THE UNIVERSITY OF MAINE

Learning from Trees (BIO 597)

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Think about your project

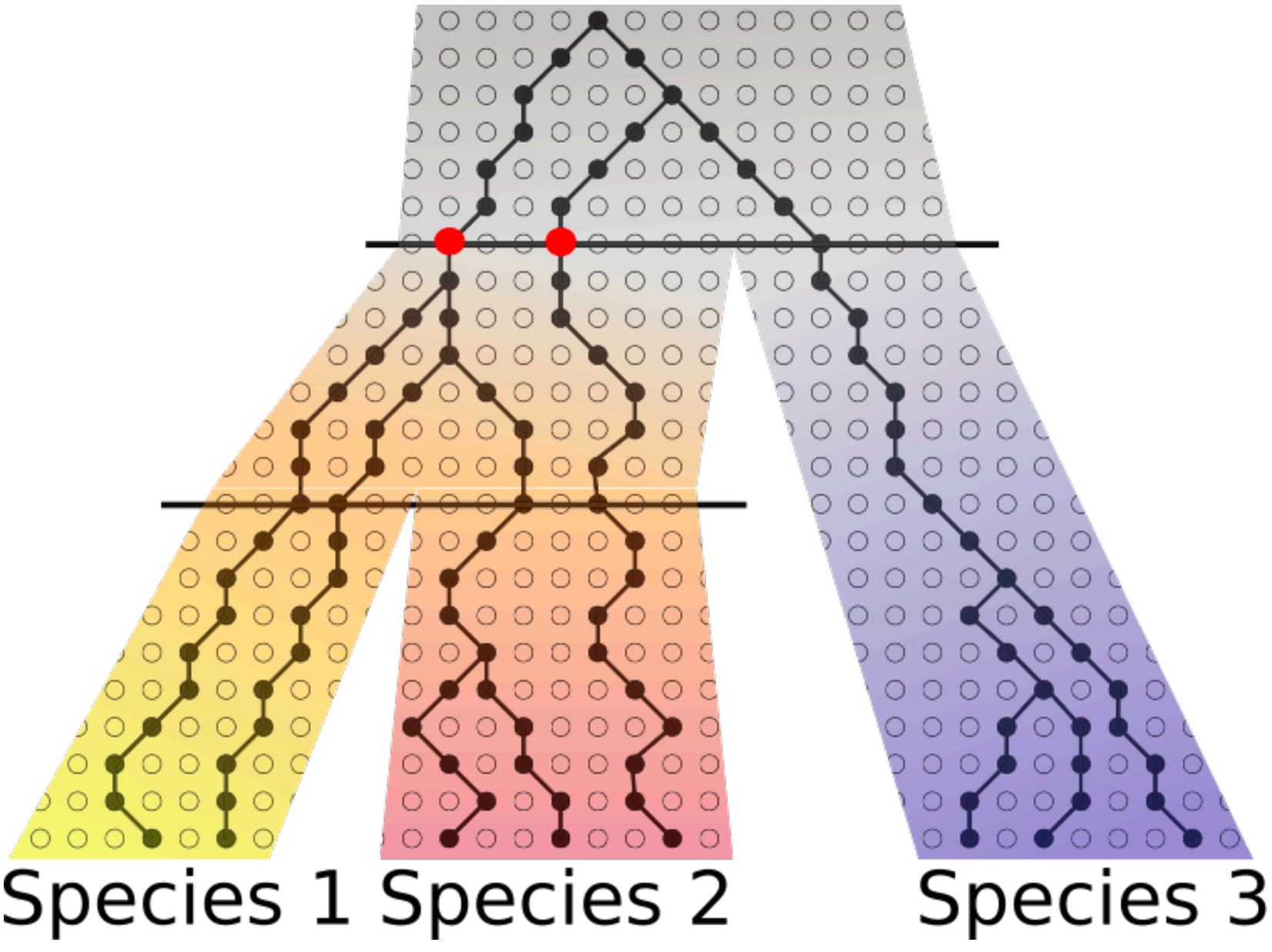
1. **Types of questions you're interested in (or tackling for your thesis)**

2. **Think about data availability. <u>Especially</u> important for ecological / morphological**

3. **I'd love to sit down for a coffee and brainstorm**

4. **But please, touch base with your advisor if you plan on using the project as a thesis chapter**

Phylogenies describe evolutionary history



Phylogenies describe evolutionary history

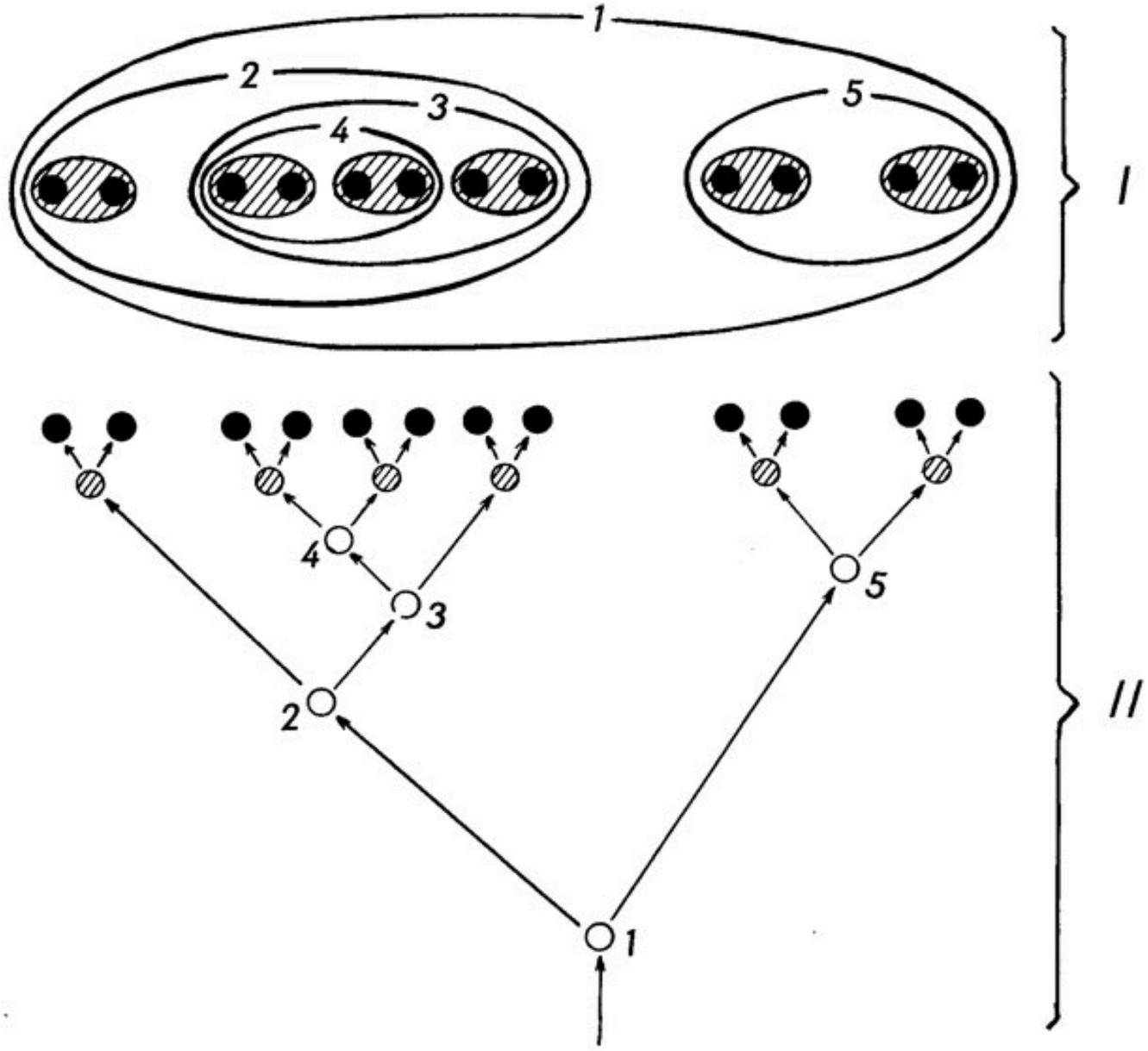
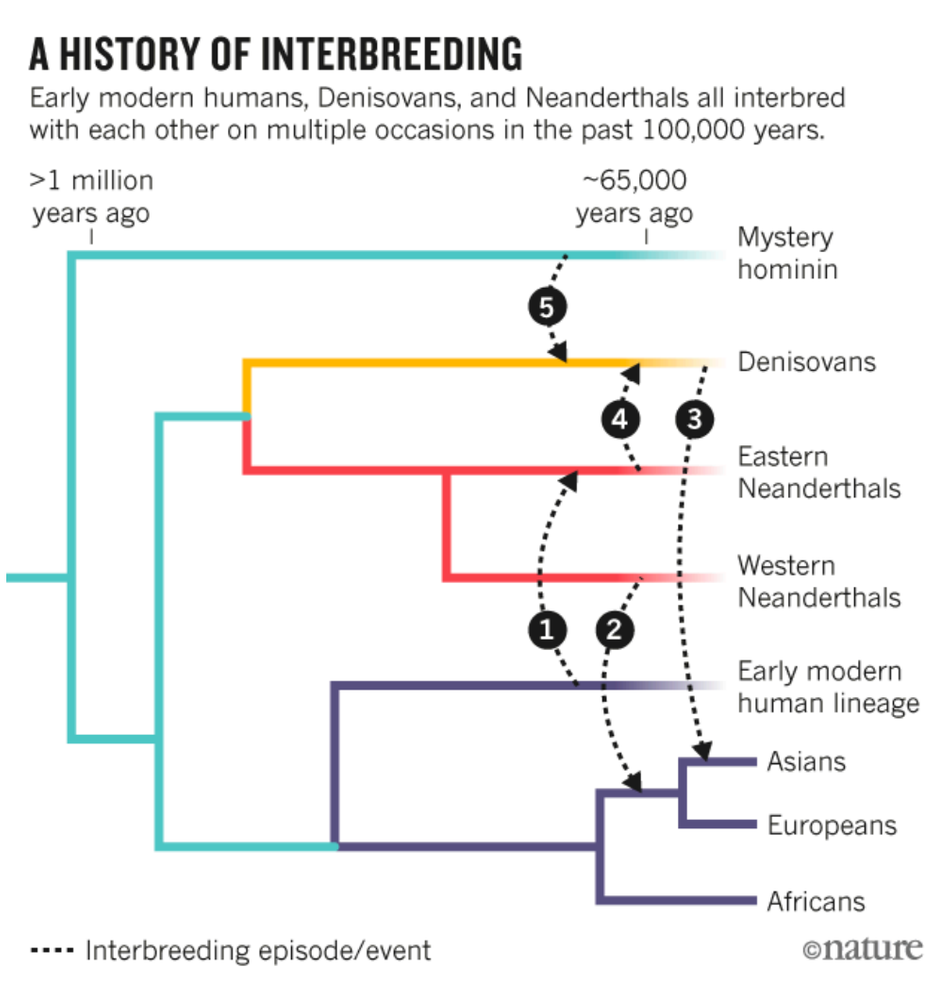


