Your coolest friend approaches you with an interesting biological problem, and asks for your help making sense of it, "So I've got these drawings of some rare creatures from a far away region of the world. All I have are these old drawings by a guy named Camin, so I'm calling these creatures "Caminalcules". Apparently he travelled to this area back in the 70's and saw and carefully documented the physical traits of these animals. He also noted where he saw each creature, and made notes about finding more specimens in several sections of rock. I have his drawings, his map, and his geological sections, and I can show them to you here. Another guy, Gendron, published a phylogeny back in 2000, but I don't think it's right. I've made an attempt at making a new taxonomy, a hierarchical grouping, of the creatures. I've divided them into five small groups I'm just calling c, t, e, x, & z. I've further grouped those five into bigger groups: Blue group is z/x, Green group is z/x/e, Orange group is c/t, and the Gray group is all of them except for one I can't quite place.

1. (2 points) Help your friend by:

(1a) Determining what big group (colored box) the unknown creature best fits in and explaining why.

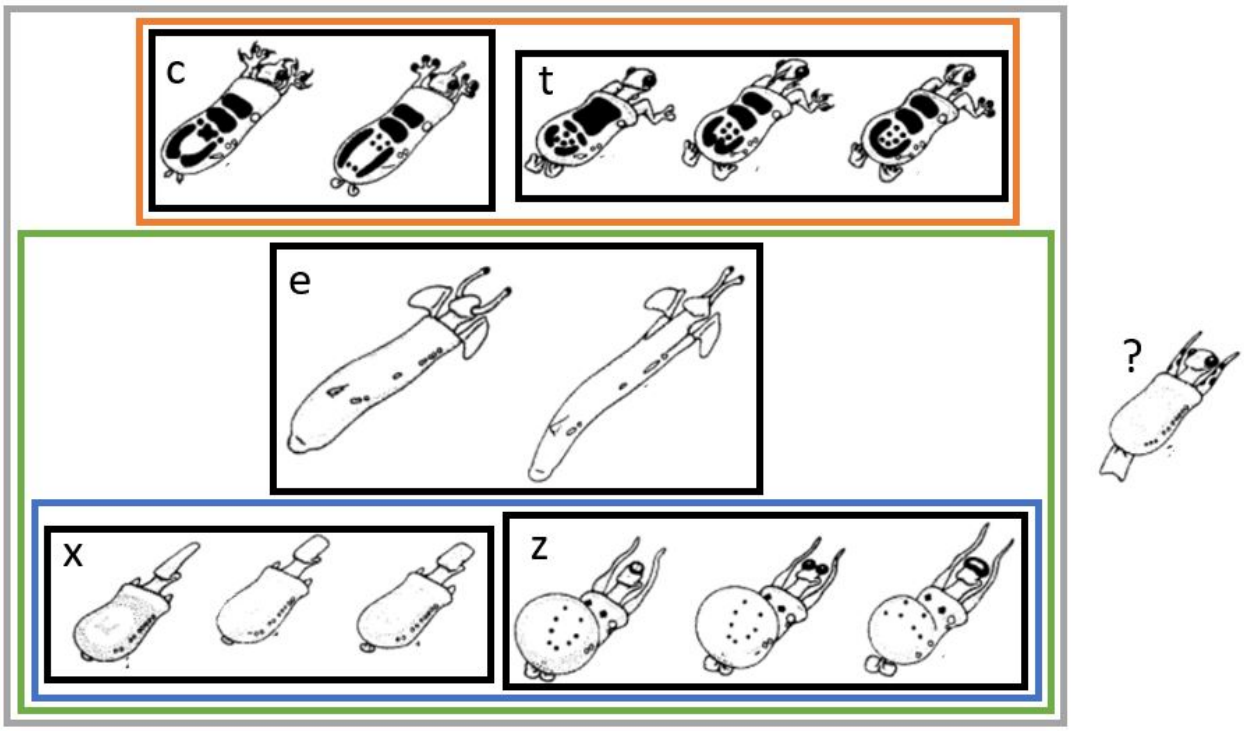
(1b) Determining how many times paired eyes evolved (i.e., are the paired eyes seen in the orange box homologous to, or convergent with, the eyes seen in groups e and one member of group z).

(1c) Identifying at least four traits that have probably evolved convergently, again assuming this set of groupings is correct.

