Complex dynamics of a discrete-time age-structured predator-prey system

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The paper proposes and investigates a prey-predator model considering age structures of the interacting species that is typical for the arctic fox - rodents community. We suggest a four-component model of community dynamics composed of two-component models of different types. Due to pronounced density-dependent limitation in rodent species, we use exponential form for birth rate function in the prey dynamics model. By contrast, predator species have less pronounced density limitation, so a linear form of dependence is quite adequate. Predator consumption results in changes of the prey population size. We use the Holling type II functional response considering predator saturation.

An analytical and numerical study of the proposed model is made. Periodic, quasi-periodic and chaotic oscillations can occur in the system, as well as a shift in the dynamics mode due to changes in the current size of one of the community populations. The dynamic modes of the proposed model, as well as the possibility of dynamic mode shift, are investigated. The system proposed shows possibility of transitions from stable dynamics to quasi-periodic oscillations and back to a stationary state, while an increase in the values of half saturation constant reduces possibility of occurrence of quasi-periodic oscillations. The long-period oscillations with a delay like auto-oscillations of the classical Lotka-Volterra model occur.

The transition scenarios from stable dynamics to fluctuations for prey and predator numbers with different values of demographic and interaction parameters are analyzed. It is shown that interacting species can demonstrate both the sustainable existence of community and different complex fluctuations of predator and prey population dynamics. As a rule, the prey dynamics determines the predator dynamics: fluctuations in the prey population size result the same type of fluctuations in the predator dynamics, while the predator demographic parameters may correspond to other dynamic modes both stable and irregular.

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