Using the Paleobiology Database to Explore the Fossil Record Without Fossils

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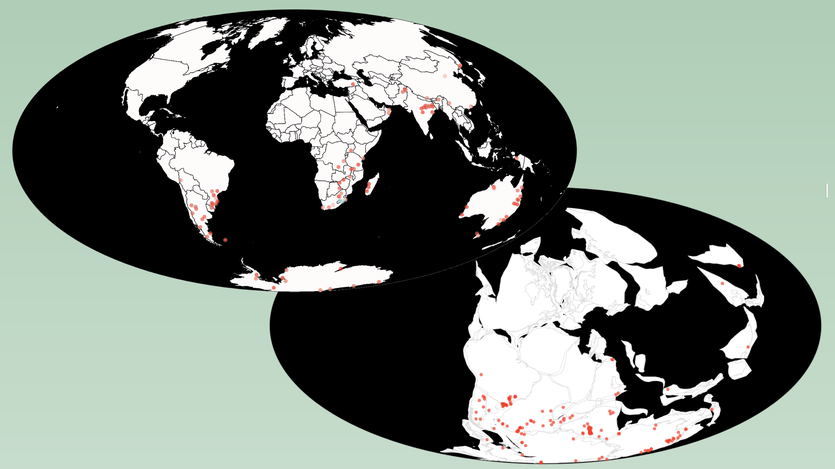
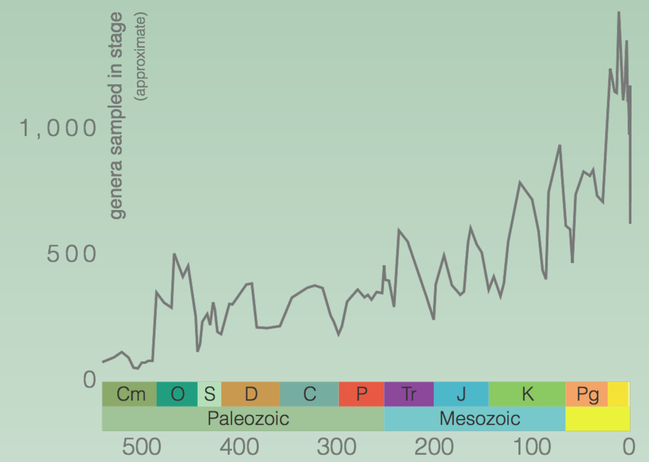
Abstract

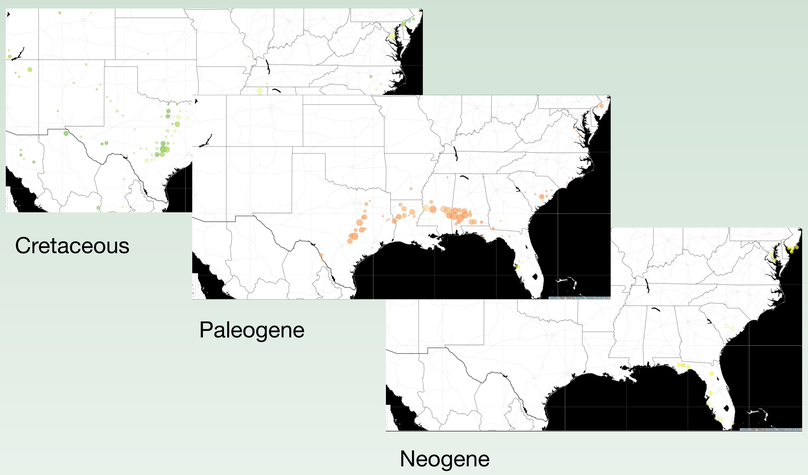
The Paleobiology Database (PBDB; paleobiodb.org) is a cyberinfrastructural initiative that compiles data on all types of fossils, across all of geologic time, around the world, and encompassing the entire tree of life. It was originally constructed to help researchers answer the "big picture" questions about the evolution of life on earth and the relationship of the evolution of life to geological processes. A team of researchers and educators is now leveraging this vast resource of fossil data to teach undergraduate students about these same processes and relationships, effectively teaching some essential paleontological concepts without reference to fossil objects themselves. These lesson plans are being made freely available to all, and in addition, the team has constructed a Resource Uploader to allow anyone who has developed lesson plans, research experiences, and other educational resources using the Paleobiology Database to share them with the world on the PBDB web site. It is hoped that this will broaden the study of paleontology to 2 year and 4 year undergraduate institutions that do not currently have fossil collections of their own and to enrich paleontologic learning for those that do. Lesson plans currently available and those under development are being assessed to determine how they affect student attitudes to undergraduate research using large scale databases.



Above: An example of a PBDB Navigator map generated by students to show the distribution of the fossil seed fern *Glossopteris* using today's geography, and the geography of the Permian, when the plant lived.



Above: A diversity curve of mollusks over the entire Phanerozoic. This curve shows that in general, mollusk diversity has increased over time, but through periods of boom and bust throughout their range in time.



Above: An example of a PBDB Navigator map generated by students to show the distribution of scleractinian corals that mark the shallow water environment of the coastline during the Cretaceous, Paleogene, and Neogene time periods.

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.

Above: An example of a research activity used by students to generate the maps above. Students are guided to perform the activity several times with individual organisms to help them understand the more general concepts of plate tectonics shifting continental positions over time, and how that affects our understanding of fossil distributions when the were alive.

Conclusions

Preliminary data from instructors using the PBDB research activities designed by the team as well as data from students who have used these activities show that the activities effectively convey the ideas being presented, and they also demonstrate to students that large datasets about fossils can be useful for research. Students who are shown how to use the PBDB report that they would use the PBDB to answer research questions about fossils in the future.

Future Plans

Additional research activities are currently being designed and tested. Completed research activities are also being revised based on feedback. Research activities are also being presented at professional meetings (Earth Educators Rendezvous, GSA etc.) along with the Resources Uploader to encourage more widespread use of these activities at 2 and 4 year institutions. Development of additional activities using the PBDB are also being strongly encouraged so that they can be uploaded to the system for widespread use.

Acknowledgements

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