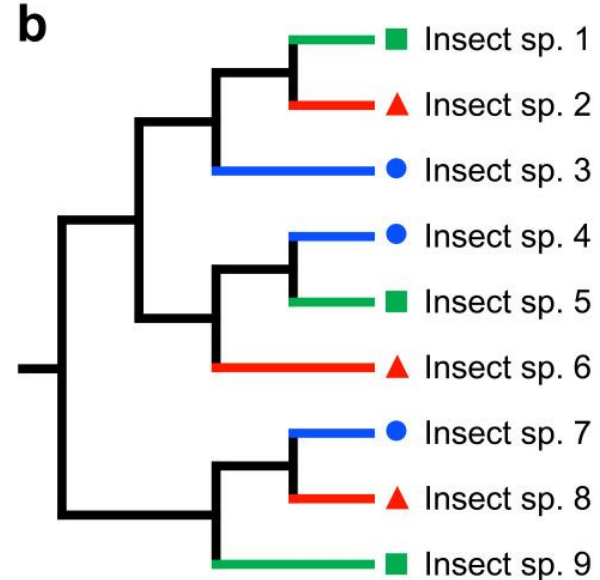
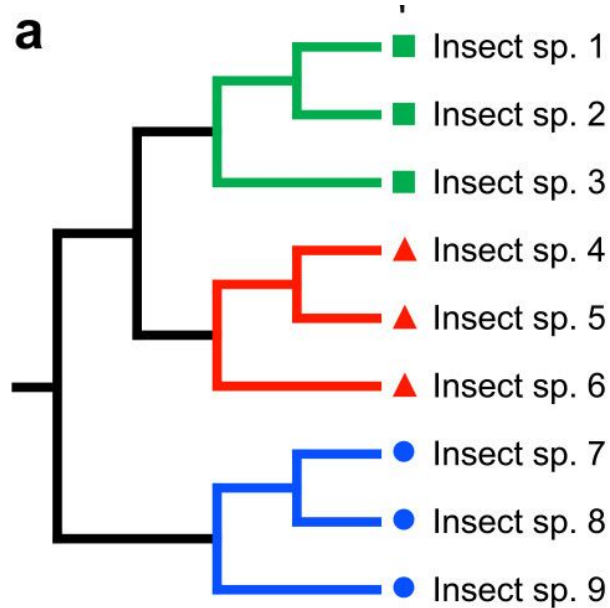

Phylogenetics of speciation, and more....

Introduction to Evolution and Scientific Inquiry
Dr. Stephanie J. Spielman; spielman@rowan.edu

Phylogenies can tell us the backstory of where different species came from (allopatric vs sympatric)



Assume each color is a distinct geographic area

THINK: Most parsimonious explanation of where each clade's ancestor lived?

Phylogenetic Species Concept

- Defines species as "tips" or CLADES on phylogenies

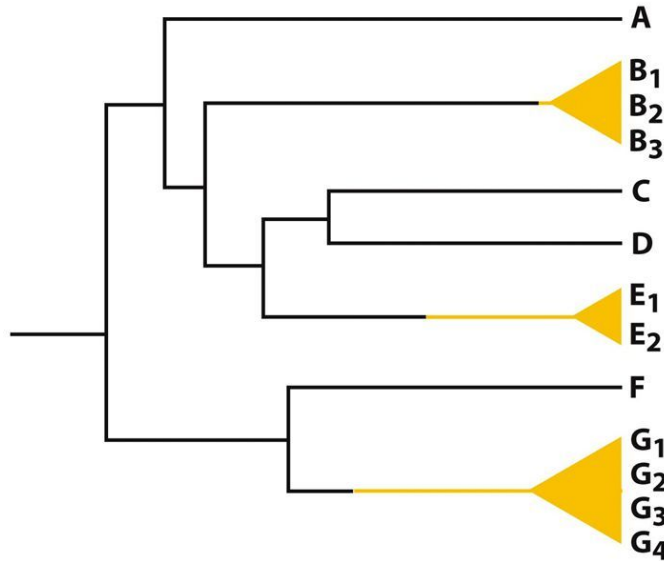
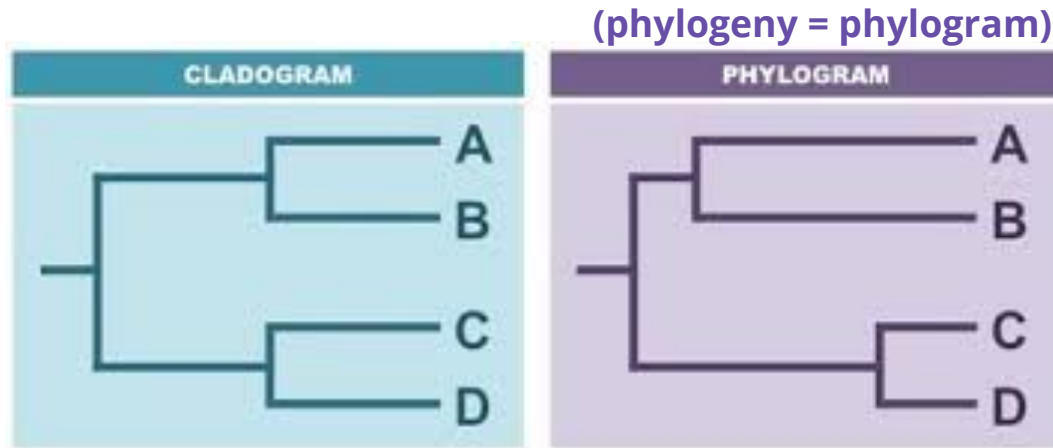


Figure 16-1 Evolutionary Analysis, 4/e
© 2007 Pearson Prentice Hall, Inc.

