**Fast climate change drives pronounced changes in species’ genetic diversity**

Numerous species responded to past climate change by tracking suitable environmental conditions and consequently, altered their genetic make-up 1,2. Future climate change velocities will likely outpace species dispersal abilities 3, leading to further changes in the distribution of genetic diversity 4, local extirpations (REFS, e.g. Bellard, C. et al (2012) Impacts of climate change on the future of biodiversity. Ecology letters 15: 365-377 & Parmesan, C. (2006) Ecological and evolutionary responses to recent climate change. Annual review of Ecology, Evolution and Systematics 37: 637-669) and ultimately to extinctions (REFS e.g. the same as previous). Under different forecasted climate change scenarios species lacking genetic variability to survive in remnant isolated populations will appear particularly threatened 5. It is expected that species under stable climatic conditions (slow climate change velocity) reach stationary demographic conditions and stable levels of genetic diversity (REFS). Counterintuitively, it is also expected that fast range contractions better preserve species levels of genetic diversity 6. These opposite expectations hinder our ability to predict responses of genetic diversity to future changes in climate and thus, have only been investigated to a very small extent. For this reason, analyses of the differences in the response of species’ genetic diversity to slow and fast climate changes are of the critical importance.

Megafaunal replacements and extinctions in the Northern Hemisphere have been linked to abrupt climate changes based on Greenlandic ice core records (Cooper). Although informative, the use of extrapolated hemispheric trends contradicts recent studies showing that species with different ecological strategies experience climate change differently (Parmesan). And furthermore, that a high variance in the velocity of climate change is expected at broad spatial and temporal scales, and also across species (Serra-Diaz 2014). In order to evaluate the response of intraspecific genetic diversity to past climate change variability at broad spatial, temporal and at the species level must be accounted for. The use of global paleoclimatic reconstructions for consecutive time bins during the last 50,000 years, the now extensive fossil record and ancient DNA sequences available can be used to better understand species genetic dynamics during the Late Quaternaty. To our knowledge species’ genetic response to climate change has not been related to the pace climate change analyzing ancient DNA and fossil record from multiple species.

Climatic fluctuations during the Late Quaternary have been characterized as slow or fast (REFS). For example, Last Glacial Maximum was a relatively stable cold period (REFS). Oppositely, Younger Dryas and Bølling-Allerød events showed substantial changes in temperature in a small period of time (REFS). Estimation of past climate change velocities has been limited to two time bins (Sandel) impeding both the comparison of periods with different velocities, and subsequently to estimate the effect of climate velocity on species genetic diversity. Here for the first time we estimated climate change velocity for 36 time bins –from 50,000 years to present- for the Northern hemisphere. Then, we used x radiocarbon-dated fossils, x ancient and x modern DNA sequences for 11 species of mammals, and tested the prediction that there is a positive correlation between the velocity of climate change and the magnitude of change in genetic diversity.

Climate change velocities experienced by Holarctic species varied across taxa. Some species showed big transitions in climate change velocity (e.g. Mammuthus primigenius) and other species showed relative stability during the last 50 kybp (e.g. Crocuta crocuta) (Fig 1). Noteworthy, M. primigenius and C. antiquitatis showed several fast shortly spaced changes in climate velocity before going extinct (Fig 1), suggesting a link between the velocity of climate change and species extinctions. Patterns in the species climate change velocities concord with population extirpations and extinctions previously published. For example, Musk ox’s North east Siberia clade extirpation occurred around 48 kybp (Campos), and our estimate for the fastest change in climate for this species was 46 kybp (Fig 1). Similarly, Fastest climate changes experienced by the Bison (Fig 1 -15 to 10 kybp-) correspond with the most pronounced decline in population size estimated for this species (Drummond 2015), followed by a climatic stability period. In general, Climate change velocity was predominantly fast during Bølling-Allerød and Younger Dryas, contranstingly, climate stability was observed before and after these periods (Fig 1).

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