Stable periodic orbits in the Harrison's predator-prey model

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In the paper [1] G. Harrison has performed a set of tests related with the problem of the best fitting, by mean of a mathematical model, of the data given by predator-prey experiments in the laboratory with dinidium and paramecium . In doing this, G. Harrison concludes that the predator-prey systems must obey to certain delay mechanism in the functional response of the predator. In this way, G. Harrison proposes in [1] a predator-prey model in which the delay is introduced, of a new point of view, as a energy mechanism modelling this by mean a equation that establishes the dynamic of the transference of energy from the prey to the predator. The predator-prey model is given by a system of three nonlinear ordinary differential equations:

$$\begin{aligned} x' &= \rho\left(1-\frac{x}{k}\right)x-\omega f\left(x\right)y \\ z' &= \sigma f\left(x\right)y-\delta z \\ y' &= \left(\frac{\lambda z}{y}-\gamma\right)y, \end{aligned}$$

where, x denotes the prey population density, y denotes the predator population density and z denotes the energy that is transfered from the prey to the predator that incorporates new predator organisms in the system. All of the parameters are positive quantities and $f(x)$ denotes the functional response of the predator population.

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We show that the previous system has the point dissipative property and therefore has a unique global attractor. The main result in this research is the existenceof orbitally asymptotically stable periodic orbits in the global attractor when the system has an unique nontrivial hyperbolic equilibrium point in the positive cone $\mathbb{R}^3_+$.

References

[1] G. W. Harrison, "Comparing Predator-Prey Models to Luckinbill's Experiment with Didium and Paramecium" Ecology, **76(2)**, (1995), 357-374.