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Appendix A from S. Tomiya, "Body Size and Extinction Risk in Terrestrial Mammals Above the Species Level"

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Comments on the Fidelity of Mammalian Fossil Record at the Species Level

While paleontological studies of diversity dynamics in fossil mammals commonly conduct parallel analyses of extinction rates at the levels of species and genera (see table 1 for examples), meaningful interpretation of species-level patterns at the scale of this study might be severely hampered by the limit of taxonomic resolution based solely on skeletal features. The challenge is not only to differentiate true lineage truncations from pseudoextinctions resulting from anagenesis but also to distinguish separate lineages that show greater morphological variations within species than across species (cf. Turvey and Cooper 2009). This latter problem may be particularly acute with regard to species-rich, small-bodied genera (Carrasco 2013). It is difficult to quantify the fidelity of species-level data in this sense for fossil mammals, but comparison of the numbers of species in individual fossil and modern (i.e., extant and recently extinct) genera raises a caution about uncritical use of fossil species for analysis of diversity patterns at the continental scale. With the added temporal dimension, genera in the fossil record are expected to contain more species on average than extant genera (unless diversification rates or selection against species-poor genera have somehow increased toward the present—scenarios that seem to lack empirical support). Contrary to this expectation, the North American fossil data set analyzed here and a taxonomically comparable modern data set have the same median species richness per genus, and the distribution of species richness per genus for the fossil genera is less positively skewed than that for the modern genera (fig. A1). In other words, the diversity of true species in the geologic past may be substantially underestimated by the currently recognized fossil "species." In this context, the apparent congruence of diversity dynamics at the genus and species levels in the Cenozoic fossil record of North American mammals may well be an artifact of the rather low species richness per genus in fossil genera (Alroy 1996).

From the practical standpoint, the focus on genus-level patterns of extinction selectivity is justified based on the following considerations: (1) the taxonomy of fossil mammalian species is considerably less stable (Alroy 2003), (2) the dearth of cladistic hypotheses makes it practically impossible to conduct phylogenetic comparative analyses of fossil species at the scale of this study, (3) the specific identities of fossils often cannot be determined with available material and existing taxonomic knowledge, the consequences of which are many fossil species that are known from too few occurrences for robust statistical analyses (see, e.g., Liow et al. 2008*a*, on a similar problem with the western Eurasian record of fossil mammals), and (4) in much of the North American Cenozoic fossil record, the temporal resolution based on the traditional mammalian biochronology is roughly equivalent to, or substantially coarser than, the median species duration of 1.5 million years (Alroy 1996).

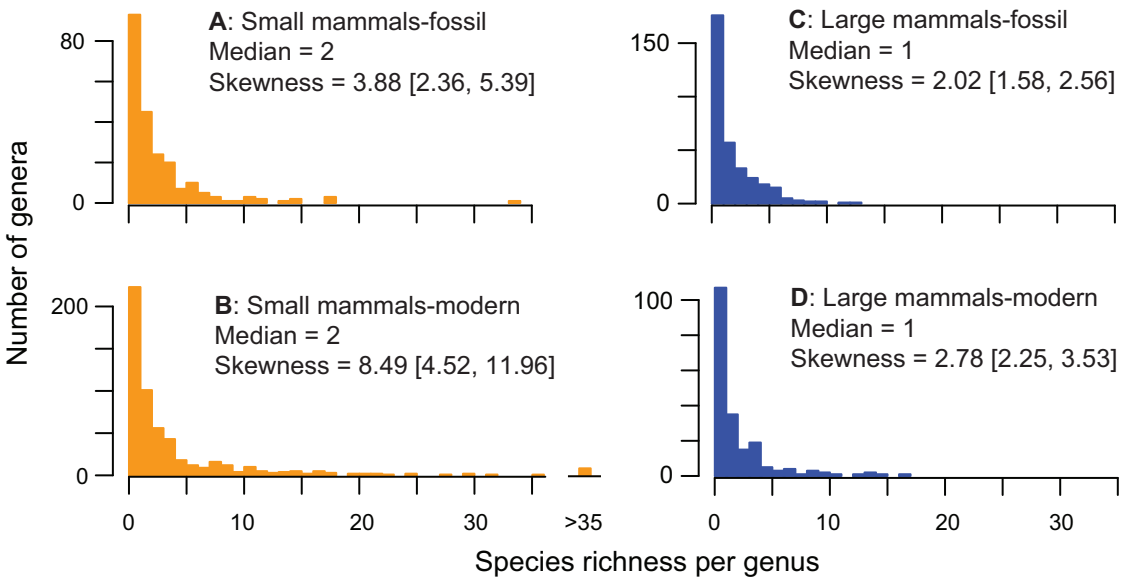

Figure A1: Species richness per genus in fossil and modern terrestrial mammals. The North American fossil data (*A*, *C*) and global modern data (*B*, *D*, consisting of extant and recently extinct taxa) come from the MIOMAP/FAUNMAP data analyzed in this study (Carrasco et al. 2005; Graham and Lundelius 2010) and the International Union for Conservation of Nature Red List (IUCN 2012), respectively. The small mammals plotted here (*A*, *B*) include only rodents, lagomorphs, and lipotyphlans, and the large mammals (*C*, *D*) consist of carnivorans and ungulates. Bootstrap estimates of bias-corrected ninety-fifth percentile confidence intervals (Efron 1981) for skewness are provided in brackets.

Literature Cited Only in Appendix A

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