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The Late Ordovician extinction conundrum

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The Late Ordovician mass extinction (LOME) has long been known for its association with the Hirnantian glaciations. Two extinction pulses seem to reflect global cooling and warming, respectively. The effects climate change had on Ordovician life are well documented through palaeontological evidence, several geochemical proxies and further simulated in modelling scenarios. Preceding the Hirnantian extinction interval was a phase of prolific faunal migrations in notably the later parts of the Katian. Well-documented evidence shows that low-latitude faunas dispersed to high latitudes, and taxa that had previously been endemic to particularly Baltica and South China, suddenly began to appear in Laurentia. These events, referred to as the Boda warming event and the Richmondian invasion, have been suggested to reflect a biotic response to warmer climate indicating that the onset of the subsequent Hirnantian icehouse marked a considerable environmental shift from the latest Katian warming phase.

Whereas a lot of focus has been on untangling the selective effects of the two Hirnantian extinction pulses on different clades, less focus has been on what led to the transition from the Middle Ordovician biodiversity rise to the dispersal phase seen during the Katian. It appears that most clades did not – during any point of time in the Ordovician – surpass the richness levels they had achieved by the earliest Katian. Rather, a plateau was established when all metazoan clades are compiled together. This could suggest that extinction rates began to increase relative to originations. Either a threshold was reached by the early Katian prohibiting ecosystems to expand, or an extinction pulse occurred that decimated overall biodiversity accumulation. Two lines of evidence suggest the latter to be the case. Firstly, several new clades became hugely diverse by the Katian. These include bryozoans, crinoids, rugose and tabulate corals, as well as molluscs such as bivalves and gastropods, and show that obviously increased ecosystem complexity with, for instance, more epifauna and tiering occurred. Secondly, large richness datasets compiled from all metazoan clades differ from biodiversity curves based on individual clades in that they show a drop in richness already by the earliest Katian (as opposed to the classic two-pulsed Hirnantian scenario). This discrepancy has long been an overlooked conundrum that arguably has been ascribed to the larger datasets having been temporally less well-resolved. However, these new multiclade Ordovician biodiversity curves are – in some cases – resolved down to the scale of millennia, and they still depict this large fall in richness levels during the early Katian. As this pattern is observed across vastly dispersed regions, it is arguably a true signal depicting a global extinction pulse that precedes the two classic Hirnantian extinction waves by several million years.

If such a three-phased ‘extended-LOME’ interval is to be corroborated, it would imply a considerably different extinction scenario from the classic Hirnantian one. For instance, most of the Katian would then have to be viewed as being part of a protracted survival phase. In such a scenario, the global dispersal of faunas during the Boda and Richmnondian events could reflect faunas adapting to changing climatic and environmental conditions during not just the classic Hirnantian icehouse–greenhouse scenario but as part of a prolonged phase culminating with the Hirnantian extinctions. It would further entail a new perspective on the possible mechanisms driving this long extinction phase. Several extinction determinants, both intrinsic and extrinsic may be culprits, but it is hard to overlook the apparent correlation between the start of this ‘extended-LOME’ phase and some of the largest volcanic eruptions known in Earth’s history. Future better temporally resolved research into both the interplay between life and the environment during the earlier parts of the Late Ordovician hopefully will shed more light on this fascinating mass extinction event.

ABSTRACT

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