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PREY REFUGE BEHAVIOR IN RESPONSE TO PREDATOR PRESENCE: IMPLICATIONS FOR A LESLIE-GOWER TYPE PREDATION MODEL

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ABSTRACT

In this work, we explore a continuous-time predator-prey model of the Leslie-Gower type, extended to include a biologically meaningful mechanism: the use of a physical refuge by a fraction of the prey population. Specifically, we assume that the proportion of prey individuals that access the refuge is directly proportional to the number of predators present in the environment. This assumption introduces a nonlinearity that significantly influences the dynamics of the system.

We analytically investigate the conditions under which equilibrium points exist and assess their local stability. Our analysis reveals that the origin, representing the extinction of both species, plays a central role in the dynamics. It generates a separatrix curve in the phase plane that divides the space of initial conditions into distinct behavioral regions. Trajectories that start above this separatrix tend to the origin, indicating that both populations face extinction in the long term. On the other hand, trajectories that originate below the separatrix may converge to a positive interior equilibrium, reflecting stable coexistence, or exhibit sustained oscillatory behavior in the form of a stable limit cycle.

This dual behavior highlights the importance of initial population sizes and the strength of the refuge effect in determining long-term outcomes. The presence of a refuge can help sustain prey populations under predation, but under certain circumstances, it may also contribute to the extinction of both species if the refuge is overutilized or ineffective due to high predator densities.

To complement the theoretical findings, we provide numerical simulations that illustrate the model's dynamics for different parameter values and initial conditions. These simulations confirm the analytical predictions and offer insight into how small changes in initial populations or refuge efficiency can lead to markedly different ecological scenarios. Our results underscore the ecological relevance of refuge mechanisms and contribute to a deeper understanding of predator-prey interactions.

***K*eywords** Predator-prey dynamics · Leslie-Gower model · Refuge · Equilibrium stability · Nonlinear system

References

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