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PERSISTENCE AND STABILITY OF A TWO-SPECIES PREDATOR-PREY SYSTEM WITH TIME DELAY

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Abstract. A two-species ratio-dependent predator-prey system with time delay is investigated. It is proved that the system is uniformly persistent under appropriate conditions. By constructing a suitable Lyapunov functional, sufficient conditions are obtained for the global stability of a positive equilibrium of the system.

Keywords. Predator-prey system, time delay, persistence, Hopf bifurcation, global stability.

AMS (MOS) subject classification: 34K20, 34K18, 92D25.

1 Introduction

Lotka-Volterra type predator-prey systems are very important in the models of multi-species populations interactions and have been studied by many authors. It is assumed in the standard Lotka-Volterra type models that the per capita rate of predation depends on the prey numbers only. Recently, there is growing explicit biological and physiological evidence that in many situations, especially when predators have to search for food (and therefore have to share or compete for food), a more suitable general predator-prey theory should be based on the so-called "ratio-dependent" theory. This roughly states that the per capita predator growth rate should be a function of the ratio of prey to predator abundance. That is, as the numbers of predators change slowly (relative to prey change), there is often competition among the predators, and the per capita rate of predation depends on the numbers of both prey and predator, most likely and simply on their ratio. These hypotheses are strongly supported by numerous field and laboratory experiment and observations (see, for example, [1]).

On the other hand, it is generally recognized that some kinds of time delays are inevitable in population interactions (see, for example, Kuang [9]). Time delay due to gestation is a common example, because generally the consumption of prey by the predator throughout its past history governs the present birth rate of the predator.

The ratio-dependent predator-prey models without predator density dependence have been studied by many researchers recently and very rich dynamics have been observed (see, for example, [3, 6, 7, 10] and the references