

# CLADE HISTORY, SPECIES ECOLOGY AND EXTERNAL CAUSAL FACTORS INFLUENCE ARTHROPOD SURVIVAL AND RECOVERY DURING PALAEOZOIC MASS EXTINCTIONS

[LAMSDELL, James C.](#), Department of Geology and Geophysics, Yale University, Kline Geology Laboratory, 210 Whitney Avenue, New Haven, CT 06511, james.lamsdell@yale.edu and SELDEN, Paul A., Paleontological Institute, University of Kansas, 1475 Jayhawk Blvd, Lindley Hall, Rm 120, Lawrence, KS 66045

Mass extinctions are known to be extraordinary events during which the normal rules of natural selection do not apply. Evidence points to the operation of a different selective regime, one where clade-level properties are selected upon; however, it is still unclear whether survivorship rules apply across different extinction events, the consequences of differential responses in diversity and disparity during extinction events, and the factors governing subsequent recoveries. Here, we compare variations in diversity and disparity across three arthropod clades for two extinction events: the end-Ordovician (443 Ma) and the late Devonian (385–359 Ma). Our study reveals different patterns of morphospace loss between the two extinctions, with the end-Ordovician characterized by random morphospace loss while a marked migration in morphospace occurs in all three clades during the late Devonian. The nature of these migrations is mediated by species ecology; in one clade, generalists survive and morphospace occupation is reduced to a portion of its original area, while the survivors in the remaining clades are specialists and morphospace expands into previously unoccupied areas. Variations in diversity between the three clades, with two related groups experiencing major diversity loss during the late Devonian with no subsequent recovery and another undergoing an evolutionary bottleneck before further radiation in the Carboniferous, suggests that inherent properties of the clade can also influence how it responds to mass extinction events. Through comparing rates of character evolution and rates of origination and extinction it is shown that clades with higher volatility fail to recover, remaining at low diversity. Differences in ecology appear to be causing the heightened levels of volatility, resulting in fewer surviving species from which to radiate and limiting the possibility for expansion into vacant ecospace. Ecology is, therefore, shown to be an important factor in mediating survival and recovery during the late Devonian. Furthermore it is shown to operate on multiple, sometimes contradictory, levels. It is shown that ecological factors, such as specialization, that influence responses in morphospace act independently of the ecological and historical factors that influence recovery.

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