

# **Phylogenetic Biology**

## **Reconciling gene trees**

## **and species trees**

Biology 1425

Professor: Casey Dunn, [dunnlab.org](http://dunnlab.org)  
Brown University

# Front matter...

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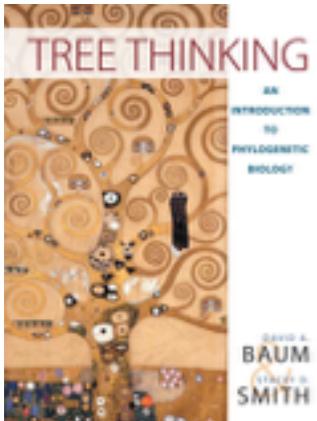
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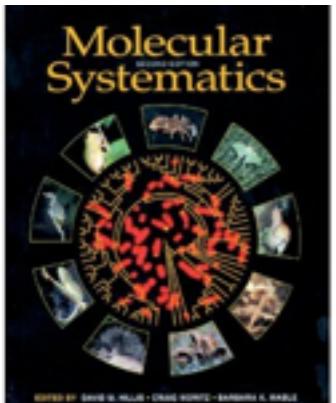
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# Sources

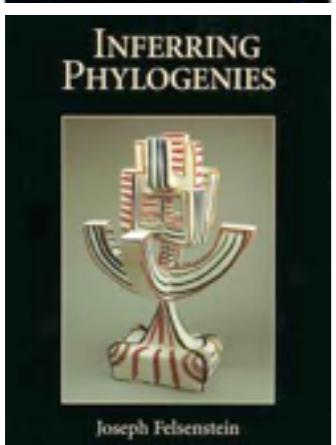
Some non-original content is drawn from:



Baum, D and S. Smith (2012) Tree Thinking: and Introduction to Phylogenetic Biology. Roberts and Company Publishers. ISBN 9781936221165



Swofford, D. L., Olsen, G. J., Waddell, P. J., & Hillis, D. M. (1996). Phylogenetic inference. In: Molecular Systematics, Second Edition. eds: D. M. Hillis, C Moritz, & B. K. Mable. Sinauer Associates. ISBN 9780878932825



Felsenstein, J. (2003) Inferring Phylogenies. Sinauer Associates. ISBN 978-0878931774

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# **Reconciling gene trees and species trees**

Sometimes gene trees and species trees are congruent...

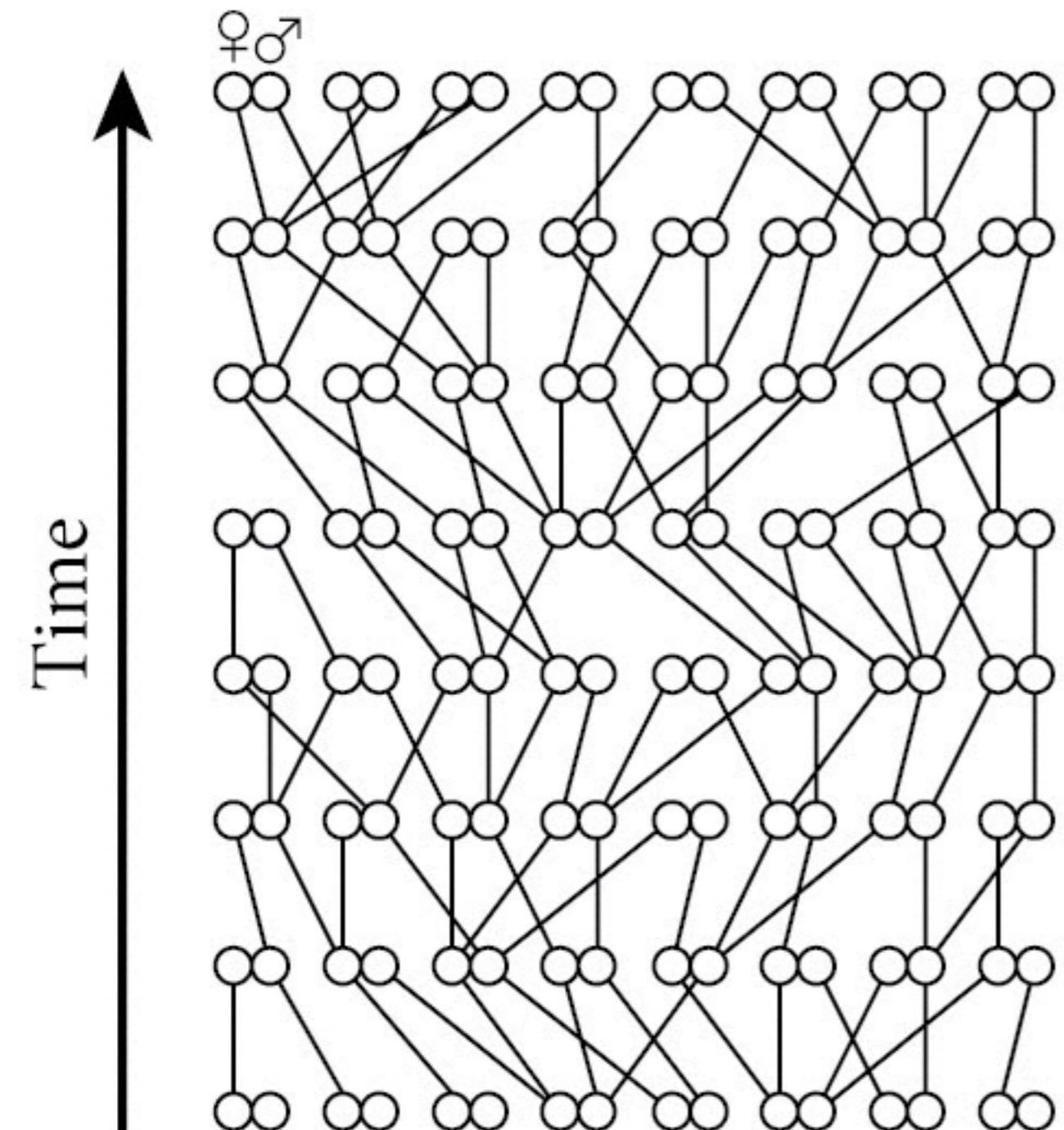
Sometimes gene trees and  
species trees are congruent...

Sometimes they aren't.