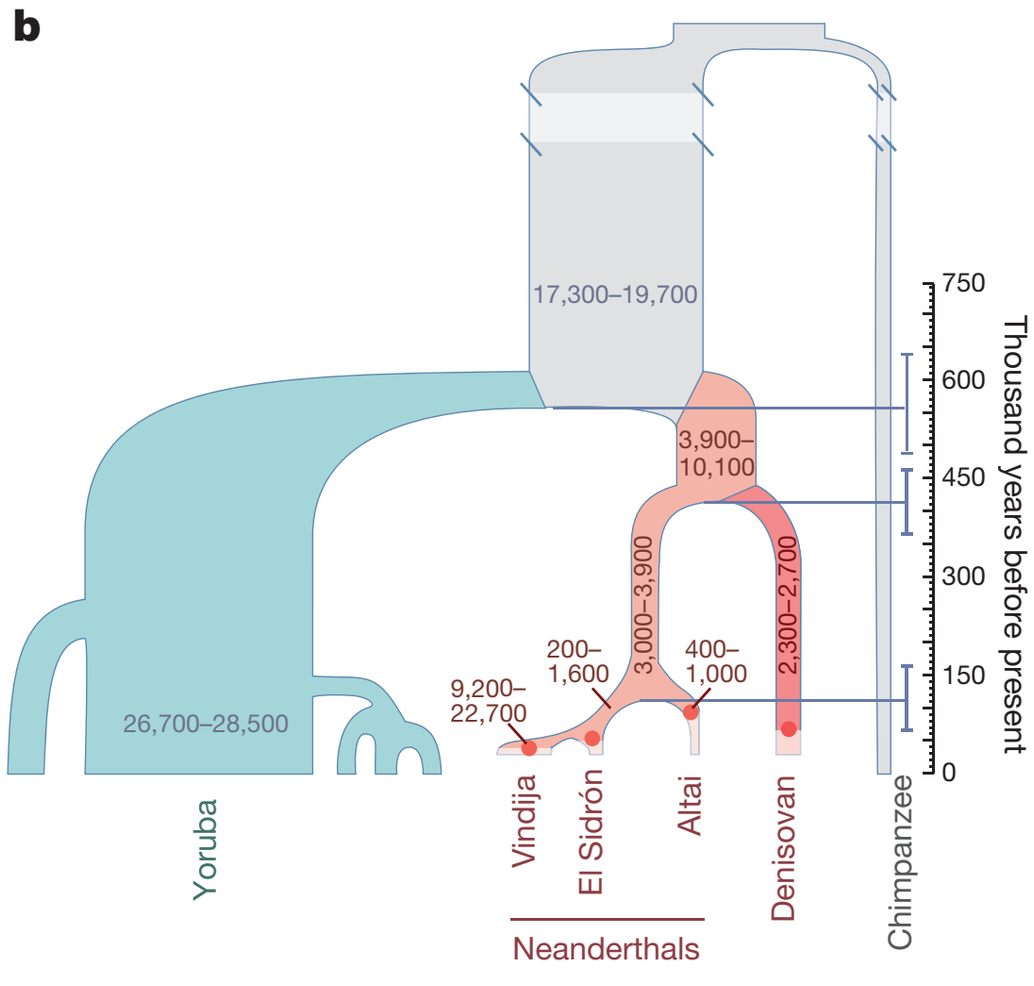
Figure 18. The phylogenetic kinship relations between the species of a monophyletic group, represented in two different ways.

Stick trees **miss** a lot of biology!