Recall: Branch lengths indicate genetic distance



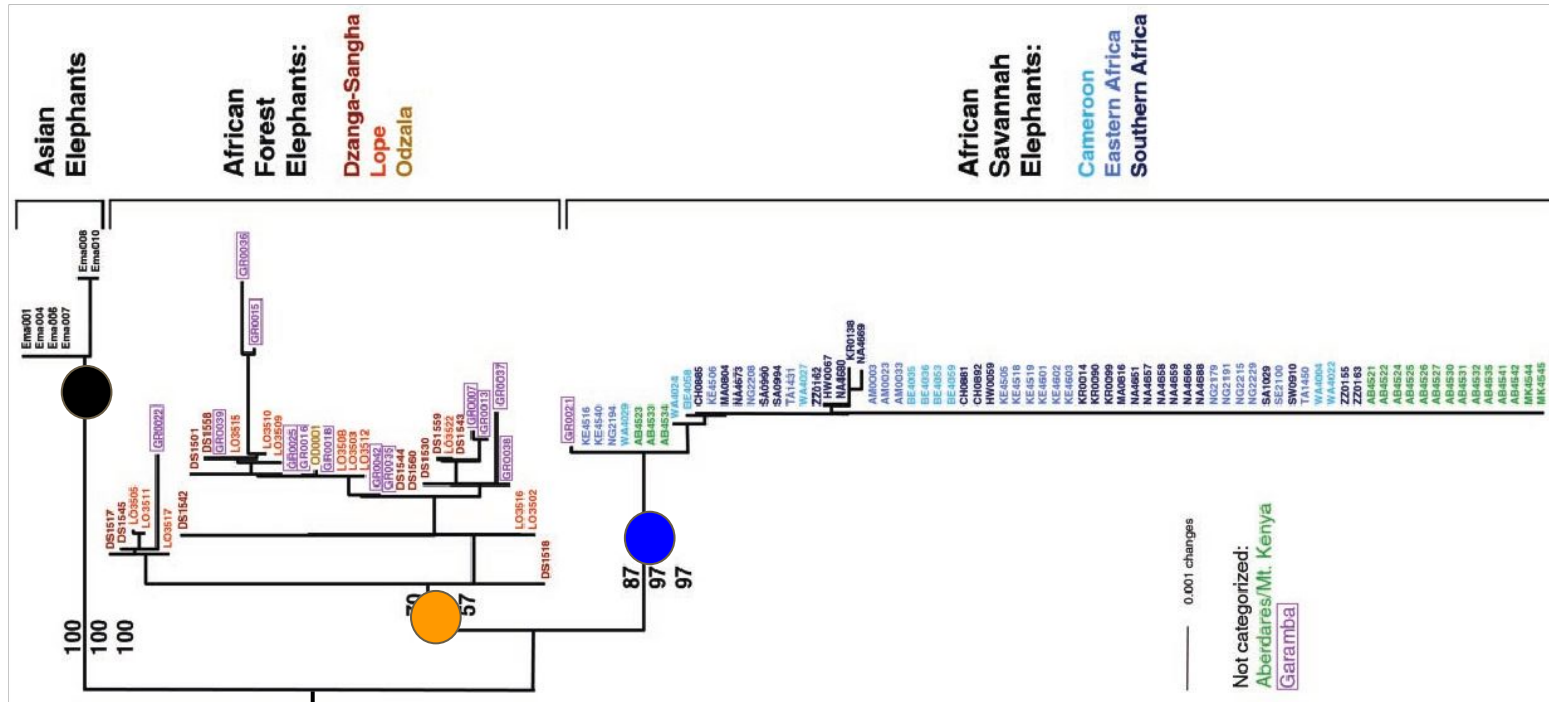
From the **PHYLOGENY**, we know that C/D are genetically more similar to each other than are A/B

Do you expect large or small genetic distance among individuals **WITHIN** a species? Between species?

Example of applying phylogenetic species concept

Got DNA sequences from MANY elephants. Asked: Are elephants in different geographic regions different species? **Yes!! Due to monophyly**

Yes!! Due to monophyly.



Coevolution and cospeciation

Coevolution: Two or more species affect one another's evolution, i.e. *reciprocal* evolutionary change. *Speciation does NOT need to happen!*

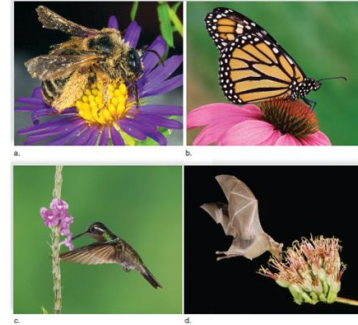
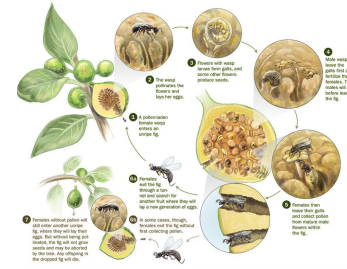
Cospeciation: When two co-evolving groups of organisms *speciate* in tandem. Extremely common in **host-parasite** or symbiont relationships. **expect EXACTLY mirrored trees.**

One of these pairs of trees shows **cospeciation**. Which one?



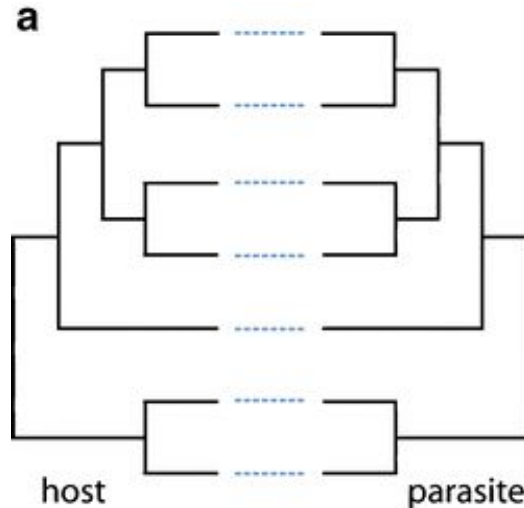
Many pairs species show strong specific associations

- Figs and wasps https://www.youtube.com/watch?v=9DQTjv_u3Vc
- Plants and their pollinators
- Selection on interacting pairs tends to increase the interdependency, i.e....
 - Plant evolves precise method to attract a specific species of pollinator
 - Pollinator species evolves strict preference for only pollinating that plant
- So the question is: What causes the close co-evolutionary relationship between species? Either...
 - **Co-speciation: The close specific interaction was inherited**
 - **By chance: The two species just happen to have a close biological interaction**

