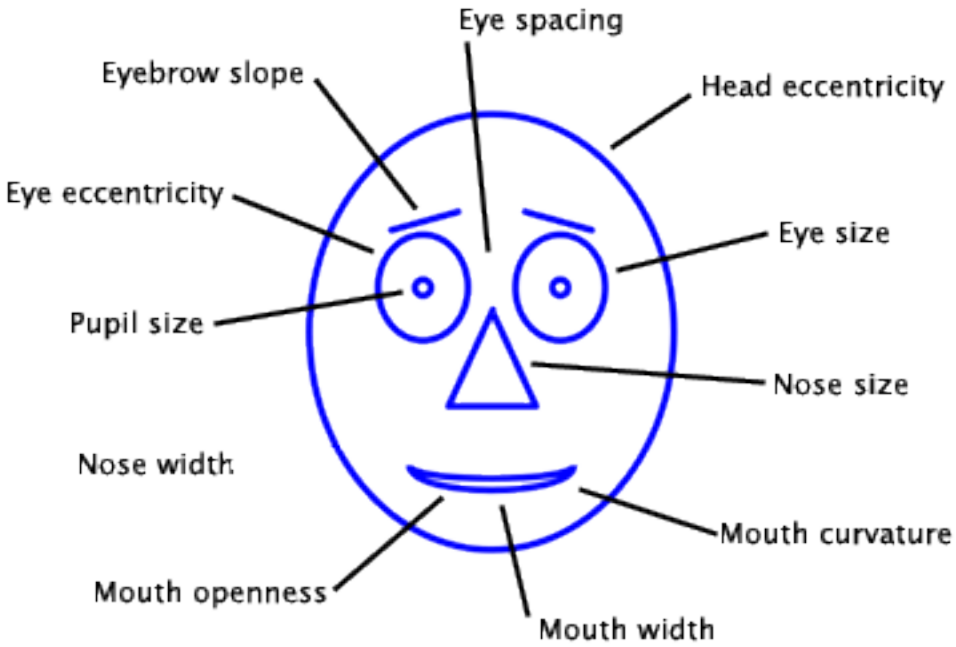
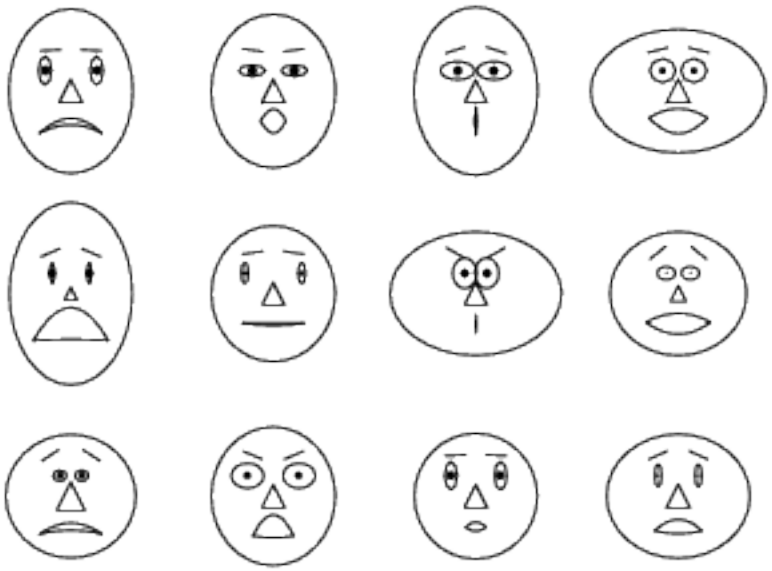
Analysis of Character Evolution

Fall 2024

KIZ Comp Genomics

Evolutionary Character & Character States

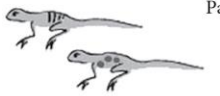


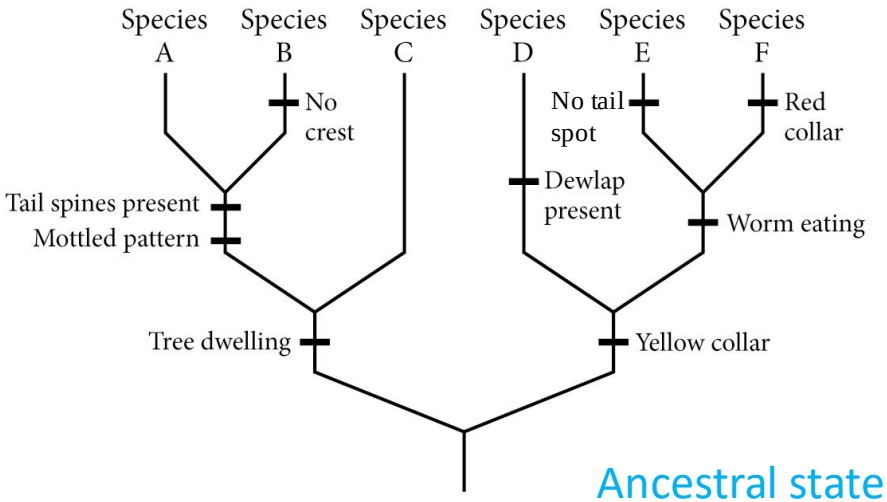


Traits	Data type	Character states
Morphological	Numeric	Measurements (e.g., length, weight, rate)
	Categorical	Color, location, habitat
	Binary	Presence/Absence; 0/1
Molecular	DNA	A, T, C, G + gap
	Protein	20 AA residues + gap

Character State Matrix

TABLE 4.1 Characters and character states in lizards

	Character	Ancestral state	Derive state
	Crest on head	Absent	Present
	Colored collar	Absent	Present
	Preferred prey	Insects	Worms
	Pattern on back	Stripes	Mottled
	Tail spines	Absent	Present
	Habitat	Ground dwelling	Tree dwelling
	Tail spots	Present	Absent
	Dewlap (flap of skin under chin)	Absent	Present

