The Pangea Puzzle

Introduction

One of the most fundamental questions we can ask in geology is how the continents that we see today got to be in their current configurations. Data on the distributions of organisms in the fossil record make it possible to identify where they lived in the past, and that data can be used to help identify past continental positions.

To do this, paleontologists track the **occurrence** of fossil organisms, in other words where a species occurs in space (geographically) and when a species occurs in time (stratigraphically). The Paleobiology Database (PBDB, https://paleobiodb.org/navigator/) is a huge online database that seeks to catalogue all fossil occurrences, across all geologic time, and across the whole tree of life. It's the standard tool used by paleobiologists to track where fossil organisms lived and when.

Delving into the Database

Open the PBDB Navigator and spend some time getting comfortable with how it works:
https://paleobiodb.org/navigator/https://paleobiodb.org/navigator/
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The Navigator consists of three parts:

1. Map (**CENTER**) showing continents with dots representing fossil occurrences. The color of these dots represents their geologic age. If you click on the dots, you can see all of the information on each site and the fossil species that occur there.
2. Geologic time scale (**BOTTOM**) showing the major eras, periods, and stages. If you click on the timescale, the map will show you the location of all fossil occurrences from that time interval.
3. Tool bar (**LEFT**) showing the tools you can use to explore the database. These include:

+ −	zoom in/out on the map
	reconstruct plate tectonic configurations for time interval (era or smaller) you are exploring
	narrow down which taxonomic group is plotted on map
	create a diversity curve for the occurrences currently plotted on map
	download the data (lat/long, geologic age, etc.) for the occurrences plotted on map

Need help? Here's a Youtube video to help you get started:
https://www.youtube.com/watch?v=db2He3p-Jcohttps://www.youtube.com/watch?v=db2He3p-Jco
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Part 1: Construct a map of fossil distributions on the modern continents.

1. Enter *Lystrosaurus* in the search field and click enter.
2. The dots on the map show where in the modern world paleontologists have discovered fossils of *Lystrosaurus*.

   At this point, stop and consider your map. In 1-3 sentences, describe how are the occurrences of *Lystrosaurus* are distributed on the modern map. If you were to redraw this map during the time that *Lystrosaurus* lived, what do you predict will happen to the distribution of *Lystrosaurus* fossil localities?

3. The color of the dots on the map match those of the geologic time scale below, indicating the age of the fossils. You may need to zoom in a bit to get the dots to change to a specific color. Based on this matching, when did *Lystrosaurus* live?
4. Now, reconstruct the map at that time period by clicking on the name of the time period in the geologic time scale.
5. Note that the map changes, moving the continents to their positions during the time period that you clicked. In 1-3 sentences, describe changes in the distribution of your fossil. Also, save a copy of your map and paste it here.

Part 2: *Mesosaurus*, and *Glossopteris*

1. Enter *Mesosaurus* in the search field and click enter.
2. Look at the distribution for these fossils. Describe the distribution of this fossil on the land masses.
3. How do you think this animal might have gotten distributed in this pattern?
4. Look up some information on *Mesosaurus*. Now that you know what kind of animal it is, does your answer to number 3 still make sense?
5. When did *Mesosaurus* live? Now click on that time period in the geologic time scale and then click the plate position button. What is different about your map? Does it make more sense now in light of what you know about *Mesosaurus*? Why or why not? Also, save a copy of your map and paste it here.
6. Repeat this procedure for the taxa *Glossopteris*. What do all of these fossil distributions suggest? Save a copy of your map and paste it here.

Part 3: Marsupialia

Try the same procedure for Marsupialia, but instead of constructing maps in the Triassic, construct one for the Neogene (Ng) and then work your way back in time constructing a map for each period (Paleogene, Cretaceous, Jurassic, Triassic). What is the most recent time period when the continents including Marsupialia were connected? How does this help explain their current distribution (Australia, South America, and North America)? Also, save a copy of one of your maps and paste it here.

Part 4: Choose your own fossil

Now try the same procedure for any fossil that you think is interesting. Dinosaurs and marine mammals like whales and dolphins have a lot of data in the Paleobiology Database if you are having trouble thinking of one to try. Try one marine organism like a whale and another terrestrial organism, like a dinosaur. If you don't get very many dots, try a larger group of organisms like a family (Tyrannosauridae instead of *Tyrannosaurus* for instance).

Do you have the same predictions for how the distributions will change from the modern map to the paleo map for both the marine and terrestrial organisms? Why might the marine and terrestrial organism distributions behave differently? Save a copy of your map and paste it here.

What did you learn about the past distributions of your fossils? Are these distributions what you expected, or were you surprised in any way? If so, what surprised you?