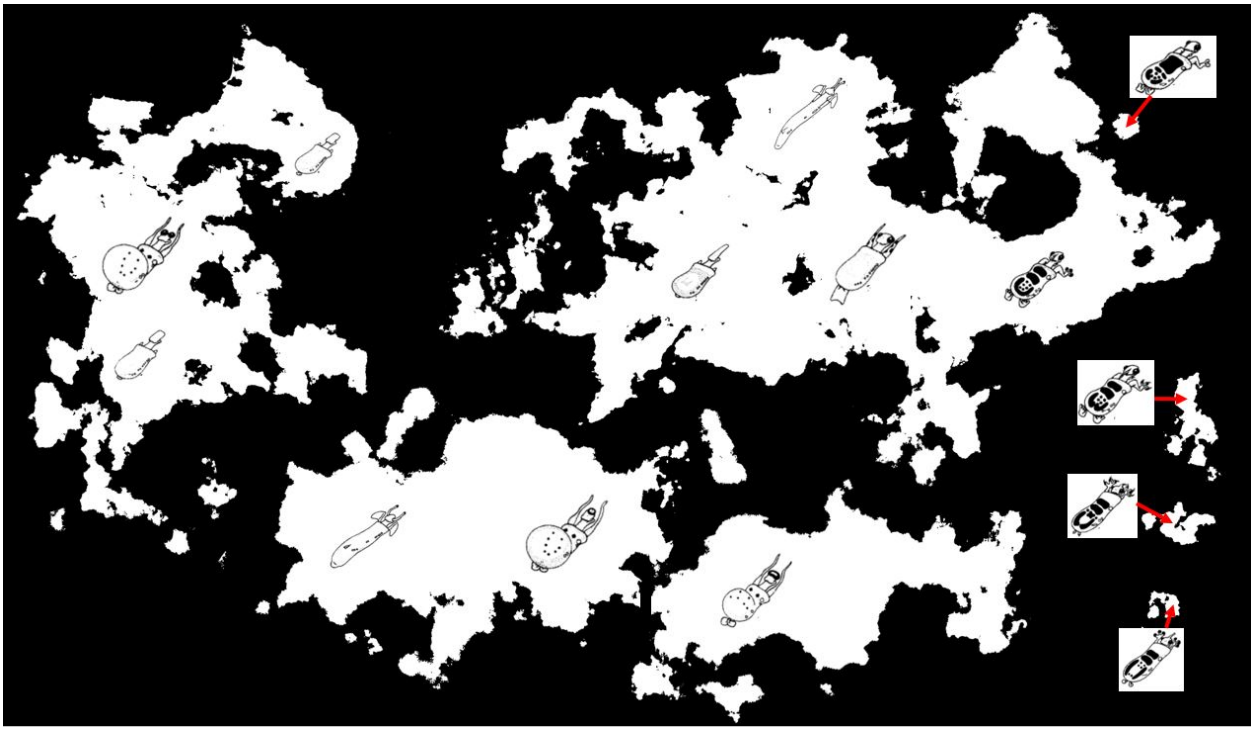
(1d) Proposing an alternative grouping that would have less convergence.

2. (1 point) Help your friend by finding (a) the *most likely* example of dispersal and (b) the *most likely* example of vicariance on the map.

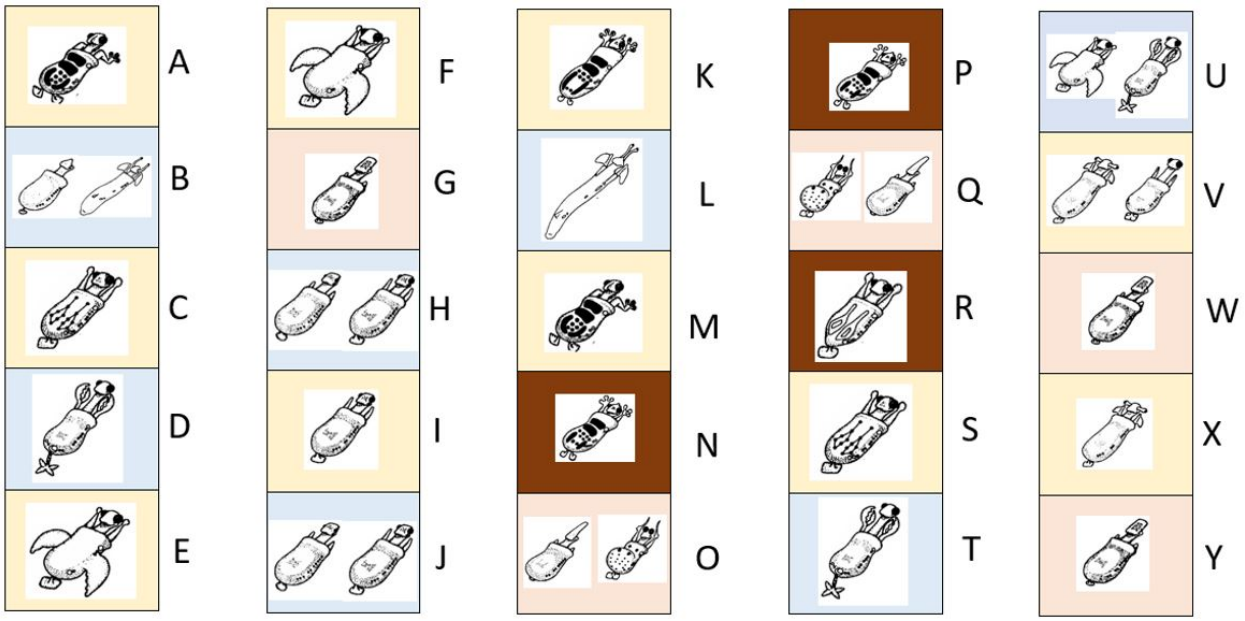
3. (2 points) Help your friend by determining the relative age of the fossils by organizing the rock layers (A - Y) from oldest to youngest. There may be uncertainty with regards to some layers, so make sure you are clear with your friend! You also need to be pretty clear about how you determined the relative age of these layers, so that your friend can better understand how to do it on their own in the future.



Proposed taxonomy & mystery creature



Biogeographic map of observations



Set of stratigraphic columns with fossil occurrences. Rock layers are colored by environment type, but that rascal Camin didn't include a key!