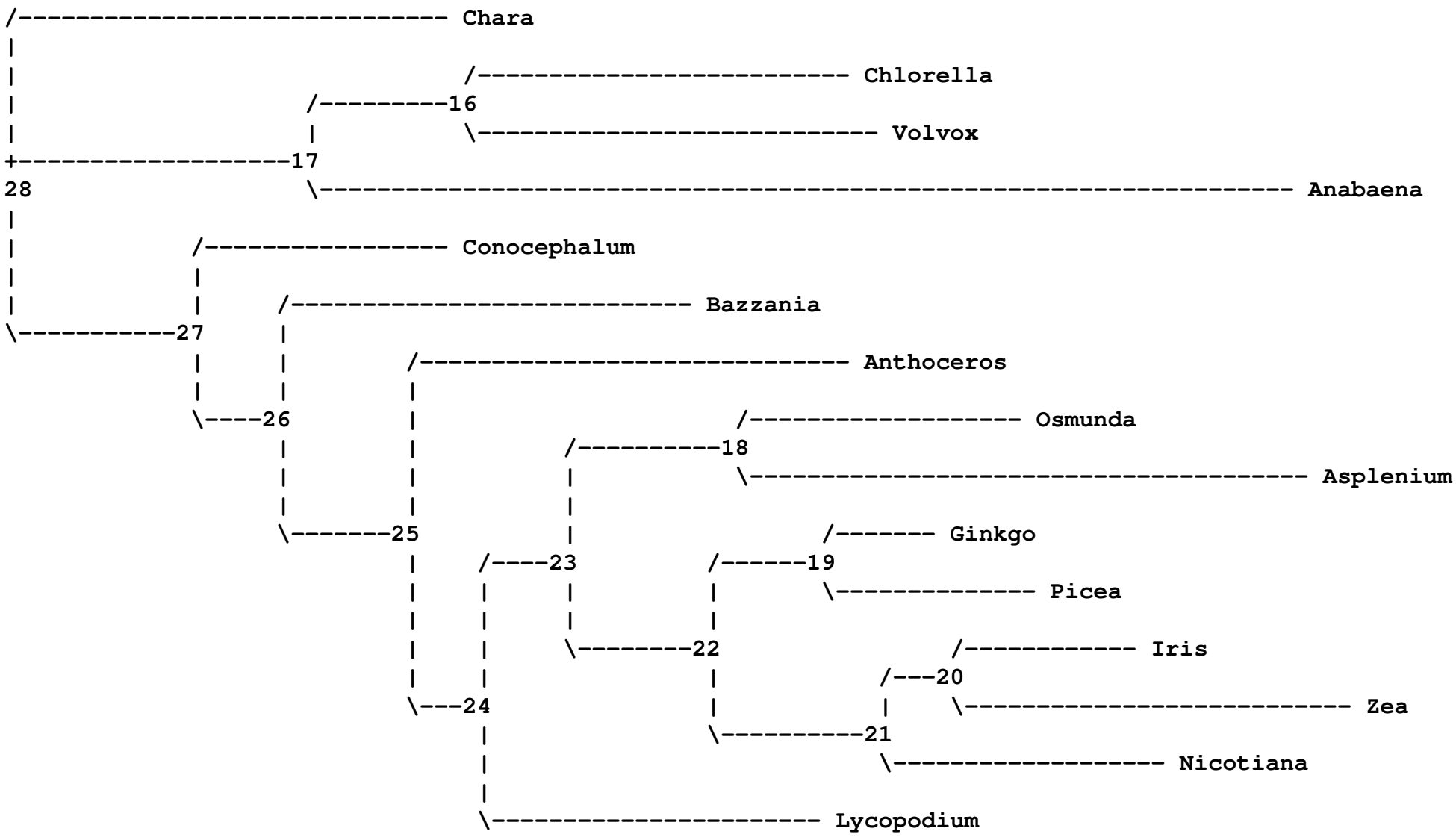
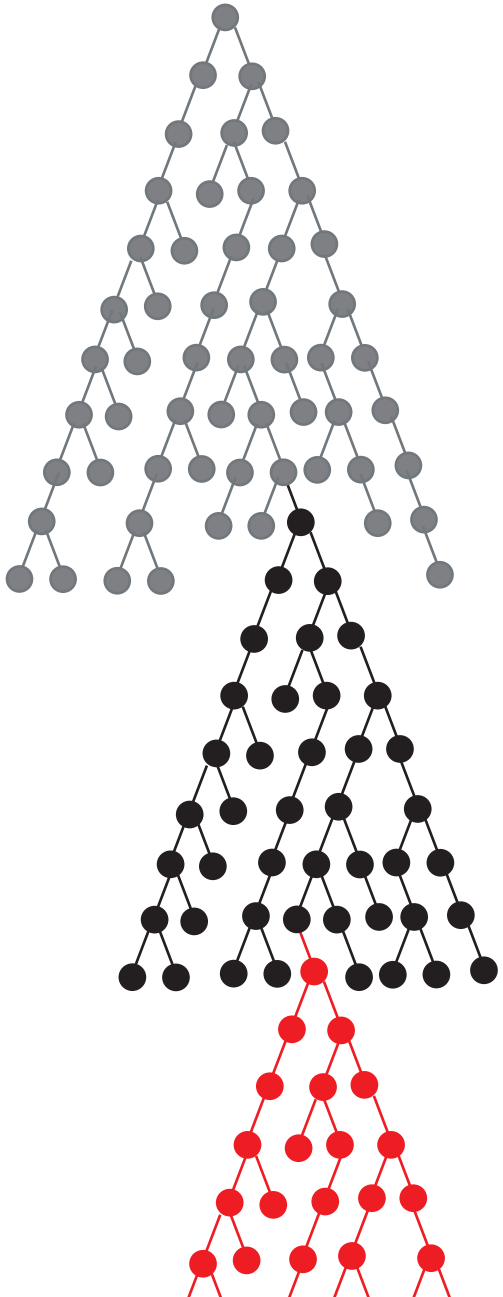
Warning: software often displays unrooted trees like this:



