

Depositional dynamics and the record of ecosystem stability: Early Eocene faunal gradients in the Pyrenean Foreland, Spain

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ABSTRACT

We studied mollusk-dominated multispecies assemblies from the south Pyrenean foreland in Spain by using relative abundance data in a framework of high-frequency depositional sequences for an interval spanning 2 myr across the early Eocene climatic optimum. The sequences are part of the Figols (middle Ypresian) and Castigaleu (upper Ypresian) allogroups and together document environmental changes influenced by tectonics at the lower frequency and driven by sea level and climate at the high-frequency temporal scale. We applied ordination through multidimensional scaling and other techniques to explore the structure of the data set. Six Figols and eight Castigaleu communities, linked along onshore-offshore gradients, were interpreted on uniformitarian grounds. Paleoenvironments ranged from mangrove forest to tidal flat, tidal creek, estuary, delta front, shoreface, carbonate ramp, and inner shelf. Some habitats were represented throughout the interval, allowing examination of the effect on coastal ecosystems of environmental disturbances tied to sea-level lowstands, as deduced from the sequence stratigraphic analysis. These disturbances presumably amounted to extirpation by river floods, burial, increased turbidity, high river-derived nutrient input, and decreased ecospace availability. The major effect on the mangrove-estuary-delta gradient was coincident with the unconformity separating the two allogroups. Mangrove communities suffered a change in rank of dominating species and a turnover of rare species. Subtidal estuarine and delta communities were affected in their relative abundances, but we observed no change in rank or turnover. We suggest that the different niche breadth of organisms leads to different responses to perturbation of several scales. Many intertidal cerithioidean gastropods went extinct, whereas subtidal turritelline gastropods were unchanged, during the major environmental variation. Mangrove gastropods experienced increased originations in the upper Ypresian. The carbonate ramp heterotrophs did not change across the Figols-Castigaleu perturbation, although throughout the early Eocene the phototroph guild within the same ecosystem was undergoing frequent turnover events. All studied associations showed significant changes

in the relative abundances of constituent species across unconformities of minor entity, proving that soft-bottom marine communities conform to an open-membership model of ecosystem recruitment, as suggested by studies of past open marine ecosystems. Persistence to a degree is suggested by mangrove communities, indicating a slightly more limited membership in low-nutrient estuarine habitats, a response more similar to that of coral reef tropical ecosystems. This study confirms the idea that different species and communities may experience opposite effects from the same events and shows that faunal distributions in estuarine and deltaic systems reflect more than just bathymetric change. High onshore origination also conforms to the theory of onshore-offshore faunal change.