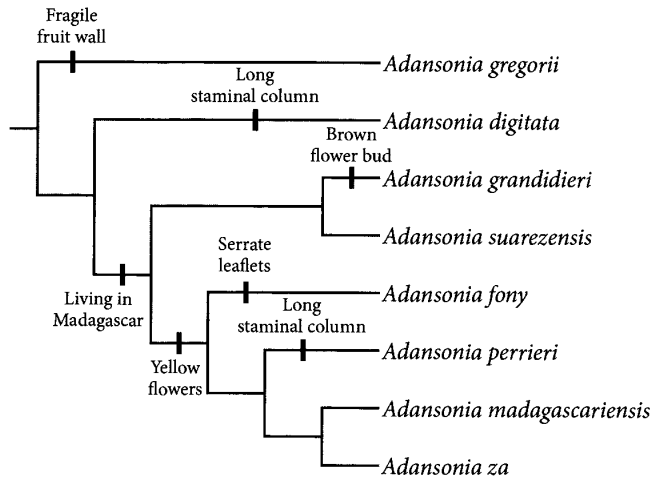


FURTHER READING

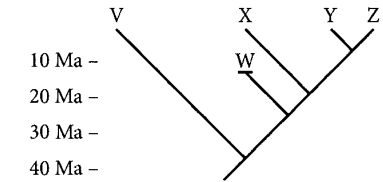
Trait evolution: Maddison and Maddison 2000
 Molecular evolution: Page and Holmes 1998; Graur and Li 2000
 Character polarity: Hennig 1966
 Homology (conceptual issues): Patterson 1982; Wagner 1989; Abouheif 1997; Mindell and Meyer 2001; Hall 2003; Scotland 2010
 Homoplasy and consistency: Farris 1989; Kitching et al. 1998; Wake et al. 2011
 Parsimony: Sober 1983, 1991

CHAPTER 4 QUIZ

- On a phylogenetic tree, where are character state changes typically marked?
 - at the root
 - at nodes
 - along branches
 - at the tips
 - character state changes are not shown on trees
- Consider a plausible phylogeny of the baobab trees, genus *Adansonia*. On the basis of this tree, which species lives in Madagascar, has woody (not fragile) fruit walls, white (not yellow) flowers, and green (not brown) flower buds?
 - A. gregorii*
 - A. digitata*
 - A. grandidieri*
 - A. suarezensis*
 - A. fony*

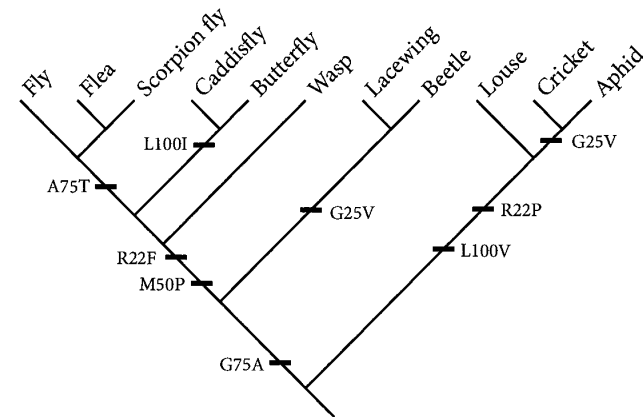


- Which statement is best supported by the chronogram?

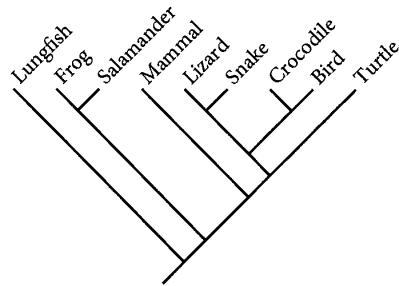


- Traits occurring in species W will be more ancient than those occurring in species Z
- Traits occurring in species Z will tend to be more advanced than those occurring in species Y
- Traits in species X will tend to be more similar to the traits of species W than to the traits of species Z
- Traits occurring in species W and X will tend also to occur in Z
- V has the most plesiomorphic character states