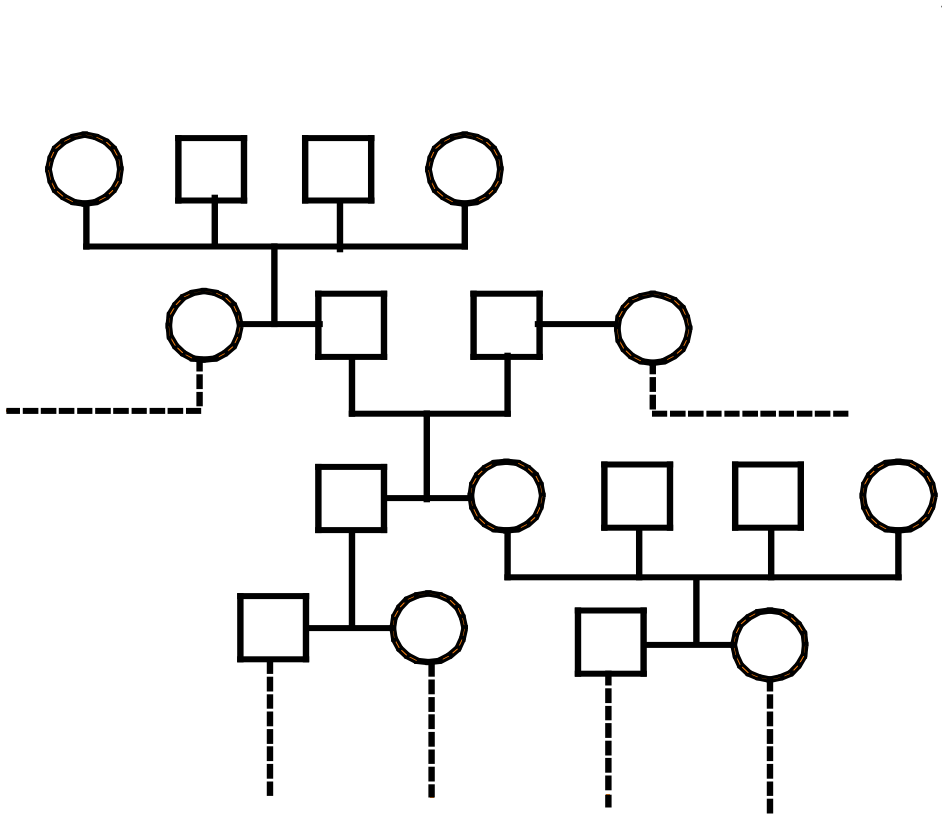
We use trees to represent genealogical relationships in several contexts.

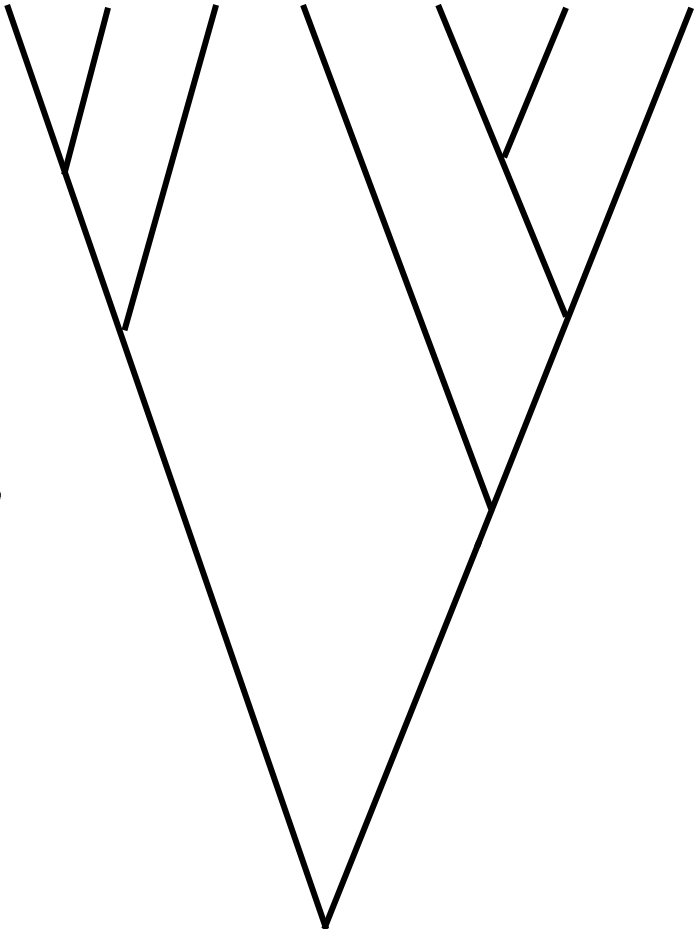
Domain	Sampling	tree	The cause of splitting
Pop. Gen.	> 1 indiv/sp. Few species	Gene tree	> 1 descendants of a single gene copy
Phylogenetics	Few indiv/sp. Many species	Phylogeny	speciation
Mol. Gen.	> 1 locus/sp. > 1 species	Gene tree. Gene family tree	speciation or duplication

