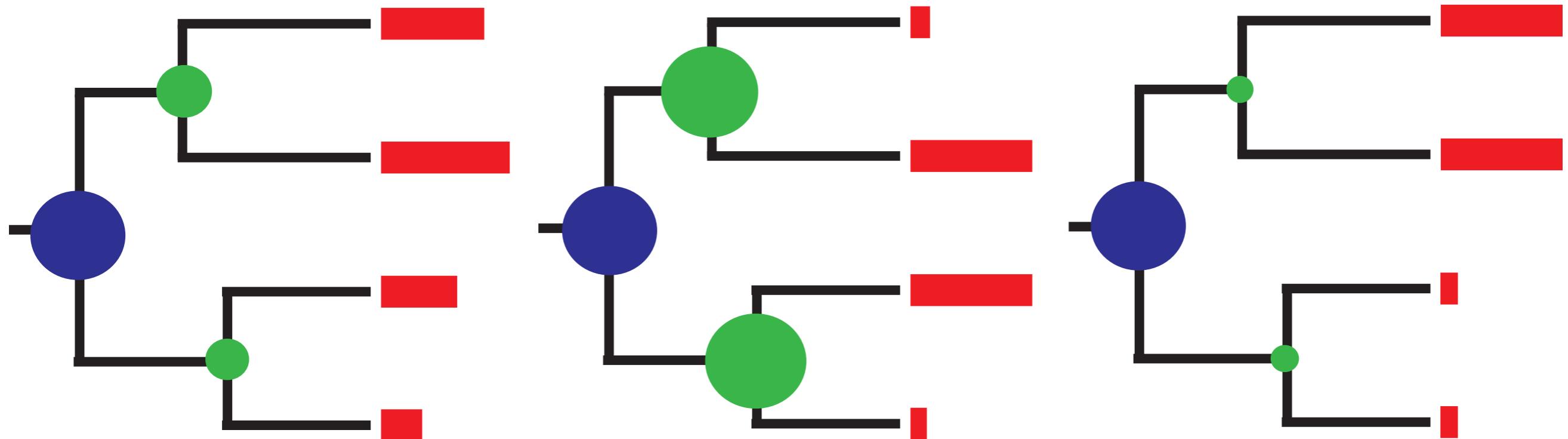
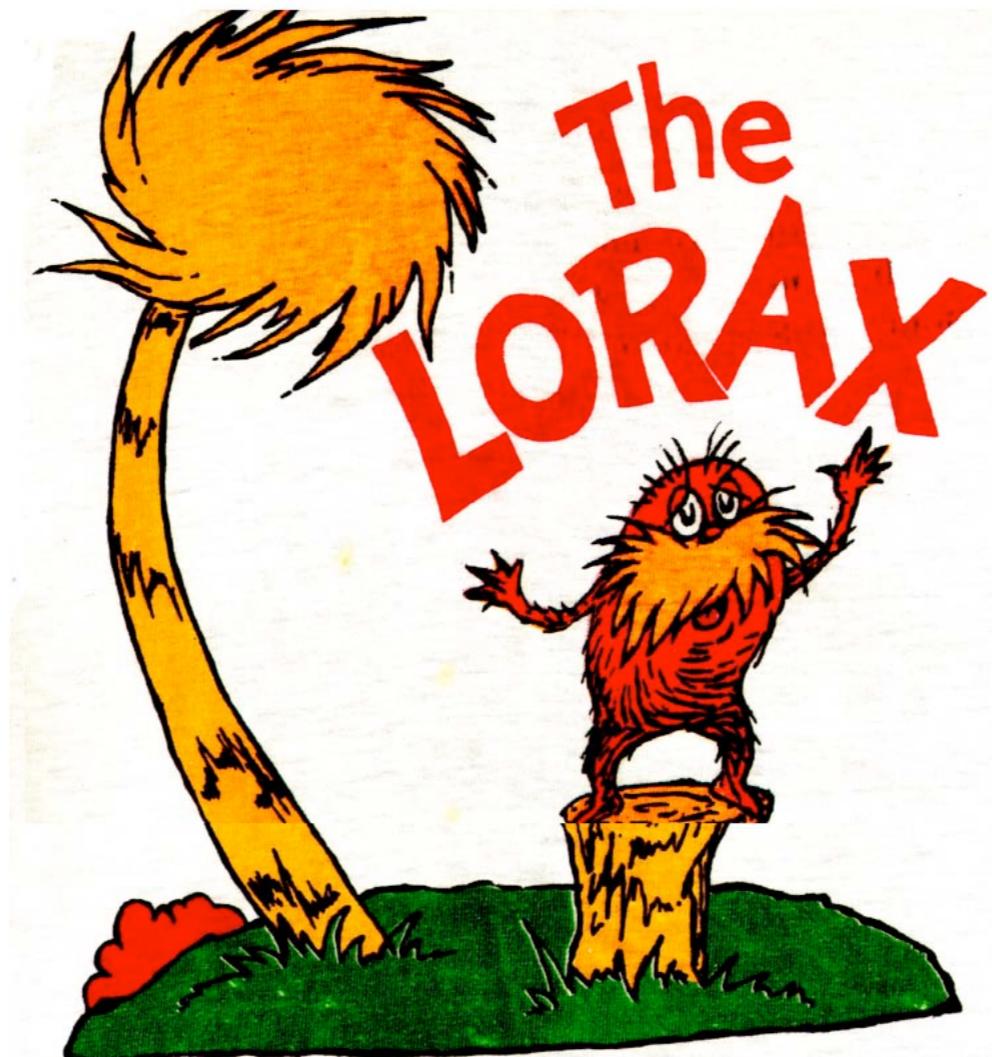


