Title:	Bifurcation analysis of the predator–prey model with the Allee effect in the predator
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Abstract:	The use of predator–prey models in theoretical ecology has a long history, and the model equations have largely evolved since the original Lotka–Volterra system towards more realistic descriptions of the processes of predation, reproduction and mortality. One important aspect is the recognition of the fact that the growth of a population can be subject to an Allee effect, where the per capita growth rate increases with the population density. Including an Allee effect has been shown to fundamentally change predator–prey dynamics and strongly impact species persistence, but previous studies mostly focused on scenarios of an Allee effect in the prey population. Here we explore a predator–prey model with an ecologically important case of the Allee effect in the predator population where it occurs in the numerical response of predator without affecting its functional response. Biologically, this can result from various scenarios such as a lack of mating partners, sperm limitation and cooperative breeding mechanisms, among others. Unlike previous studies, we consider here a generic mathematical formulation of the Allee effect without specifying a concrete parameterisation of the functional form, and analyse the possible local bifurcations in the system. Further, we explore the global bifurcation structure of the model and its possible dynamical regimes for three different concrete parameterisations of the Allee effect. The model possesses a complex bifurcation structure: there can be multiple coexistence states including two stable limit cycles. Inclusion of the Allee effect in the predator generally has a destabilising effect on the coexistence equilibrium. We also show that regardless of the parametrisation of the Allee effect, enrichment of the environment will eventually result in extinction of the predator population.
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