Cosmopolitan and endemic mammal dynamics of Cenozoic North America

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Extended abstract

Evolutionary paleoecology is defined as the study of the consequences of ecological properties, roles and strategies at any and all levels on the evolutionary process [5]. Biotic and abiotic interactions change over time and understanding their interplay is important for determining which ecological properties affect macroevolutionary patterns and how. How community composition has changed over time is of interest because community composition determines the range of plausible biotic interactions. Additionally, if change in taxonomic and life history composition is correlated with abiotic factors such as temperature, then our knowledge of the pattern of mammalian evolution in the past and in the future might be better constrained.

Previous work on mammalian site similarity has focused on distributions of terrestrial mammals in the Neogene Old World [3, 4]. Here I analyze the Cenozoic record of North America to understand if either dietary and/or locomotor categories affect the distribution of terrestrial mammals. Additionally, I analyze if shifts in taxonomic and life history composition are correlated with climatic change. To measure taxonomic distribution as a proxy for community structure, biogeographic networks were constructed between species and formation occurrence. Four different summaries of biogeographic network structure were used to assess changes in mammalian community structure through the Cenozoic.

Methods

Mammalian taxonomic occurrence information was obtained from the Paleobiology Database (`http://www.paleodb.org`). Occurrence information was restricted to only mammals occurring in North America during the Cenozoic. Ambiguously identified taxa were excluded from all analyses (e.g. aff., cf., ?). Temporal, geologic, and life history information was also compiled. Because terrestrial assemblages across the Cenozoic do not preserve as a complete record of community structure, abundance distributions were not analyzed.

Following Sidor et al. [6] and Vilhena et al. [7], bipartite taxa-locality networks were constructed. Here, taxa were defined as the occurrence of a unique species at a locality which is here defined as a formation. Biogeographic networks were constructed for uniform 2 My bins from the K/Pg to the Recent. This bin size was chosen for multiple reasons. Prior analysis has shown that the mammalian fossil record of the Cenozoic of North America is resolvable to approximately 1 My [1, 2]. Here, because I am interested in diversity dynamics across multiple formations, I used a bin width of 2 My to allow for every bin to be represented by minimum of two formations.

Biogeographic network structure was assessed using four previously defined measures [6]: average number of locality occurrences per taxon, biogeographic connectedness, code length, and average number of endemic taxa per locality.

Climate change, specifically temperature, was estimated using a benthic foram δO^{18} isotope curve of the whole Cenozoic [8]. Bin δO^{18} values were calculated as the average of all data points occuring in that bin.

Correlation tests were done between between the first differences of all biogeographic summary statistic time series and the δO^{18} curve.