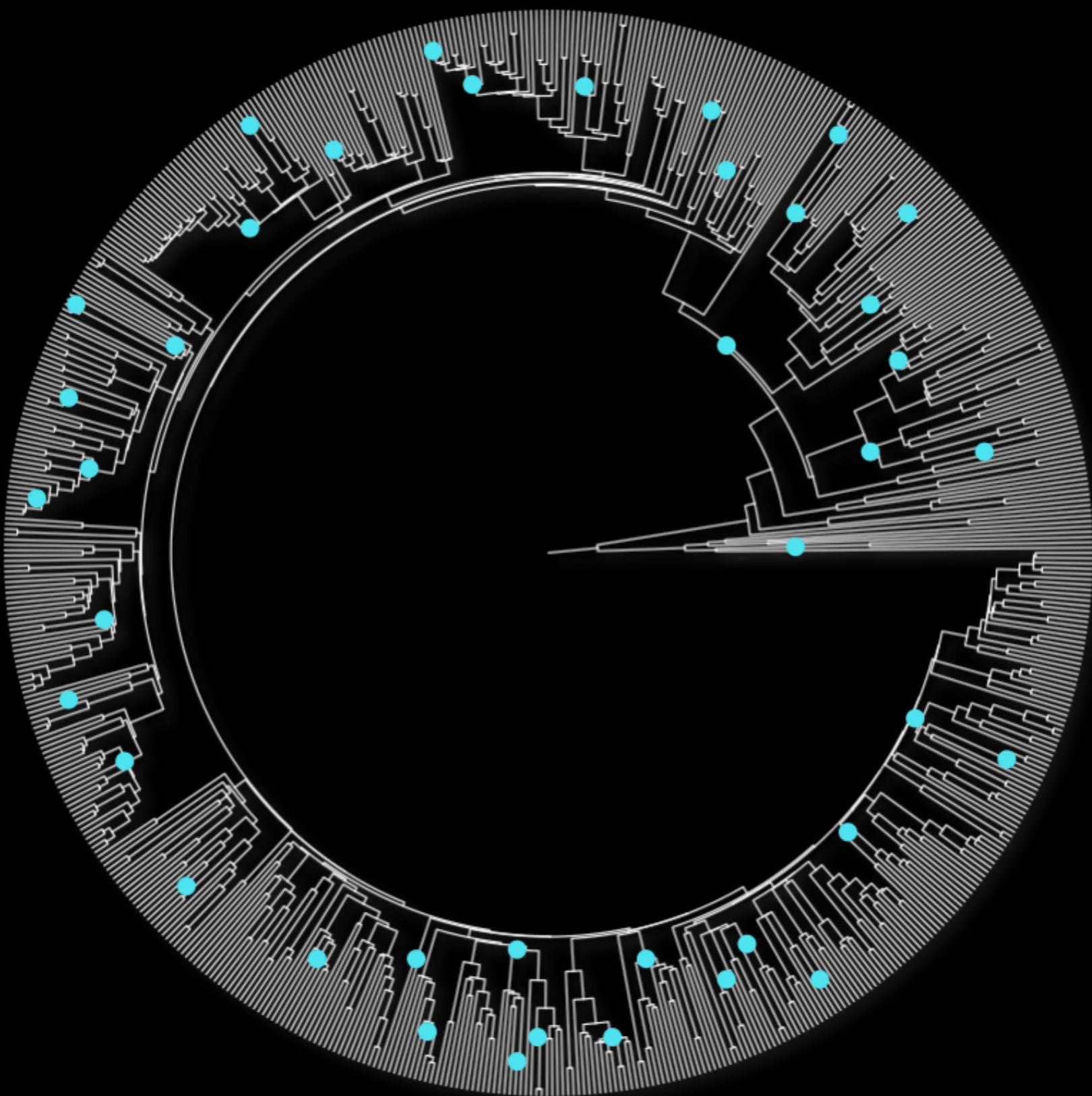
# Introduction to Comparative Methods



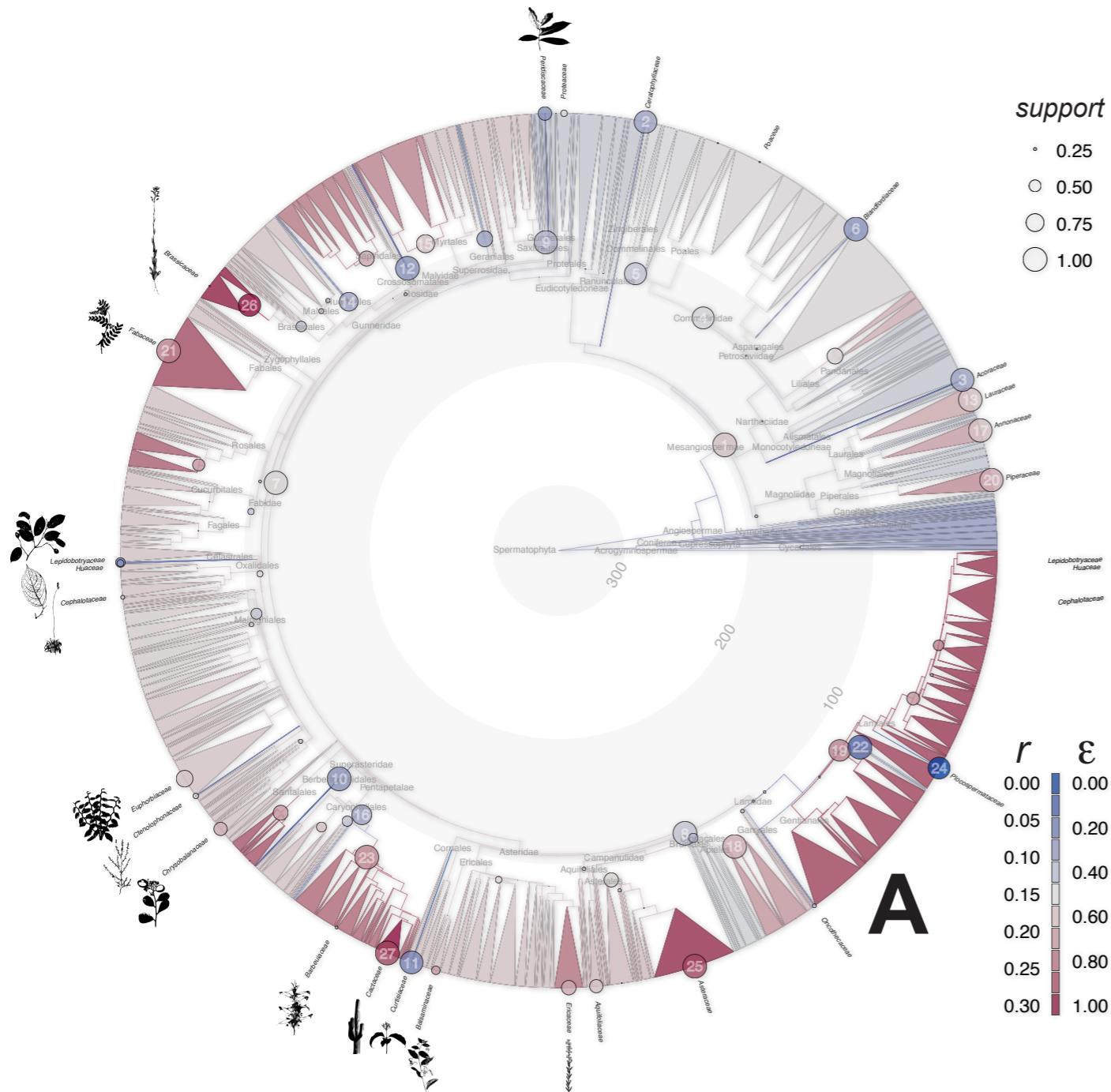
# What can we learn from a tree?