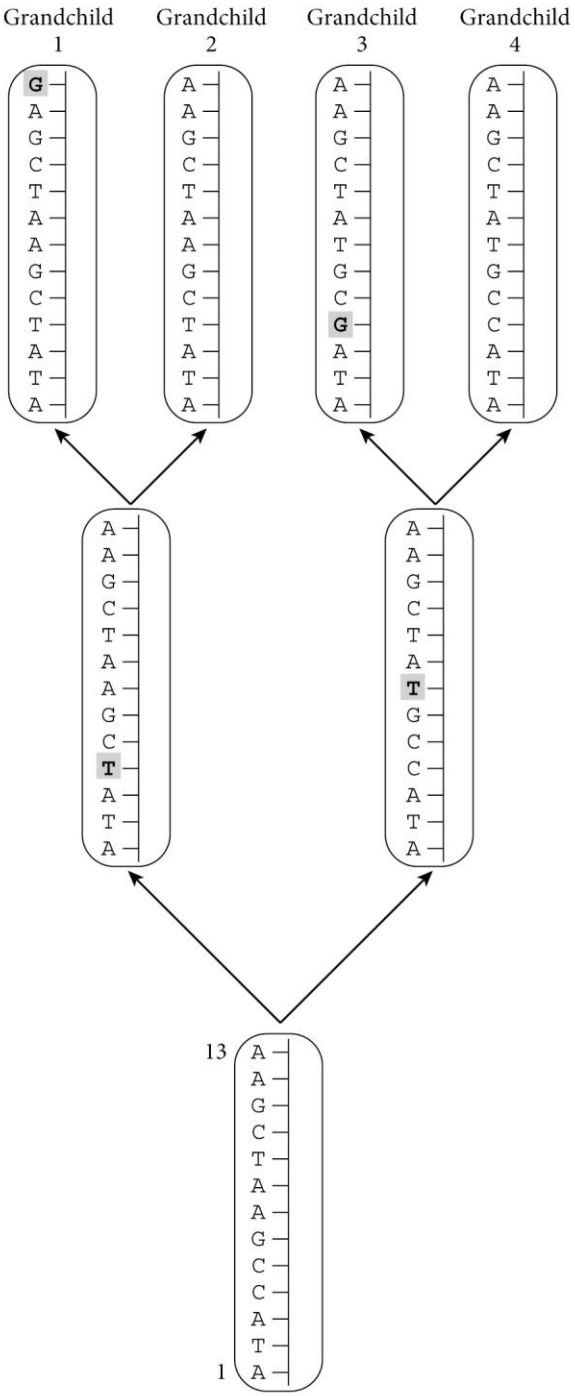


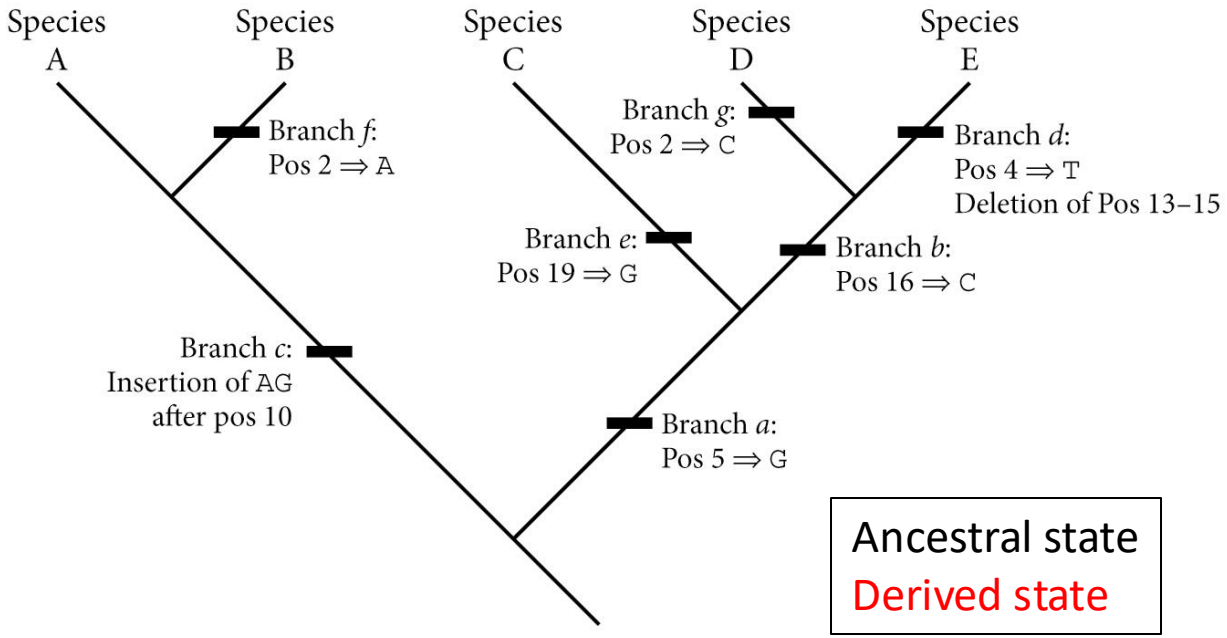
Ancestral state

Derived state

	Crest	Collar color	Prey	Tail spine	Back pattern	Habitat	Tail spot	Dewlap
A	Present	Absent	Insect	Present	Mottled	Tree	Absent	Absent
B	Absent	Absent	Insect	Present	Mottled	Tree	Absent	Absent
C	Present	Absent	Insect	Absent	Striped	Tree	Absent	Absent
D	Present	Yellow	Insect	Absent	Striped	Ground	Absent	Present
E	Present	Yellow	Worm	Absent	Striped	Ground	Present	Absent
F	Present	Red	Worm	Absent	Striped	Ground	Absent	Absent

