QUANTIFYING THE HABITAT ASSOCIATIONS OF EXTINCT MAMMALS, INCLUDING HOMININS, IN PLIOCENE-PLEISTOCENE EASTERN AFRICA

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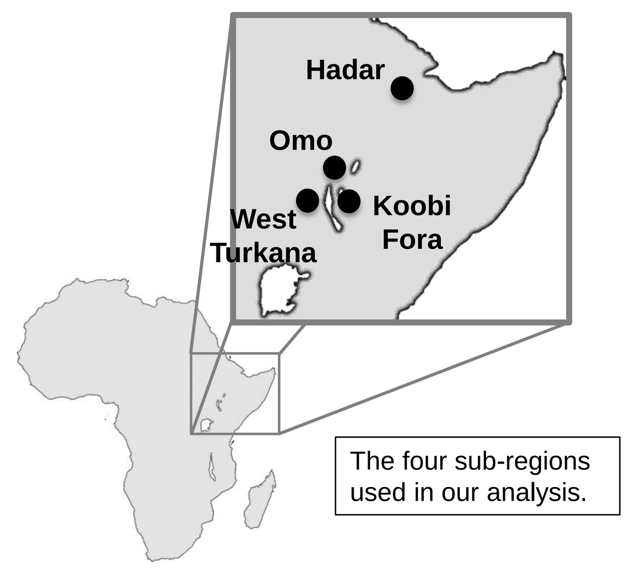
INTRODUCTION

- Previous researchers have inferred habitat associations of extinct mammals using functional morphology, stable isotopes, dental wear, and/or habitat associations of extant relatives
- These measures, however, are all ***indirect*** habitat indicators and do not measure the ***direct*** association between a taxon of interest and its inhabited environment
- Understanding the link between a taxon and its habitat is especially important because taxonomic composition of fossil mammal assemblages is often used to reconstruct the paleoenvironments in which they occurred

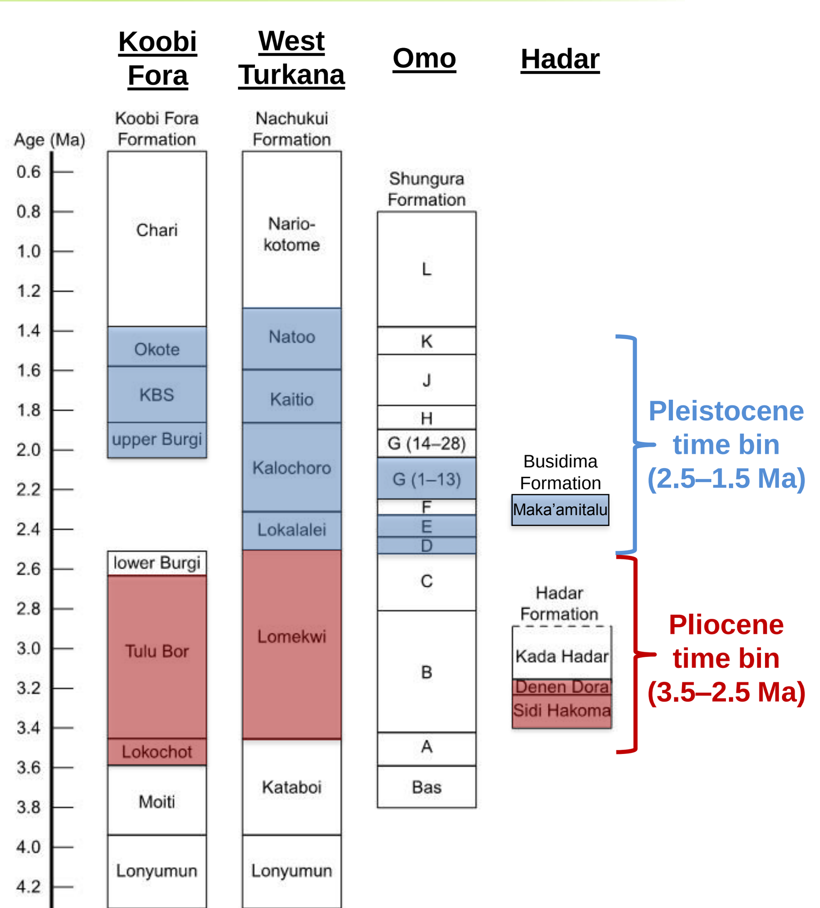
Research Objective

Here, we quantify the type and range of habitats occupied by fossil large mammals based on their observed associations with sites of varying woody canopy cover (estimated from pedogenic carbonates)

AREA & TIME PERIOD OF STUDY



The four sub-regions used in our analysis.



