Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **26 (2019)** 39-52

GLOBAL STABILITY OF A THREE SPECIES PREDATOR-PREY FOOD CHAIN DYNAMICS

Safaa Jawad Ali[1,2,*] Norihan Md. Arifin[1] Raid Kamel Naji[3] Fudziah Ismail[1] and Norfifah Bachok[1]

[1]Institute for Mathematical Research
University Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

[2]Technical Instructor Preparing Institute
Middle Technical University, Baghdad, Iraq
[3]Department of Mathematics
College of Science, University of Baghdad, Iraq

*Corresponding author email:safa_ali1962@yahoo.com

Abstract. In this paper controlling chaotic dynamics in a three species food chain model with modified Holling type IV functional response is proposed and studied. The system is observed to be dissipative in the positive octant. The global stability of the equilibrium points is analyzed using Routh-Hurwitz criterion and Lyapunov second method. Lyaponuv exponent and bifurcation diagrams are used to study the dynamics of the system. The effect of the death rate in the dynamics of the food chain system is discussed. Moreover, the role of intraspecific competition in the dynamics of the model is investigated theoretically and additionally numerically.

Keywords. bifurcation diagram, chaotic dynamics, Holling type IV, global stability, period doubling.

AMS (MOS) subject classification: 37D45, 37D50, 37C75.

1 Introduction

The concept of chaos is one of the major discoveries of recent times. Since the work of May [22] in the last century, researchers in ecology and biology reported the existence of chaos, see [2, 9, 19, 20, 23, 30]. The inclusive search for ecological chaos was carried out by Ellner at el [31]. Ayala [10] proved that two species of Drosophila could coexist upon a single limit resource. Ayala's experiment leads to a large body of work, see [1, 4-6, 15-17, 19-27]. Gardini [15] studied a class of Lotka-Volterra systems. It is shown that in a suitable class of these systems to characterize a Hopf bifurcation of three species model. Rai [34] presented a new food chain model involving three species and show the presence of period doubling scenario leading to chaos. Upadhyay [20] studied Rosenzweig-McArthur model [18] to investigate a food