Hybridization and introgression



Demography

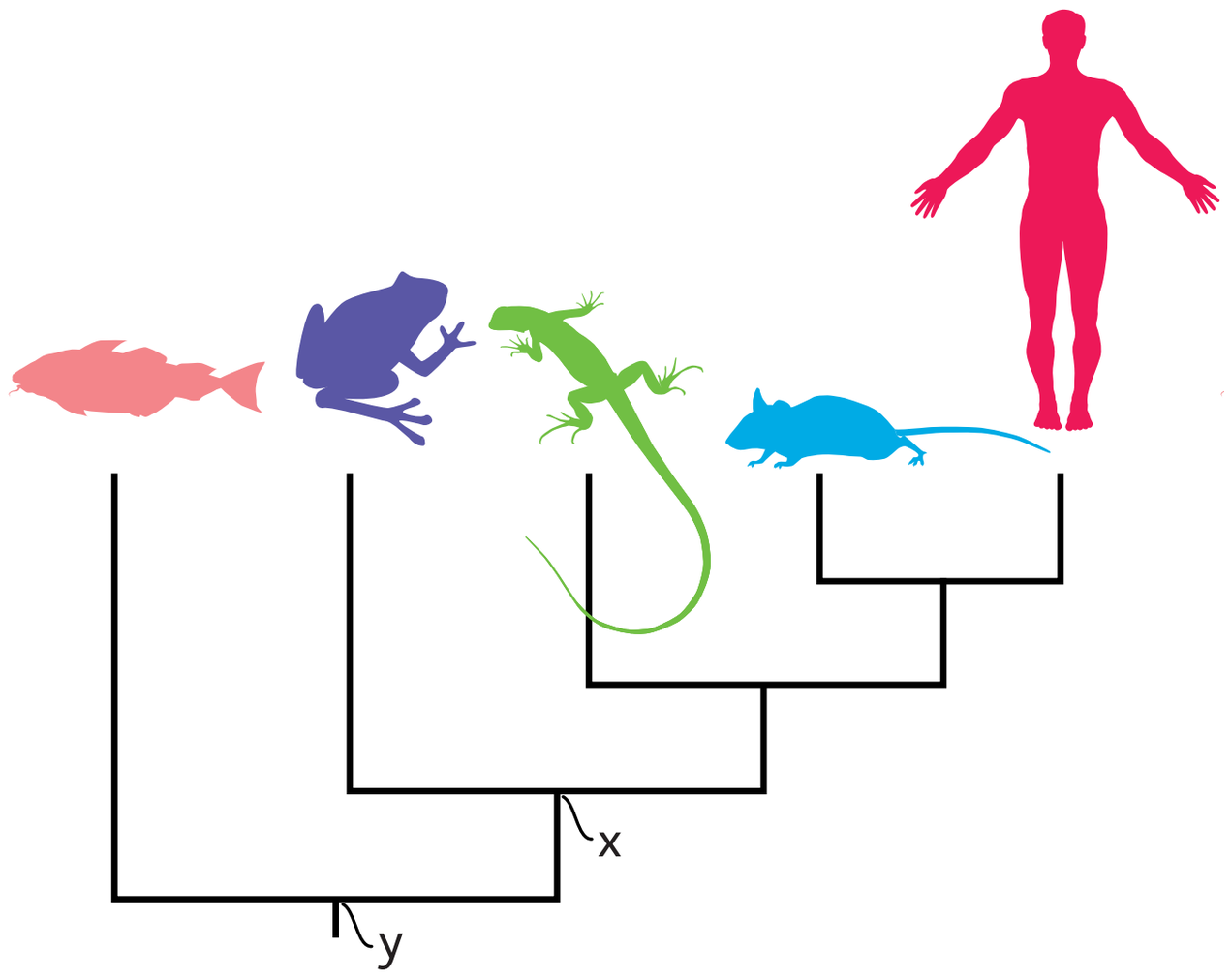


Kuhlwilm et al. 2016. Nature

Reading & Describing Trees

Trees

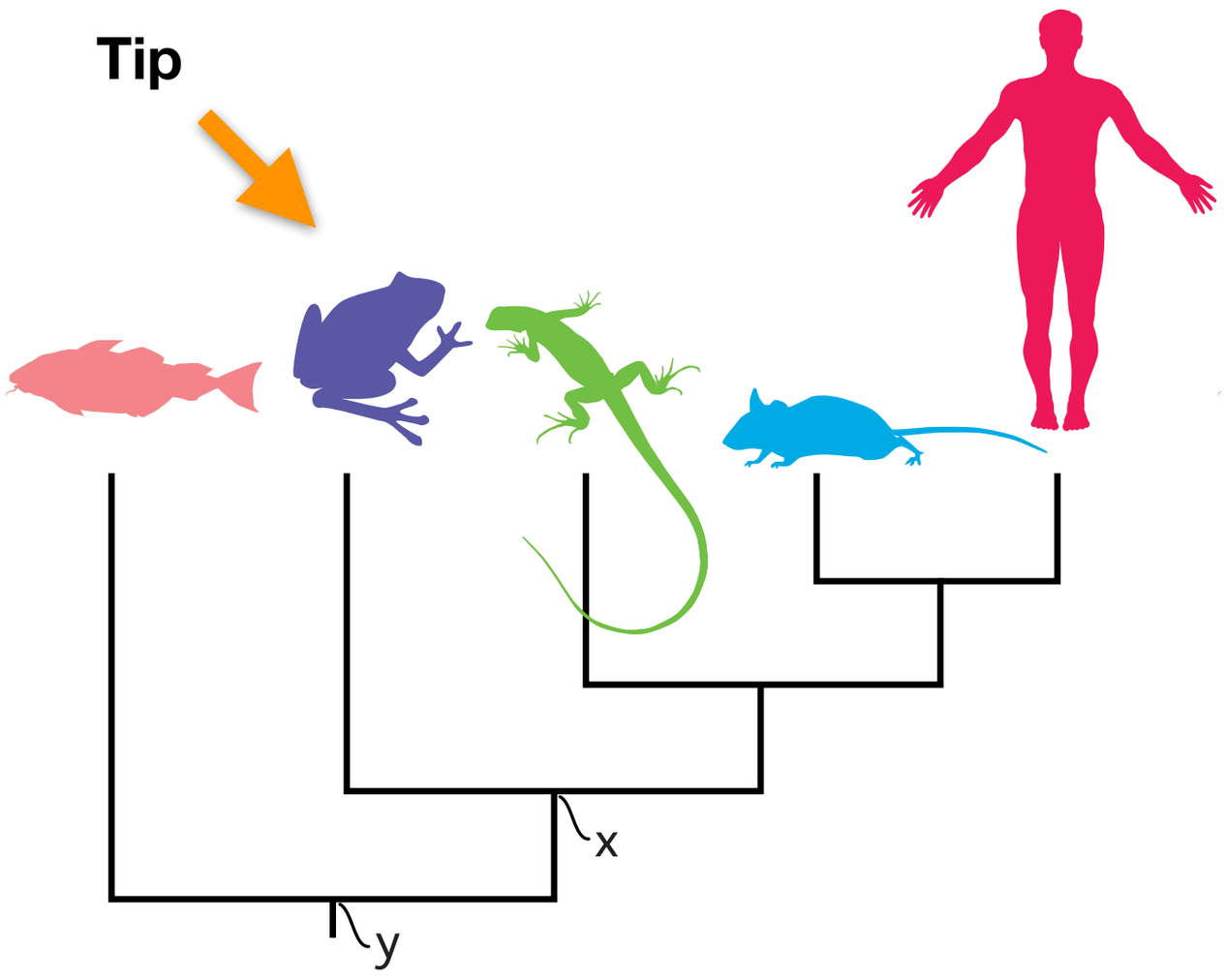
- Common names
  - Phylogeny
  - Cladogram (meaningless branch lengths)
  - Phylogram (meaningful branch lengths)
- Properties:
  - Topology (structure)
  - Usually have a length (when branch lengths are meaningful)



Baum et al. 2005. Science

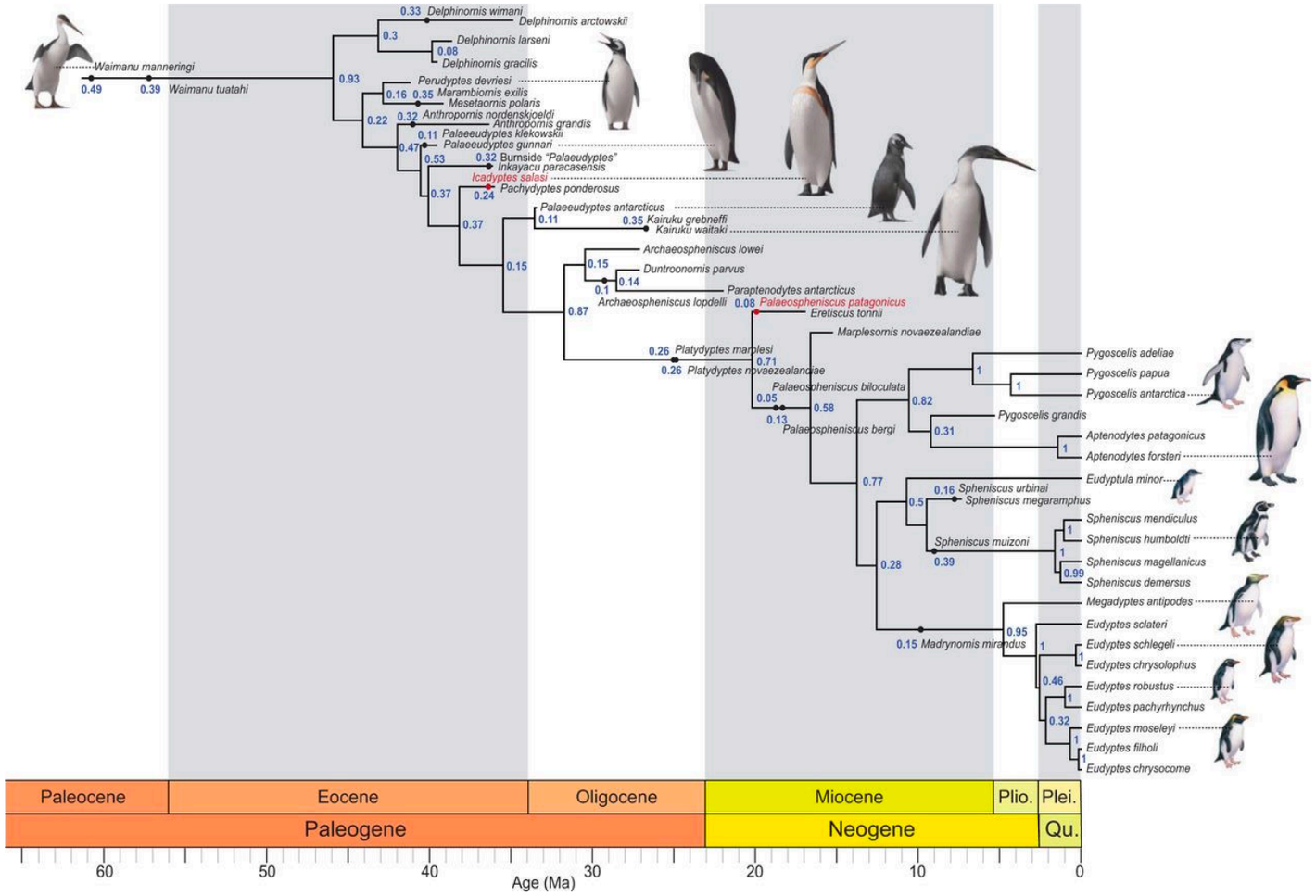
Tips

- Alternative names
  - Terminal
  - Terminal node
  - Leaf
  - Taxon
- Are nodes of *degree 1*
- Do not have to be extant