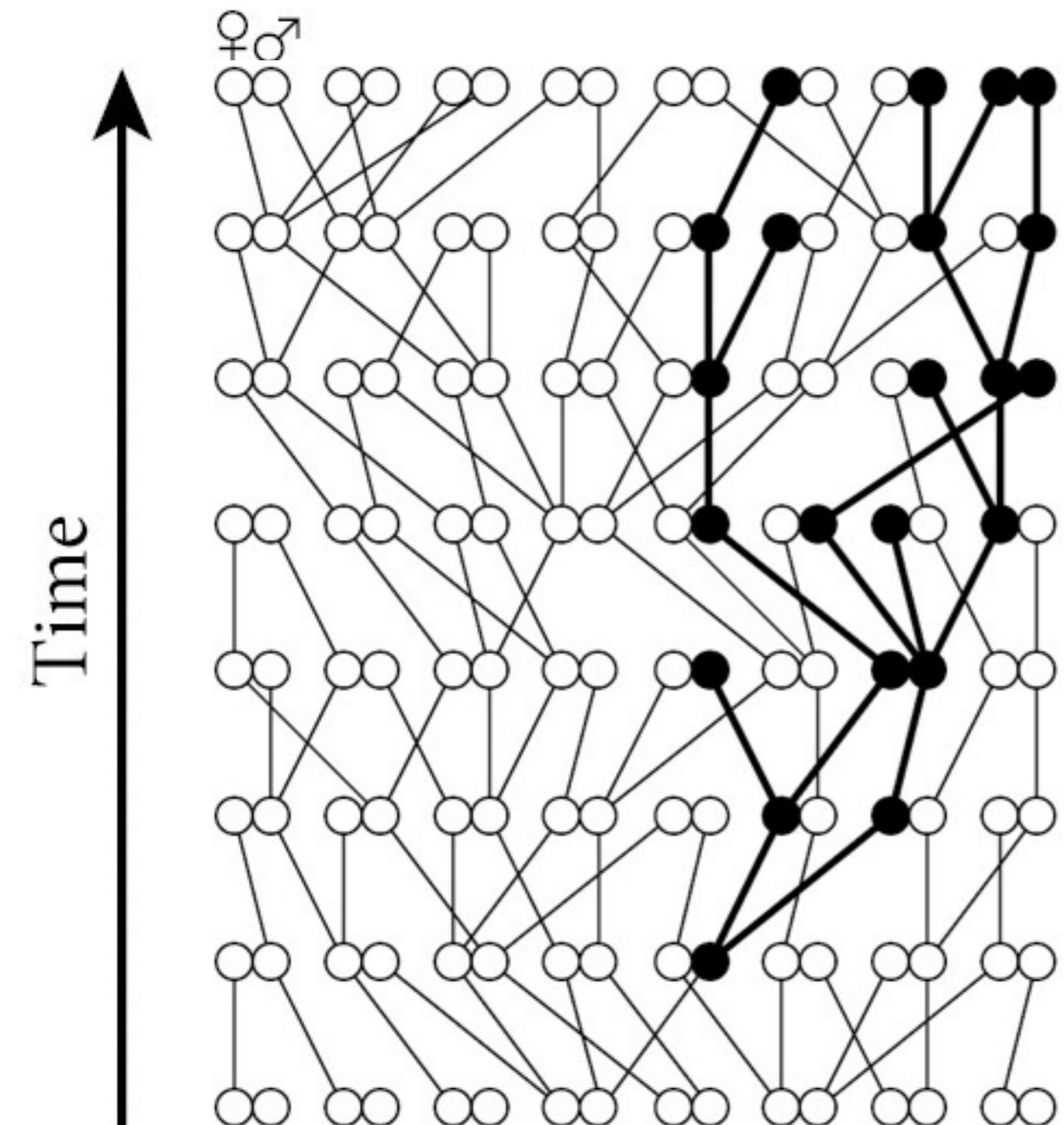
Incongruence can be due to incorrect phylogenetic inference (ie, they do have the same history but this history isn't recovered in analyses of contemporary data).

There are also multiple biological reasons that gene trees can really differ from each other and from the species tree.

# Incomplete lineage sorting

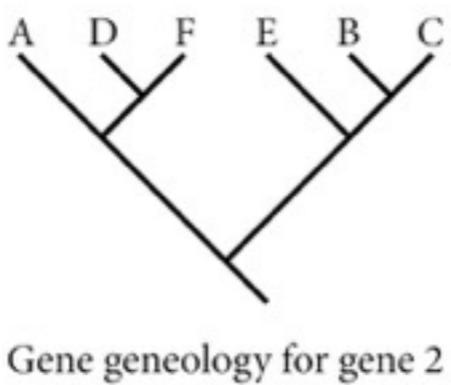
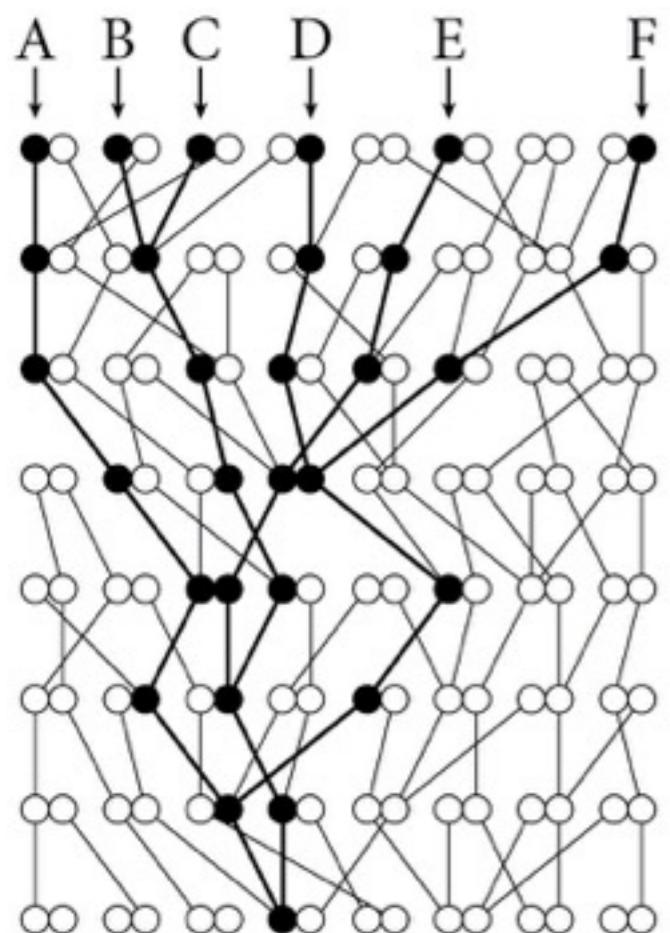
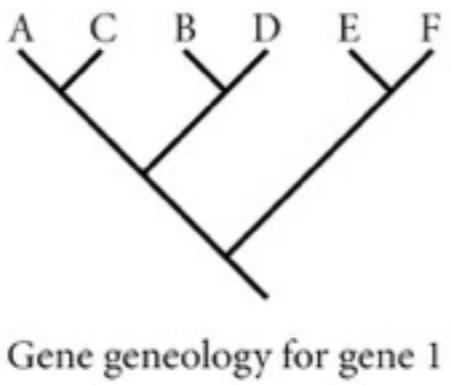
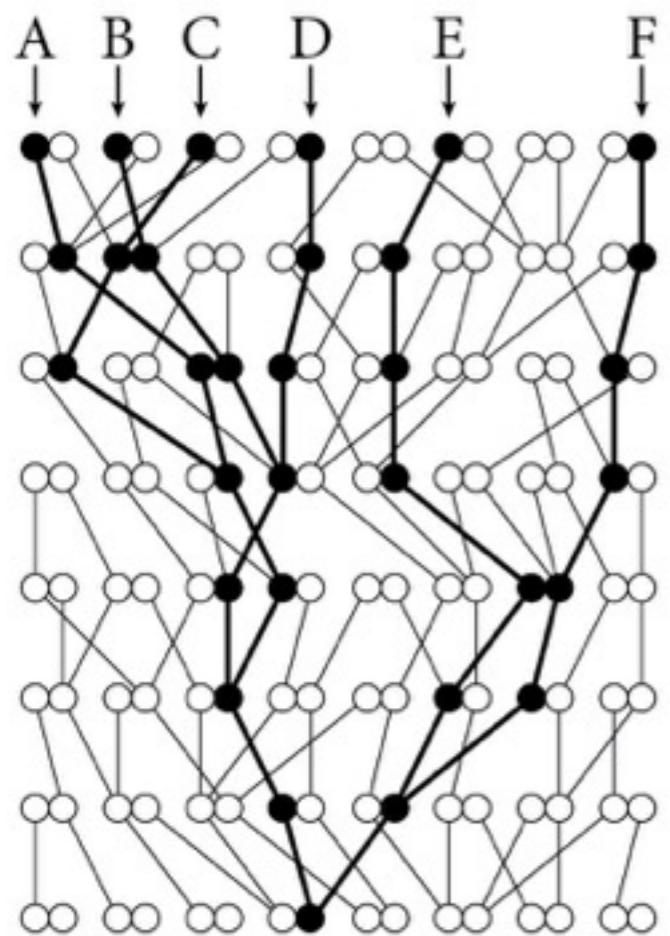


