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A nonconservative kinetic framework with logistic growth for modeling a multi-species ecological system

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Kinetic theory frameworks are widely used for modeling stochastic interacting systems in various fields: opinion dynamics, economics, psychology, traffic-flow problems, epidemiology and behavioral epidemiology, among others [1]; where the evolution primarily depends on binary interactions. Recently, in this framework the action of the external force field has been introduction in order to gain a more realistic picture of some phenomena. In this work, a nonconservative kinetic equations for an ecological system accounting for population growth is proposed, where a particular shape external force field acts on the overall system. Notice that the introduction of nonconservative terms in a kinetic system may lead to the loss of certain analytical properties, such as, for example, the boundedness of solutions. In particular, the ecological context for modeling the evolution of this system consists into two species interacting with a prey–predator mechanism.

Therefore, some further analytical assumptions are required in order to preserve the well posedness of the problem because the solution is required to be positive and bounded. Then, some first stability results are obtained. In particular, among the equilibria provided by the system, we will focus our attention on the coexistence equilibrium point, that is the equilibrium point that ensures the survival of both populations.The linear stability analysis concerned with the coexistence equilibrium point is provided, and a case where a Hopf bifurcations occurs is discussed. Finally, some relevant scenarios are numerically simulated.

Keywords: kinetic theory, differential equations, nonconservative dynamics, stability, ecological systems

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References

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