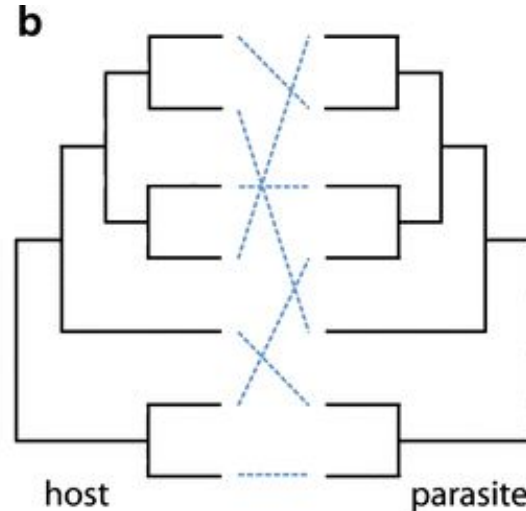


Phylogenies can help determine how associations are formed

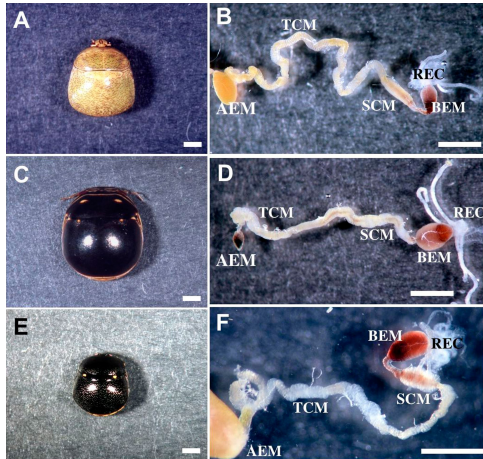
a: Cospeciation causes host-parasite specific relationships. Host-parasite remain linked "forever" in evolutionary time



b: By chance, host-parasite specific relationships come to be. "Host-switching" events occur when host speciates; parasite speciation does not "follow" host speciation

