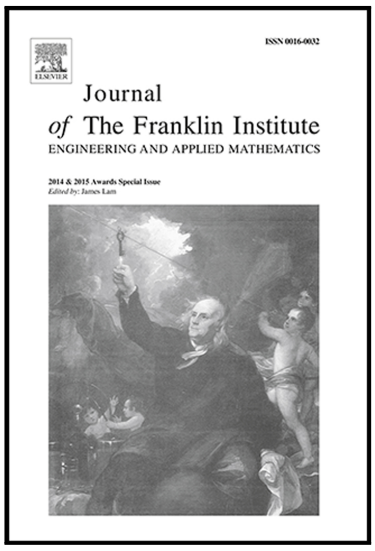

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PII: S0016-0032(18)30507-6
DOI: https://doi.org/10.1016/j.jfranklin.2018.07.029
Reference: FI 3576

To appear in: *Journal of the Franklin Institute*

Received date: 4 January 2018
Revised date: 6 June 2018
Accepted date: 31 July 2018

Please cite this article as: Jai Prakash Tripathi, Syed Abbas, Gui-Quan Sun, Debaldev Jana, Cui-Hua Wang, Interaction between prey and mutually interfering predator in prey reserve habitat: pattern formation and the Turing-Hopf bifurcation, *Journal of the Franklin Institute* (2018), doi: https://doi.org/10.1016/j.jfranklin.2018.07.029

Interaction between prey and mutually interfering predator in prey reserve habitat: pattern formation and the Turing–Hopf bifurcation

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Abstract

In this paper, we propose a diffusive prey-predator system with mutually interfering predator (Crowley-Martin functional response) and prey reserve. In particular, we develop and analyze both spatially homogeneous model based on ordinary differential equations and reaction-diffusion model. We mainly investigate the global existence and boundedness of positive solution, stability properties of homogeneous steady state, non-existence of non-constant positive steady state, conditions for Turing instability and Hopf bifurcation of the diffusive system analytically. Conventional stability properties of the non-spatial counterpart of the system are also studied. The analysis ensures that the prey reserve leaves stabilizing effect on the stability of temporal system. The prey reserve and diffusive parameters leave parallel impact on the stability of the spatio-temporal system. Furthermore, we illustrate the spatial patterns via numerical simulations, which show that the model dynamics exhibits diffusion controlled pattern formation by different interesting patterns.

Keywords: Crowley-Martin functional response; Prey reserve; Hopf bifurcation; Global stability; Positive steady states; Turing pattern

1 Introduction

The interactions of individual organisms with each other and the environment are the most important distinctive features in ecological systems. Predation is an important type of interaction that affects the population dynamics of all species. As a result, one of the main objectives of ecologists is to get insight into prey-predator relationship [1, 2, 3, 4]. The rate of prey consumption by an average predator (functional response) is one of the significant characteristics of the prey-predator relationship. Functional response determines stability and bifurcation scenarios with diverse parameter range of ecological systems. The real functional responses not only show the consistency of data fitting with experimental results but also play an important role for accurate predictions of models. Functional responses can primarily be classified in two categories: (i) prey dependent (linear and Holling type functional responses) [5, 6], (ii) predator dependent (ratio dependent, Beddington-DeAngelis, Crowley-Martin and Hassel-Varley) [7]–[13]. The intuitive