Biodiversity and Ecosystem Functioning in Evolving Food Webs

Supplementary Material

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Abstract

We use computer simulations in order to study the interplay between biodiversity and ecosystem functioning (BEF) both during the formation and during the ongoing evolution of large food webs. A species in our model is characterized by its own body mass, its preferred prey body mass, and the width of its potential prey body mass spectrum. On an ecological time scale, population dynamics determines which species are viable and which ones go extinct. On an evolutionary time scale, new species emerge as modifications of existing ones. The network structure thus emerges and evolves in a self-organized manner. We analyse the relation between the functional diversity and five community level measures of ecosystem functioning. These are the metabolic loss of the predator community, the total biomasses of the basal and the predator community and the consumption rates on the basal community and within the predator community. Clear BEF relations are observed during the initial build-up of the networks or when parameters are varied, causing bottom-up or top-down effects. However, ecosystem functioning measures fluctuate only very little during long-term evolution under constant environmental conditions, despite changes in the functional diversity, supporting the hypothesis that trophic cascades are weaker in more complex food webs.

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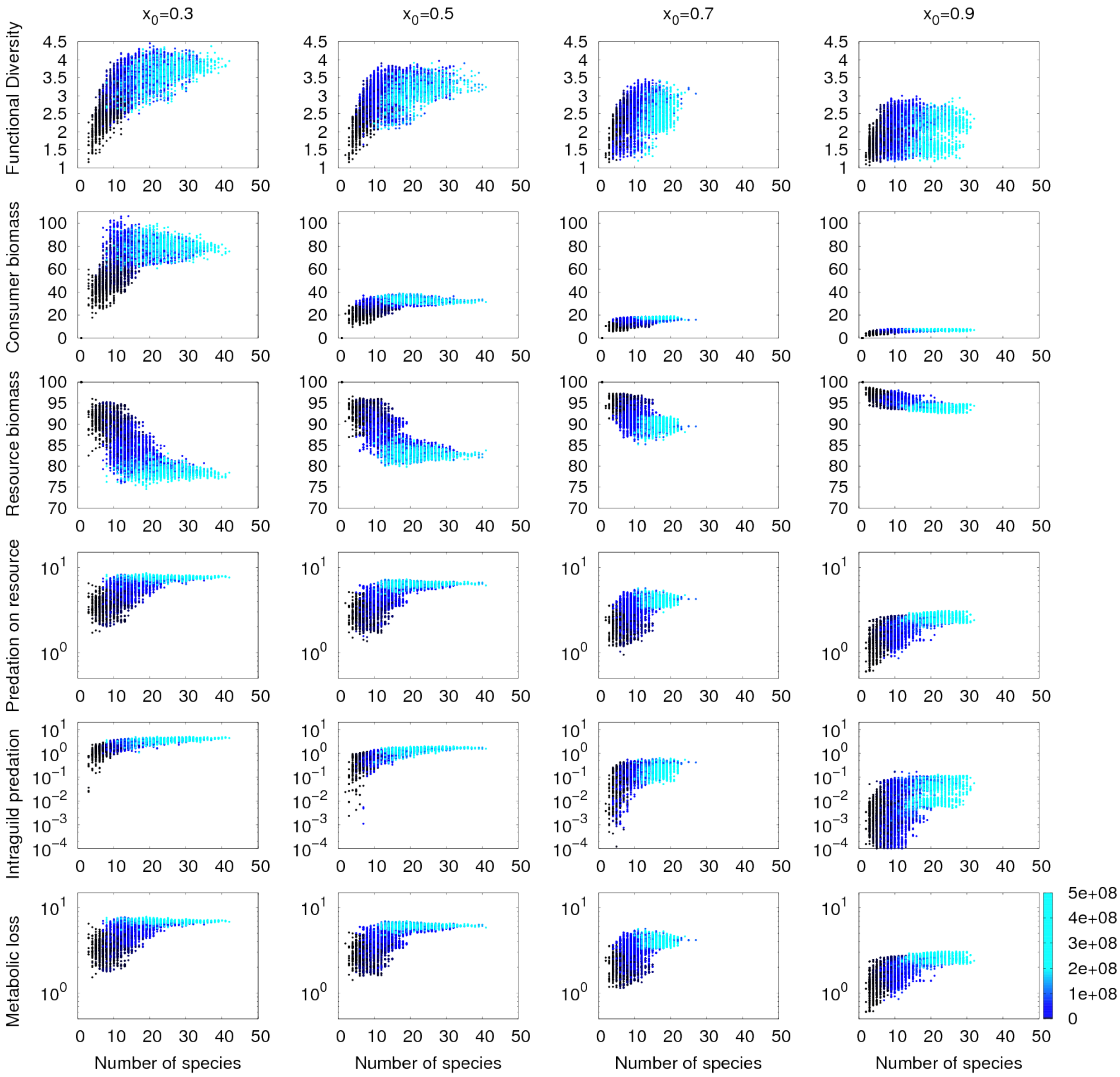