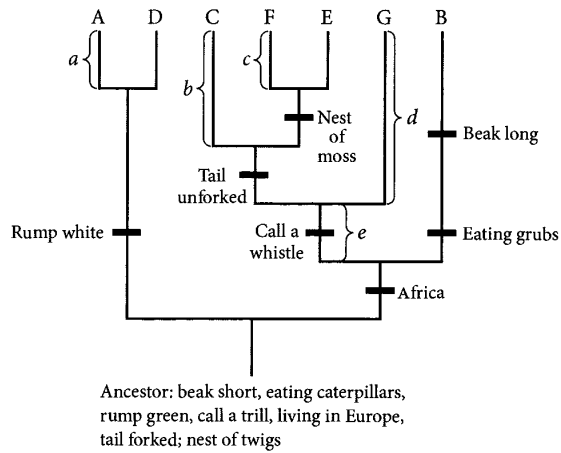
- Consider a plausible phylogeny for some of the major insect groups. Along the branches are marked changes in a hypothetical protein sequence. The marks list the amino acid position in the protein that changed, flanked by the standard one-letter codes for the amino acids before the change (to the left of the number) and after the change (to the right of the number). For example, L122S means that position 122 changed from a leucine (L) to a serine (S). Based on this tree, what amino acids does a butterfly have at positions 50, 75, and 100?
 - 50 = P (proline); 75 = A (alanine); 100 = I (isoleucine)
 - 50 = M (methionine); 75 = G (glycine); 100 = L (leucine)
 - 50 = R (arginine); 75 = G (glycine); 100 = V (valine)
 - 50 = P (proline); 75 = T (threonine); 100 = V (valine)
 - 50 = F (phenylalanine); 75 = T (threonine); 100 = P (proline)



5. Consider the following three facts: (1) the tree shown is correct; (2) The amnion (a membrane that surrounds the embryo) evolved once and was never lost; (3) A snake and a turtle have an amnion. Which of the following *must* also be correct?
- Salamanders have amnions
 - Birds have amnions
 - Mammals have amnions
 - Lungfish do not have amnions
 - Mammals do not have amnions

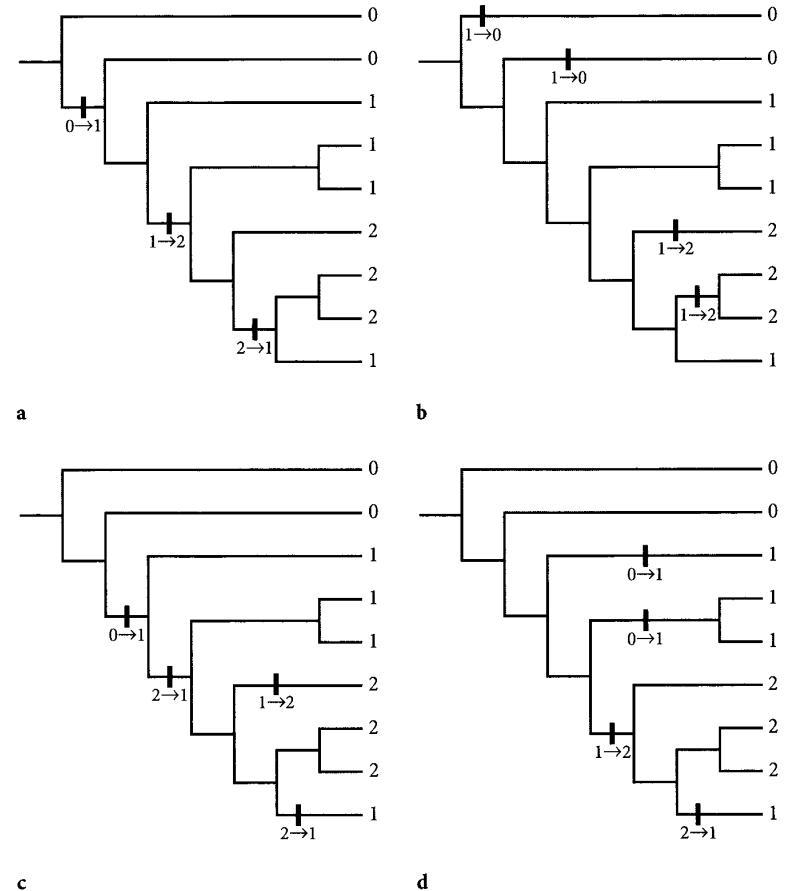


Questions 6-7 refer to the tree for a hypothetical group of birds.

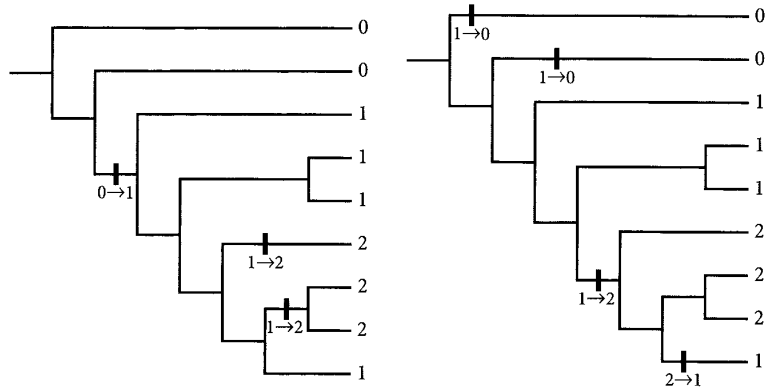


6. Which of the following sets of traits do you expect to find in bird E?
- Rump white, Africa, call a whistle, tail unforked, beak long
 - Eating caterpillars, rump green, Europe, nest of moss
 - Nest of moss, forked tail, rump white, Africa
 - Beak short, eating caterpillars, rump green, tail unforked
7. Which of the labeled branches (*a*, *b*, *c*, *d*, or *e*) contain at least some individuals with the following combination of traits: eating caterpillars, rump green, Africa, and call a trill?

8. The four trees each depict a history of trait evolution for a character with three character states, 0, 1, and 2. The character states at the tips are shown, as well as each transition. Which of these four provides a complete and plausible history of trait evolution?

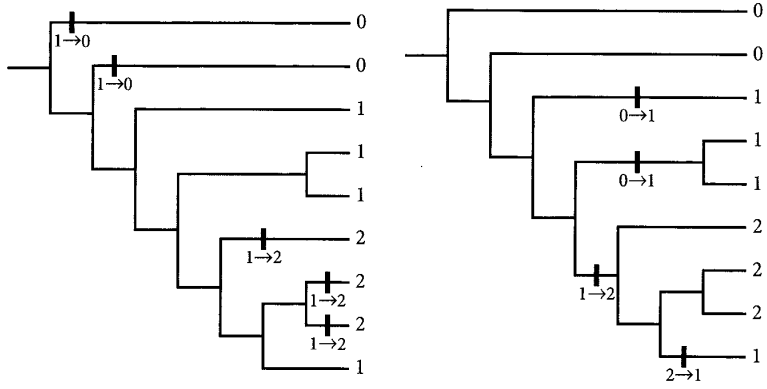


9. The four scenarios for trait evolution all validly explain the observed trait variation on this tree. Which is most parsimonious?



a

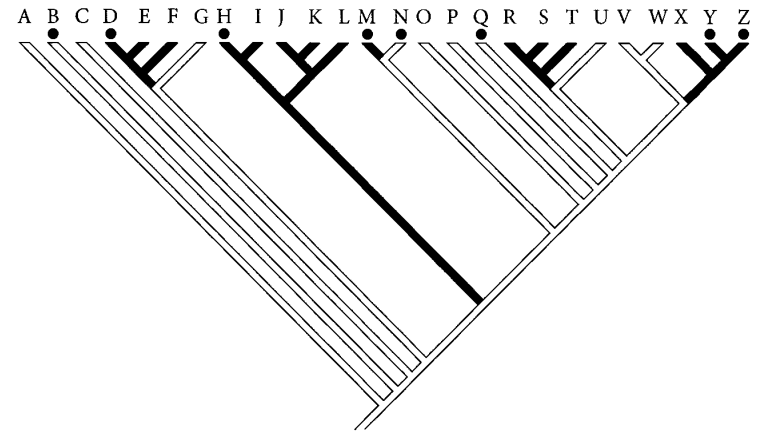
b



c

d

Questions 10–11. In the tree, white branches depict lineages that live in Africa, whereas the others live in South America. The taxa marked with a black circle have pink flowers, whereas the rest have yellow flowers.