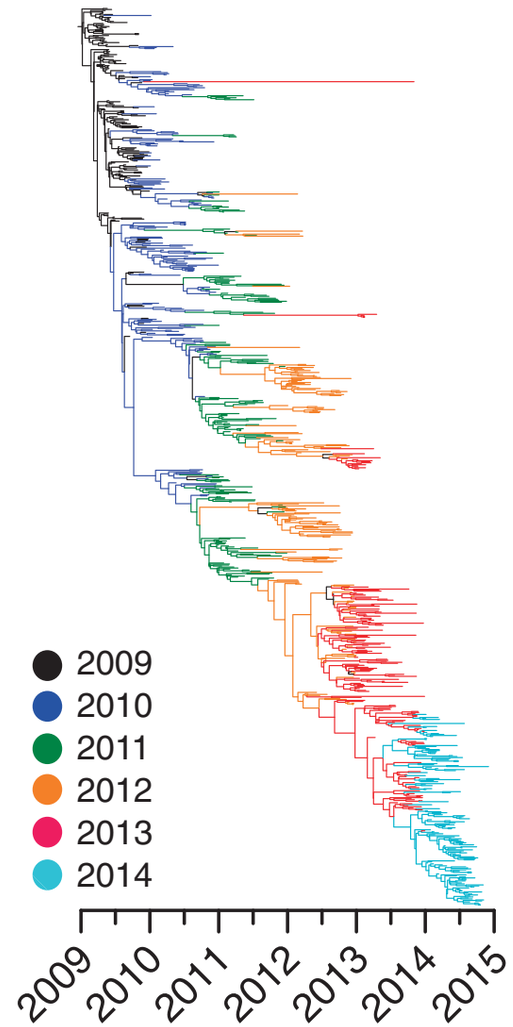


Baum et al. 2005. Science

Tips can be **fossils** or **viruses** sampled over time



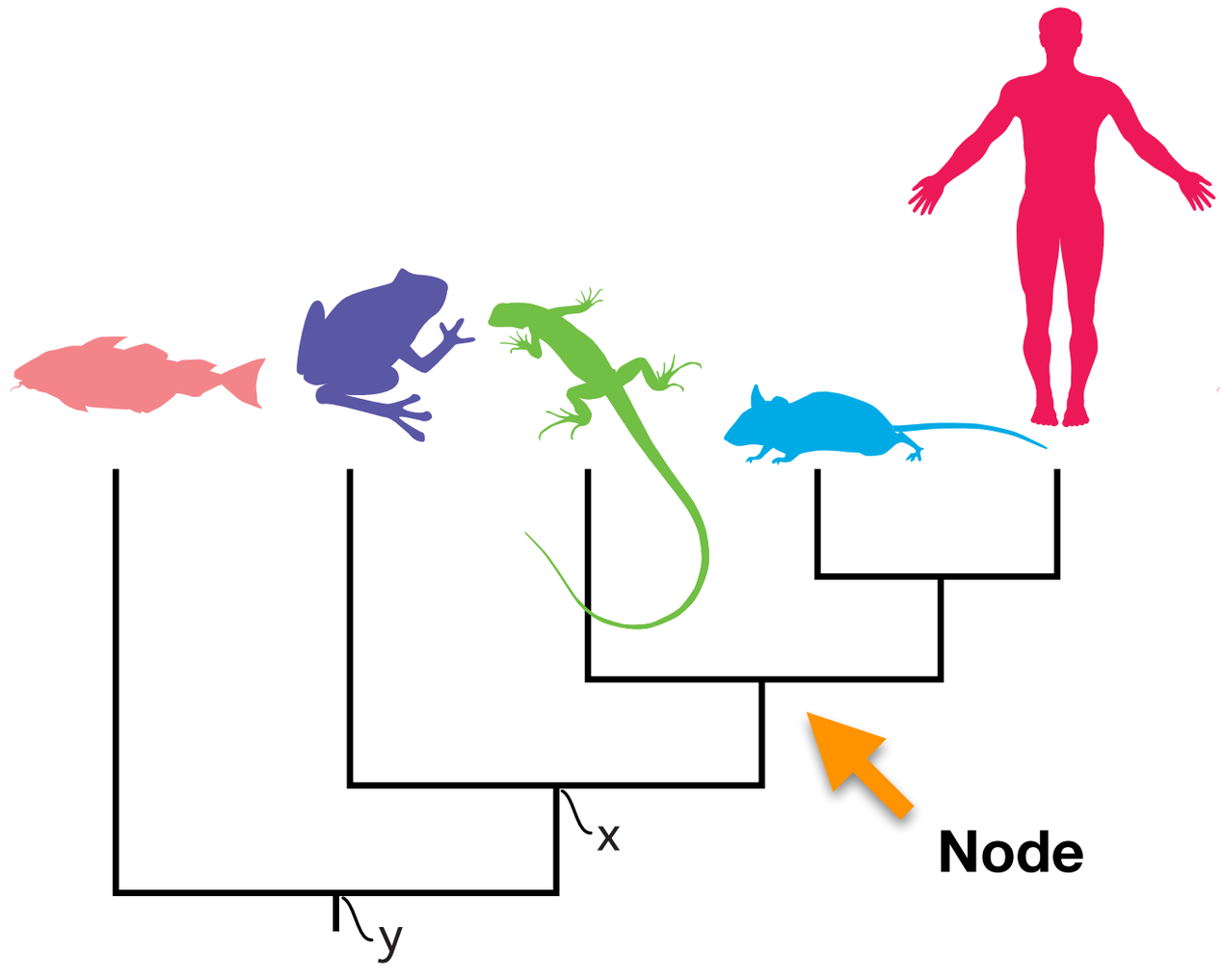
Gavryushkina et al. 2017. Systematic Biology



Su et al. 2015. Nature Comm.

Internal Nodes

- Alternative names
  - Ancestor
  - Node (sloppy shortcut)
- Are vertices of *degree > 3*
- Represent
  - Ancestor species
  - Speciation event
- Have **descendants**, that are either tips or other internal nodes



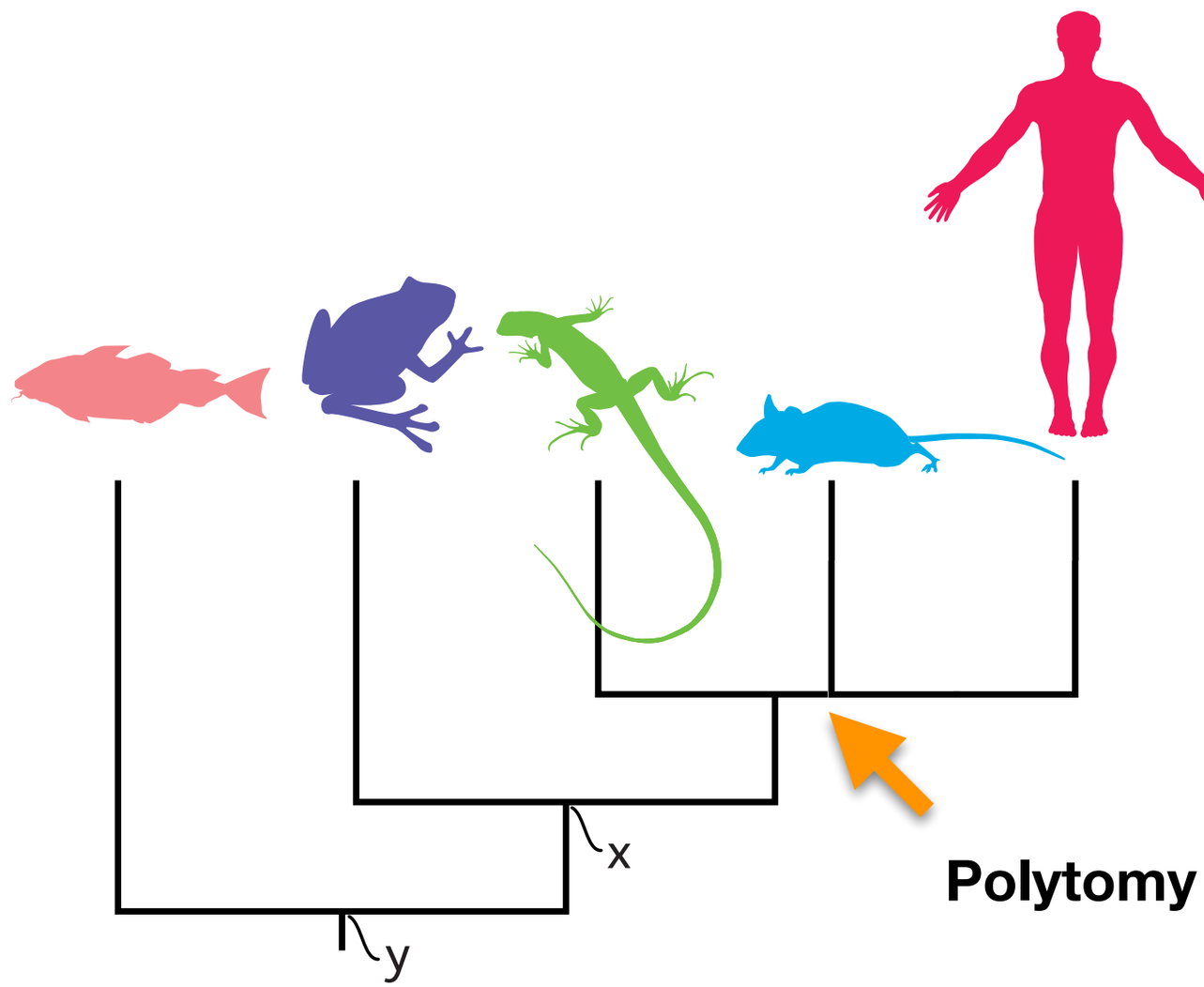
Baum et al. 2005. Science

Dichotomy vs Polytomy

- We always assume ancestors only have two descendants. **True tree is dichotomous**

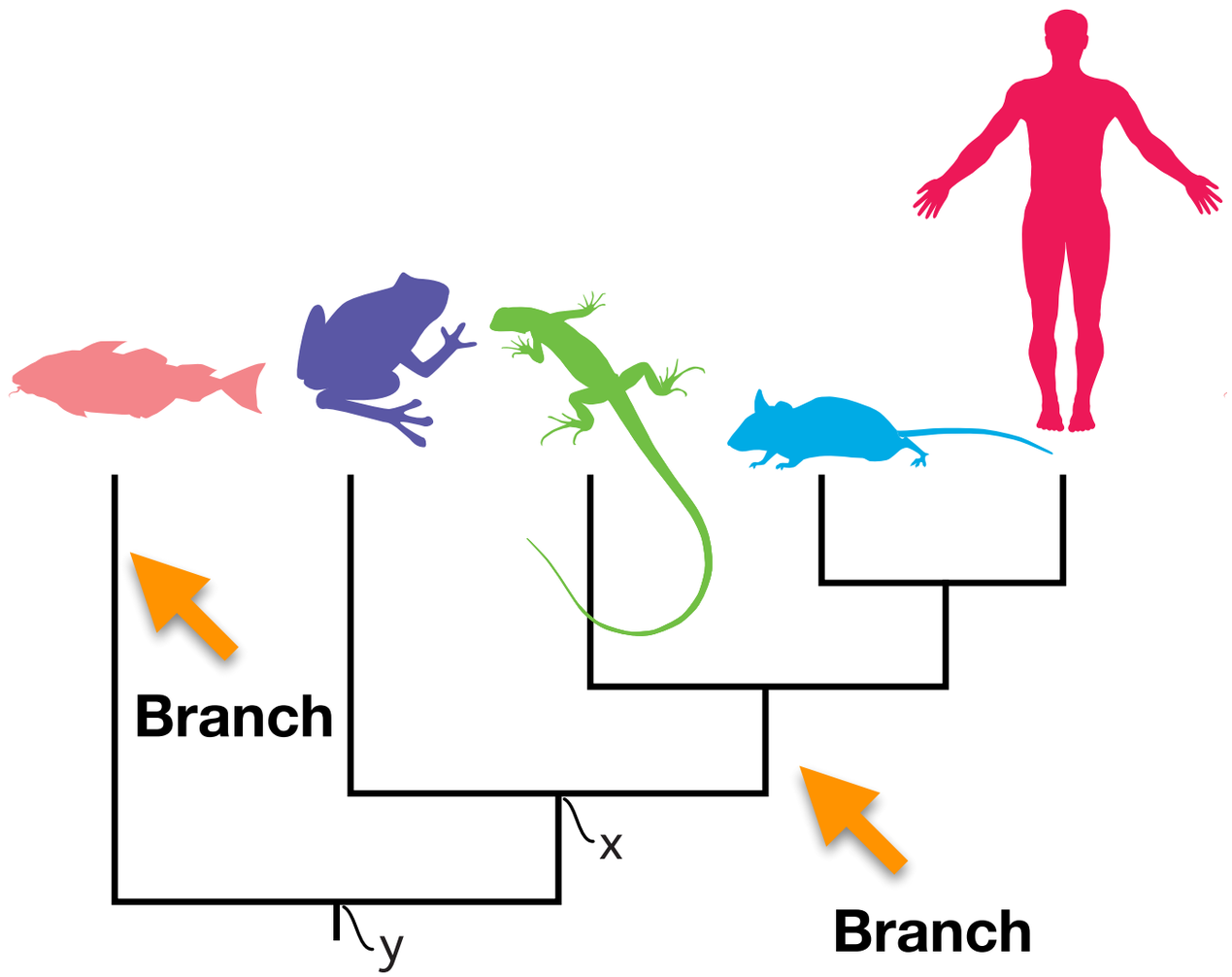
- But we may depict an ancestor having three direct descendants (**polytomy**).

