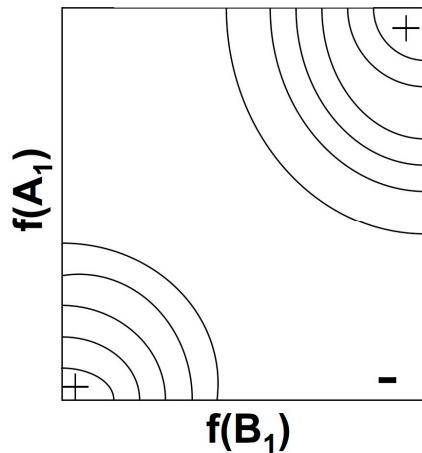


1). This is an adaptive landscape with the contour lines representing mean fitness as a function of allele frequencies at two loci. What are the genotypes in the four corners of the fitness landscape below?

From which corners is it possible for a population to start and subsequently speciate? What is epistasis and how does it influence your choice of locations on the fitness landscape where speciation is possible?



2.) An example of a well-studied ring species is *Ensatina escholtzii* found along the Pacific coast. Some researchers state that there is only one species. What is their evidence?

Others argue there is evidence that there are two species in southern California. What is their argument?

According to our definition of a species (a group of natural populations that is evolutionarily independent from other such groups), should we consider *Ensatina escholtzii* just one species or more than one species? Why or why not?

What would have to happen in order for this group to unambiguously be described as two separate species?

3.) Red crossbills are small finches specialized for eating seeds out of the cones of conifer trees. They fly thousands of kilometers each year in search of cone crops. Despite their mobility, crossbills have diverged into several types that differ in bill shape, body size, and vocalizations. Each type prefers to feed on a different species of conifer and each species of conifer is found only in widely separated forests. Bill size and shape affect how efficiently a bird can open cones of a certain conifer species.

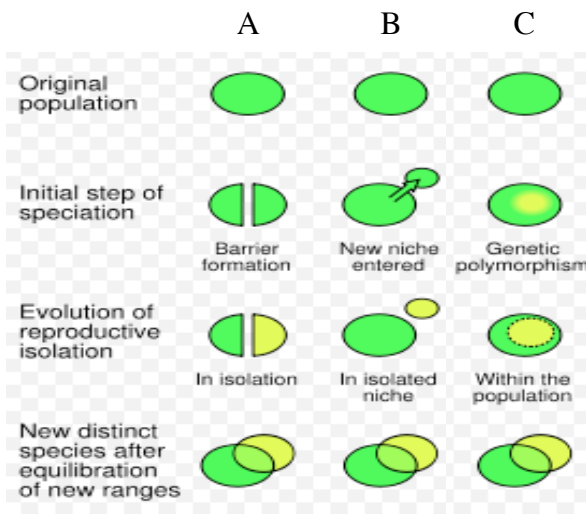
a.) give a scenario in which divergence arose in allopatry.

b.) give a scenario in which divergence arose in sympatry.

c.) if crossbills could not fly, do you think speciation would occur more rapidly or more slowly and why?

d.) if the conifer forest occurred in a broad, contiguous expanse, would speciation occur more rapidly or slowly and why?

4. Modes of speciation are diagrammed in the figure below. Name the mode of speciation for A, B, and C.



(Figure from Wikipedia)

Describe an example we discussed in class that represents each of the above modes of speciation.

5.) Paulson (1974) conducted field experiments using males and females of several species of damselflies (Family Coenagrionidae) to determine the relative importance of different types of reproductive isolating mechanisms in co-occurring (sympatric) species. Observation of attempted matings between males and females of different species suggest that males could not visually distinguish females of their own species from females of other species but when males attempted to mate with females of other species they were usually prevented from doing so because they were unable to secure a firm grip on the appropriate thoracic structures of females using their abdominal appendages. Interestingly, male abdominal appendages vary greatly across these species and their genitalia are very similar.

a.) what type/category of reproductive isolating mechanism is preventing production of offspring between different damselfly species?

b.) describe an example discussed in class where a similar isolating mechanism was preventing successful reproduction.

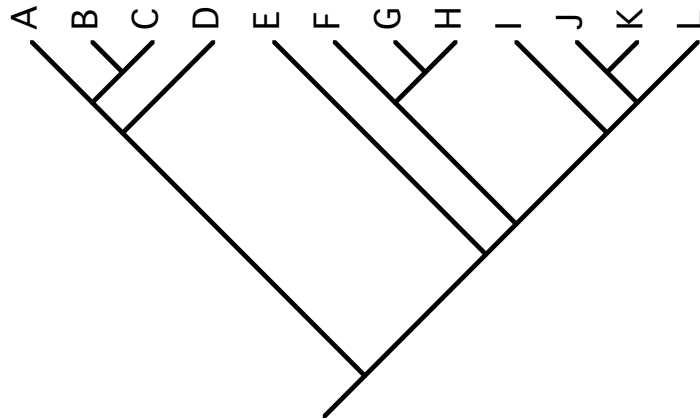
c.) based on the information provided, is it possible to determine the mode of speciation that underlies this case? Defend your answer based on what we've discussed in class.