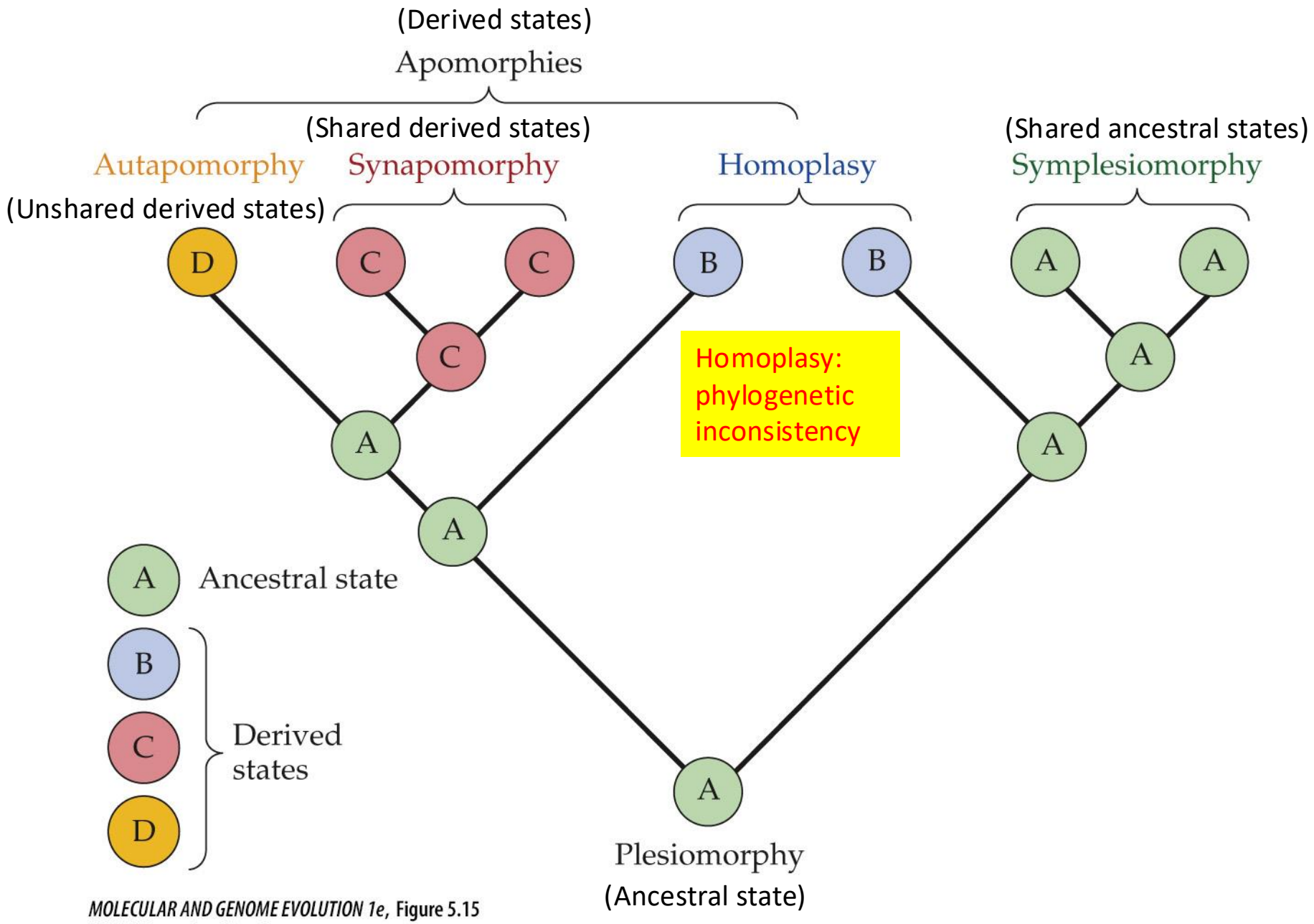
Character & Character States
DNA Sequences





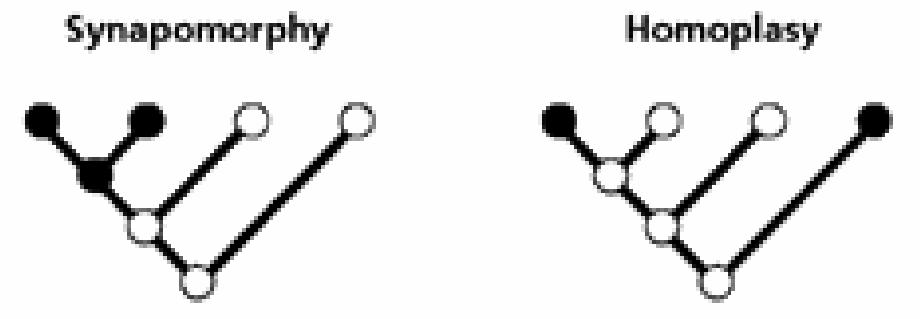
Ancestral state
Derived state

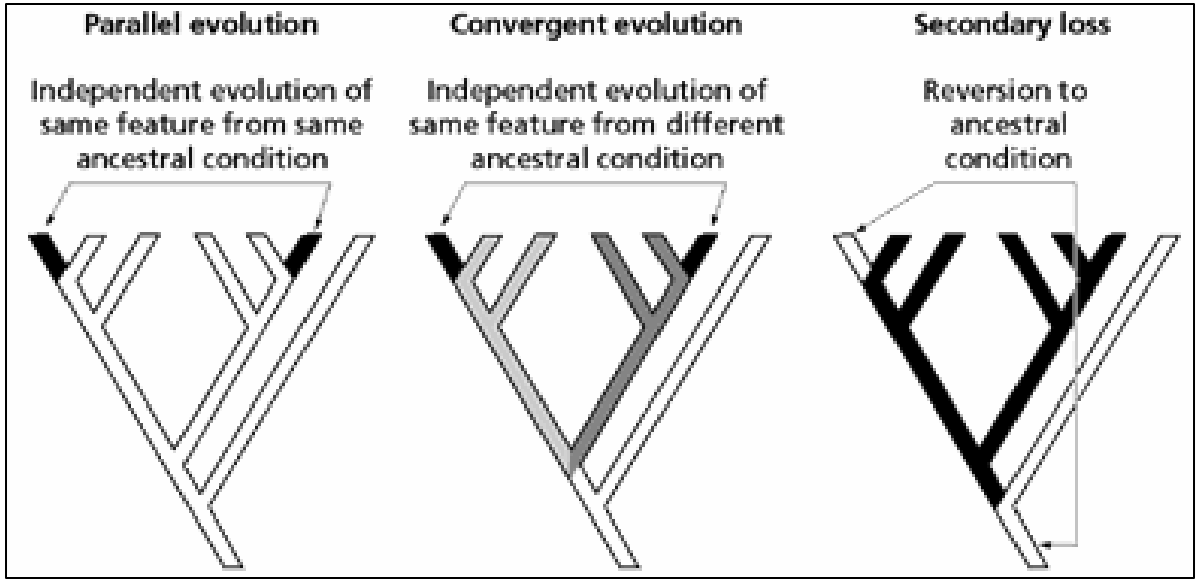
```
          G T A A C G A T A T A G C C C T A G A T
          1       5       10      15      20
A-        G T A A C G A T A T A G A G C C C T A G A T
B-        G A A A C G A T A T A G A G C C C T A G A T
C-        G T A A G G A T A T - - A G C C C T A G G T
D-        G C A A G G A T A T - - A G C C C C A G A T
E-        G T A T G G A T A T - - A G - - - C A G A T
```



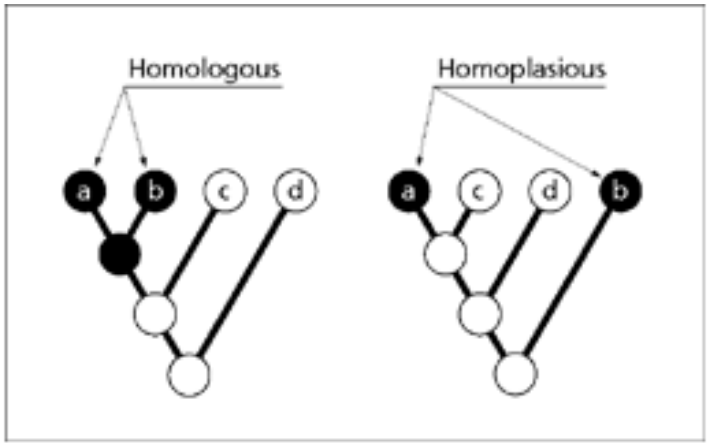
MOLECULAR AND GENOME EVOLUTION 1e, Figure 5.15

