A MODIFIED LESLIE-GOWER PREDATOR-PREY MODEL INCORPORATING PREY REFUGE AND TIME DELAY: DYNAMIC CONSEQUENCES

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Abstract. In this paper, a modified Leslie-Gower predator-prey model incorporating prey refuge and time delay is proposed. We investigated both effects of prey refuge (stabilizing effect) and time delay (destabilizing effect) on the dynamic consequences of the considered model. The results show that the equilibrium densities of prey and predators increase with refuge used by prey under a restricted set of conditions and the effect of prey refuge has no influence on the stability properties of the considered model when the time lag is smaller than the threshold. Our analyses also show that the effect of prey refuge can decrease the stability of the interior equilibrium point of the considered model when the time lag is larger than the threshold.

Keywords. leslie-gower; prey refuge; time delay; stability; bifurcation.

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1 Introduction

The dynamic relationship between predators and their prey has long been and will continue to be one of the interesting and dominant issues in both ecology and mathematic ecology due to its universal existence and importance. Decades years ago, Leslie [1,2] introduced the following predator-prey model where the environmental carrying capacity of predator population is proportional to the number of prey

$$\begin{aligned}
\dot{x}(t) &= (r_1 - bx - a_1 y)x \\
\dot{y}(t) &= (r_2 - \frac{a_2 y}{x})y
\end{aligned} \tag{1}$$

in which x and y is the density of prey and predators respectively and hence are all positive. The other parameters have the following ecological meanings: