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Filling the gaps: A comprehensive understanding of diets and ecosystem interactions within the modern and fossil small mammal communities of Meade Basin, Kansas

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Context and Motivation

- The modern Great Plains ecosystem began shifting from a C_3 plant-dominated biome to a C_4 grassland 5 MYA
- The Meade Basin in Southwestern Kansas contains a rich and fairly complete fossil record of a Great Plains small mammal community throughout the past 5 million years.
 - Stable isotope analysis (SIA) of these fossils provide a paleoenvironmental record of the shift from C_3 plant to C_4 grass biomass
 - SIA of fossils also provide a paleoecological record of species interactions and community dynamics.
- The goal of this project is to fill taxonomic gaps in the modern sample
 - The majority of the modern Meade dataset was derived from 5 years of live and this sample is inherently biased towards small bodied and nocturnal species.
 - Incomplete understanding of modern ecosystem interactions hinders our interpretation of fossil isotopic datasets
 - Our samples are derived from biologic and anthropogenic collections, which contain remains of previously under sampled taxa within the small mammal community.
- This project uses SIA of bone collagen
 - Collagen sampling allows for a complete modern SI dataset and avoids capture bias
 - Collagen acts as a lifetime average of isotopes, while hair acts as a snapshot into a single time period

Study System

Epoch	Ma	Marker beds
Pleistocene	5.0	Lower Grand B (0.6-0.8 Ma)
Pleistocene	4.0	Upper Grand B (0.8-1.0 Ma)
Pleistocene	3.0	Upper Grand B (1.0-1.2 Ma)
Pleistocene	2.0	Upper Grand B (1.2-1.4 Ma)
Pleistocene	1.0	Upper Grand B (1.4-1.6 Ma)
Pleistocene	0.5	Upper Grand B (1.6-1.8 Ma)
Pleistocene	0.0	Upper Grand B (1.8-2.0 Ma)
Pliocene	5.0	Upper Grand B (2.0-2.2 Ma)
Pliocene	4.0	Upper Grand B (2.2-2.4 Ma)
Pliocene	3.0	Upper Grand B (2.4-2.6 Ma)
Pliocene	2.0	Upper Grand B (2.6-2.8 Ma)
Pliocene	1.0	Upper Grand B (2.8-3.0 Ma)
Pliocene	0.5	Upper Grand B (3.0-3.2 Ma)
Pliocene	0.0	Upper Grand B (3.2-3.4 Ma)
Pliocene	0.0	Upper Grand B (3.4-3.6 Ma)
Pliocene	0.0	Upper Grand B (3.6-3.8 Ma)
Pliocene	0.0	Upper Grand B (3.8-4.0 Ma)
Pliocene	0.0	Upper Grand B (4.0-4.2 Ma)
Pliocene	0.0	Upper Grand B (4.2-4.4 Ma)
Pliocene	0.0	Upper Grand B (4.4-4.6 Ma)
Pliocene	0.0	Upper Grand B (4.6-4.8 Ma)
Pliocene	0.0	Upper Grand B (4.8-5.0 Ma)
Pliocene	0.0	Upper Grand B (5.0-5.2 Ma)
Pliocene	0.0	Upper Grand B (5.2-5.4 Ma)
Pliocene	0.0	Upper Grand B (5.4-5.6 Ma)
Pliocene	0.0	Upper Grand B (5.6-5.8 Ma)
Pliocene	0.0	Upper Grand B (5.8-6.0 Ma)
Pliocene	0.0	Upper Grand B (6.0-6.2 Ma)
Pliocene	0.0	Upper Grand B (6.2-6.4 Ma)
Pliocene	0.0	Upper Grand B (6.4-6.6 Ma)
Pliocene	0.0	Upper Grand B (6.6-6.8 Ma)
Pliocene	0.0	Upper Grand B (6.8-7.0 Ma)
Pliocene	0.0	Upper Grand B (7.0-7.2 Ma)
Pliocene	0.0	Upper Grand B (7.2-7.4 Ma)
Pliocene	0.0	Upper Grand B (7.4-7.6 Ma)
Pliocene	0.0	Upper Grand B (7.6-7.8 Ma)
Pliocene	0.0	Upper Grand B (7.8-8.0 Ma)
Pliocene	0.0	Upper Grand B (8.0-8.2 Ma)
Pliocene	0.0	Upper Grand B (8.2-8.4 Ma)
Pliocene	0.0	Upper Grand B (8.4-8.6 Ma)
Pliocene	0.0	Upper Grand B (8.6-8.8 Ma)
Pliocene	0.0	Upper Grand B (8.8-9.0 Ma)
Pliocene	0.0	Upper Grand B (9.0-9.2 Ma)
Pliocene	0.0	Upper Grand B (9.2-9.4 Ma)
Pliocene	0.0	Upper Grand B (9.4-9.6 Ma)
Pliocene	0.0	Upper Grand B (9.6-9.8 Ma)
Pliocene	0.0	Upper Grand B (9.8-10.0 Ma)

