Biospheric Cooling And The Emergence Of Intelligence

David Schwartzman; Howard University, Department of Biology
George Middendorf; Howard University, Department of Biology

The long-term cooling history of the Earth’s biosphere implies a temperature constraint on the timing of major events in biologic evolution, e.g., emergence of cyanobacteria, eucaryotes and Metazoa apparently occurred at times when temperatures were near their upper growth limits. Could biospheric cooling also have been a necessary condition for the emergence of vertebrates and their encephalization? The upper temperature limit for vertebrate growth is about 10 degrees below the limit for Metazoa (50 degrees C). Heterothermy followed by full homeothermy was likely a necessary condition for greater encephalization because of the energy requirement of larger brains. The temperature differential between an animal and a cooler environment, all other factors equal, will increase the efficiency of heat loss from the brain, but too large a differential will shift metabolic energy away from the brain to the procurement of food. Encephalization has also entailed the evolution of internal cooling mechanisms to avoid overheating the brain. The two periods of pronounced Phanerozoic cooling, the Permocarboniferous and late Cenozoic, corresponded to the emergence of mammal-like reptiles and hominids respectively, with a variety of explanations offered for the apparent link. The origin of highly encephalized whales, dolphins and porpoises occurred with the drop in ocean temperatures 25-30 mya. Of course, other possible paths to encephalization are conceivable, with radically different solutions to the problem of heat dissipation. But the intrinsic requirements for information processing capacity necessary for intelligence suggest our terrestrial pattern may resemble those of alien biospheres given similar histories.