- Polytomy represents **uncertainty** about the relationship



Branches

- Alternative names
  - Edges
- Connect nodes
- Define relationships
- Can have lengths depicting
  - Degree of divergence in molecular or morphological characteristics
  - Time, in generations, millions of years, etc.

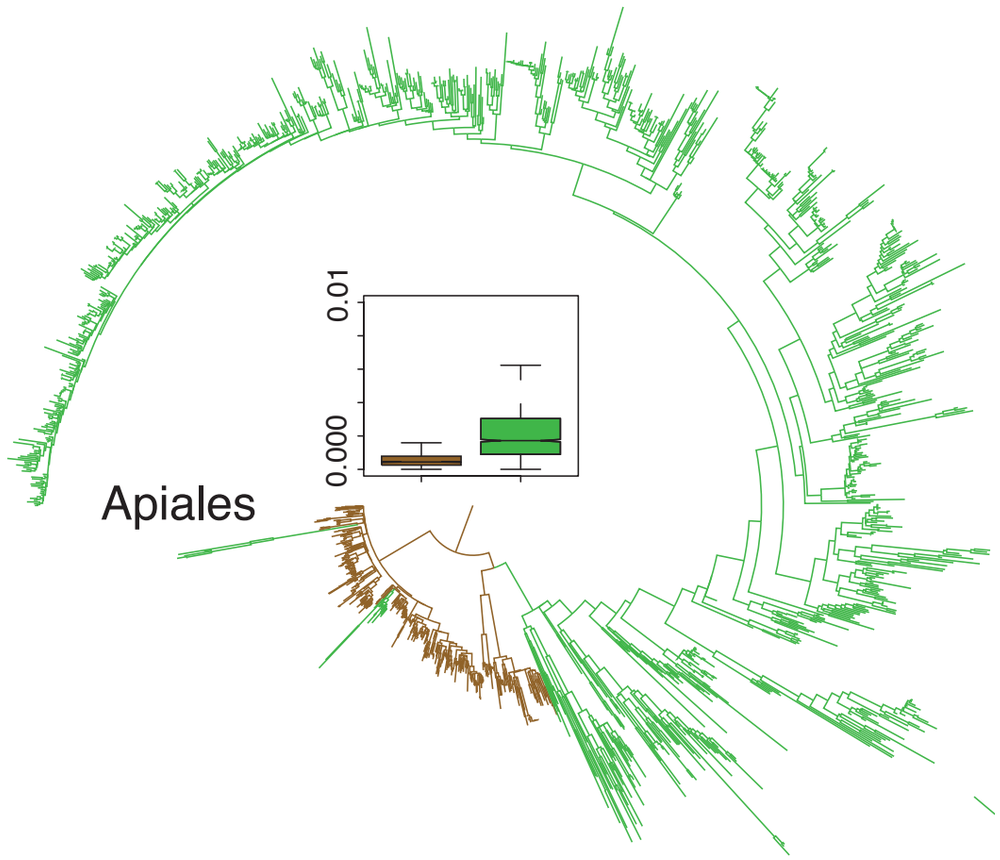


Baum et al. 2005. Science

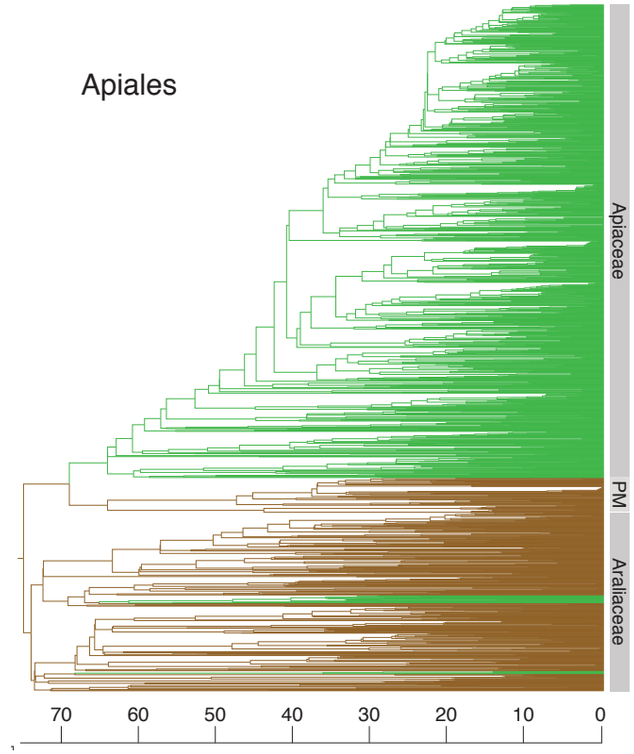
Branch lengths as ***mutations per site***

