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Biofacies recurrence in the Middle Devonian of New York State: An example with implications for evolutionary paleoecology

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ABSTRACT

The diverse, well-preserved fauna of the Middle Devonian Hamilton Group of western New York has become an exemplar of long-term taxonomic and paleoecological stability and habitat tracking in response to sea-level change. Recent detailed, quantitative studies have challenged this view, suggesting instead a relatively low proportion of persistent lineages and recurrent biofacies sharing only the most abundant species; however, most studies have considered only limited geographic areas. As a result of shifting basin-forebulge positions and sedimentation patterns, analogous facies do not occur in every cycle of single geographic areas but show complex migration within the Appalachian Basin. Consequently, similarity of biofacies recurrence can only be fairly assessed by considering the most analogous facies wherever they occur across a major cross section of the basin. This paper evaluates patterns of biofacies recurrence based on samples from subsymmetrical cycles of dark-gray shale, calcareous mudstone, and argillaceous limestone. Low-sedimentation, depth-related biofacies, identified quantitatively using cluster analysis, recur symmetrically in single third-order regressive-transgressive cycles throughout the 5–6 myr duration of the Givetian Hamilton Group and Tully Formation at different geographic locations. Detrended correspondence analysis was used to recognize gradients of species and sample distribution both within and among depositional cycles; depth-related biofacies range from basinal, low-diversity leiorhynchid brachiopod–dominated associations to highly diverse coral-brachiopod (shallow subtidal) assemblages. This pattern is also comparable to the order of species-biofacies appearances in single, small-scale shallowing-upward cycles. In addition to similarities of species richness and guild structure, given biofacies show strong similarities of species composition. Low-diversity, high-dominance associations typical of deeper water biofacies show lower similarities (60%–75% species overlap), suggesting that they represent loosely structured aggregations of eurytopic taxa. Similarities are greatest in the diverse coral and brachiopod biofacies, for which most pairwise comparisons of samples throughout the Hamilton–Tully interval show >80% overlap in species composition and very strong similarity of richness and guild structures but not necessarily rank or relative

abundance of taxa. Overall, these data suggest that gradients of species distribution in relation to environmental gradients, especially depth-related factors, were quite stable over several million years and that biofacies shifted in response to transgressive-regressive cycles. Such biofacies stability need not imply persistence of tightly integrated communities. Nonetheless, the long range of many species and maintenance of biotic gradients have important evolutionary implications—under relatively stable conditions, a majority of species track shifting habitats rather than adapt to changing local conditions.