



Constructing Evolutionary Trees – the Basics

Introduction:

An evolutionary tree is a map of the evolutionary relationships between organisms. The more closely two organisms are related, the nearer they will be to each other on the tree.

Steps in constructing an evolutionary tree:

- 1.) Select a group of organisms that you want to analyze.
- 2.) For each member of the group, determine some observable characters (traits). Ideally, the characters should have only two possible states. For example, given the character “wings”, there are two possible states – “wings present” and “wings absent”.
- 3.) For each character, determine which state is evolutionarily older (ancestral) and which is evolutionarily newer (derived). This is usually done by comparison with a more distantly related organism termed the “outgroup”. Characters shared with the outgroup are likely to be ancestral traits. Characters that differ from the outgroup are likely to have arisen since the group being considered branched from its shared common ancestor with the outgroup. These differing characters are derived. If two or more organisms share a derived character, this is evidence that these organisms are related.
- 4.) Construct a table showing the states of the characters exhibited by each organism in your analysis.
- 5.) Construct a matrix showing the number of identical characters exhibited by each pair of organisms in your analysis.
- 6.) Use the matrix to identify the organism most closely related to the outgroup (determined by the number of shared characters with the outgroup). This organism will be placed closest to the outgroup on the evolutionary tree.
- 7.) Repeat the last step to determine the next organism to place on the tree.

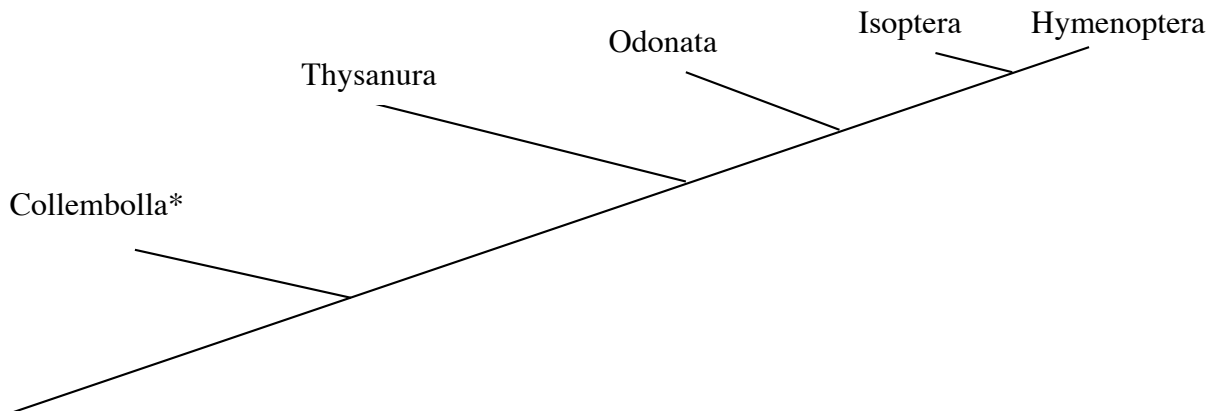
Example: Evolutionary tree of insects

Character	Outgroup Collembola (springtails)	Thysanura (silverfish)	Odonata (dragonflies)	Isoptera (termites)	Hymenoptera (bees, ants, wasps)
Jointed legs	yes	yes	yes	yes	yes
Mouthparts	internal	external	external	external	external
Wings	no	no	yes	yes	yes
Wing flexion	no	no	no	yes	yes
Complete metamorphosis	no	no	no	no	yes

Matrix showing number of characters shared:

	Collembola	Thysanura	Odonata	Isoptera
Thysanura	4			
Odonata	3	4		
Isoptera	2	3	4	
Hymenoptera	1	2	3	4

Hypothetical Evolutionary Tree for Insects:



* Typically, the outgroup is not represented on the tree, but if it were, it could be represented on a separate branch, indicating a shared common ancestor with the other organisms.

As you can see from the tree diagram, the most ancestral group among the insects is the Thysanura, which shares the most characters with the outgroup. The most derived group is the Hymenoptera.