Phylogenies are an inevitable result of molecular genetics

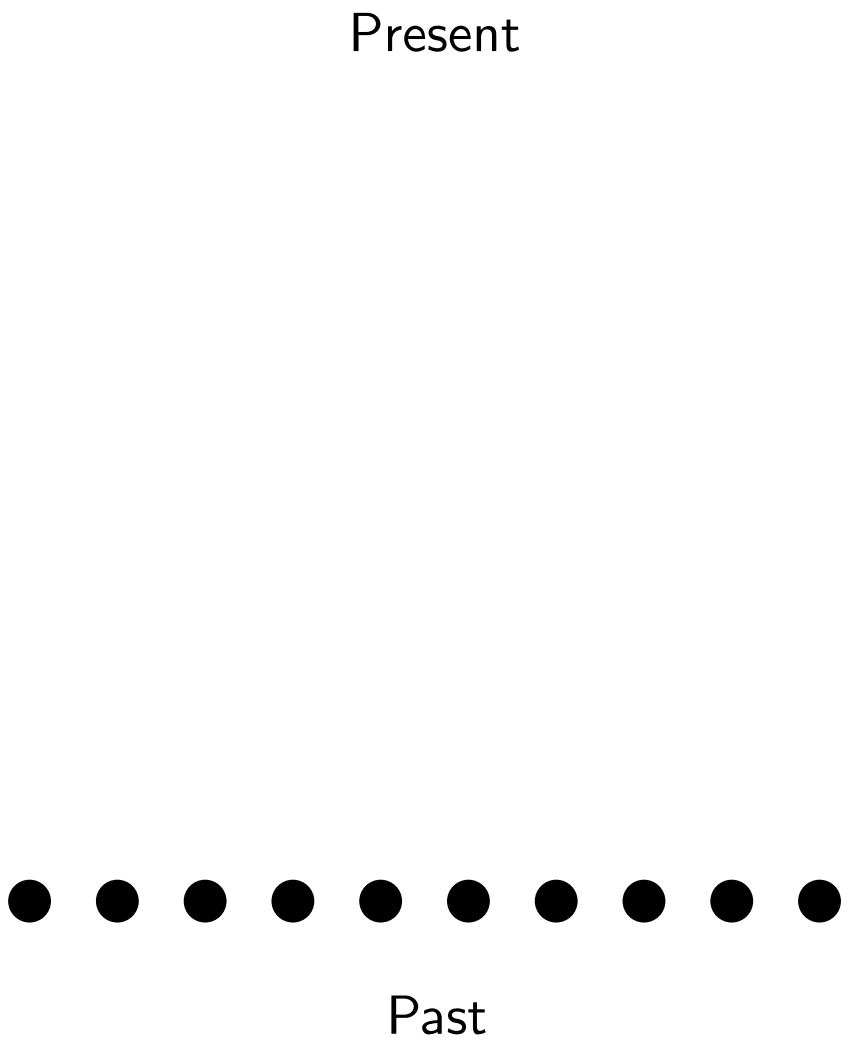


Two types of genealogies



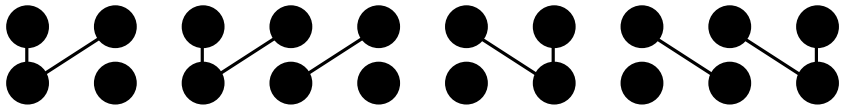


Genealogies within a population



Genealogies within a population

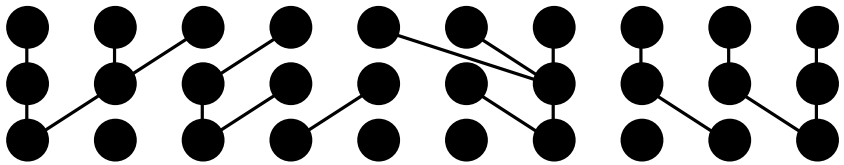
Present



Past

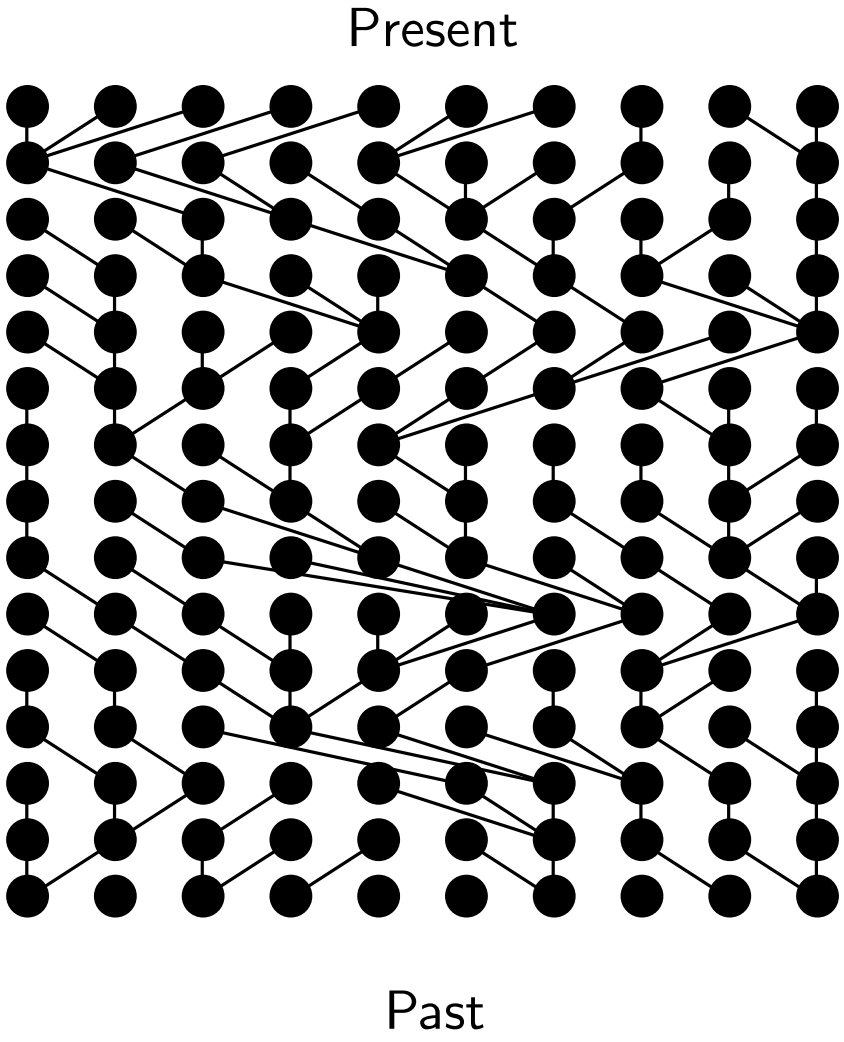