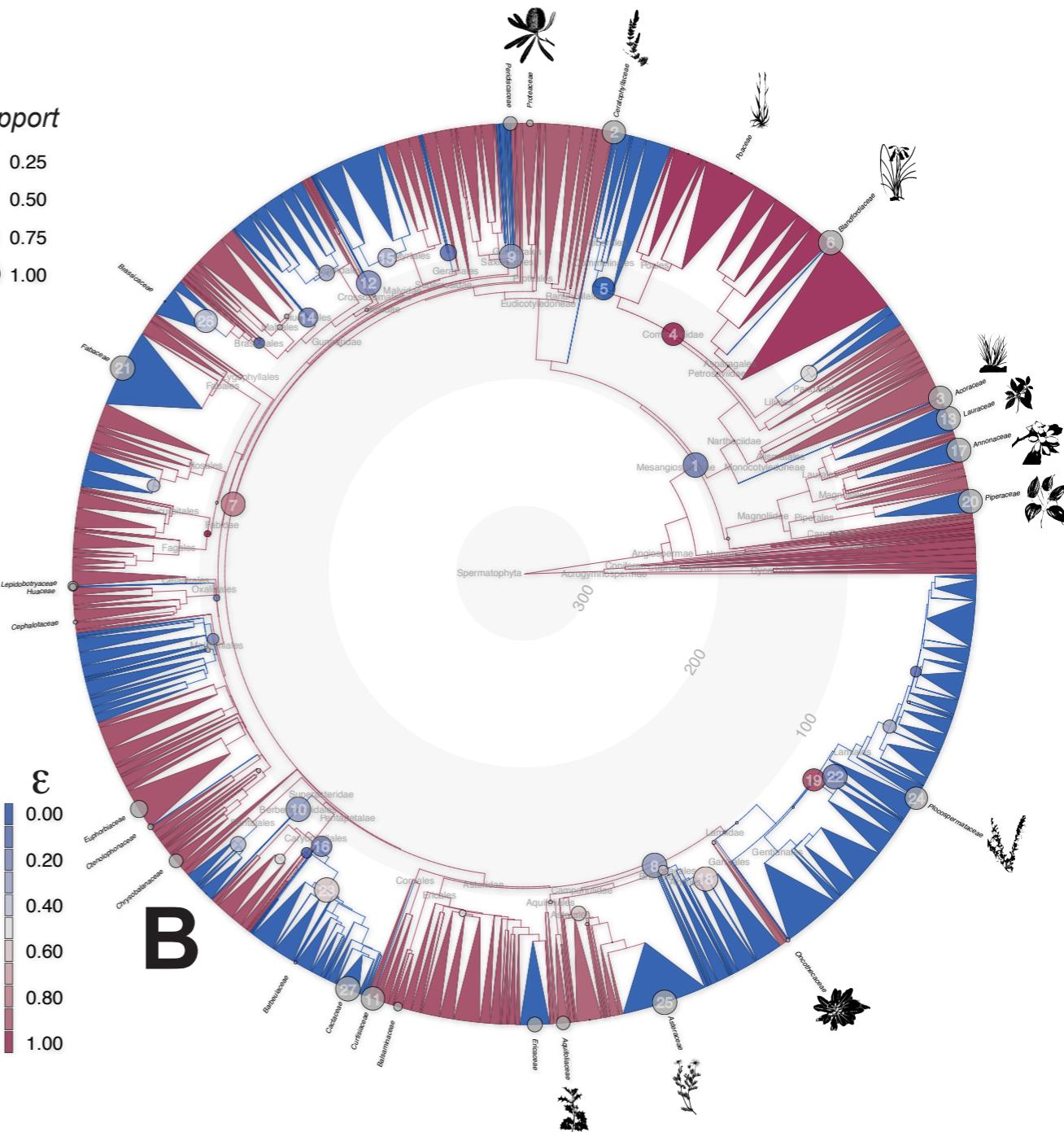
"I am the Lorax. I speak for the trees.  
I speak for the trees, for the trees have no tongues.  
And I'm asking you, sir, at the top of my lungs.  
Oh please do not cut down another one."



# Net diversification ( $r$ )



# Relative extinction ( $\varepsilon$ )



**A**

**B**

making trees is hard....

