Habitat quality and the velocity of spatial population expansion

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Abstract

An important prediction of several spatio-temporal models of population dynamics is that habitat quality, defined here as the carrying capacity (K) of the environment, should have no influence on the velocity (v) of a population expansion. Using different modelling frameworks: reaction-diffusion equations to stochastic individual based models (IBM), we show that this prediction is far from being generic.
We review known results on theoretical diffusion models, regarding the dependence between K and v for logistic-like growth functions and we derive some additional results for other growth functions (weak or strong Allee effects). We also report some results for equations describing density-dependent dispersal. Then, using discrete space stochastic models, we investigate the dependence between K and v under different assumptions: no Allee effect, weak and strong Allee effects, and positive density-dependent dispersal.

We show that both models lead to an increasing relationship between v and K in the presence of an Allee effect or of positive density-dependent dispersal. This relationship still holds in the IBMs even when there is no Allee effect or positive density-dependant dispersal. This effect is especially strong when K is small (or close to the Allee threshold in the presence of a strong Allee effect), and tends to become less powerful or negligible when K becomes large. Experiments that we have conduced on minute size wasps *Trichogramma chilonis* in laboratory microcosms confirm the existence of this positive relationship.
Finally, we discuss how this dependence is related to the pulled/pushed nature of the expansion process.

Keywords: habitat quality, carrying capacity, velocity, population expansion, Allee effect, density, dependent dispersal, Trichogramma chilonis

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