Nodes are alleles. Pairs  
of nodes are individuals.  
Edges indicate  
inheritance of alleles



Any set of alleles in one generation can be traced back to a common ancestor in a previous generation - coalescence.

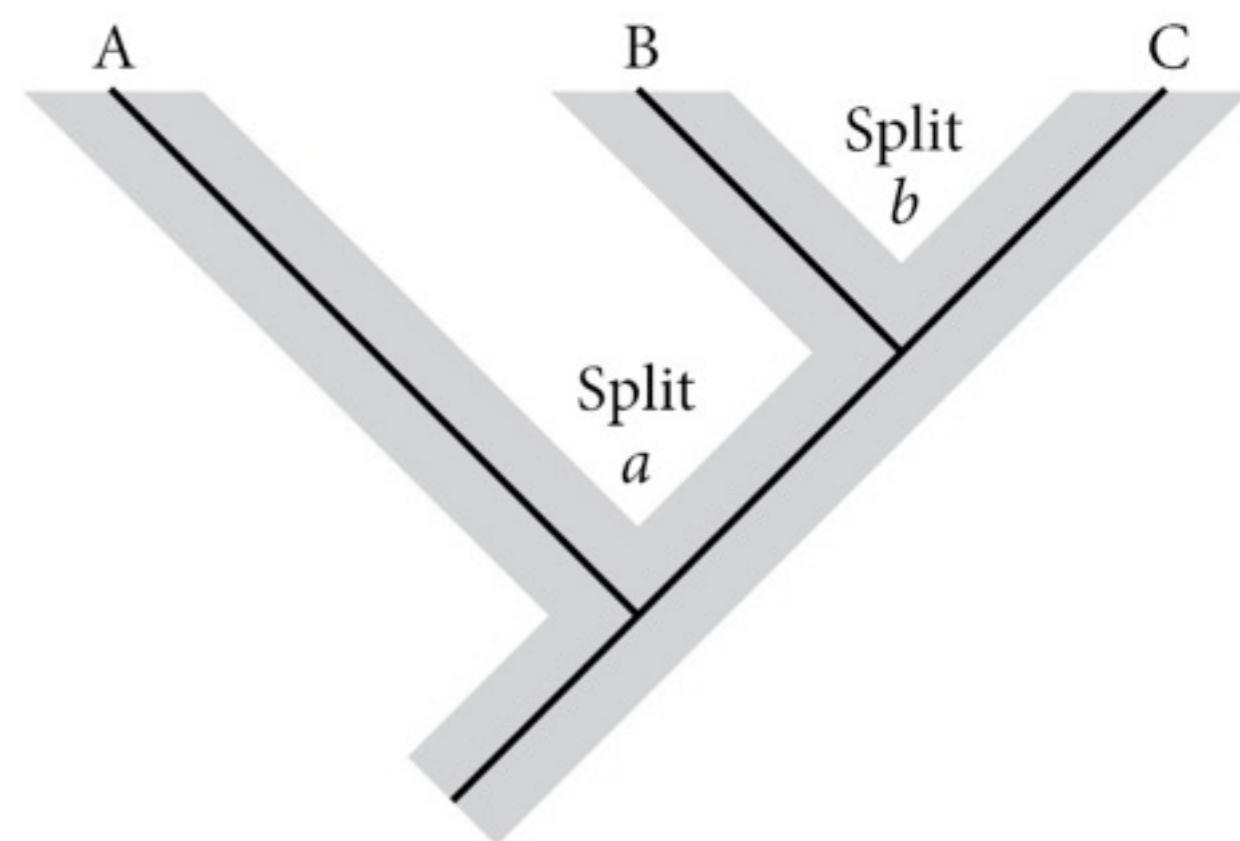
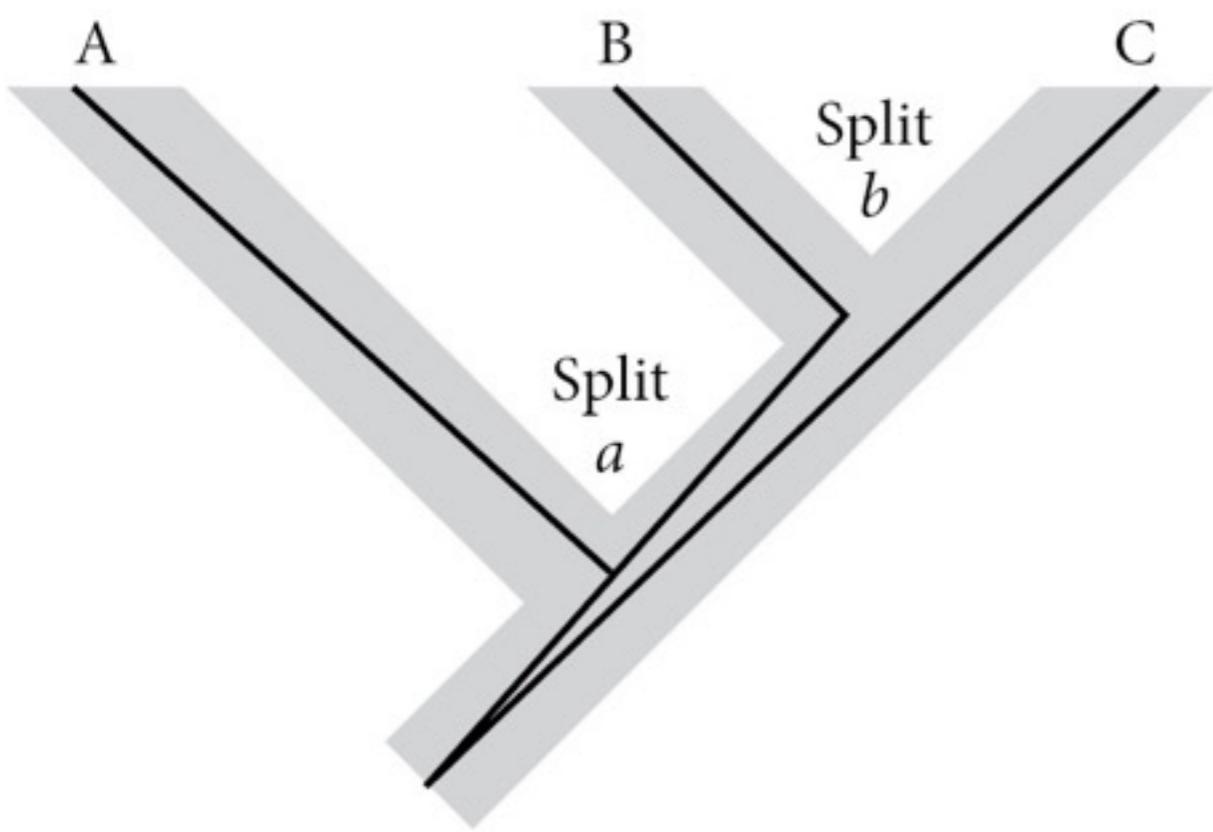
For any group of individuals in a sexual population, different genes will have different histories.



