Mutation in the rock-paper-scissors system

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ABSTRACT

In this talk, we consider emergences of mutant species among self-competing three species in the cyclic dominance. By defining mutation as the birth of mutant species, we investigate how mutant species can affect biodiversity in the existing ecosystem. Through microscopic and macroscopic approaches, we have found that the society of existing normal species can be disturbed by mutant species either the society is maintained accompanying with the coexistence of all species or jeopardized by occupying of mutant species.

MUTATION

Mutation caused by errors in genetic replication is rare, but a ubiquitous phenomenon in biological systems. Although mutation may or may not induce noticeable changes in properties of organisms, it is obvious that mutation can play a normal, abnormal, beneficial or harmful role in biological processes such as resistance to HIV infection, emergence and role of mutants, and beneficial/harmful effects for fitness, In this perspective, understanding mechanisms and effects of mutation on biodiversity is important, and evolutionary games have been adopted as powerful tools for interpreting various phenomena. Employing mathematical/theoretical models based on evolutionary games, mutation has been addressed in two different ways depending on how it occurs: (a) the change of phenotypes, and (b) the birth of new mutant species.

Within the assumption of the birth of mutant species, it has been found that the emergence of mutant species by mutation can affect the existing ecosystem by (a) destroying existing alliances and taking over the population, (b) enabling one of the residents or a new alliance of residents to take over, or (c) leading to another stable alliance together with a subset of the resident types or all of them. Based on these findings, we may ask how biodiversity may be changed if mutant species may emerge by mutation and compete with existing species in which stably coexist.

MAIN CONTRIBUTION

When mutation occurs as the birth of mutant species, new group for mutant species can be formed. In this case, the system in which only three species existed at the beginning is extended to a system in which all six species compete with each other by the newly born mutant species. These six species can also compete cyclically due to the heredity, and the system can be ultimately regarded as cases in cyclic competition of many species. To summarize the results briefly, our main findings are as follows. When a mutant birth is rare or weak, depending on the strength of mutual competition between the normal species and the mutant species, one

normal species and one mutant species survive or coexist with one normal species and all mutant species. As mutation occurs more frequently, the biodiversity is also changed. When mutual competition rates are moderate with respect to the frequency of mutation, all species can coexist, but the coexistence becomes unstable as mutual competition intensifies. Consequently, we may find the survival of only one mutant and one normal species, or the coexistence of only mutant species.

REFERENCES

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