Population Genomics and Demographic History of South Asian Megafauna

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Abstract

Understanding the demographic histories of megafauna is essential for conservation biology and for resolving the relative roles of climate change and human impact in driving population decline. This thesis assembles one of the most comprehensive population-level whole-genome sequencing datasets for living megafauna to date, encompassing 534 individuals across eleven species from South Asia and Africa. Using a largely automated bioinformatics pipeline created for this study, long-term effective population size (N_e) trajectories were inferred using SMC++, alongside recent trajectories estimated using GONE2, providing complementary reconstructions spanning deep evolutionary history to the present. SMC++ trajectories revealed a broadly consistent pattern across species, with elevated N_e during the mid to late Pleistocene followed by progressive declines toward the present. In several species, this peak broadly overlaps the Last Glacial Maximum (∼20,000 years ago). Contrary to expectations, no clear distinction was observed between the demographic histories of South Asian and African megafauna, suggesting that shared global drivers — particularly climate cycles and human expansion — have shaped megafauna demography more strongly than region-specific factors. GONE2-derived recent N_e trajectories showed predominantly negative correlations with human impact variables across most species, consistent with associations between increasing human populations, land use expansion, and megafauna decline over recent centuries. Mixed-effects modelling of SMC++-derived trajectories against palaeoclimate and human arrival pressure indicated that the human-only model provided the best fit to the data. Both human pressure and mean annual temperature showed negative associations with N_e, although neither effect reached statistical significance, likely reflecting limited statistical power given the number of species analysed. Together, these results support a model in which megafauna demographic histories have been shaped by a combination of long-term climatic processes and more recent anthropogenic pressures, with human impact emerging as a key driver of recent population decline across species.

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