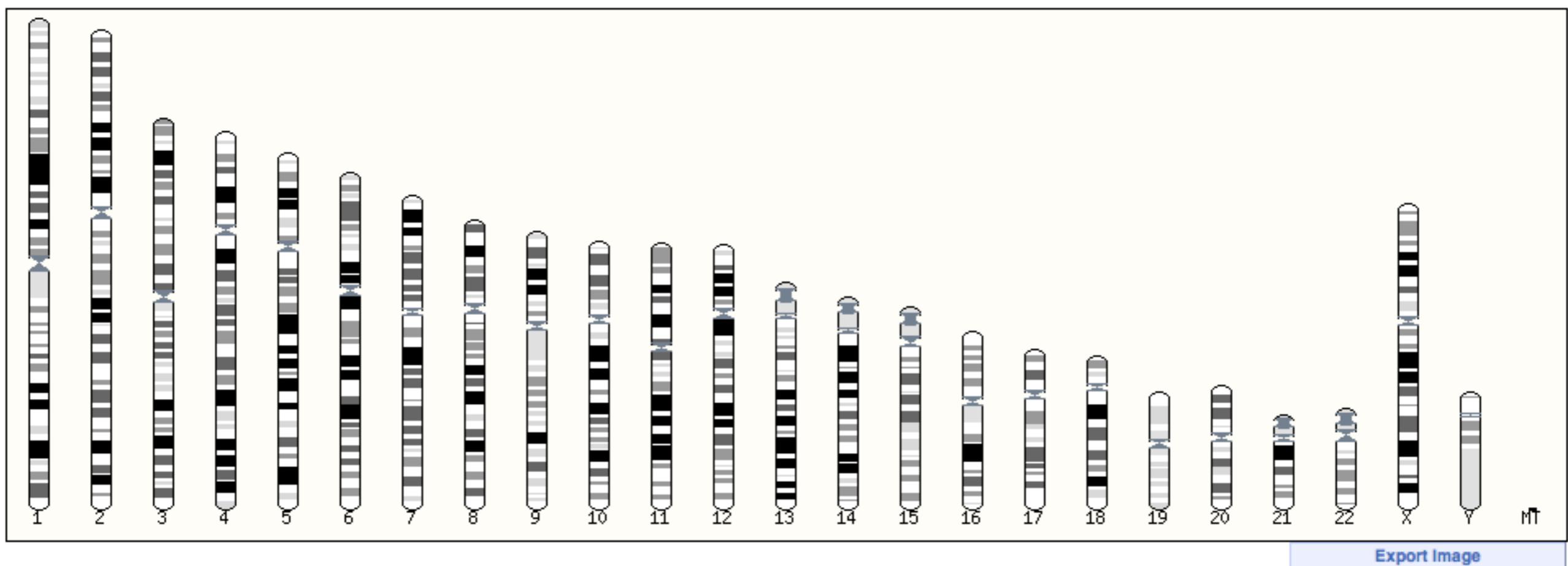
**because trees are information-rich**



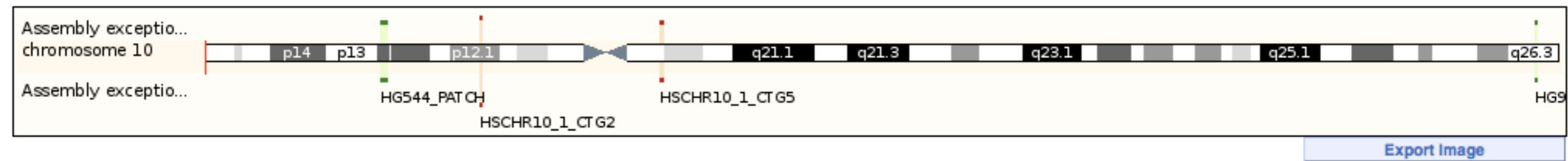
the coming age of the megaphylogeny\*

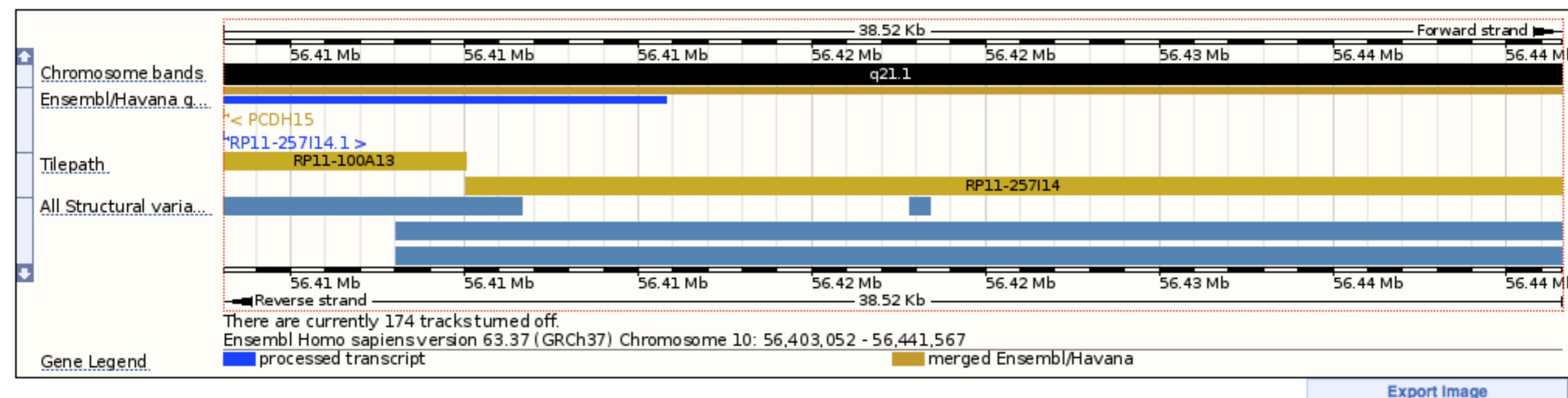
# the coming age of the megaphylogeny\*

\* trees that are too big for your brain



ensembl





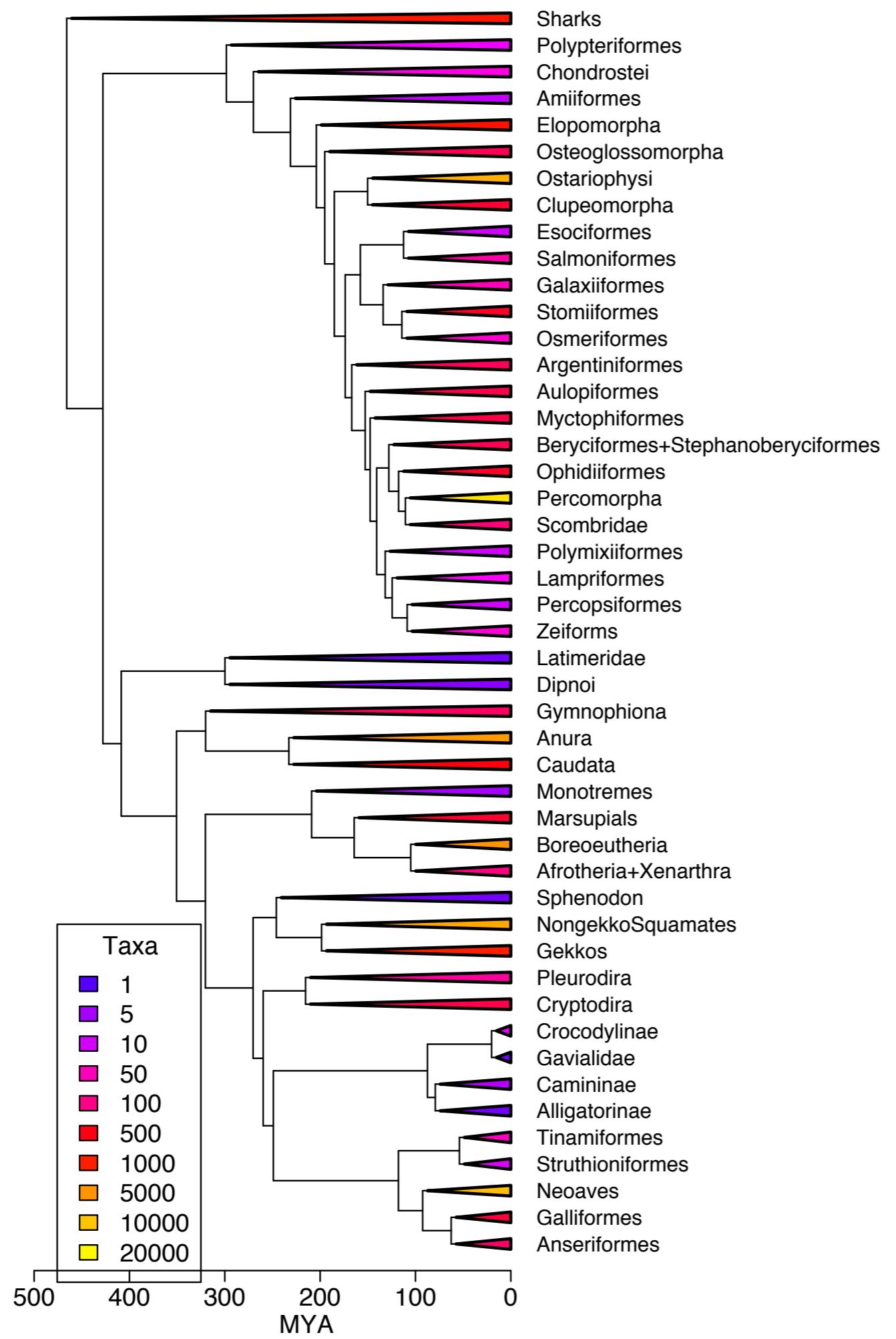
**Why do you want to make or use trees?**

