

Cosmopolitan and endemism dynamics of terrestrial Cenozoic mammals

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Extended abstract

Community structure plays a fundamental roll in determining ecological dynamics. 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, both biotic–biotic and biotic–abiotic, is important for better understanding how and which ecological properties affect macroevolutionary trends. How taxonomic composition of communities have 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 Previous work on mammalian site similarity has focused on organismal dietary distributions of terrestrial mammals in the Neogene Old World [3, 4]. Here, I expand that analysis the entire Cenozoic of North America and analyze both diety and locomotor categories 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 community structure beioegrpahic networks were constructed between species and formation occurrence. Four different measures of beiogeographic 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>). Taxonomic occurence 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 informaiton was also compiled for all taxa. Because terrestrial assemblages across the Cenozoic do not preserve as complete a record of community structure, taxonomic 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 occurence list of all unique species and locality was defined as formation. Biogeographic networks were constructed for uniform 2 My bins from the K/Pg to the Recent which were 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 increased bin width to 2 My to allow for every bin to be represented by minimum two formations. Biogeographic network structure was measured 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 determined 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 occurring in that bin. Correlation tests were done between between the first differences of all biogeo-graphic summary statistic time series and the δO^{18} curve.

δO^{18}

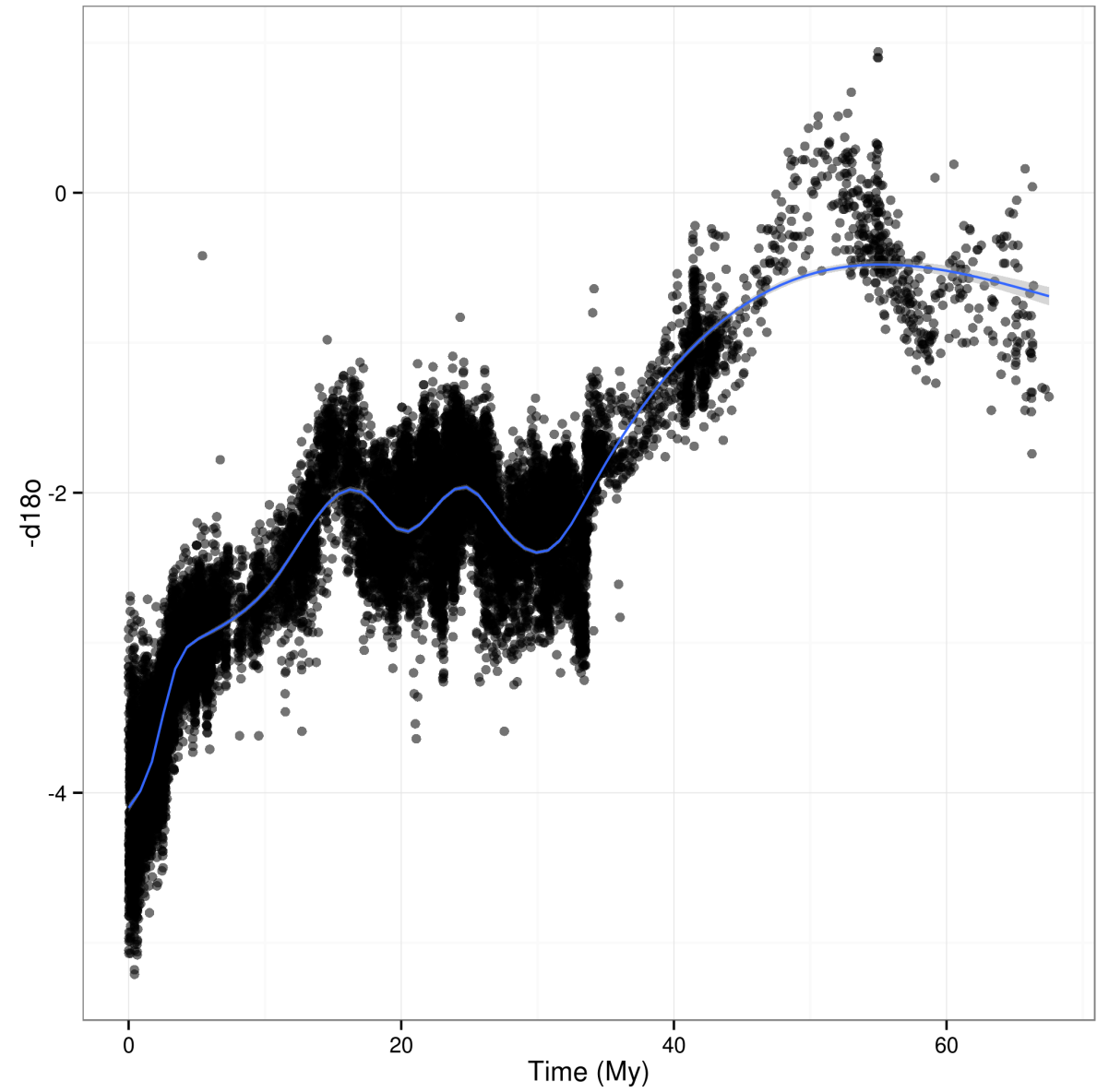


Figure: Oxygen curve [8] with fitted GAM to illustrate overall structure.

