Effects of Nonlinear Growth and Death Rates for the Predator in Predator-Prey Type Models

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Keywords: Predator-prey type models, Stability, Persistence, Generic birth and death rates

Mathematical modelling is an important tool in population dynamics that allows describing various ecological and biotechnological processes.

The classical models (e.g., the Monod-type models, modelling microbial growth or the Rosenzweig-MacArthur predator-prey model, among others) assume a per capita growth rate that is linear w.r.t. the food intake and a constant per capita death rate. In the present work, we consider generic birth and death rates based on several observations proposed by A.J. Terry [1].

For sufficiently small values of the consumption, the reproduction will be zero rather than linearly increasing. Also, there will always be a limit to the rate at which an individual can reproduce. On the other hand, every organism needs some minimal energy intake, in order to survive. Therefore, under this threshold the death rate should be higher.

Using the idea of non-linear birth and death rates, we propose models that are generalizations of classical models in population dynamics. We study the asymptotic properties of the solutions of the considered models. We show that in some cases those models have much richer dynamics and, thus, allow us to model more complex behaviour of the biological system. Also, we investigate their ability to model real processes by comparing the results of the parametric identification process to experimental data for different microbial cultures.

References

[1] A.J. Terry, A predator-prey model with generic birth and death rates for the predator, Mathematical Biosciences 248 (2014) 57–66.