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STABILITY OF A PREDATOR-PREY SYSTEM WITH DIFFUSION AND STAGE STRUCTURE

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Abstract. In this paper, a two-species predator-prey system with diffusion terms and stage structure is discussed. The stability of the equilibria and all of coexistence states of the system and the global stability of the system are also investigated. The asymptotic behavior of solutions and the negative effect of stage structure on the permanence of populations are analyzed.

Keywords. Predator-prey systems; stage structure; reaction diffusion system; global stability; upper and lower solutions.
AMS (MOS) subject classification: 34D23; 35B40; 35K57

1 Introduction

Predator-prey models have been studied by many authors(see [7, 17]), but the stage structure of species has been ignored in existing literature. In the natural world, however, there are many species whose individual members have a life history that take them through two stages, immature and mature(see [1, 2, 4, 6, 8, 9, 10, 15]). In particular, we have in mind mammalian populations and some amphibious animals, which exhibit these two stages. In these models, the age to maturity is represented by a time delay, leading to systems of retarded functional differential equations. Cannibalism has been observed in a great variety of species, including a number of fish species. Cannibalism models of various types have also been investigated(see[5]). For general models population growth see[11].

Recently, a model of two species predator-prey with stage structure was derived in [15]. The model is taken in the following form:

$$\begin{cases} \dfrac{dX_1(t)}{dt} = \alpha X_2(t) - \gamma X_1(t) - \alpha e^{-\gamma\tau} X_2(t-\tau), \\ \dfrac{dX_2(t)}{dt} = \alpha e^{-\gamma\tau} X_2(t-\tau) - X_2(t)\left(h + \beta X_2(t) + a_1 Y(t)\right), \\ \dfrac{dY(t)}{dt} = Y(t)(-r_1 + a_2 X_2(t) - bY(t)), \\ X_1(0) > 0, Y(0) > 0, X_2(t) = \varphi(t) \geq 0, -\tau \leq t \leq 0, \end{cases} \tag{1.1}$$