Outline

October 27, 2020

Introduction

- Classical paragraph on plant biodiversity / the phytoplankton paradox
- Importance of the seedling/juvenile stage in theoretical model to explain terrestrial plant biodiversity (definition of some of the mechanisms that can sustain biodiversity)
  - Modeling several life stages allow the detection of mechanisms such as storage effect.
  - However, storage effect is not needed. For instance, Wisknoski find that dormancy and dispersal alone can explain higher diversity.
- Low occurrence of the seed stage in phytoplankton models focusing on coexistence, even though we know cyst banks are important.
  - cyst banks are rarely modeled because phytoplankton dynamics are assumed to be explained by environmental variation
  - however, cyst banks do exist and data seem to prove they are important for species persistence
  - they have been modeled for species-specific model or, in the best-case scenario, 2-species models
- Presentation of the observed exchanges that happens between seed bank/ocean/coast, the three compartments that we model here
- Outline of the model (with details on what features of which model we take from whom) and the main hypotheses on the effect of the seed bank (maintenance of biodiversity and production in harsher conditions + effect of exchanges and seed bank on the ocean richness)

Methods

Models

- global presentation of state variables and parameters (Table 1[1]), as well as the two main steps in the model (growth; exchanges between compartments)
- focus on the growth rate and the alterations that were made on the Scranton & Vasseur model (only the fact that b_i will be varied; and that Bissinger will be used instead of Eppley. Details will be given in SI)
- Variations
  - Classical BH model: Type I functional response, with a threshold
  - Saturating interaction model (type II functional response)

[1] Do we indicate in the table which parameter will be calibrated, which parameter will be assessed, wich parameter will be used in the scenarii

Parameters from the literature[2]

Parameters that are not already described, most of them being the ones whose impact of the model outputs will be assessed

- loss rate
- sinking rate
- exchange rate
- cyst mortality and burial
- germination/resuspension

Parameter fit to dataset

Data set

Usual presentation of a REPHY dataset (no detail on monitoring, just basic information on the location and species)

Calibration and model variability

- Definition of summary statistics
- Calibration of interactions (NO quadratic programming. This might be tackled in SI, not in MS)
- Analyses of the effect of other parameter variations, defining parameter space.
  - sinking rate $\{0.1; 0.3; 0.5\}\beta(0.55, 1.25)$
  - cyst mortality and burial $\approx 10^{-4}/10^{-5} + 10^{-3}, 10^{-2}, 10^{-1}$
  - germination/resuspension $10^{-3}, 10^{-2}, 10^{-1} \times 10^{-5}, 10^{-3}, 10^{-1}$
  - loss rate $0.04; 0.1; 0.2$

Scenarios

1. Effect of seed bank (with seedbank, cyst mortality=10^{-4}, without seedbank cyst mortality=1) on the coastal community
   (a) final richness vs mean interspecific interaction strengths. Hypothesis: in the absence of a seed bank, final richness decreases when interspecific interaction strengths increase, in absence of a seed bank.
   (b) final abundance vs high and low temperatures / or higher variability in the environment. Hypothesis: in the absence of a seed bank, final abundance decreases when there are extreme temperatures or variability
2. Variations in the exchange rate with the ocean, interacting with the effect of the seed bank. In this case, the final richness in the ocean would be a good statistic.

Results

Dynamics

Presentation of the final dynamics observed in the model (Fig. 1)

Parameter effect

Find a way to represent the variation in total abundances in the models (Fig. 2) (mostly bar plots?)

Scenarios

Proposed Fig. 3 and 4 as already shown in the main text.

[2] Will need to find better titles

Discussion

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About real data: wondering if I do a paragraph or try to insert it in the different topics