Homoplasy & Consistency

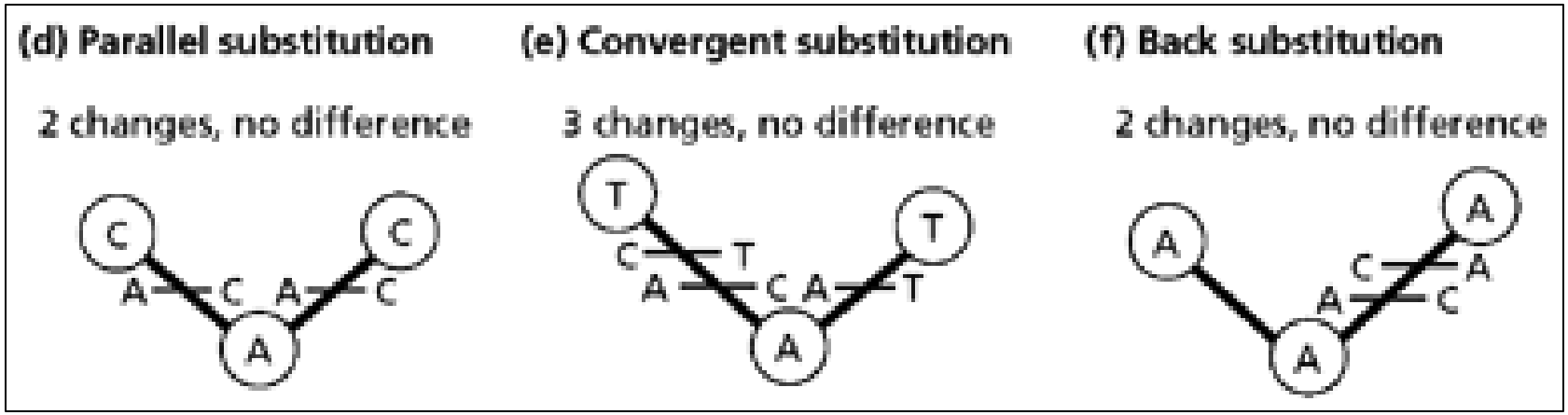




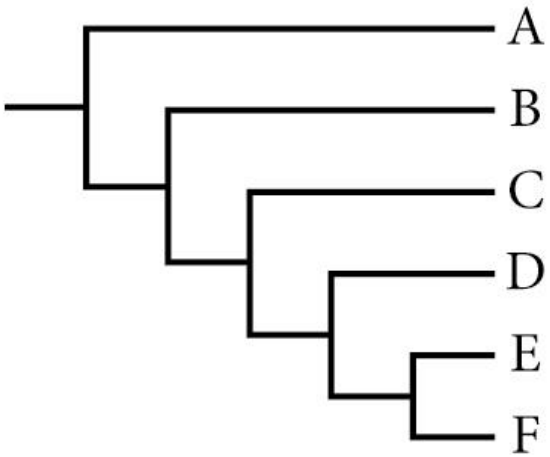
Homoplasy & Consistency



b Page, Holmes
Molecular Evolution



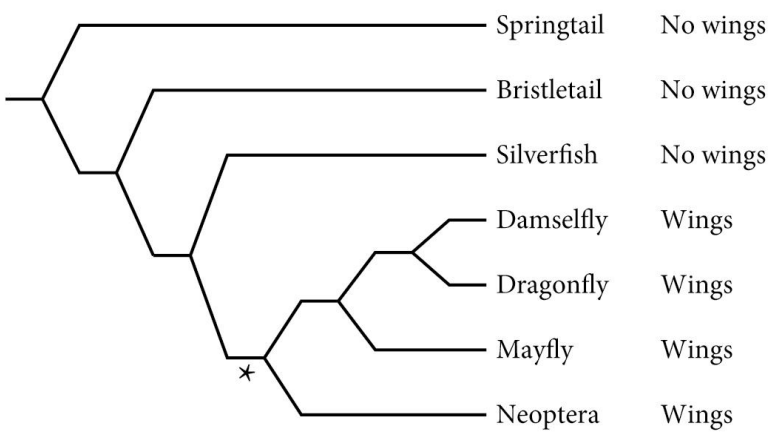
Consistent or Homoplastic ?



1	2	3	4	5	6	7	8	9	10
A	G	C	T	G	T	A	G	G	G
A	G	T	T	G	G	C	G	G	G
A	A	T	T	G	A	G	A	G	C
A	A	C	T	G	T	C	A	T	T
A	G	C	C	A	C	A	G	T	A
A	G	T	C	G	G	G	G	C	A
✓	✗	✗	✓	✓	✗	✗	✗	✓	✓

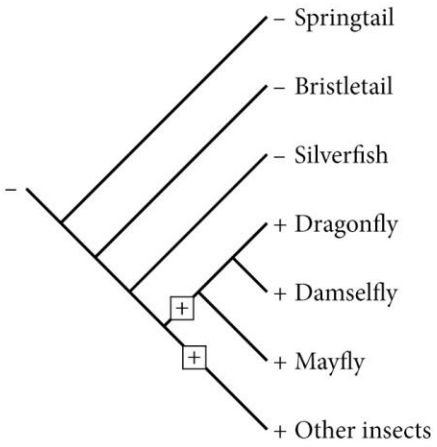
Phylogenetic Consistency & Parsimony

$$C.I. = \frac{N_{smallest\_number\_of\_changes}}{N_{observed\_number\_of\_changes}}$$