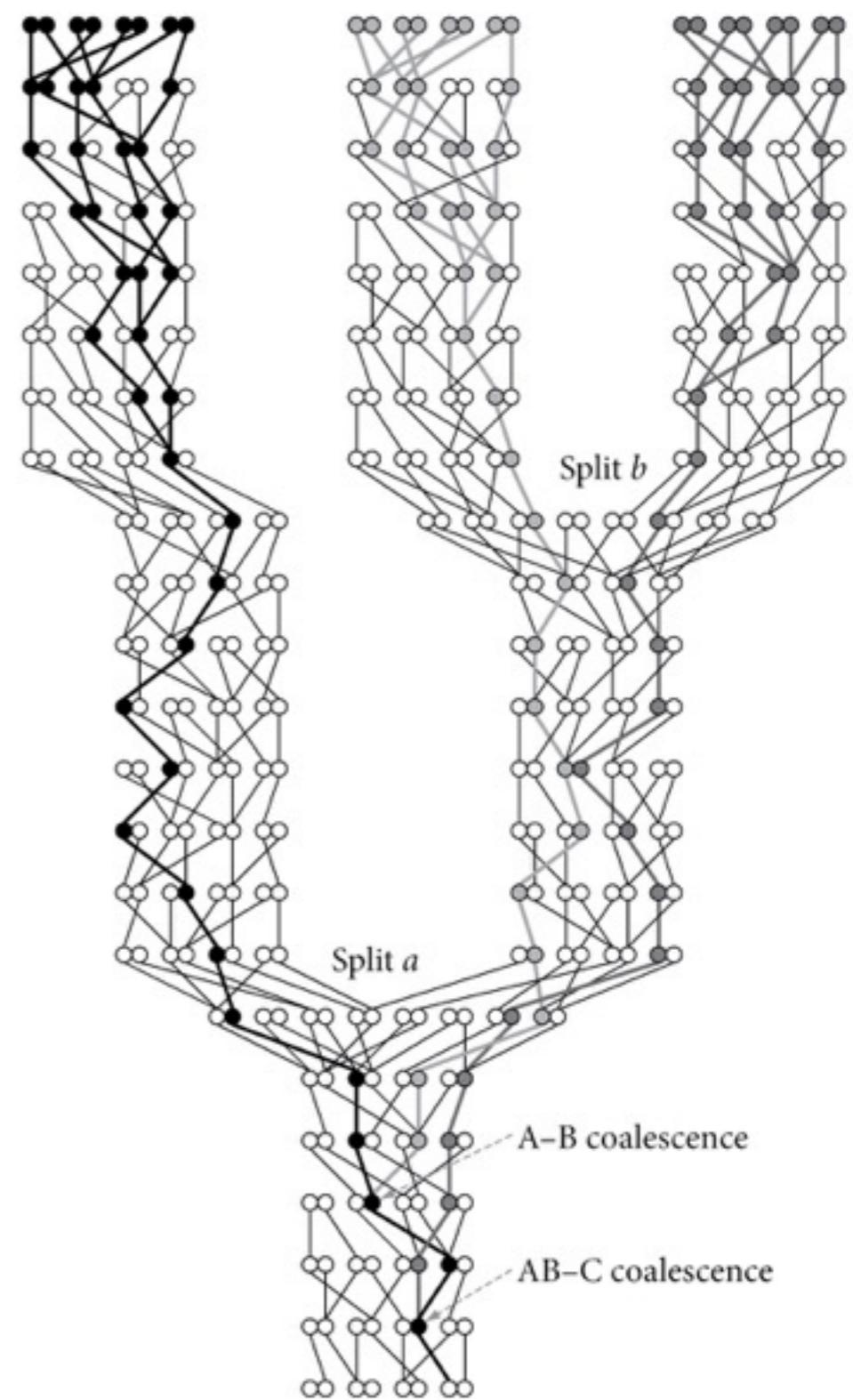
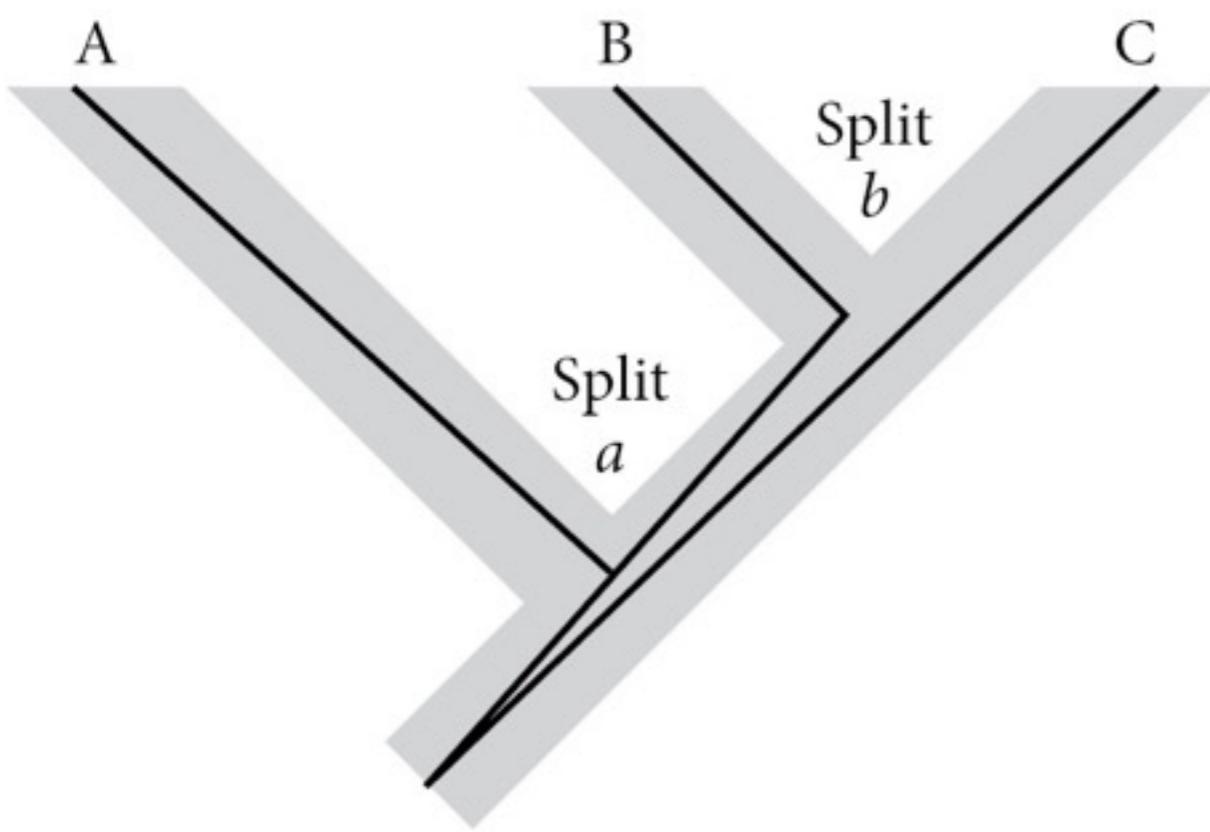
Baum and Smith 2012, Figure 6.3

That's in a single unbranching population... what about when the population is branching?