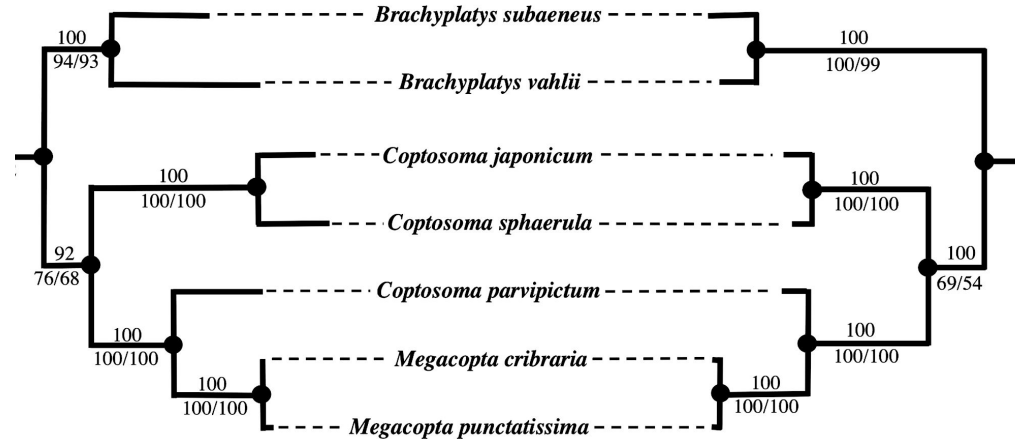


Stinkbug and symbiotic bacteria cospeciation

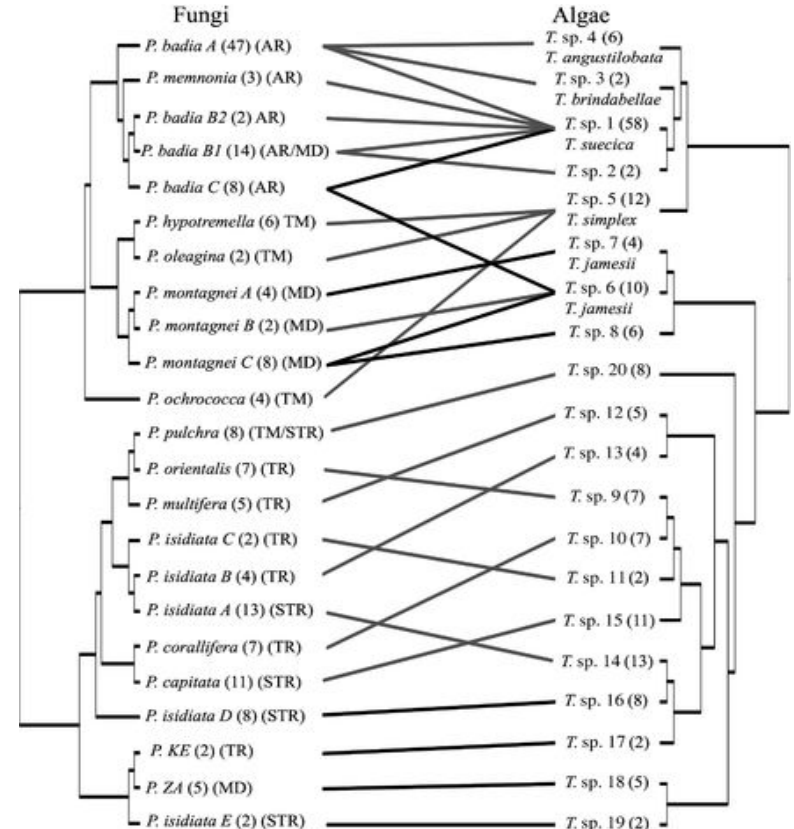


Stinkbug phylogeny

Symbiotic bacteria phylogeny



Lack of cospeciation in fungi and symbiotic green alga

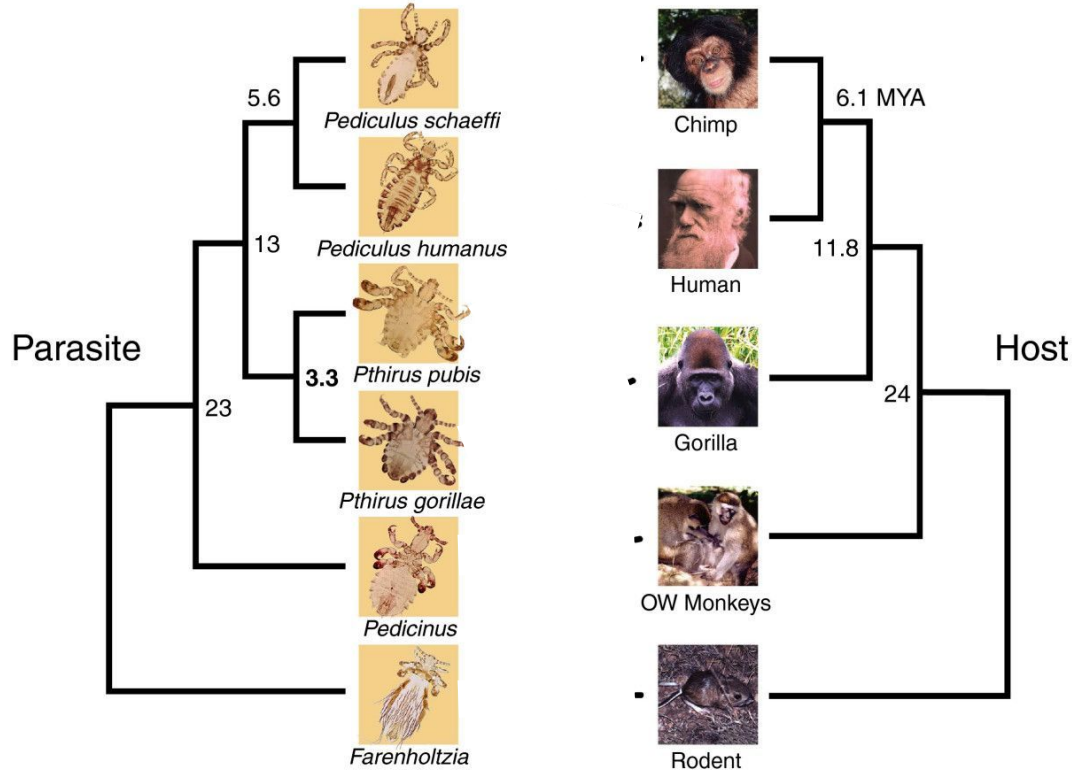


THE HORROR



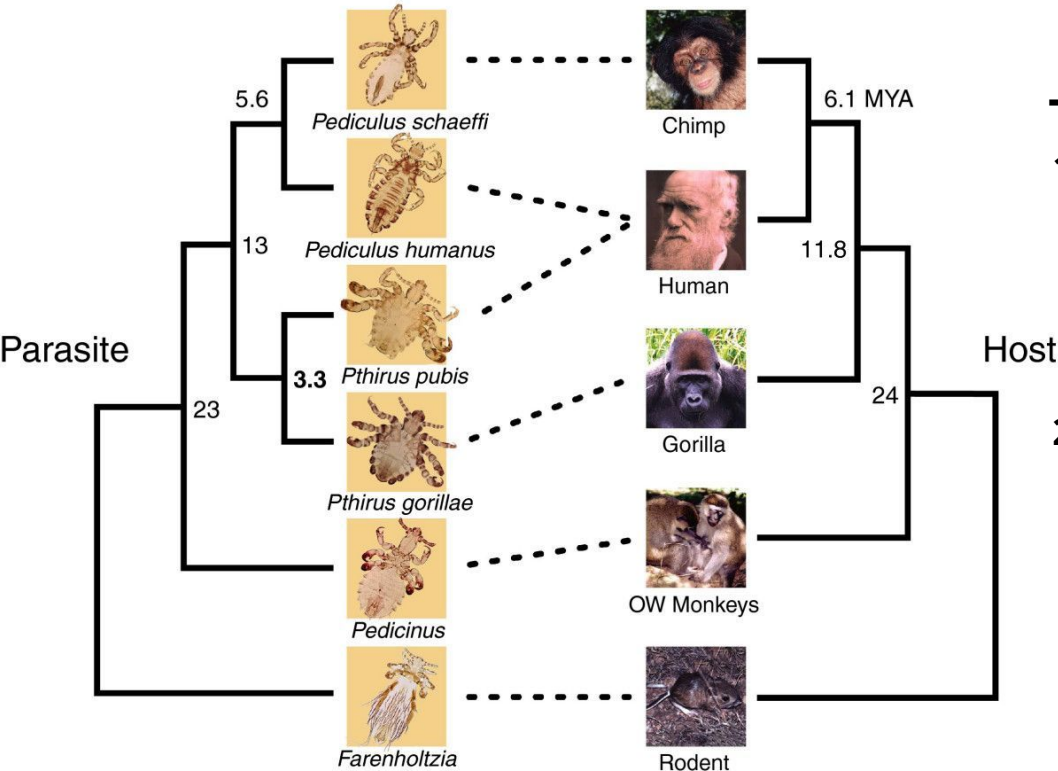
Pair of lice lost or parasites regained: the evolutionary history of anthropoid primate lice

David L Reed^{*1}, Jessica E Light¹, Julie M Allen^{1,2} and Jeremy J Kirchman^{1,2,3}



Pair of lice lost or parasites regained: the evolutionary history of anthropoid primate lice

David L Reed^{*1}, Jessica E Light¹, Julie M Allen^{1,2} and Jeremy J Kirchman^{1,2,3}



Two options:

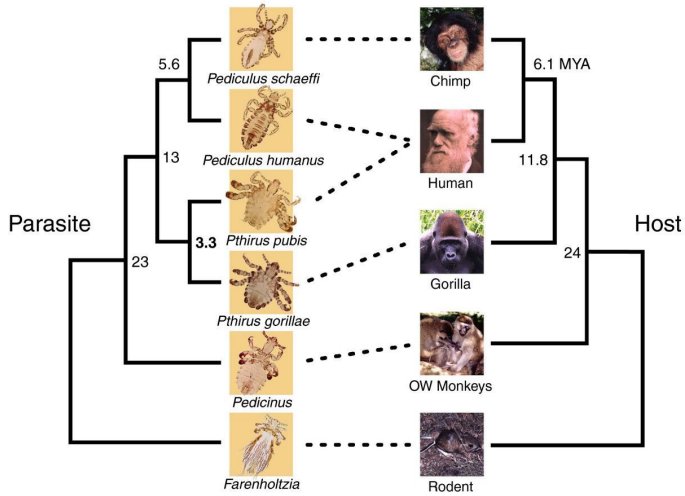
1. A host-switching event occurred

- Mutation in *Pthirus pubis* changed it to infect humans and not gorillas
- Raises uncomfortable questions about human-gorilla interaction...

