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The end-Permian mass extinction and the plants – how much of it is taphonomical bias?

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The end-Permian mass extinction is marked by a pronounced terrestrial ecosystem turnover and a severe loss of marine invertebrate biodiversity. This extinction event is accompanied by a prominent negative carbon-isotope excursion indicating massive changes in the global carbon cycle across the Permian-Triassic boundary[1]. However, for non-marine environments the timing and dynamics of this mass extinction are still poorly understood. So far theories range from a single severe crisis with a profound extinction event, to up to multiple disturbed terrestrial ecosystems with repeated changes in the dominance structure of plant assemblages, i.e. spore-dominated and pollen-dominated phases. Also the duration of ecosystem turnovers and subsequent biotic recoveries are under debate ranging from some 10ka [2] to 4-5 million years [3].

These diverging views are partially caused by the paucity of continental deposits of the right age. This restricts the study of terrestrial ecosystems basically to the few continuous successions preserved in South Africa, China, Russia, Australia and Antarctica. However, most of the non-marine Permian-Triassic successions show a qualitatively and quantitatively poor plant macrofossil record, opening a discussion on how much of the observed loss in diversity across the PT-boundary is based on a taphonomic or preservation bias. Especially in the Lower Triassic land plant remains are very rare and almost completely absent from the most basal part of the Lower Triassic. A few records from Australia, China, and South Africa are the rare exceptions where apparent plant remains are preserved across the PT-boundary. Therefore, studies on the effects of the PT-boundary extinction event on land plants are so far based almost exclusively on palynological data. In contrast to macro-remains, which reflect mostly a local flora, palynological data reflect a regional flora influenced by the global climate. We need these global patterns to evaluate the impact of an extinction event on the plant record.

However, even this palynological approach is complicated by the fact that it is sometimes not clear if a certain taxon/group really disappears. This is especially the case when botanical affinities of sporomorphs are not well understood. An additional problem may be the fact that one plant species can produce one spore/pollen morphology or several morphologically closely related spores/pollen types; i.e. spores and pollen found in one sporangium/pollen sac may have a very high morphological variability up to the fact that they would be interpreted as different taxa when found dispersed.

Therefore, it is essential to be aware of the taphonomic processes and their consequences for the interpretation of plant macrofossil and plant microfossil records, respectively – especially for studying critical time intervals in Earth history such as extinction events.

References:

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[3] Looy C et al. (2001) PNAS 98(14): 7879–7883