- FIrst paragraph: reminder of results. Basically: higher richness and biomass with seed bank. Better resistance to interaction change. Better resistance to changes in the environment. May be due to the abundance variation of certain species.
- Our results are similar to Wisknoski et al.
  - We do have a strong increase in diversity when there is dormancy and dispersal.
  - However, our model is slightly different as we do not allow for seed dispersal (we are in the case gamma=0) nor asynchronous environmental variability or one-time disturbance. We also test propositions (effect of the interactions or permanent change in the environment) that they do not consider in their analysis.
  - On the impact of dispersal/dormancy covariation: could we maybe discuss the fact that they do not actually have a real covariation? (even though we could not test that either - would maybe be a gratuitous criticism?)
  - Finally, we also test another type of interactions in our model.
- The importance of interaction. There are two things to consider:
  - the expected effect: increased competition does diminish biodiversity because better competitors can exclude weaker species and prevent reestablishment .
  - However, the strongest effect, by far, is the impact of facilitation. Facilitation is often mentioned (apparent facilitation in observations, see for instance: de Ruiter and Gaedke 2017; for models, Chu and Ellner mention its possible importance but do not model it, Martorell and Freckleton use it but emphasize on the fact that during growth, intraspecific interactions dominate the others). The imbalance intra/inter is, as usual, of importance.
  - Orgy of mutual benefaction (May 1981) is possible in model II even if we have tried to decrease its plausibility and is also a likely explanation. Discuss Qian and Akçay.
  - However, species most likely to be excluded are not necessarily the ones most affected by either positive or negative interactions.
- The most important life history traits that explain sensitivity to exclusion:
  - high amplitude of variation, which may be linked, in this case, to the temperature sensitivity. However, this can be extended to a lot of other traits that are not described here (nutrients, predation, etc.)
  - It is notable that neither sinking (but maybe because we miss fine hydrodynamics descriptors and are only using a proxy for sinking) nor growth rates are really good predictors of the survival (however, lower growth rates tend to be associated to higher probability of survival).
- At one point, we will need to discuss potential limits. Comparison with the JEcol paper, saying that we do not have exactly the same interactions (We had another argument, I cannot remember it right now). Our sensitivity analysis shows that qualitatively, we may be good. However, field-calibrated parameters are lacking ('Hydrodynamics features are highly site-dependent and sometimes poorly defined: cyst burial and resuspension, for instance, are functions of the shape of the coastal site and its interface with the ocean, as well as stochastic phenomena, such as gusts of wind, bioturbation or anthropogenic disturbances.').

- Moving forwards: do we *need* to model the seed bank ? there are *a lot* of coexistence models on phytoplankton (even though models with >2/3 species are just a bit less frequent). However, seed bank models are quite rare. It would be interesting to have both, focusing on hydrodynamical features interacting with species shape characteristics which may impact the exchanges, as well as characteristic growth traits. Plant models show that ignoring this stage can still give interesting results but new mechanisms can emerge from seed modeling? (i.e. storage effect, which we do not have here) + A really interesting feature would be adding reproduction vs resistance of seed (but does that also exist for phytoplankton?)

Supplementary Information

Dataset

Map of the location (Fig. S1), table of species, time-series (Fig. S2)

Parameter defintion

Better explanation of references for each value

- loss rate
- sinking rate: values in the literature + distribution (Fig. S3)
- cyst mortality and burial: explanation of the inference of mortality from McQuoid 2002 + literature on burial by sedimentation
- germination/resuspension: a bit more details, as it may have been really reduced in main text

Focus on growth rate

- Remind the variability of the growth rates of phytoplankton (Balzano 2011 among others), introduce fixed values from the literature Reynolds and dependence on environmental factors (Edwards 2015, 2016)
- Remind the SV growth part and its decomposition between niche and metabolism; add niche width (Fig. S6)
- Equation Eppley and Bissinger for the metabolism part, show comparison of growth rates (Fig. S5) and what we finally chose (already in main text, so we don't have to dwell on that)
- **MAYBE**: field-based niche estimates if we don't already describe it in the MS
- Growth rate as a function of temperature (that is, basically, Fig. S5) for each species defined by b_i and T_iˆopt

Community matrix

- From MAR to BH
- From type I to type II

Calibration

Effect of quadratic programming (smoothing??), then maybe a view of the calibration of interaction matrix (interactions before and after)

Final parameter set/golden set

Tables for the final species-specific parameters (for sinking rates, b, T_opt)

Effect of variation around the set

Show the changes for each morphotype due to changes in parameter sets (basically, same as Fig. 2, but for each morphotype)

Use of quadratric programming

Definition by Bazaara, use in Maynard, implementation here. Can only be used on the first model, and may smooth the signal a bit much.