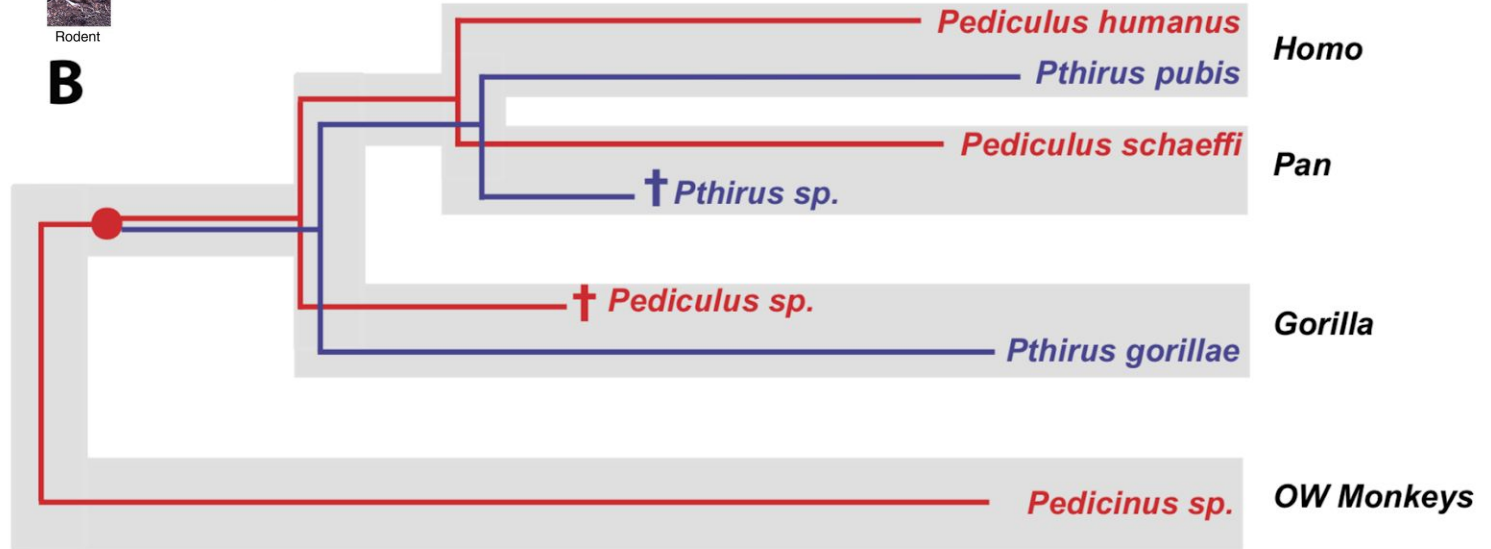
2. There was another species that went extinct

- We don't see a mirror phylogeny because all the species didn't survive, not because it didn't happen!

In your "free time", this is extremely cool
<https://www.pbs.org/wgbh/nova/video/lice-and-human-evolution/>



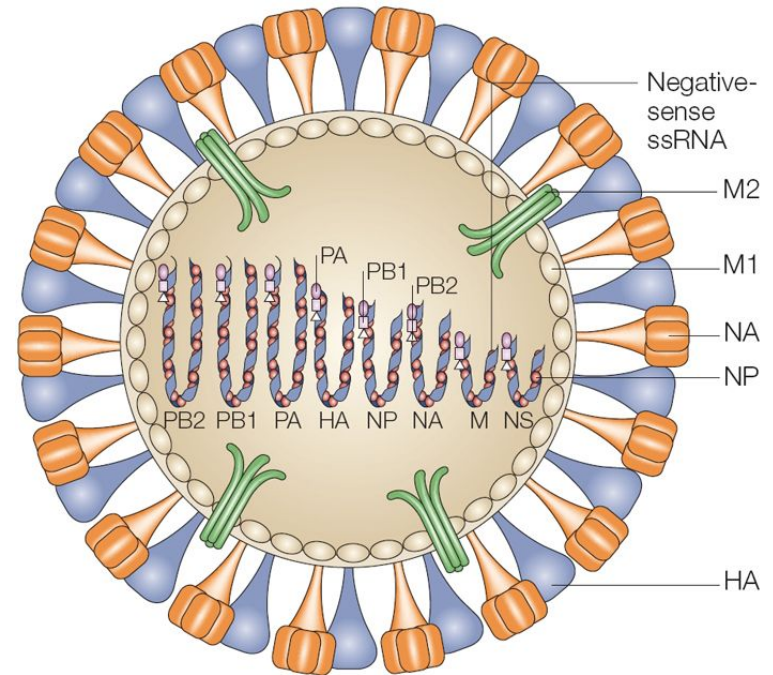
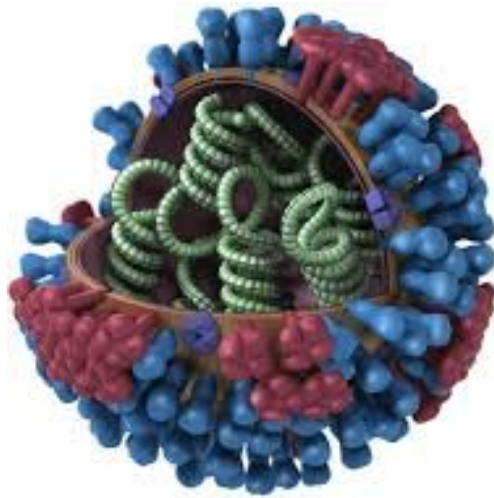
B



Phylogenies can help us understand the history and dynamics of pathogens!