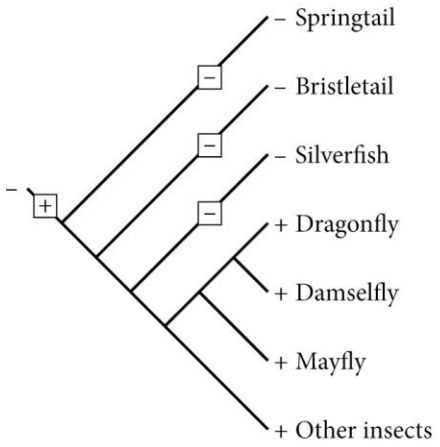


Consistency Index (C.I.)=1

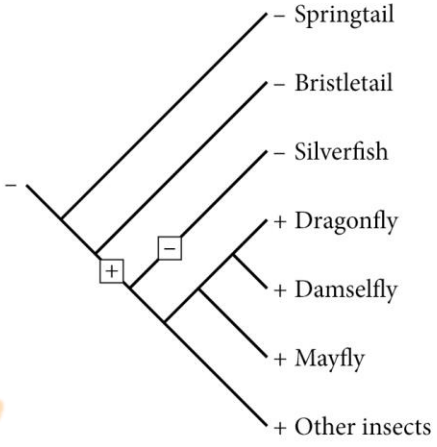
PARSIMONY



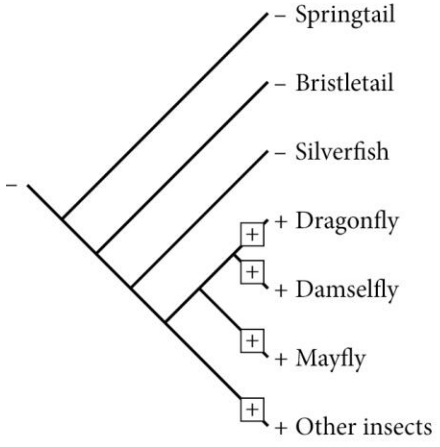
Number of changes = 2
CI = 0.5



Number of changes = 4
CI = 0.25



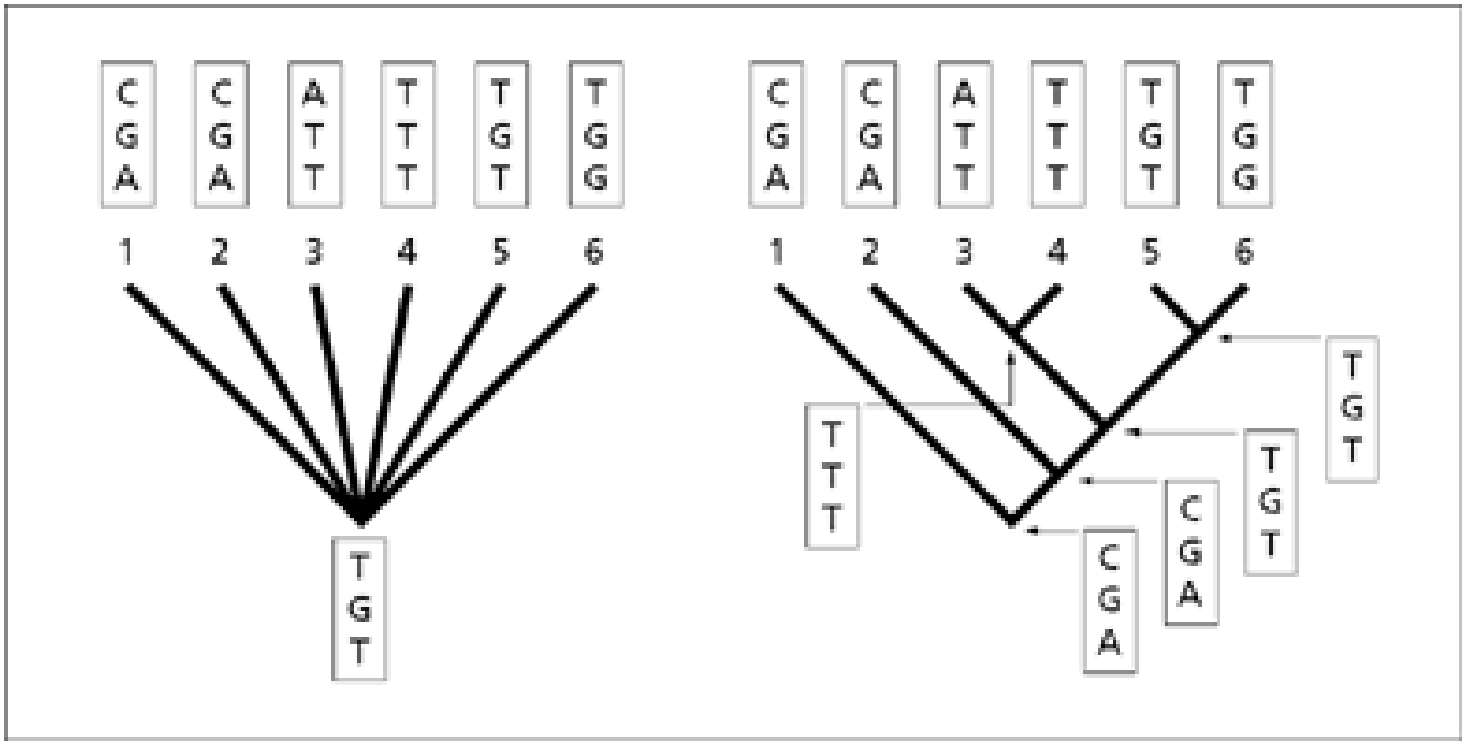
Number of changes = 2
CI = 0.5



Number of changes = 4
CI = 0.25

