
Summary: How biodiversity is maintained is one of the most important problems in biology. It, seemingly, challenges the Darwinian evolutionary theory which assumes that only the fittest species survive. Most previous researches try to solve the puzzle based on deterministic dynamics. However, it is not clear how demographic stochasticity plays a role in biodiversity, even though randomness cannot be ignored in real biological systems. In contrast with deterministic methods, we propose that biodiversity is measured by the time that the species coexist. Modeled by the cyclic Rock-Paper-Scissors game, we concentrate on the Fermi process, where randomness is captured by the selection intensity. We find that there is a non-monotonic relationship between the selection intensity and the time that the species coexist. Intrinsic differences between stochastic dynamics and deterministic dynamics are shown to be present, even if the selection is in its strong limit which mirrors the deterministic dynamics. Furthermore, we prove that these results are robust for general stochastic imitation processes beyond the Fermi process. Our work highlights the importance of transient dynamics on biodiversity, which is absent in the deterministic counterpart, and opens an avenue to calculate biodiversity under stochastic evolutionary process.

MSC:
92-XX Biology and other natural sciences
91-XX Game theory, economics, finance, and other social and behavioral sciences

Keywords: biodiversity; rock-paper-scissors game; stochasticity; fixation time

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References:

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