6.) a. What is epistasis?

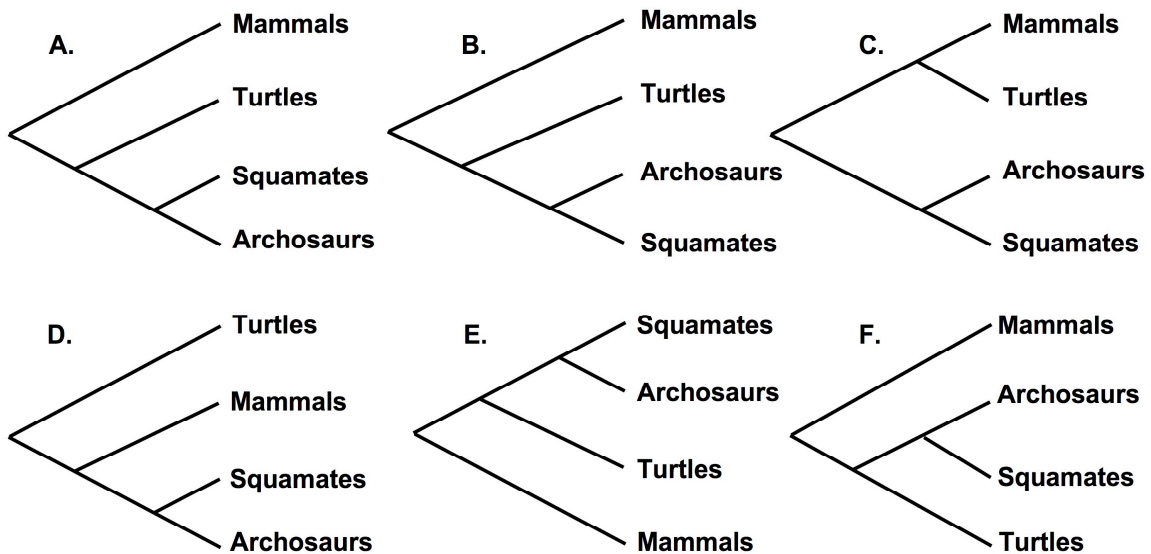
b. What role (if any) does epistasis play in the 1 locus and 2 locus genetic models we discussed in class?

7.) How does assortative mating facilitate speciation when there is no sexual isolation?

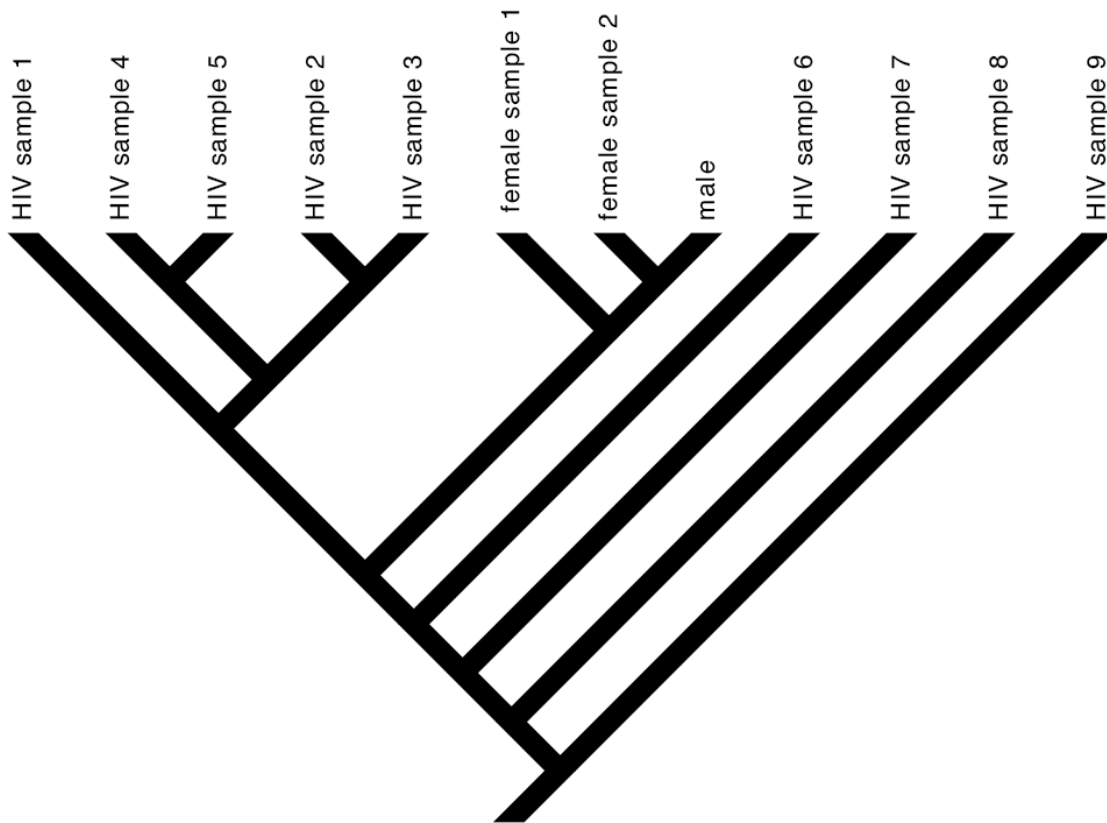
- 8.)
- The sister group of K.
 - The sister group of E.
 - The most recent common ancestor of A and L.
 - The most recent common ancestor of E and G.
 - All taxa that are more closely related to C than they are to D.
 - All taxa that are more closely related to K than they are to H.
 - Four monophyletic groups that include K (circle groups).
 - A paraphyletic group that includes F.
 - A polyphyletic group that includes L.