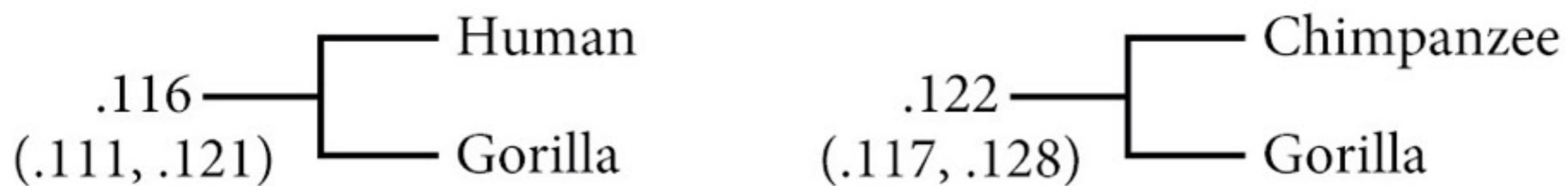
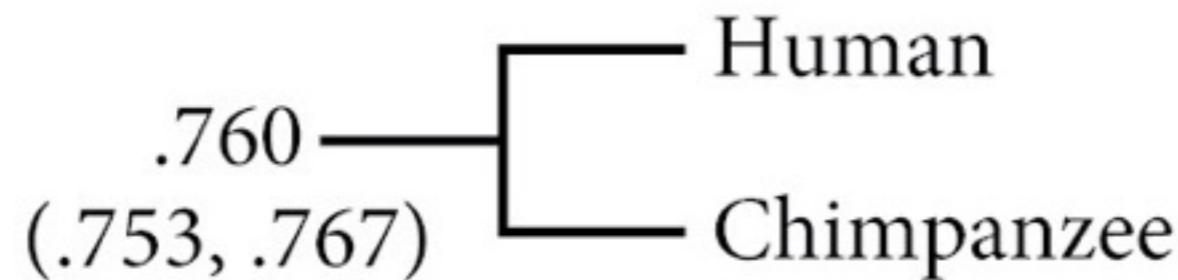
# Results can differ...



Baum and Smith 2012, Figures 6.5-6.6



Baum and Smith 2012, Figures 6.6-6.7



What is the average time to coalescence?

$$E(T) = 2N \text{ generations}$$

# **Gene duplication and loss**

**Species A**



**Species B**



**Species C**



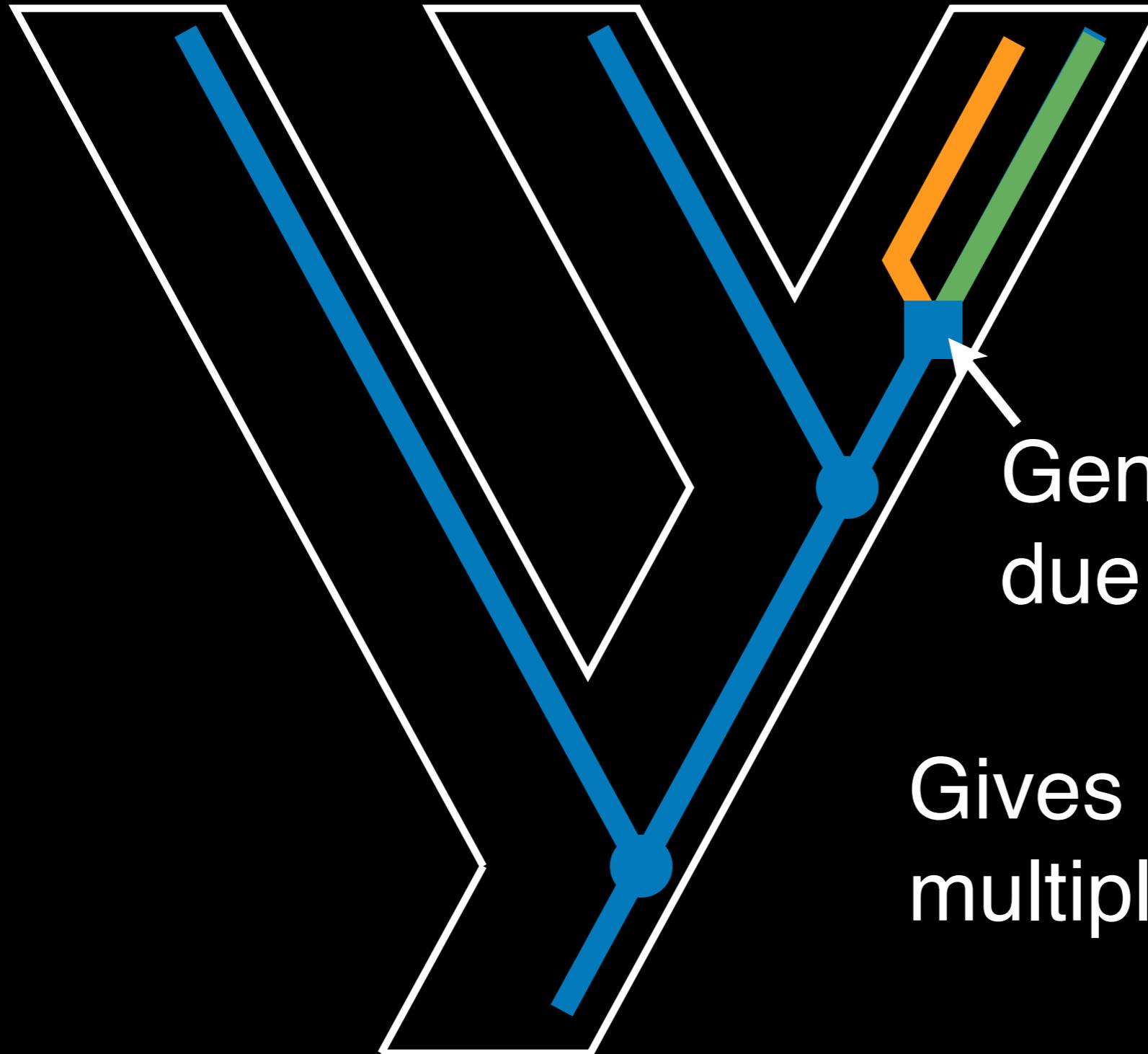
**Species A**



**Species B**



**Species C**



Gives rise to  
multiple “paralogs”