The two 1 Myr time bins used in our analysis. Shaded members are ones in which faunal and carbonate data could be spatially and temporally linked (see Methods).

Materials

- Genus-level large mammal abundance data from Turkana Database, American Omo Database, & Hadar Catalog
- Pedogenic carbonate data from Naomi Levin's public database (1)
- Transformed $\delta^{13}C$ into fraction woody canopy cover (2)

METHODS

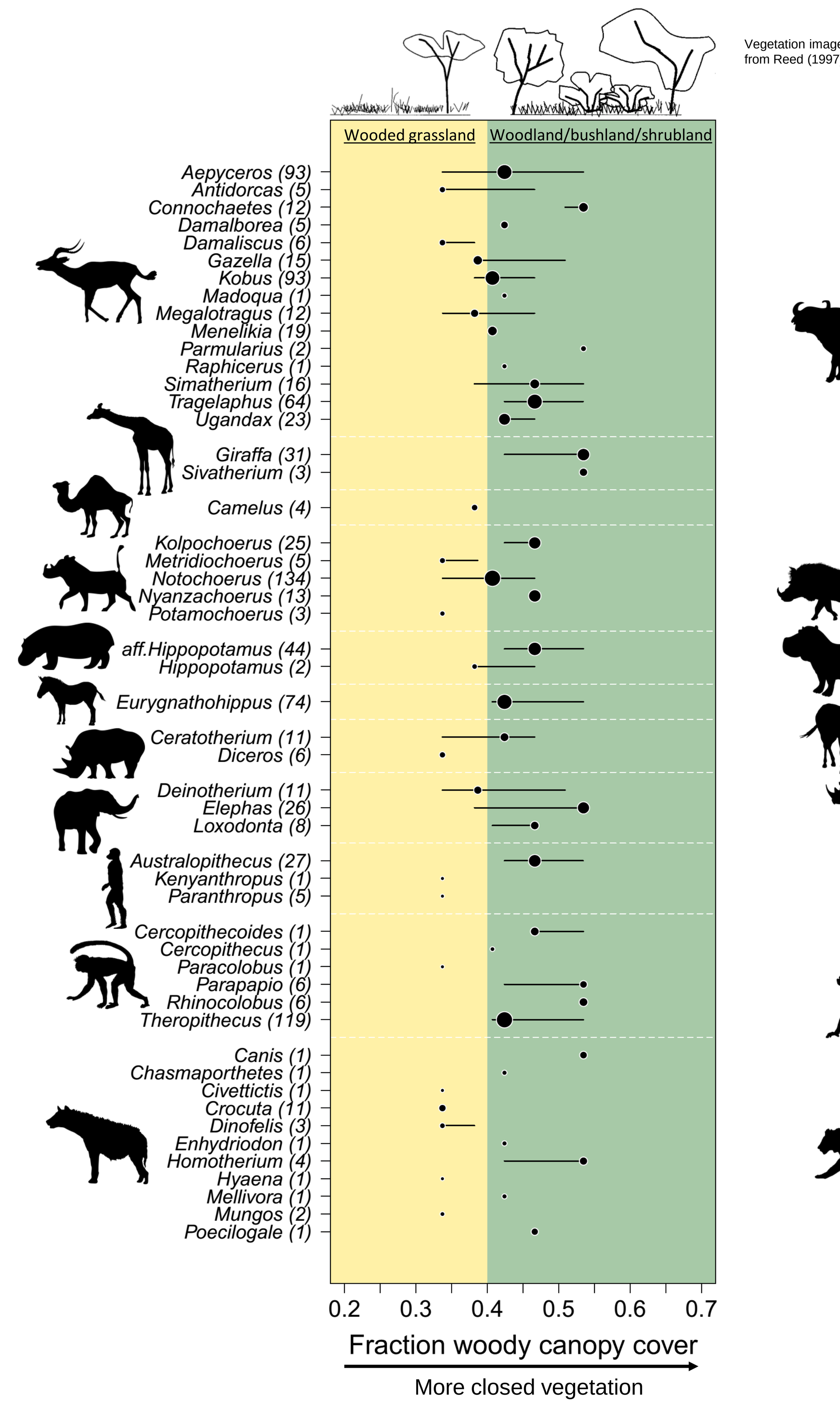
- Faunal and woody cover data were linked spatially and temporally and aggregated into analytical units called "sites." The amount of spatial- and temporal-averaging involved in this aggregation can be seen in the table to the right
- Median fraction woody cover was calculated for each "site"
- Relative abundance of genera was calculated member by member to control for sample size effects among members
- Weighted 25th, 50th (i.e., median), and 75th quartiles were calculated using the "rq()" function from the "quantreg" R package. Weights were a function of summed relative abundances across "sites" for each genus