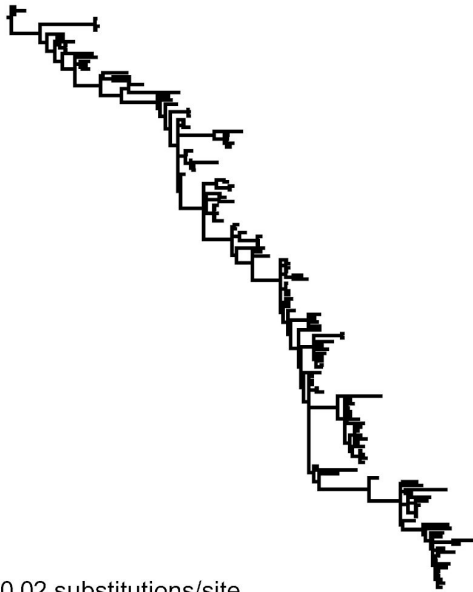
Evolution of influenza and other viruses

<https://nextstrain.org>



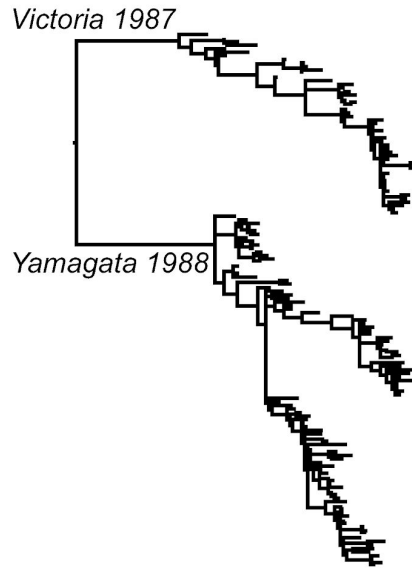
Phylogeny of flu tends to look like a ladder. Why?

Influenza A virus (H3N2)