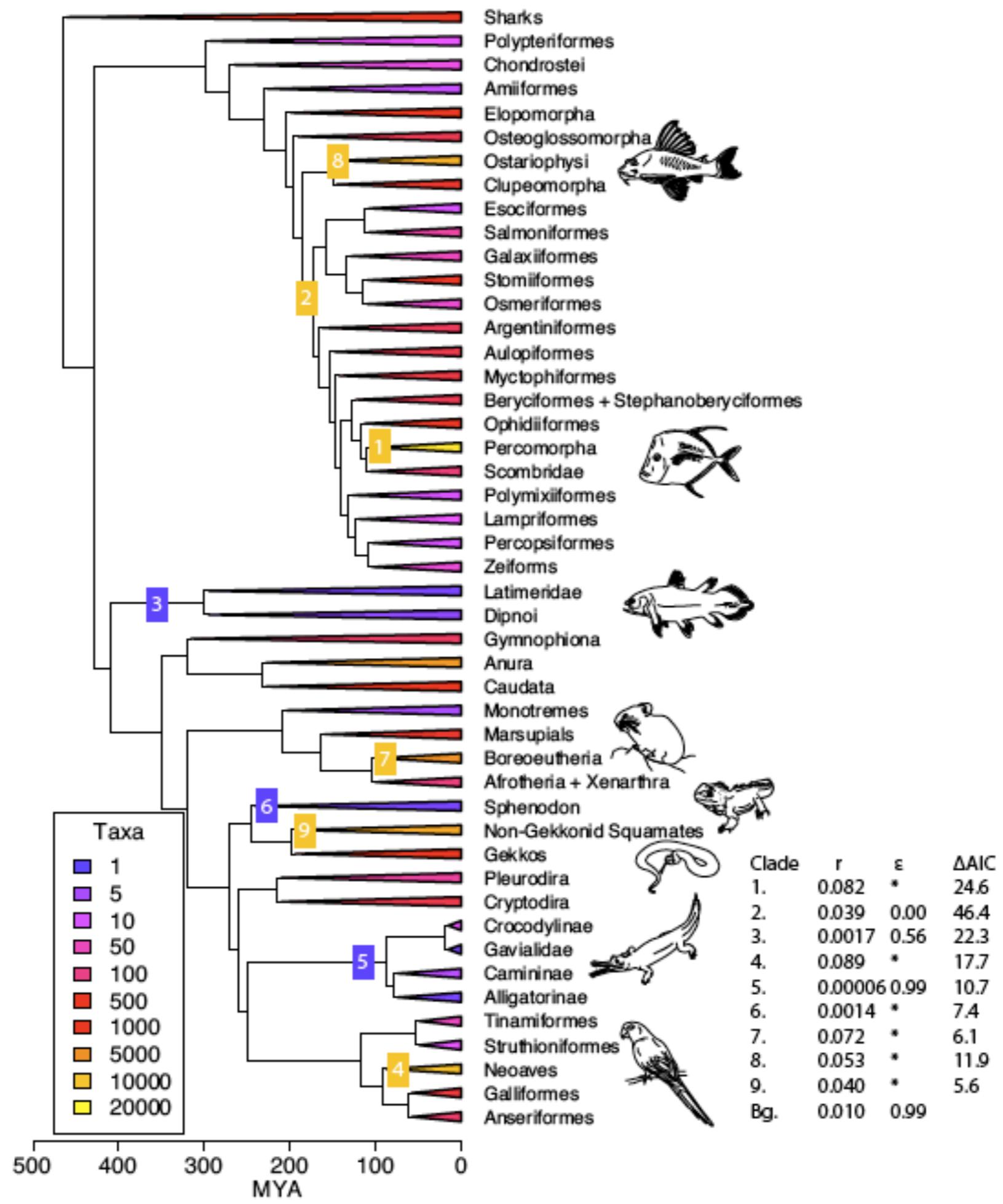
**What do you hope to learn?**

# What can you do?

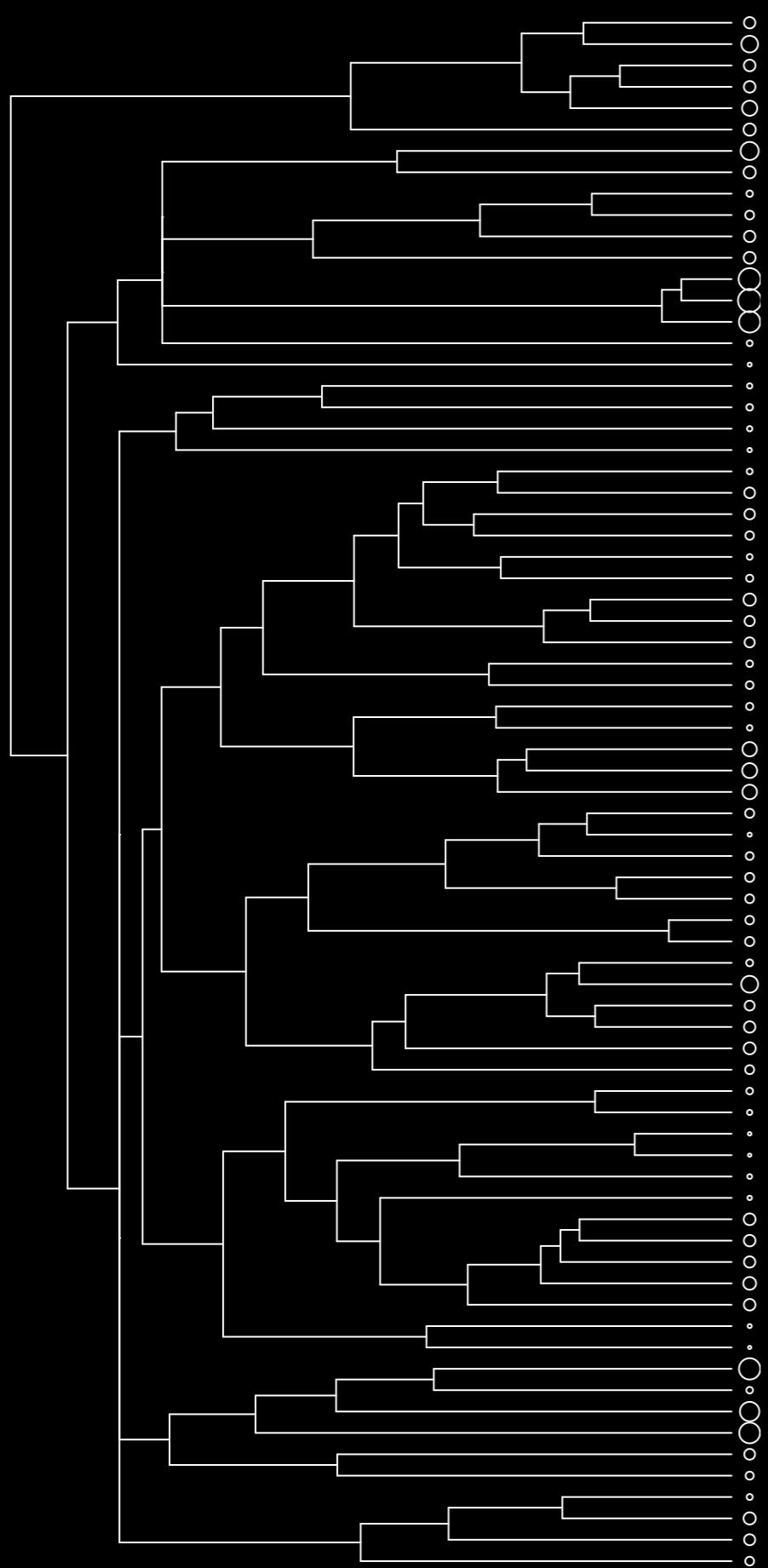
- Diversification (speciation and extinction)
- Character evolution
- Characters and diversification
- Biogeography
- Testing complex evolutionary models

