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DYNAMICAL STUDY OF TRI-TROPHIC HYBRID FOOD WEBS WITH SPATIAL EFFECT: A HIGHER ORDER ANALYSIS

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Abstract. In this study, a population of one prey species and two predator species with Holling type II functional responses are used as model systems for three species. We mainly focus on spatiotemporal system and provided an analytical and numerical explanation for understanding the diffusion driven instability condition and spatial patterns have emerged at different levels of the diffusion coefficient. We also look at the spatial phytoplankton system's higher-order stability analysis for both linear and non-linear systems. We discovered the system's of local stability and boundedness. Furthermore, using predator rates as the temporal system's bifurcation parameter and using direction local stability criterion for equilibrium locations, we were able to prove Hopf-bifurcation existence. We established the system's stability and identified the circumstances under which it becomes unstable. Furthermore, the higher-order stability analysis of the spatiotemporal domain is explored. A few numerical simulations are then performed to generate patterns.

Keywords. Food web, Holling type-II, Hopf bifurcation, directional-stability, Turing instability, pattern formation, Higher order Stability.

AMS (MOS) subject classification: 37N40, 92D25, 92D40, 93C15, 93C20, 97Mxx.

1 Introduction

Aquatic ecologists have recently become captivated by the dynamics of explosive phytoplankton blooms, or the quick population expansion and decline [**?**]. The flowers come in two varieties: red bloom and spring bloom. The shift in temperature and nutrition level that occurs in the spring is a seasonal phenomenon [1]. Literature reports the categorization of phytoplankton blooms [2, 3]. A phytoplankton bloom is neither a reason for alarm or a threat to the quality of the water; rather, it is a normal ecological phenomenon. In the actual world, a planktonic bloom production frequently results in a huge number of planktonic organisms rapidly disintegrating and lysing in vast numbers