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Dynamics of a three species ratio-dependent food chain model with intra-specific competition within the top predator

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Abstract

In this paper, a ratio-dependent food chain model has been considered. The total population has been divided into three classes, namely prey, predator and top-predator population. We have also incorporated intra-specific competition of predators in the model. We have studied the boundedness, dissipativeness and permanence of the solutions of the system and analyzed the existence of various equilibrium points and stability of the system at those equilibrium points. The system exhibits Bogdanov-Takens bifurcation, saddle-node bifurcation, Hopf bifurcation for suitable choice of the relevant parameters. The results of extensive numerical simulation are provided to support the validity of the theoretical findings. The ecological implications of our analytical and numerical findings are discussed.

Keywords: Food chain; Intra-specific competition, Stability, Saddle-node, Transcritical, Hopf-Andronov bifurcations, Takens-Bogdanov bifurcations, Lyapunov function

1. Introduction

Coexistence of all species in an ecological system and biological control of infest ants are both important issues for the management of natural resources. When the predator constitutes a pest, it must be controlled in order to preserve the prey population level. This type of situation can be handled by the introduction of a predator's natural enemy as a biological control agent. In the ecosystem it thus represents the top-predator. Many natural situations can be reduced to this description, ecological systems in which populations constitute food chains where the biological control agent is significant for the control of unpleasant activities of the pest species. On the other hand, for conservationists

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