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Climatic variation and age-specific survival in Asian elephants from Myanmar

HANNAH S. MUMBY,[1,4] ALEXANDRE COURTIOL,[1,2,3] KHYNE U. MAR,[1] AND VIRPI LUMMAA[1,3]

[1]*Department of Animal and Plant Sciences, Alfred Denny Building, University of Sheffield, Western Bank, Sheffield S10 2TN United Kingdom*
[2]*Department of Evolutionary Genetics, Leibniz Institute for Zoo and Wildlife Research, Alfred-Kowalke-Strasse 17, 10315 Berlin, Germany*
[3]*Wissenschaftskolleg zu Berlin, Wallotstrasse 19, 14193, Berlin, Germany*

Abstract. Concern about climate change has intensified interest in understanding how climatic variability affects animal life histories. Despite such effects being potentially most dramatic in large, long-lived, and slowly reproducing terrestrial mammals, little is known of the effects of climatic variation on survival in those species. Asian elephants (*Elephas maximus*) are endangered across their distribution, and inhabit regions characterized by high seasonality of temperature and rainfall. We investigated the effects of monthly climatic variation on survival and causes of death in Asian elephants using a unique demographic data set of 1024 semi-captive, longitudinally monitored elephants from four sites in Myanmar between 1965 and 2000. Temperature had a significant effect on survival in both sexes and across all ages. For elephants between 1 month and 17 years of age, maximal survival was reached at ~24°C, and any departures from this temperature increased mortality, whereas neonates and mature elephants had maximal survival at even lower temperatures. Although males experienced higher mortality overall, sex differences in these optimal temperatures were small. Because the elephants spent more time during a year in temperatures above 24°C than in temperatures below it, most deaths occurred at hot (temperatures >24°C) rather than cold periods. Decreased survival at higher temperatures resulted partially from increased deaths from infectious disease and heat stroke, whereas the lower survival in the coldest months was associated with an increase in noninfectious diseases and poor health in general. Survival was also related to rainfall, with the highest survival rates during the wettest months for all ages and sexes. Our results show that even the normal-range monsoon variation in climate can