- Estimated from the molecular data and evolutionary model

Molecular divergence tree



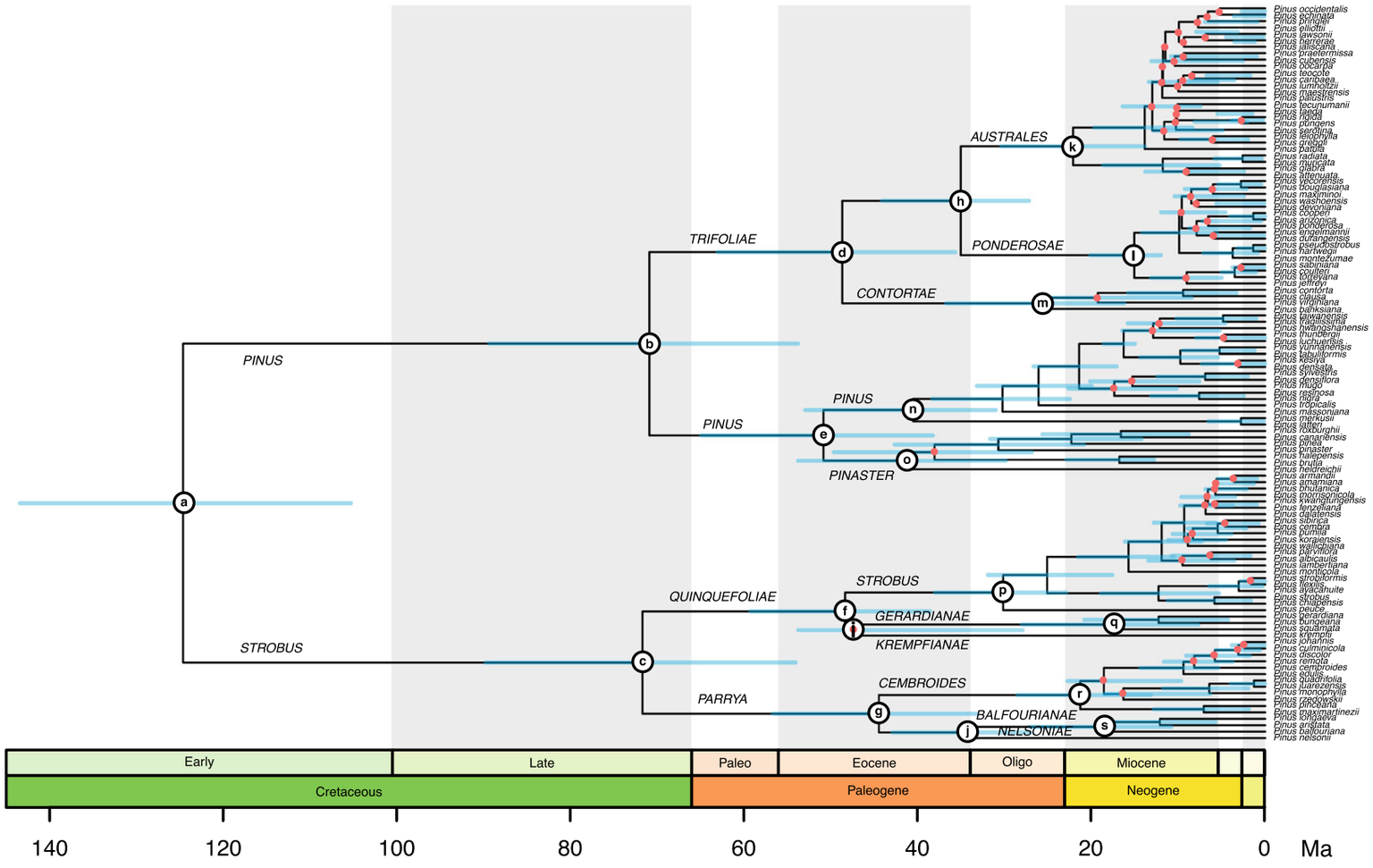
Time tree



Smith and Donoghue 2008. Science

Branch lengths as **time**

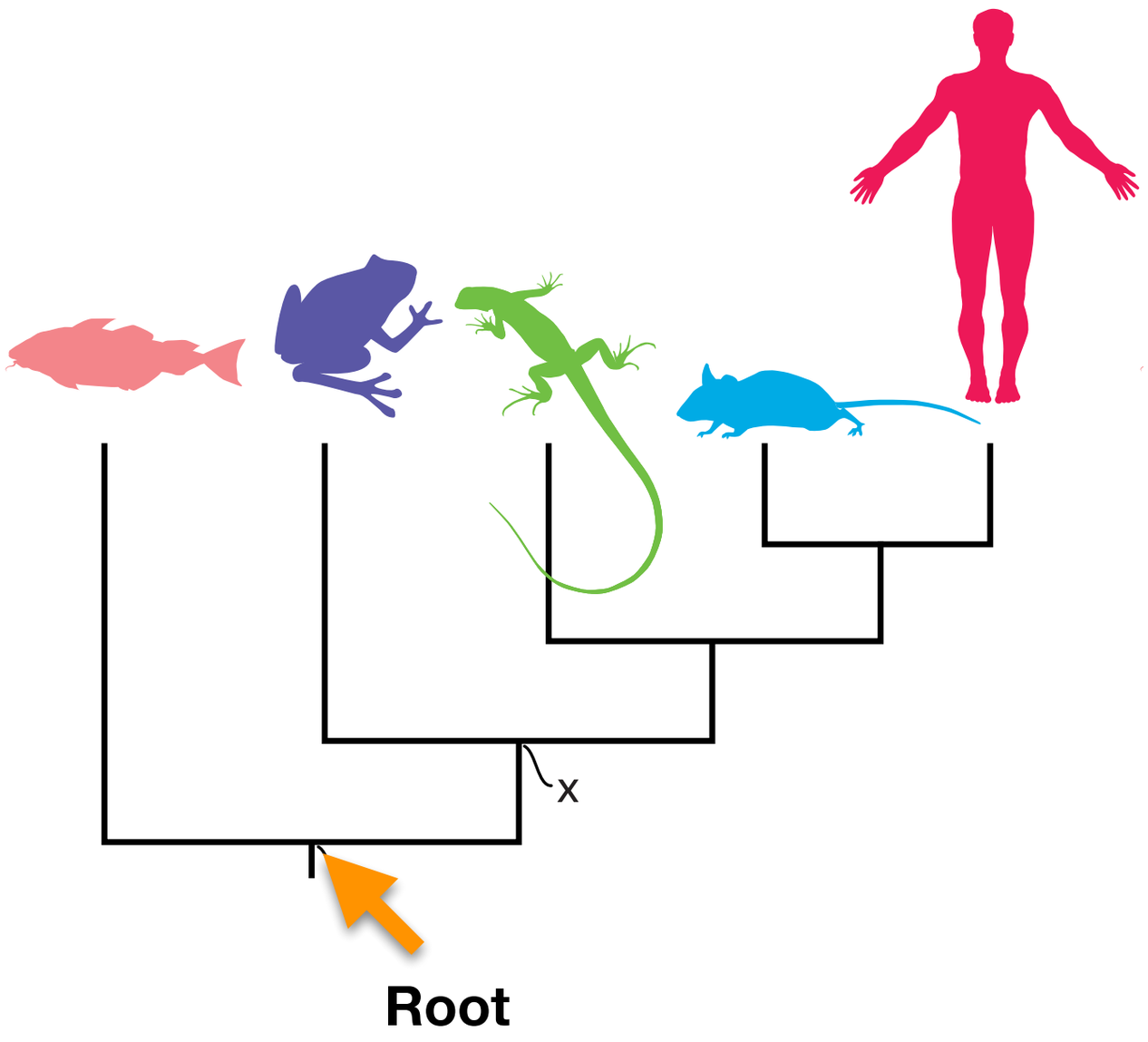
- Calibrated using a molecular clock
- Node age uncertainty shown as blue bars



Saladin et al. 2017. BMC Evolutionary Biology

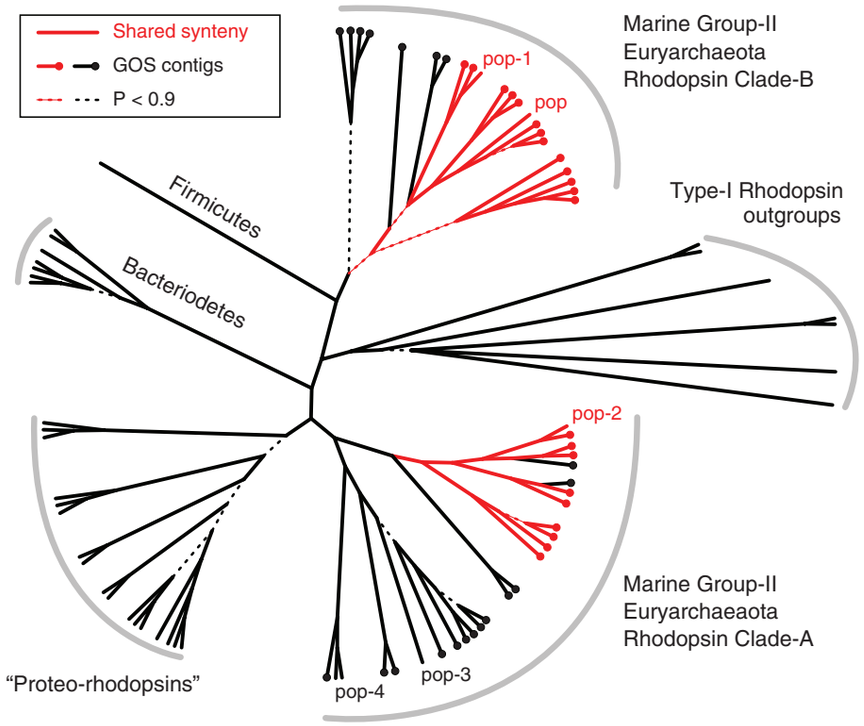
Root

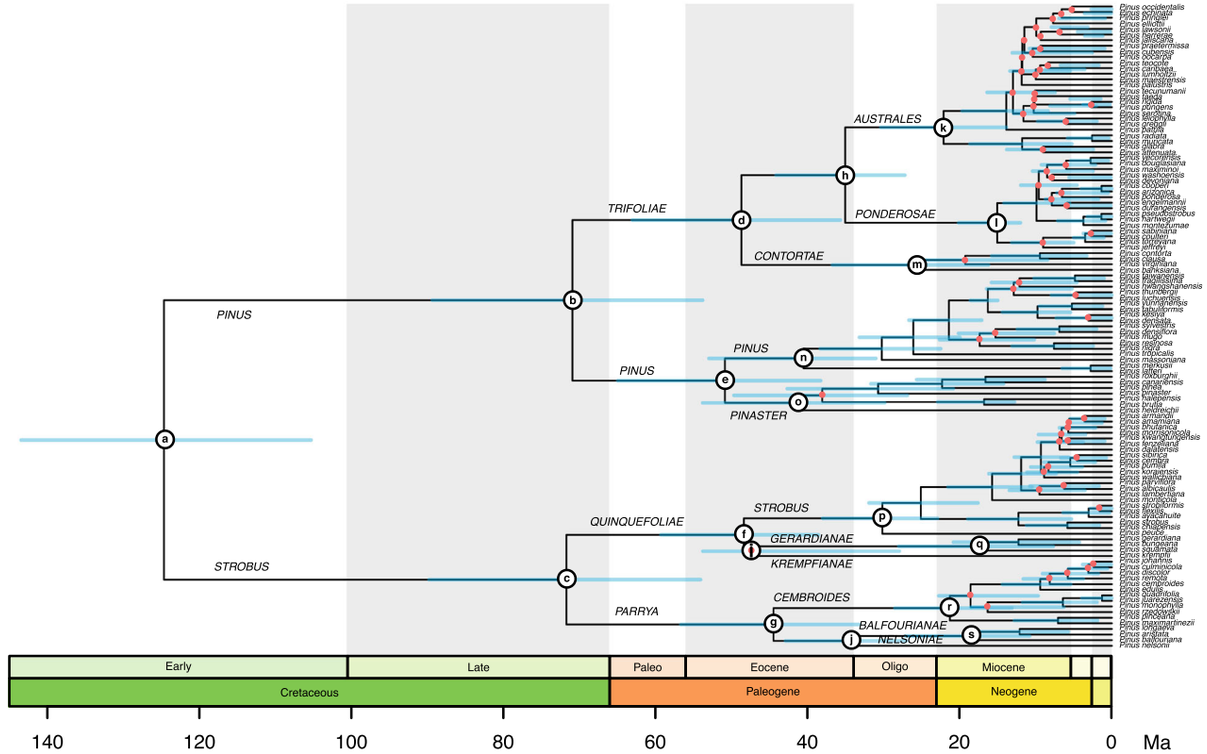
- Alternative names
  - Most recent common ancestor
- Is a vertex of *degree 2*
- Represents the ancestor of all taxa at hand
- The link point between our tree to the rest of the tree of life.