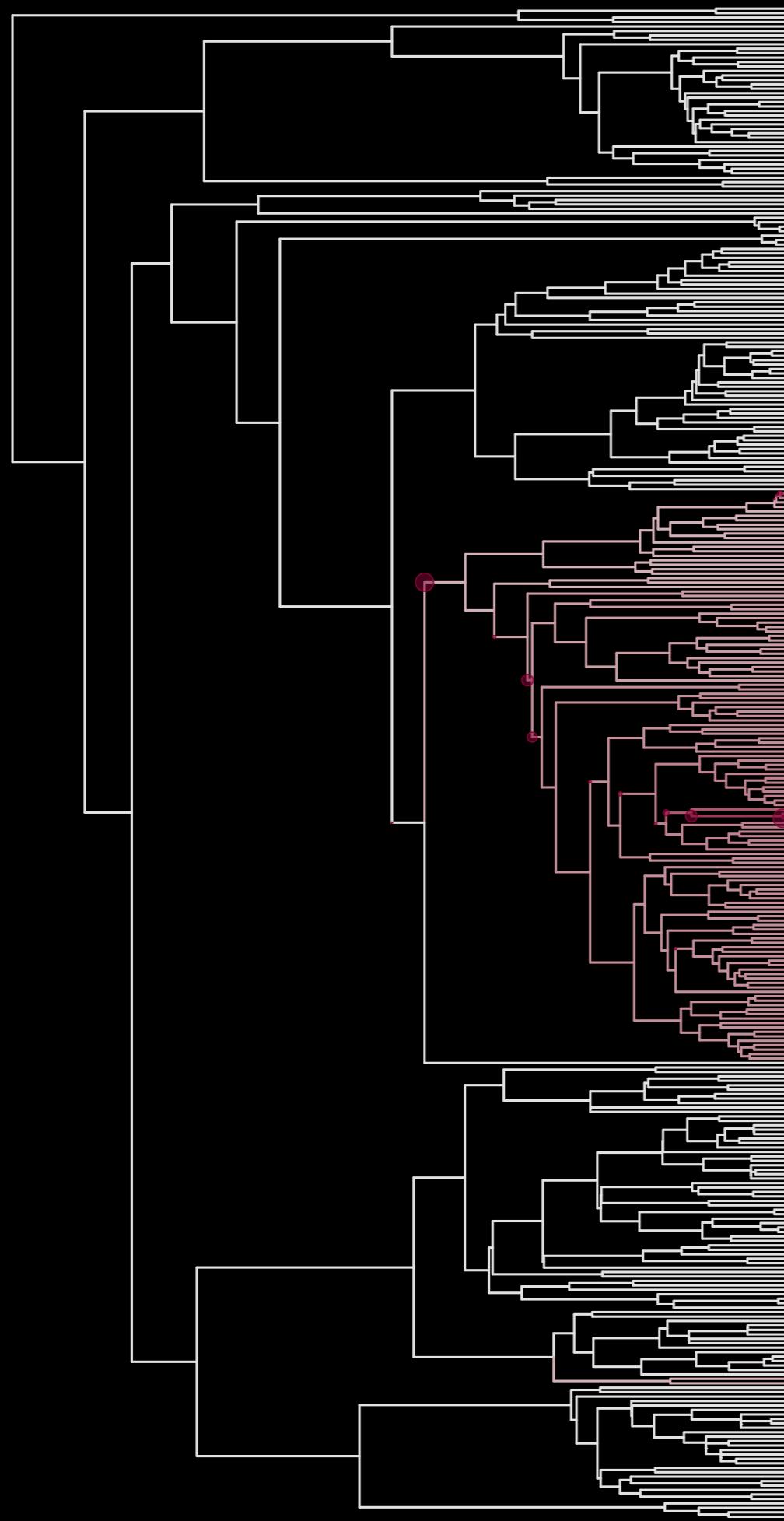
# Diversification (speciation and extinction)





# Character evolution

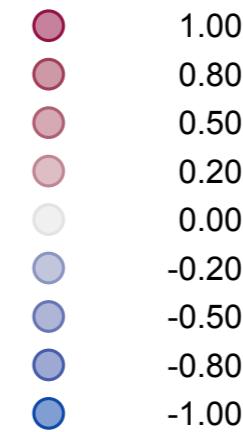




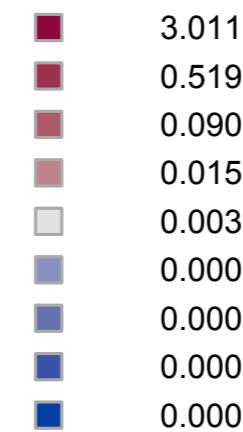
## Bolitoglossinae



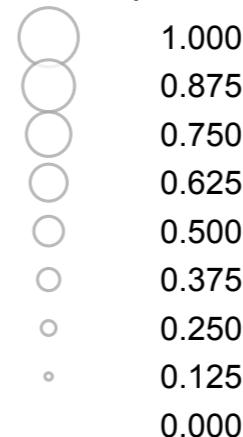
shift direction



posterior rates



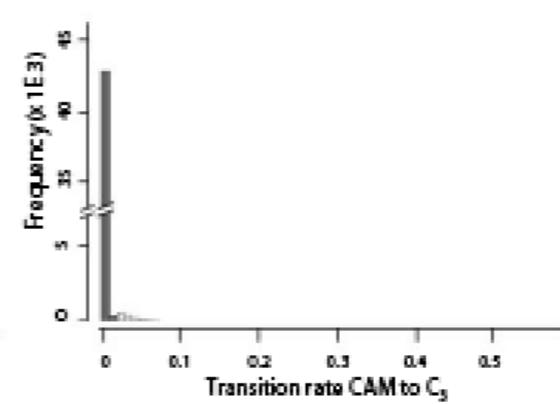
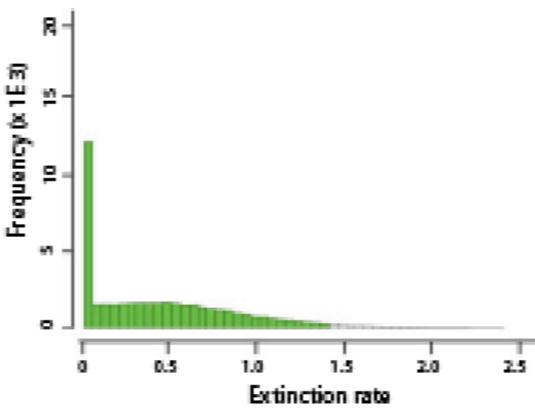
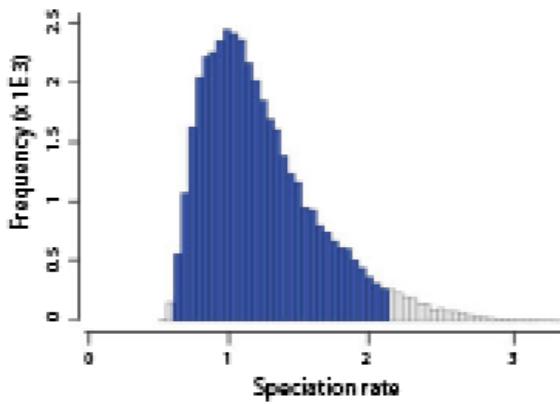
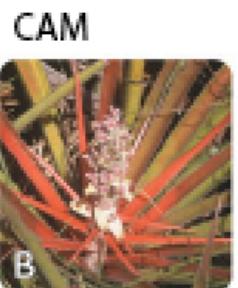
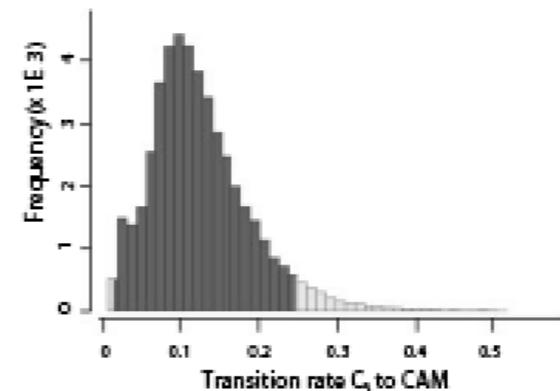
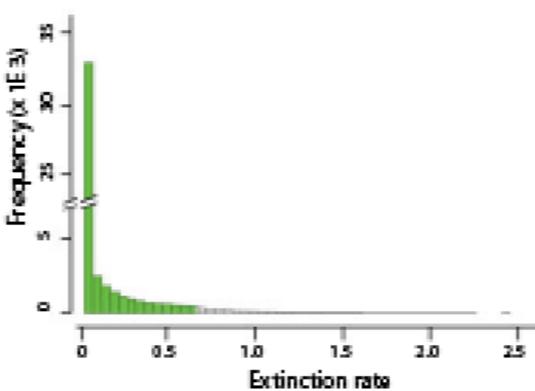
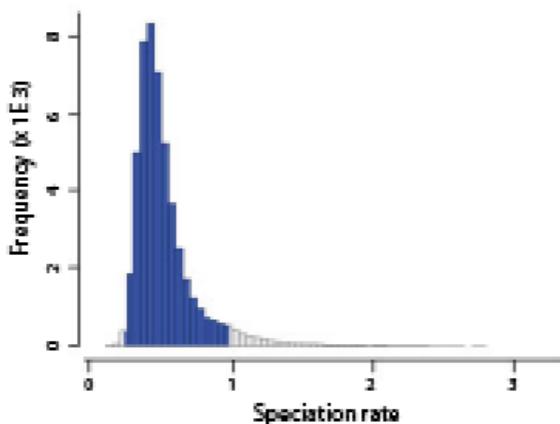
shift probability