Gene divergence  
due to duplication

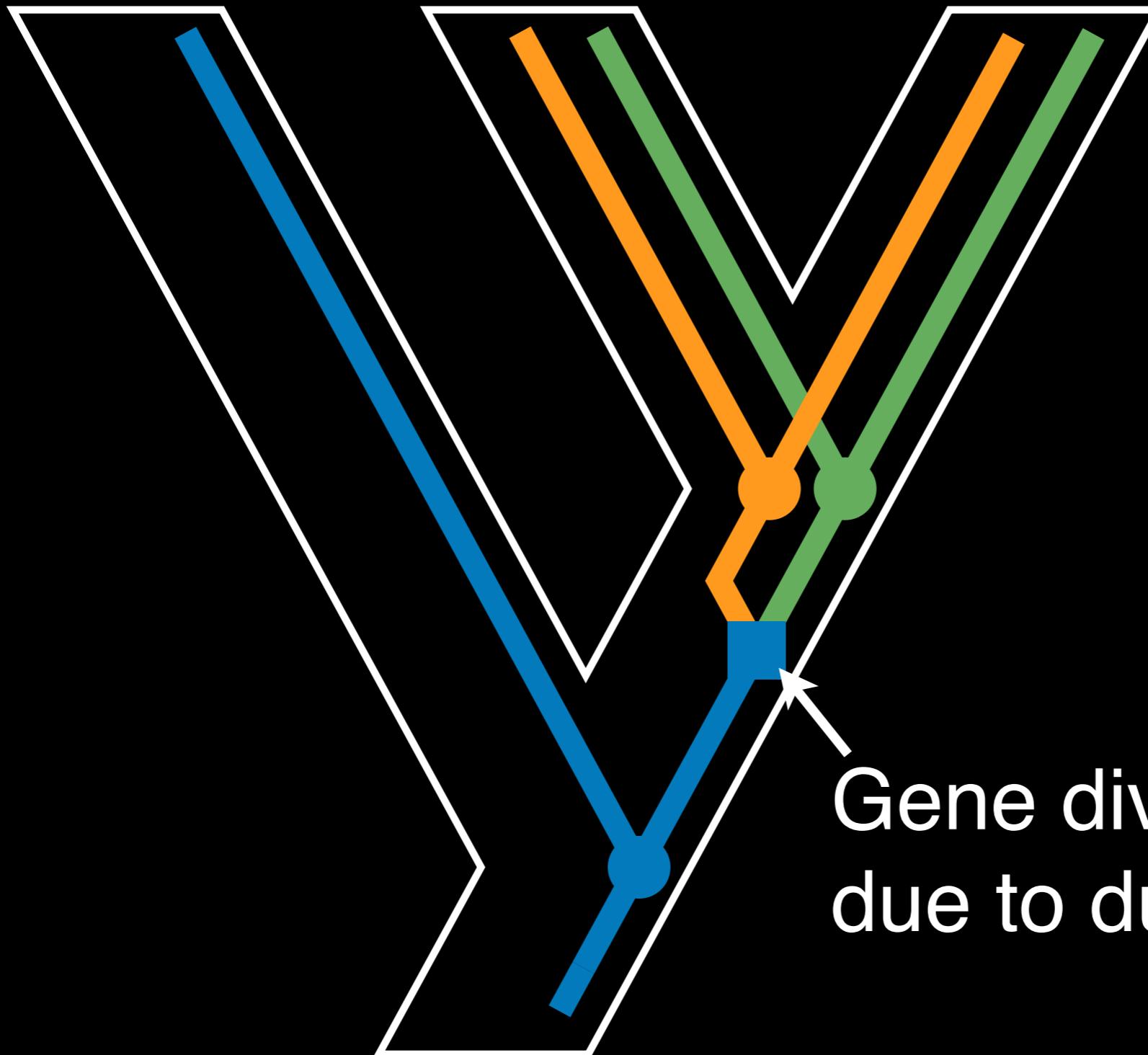
**Species A**



**Species B**



**Species C**



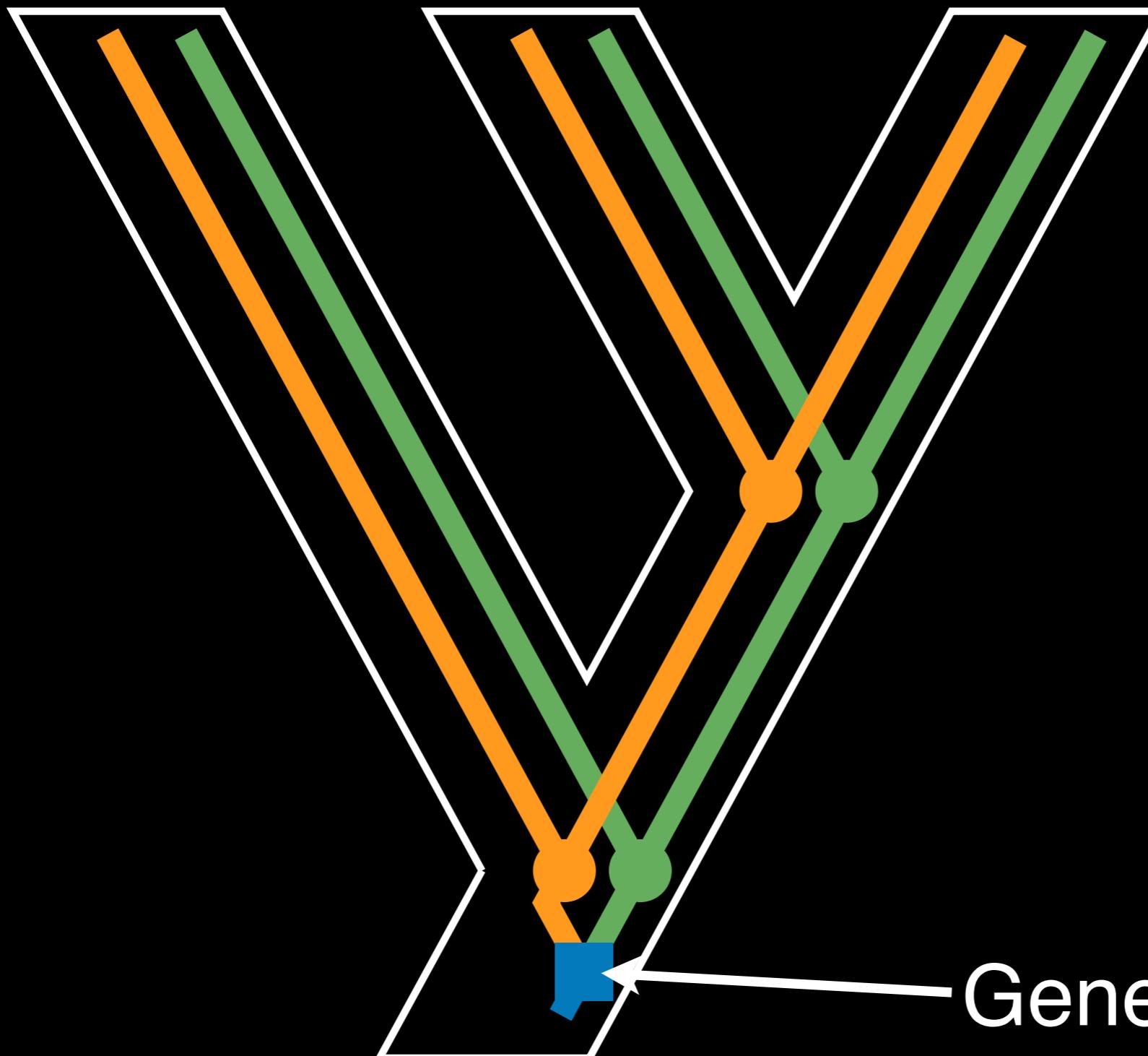
**Species A**



**Species B**



