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A methodological scheme to analyse the early Palaeozoic biodiversification with the example of echinoderms

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ABSTRACT

The early Palaeozoic biodiversification is the most significant radiation of marine ecosystems of Earth's history, starting with the appearance of invertebrate organisms near the Precambrian–Cambrian boundary and followed by a significant diversification during the Great Ordovician Biodiversification Event (GOBE). The apparently sudden appearance of major phyla of metazoans during the earliest Cambrian (i.e., the 'Cambrian Explosion', c.a. 540 Ma) has been considered by many as corresponding to an 'explosive' process that took place during a very short time interval. Similarly, the GOBE has been considered as a short spectacular global event triggering a massive biodiversification during the early Middle Ordovician (c.a. 470 Ma). However, it appears that both 'events' have been more intensively studied in a few locations, creating multiple gaps, and thus a bias, in the biodiversity datasets. For example, the 'Furongian gap' (late Cambrian) is clearly an artefact in the Paleobiology Database (PBDB), which includes mostly data from North America and Western Europe. These geographic areas were more intensively sampled and recorded in the PBDB than others (e.g., China), separating the 'Cambrian Explosion' and the GOBE artificially, whereas the Geobiology Database (GBDB), which is focused on data from eastern Asia, records a more gradual increase of the global diversity during the early Palaeozoic.

These diversity curves are indeed not truly global but reflect patchy data from different palaeocontinental margins. Moreover, the evolution of global biodiversity is mostly estimated only in two dimensions (taxonomic richness *versus* time) and spatial distribution is rarely assessed. The organisms might have occupied the Earth's surface heterogeneously because of constraints on their ecological niches, generating 'diversity hotspots' that were recorded in some databases and not in others.

We want to test whether global 'explosions' of diversity ever occurred, or instead a single, but very complex, long-term evolutionary process took place over space and time, starting in the late Precambrian and lasting throughout most of the early Palaeozoic, with changing 'diversity hotspots' at different palaeogeographical locations. To do so, we use echinoderms as a model and we propose a protocol to (1) assess the validity of diversity curves based on data currently available online, and (2) analyse the spatio-temporal evolution of their diversity (i.e., generic richness) in the Cambrian and the Ordovician.

We first compare echinoderms diversity curves between the PBDB, the GBDB and an original database built from a comprehensive synthesis of the literature, with a temporal resolution at the scale of the stratigraphic stage. Then, we gather the three datasets to build a synthetic database that includes a revised taxonomy. To avoid fake spatio-temporal diversity peaks and hotspots, we define comparable stratigraphic units in terms of temporal range and gather sampled sections that refer to the same locality (e.g., the Montagne Noire).

We will present the comparison of the diversity curves between the three databases and the details of the whole methodological protocol.

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