- 9.) Circle the trees that are the same phylogeny as tree A.



10.) In Stockholm, Sweden, a man went to trial and was convicted for the rape of a woman. Researchers later were able to compare HIV DNA sequence data from the convicted rapist and the victim. They built a phylogenetic tree, which included sequence data from the convicted rapist, the victim, and a random sample of nine other HIV infected individuals from Stockholm. Here's the resulting tree.

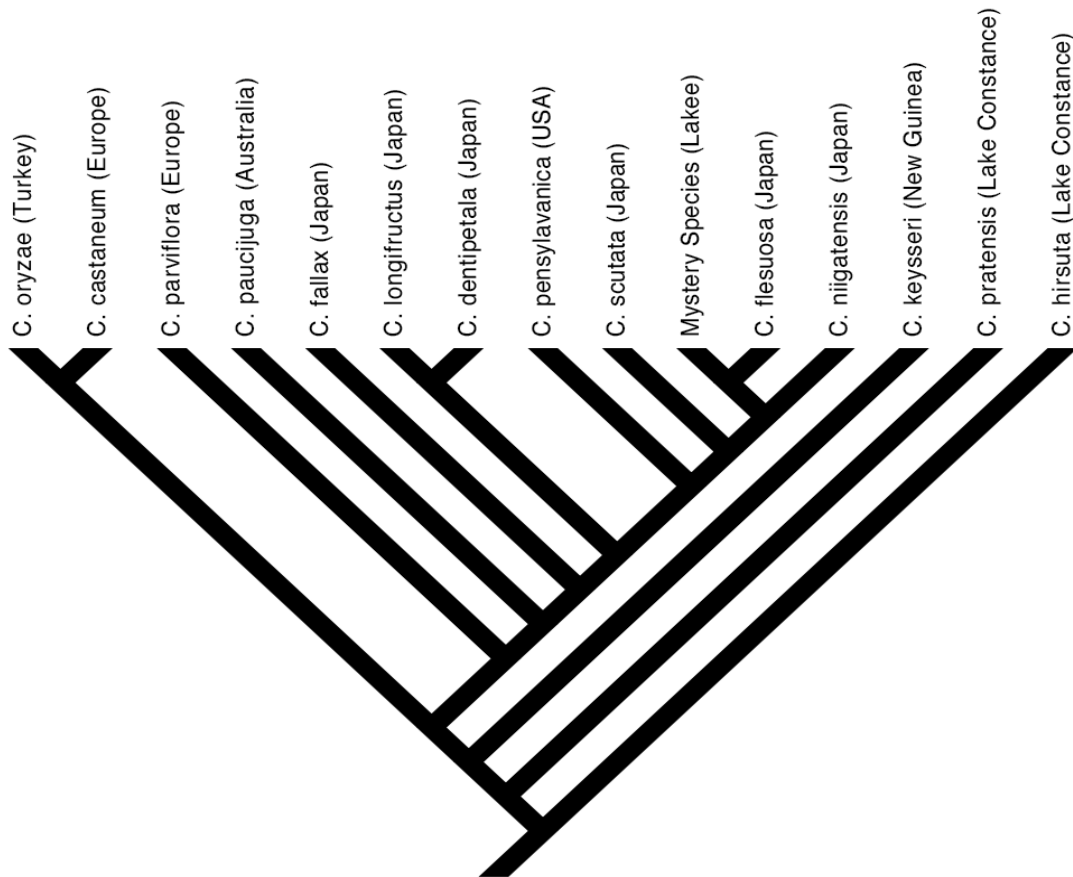


a.) does this tree support the guilty verdict given to this man? Why or why not?

b.) how would the results have to look like in order for you to change your mind?

c.) based on what we learned about the evolution of the HIV virus in class, how might you explain the fact that one HIV sequence from the female victim is more closely related to an HIV sequence from the male convict than it is to another sequence taken from the same female victim?

