Contributed Talk

Quenching of Chaos in Externally Driven Metacommunities

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Chaotic population dynamics have been observed in various natural ecosystems of widely varying spatial scales. Chaotic fluctuations in population density, barring a very few specific conditions, have generally been established to be more prone to extinction through cascading effects, environmental noise, and frequent occurrence of low species density [1]. In particular, it has been shown that low density populations have an elevated chance of extinctions in the chaotic domain of population density, especially under high environmental stochasticity [2]. Irrespective of this, inherently chaotic ecosystems survive. This is attributed to internal and external control of chaos engineered by either the ecosystems themselves, or external influence from other ecosystems. Notwithstanding, the question of chaos control in metacommunities (i.e., ecosystems coupled through dispersal) arising due to a fundamental ecological feature like habitat heterogeneity has not yet been properly investigated. Moreover, ecosystems when connected to each other through dispersal exhibit different states of stability, compared to their individual behavior. Thus, stability of a chaotic ecosystem connected to a network also merits investigation. An ecological network, connected through dispersal where each node (patch) represents an ecosystem, is called a metacommunity. In this study, we analyze the dynamics of a drive-response metacommunity, where each patch consists of an inherently chaotic tritrophic food web [3] with inherent habitat heterogeneity. In such a metacommunity, one patch drives the dynamics of the remaining patches of the network. We report that dynamical chaos in both drive and response patches are quenched under a strong influence of the drive, subsequently leading to steady states in most cases. We report the occurrence of this phenomenon for two diverse network structures. We discover that the heterogeneity of the response systems and dissimilarity of the drive and response systems play a major role in quenching chaos. Thus, it is extremely possible that the existence of an inherently chaotic metacommunity is strongly due to interplay of chaos, habitat heterogeneity and the structure of the network. Notably, metacommunities consisting of inherent chaotic patches also face the risk of extinction due to various types of dispersal-induced synchronization[4]. Therefore, we have investigated dispersal-induced complete, phase, and general synchronization between the constituent patches of these drive-response metacommunities. We show that generalized synchronization among the drive and response patches increases with increasing dispersal. Complete and phase synchronizations between drive and response patches and two response patches are shown to be strongly governed by the network structure [5].

References

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