Public release date: 18-Jul-2005

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Space matters: Estimating species diversity in the fossil record

Estimates for the number of living species on earth range from 3.5 million to over 30 million but only 1.9 million species have been classified and described. Estimating historical biodiversity from the fossil record is an even more daunting task. One tool ecologists - but not paleontologists - have traditionally relied on to identify patterns of existing biological diversity is a long-established rule of thumb called the species-area effect: the tendency for species number, or richness, to increase in a predictable way with area. Paleontologists have been unable to account for the species-area effect, or to even know whether it applies, in estimating paleodiversity because of various confounding factors. But, in a new study, published in the premier open access journal *PLoS Biology*, Anthony Barnosky, Marc Carrasco, and Edward Davis are able to test this assumption and discover that the golden rule of ecology holds for the rock record as well. Just as geographic sampling influences diversity counts in the modern landscape, the species-area effect strongly influences counts in the fossil record. Taking this into account will alter historical estimates of species distributions and extinction.

Caption: A new, comprehensive database compiles mammalian fossils including this upper jaw of the Sthenicitis campestris, a weasel from about 12 million years ago. (Photo: Alan B. Shabel)
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Barnosky et al. used mapping and imaging systems that generate direct measures of the geography for a given set of fossil species. To get a sense of diversity across time and space, the authors used a recently completed archival database (which they also built) that integrates the geographic data with fossil datasets, called the Miocene Mammal Mapping Project (MIOMAP). MIOMAP includes all western North American mammals from 5-30 million years ago - 3,100 localities and 14,000 occurrences of species in all. The authors then tested the fossil data for species-area effects by plotting fossil species richness against different geographic areas. After correcting for possible biases in sample size that might influence the number of species, Barnosky et al. found a strong species-area effect.

These results, they argue, suggest that many fluctuations in diversity seen in fossil analyses actually arise from the species-area effect and are not actually the result of true changes in the distribution of species. Given the lack of uniform geographic sampling in paleontological data, the impact of this effect may be significant - and likely applies to other taxa as well. Once the effect is factored in, one might expect significant adjustments in accepted patterns of global and regional paleodiversity. And because an important metric for understanding current extinctions relies on descriptions of past extinction events, controlling for a paleodiversity¡Varea effect may provide a better frame of reference for understanding the current biodiversity crisis. Thanks to the innovative text-mining tools and approach presented here, future studies can more easily correct for area effects and explore these issues. And given the parallels between species-area relationships in paleontology and ecology, collaborations across disciplines may offer valuable insights into ecological dynamics through time.

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Citation: Barnosky AD, Carrasco MA, Davis EB (2005) The impact of the species-area relationship on

estimates of paleodiversity. PLoS Biol 3(8): e266.

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