Baum et al. 2005. Science

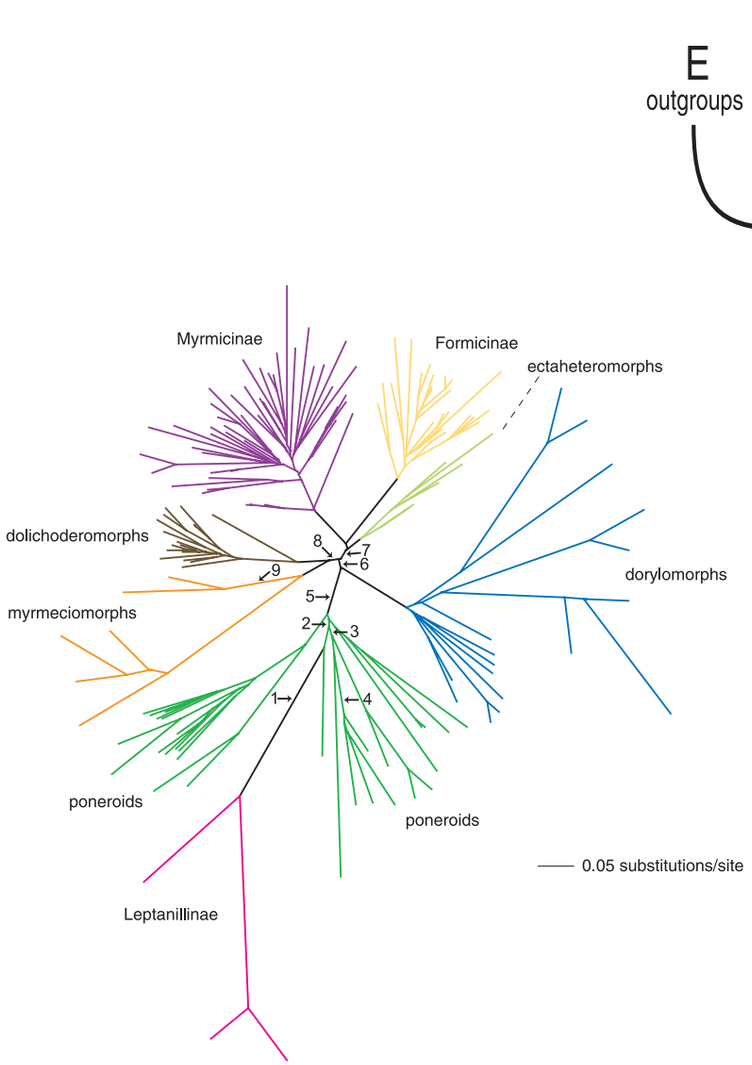
Rooted vs Unrooted Tree



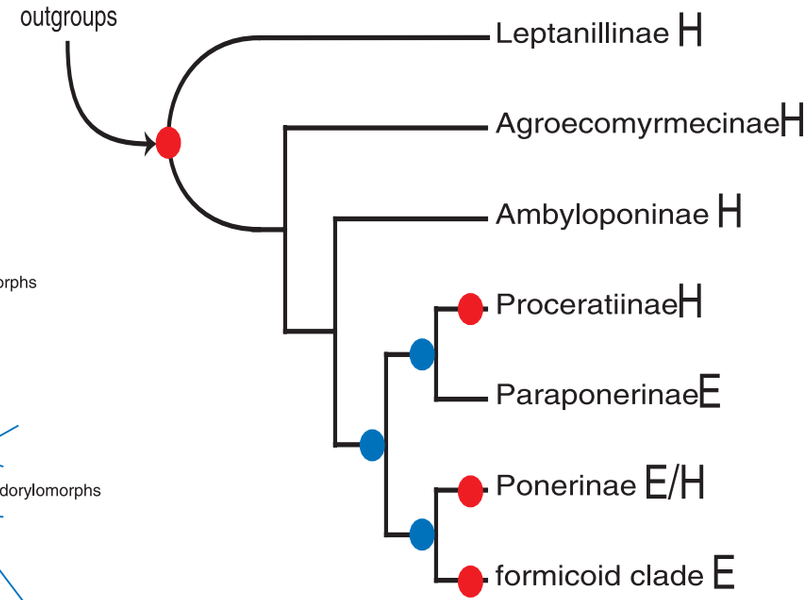


Rooting matters for inference

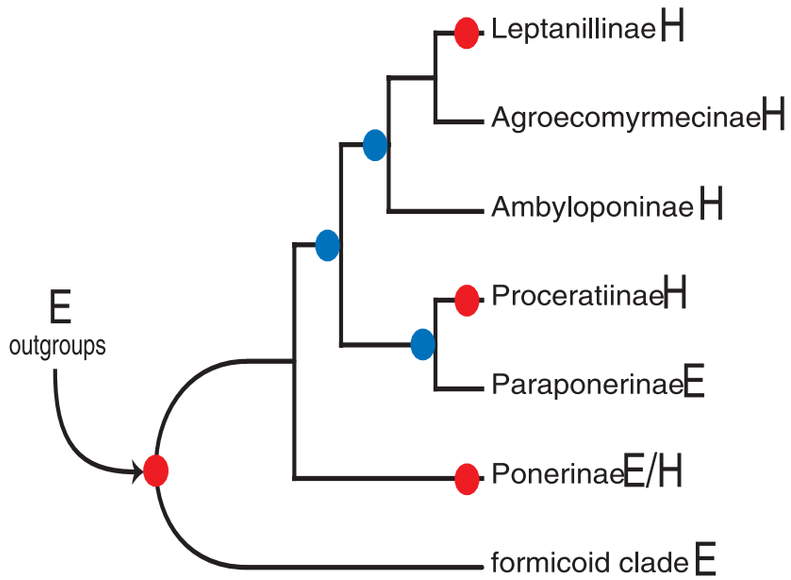
H = small colony
E = **large** colony



Rooting 1



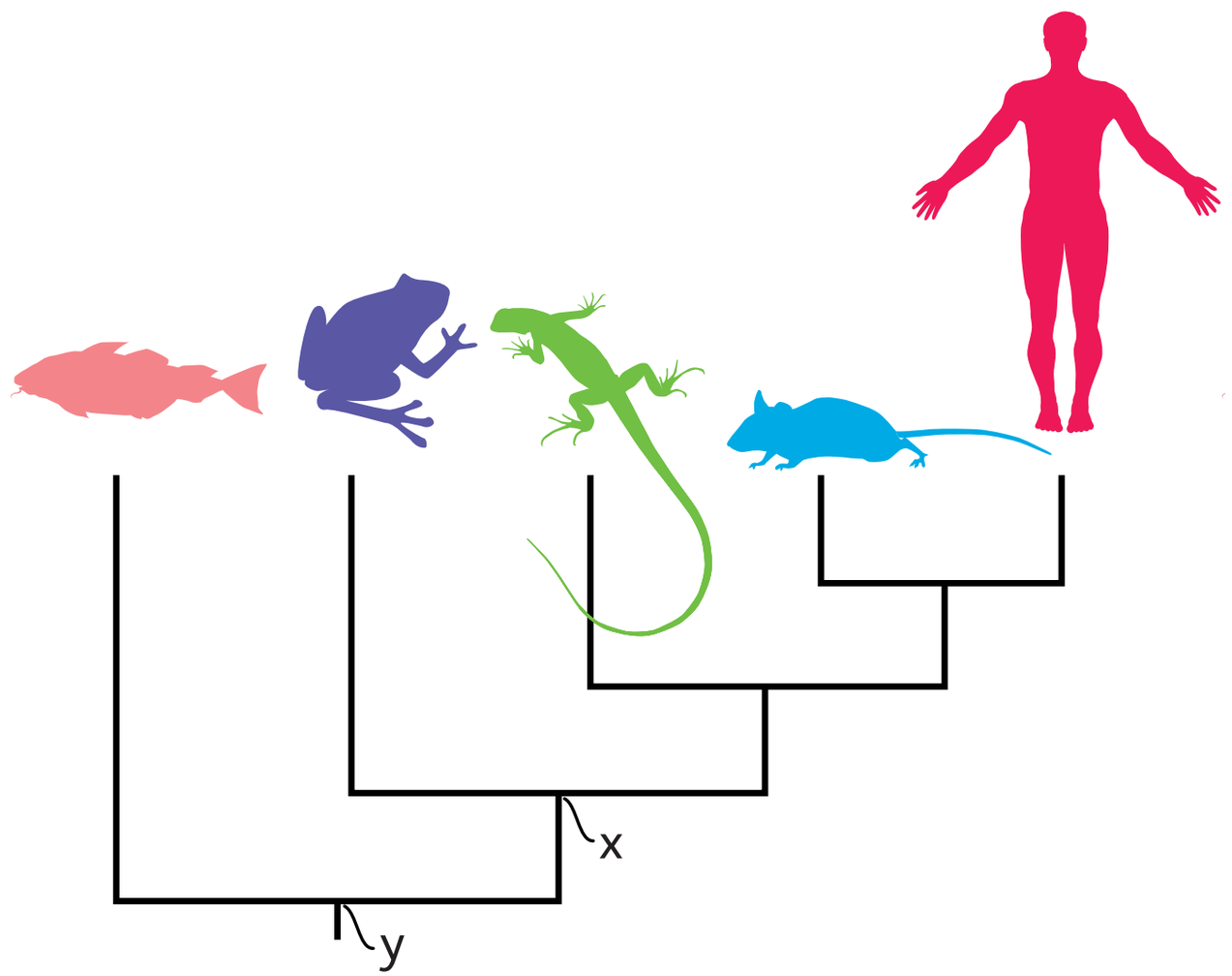
Rooting 5



Brady et al. 2006. PNAS

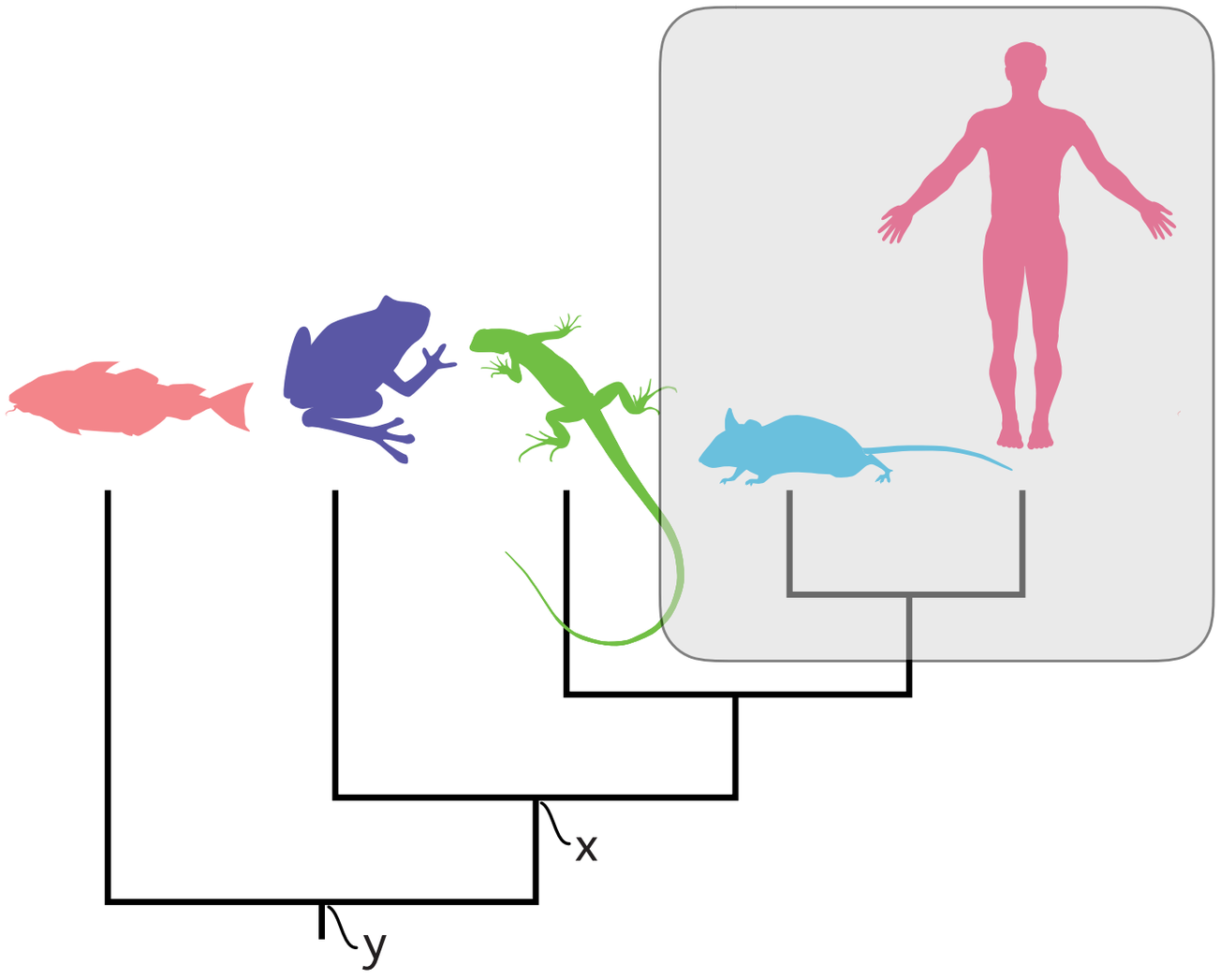
Describing trees:
Sister groups

- The two descendants form the same ancestor:
  - ***Amphibians and tetrapods are sister***
  - ***Humans are sister to mice***