10. Using parsimony, how many times did pink flowers evolve?

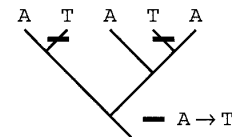
- a. 1 b. 3 c. 4 d. 6 e. 8

11. How many of those origins of pink flowers occurred in populations that were living in Africa?

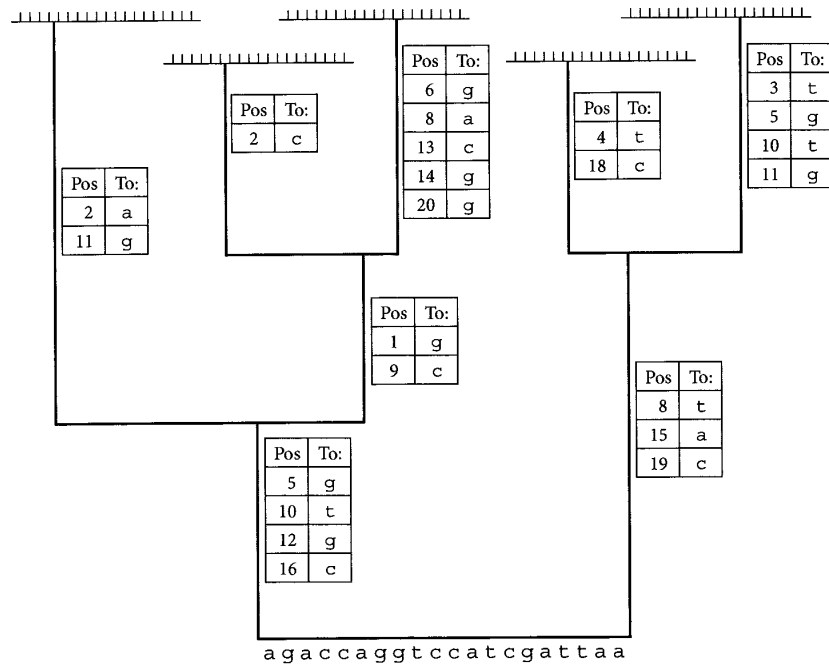
- a. 0 b. 1 c. 3 d. 4 e. 6

12. This tree shows the state of each tip for a particular position in a DNA molecule. What is the consistency index for this position?

- a. 0.2 b. 0.25 c. 0.4 d. 0.5 e. 2



13. The tree shows an ancestral sequence of 20 nucleotides. Along the branches the changes are shown. Deduce the sequences of the five living species.



14. The tree shown for Questions 6–7 has one branch with two trait changes shown, beak long and eating grubs. Why should one be careful about assuming, on the basis of this diagram, that the diet trait changed before the beak trait? What additional information might support the conclusion that indeed beaks lengthened after the transition to grub eating?
15. Trait evolution is often represented with a line drawn across a branch of a phylogenetic tree. Describe the evolutionary phenomena that are represented by this line.
16. Dogs have a tiny appendage above their paw, the so-called dewclaw. If we had a time machine, how could we determine definitively whether this body part is homologous to the human thumb? Assume that if we look at a parent and its offspring we can unambiguously identify the structures in each that are homologous.

Relatedness and Taxonomy

Following the acceptance of evolutionary theory in the nineteenth century, *taxonomy*, the science of establishing and using biological classifications, acquired a clear mission to represent evolutionary relationships. In so doing taxonomy became a branch of *systematics*, the study of the evolution of biological diversity. Nonetheless, it took another hundred years for all of the implications of that merger to become clear. First, taxonomists had to clarify that evolutionary relatedness should be defined in terms of common ancestry. Second, because common ancestry is captured in phylogenetic trees, taxonomists had to adapt to the idea that their classification systems should mirror the tree of life. That is to say, classification should follow the rule that the more recently two organisms last shared a common ancestor, the more closely they should be classified. And third, systematics needed to develop the tools to build reliable trees. In short, it took biologists over a hundred years to recognize that classification, relatedness, and trees are really three sides of the same coin, so to speak.

In this chapter, we clarify the concept of relatedness and show that it applies equally to family trees (pedigrees) and phylogenetic trees. Then we discuss the common confusion between relatedness and similarity and explain why modern taxonomy focuses on phylogenetic relatedness rather than similarity. We explore *nomenclature*, the rules regulating the names of taxa, and show why the concept of taxonomic rank is not meaningful in a phylogenetic context. We end the chapter with a brief discussion of phylogenetic nomenclature, a new, but controversial, approach that attaches names to clades rather than to ranked taxa.

THE CONCEPT OF RELATEDNESS

The concept of relatedness as applied to the branches of a phylogenetic tree mirrors that used in discussions of human familial relationships. In both cases, the