Predicting Qualitative Behavior of a Tri-trophic Food Chain Model Having Allee Effect on Prey-growth Using Spectral Theory

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A B S T R A C T

Trophic interactions between predator and prey are a fundamental dominating matrix component to determine the functioning of ecosystems. These interactions influence population dynamics, community structure and food web dynamics. They control the fluxes of energy and matter transfer between trophics in ecosystems. Predators often have directed impact on prey abundance through consumption or indirectly through density-mediated trophic cascades. Prey change their strategies and traits for their existence due to presence of predators. Allee effect naturally occurs in almost all population models at low species density. Preferably, prey population is supposed to go under Allee effect frequently as higher predations in natural ecosystems often suppress prey density and consequently Allee effect imposed on such low prey population. In the present study, a simple tri-trophic food-chain model consisting of bottom prey, middle predator and top predator with Allee effect in prey has been extensively analyzed using Spectral Theory (ST). We derive the stability criterions of equilibrium points, the qualitative changes against the parameter range and bifurcation analysis. Using the spectral analysis, the prediction of chaos is also established. Allee effect has significant control on coexistence and persistence of the tri-trophic model.

Keywords: Spectral Theory, Allee effect, Takens-Bagdanov bifurcations, Chaos.

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