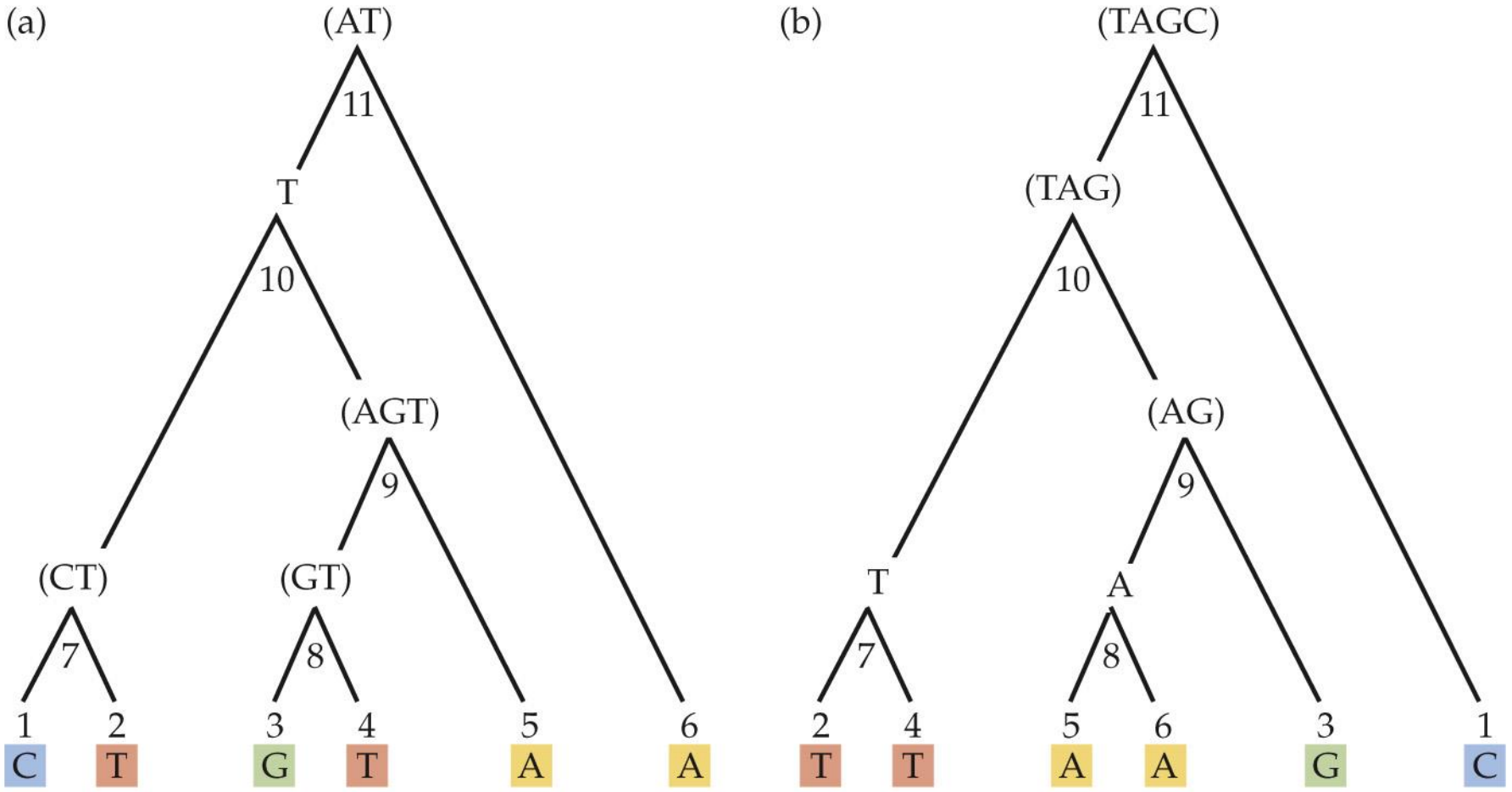
Ancestral Sequence Reconstruction

Consensus sequence as ancestral sequence works ONLY for species that are equally related to each other (a "star tree", *left*), but not for those related to each other with bifurcating tree (*right*)



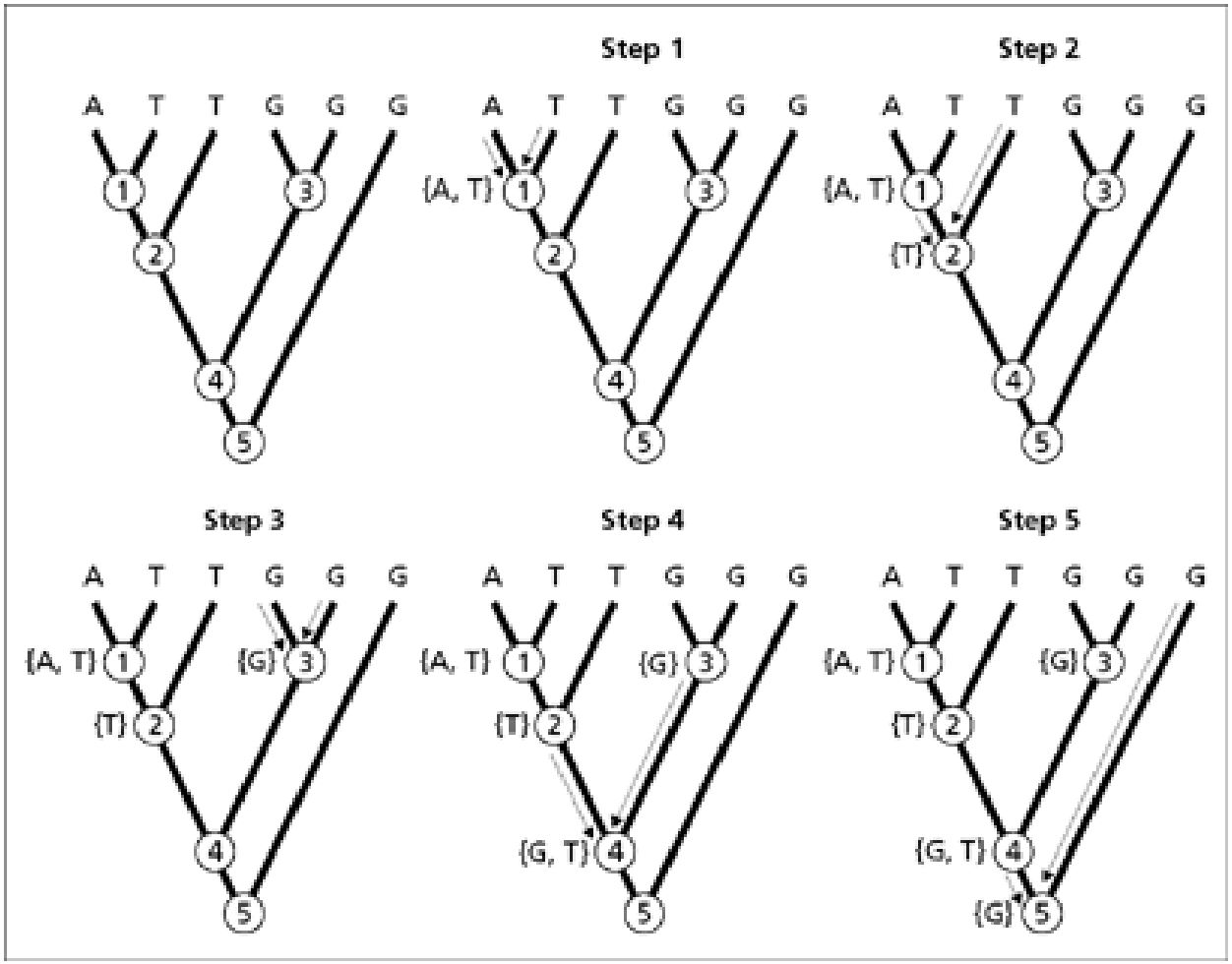
Page, Holmes
Molecular Evolution
Blackwell Science

