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Framing origins and dynamics of biodiversity in the paradigm of space and time scaling

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The biodiversity is the fundamental aspect and transitive measure of biota and the evolutionary process itself. The biodiversity is usually understood as the diversity of morphological or structural types, and also as the number of taxa (species, genera, families etc.) or branches of different ranks in evolutionary trees or networks. The biodiversity is hierarchical and universal feature of biological systems. Despite its conceptual simplicity, the origins and patterns of variability of diversity, except the fact that they are based on the evolutionary process, are rather hardly comprehensively understood. Therefore, the determination of origins, and the dynamics of biodiversity through the space and time, is one of the most fundamental open questions of biology.

The theory of evolution reveals a number of possibilities on how biodiversity can change, and also predicts patterns which underlie the mechanism: if the biodiversity is autonomous and self-regulating process, or if opposite is true – the biodiversity is a driven variable dependant on many varying Earth system, and possibly astrophysical components. One of the most promising approaches in characterizing the dynamics of biodiversity, and discriminating between the underlying causes of the dynamics, is the analysis of scaling.

The spatial scaling of biodiversity is a well developed field of science. The dependence of species richness on the geographical area is described by power laws. The values of parameters could be interpreted with respect to possible controlling genealogical and ecological mechanisms of evolution. The scaling of biodiversity in space, also suggests the scaling of biodiversity as a function of time scale. The scaling is time scale symmetry which connects the large and small scales, and it reveals the uniformity of a mechanism in a scaling range. Presented approach allows the summarization of macroevolution in very simple terms.

Here we present a case of global marine animal biodiversity, and based on the revealed crossover-like time scaling pattern, we suggest that two competing time symmetric scaling mechanisms, with opposite effects on biodiversity (stabilizing versus destabilizing), are responsible for the evolution of the biota at the eon scale. The presented results can serve as a null model in understanding global evolution, and also can serve in sharpening and strengthening of our intuitions in exploring and explaining macroevolutionary patterns.

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