

Detailed comments and corrections for the paper ‘Plant eco-evolution weakens mutualistic interaction with declining pollinator populations’ By A. Weinbach, N. Loeuille and R.P. Rohr

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Abstract

- Do the author consider that “population decline” = “decrease of the intrinsic growth rate” as suggested in the abstract? I would rather think of population decline as the population size decrease rather than the intrinsic growth rate. I imagine that decreasing the growth rate gives a lower population size but a population decline can come from many other possible mechanisms, for instance fragmentation.

Introduction

- Line 32: ‘shown’ → ‘showed’, or ‘have shown’
- Line 33: ‘already’ can be removed
- Line 36: ‘high’ → ‘height’
- Line 38: I am not sure these experiments consider ‘deterioration’ of pollinator communities. I would avoid the term.
- Line 46: Isn’t a little exaggerated to talk about a plant-pollinator community when considering a pair of species only?
- Line 50: ‘Clarify’, why does one need clarification? Are there results not clear? Which ones? Be more explicit.

Model.

- I am not sure that Fig. 1 is helpful. The model is simple enough and Eq. 1 are self-sufficient
- Lines 64-70: precise whether the parameters are supposed positive or not, especially the parameters γ . I suspect they’re supposed both positive?
- A main comment about the model derivation: you consider that mutualistic interactions have no cost, while it is well-known that it is never the case: mutualistic interactions can be defined as when the net benefit for both species is positive, which is not necessarily always true, in particular because the cost and benefits of the interspecific interactions can depend on species density. See for instance Holland and DeAngelis (2010). Considering the interaction between species as a resource exchange can help in avoiding the artificial positive feedback loop mentioned by the authors (Eq. 4). Even though I am aware the authors want the model to be as simple as possible, I think this is an important limitation of the current model which should either be justified or discussed.
- Line 67: I tend to partially disagree that α represents attractiveness. It can be interpreted that way but I think it is much more general: it is the interaction rate, which might be affected by plant attractiveness, or many other mechanisms, for instance pollinator flight speed, or visitation speed, etc. For me it is not straightforward that introducing attractiveness in a model would result in Eq. 1. If one would start from the mechanistic point of view, it is not clear what assumptions should be made to obtain such equation (see for instance Fishman and Hadany 2010 TPB). I would expect more precise justification on the chosen form of equation 1.
- Line 69: ‘encompasses’
- Line 75: ‘coexistence of the two species in time can be maintained’ could be replaced by ‘coexistence is stable’
- Globally, I am not sure to understand why the authors focus their study on plant-pollinator. Indeed, their model is not specific to a plant-pollinator interaction but rather to any mutualistic interaction in a classic mutualistic Lotka-Volterra system with Holling Type I functional response where the interaction rate evolves. I would find more appropriate to present the paper and its model like this more general, and the authors could present their results regarding the decline of pollinator as an

application of the general model, discussing the fact that their model lack plant-pollinator specificities.

- I am rather surprised that no one ever produced an adaptive dynamics model for the evolution of mutualism under the mutualistic Lotka-Volterra system. I am not a specialist of this literature, but it would be worth looking for such potential previous paper. If such a paper does not exist, then it is worth stressing about this in the paper. If the authors are the first to analyze such a simple and general model, the authors should state it. However, consider replacing the present work in older ones such as Ferrière et al. 2002 for instance.

Results: evolution of plant attractiveness

- Line 95: since the trade-off is the core of the model, I would not put the definition of the trade-off functions in Supp. Mat., but rather in the main text. Fig. 1 would be advantageously replaced by Fig. 1 in the SM.

- Lines 98-137: The very classical and canonical adaptive dynamics methods are extensively described. I think this is not necessary: the description made here are not sufficient for the reader to be able to do the calculation by themselves, and this is the goal of the SM. I would remove this part, summarize it and place a summary in the model description section. Instead of giving a vague description of the method here, I would find more important to give the most important analytical results here, which could help the readers to better understand what's happening.

Results: Consequences of pollinator population decline

-L 160: I suspect that α_{max} corresponds to α_{cl} from Eq. 4, I am exact?

- L167: Reconsider rephrasing the sentence beginning by 'In this case'. The sentence is long and complex, and it is difficult to understand it. For instance, I suspect that a comma is missing as well as a 's' giving '...above the Garden of Eden value, the evolution converges ...', otherwise the sentence is hard to understand.

- L173: 'Now consider the environmental degradation': It was not clear that all the description of Fig. 3 before now was about a case without degradation. I would suggest to explicitly introduce the previous description of Fig. 3 as a 'reference' case.

- L178: Restoration has not been defined: what did the authors do exactly? What is it changed in the model?

- There are important implicit assumptions regarding the timescales: do the authors really think that 'restorations' play on the same timescale than the eco-evolutionary feedbacks in their model? I do not think so. The implication of their results regarding the restoration should be taken with caution and justified and discussed further.

- The paper lacks any technical information regarding how the authors obtained their results about environmental degradation and restoration. Which equations are used? How? How exactly are Fig. 3 and 4 obtained? Instead of describing very well-known adaptive dynamics in the previous section, I would find more appropriate that the authors give much more details about what makes the technical specificity of their paper: how to take into account environmental degradation and restoration. This remark is to be related with the previous one: more technical details would make more explicit the underlying assumptions concerning timescales.

Discussion

- To my mind the first sentence of the Discussion summarizes very well the true objective of the paper: 'The present work highlights how evolution may play a critical role for mutualistic interaction maintenance in time'. Plant-pollinator responses to decline and restoration is an application of this model.