Figure 1. Photos of creatures analyzed in this study

Figure 2. (above) Map of Kansas state, Meade County highlighted in pink

Figure 4. (left) Stratigraphic column of Meade Basin, KS

Figure 3. Identifying and taking hair samples from trapped rodents

Specimens

- 250 hair specimens, collected by live trapping
- 60 collagen samples, collected from owl pellets, raptor nests, prairie dog burrows, surface collections, and road kill
- 300 fossil enamel specimens, collected by screen washing

Figure 5. Examples of hair, collagen, and fossil sample type from left to right: road kill, rodent trap, owl pellet, and screen washing

Question 1: Modern Perspective

- How are dietary niches partitioned within a Great Plains small mammal* community?
- At the community level, how do small mammals reflect plant biomass in a grassland ecosystem?

*And some other common species

Figure 6. Species averages and standard deviation. Dashed lines indicate this study's collagen data, while solid lines indicate previous study's hair data. All data has been corrected for hair data.

Question 1a Observations

- Omnivorous generalists like the pocket mouse eat a combination of plant and insect diets and thus have more variable $\delta^{15}N$ spreads.
- Herbivorous generalists such as the prairie dog reflect annual and seasonal plant biomass variability, resulting in more variable $\delta^{13}C$ spreads.

Figure 8. $\delta^{13}C$ isotope data corrected for diet, organized by species. Data is a culmination of previous years hair data and this project's collagen data. Average plant biomass $\delta^{13}C$ value estimated using 78% C_4 biomass on landscape and modern plant isotopic values.

Question 1b Observations

- Modern species diets underrepresent the actual distribution of C_3 and C_4 plant biomass, as 78% of plant biomass in Meade are C_4 .
- At the community level, there is a full range of $\delta^{13}C$ diets which is, in general, biased towards the C_3 end of the spectrum. Differences among taxa are determined by ecology and niche partitioning.

Question 2: Geohistoric Interpretations/perspective

- Does the fossil small mammal isotopic record reflect changes in C_4 plant biomass over the past 5 million years in the Great Plains?
- How have the diets of major small mammal lineages changed in response to an evolving ecosystem?

Question 2a Observations

- Overall, there is a small mammal dietary expansion into C_4 space as C_4 plant biomass increases and evolves in the Great Plains paleoecosystem
- Possible community or taphonomic bias around 0.7MYA

Question 2b Observations

References and Acknowledgements

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[1] Martin, R., Peláez-Campomanes, P., Honey, J., Fox, D., Zakrzewski, R., Albright, L., . . . Goodwin, H. (2008). Rodent community change at the Pliocene–Pleistocene transition in southwestern Kansas and identification of the *Microtus* immigration event on the Central Great Plains. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 267(3-4), 196-207. doi:10.1016/j.palaeo.2008.06.017

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