Round #4

Decision

by Samraat Pawar, 2020-02-10 08:15
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Second decision on manuscript

Dear Authors,

Your response and edits clarifies somewhat, but I am concerned that you did not find values from the literature leading to a "satisfying species persistence". Can you please clarify what you mean by that?

Also, do your scaling relationships for search/attack rates and handling times match up with recent work by Carbone et al and Pawar et al (myself!)? The papers are:

1. Carbone, C., Codron, D., Scofield, C., Clauss, M. & Bielby, J. Geometric factors influencing the diet of vertebrate predators in marine and terrestrial environments. Ecol. Lett. 17, 1553–9 (2014).
2. Pawar, S., Dell, A. I., Lin, T., Wieczynski, D. J. & Savage, V. M. Interaction dimensionality scales up to generate bimodal consumer-resource size-ratio distributions in ecological communities. Front. Ecol. Evol. 7, 1–11 (2019).

These studies do find energetically and dynamically feasible regions of coexistence between consumers and resources using updated (relative to Yodzis and Innes and Brose et al) scaling equations for search rate and handling time.

I sincerely apologize for delaying this preprint's recommendation so much. However, the above is an important issue because future studies might want to use the scaling relationships you are using, and your results do rely strongly on them.
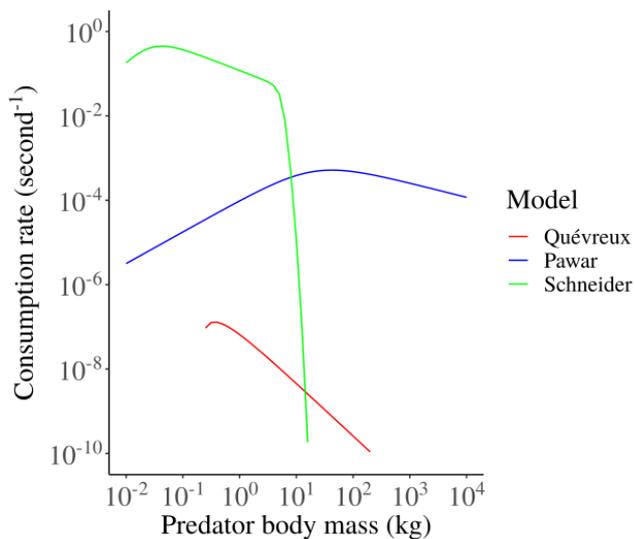
Best wishes,

Samraat

Dear Samraat,

We understand your concerns about the scaling of the attack rate and the handling time. Please find the following arguments to justify our choices:

The scaling of the attack rate and of the handling time are highly variable in the literature. For instance, Rall et al. 2012 found a scaling different from yours and the dynamical model of Heckmann et al. 2012 used a simple quarter-power law. This leads to very different consumption rates as you can see in the following graph. Units in our model have been converted to be consistent with your model and Schneider's model and we tested two values of prey biomass. The red curve corresponds to our model, the blue curve to your model and the green curve to the dynamical model of Schneider et al. 2016 using Rall's scaling.

A Prey biomass density = 1 kg. m^{-3} **B** Prey biomass density = 100 kg. m^{-3}
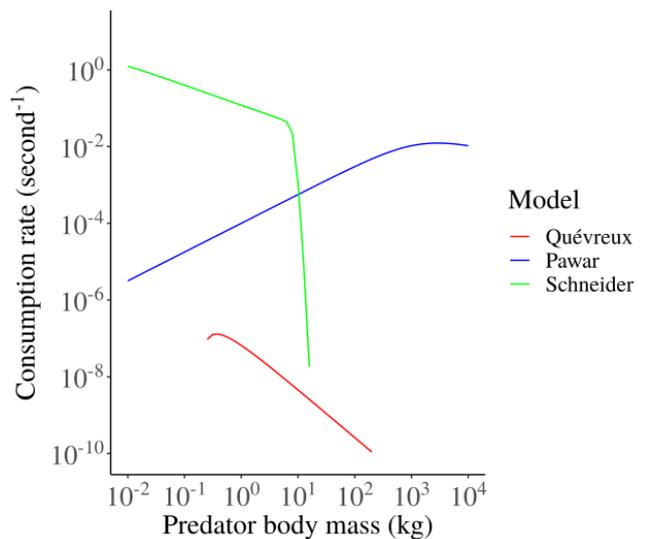
Instead of choosing one of them, we calculate the handling time from the maximum ingestion rate (Yodzis et Innes 1992; Brose, Williams, et Martinez 2006) to fit Petchey et al. 2008 expression and arbitrary select the scaling constant of the attack rate to get a sufficient species persistence and limit cycles. The dynamically feasible region you mention in your article only holds for simple systems with only one predator and one prey while multi-trophic food web models usually make species persistence harder to obtain (see Dougoud et al. 2018 for instance).

These differences in the scaling of attack rate and handling time have an impact on food web dynamics for sure (as shown in your paper (Pawar et al. 2019)) but these differences are not the point of our study. In fact, we aim to study the impact of nutrient cycling in food webs displaying limit cycles, which are common with allometric parametrisation (Brose, Williams, et Martinez 2006; Otto, Rall, et Brose 2007; Binzer et al. 2012).

