Anomalous fluctuations and selective extinction in populations of primordial replicators

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Abstract

The prevalent presence of a single chiral variant of molecules in live organisms is one of the most distinctive signs of life as a global phenomenon, specially from the point of view of Chemistry. One of the ambitions of Biochemistry and Astrobiology is to provide an explanation of this fact. Several well-known mechanisms have been proposed in the past, based on either (1) "propagation" of chirality from a homo-chiral substrate and (2) amplification of effects associated with electro-weak interaction. Elaborating ideas proposed by the present author in the past, a different scenario is proposed. Anomalous fluctuations associated with a self-replication scenario can lead to selective extinction of one of the two variants. These fluctuations arise spontaneously when a global feedback but not a local one acts. To demonstrate this mechanism, a model is developed, describing the "struggle for life" of two different kinds of primordial replicators, which employ catalyzers of different chirality but on a non-chiral substrate, thereby with no selective advantage. A fixed flow of a chemical needed to perform replication provides a control on the total number of replicators. Results clearly show that, while the fluctuations of the number of replicators are effectively damped by the feedback, strong fluctuations in the number of individuals of each species are observed. This dynamics is explained by a meta-model based on a nonlinear Chapman-Kolmogorov equation which is solved numerically. These studies may contribute to shed light on a most mysterious phase transition occurred during the biochemical evolution of our planet.

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