

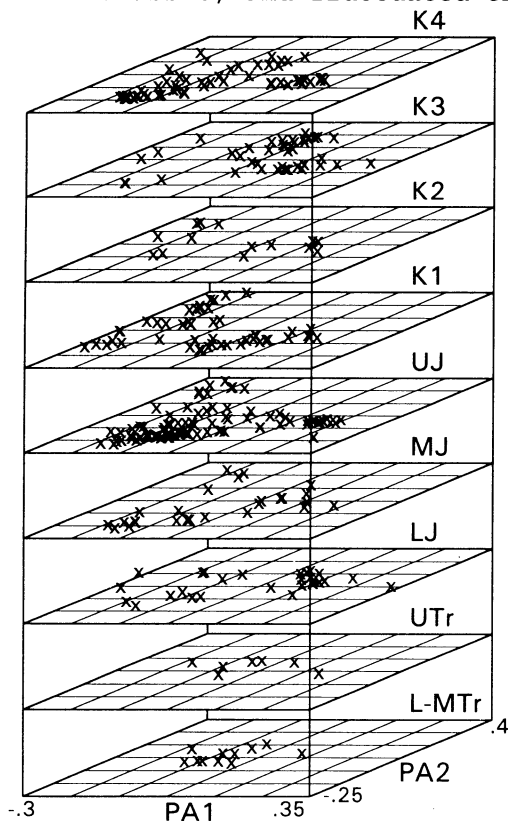
MORPHOLOGICAL DIVERSIFICATION OF MESOZOIC CRINOIDS

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Many Paleozoic clades show morphological diversification that is concentrated early in time, with maximal disparity preceding maximal taxonomic diversity. One such group, the echinoderm class Crinoidea, nearly perished in the Permian. Its diversification in the Mesozoic allows us to compare the radiation of the same clade in what are often seen as substantially different ecological circumstances.

The suggestion that, despite low taxonomic diversity, early Mesozoic marine ecosystems were more "crowded" than those of the early Paleozoic, i.e., that most adaptive zones were at least partially occupied in the early Mesozoic, might lead one to expect that morphological diversification should have been more gradual in the Mesozoic than it had been in the Paleozoic. Although the postulated ecological differences are most relevant to the diversification of the entire biosphere, it is also instructive to examine single clades. To this end, a global sample of about 300 Mesozoic crinoid species was studied, using some 70 discrete morphological characters.

The figure shows the temporal pattern of morphospace occupation as represented by the first two principal-coordinate axes derived from the interspecies differences in these discrete characters. The range of morphospace occupied expanded from the Lower Triassic into the Lower Jurassic, and fluctuated thereafter. The mean pairwise



dissimilarity between species was already rather high in the Triassic, suggesting a broad but sparse occupation of morphospace. The large-scale diversification of morphology in Mesozoic crinoids was similar to that in the Paleozoic, with the Triassic-Jurassic contrast resembling that between the Lower and Middle Ordovician, and spanning a comparable amount of time.

At the scale of radiation within an adaptive zone, early Mesozoic ecosystems provided considerable opportunities for innovation. Thus, within a single clade, morphological diversification in the early Mesozoic was not substantially more subdued (relative to that in the later Mesozoic) than was early Paleozoic diversification (relative to that in the later Paleozoic).