Turtle Abundance Through Miocene Climatic Transitions

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INTRODUCTION

Understanding past biological response to historical climate transitions is imperative for forecasting the effects of anthropologic climate change on modern and future faunas.

Few deep time vertebrate records are available to study, with the exception of the Cenozoic vertebrate fossil record of Nebraska, especially the Miocene (Voorhies, 1983).

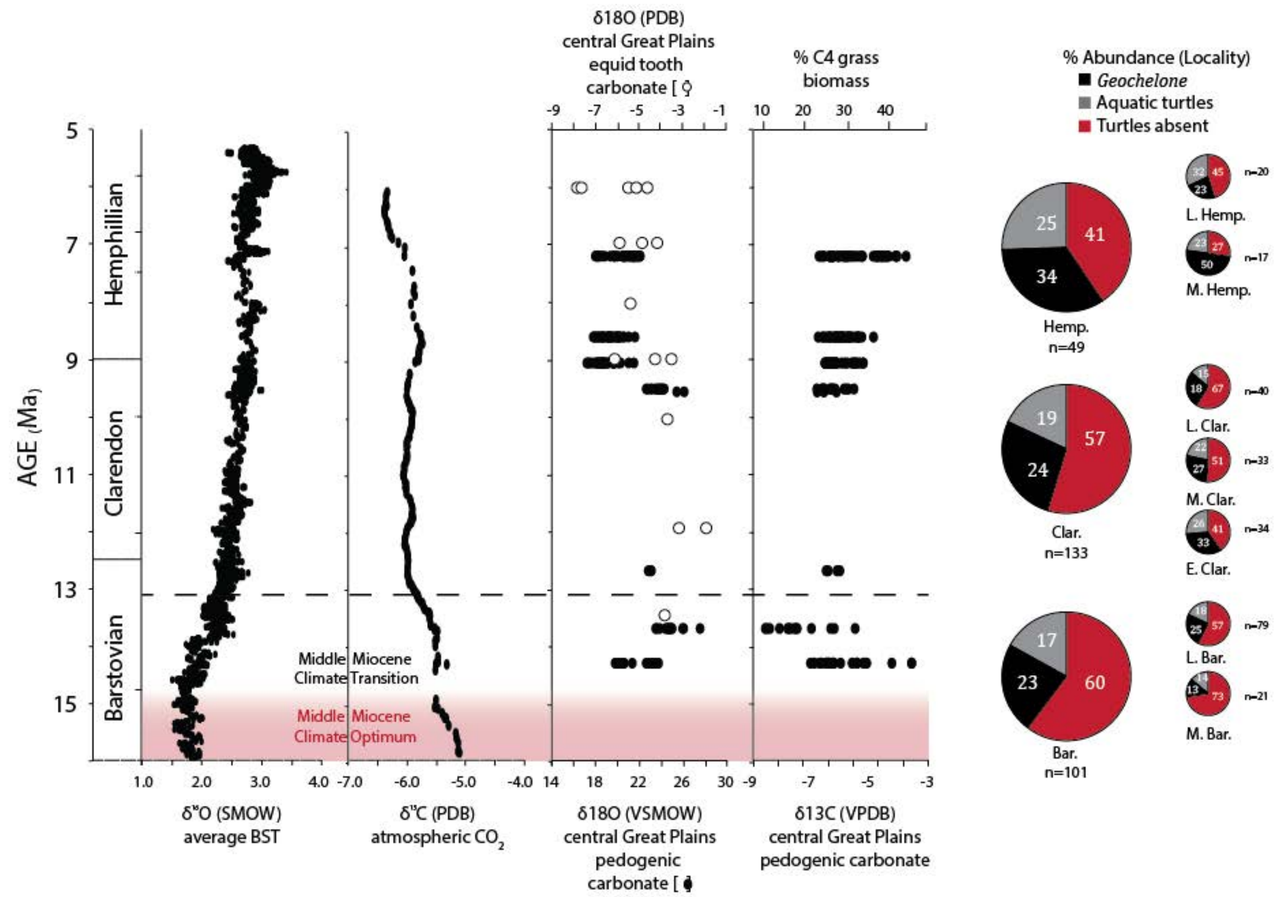
The Miocene includes a series of climate transitions. Within the Great Plains, climate change includes a transition from a warm and humid climatic episode known as the Mid-Miocene Climatic Optimum during the middle Miocene (21-14 MYA) to cooling and aridification during the middle to late Miocene.The shifts in climate correlate with shifts in both plant and animal biodiversity (Fox and Koch, 2003, Finarelli and Badgley, 2010).

Turtles of the Great Plains Miocene can be classified into two major climatically-sensitive ecologies: aquatic turtles (emydids, trionychids, chelydrids) and terrestrial turtles, or tortoises, represented by the giant *Geochelone.*

Reptiles such as turtles are useful for reconstructing paleoenvironments due to their ectothermic physiology (Head et al., 2009). Turtles are strongly limited geographically by minimum yearly temperature, with an additional limitation of surface water availability for aquatic turtles (Buhlmann et. al., 2009). Therefore, presence of either aquatic or terrestrial turtles can indicate regional environmental conditions.

Purpose: This research seeks to determine the scope of faunal response to climate change among environmentally sensitive vertebrates by measuring shifts in relative abundance of terrestrial and aquatic fossil turtles through the middle and late Miocene.

Comparison of Turtle Abundance and Climate Proxies during Miocene Climatic Shift



Left to Right: $\delta^{18}O$ ocean values indicating increased glaciation (Zachos et al., 2001), $\delta^{13}C$ atmospheric values indicating decreased global temperatures (Tipple et al., 2010), $\delta^{18}O$ equid tooth carbonate and pedogenic carbonate indicating increased seasonality of the Great Plains (Fox and Koch, 2004), $\delta^{13}C$ pedogenic carbonate indicating increased %C4 grass biomass (Fox and Koch, 2003).

MATERIALS & METHODS

I surveyed the University of Nebraska State Museum (UNSM) vertebrate fossil collection from the Miocene by fossil locality. The sample of localities was limited to the Barstovian (Bar.), Clarendonian (Clar.), and Hemphillian (Hemp.) North American Land Mammal Ages (NALMAs). Each NALMA was divided into Early, Middle, and Late temporal divisions, excluding Early Barstovian and Hemphillian due to sample size (n<15). I classified each locality for presence or absence of turtles, either aquatic or *Geochelone,* and determined relative abundance from these values.

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RESULTS & DISCUSSION

Overall increased abundance of both *Geochelone* and aquatic turtles from Barstovian and Clarendonian through the Hemphillian.

Geochelone Abundance

- Large (>10%) increases from M. Bar. through L. Bar. And E. Clar.
- Large decrease into M. Clar.
- Small (<10%) decrease into L. Clar.
- Large increase into M. Hemp.
- Large decrease into L. Hemp.

Aquatic Turtle Abundance

- Small increase from M. Bar. To L. Bar.
- Large increase into E. Clar.
- Small decreases through M. Clar. Into L. Clar.
- Small increase through M. Hemp. Into L. Hemp

Rise in %C4 grass biomass and increased terrestrial habitat due to aridification seems to have affected *Geochelone* abundance more than decreased temperatures.

Aquatic turtle abundance does not parallel decrease of temperature and aquatic habitat as expected.

Aquatic turtle abundance results could be due to ecological factors or error

- Increased niches due to increased heterogeneity of environment
- Sampling size of Hemphillian half the size of other NALMAs

Future Work

- Expand temporal range into Early Miocene and Pleistocene
- Body size evolution analysis of *Geochelone* through Miocene

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