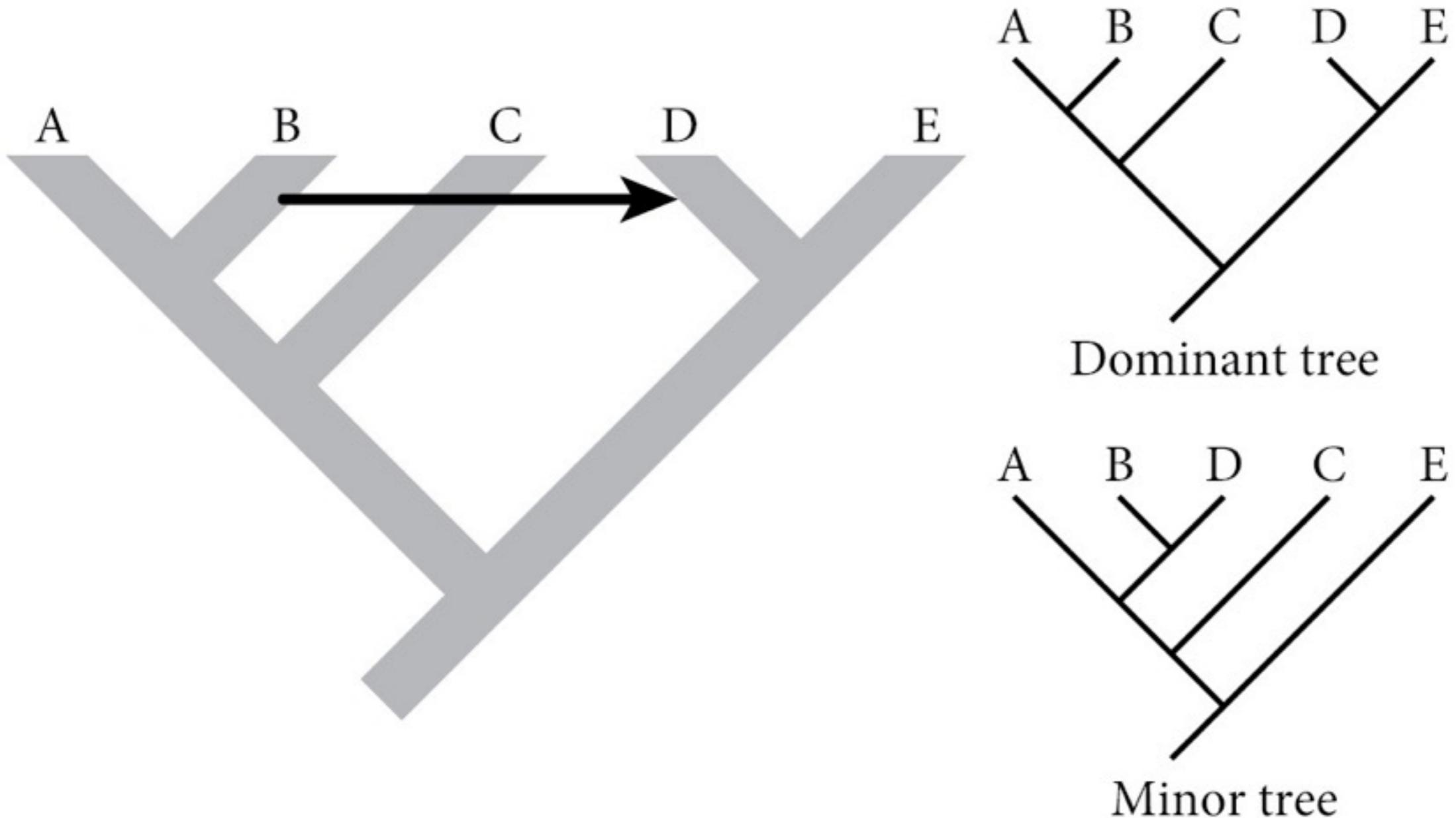
**Species C**



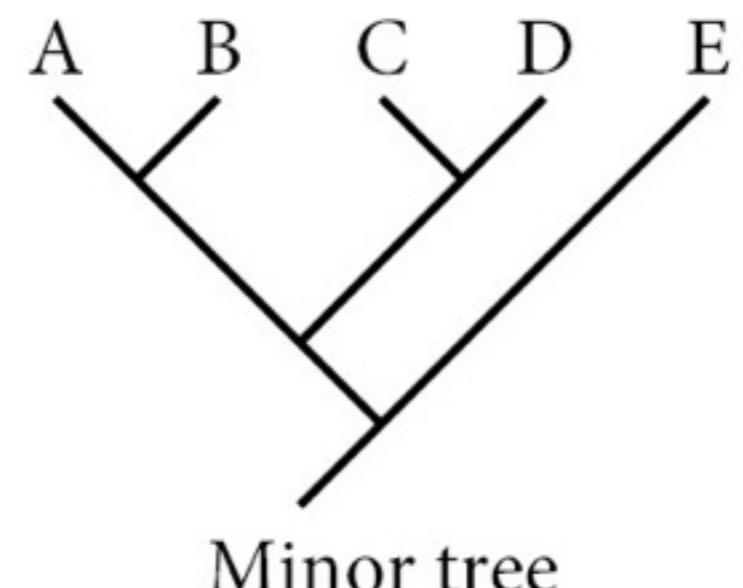
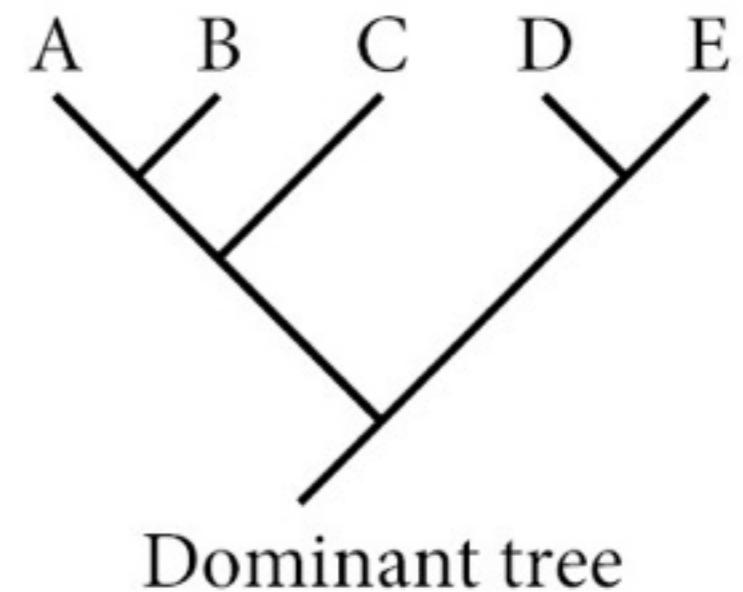
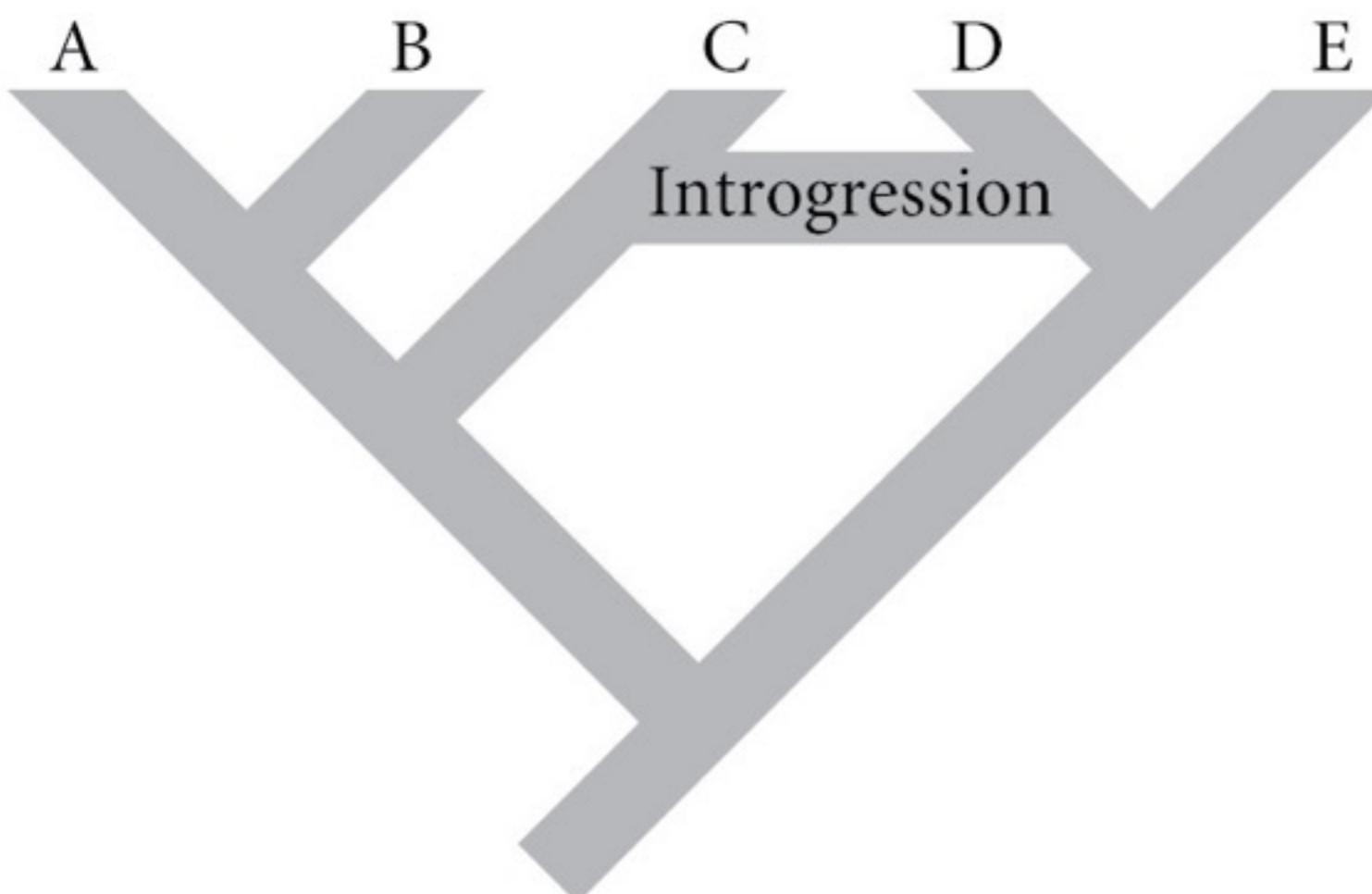
Gene divergence  
due to duplication

