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Accelerated rates of foraminiferal origination and extinction during the Late Paleozoic Ice Age

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The Late Paleozoic Ice Age (LPIA) was an interval from Late Mississippian through Early Permian time (~50 million years in duration) during which continental glaciers were widespread throughout the Southern Hemisphere. Marine invertebrates experienced unusually low rates of origination and extinction during this period. An explanation for this phenomenon is that cooler and more seasonal climates of the LPIA would have led to an increase in the stability of marine communities, as well as increases in the environmental tolerances, geographic ranges, and population sizes of marine species. Species with these attributes are resistant to extinction and also less likely to speciate via ecological divergence or geographic isolation; thus, the suppressed rates of evolution. Detailed work (by others) on brachiopods showed that the biotic effects of the LPIA were most pronounced at low latitudes, and that these invertebrates did, in fact, exhibit broader latitudinal ranges and longer stratigraphic ranges during the LPIA than during earlier and later non-glacial times.

In contrast to marine invertebrates, foraminifers experienced increased rates of origination and extinction during the LPIA. Analysis of foraminiferal occurrence records shows that their rates of origination and extinction accelerated in latest Mississippian time, fluctuated at relatively high levels throughout most of Pennsylvanian time before another episode of rapid acceleration at the Pennsylvanian-Permian boundary, and then gradually declined during the remainder of Early Permian time. These results suggest that not all marine organisms responded similarly to environmental changes during the LPIA and (or) that factors other than climate may have influenced foraminiferal evolution. Examples of non-climatic factors include:

- 1) global tectonic events that are known to have caused changes in marine circulation patterns and provinciality;
- 2) repeated glacio-eustatic sea-level changes that caused instability and shifting of neritic habitats.

It is also possible that high rates of foraminiferal evolution during the LPIA may have been triggered by a chance evolutionary innovation, such as the acquisition of fusiform morphology, followed by rapid diversification within the order Fusulinida. A prominent feature of the foraminiferal data is the close correlation between rates of origination and rates of extinction throughout the LPIA.