Biogeographic structure

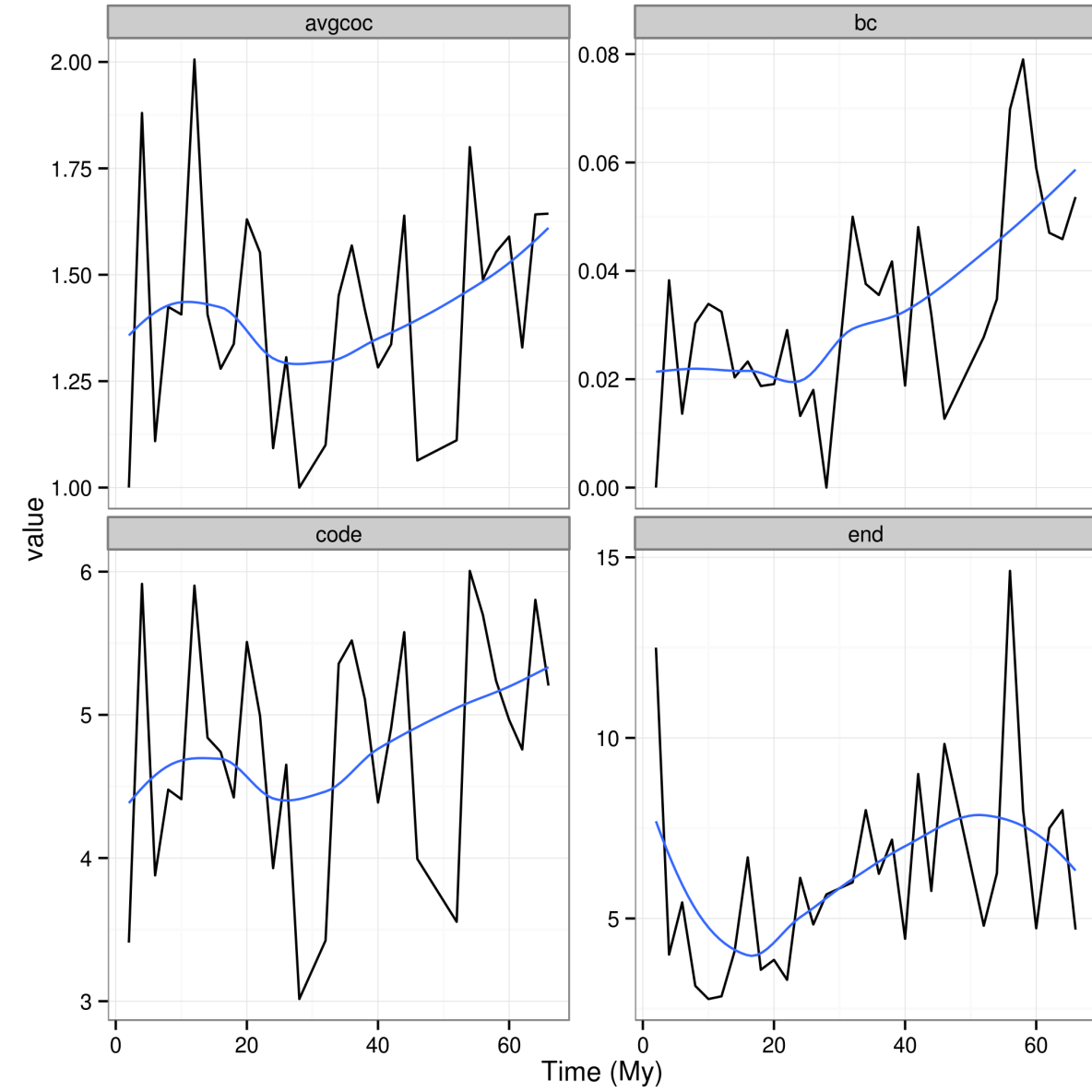


Figure: Summary statistics of the mammal wide biogeographic networks for every 2 My bin.