Ancestral State Depends on Tree Topology



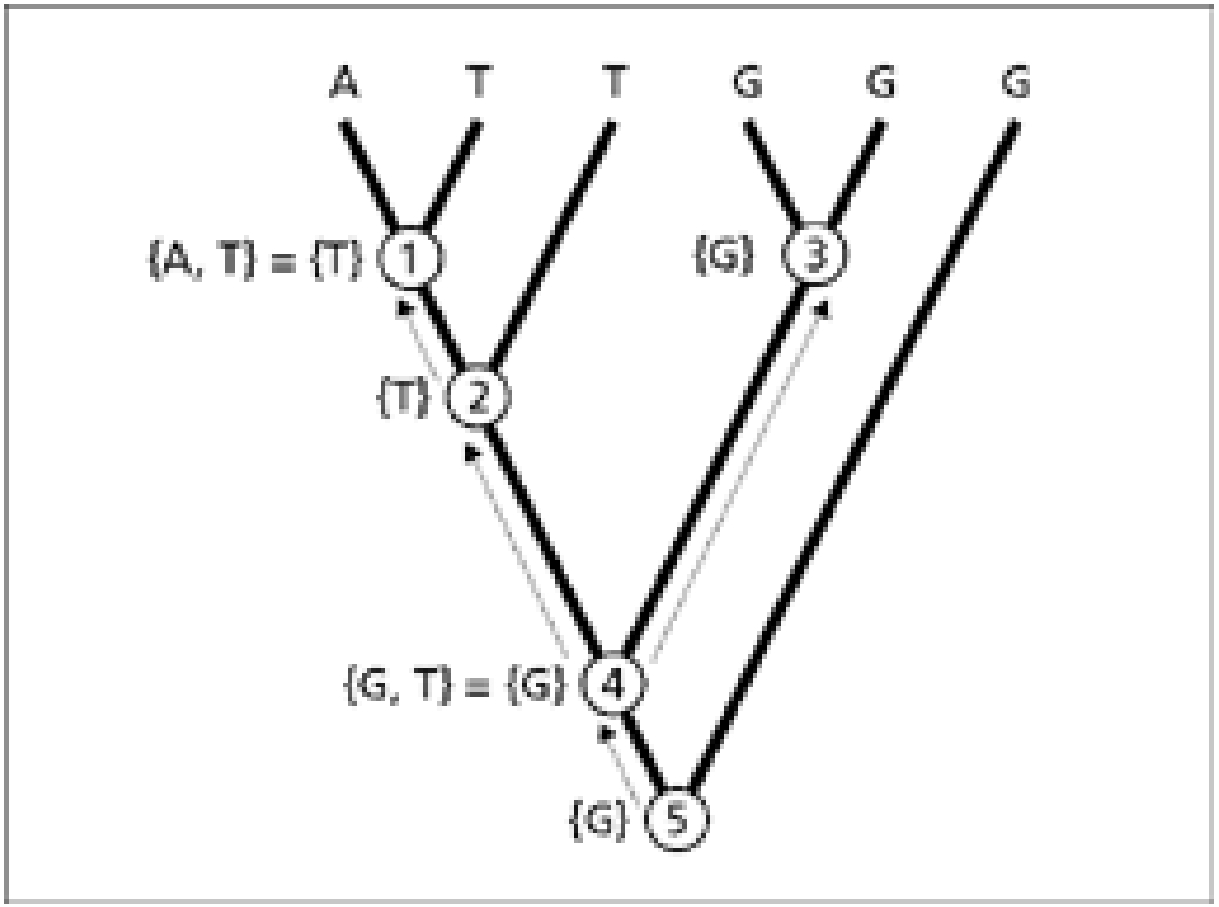
MOLECULAR AND GENOME EVOLUTION 1e, Figure 5.22

Parsimony Reconstruction (1)