Genealogies within a population

Present

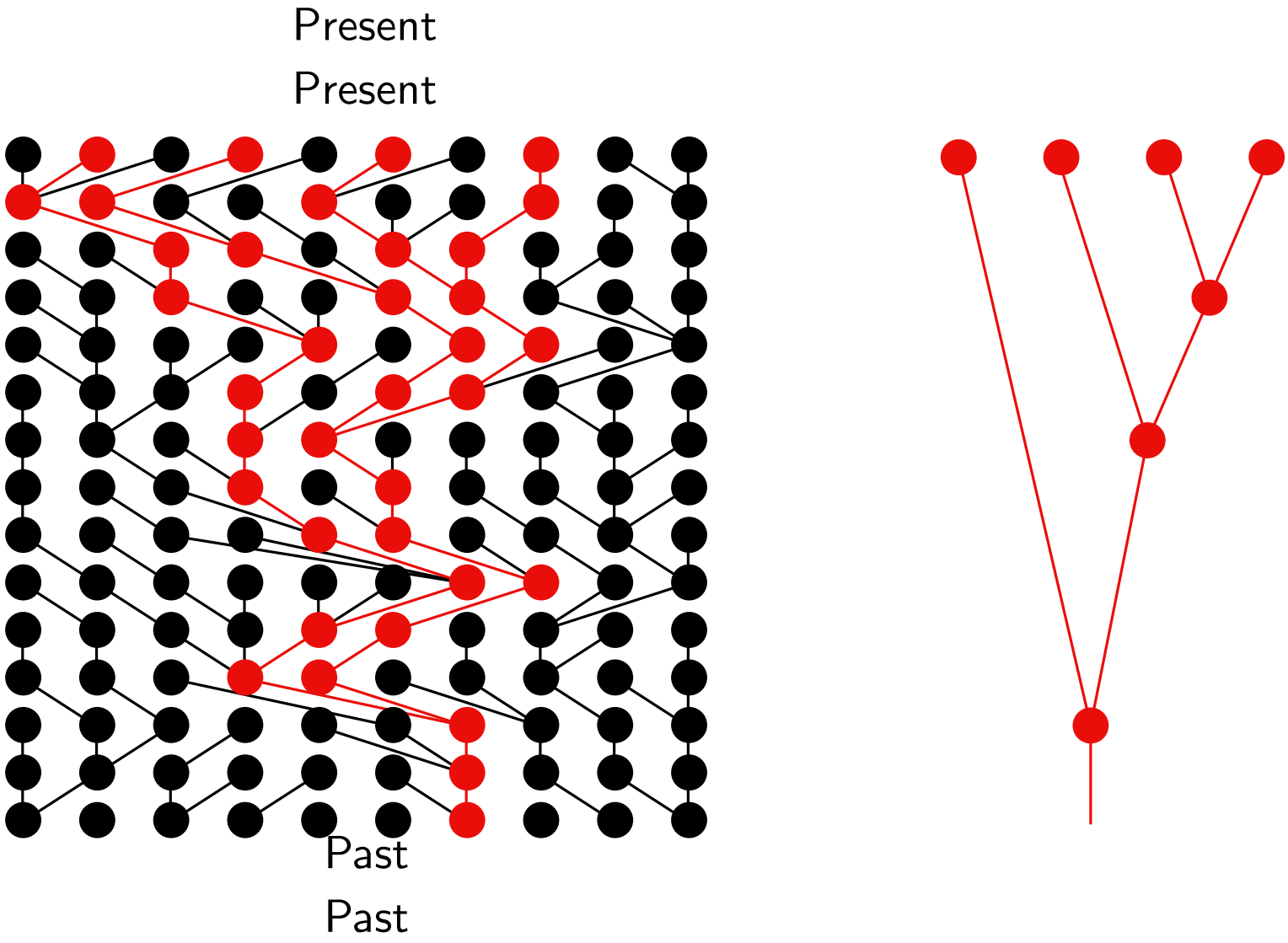


Past

Genealogies within a population



Genealogies within a population



Biparental inheritance would make the picture messier, but the genealogy of the gene copies would still form a tree (if there is no recombination).