Degree of spatial- and temporal-averaging of "sites" in each sub-region

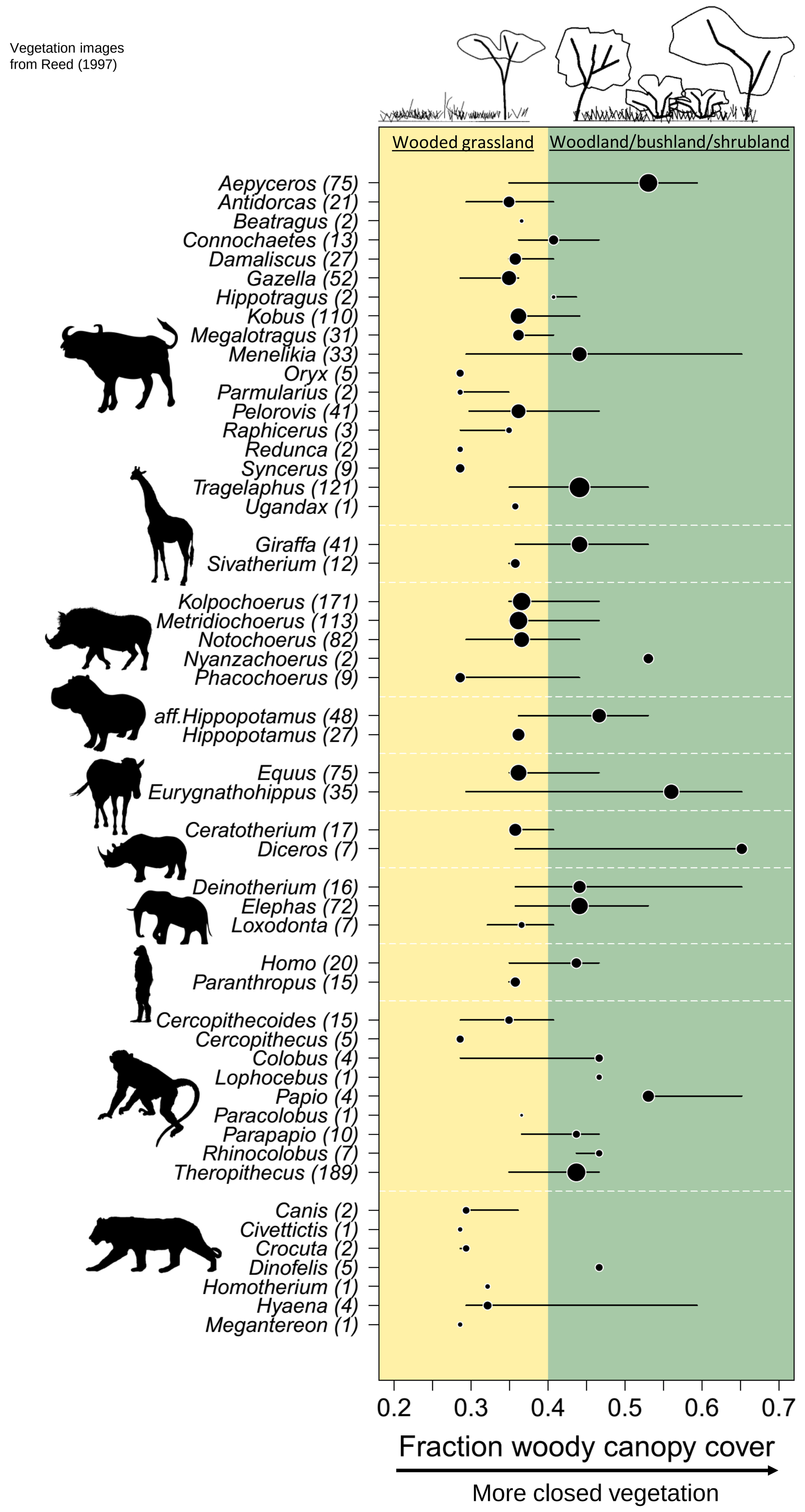
	Spatial	Temporal
Koobi Fora	10^{-1}-10^{1} km^2	10^5 yrs
West Turkana	10^{-1}-10^{1} km^2	10^5 yrs
Omo	10^{1} km^2	10^4 yrs
Hadar	10^{1} km^2	10^3 yrs

RESULTS

Pliocene time bin (3.5–2.5 Ma)

