Reviewer's comments on Manuscript: "When sinks become sources: adaptive colonization in asexuals"

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Submitted to PCI Evol Bio, round #1

The authors investigate the possible adaptation of a population to a "sink" environment where it is initially maladapted. The initial population is arriving in the sink by a constant immigration from a source where it is well-fit and at equilibrium at a different fitness optimum. By using Fisher's Geometric Model (FGM) and a Weak Selection Strong Mutation (WSSM) assumption, the authors develop estimates on the cumulant generating function of the distribution of population in the sink, which lead to analytic formulae and a precise description of the transient and long-time behaviour of the latter population. Particularly, the authors obtain an explicit formula for the mean fitness of the population in the sink at time $t > 0$; this formula allows the prediction of the eventual adaptation of the population (i.e. the mean fitness becomes positive in finite time) and, in the case where establishment happens, an expression of the time to adaptation. The analysis is also supported by individual-based stochastic simulations which help testing the robustness of the predictions in a slightly different, presumably more realistic, context.

I found the paper very well written and well-documented. The framework is fairly simple (quadratic fitness function) and somehow restrictive due to the WSSM assumption, but the fact the population dynamics can be fully understood gives a high relevance to the study as it constitutes a solid basis on which theories can be constructed or tested. Additionally, the existence of explicit formulae is sufficiently rare to be noticed. However there are a couple of details that need to be further checked or explained before I can fully recommend the paper. I would be happy to review the paper again once the authors have replied to the following comments.

Major comments

1. The authors present simulation results and describe the algorithm used for the actual computations, but do not present the precise implementation of the computer code used to do the simulations. If the publication of the latter code is not restricted because of industrial or strategic interests (which I doubt), I suggest the authors to publish their code and to advertise it in the paper, as it builds trust in their results.

2. Some choices in the algorithm could be discussed in more details; in particular, the stopping criterion for the source population : where does the $20/\sqrt{\mu}$ generations come from (l. 271)? The given reference (Martin and Roques, 2016) containing a lot of results, which one is targeted by the reference? And, similarly, to what does the criterion $t > 5 \cdot 10^3$ correspond (l. 282)?

3. Is there a realistic scenario in which $U_c > U_{lethal}$?

4. Appendix C, p.32, before l.677, after "$v(t)$ is given by": I agree with the computation if $N(0) = N_0 > 0$ but there are sanity checks to do when $N(0) = 0$ ($1/N(t) \to \infty$ as $t \to 0$, $N'(s)/N(s)$ is not integrable on $(0, t)$, ...). This remark especially concerns the "The above expression can be simplified to ..." statement.

5. Appendix D, Case (iii), p.35, from 9 lines before line 694, the end of the computation is not so clear. If the sign of ε is the only thing that matters here, then it would be nice to have a simple argument rather than a series expansion which is painful to check and the validity of which is not clear to me (I couldn't get rid of the dependency in m_D and r_{max}, has the hidden dependency in μ of X been taken into account?) It would also be nice to be recalled of the aim of the computation at this point. Finally, there is a discussion about the valid values of α; it seems to me that, with α small enough, then one does not need to worry about dimension (any n satisfies the inequality before line 694). Maybe the authors should comment on the interest of taking larger values of α?

6. Appendix E: between line 706 and 707, I think a few more lines would greatly ease the understanding for some readers (the computation is not really explained in the present version).

Minor comments

1. l.220 p.9, there is no real "need" to know the moment generating function, this is rather the particular method you chose to solve the problem.

2. Note that this is a matter of taste and I will not require this to be changed, but I find the choice $C_t(z)$ to denote the value of the cumulant generating

function at time t rather disturbing: the "underscore t" $\square_t$ notation being frequently used in some other context to denote the time derivative.

3. p. 12 Section 3.1, lines 285-287: the sentence is a little ambiguous, and the indentation is wrong.

4. Appendix A, p. 28, I don't understand the notation $\mathbb{E}_{m_{source}}[...]$ which appears in the computation of M_{migr}, as it is the standard expectation.

5. Appendix C: maybe recall that $\overline{m}(t) = \partial_z C_t(0)$ before or immediately after Equation (15).