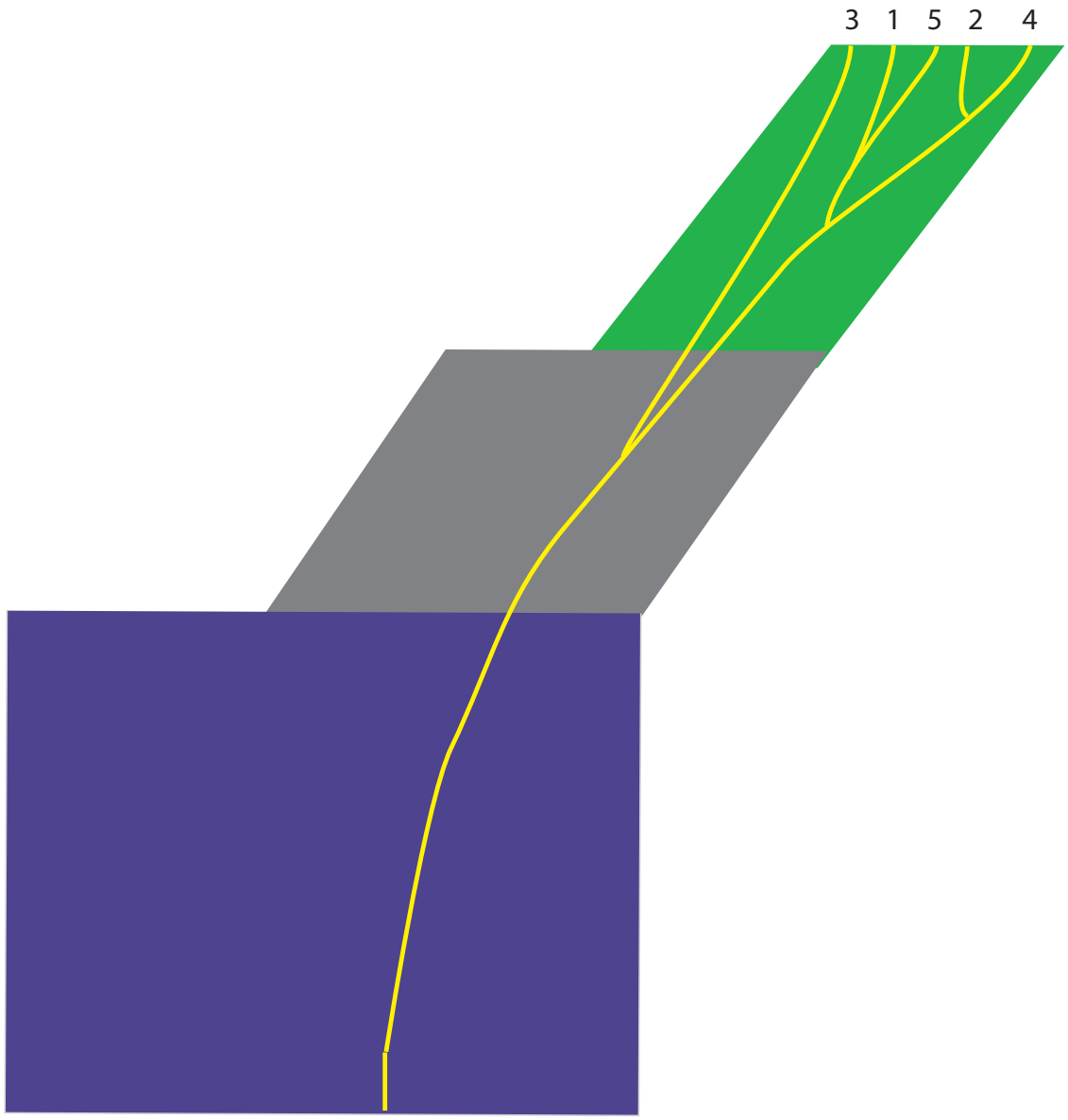
terminology: genealogical trees within population or species trees