0.02 substitutions/site

Influenza B virus



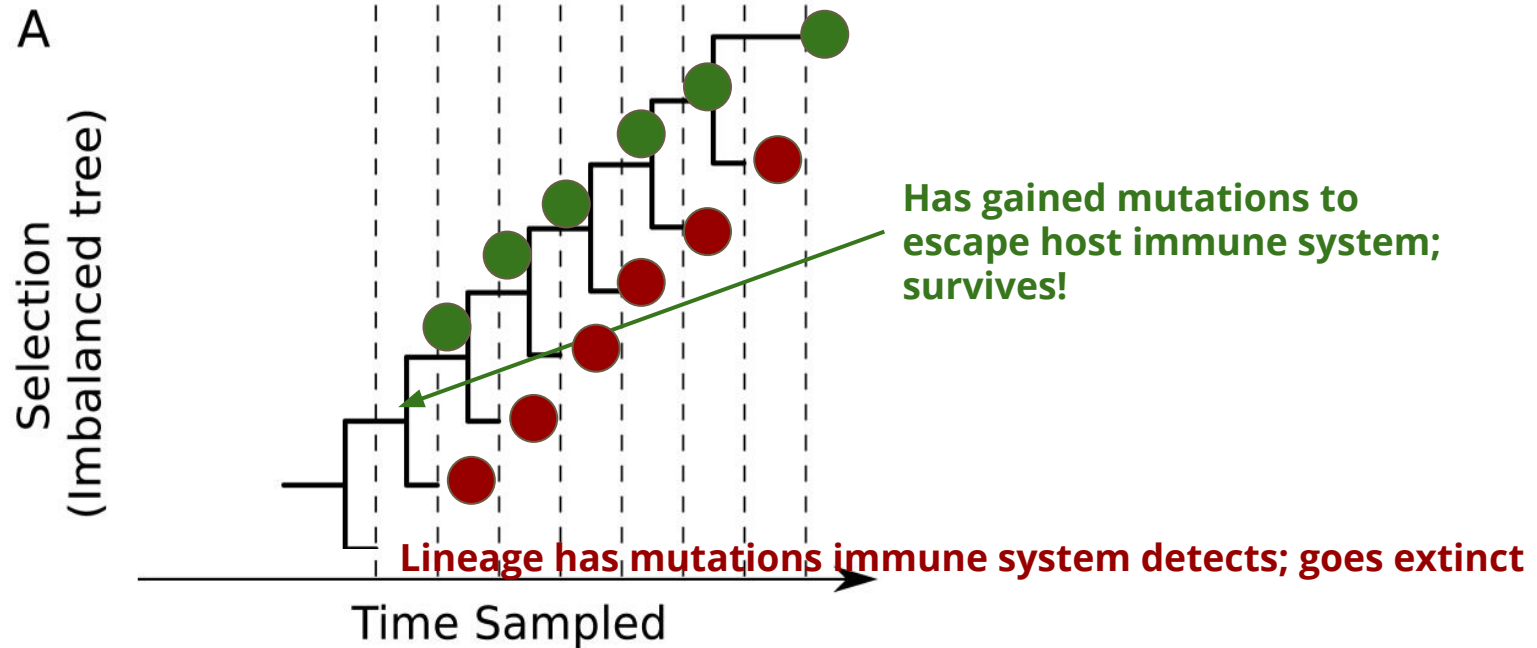
0.02 substitutions/site

H4 avian influenza virus

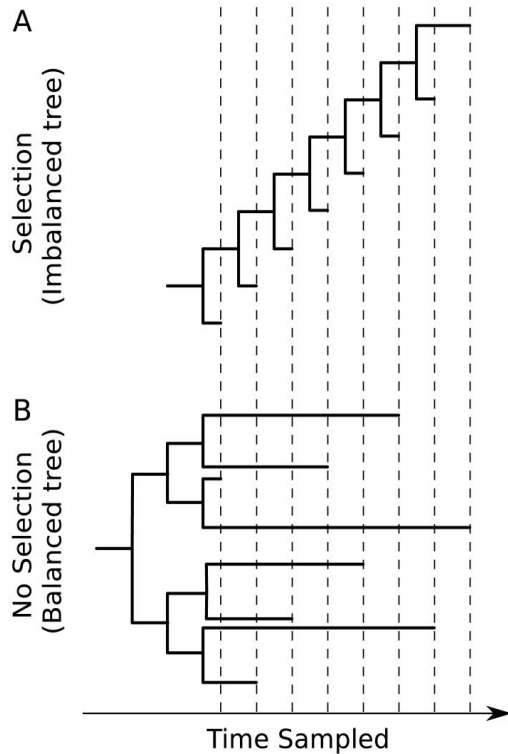


0.02 substitutions/site

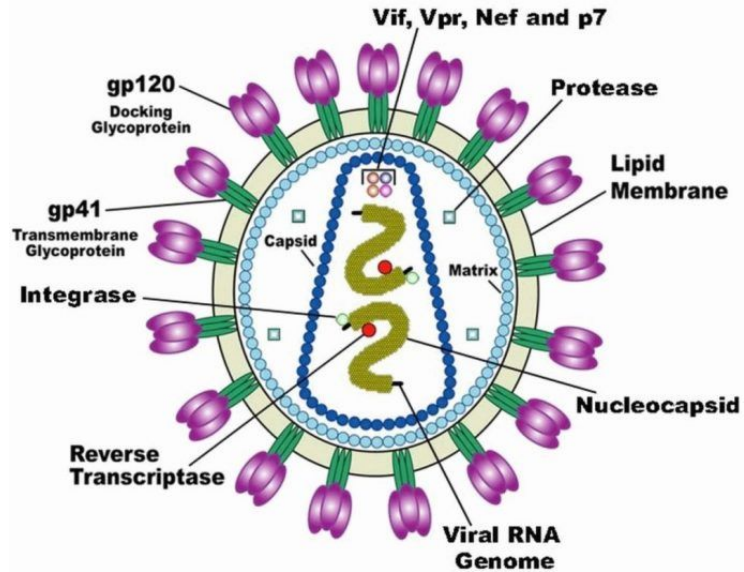
The virus experiences selection (from host immune system) - creates a characteristic phylogeny shape



Without selection, lineages randomly die or survive without the ladder ("imbalanced") pattern



The phylogeography of HIV



ANNOTATED GENOME OF HIV

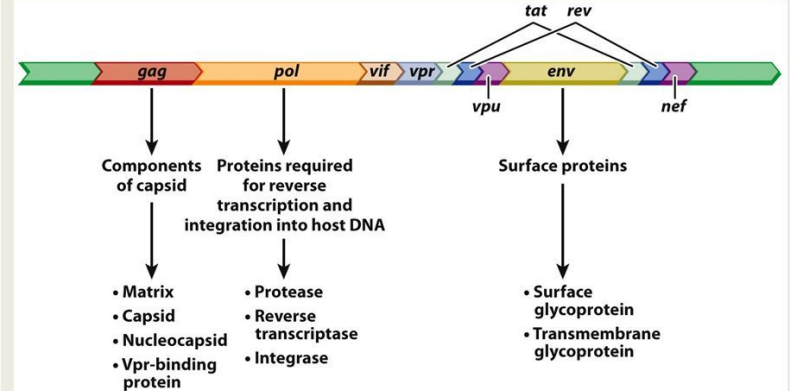
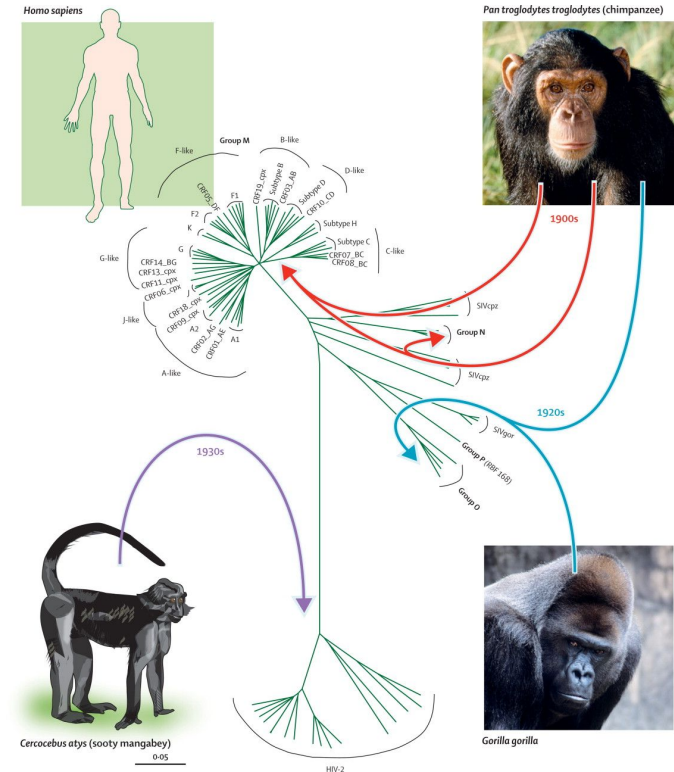
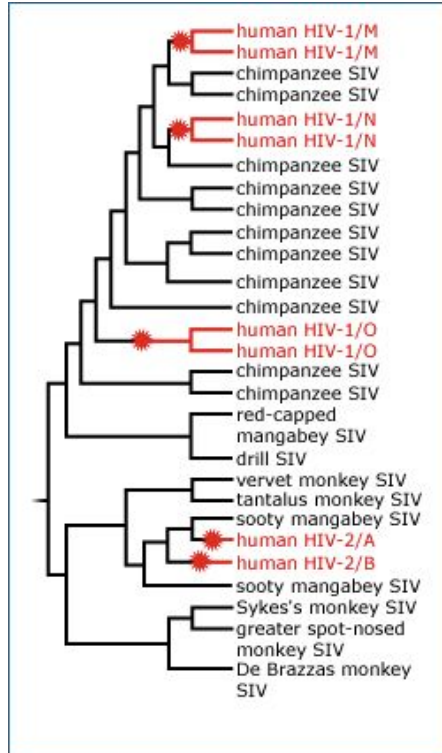
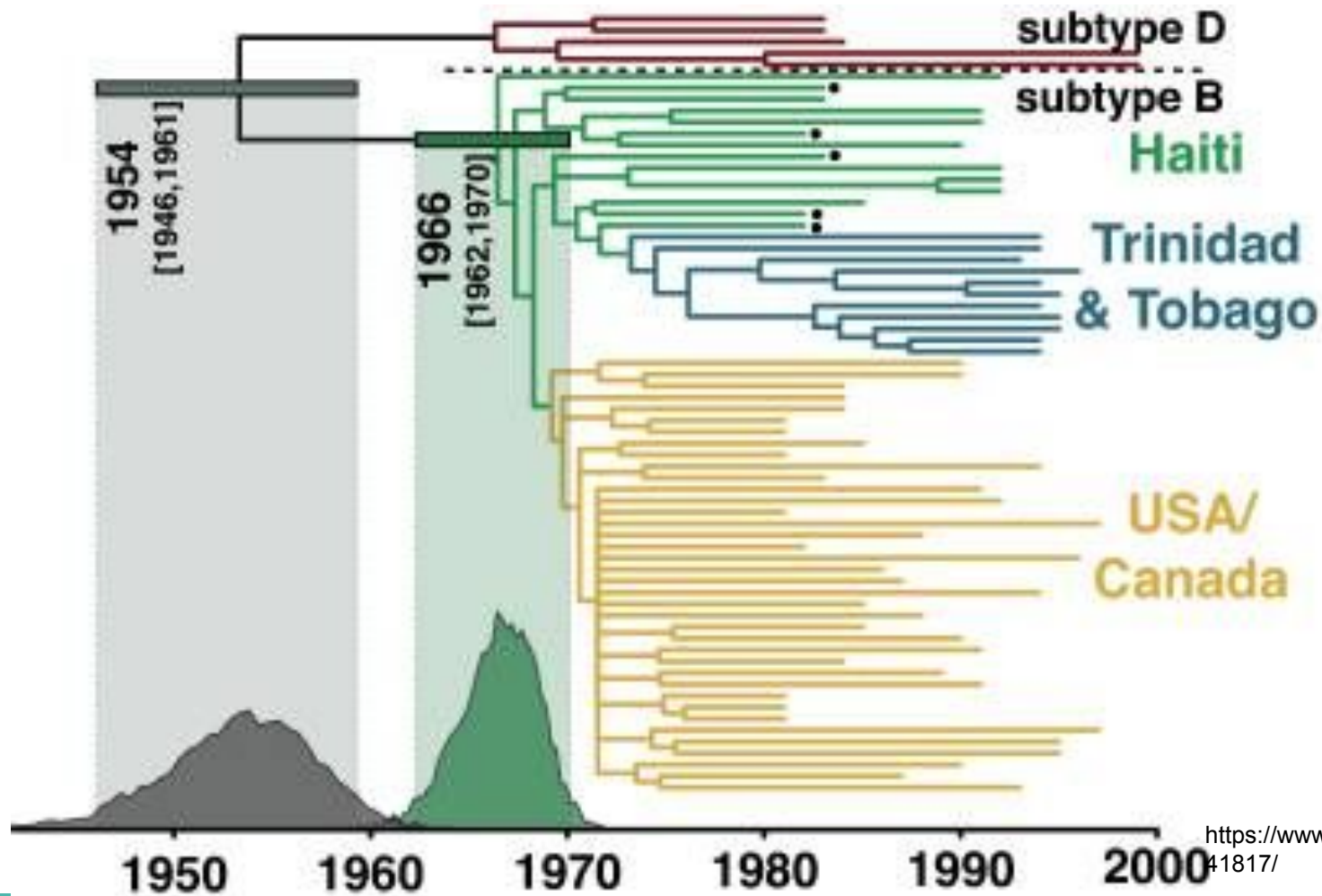


