A comparative analysis of African Plio-Pleistocene patterns of environmental variability and biological evolutionary implications

Andrew Cohen[1], Anne Billingsley[1], Christopher Campisano[2], Rachel Lupien[3], Veronica Muiruri[4], R. Bernhart Owen[5], James Russell[3], Mona Stockhecke[6], Chad Yost[1], HSPDP Team Members[1]
[1]University of Arizona, TUCSON, USA. [2]Arizona State University, Tempe, USA. [3]Brown University, Providence, USA. [4]National Museums of Kenya, Nairobi, Kenya. [5]Hong Kong Baptist University, Kowloon Tong, Hong Kong. [6]University of Minnesota-Duluth, Duluth, USA

Abstract

Environmental variability has been hypothesized to play an important role as a driver of evolution, specifically through its role as a selective agent towards adaptation to unpredictable environments. In particular, variability selection has been proposed as an important factor in the radiation and extinction of hominins in Africa. To date, most attempts to evaluate the variability selection hypothesis have examined correlations between evolutionary events and either theoretical drivers of variability, such as insolation, or single paleoenvironmental indicators with an eye towards identifying episodes of higher variability. Here we report on a meta-analysis of patterns of variability in 30 long (>400 kyr) and highly resolved paleoenvironmental records from on and around the African continent spanning the last 5.3 Ma. These records include published marine and lacustrine cores, as well as outcrop archives of sedimentological, geochemical and paleoecological change. Our analysis uses a new normalization metric (comparison of binned standard deviations in detrended z-score time series) to allow comparison of different types of data across the Plio-Pleistocene study interval. The variability mean time series is strongly correlated with available long SST records around Africa, the $\delta^{18}O$ global marine stack and insolation, but not with CO_2. Consistent with prior studies (Potts and Faith, 2015), we observe a strong 400 kyr cyclicity in the variability means time series, strongly suggesting orbital forcing as an important driver of Neogene environmental variability in Africa. However, this cyclicity is superimposed on a long-term trend toward increasing variability throughout the last 3.5 Ma. Furthermore, major increases in variability predate the onset of significant Northern Hemisphere glaciation. Our findings suggest that if environmental variability selection during the Plio-Pleistocene in Africa has been an important evolutionary selective agent, then it is likely that those selective pressures have intensified through much of the course of human evolution.

Potts, R. and Faith, J.T., 2015, *Journal of Human Evol*. 87:5-20.