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A Qualitative Description of the Dynamics in the Interactions between Three Populations: Pollinators, Plants, and Herbivores

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Abstract : In population dynamics the study of both, the abundance and the spatial distribution of the populations in a given habitat, is a fundamental issue a From ecological point of view, the determination of the factors influencing such changes involves important problems. In this paper a mathematical model to describe the temporal dynamic and the spatiotemporal dynamic of the interaction of three populations (pollinators, plants and herbivores) is presented. The study we present is carried out by stages: 1. The temporal dynamics and 2. The spatio-temporal dynamics. In turn, each of these stages is developed by considering three cases which correspond to the dynamics of each type of interaction. For instance, for stage 1, we consider three ODE nonlinear systems describing the pollinator-plant, plant-herbivore and plant-pollinator-herbivore, interactions, respectively. In each of these systems different types of dynamical behaviors are reported. Namely, transcritical and pitchfork bifurcations, existence of a limit cycle, existence of a heteroclinic orbit, etc. For the spatiotemporal dynamics of the two mathematical models a novel factor are introduced. This consists in considering that both, the pollinators and the herbivores, move towards those places of the habitat where the plant population density is high. In mathematical terms, this means that the diffusive part of the pollinators and herbivores equations depend on the plant population density. The analysis of this part is presented by considering pairs of populations, i. e., the pollinator-plant and plant-herbivore interactions and at the end the two mathematical model is presented, these models consist of two coupled nonlinear partial differential equations of reaction-diffusion type. These are defined on a rectangular domain with the homogeneous Neumann boundary conditions. We focused in the role played by the density dependent diffusion term into the coexistence of the populations. For both, the temporal and spatio-temporal dynamics, a several of numerical simulations are included.

Keywords : bifurcation, heteroclinic orbits, steady state, traveling wave
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