# Supercontinents and Evolution Reading

## Supercontinents and speciation

Charles Darwin observed that the finches of the Galapagos Islands seemed to have recently originated from a common ancestor (Figure 1). The birds had been selected for different conditions on isolated islands and become different species. This led Darwin to propose the theory of evolution by means of natural selection. Speciation triggered by geographic separation was an important argument used by Wegener to argue for the supercontinent of Pangea and the theory of continental drift.

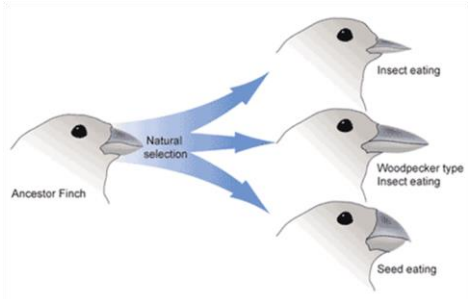


Figure 1: The Galapagos finches clearly came from a common ancestor, with variations selected for by different environments. (National Human Genome Research Institute 2013, public domain)

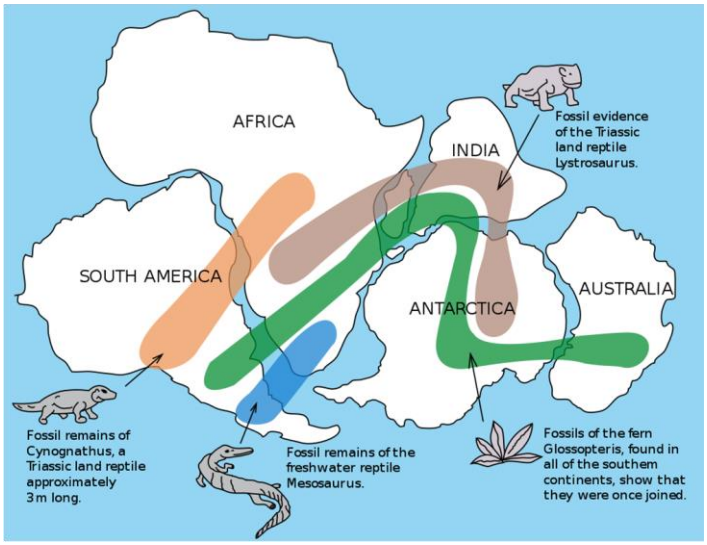


Figure 2: Supercontinents permit terrestrial and freshwater species to inhabit large areas. The distribution of such fossils was used by Wegener as evidence for Pangea. (USGS 1996, public domain)

The presence of identical fossil species along the coasts of Africa and South America was key evidence in Wegener's argument for the radical theory of continental drift. Fossil finds throughout the southern hemisphere supported the idea that continents were once connected (Figure 2).

The breakup of a supercontinent leads to a greater range of terrestrial species. Genetic isolation and different conditions result in natural selection for different traits on different landmasses.

## Supercontinents and major evolutionary events

The supercontinent cycle causes major shifts in global climate, geochemical cycling of carbon and sea level. Any one of these factors is likely to affect evolution, and the combination of all can have profound effects. The break-up of ancient supercontinents has been associated with the evolution of eucaryotes, poriferans (sponges), metazoans, vertebrates and endotherms (Figure 3). The timing of this association is not tight. However, major evolutionary events appear to correlate with rises in sea level during rifting.

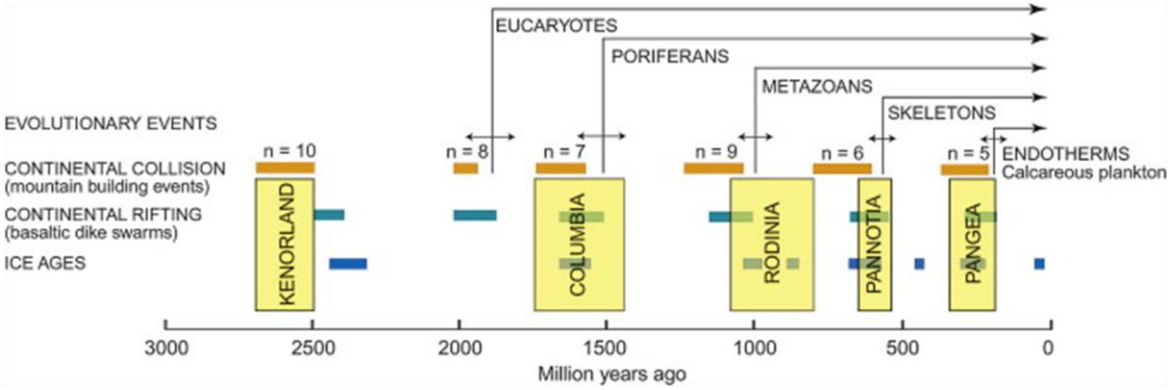


Figure 3: Comparison of major evolutionary events with events in the supercontinent cycle with the duration of supercontinents shown. (Figure 9 from Nance & Murphy, 2013)

## Supercontinents and mass extinction

The association of supercontinents and mass extinction is based primarily on the end Permian event. As noted above, the supercontinent cycle causes many global shifts that can have a profound effect on evolution. The Tunguss Trap (a.k.a. Siberian Traps) erupted during the integration of Pangea. This extensive period of mantle plume activity released huge volumes of carbon and toxic gases that not only led to global warming, but also ozone and oxygen depletion.

Although the end Permian extinction may be associated with Pangea, there are many other causes of mass extinctions in the Phanerozoic. These include marine regression (end Ordovician), changes in ocean and atmospheric chemistry (end Ordovician, Permian, Triassic and Cretaceous), climate change (end Devonian, Permian, Triassic and Cretaceous), volcanic activity (end Permian, Triassic and Cretaceous) and large extraterrestrial impacts (end Cretaceous and possibly Devonian or Permian). These events may cause local or global extinction. If a chain reaction causes a major disruption of Earth systems, a major extinction is more likely.

**References:**

Kious WJ, Tilling RI (1996). *This Dynamic Earth: The Story of Plate Tectonics*. USGS. Accessed 6 May 2020 from https://pubs.usgs.gov/gip/dynamic/dynamic.html

Nance RD, Murphy JB (2013). Origins of the supercontinent cycle. *Geoscience Frontiers* **4(4)**: 439-448. https://doi.org/10.1016/j.gsf.2012.12.007

Science China Press (2013). The biggest mass extinction and Pangea integration. Accessed 6 May 2020 from https://phys.org/news/2013-11-biggest-mass-extinction-pangea.html

University of California, Berkeley (n.d.). Understanding evolution: What causes mass extinctions? Accessed 6 May 2020 from https://evolution.berkeley.edu/evolibrary/article/massextinct_08