Life history dynamics

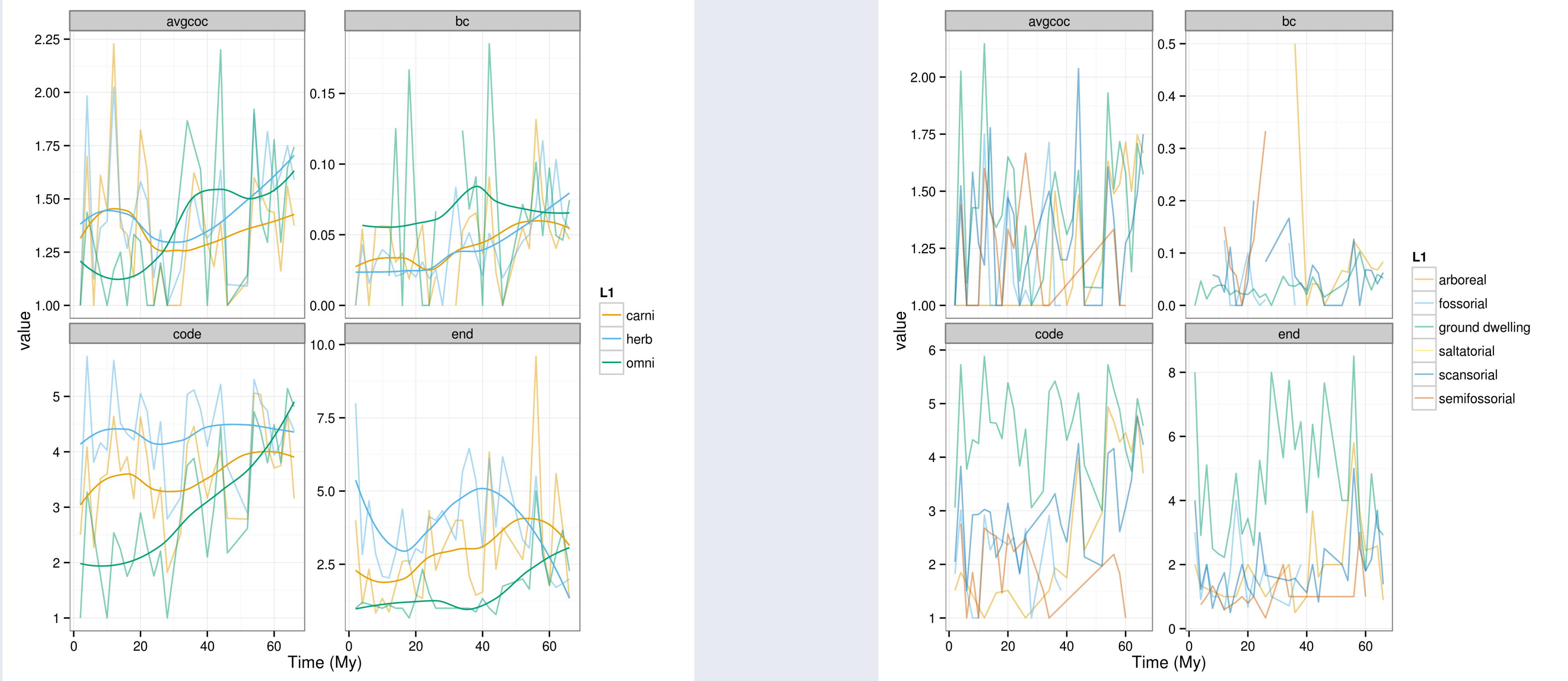


Figure: Biogeographic network summary statistics from the 2 My bins.

