Changes in dynamics modes for discrete-time predator-prey model due to variation of initial number

Oksana Revutskaya, Matvey Kulakov, Efim Frisman
Institute for Complex Analysis of Regional Problems Far Eastern Branch Russian Academy of Sciences, Birobidzhan, Russia

The study of communities such as predator-prey or host-parasite is one of the most important environmental problems, which are devoted to the solution of theoretical, laboratory and field research for many decades. Most predators carry out selective removal of individuals from the prey population that lead to various kinds of prey's structural changes depending on direction and force of predator impact on prey. Consequently, when studying the interacting species dynamics, it is important to consider the population, primarily the age structure of the prey. The paper investigates dynamic modes of the predator-prey model with age structure for prey. We use a slight modification of the Nicholson-Bailey model to describe the interaction between predator and prey. We assume the population size is regulated by decreasing juvenile survival rate with growth of age class sizes. Conditions for sustainable coexistence of interacting species are described. It is shown that the coexistence of species becomes possible if there are a transcritical or saddle-node (tangential) bifurcations. Due to the saddle-node bifurcation there is bistability in the system of interacting species: predator either coexists with prey or dies depending on the initial conditions. It is shown that the range of demographic parameters, for which the prey and predator coexist, can significantly increase with growth of survival of adult prey or the proportion of predators born or the prey consumption rate of the predator. We studied the oscillation scenarios of interacting population, influences of reproduction, survival and self-regulation rates of population prey and age-dependent predation as well as variations in the current number on transitions between different dynamic modes. It is shown that an increase in the birth rate of the prey under intraspecific competition can lead to a dynamics destabilization and to complex oscillations appearance in numbers. Age-dependent predation is shown to be a stabilizing influence. It was found that in the model parametric space, both bistability and multistability arises, which are not related to each other. Consequently, even a small variation of the current population size leads to more complex behavior of the interacting species, and can give a significant change in both the observed dynamic mode and the coexistence scenario of the species.

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