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Diversity or disparity as a measure of extinction? An example from the leaf record across the Cretaceous-Tertiary boundary in North America

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Extinctions are typically described either by the percentage of taxa at a given rank whose last appearances occur together or by the largest taxon that disappears at a particular time. An example of the former is the extinction of 50-60% of plant morphotypes in the Hell Creek Formation; of the latter, the global extinction of dinosaurs, both at the Cretaceous-Tertiary boundary. Implicitly these are measurements of extinction as a reduction in diversity from one time period to another and diversity is notoriously difficult to explain and sensitive to taxonomic splitting or lumping. An examination of the North American leaf record across the Cretactous-Tertiary boundary, suggests a general alternate way of measuring the effect of an extinction: partitioning diversity into ecologically meaningful bins and looking at changes in membership of functional groups rather than overall extinction rates. Using this procedure, the changes in leaf architecture at the Maastrictian-Paleocene boundary cannot be statistically distinguished from the population of changes at other stage boundaries in the Cretaceous and epoch boundaries in the Cenozoic. So Cretaceous-Tertiary plant extinctions in North America seem to have been less severe ecologically than taxonomically. To the extent that leaf architectural categories are useful proxies for functional groups, we can conclude that the effect of local species extinctions on the structure of plant ecosystems was either minor or short-lived. Certainly, the extinction seems insignificant compared with the dramatic changes in leaf-architecture that accompanied the evolutionary innovations surrounding the rise of angiosperms in the middle Cretaceous. This apparent contradiction between effect on disparity and effect on diversity could be a result of low ecological specificity of the extinctions or low correlation between taxonomic relationships among extinct species and ecological similarity. Regardless of the cause, it supports the argument for trying to quantify disparity as a better metric than diversity for measuring evolutionary change. Partitioning diversity into proportional morphological bins also provides a multivariate response, more direct environmental interpretations, and automatic normalization for taxonomic and taphonomic biases.