Relative diet

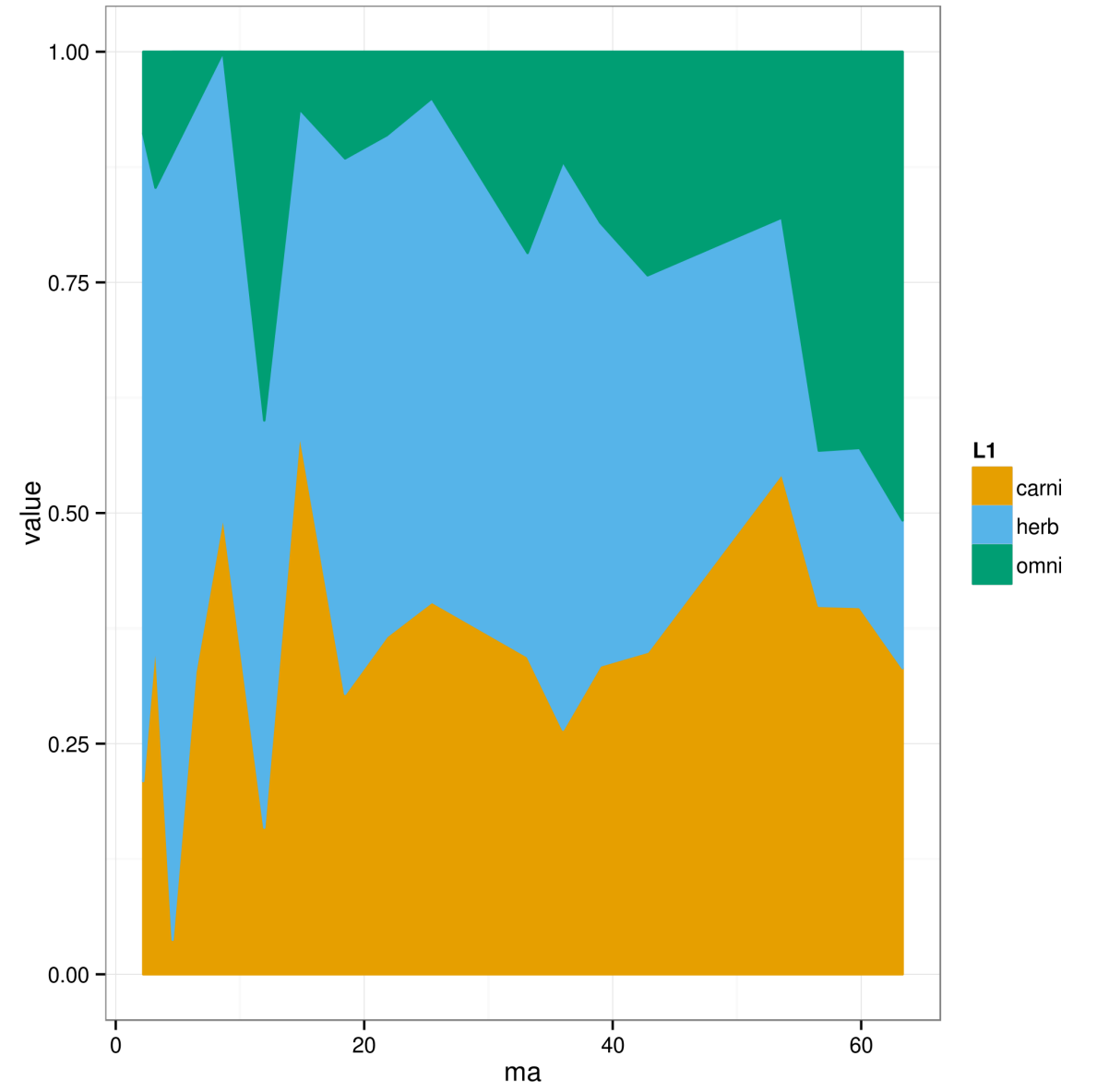


Figure: Relative abundance of mammalian dietary categories. Abundance is based on subsampling using SQS.