# **Reticulation**

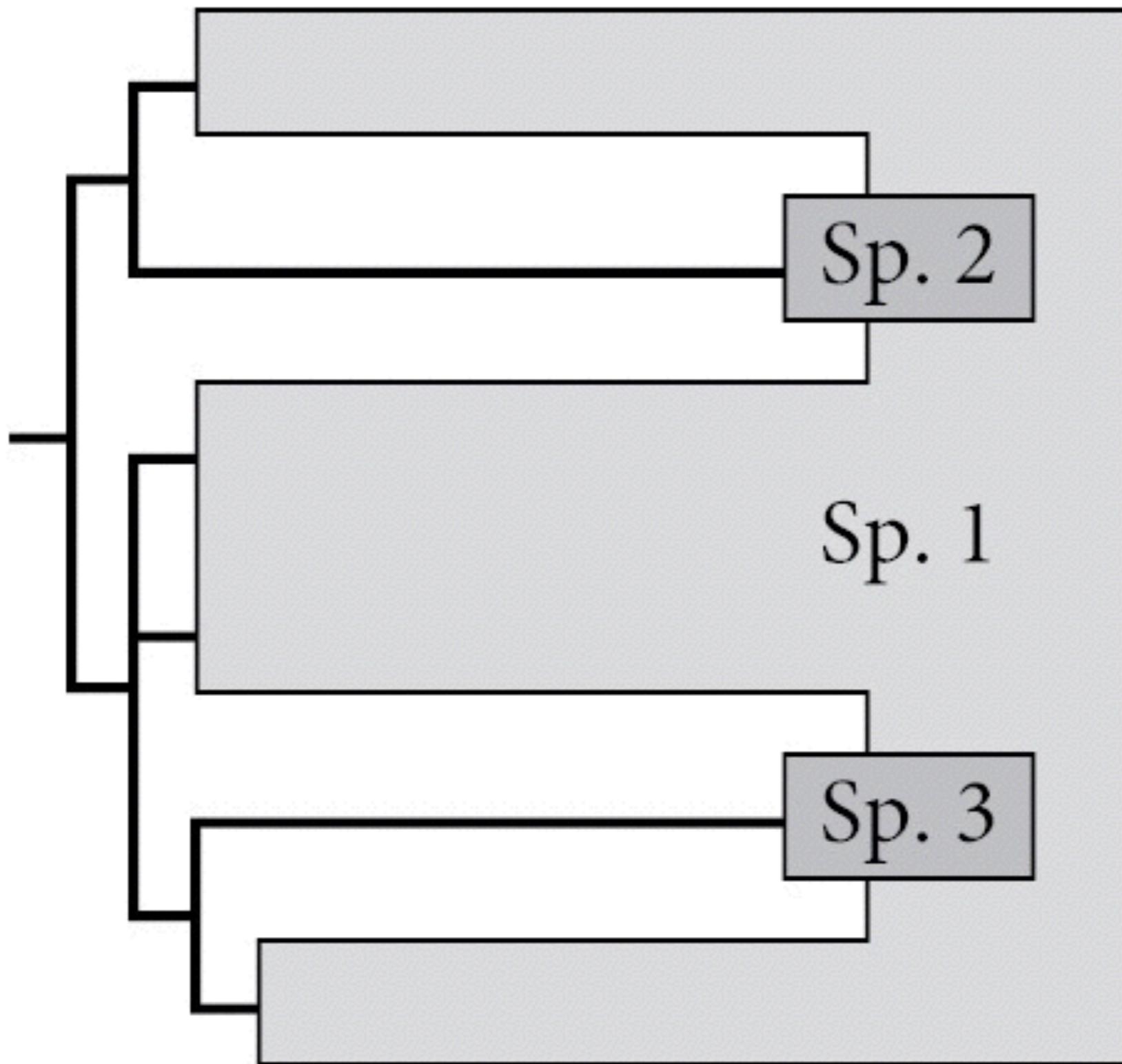
# Lateral (aka horizontal) gene transfer



# Introgression



# **Species paraphyly**



Baum and Smith 2012, Figures 6.20