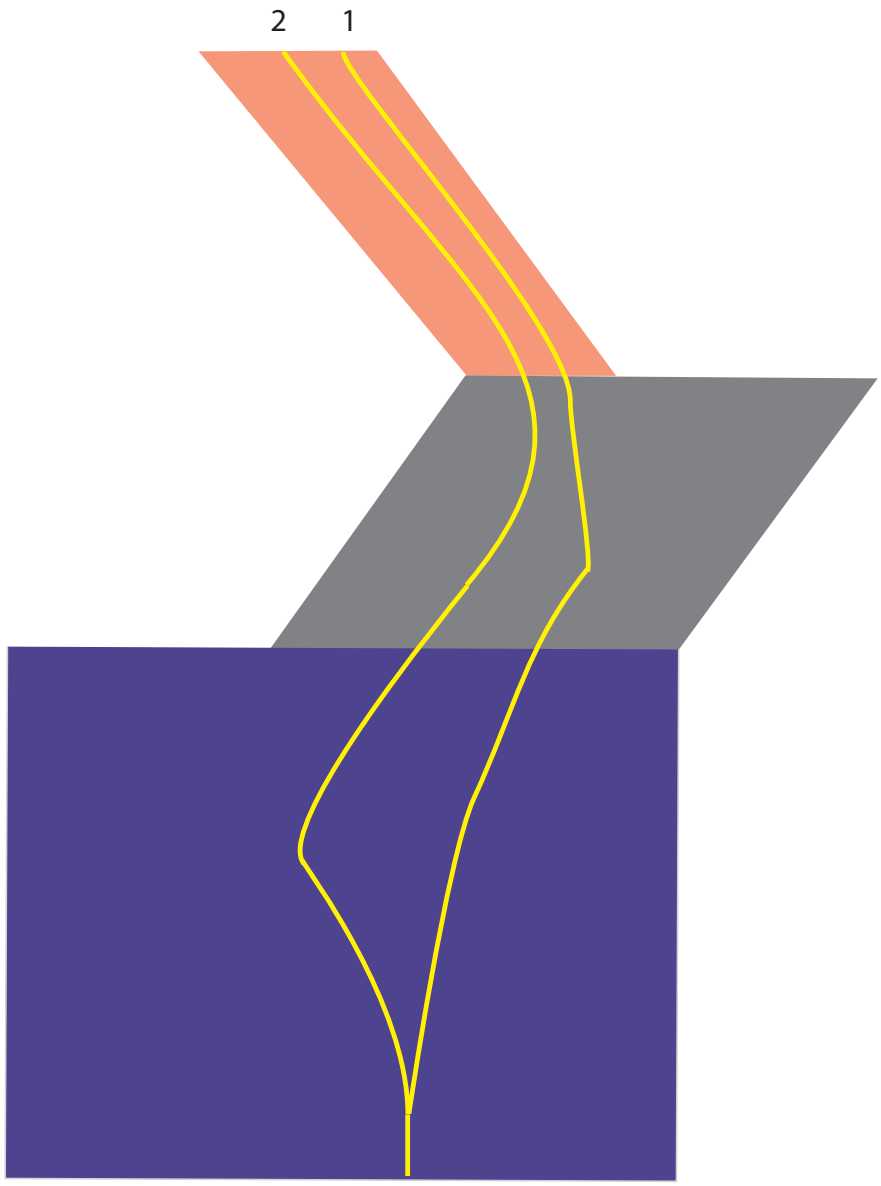
It is tempting to refer to the tips of these gene trees as alleles or haplotypes.

- allele – an alternative form a gene.
- haplotype – a linked set of alleles

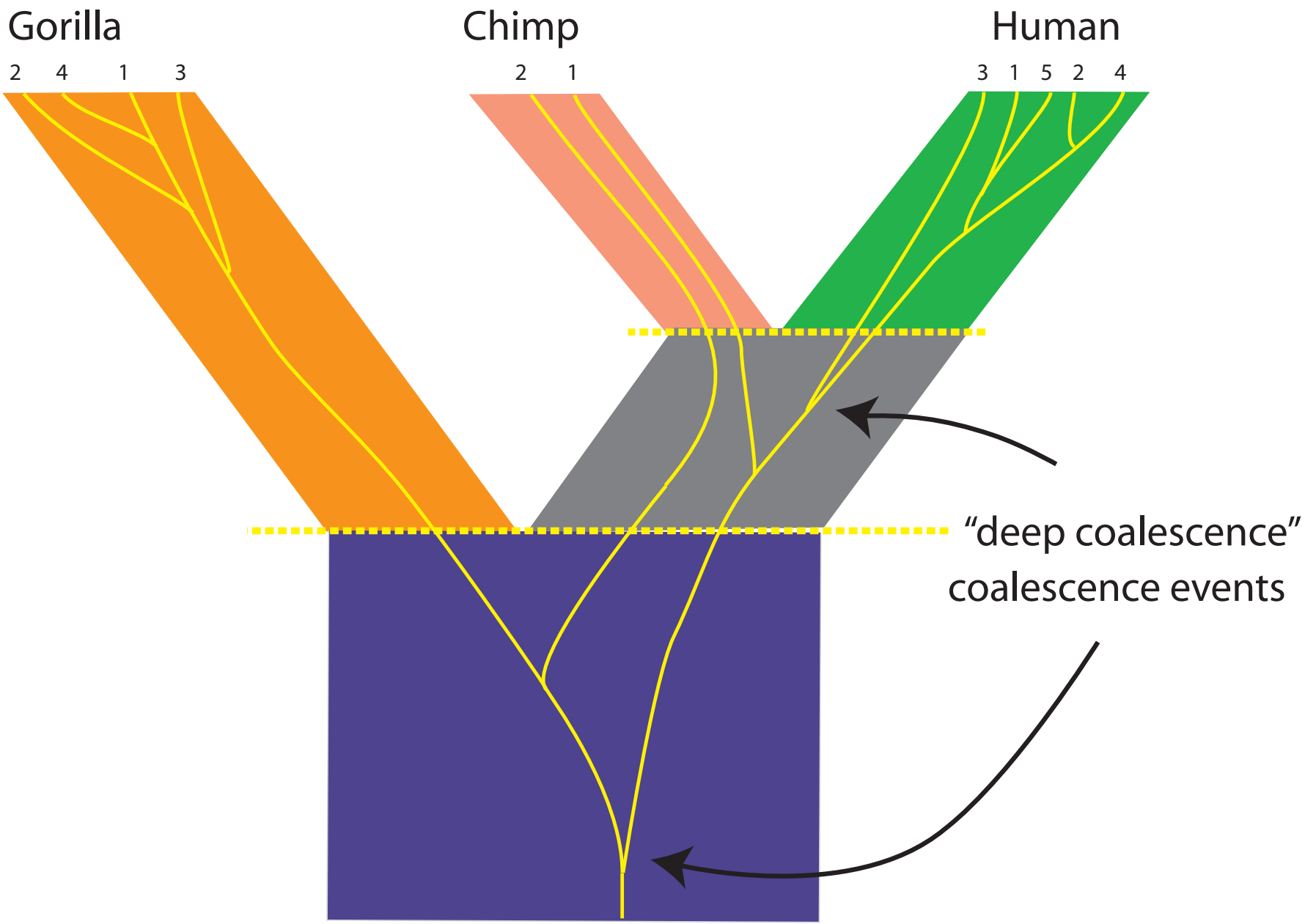
But both of these terms require a differences in sequence.