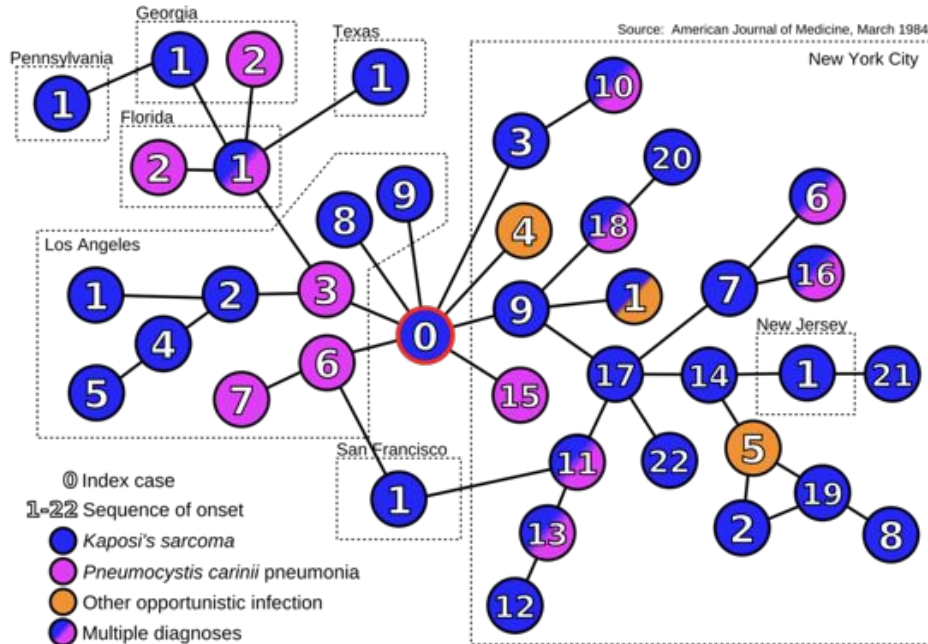
Figure 13.7
Biology: How Life Works
© 2014 W. H. Freeman and Company

A phylogeny of human HIV subtypes. Origin?





HIV in the United States: "Patient 0"



Auerbach, David M., et al. (1984) Cluster of Cases of the Acquired Immune Deficiency Syndrome. *The American Journal of Medicine*.
http://ac.els-cdn.com/0002934384006685/1-s2.0-0002934384006685-main.pdf?_tid=575f8d1c-1899-41e7-b809-00000a0b35e8&acdnat=1491243433_290905aa956409af0e72f8fa23c6c156

Was Patient 0 the first American with HIV?

