Peer Community In
Ecology

Modeling jointly landscape complexity and environmental heterogeneity to envision new strategies for tsetse flies control

Benjamin Roche *based on peer reviews by* ***Timothée Vergne*** *and 1 anonymous reviewer*

Cecilia H, Arnoux S, Picault S, Dicko A, Seck MT, Sall B, Bassene M, Vreysen M, Pagabeleguem S, Bance A, Bouyer J, Ezanno P (2019) Environmental heterogeneity drives tsetse fly population dynamics and control. Missing preprint_server, ver. Missing article_version, peer-reviewed and recommended by Peer Community in Ecology. 10.1101/493650

Submitted: 14 December 2018, Recommended: 12 June 2019

Cite this recommendation as:
Roche, B. (2019) Modeling jointly landscape complexity and environmental heterogeneity to envision new strategies for tsetse flies control. *Peer Community in Ecology*, 100024. 10.24072/pci.ecology.100024

Published: 12 June 2019

Today, understanding spatio-temporal dynamics of pathogens is pivotal to understand their transmission and controlling them. First, understanding this dynamics can reveal the ecology of their transmission [1]. Indeed, such knowledge, based on data that are quite easy to access, can shed light on transmission modes, which could rely on different animal species that can be spatially distributed in a non-uniform way [2]. This is especially true for pathogens with complex life-cycles, despite that investigating such dynamics is very challenging and rely mostly on mathematical models. Moreover, this knowledge can also highlight some weak points in a complex web of transmission and therefore allowing us to envision new innovative control strategies. This has been first proposed on human pathogens, where connectivity among populations can be analyzed to identify which connections need to be targeted to stop or slow down an epidemics [3]. However, this idea is increasingly recognized as a promising new approach for pathogens involving vector populations, especially regarding the complexity to decrease on a long-term the abundance of these vector populations [4]. In "Environmental heterogeneity drives tsetse fly population dynamics and control" [5], Cecilia and co-authors have developed a sophisticated spatio-temporal mechanistic model to figure out how local environment, involved within landscape of different complexities, can impact the population dynamics of tsetse flies, an invertebrate species that can serve as a vector for many pathogens of animal and human importance. They found that spatial patches with the lowest temperature mean and the lowest environmental fluctuations can act as refuge for this species, representing therefore preferential targets for disease control. The reviewers and

I agree that the mathematical framework developed address very well an important topic for both ecological and public health literature. More importantly, it shows how fundamental ecological knowledge can drive pathogen control strategies, opening an interesting avenue for cross-disciplinary research on vector-borne diseases.

References:

[1] Grenfell, B. T., Bjørnstad, O. N., & Kappey, J. (2001). Travelling waves and spatial hierarchies in measles epidemics. Nature, 414(6865), 716-723. doi: [10.1038/414716a](https://dx.doi.org/10.1038/414716a)

[2] Perkins, S. E., Cattadori, I. M., Tagliapietra, V., Rizzoli, A. P., & Hudson, P. J. (2003). Empirical evidence for key hosts in persistence of a tick-borne disease. International journal for parasitology, 33(9), 909-917. doi: [10.1016/S0020-7519(03)00128-0](https://dx.doi.org/10.1016/S0020-7519(03)00128-0)

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[4] Pepin, K. M., Leach, C. B., Marques-Toledo, C., Laass, K. H., Paixao, K. S., et al. (2015) Utility of mosquito surveillance data for spatial prioritization of vector control against dengue viruses in three Brazilian cities. Parasites & Vectors 8, 1–15. doi: [10.1186/s13071-015-0659-y](https://dx.doi.org/10.1186/s13071-015-0659-y)

[5] Cecilia, H., Arnoux, S., Picault, S., Dicko, A., Seck, M. T., Sall, B., Bassène, M., Vreysen, M., Pagabeleguem, S., Bancé, A., Bouyer, J. and Ezanno, P.(2019). Environmental heterogeneity drives tsetse fly population dynamics and control. bioRxiv 493650, ver. 3 peer-reviewed and recommended by PCI Ecology. doi: [10.1101/493650](https://dx.doi.org/10.1101/493650)

Reviews

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.1101/493650
Version of the preprint: 1

Authors' reply, 26 May 2019

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Decision by Benjamin Roche, posted 01 March 2019

Minor revision before recommendation

With two reviewers, we had now assess your manuscript. As you will see, both reviewers found your manuscript very interesting, but have provided some insightful remarks, especially to improve clarity and add new perspectives to your study. Once these remarks would have been considered, I would be happy to recommend this manuscript.

Reviewed by anonymous reviewer 1, 19 February 2019

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Reviewed by Timothée Vergne, 21 February 2019

This manuscript presents thoroughly a deterministic compartmental model of tsetse fly population dynamic that accounts for a spatially heterogeneous environment (through a regular grid of 900 cells), movement of flies between cells and a density dependence of the fly dynamic. It includes a sensitivity analysis of the model input parameters on population size that demonstrates that the population dynamic is mostly driven by temperature and adult mortality. Simulations were subsequently conducted to simulate the impact of an increase of the adult mortality on the reduction of the population. The paper is strong (but could be stronger), well-written and clear. After a careful read, I am a little bit frustrated as this study ends in the middle of 2 interesting stories: the description of the population dynamic and recommendations for control strategies. Indeed, should you want to assess the effectiveness of control strategies, you can go further by taking the most out of your spatial model and determining the best spatio-temporal combination of adult mortality increase. So far, your paper assesses the effectiveness of a strategy based on a spatially homogeneous control approach. Given the specificities of your model, it would be very elegant to characterise where and when to increase the mortality to maximise the chance to decrease quickly the fly population. My feeling is that the current version of your manuscript tells too much or too little. My suggestion is that either you make it slightly shorter (and remove the last section on evaluation of control strategies) or you make it much stronger by including an optimisation algorithm to assess where and when to do fly control.

Very minor comments: Abstract: management strategies I missed Table S2 in the main text. L144: cooler instead of lower L171-172: any reference to justify this? Otherwise it needs to be included in the sensitivity analysis. L174-179: theta needs to be defined L176: shoudn't F be F1:4+? L181: fitted "to the" data. Check other occurrences in the text. L218: Unclear, try to reformulate.