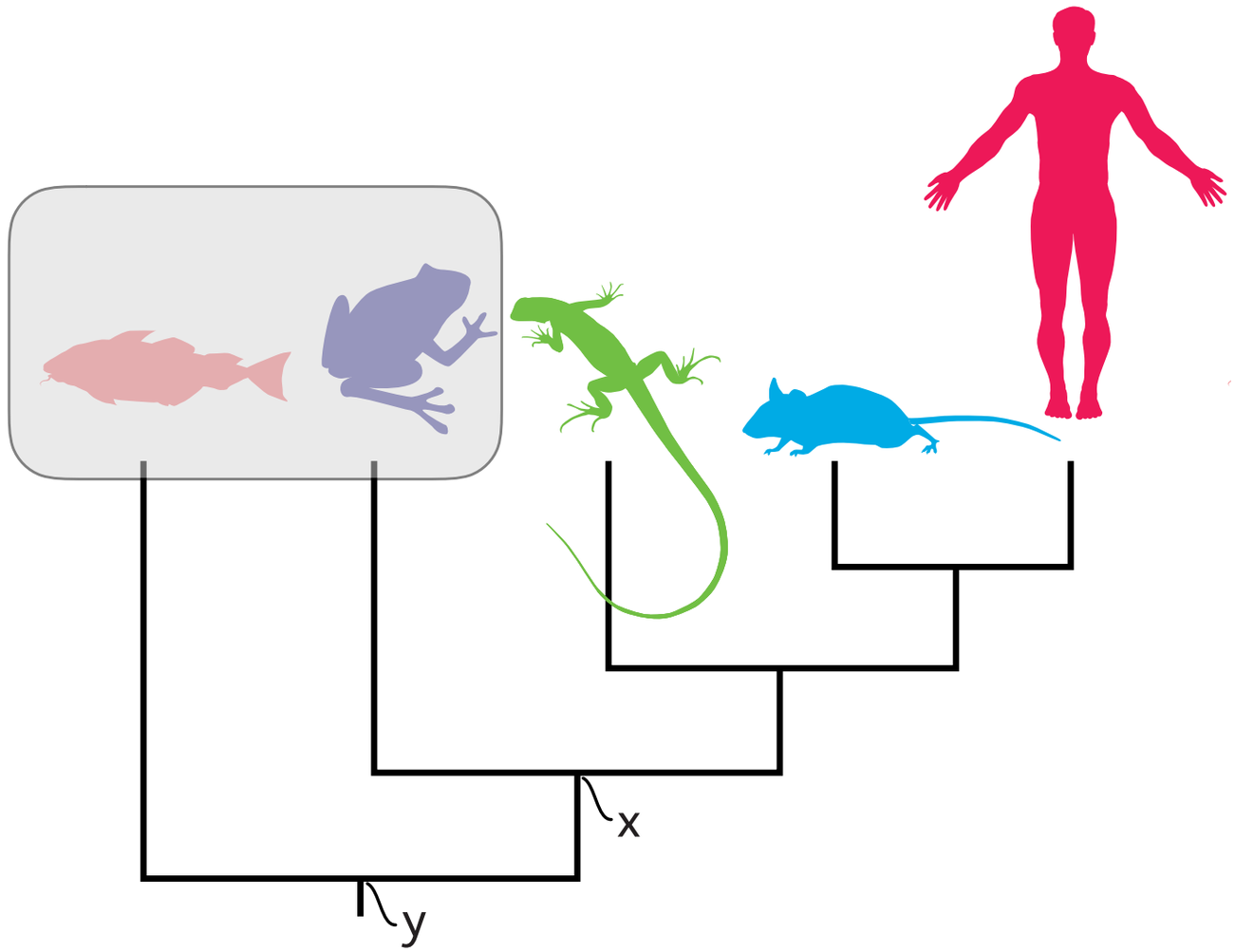
Describing trees:
Clades

- Alternative names
  - Lineage
  - ***Monophyletic*** group
- An ancestor and all of its descendants
  - ***Mice and humans form a clade***

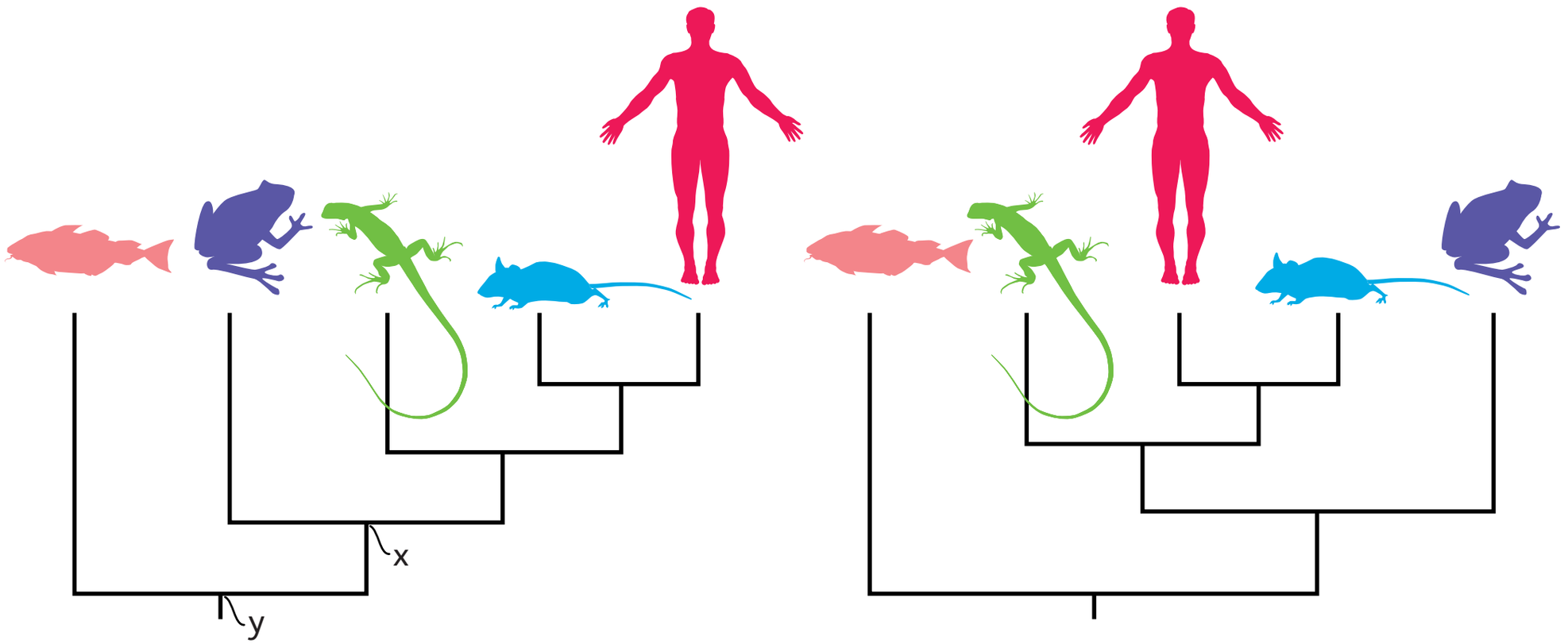


Describing trees: **Paraphyletic**

- An ancestor and **some** but **not all** of its descendants
  - ***Slimy skinned animals are a paraphyletic group***



Reading a tree



Baum et al. 2005. Science

Next time:

Importing, manipulating, and visualizing trees in R