11.) In 2004 an unknown species of plant in the genus *Cardimine* was discovered along the shores of Lake Constance in Germany. The ecological community surrounding the lake includes many endemic species. Conservation biologists became very concerned about this possible invasive species. Two species of *Cardimine* are native to this region, *C. hirsutu* and *C. pratensis*. Two hypotheses were suggested to explain the presence of this potential invasive. The first hypothesis suggested that the new species was actually a hybrid between the two native species. The second hypothesis suggested that the new species had been introduced from another region. A phylogenetic analysis was performed in order to distinguish between these two hypotheses. The results of this analysis are shown below.



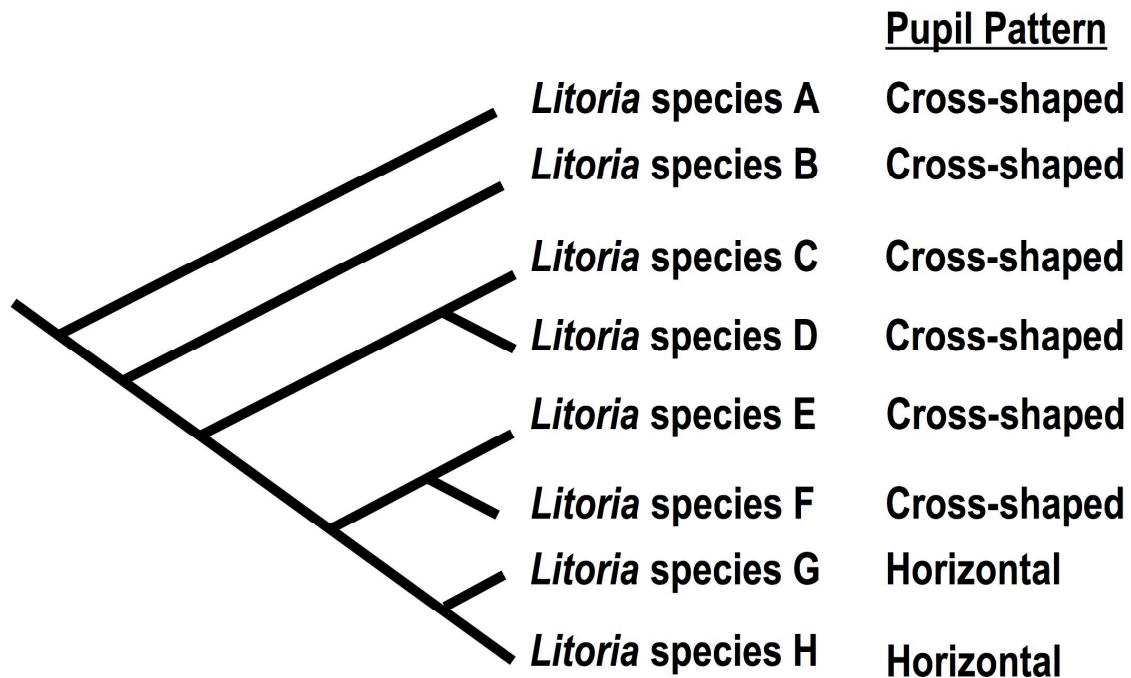
In the above tree the Query sequences (Lake Constance) represents the unknown species.

a.) based on the above tree, which of the competing hypotheses are best supported and why?

b.) in what region would you suggest this mystery species is native to and why?

c.) in what part of the tree would you expect to find the Mystery Tree in order to support the other hypothesis?

12.) Hylid frogs (true “tree” frogs) in Australia consist of three genera: *Nyctimystes*, *Cyclorana*, and *Litoria*, and a total of about 70 species (apparently, one species’ skin smells like curry!). The phylogenetic tree of the relationships among the *Litoria* species from the state of Victoria (denoted A-H) is shown below, along with information about **one** character in these frogs: Pupil Pattern. Using the tree & distribution of **character states** of this trait, answer the following questions:



a. What is the derived state for Pupil Pattern?

b. Mark on the tree where Horizontal pupils evolved.

c. Do the *Litoria* species that have cross-shaped pupils represent a paraphyletic or polyphyletic group? Justify your answer.