Diet oxygen

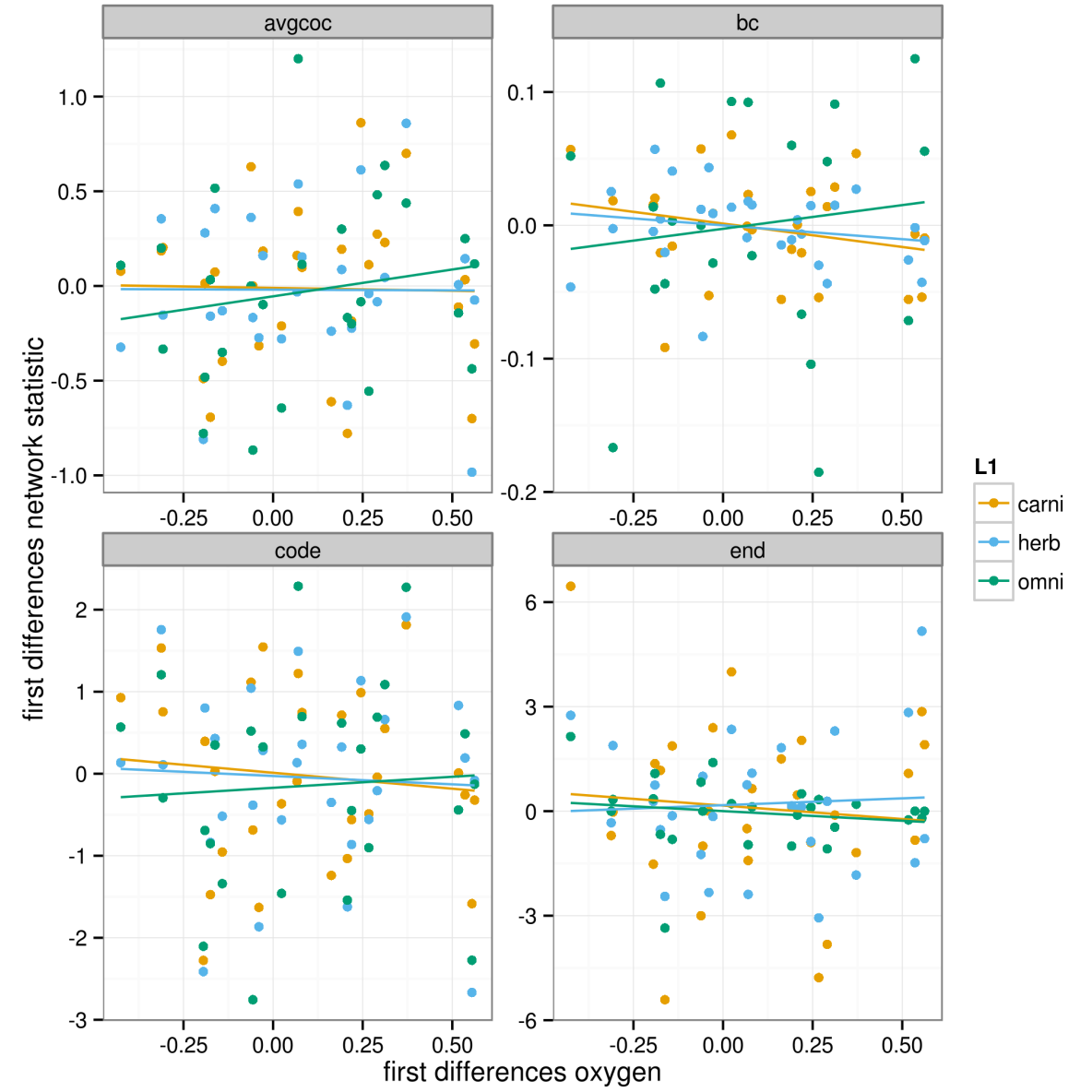


Figure: <+caption text+>

Discussion

- primarily stationary time series of biogeographic structure over Cenozoic (Fig. 2)
- no correlation between oxygen and dietary (Fig. 5) or locomotor category (not shown)
- increase in relative proportion of herbivores (Fig. 4)
- preliminary correlation between dietary and locomotor categories

Future directions

- restrict to major orders [4]
- reorganize locomotor categories (i.e. fewer)

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Bibliography

- [1] J. Alroy. Constant extinction, constrained diversification, and uncoordinated stasis in North American mammals. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 127:285–311, 1996.
- [2] J. Alroy, P. L. Koch, and J. C. Zachos. Global climate change and North American mammalian evolution. *Paleobiology*, 26(1981):259–288, 2000.
- [3] J. Jernvall and M. Fortelius. Common mammals drive the evolutionary increase of hypsodonty in the Neogene. *Nature*, 417(6888):538–40, May 2002. ISSN 0028-0836. doi: 10.1038/417538a.
