Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **26 (2019)** 221-242

A NEW NUMERICAL METHOD FOR SOLVING SYSTEM OF FDES: APPLIED IN PLANKTON SYSTEM

Mohammad Shahbazi Asl and Mohammad Javidi

Faculty of Mathematical Sciences, University of Tabriz, Tabriz, Iran.

Abstract. A fractional order mathematical model for the interaction of non-toxic phytoplankton, toxic phytoplankton and their predator zooplankton population in an open marine system is investigated, from both theoretical and numerical point of view. All the feasible equilibria of the system are obtained and the criteria for the existence of the interior equilibrium are determined. The local stability analysis of all the feasible equilibria is studied. A new high order numerical scheme for solving a linear system of fractional equations is presented. A comprehensive stability and error analysis of the presented scheme are studied. The stability region of the numerical scheme is performed. A wide number of numerical simulations are provided and compared with literature to support the theoretical results and demonstrate the computational efficiency of the presented numerical scheme.

Keywords. Plankton, Numerical method, Fractional order system, Fractional differential equation, Stability.

AMS (MOS) subject classification: 26A33, 65R10, 37N25.

1 Introduction

Plankton is a diverse group of microorganisms, which are floating freely near the surfaces of all aquatic environments. They are the basis of all aquatic food chains, so almost all aquatic life is based upon plankton [26]. The importance of plankton for the ocean ecosystems and ultimately for the planet itself is well-established [28]. The plant forms of plankton community are known as phytoplankton, and the animals in the plankton community are known as zooplankton [43].

Phytoplankton is responsible for the production of $50-80\%$ of all the oxygen for human and other living animals after absorbing half of the carbon dioxide from the Earths atmosphere, that may contribute to global warming [18, 9]. They are also responsible for approximately 40% of the global primary productivity and play an important role in most biogeochemical cycles [29]. Hence, the dynamics of the rapid increase or decrease of plankton populations is, therefore, an important subject for marine plankton ecology.

Toxin-producing phytoplankton (TPP) is a specific group of phytoplankton common to most aquatic ecosystems. they have the ability to produce toxic chemicals which affect the growth of other microalgae or can result in paralysis and death in seabirds and humans [42, 18]. The adverse effects of TTP species on human