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Palaeoecology of the Spathian Virgin Formation (Utah, USA) and its implications for the Early Triassic recovery

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The Spathian (late Early Triassic) Virgin Formation of south−western Utah (USA) yields a comparatively diverse benthic fauna that flourished ~2 Ma after the end−Permian mass extinction. In this study, we present quantitative palaeoecological data, which are analysed in the context of depositional environments. This integrated approach helps to discriminate between effects of the end−Permian mass extinction event and local environmental factors on alpha diversity and ecological structure of the Virgin Fauna. Shallow subtidal environments yield the highest species richness and lowest dominance values as recorded in two benthic associations, the *Eumorphotis ericius* Association and the *Protogusarella smithi* Association, both of which contain 20 benthic species (bivalves, gastropods, brachiopods, echinoderms, and porifers). Tidal inlet deposits yield a low diverse fauna (*Piarorhynchella triassica* Association) with a very high dominance of filter feeders adapted to high energy conditions. Another comparably low diverse fauna is recorded by the *Bakevellia exporrecta* Association, which occurs in deposits of the offshore transition zone, most likely reflecting unconsolidated substrates. A single sample containing five bivalve species (*Bakevellia costata* Assemblage) is recorded from a marginal−marine setting. The Virgin fauna yields a bulk diversity of 30 benthic species (22 genera) of body fossils and 14 ichnogenera and, thus, represents the most diverse marine bottom fauna known so far from the Early Triassic. Our results suggest that oceanographic conditions during the early Spathian enabled ecosystems to rediversify without major abiotic limitations. However, taxonomical differentiation between habitats was still low, indicating a time lag between increasing within−habitat diversity (alpha diversity) and the onset of taxonomical differentiation between habitats (beta diversity). We suggest that taxonomical habitat differentiation after mass extinction events starts only when within−habitat competition exceeds a certain threshold, which was not yet reached in the Spathian of the investigated area. This interpretation is an alternative to previous suggestions that the prevalence of generalistic taxa in the aftermath of mass extinction events reflects protracted environmental stress. The onset of increasing beta diversity is a potential criterion for distinguishing two major recovery phases, the first ending with habitat saturation and the second ending with the completion of ecosystem differentiation.

Key words: Biotic recovery, mass extinction, palaeoecology, diversity, Early Triassic, Spathian, Virgin Formation, USA.

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