We added several new figures in the supporting information (Appendix S3) to detail the impact of the attack rate allometric constant on the different regimes of food webs and on the effect of nutrient cycling:

"*In spite of the high variability of species persistence and species biomass CV representing different possible regimes (fixed points or limit cycles in Fig. S3-4F) depending on the values of the attack rate allometric constant a and the density dependent mortality rate allometric constant β, we do not see a significant difference between the responses of the C (with nutrient cycling) and the SC models (without nutrient cycling but with a simulated enrichment effect). Relative to the average values of species persistence (Fig. S3-4A) and biomass CV (Fig. S3-4B), the difference between the C and SC models are generally negligible (Fig. S3-4C and D). The significant differences occur only for species biomass CV when food webs are by the border between fixed point and limit cycle domains (Fig. S3-4F) as they can switch between food webs with only primary producers and food webs with consumers (Fig. S3-4E). Therefore, nutrient cycling mainly consists in an enrichment effect and weakly affects food web dynamics, whatever the value of the attack rate allometric constant a and the density dependent mortality rate allometric constant β. Thus, our results are robust to the arbitrary choice of these parameters.*" (l. 1150-1161).

We also refer to the impact of the scaling of the attack rate in the discussion:

"*For instance, the scaling of the attack rate with predator and prey body masses strongly determines the occurrence of limit cycles (Pawar et al., 2019) and varies a lot between studies (Rall et al., 2008; Pawar et al., 2012). However, such differences do not change our main results as the C and SC models respond similarly whatever the values of our scaling constants (Fig. S3-4 in the supporting information).*" (l.402-406)
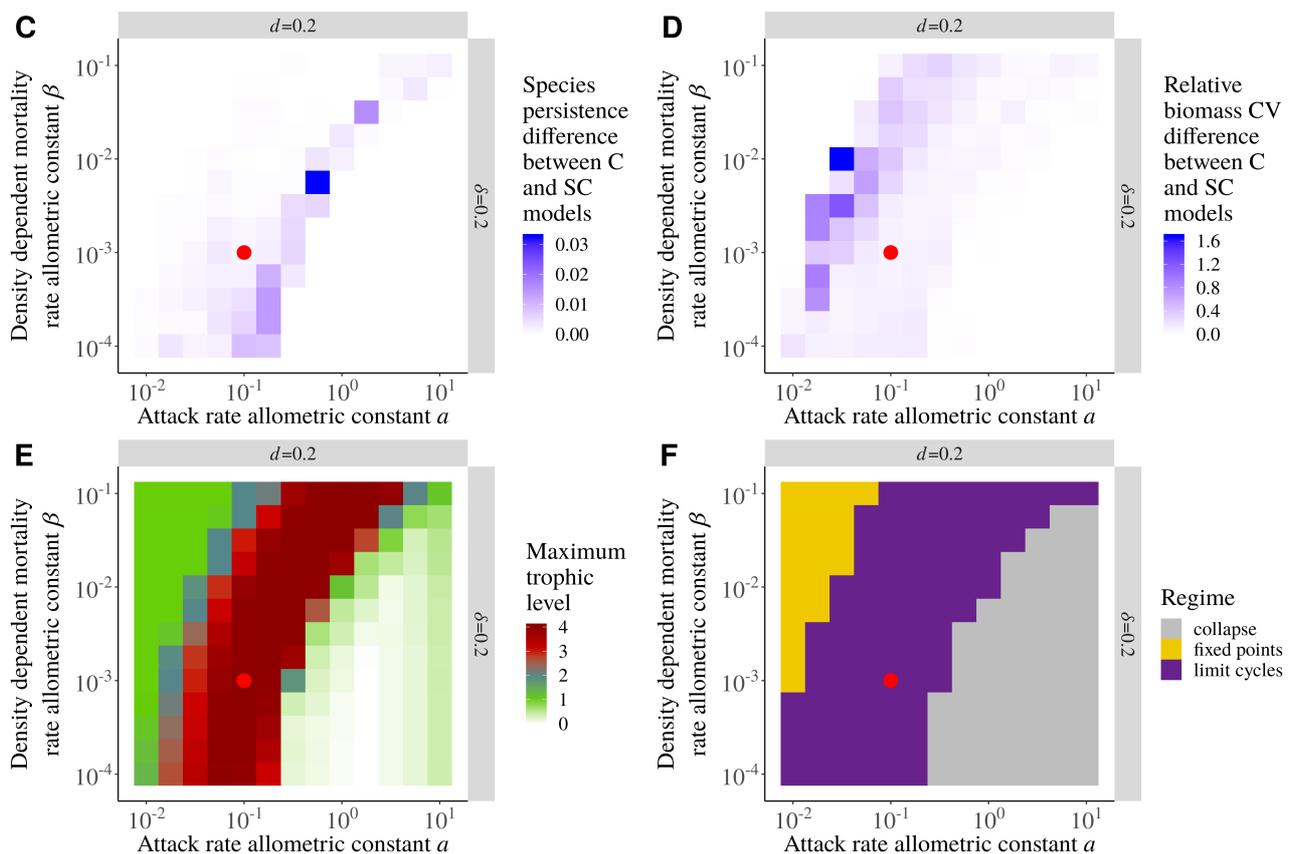
*Figure S3-4: Effects of the attack rate allometric constant a and the density dependent mortality rate allometric constant β on the average of the absolute value of the difference between the C and SC models for **C)** species persistence and **D)** species biomass CV. **E)** Average maximum trophic level. **F)** Regime of food webs that can display limit cycles or fixed points (average biomass CV lower than 10^{-4}). When species persistence is mostly equal to zero, we consider that food webs collapse. Each square is the average of 100 simulated food webs (except for **B)**, **D)** and **E)** where only data from persistent food webs are represented). The mineral nutrient input is $I = 40$, the fraction of direct recycling is $\delta = 0.2$ and the decomposition rate of detritus $d = 0.2$. The red dots represent the combinations of parameters used in the main study ($a = 0.1$ and $\beta = 0.001$).*

We hope this proved that our main results are not specific to the scaling of attack rate but describe the general response to nutrient cycling of food webs displaying limit cycles.

Best regards,
Pierre Quévreux, on behalf of the authors

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