δO^{18}

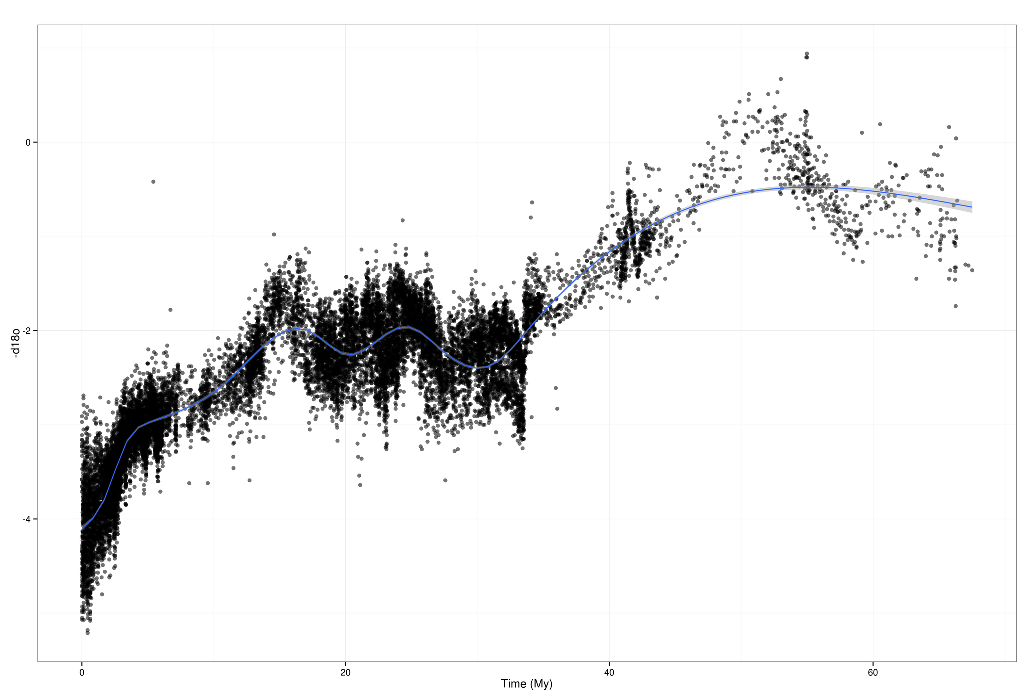

Figure 1: Oxygen curve [8] with fitted GAM to illustrate overall structure.

Biogeographic structure

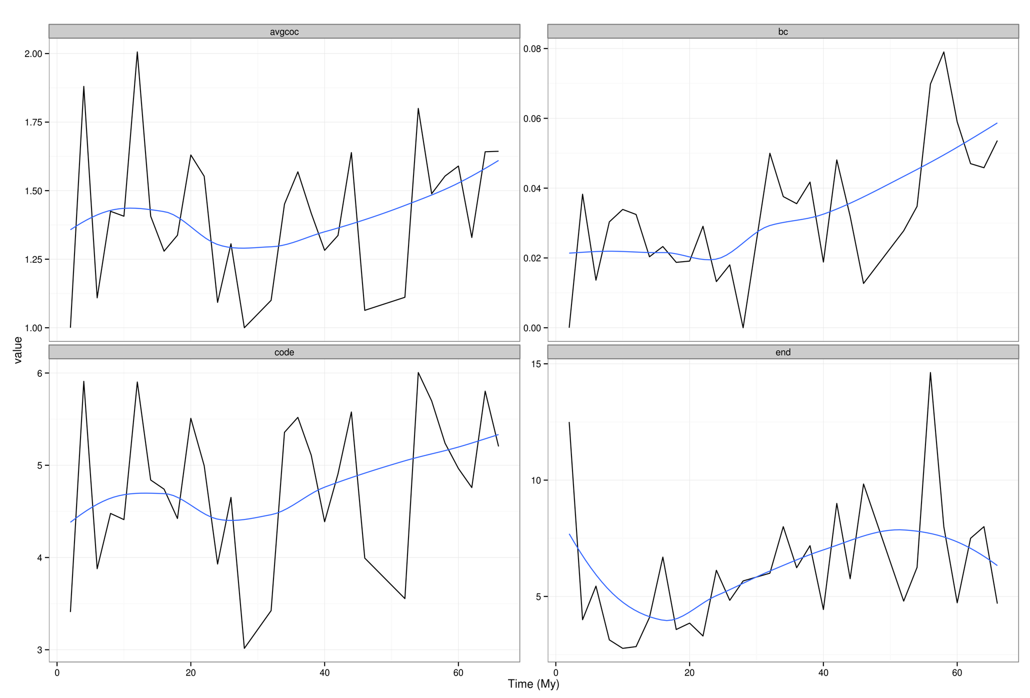

Figure 2: Summary statistics of the mammal-wide biogeographic networks for every 2 My bin.