- [4] J. Jernvall and M. Fortelius. Maintenance of trophic structure in fossil mammal communities: site occupancy and taxon resilience. *American Naturalist*, 164(5):614–624, Nov. 2004. ISSN 1537-5323. doi: 10.1086/424967.
- [5] J. A. Kitchell. Evolutionary paleoecology: recent contributions to evolutionary theory. *Paleobiology*, 11(1):91–104, 1985.
- [6] C. a. Sidor, D. a. Vilhena, K. D. Angielczyk, A. K. Huttenlocker, S. J. Nesbitt, B. R. Peacock, J. S. Steyer, R. M. H. Smith, and L. a. Tsuji. Provincialization of terrestrial faunas following the end-Permian mass extinction. *Proceedings of the National Academy of Sciences*, 110(20):8129–33, May 2013. ISSN 1091-6490. doi: 10.1073/pnas.1302323110.
- [7] D. a. Vilhena, E. B. Harris, C. T. Bergstrom, M. E. Maliska, P. D. Ward, C. a. Sidor, C. a. E. Strömberg, and G. P. Wilson. Bivalve network reveals latitudinal selectivity gradient at the end-Cretaceous mass extinction. *Scientific reports*, 3:1790, May 2013. ISSN 2045-2322. doi: 10.1038/srep01790.
- [8] J. C. Zachos, G. R. Dickens, and R. E. Zeebe. An early Cenozoic perspective on greenhouse warming and carbon-cycle dynamics. *Nature*, 451(7176):279–283, Jan. 2008. ISSN 1476-4687. doi: 10.1038/nature06588.