The gene trees that we draw depict genealogical relationships – regardless of whether or not nucleotide differences distinguish the "gene copies" at the tips of the tree.


3 1 5 2 4


2
1

A “gene tree” within a species tree



terminology: genealogical trees within population or species trees

- coalescence – merging of the genealogy of multiple gene copies into their common ancestor. "Merging" only makes sense when viewed *backwards in time*.

- "deep coalescence" or "incomplete lineage sorting" refer to the *failure* of gene copies to coalesce within the duration of the species – the lineages coalesce in an ancestral species

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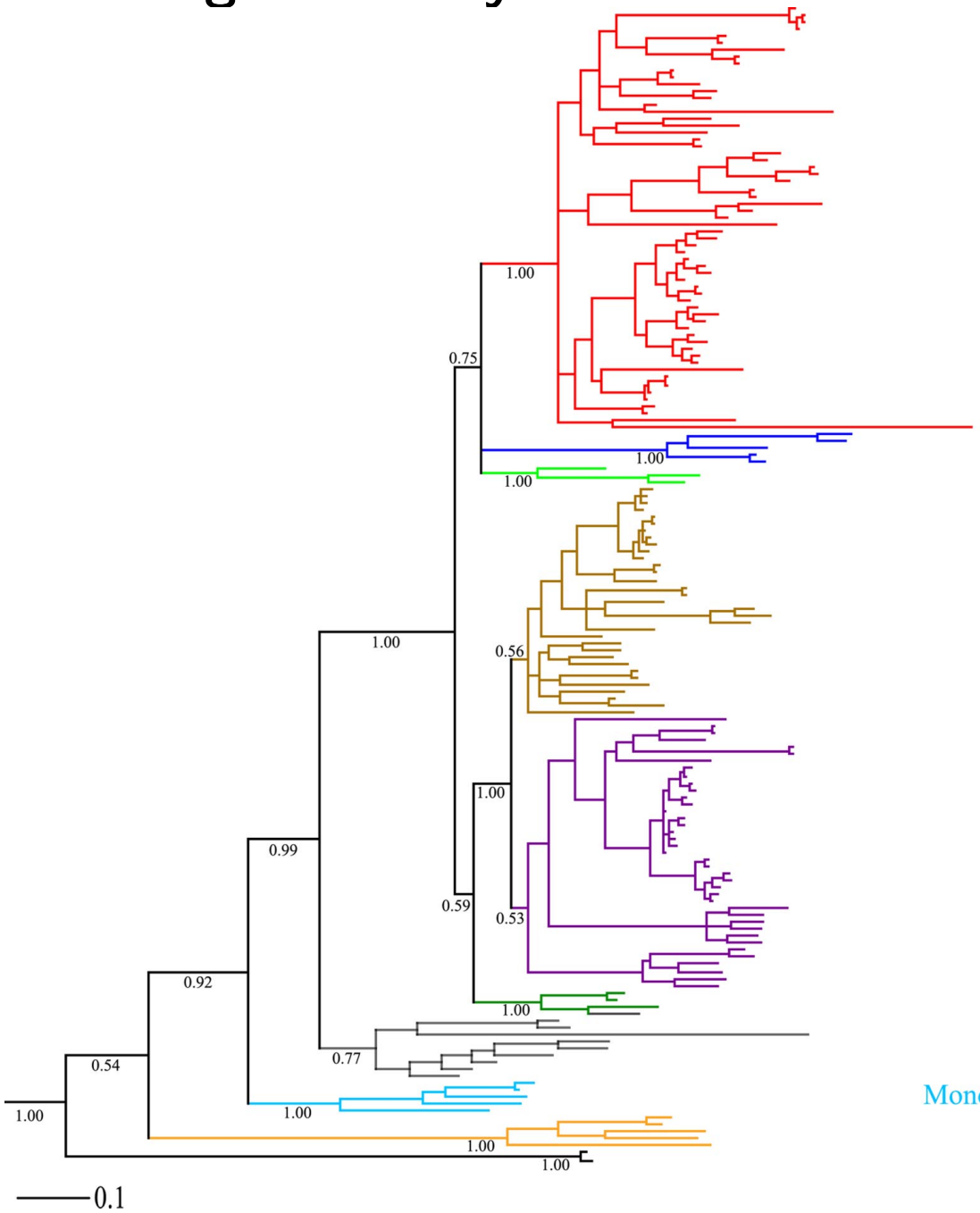
A "gene family tree"