Life history dynamics

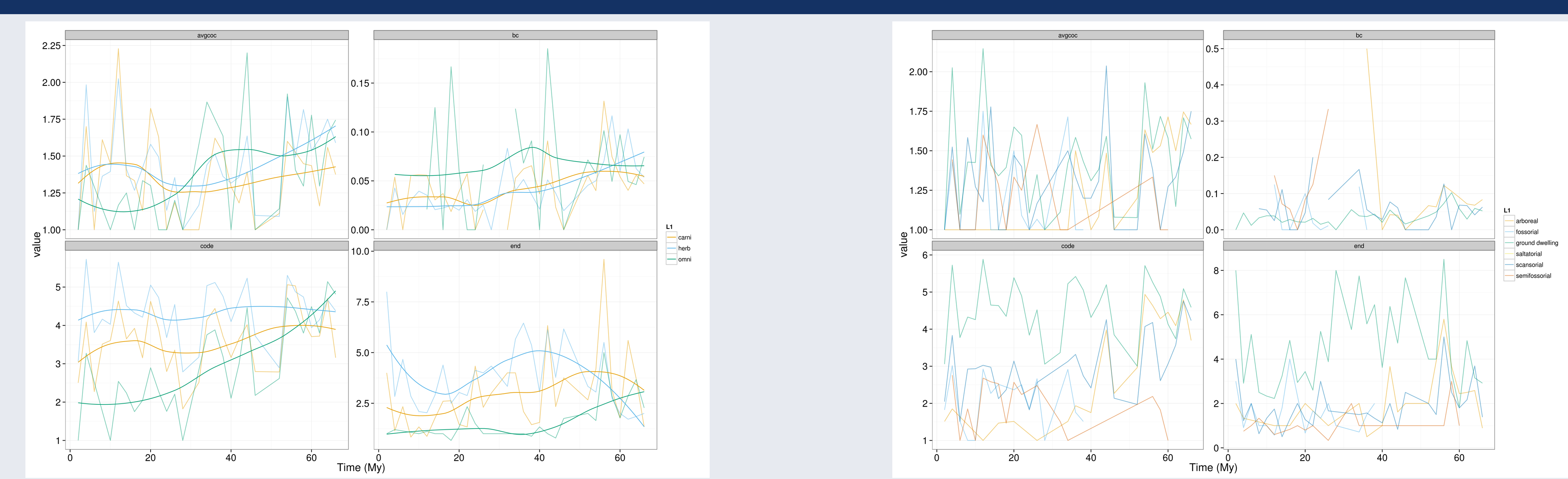

Figure 3: Biogeographic network summary statistics from the 2 My bins.

Relative diet

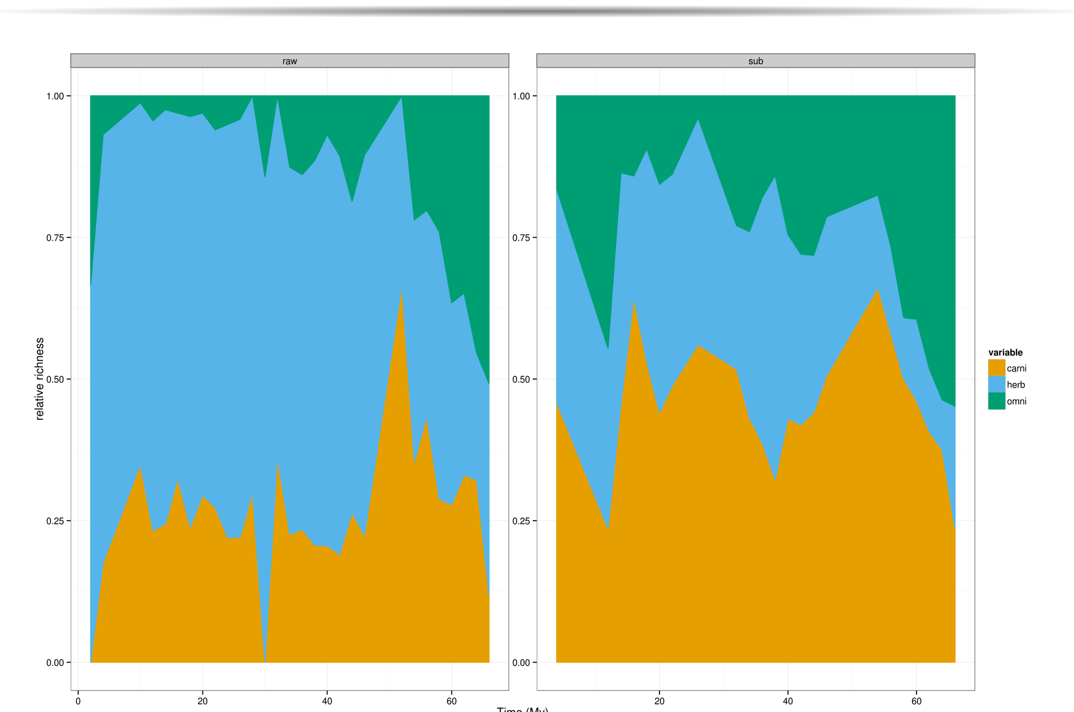

Figure 4: Relative abundance of mammalian dietary categories both raw and subsampled. Subsampled abundance was done using SQS. Some interpolation of points was needed for subsampling in parts of the Neogene.