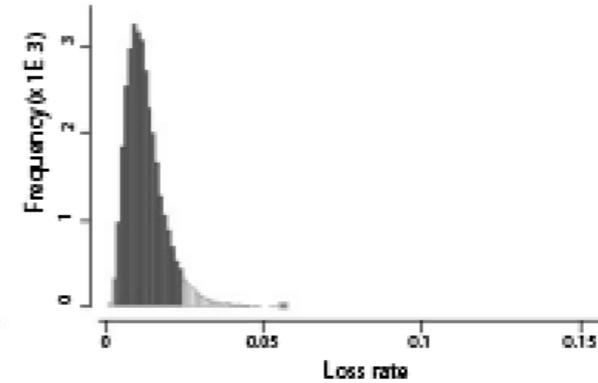
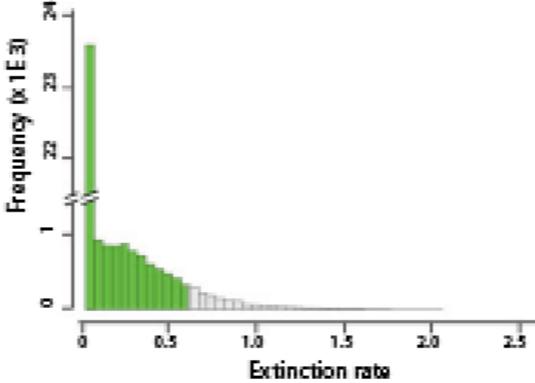
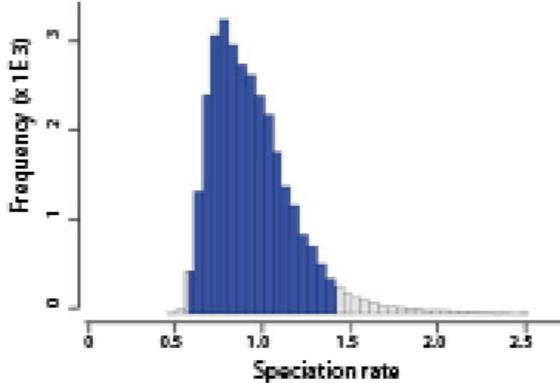
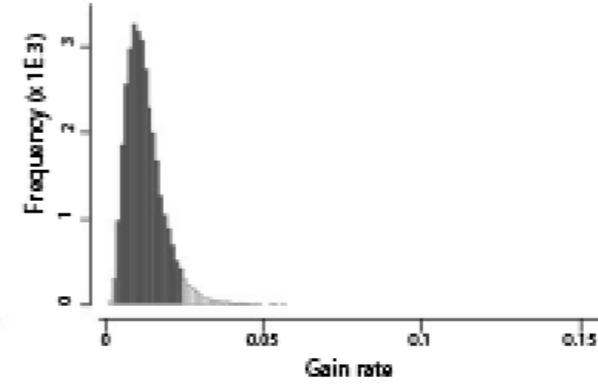
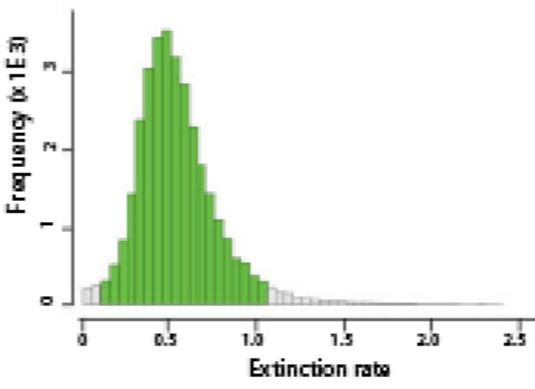
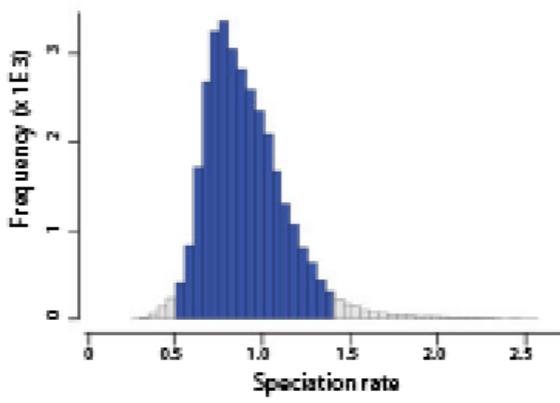
photos from wiki commons

