NEW MODELS FOR SURVIVAL AND RECOVERY FROM MASS EXTINCTION: DO WE REALLY NEED "EXPLOSIVE" RADIATIONS TO EXPLAIN THE RECORD?

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Current hypotheses suggest that mass extinction events are so pervasive, abrupt, and involve extincting mechanisms of such magnitude that they represent different macroevolutionary regimes compared to those associated with background conditions. In this view, mass extinction events are genetically, ecologically and biogeographically non-selective. Survival strategies which are successful during background conditions are viewed as relatively ineffective during mass extinctions. This, in turn, predicts that survivors will be few and mainly ecological generalists and refugia species. In turn, these hypotheses require dramatic, short-term radiation intervals, broadly involving punctuated and macroevolutionary events, to explain the subsequent restructuring of global ecosystems from generalized surviving clades following mass extinctions. These are testable hypotheses utilizing high-resolution stratigraphic and paleobiologic analyses of large, closely spaced samples spanning the commonly 1 - 3 My-long extincton-survival-recovery intervals. The results of two such tests across the middle Cretaceous (Cenomanian-Turonian) and Cretaceous-Tertiary mass extinction intervals suggest alternative hypotheses. These mass extinctions are not catastrophic, but spread out over one or more My and associated with increasingly more severe perturbations in the ocean-climate system, geochemically defined. Extinction patterns are rapidly graded to stepwise in nature, even when observed data is statistically tested for sampling biases (e.g. Signor-Lipps Effect), and is ecologically graded, beginning with the abrupt demise of tropical reef ecosystems and progressing through time toward extinction of more temperate and more cosmopolitan lineages/communities. Evolution at lower taxonomic levels takes place rapidly during the extinction interval, especially between discrete "steps" or events, when environmental conditions begin to normalize. Presumably, this involves in part the modification of normal survival mechanisms to better adapt to increasing environmental stress. Among these newly evolved lineages are also crisis progenitors, taxa specifically adapted to extinction-related environments, which in turn are the first to undergo rapid radition during the survival and recovery intervals. In this scenario, supported by a good fossil record, survivors of mass extinction intervals may be genetically and ecologically diverse, and some may be specifically adapted to immediate post-extinction environments. These diverse surviving clades provide a complex group of evolutionary rootstocks to seed subsequent radiation, without invoking "explosive" radiation characterized by unique macroevolutionary regimes.