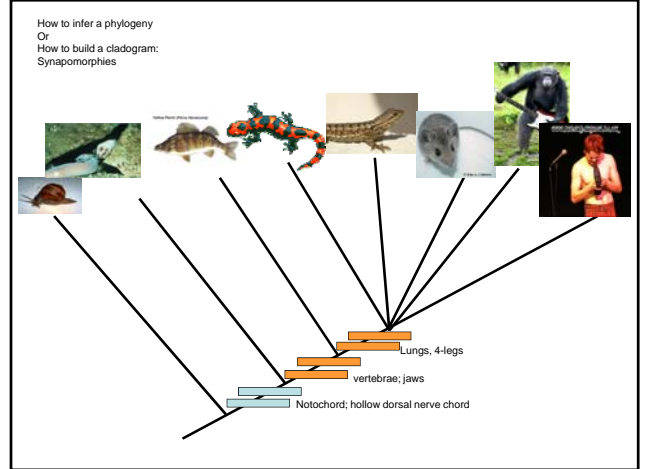
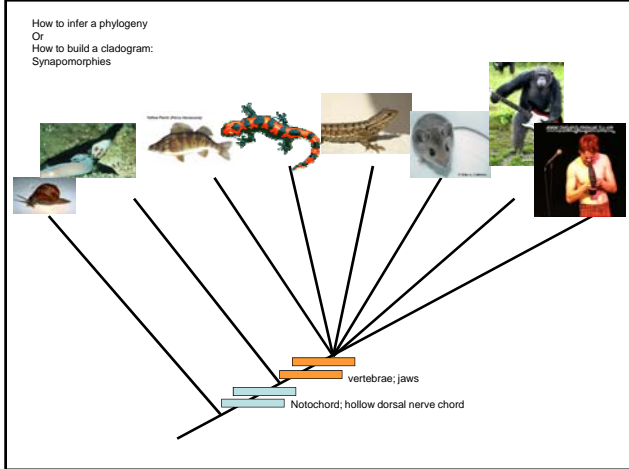
Taxon	muscle	tail	scale	kidney	internal	stomach	stomach	stomach	two temporal	teeth	rodentia	rodentia	rodentia	rodentia	rodentia
perch	no	no	yes	cold	no	no	no	no	no	no	no	no	no	no	yes
coelocanth	no	no	yes	cold	yes	yes	no	no	no	no	no	no	no	no	yes
salamander	no	yes	no	cold	yes	yes	no	no	no	no	yes	no	no	no	yes
frog	no	yes	no	cold	yes	yes	no	no	no	no	yes	no	no	no	yes
turtle	yes	yes	yes	cold	yes	yes	no	no	no	no	no	no	no	no	yes
man	yes	yes	no	warm	yes	yes	no	no	no	no	no	no	no	no	yes
gecko	yes	yes	yes	cold	yes	yes	yes	yes	no	no	no	no	no	no	yes
snake	yes	yes	yes	cold	yes	yes	yes	yes	no	no	no	no	no	no	yes
alligator	yes	yes	yes	cold	yes	yes	yes	yes	no	yes	no	no	no	no	yes
budgy	yes	yes	no	warm	yes	yes	yes	yes	no	yes	no	yes	yes	yes	yes

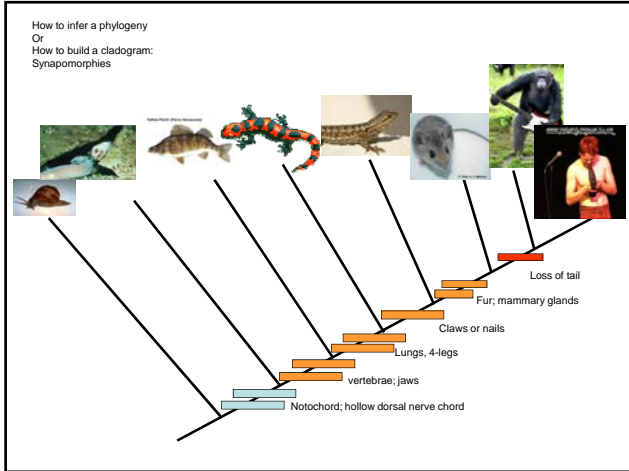
The preceding matrix, again, can be represented numerically (for convenience) as:

	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
perch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
coelocanth	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
salamander	0	1	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
frog	0	1	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
turtle	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
man	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
gecko	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
snake	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
alligator	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
budgy	1	1	1	1	1	0	1	1	0	1	0	1	1	1	0	0	0	0	0	0

<http://research.amnh.org/~siddall/methods/day2.html>







II. Cladogram Construction



C. Parsimony
 to cladogram construction / phylogenetic inference

1. For one character at a time (e.g., Tutorial 1)

	VERTEBRAE	LEGS	ENDOTHERMY	FUR	MAMMARY GLANDS	OPPOSABLE THUMB	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.

II. Cladogram Construction



Simple when all characters yield compatible results
 i.e., no homoplasy, where one character does not contradict another
 Examples of homoplasy: reversal and parallelism/convergence

	VERTEBRAE	LEGS	ENDOTHERMY	FUR	MAMMARY GLANDS	OPPOSABLE THUMB	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.

II. Cladogram Construction



e.g., adding snake would introduce a reversal regarding
 absence of legs.

	VERTEBRAE	LEGS	ENDOTHERMY	FUR	MAMMARY GLANDS	OPPOSABLE THUMB	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.

II. Cladogram Construction



e.g., adding pedalism as a character would introduce a parallelism / convergence regarding bipedalism.

	VERTEBRAE	LEGS	ENDOTHERMY	FUR	MAMMARY GLANDS	OPPOSABLE THUMB	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.

II. Cladogram Construction

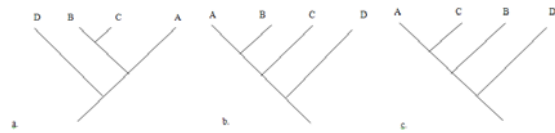


C. Application of Parsimony to cladogram construction / phylogenetic inference

2. For multiple characters at a time (e.g., Tutorial 2, but below is different)

a. Start with all possible ingroup topologies

	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

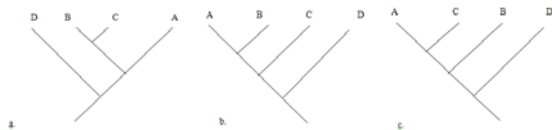


C. Application of Parsimony to cladogram construction / phylogenetic inference

2. For multiple characters at a time (e.g., Tutorial 2)

b. 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



C. Application of Parsimony to cladogram construction / phylogenetic inference

2. For multiple characters at a time (e.g., Tutorial 2)

c. Choose cladogram with fewer 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