Figure 1: As in Fig. 3 of the original article, but with the total number of species instead of the functional diversity on the x-axis: The relationship between biodiversity and ecosystem functioning during the evolutionary history of the food webs with different values of the respiration and mortality rate x_0. The carrying capacity is set to $K = 100$. Different colours indicate different times: Black represents data from networks shortly after the simulation start, whereas light blue represents data from fully developed networks after $1.5 \cdot 10^8$ time units.

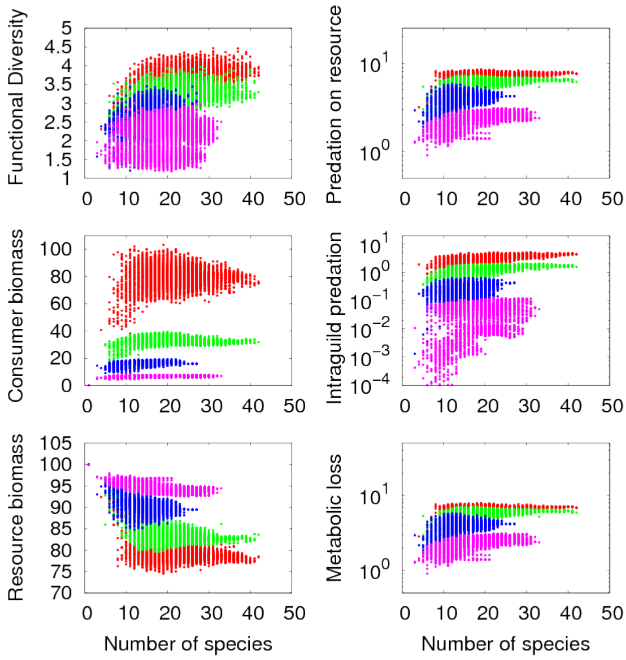

Figure 2: As in Fig. 4 of the original article, but with the total number of species instead of the functional diversity on the x-axis: The relationship between biodiversity and ecosystem functioning during the ongoing species turnover after the initial build-up of the emerging food webs. The colors represent four different values of the respiration and mortality rate: red (in the background) $x_0 = 0.3$, green $x_0 = 0.5$, blue $x_0 = 0.7$, pink (in the foreground) $x_0 = 0.9$. The carrying capacity is set to $K = 100$.