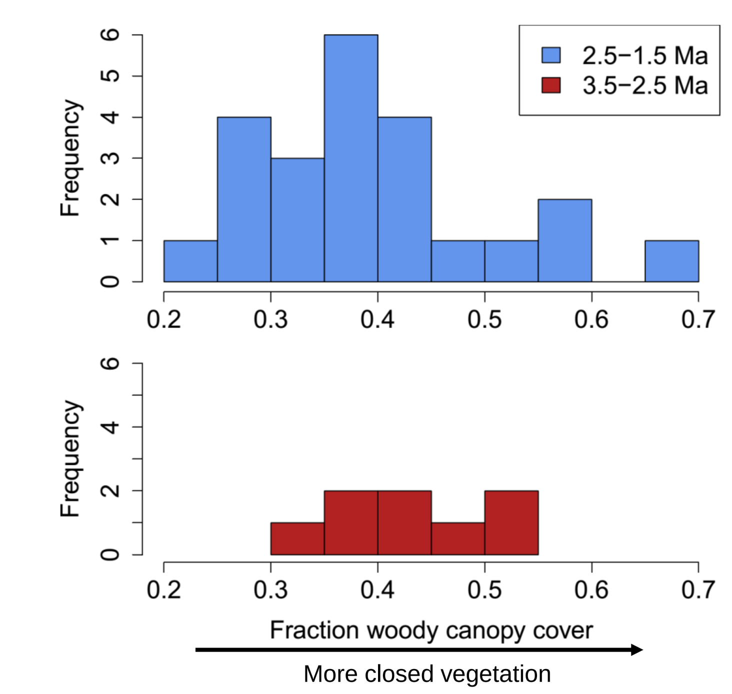


Pleistocene time bin (2.5–1.5 Ma)



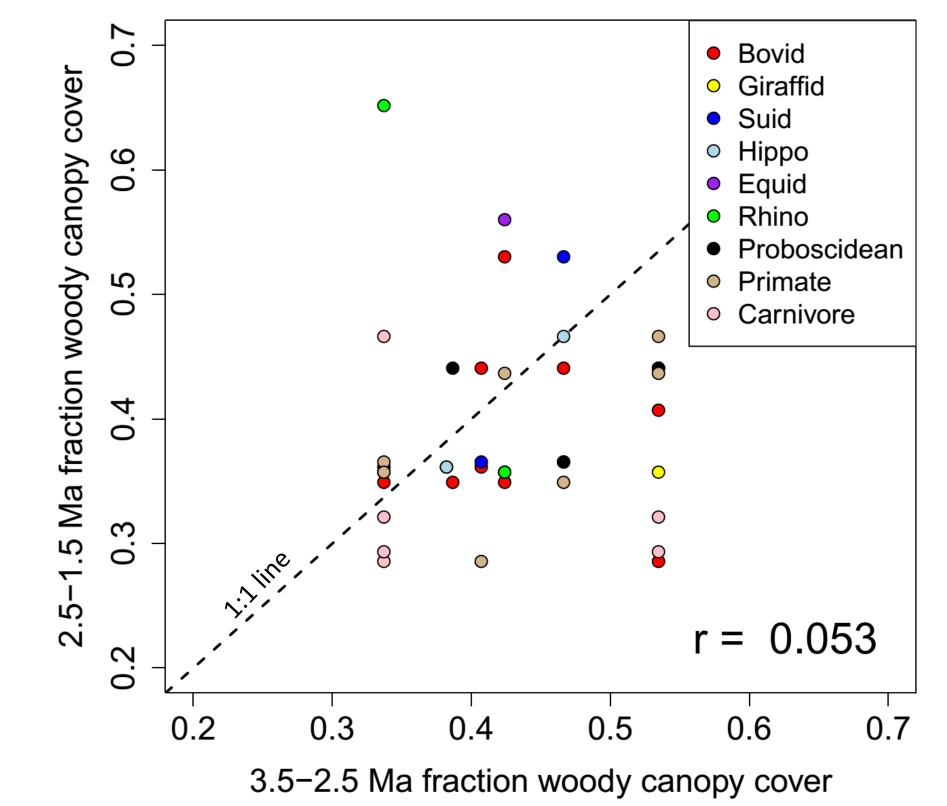
Points represent weighted medians, and lines represented weighted 25th & 75th quartiles. Line length can be interpreted as how generalized a genus is regarding habitat associations. Point size is proportional to summed relative abundances across "sites" for each genus. Absolute abundance is in parentheses next to genus name.

