Appendix S2

for

"Emergent niche structuring leads to increased differences from neutrality in species abundance distributions"

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S2 Discussion of the detailed differences in the SAD of our model, compared with the neutral case and the C&P model

Understanding exactly how heterogeneity in interactions creates the particular SAD differences from neutrality our model predicts is not intuitive, but there are some things we can highlight. First consider the 5-niche case, where one of the key SAD features of our model is a larger number of species in the highest abundance class than expected in the neutral case. These highly dominant species always occur at or near the center of a niche. This effect is not seen in the C&P model of extreme niche structure with neutrality within niches. This effect is arguably due to heterogeneity in between-niche interactions, which is what favors species at the centers of niches and causes them to achieve such high abundance. However, surprisingly, our between-niche heterogeneity only model case produces and SAD in the 5-niche case that is closer to the neutral SAD in the highest abundance class than our full interaction heterogeneity model. This suggests that translating differences in the profile of abundance as a function of niche into differences in the SAD is complicated. Perhaps the addition of within-niche interactions leads to larger variation in the abundance of species at the centers of niches, because when species in the same niche happen to be of low abundance those species are at a particular advantage compared to other species in the community. Or perhaps differences in richness between our between-niche heterogeneity only case and our full model complicate interpretation. Despite there being a higher absolute number of species in the former compared with the latter, there may be an even bigger jump in the number of species in other abundance classes, causing the proportion of species in that abundance class to be lower.

With a higher number of niches, the community is essentially divided into more pieces, lowering the maximum abundance that can be achieved by any one species. This leads to fewer species in the highest abundance classes than in the neutral case in both models, but ours produces slightly more species in the highest abundance class that is not essentially empty of species (the 11th class in the 20-niche case and the 10th class in the 50-niche case), presumably because it incorporates the favoring of a particular species within the niche.

In the 5-niche case, our model also produces fewer species of intermediately high abundance (9th and 10th abundance classes), and more species of moderate abundance (6th to 8th abundance classes) than the neutral case. This suppression of species' abundances could be due to the high between-niche competition on species near the niche edge. We see evidence for this in Figure 1 (main text), where species at the outskirts of niches are rarely over about 250 individuals. We also see evidence of this in that our between-niche heterogeneity only cases, in which the disadvantage of species slower to the outside of niches is magnified, the SAD has even fewer species of intermediately high abundance, and even more species of moderate abundance. Our model also produces a strong central peak with more niches, presumably due to similar effects. Our model also predicts a smaller number of intermediately rare species (compared with the neutral case) for all the number of niches we examined. We propose that this could be due to the competitive suppression of many of the species that might immigrate into the community. They can first immigrate successfully because we assume competition does not impact immigration. However there is density dependence in the death rate, and hence one would expect fewer of these new immigrants to become abundant by chance than in the neutral case, as most trait values are disfavored.