

## Deglacial enhanced summer monsoon improves snail species diversity in ecologically stressed region in East Asia

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The East Asian summer monsoonal margin is among the most vulnerable terrestrial ecosystems to climate change, but how their species diversity response to ongoing monsoon climate change remains uncertain. Understanding how organisms adapt to past glacial-interglacial climate change is important for assessing potential biotic responses to future climate change. Terrestrial mollusks are one of the most diverse groups of animals in the East Asian monsoon region, which fossil record can provide valuable information on the past response of organisms to natural climate change. Here, we present three well-dated high-resolution terrestrial mollusk records spanning the last 25,000 years from the northwest to the southeast of the Chinese Loess Plateau (CLP). Our fossil records show a significant increase of the mollusk species diversity from the last glacial maximum (~2-3 species) to the early-mid Holocene (~5-6 species) in Huanxian site (northwestern CLP). By comparison, mollusk species diversity in Yaoxian site (southeastern CLP) is always higher than that in northwestern sites, and their composition restructures without appreciably changing species diversity (with an average of ~8-10 species) from the last deglacial maximum to the early-mid Holocene. This is consistent with the East Asian summer monsoon progressively affecting toward northern region and their associated hydrothermal configuration since the last deglacial. The East Asian summer monsoon was a major and persistent influence in southeastern region of CLP over the last 25 ka, even during the last glacial stage, thus supported and maintained mollusk species diversity. Whereas in contrast, the marked weakening or disappearance of EASM intensity in last glacial will lead to the loss of mollusk species diversity in northwestern CLP. Our results therefore suggest that the advance of summer monsoon from southeast to northwest during the last deglacial period is the primary driver of the temporal-spatial pattern of the mollusk species diversity. The extent to which climate change affects biodiversity vary across different regions in CLP, and the ecologically stressed areas in the northwest are most susceptible to monsoonal climate change.