ABSTRACT

Sundarban mangrove forest is one of the largest mangrove forests, and it is very rich in dynamics due to its diversity. The forest and its adjacent estuary support detritus-based food chain, which is the most common and significant food chain to shape the dynamics of that ecosystem.

In this thesis, some non-spatial detritus-based prey-predator models in the Sundarban mangrove forest and the nearby estuary have been examined to study the dynamics of interaction between the micro-organism pool feeds on detritus and its invertebrate predators. This detritus is mainly produced from the plant litter of several mangrove trees by the decomposition process with the help of micro-organism pool. This detritus is the primary energy source of this ecosystem, and the energy is transferred from the detritus to the higher tropic levels. The rate of uptake of invertebrate predators is taken as Ivlev-type response function. We have also considered some models where the loss of detritus due to micro-organism pool is assumed to follow Holling type-II functional response. The mathematical analysis includes the existence of different feasible equilibria and their stability behaviour, including the existence of Hopf-bifurcation and limit cycle.

Next, we consider a model where it is assumed that besides the plant litter, a small amount of detritus is also formed from the dead bodies of invertebrate predators by the recycling process and the effect of single discrete-time delay is studied. Next, a model with multiple time delays is considered. These time delays play a pivotal role in building the dynamics as these delays can destabilize a stable ecosystem.

We have also formulated some models with Caputo fractional order derivatives. Due to its memory effect; these fractional order systems are more realistic and complicated than the integer order systems. Using the Homotopy perturbation method, the approximate solution of a fractional order model has been derived. Next, the effect of prey refuge is considered in a model in presence of toxicity. In mangrove estuary, tidal waves come twice a day, and due to tidal influence, some amount of micro-organisms of the adjacent estuary always washed out. As a result of this type of prey refuge, an amount of micro-organism is protected from predation. This prey refuge enhances the prey-predator coexistence and prevents the micro-organism from extinction. It is known that industries always release a huge amount of toxic substances into marine water. Due to the tidal influence of the adjacent Bay of Bengal, a huge amount of marine water enters in the estuary. The growth of micro-organism pool and invertebrate predators are affected because of this toxicity.

All the theoretical outcomes are verified by numerical simulations.

keywords: Detrtitus, Micro-organism pool, Ivlev-type functional response, Invertebrate predator, Time delay, Fractional order, Prey refuge, Toxicity.

Manwar 09/09/2024

Professor
DEPARTMENT OF MATHEMATICS
Jadavpur University
Kolkata - 700 032, West Bengal

Tanushree Murmu
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