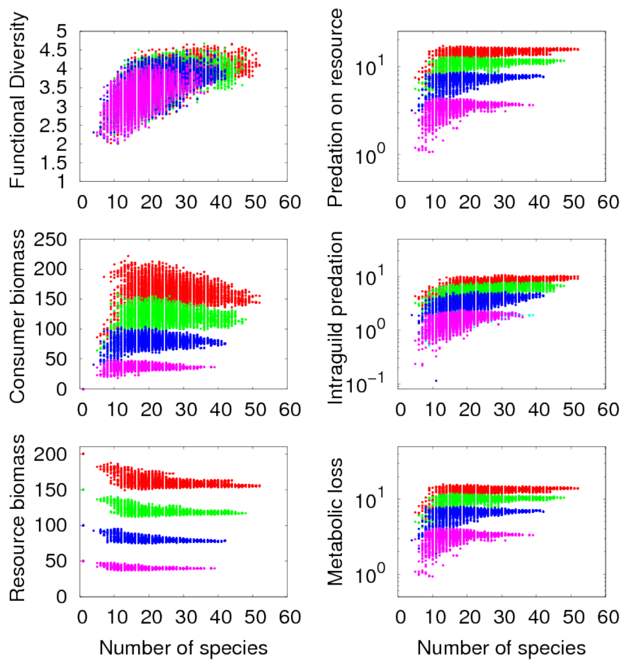

Figure 3: As in Fig. 5 of the original article, but with the total number of species instead of the functional diversity on the x-axis: The relationship between biodiversity and ecosystem functioning during the ongoing species turnover after the initial build-up of the emerging food webs. The colors represent four different values of the carrying capacity: red (in the background) $K = 200$, green $K = 150$, blue $K = 100$, pink (in the foreground) $K = 50$. The respiration and mortality rate is set to $x_0 = 0.3$.

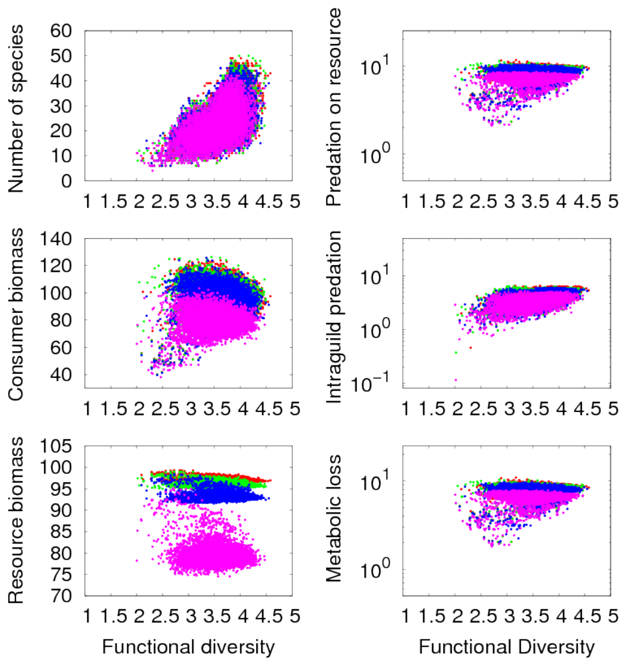

Figure 4: The relationship between the functional diversity and ecosystem functioning during the ongoing species turnover after the initial build-up of the emerging food webs. The colors represent four different values of the growth rate r: red (in the background) $r = 0.7$, green $r = 0.5$, blue $r = 0.3$, pink (in the foreground) $r = 0.1$. The respiration and mortality rate is set to $x_0 = 0.3$ and the carrying capacity is set to $K = 100$. The results are similar to those obtained with a variable carrying capacity K (Fig. 5 of the original article), but less prominent, since the growth rate does not change the maximum amount of available biomass that is determined via K.

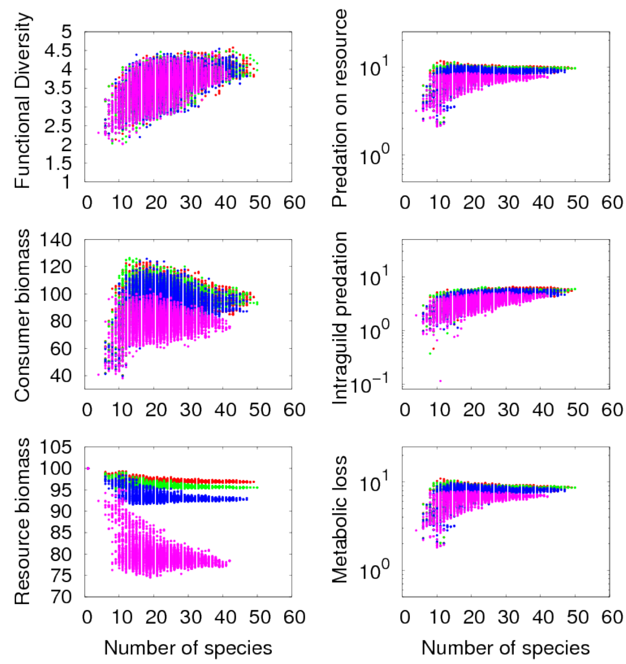

Figure 5: As in Fig. 4 above, but with the total number of species instead of the functional diversity on the x-axis.