Eutherian β-δ globin

Marsupial β-globin

Monotreme ε^P-β^Pglobin

Eutherian ε-globin

Eutherian γ-globin

Marsupial ε-globin

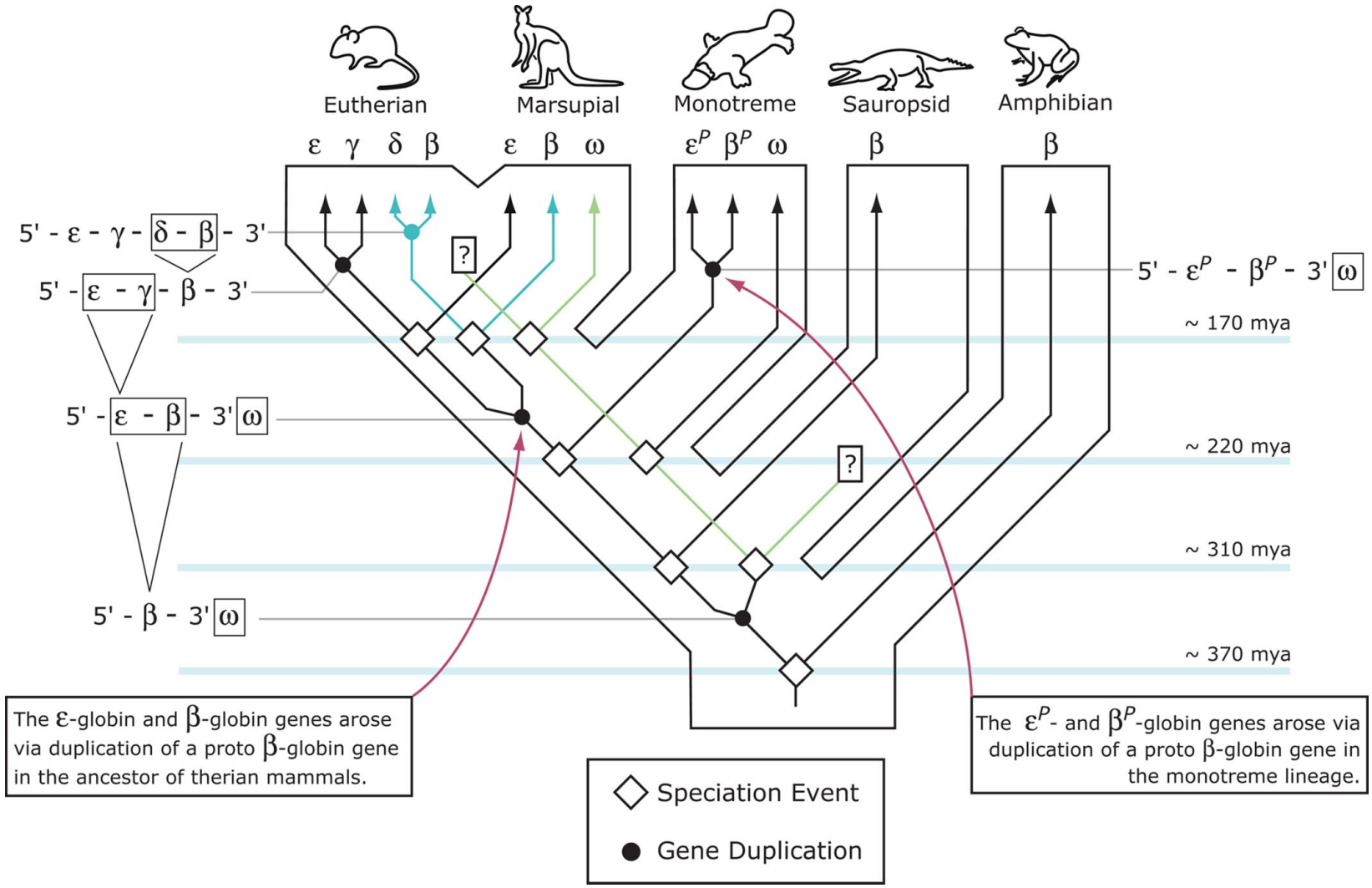
Sauropsida β-like globins

Monotreme and marsupial ω-globin

Amphibian β-like globins

Fish β-like globins

Opazo, Hoffmann and Storz "Genomic evidence for independent origins of β-like globin genes in monotremes and therian mammals" PNAS **105(5)** 2008



Opazo, Hoffmann and Storz "Genomic evidence for independent origins of β-like globin genes in monotremes and therian mammals" PNAS **105(5)** 2008

terminology: trees of gene families

- duplication – the creation of a new copy of a gene within the same genome.
- homologous – descended from a common ancestor.
- paralogous – homologous, but resulting from a gene duplication in the common ancestor.
- orthologous – homologous, and resulting from a speciation event at the common ancestor.

Multiple contexts for tree estimation (again):

	The cause of splitting	**Important caveats**
"Gene tree"	DNA replication	recombination is usually ignored
Species tree Phylogeny	speciation	recombination, hybridization, and deep coalescence cause conflict in the data we use to estimate phylogenies
Gene family tree	speciation or duplication	recombination (eg. domain swapping) is not tree-like