Diet – oxygen

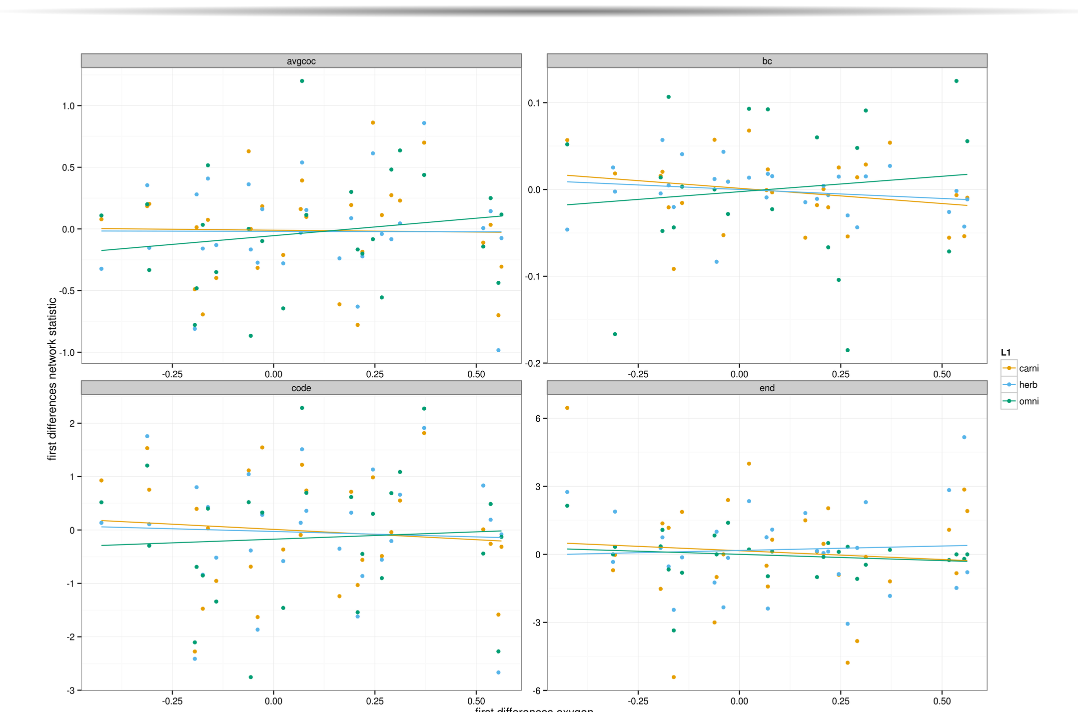

Figure 5: Biplots of the first differences of the biogeographic network summary statistic time series versus the first differences of the binned δO^{18} isotope curve from [8].

Discussion

- generally stationary time series of biogeographic structure over Cenozoic (Fig. 2)
  - herbivore pattern is most similar to overall pattern, similar to Jernvall and Fortelius [3] and Jernvall and Fortelius [4]
  - increase in relative proportion of herbivores (Fig. 4)
- no correlation between oxygen and dietary (Fig. 5) or locomotor category (not shown)
  - climate not a correlate/driver of NA-wide community structure over all Cenozoic
  - life history traits play a stronger role
- preliminary correlation between dietary and locomotor categories (not shown)

Future directions

- restrict to major orders [4]
- reorganize locomotor categories (i.e. fewer)
  - arboreal versus ground dwelling
- account for difference in (relative) abundance (Fig. 4)
  - maintenance of trophic structure [4]?
  - common taxa driving structure (ground-dwelling herbivores) [3]?
- is ecotype effect stronger than taxonomic effect?
- comparison with Europe and South America

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Paleobiology Database

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