Distribution of "site" fraction woody canopy cover for each time bin

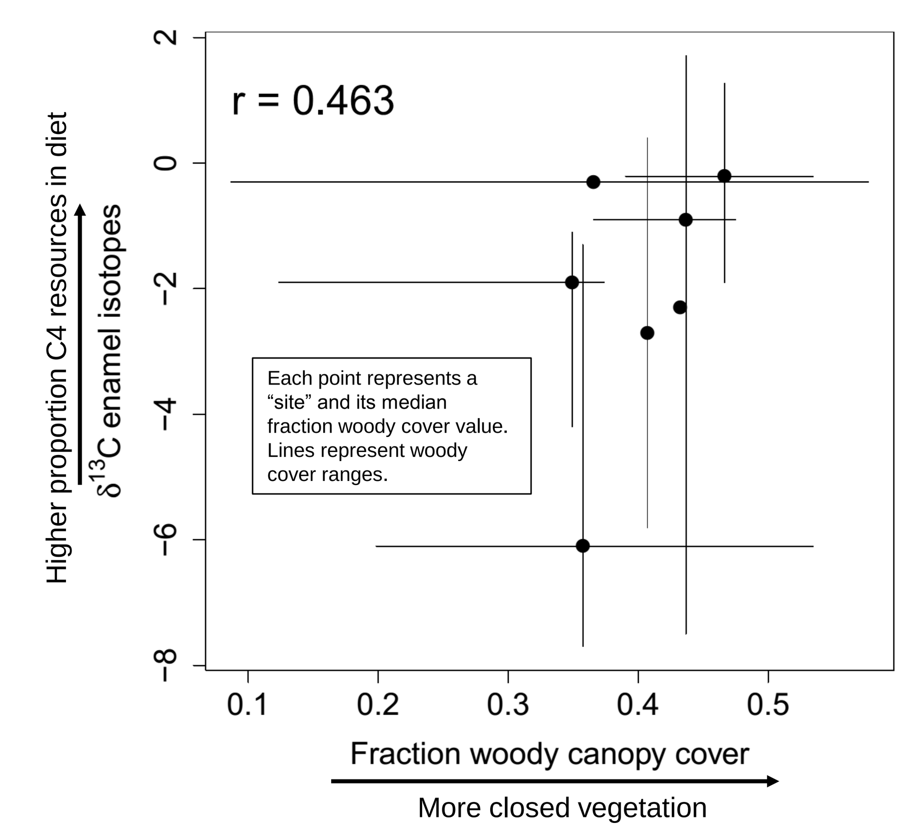


A larger number and range of fraction woody cover values are sampled in the later time bin. The right-skewed distribution in the Pleistocene may partly explain the increase in wooded grassland-associated genera, although there were still closed habitats for mammals to occupy.

For genera shared between time bins, how do habitat associations change through time?



Pleistocene habitat association is not a predictable function of Pliocene habitat association (r=0.052). 26 genera become associated with more open habitats, whereas 13 move in the opposite direction. Visually, these patterns do not seem to be non-randomly distributed across higher taxa.



Could pedogenic carbonates & fossil mammals be recording different parts of a time-averaged signal?

- Koobi Fora fraction woody cover compared to mammal enamel isotope data (3, 4, D. Patterson, unpublished) from the same member and collecting area (i.e., same "site")
- One would expect a negative correlation (more woody cover associated with consumption of less C4 resources), but it is positive instead

Potential explanations (not mutually exclusive)

- Mammals are not eating where they are dying
- "Sites" are too heterogeneous to be described by one woody cover value
- Mammals and pedogenic carbonates record different seasonal/climatic signals or do so at different spatial and temporal scales. This could be due to fossils coming from depositional environments and paleosols forming during drier, subaerial times, or the 10^2-10^5 years it takes pedogenic carbonates to form (5)

CONCLUSIONS

- We present a new method to quantify the types and ranges of woody cover habitats occupied by fossil mammal genera
- Some genera show expected habitat associations (e.g., Pleistocene alcelaphines) while others were more unexpected (e.g., *Theropithecus*)
- Most genera shift to more open habitats from the Pliocene to Pleistocene, but some shift to more closed habitats as well
- If these results represent ecological reality,
  - Many genera exhibit the capacity for high ecological plasticity or niche evolution
  - Reconstructing paleoenvironments using strict taxonomic uniformitarianism should be done with caution
- If these results do not represent ecological reality,
  - There is a lot of noise in comparing mammal and pedogenic carbonate data because they **record paleoecological information at different spatio-temporal scales.** Researchers therefore need to be mindful about the scale of their analysis and how this determines their proxy of choice and vice versa

ACKNOWLEDGMENTS

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