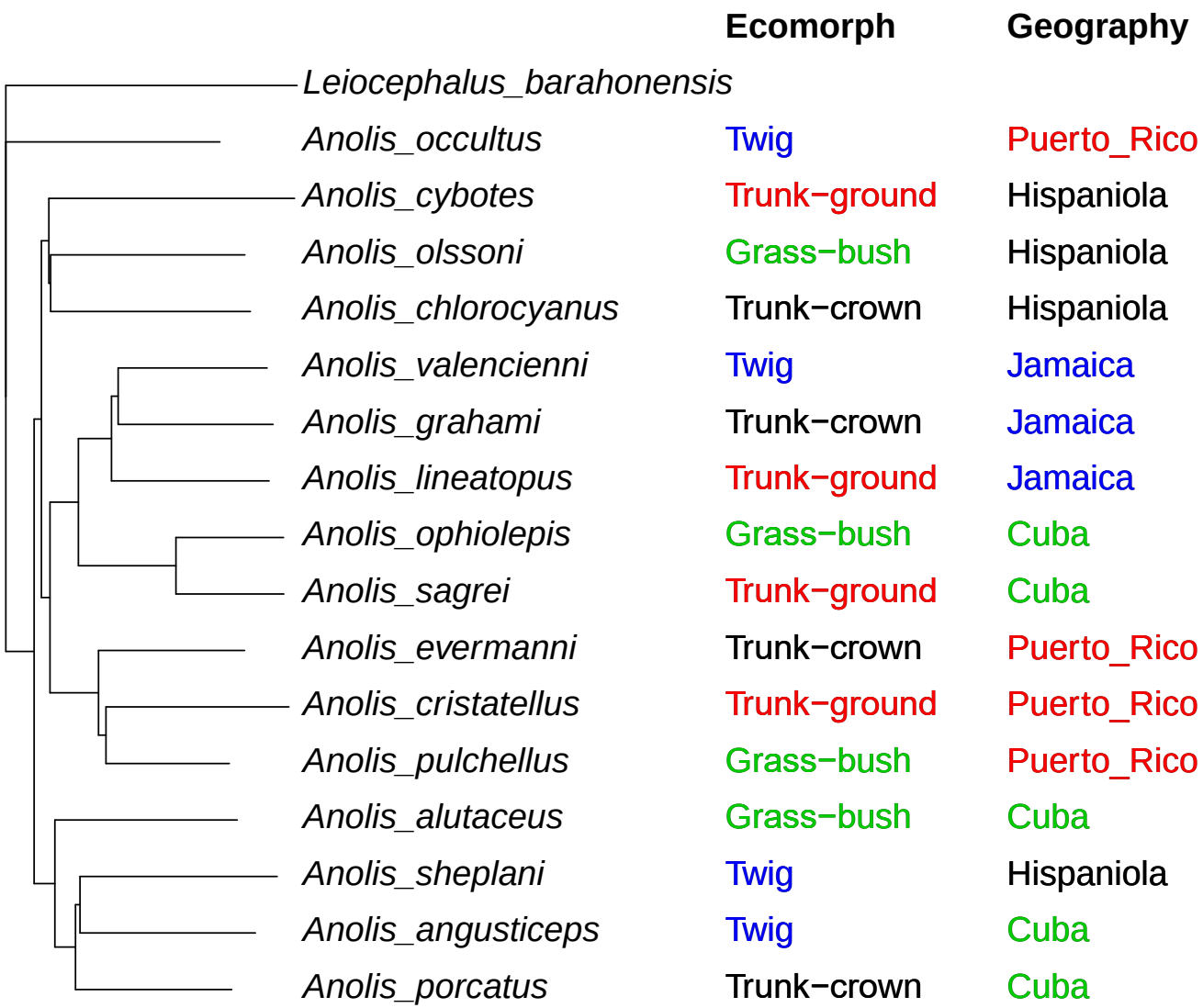


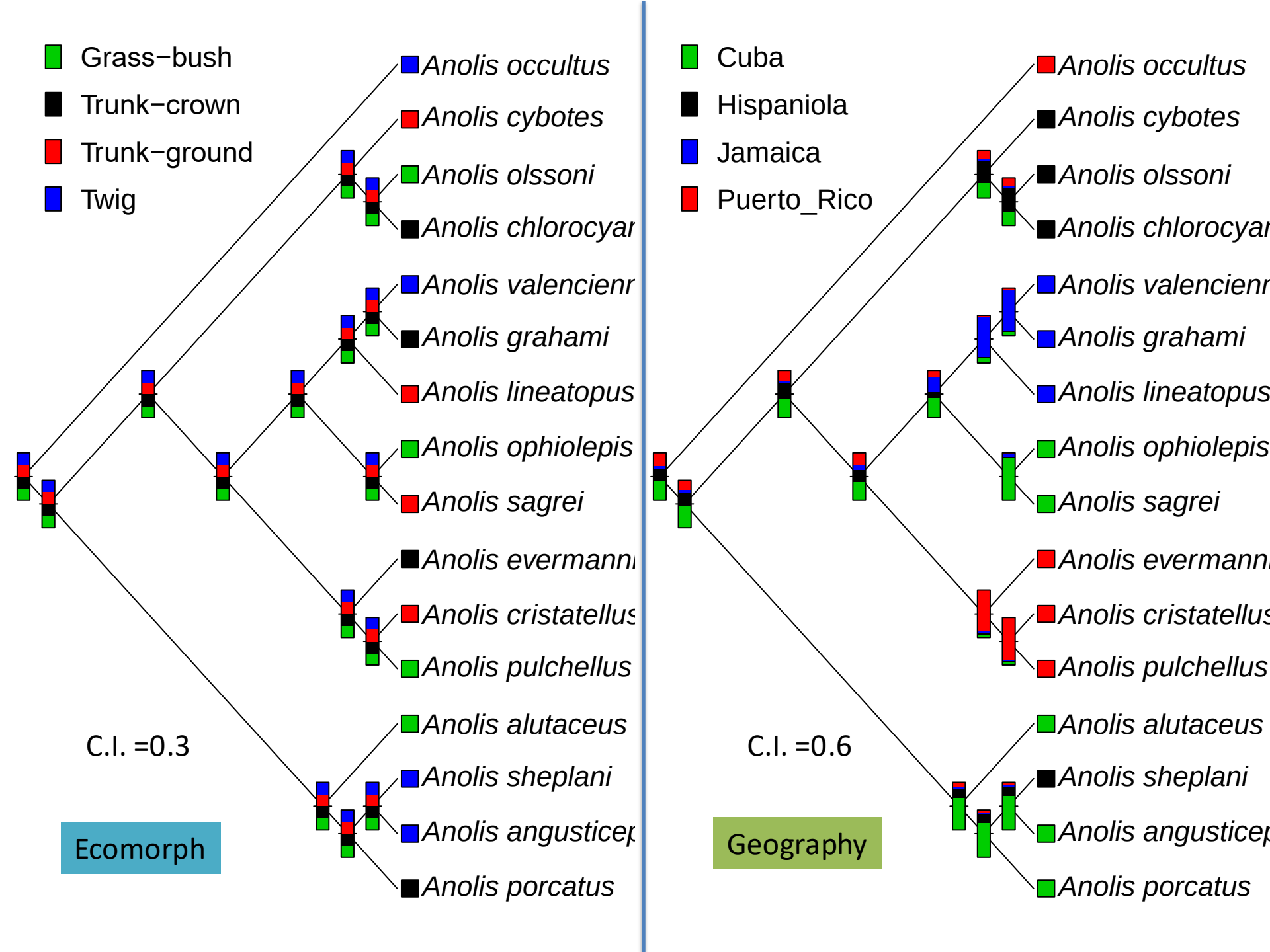
Rule 1: From two sister nodes, infer parent state by choosing intersection, if any. Otherwise, take the union

Parsimony Reconstruction (2)



Rule 2: From a parent node, infer child state by choosing intersection, if any. Otherwise, select an arbitrary state


Ecomorph
Geography
Leiocephalus_barahonensis
Anolis_occultus
Twig
Puerto_Rico
Anolis_cybotes
Trunk−ground
Hispaniola
Anolis_olssoni
Grass−bush
Hispaniola
Anolis_chlorocyanus
Trunk−crown
Hispaniola
Anolis_valencienni
Twig
Jamaica
Anolis_grahami
Trunk−crown
Jamaica
Anolis_lineatopus
Trunk−ground
Jamaica
Anolis_ophiolepis
Grass−bush
Cuba
Anolis_sagrei
Trunk−ground
Cuba
Anolis_evermanni
Trunk−crown
Puerto_Rico
Anolis_cristatellus
Trunk−ground
Puerto_Rico
Anolis_pulchellus
Grass−bush
Puerto_Rico
Anolis_alutaceus
Grass−bush
Cuba
Anolis_sheplani
Twig
Hispaniola
Anolis_angusticeps
Twig
Cuba
Anolis_porcatus
Trunk−crown
Cuba


Grass−bush
Trunk−crown
Trunk−ground
Twig
Anolis occultus
Anolis cybotes
Anolis olssoni
Anolis chlorocyar
Anolis valencienr
Anolis grahami
Anolis lineatopus
Anolis ophiolepis
Anolis sagrei
Anolis evermanni
Anolis cristatellus
Anolis pulchellus
Anolis alutaceus
Anolis sheplani
Anolis angusticep
Anolis porcatus
C.I. =0.3
Ecomorph
Cuba
Hispaniola
Jamaica
Puerto_Rico
Anolis occultus
Anolis cybotes
Anolis olssoni
Anolis chlorocyar
Anolis valencienr
Anolis grahami
Anolis lineatopus
Anolis ophiolepis
Anolis sagrei
Anolis evermanni
Anolis cristatellus
Anolis pulchellus
Anolis alutaceus
Anolis sheplani
Anolis angusticep
Anolis porcatus
C.I. =0.6
Geography