# **Characters and diversification**

## Photosynthetic pathway

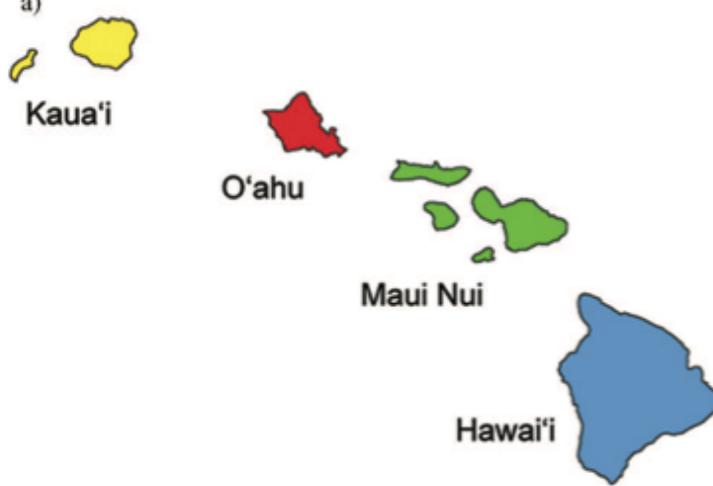


## Tank habit

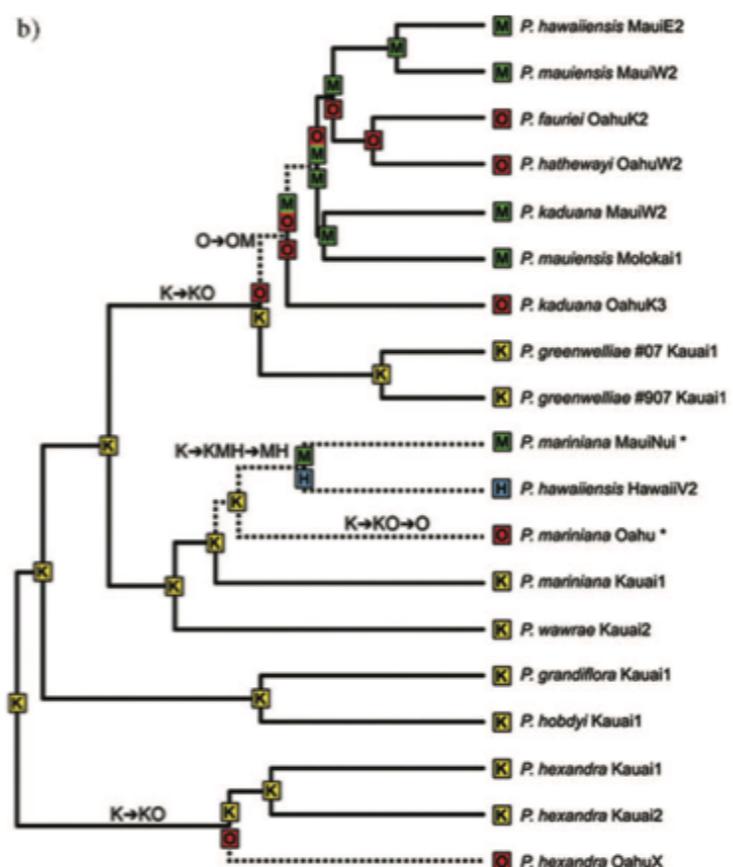


# Biogeography

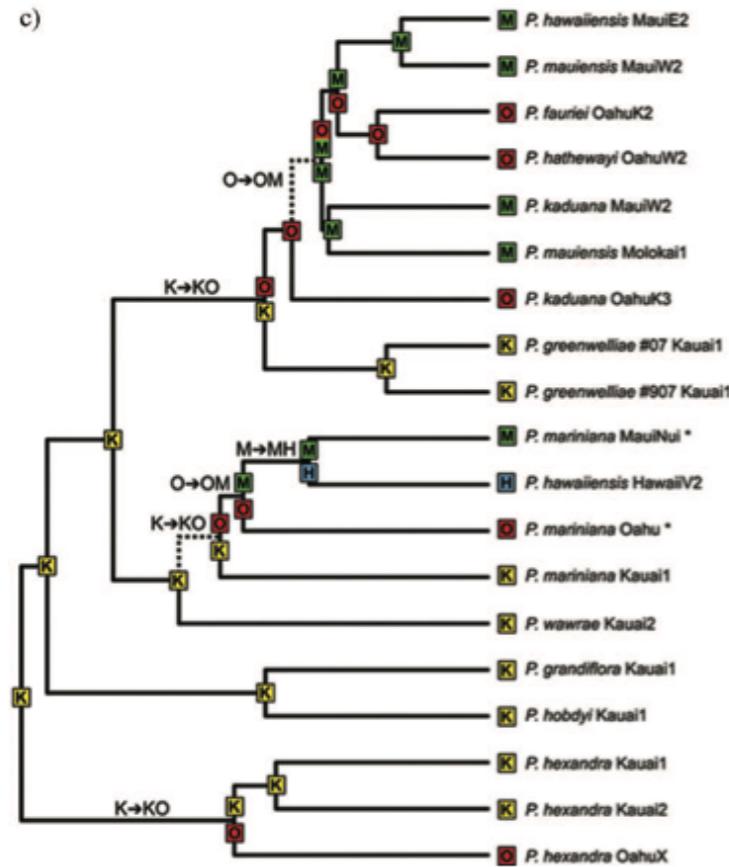
a)



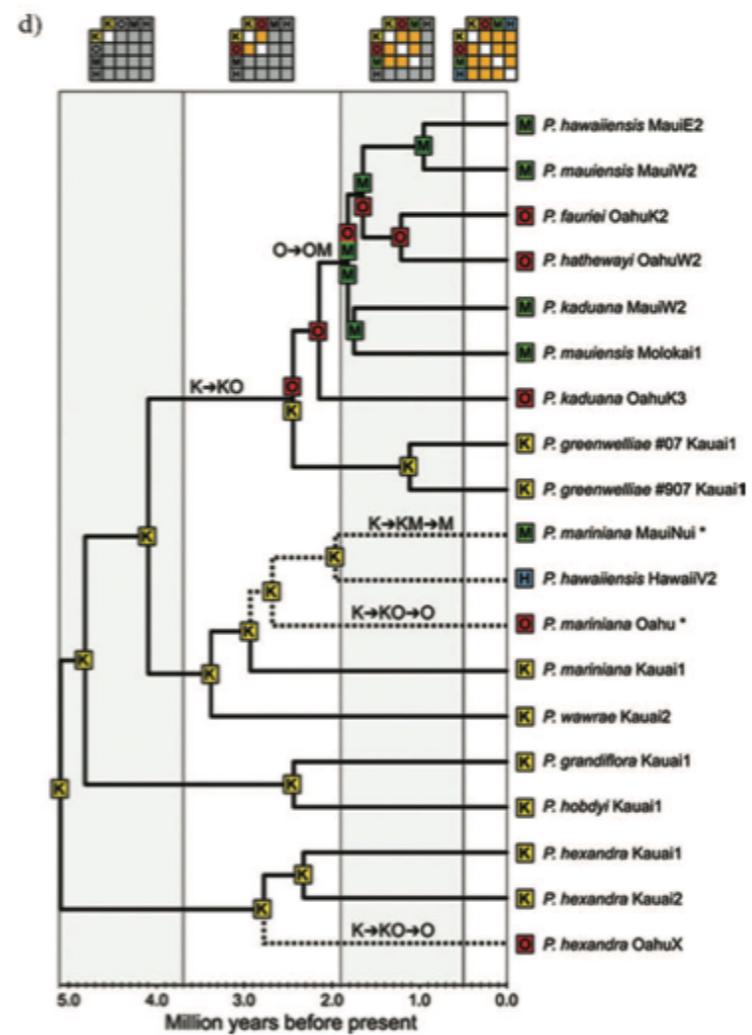
b)



c)



d)



# Testing Complex Evolutionary Models

