CEMRACS project: Influence of the mode of reproduction on species invasion

Dispersal evolution during species range expansion: comparative analysis of asexual and sexual modes of reproduction.

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Summary:

Dispersal evolution at the vanguard of species' range expansion possibly leads to intricated dynamics such as spatial sorting [1] and front wave acceleration [2,3]. So far, quantitative results were obtained based on the modeling assumption that reproduction is clonal with possible mutations which affect dispersion of offspring. In particular, recent techniques of geometric approximation of front propagation were used successfully to compute quantitative features: either the asymptotic speed of propagation, or the rate of acceleration in the transient regime.

On the other hand, similar techniques were successfully developed in a different context: the analtyical description of equilibria in quantitative genetic models involving sexual mode of reproduction. This methodology has been recently completed for Fisher's infinitesimal model which assigns to one offspring the mid-value of the parental phenotypic traits plus random normal deviation [4].

Preliminary heuristics seem to show that this mode of reproduction significantly slows down the wave of expansion. It is expected that, in the transient accelerating regime, the population spreads as t^(5/4) under the infinitesimal mode of reproduction, whereas it has been shown that the spreading occurs at rate t^(3/2) with the clonal mode of reproduction [2,3].

The goal of this project it to develop numerical schemes in order to compare both modes of reproduction, and its consequences on the rate of acceleration, to prove or disprove the heuristics. The challenge is to follow accelerating fronts over sufficiently long time in order to catch the transient regime. Alternatively, individual based simulations could be developed for their own interest, and the sake of comparison with the integro-differential model. Mathematical problems may emerge from numerical investigations and lead to fruitful analytical studies.

References:

[1] R Shine, GP Brown, BL Phillips. An evolutionary process that assembles phenotypes through space rather than through time, PNAS (2011)
[2] N Berestycki, C Mouhot, G Raoul. Existence of self-accelerating fronts for a non-local reaction-diffusion equations, preprint arXiv (2015)
[3] E Bouin, C Henderson, L Ryzhik. Super-linear spreading in local and non-local cane toads equations. Journal de Mathématiques Pures et Appliquées (2017)
[4] Bouin et al, in preparation (2018)

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