Oikos

OIK-06104

Simmons, B. I., Vizentin-Bugoni, J., Maruyama, P. K., Cotton, P. A., Marín-Gómez, O. H., Lara, C., Rosero-Lasprilla, L., Maglianesi, M. A., Ortiz-Pulido, R., Rocca, M. A., Rodrigues, L. C., Tinoco, B., Vasconcelos, M. F., Sazima, M., Martín González, A. M., Sonne, J., Rahbek, C., Dicks, L. V., Dalsgaard, B. and Sutherland, W. J. 2019. Abundance drives broad patterns of generalisation in plant–hummingbird pollination networks. – Oikos doi: 10.1111/oik.06104

Appendix 1 is supplied as a separate Excel-file

Appendix 2 – next page

Appendix 2

We repeated all analyses excluding four networks where we used frequency of occurrence (the proportion of days of fieldwork in which a given species was recorded) as a proxy for relative abundances, because species were not recorded within the sampling plots during transect counts or mist netting for these networks. We note that frequency of occurrence and relative abundance are strongly correlated and frequency of occurrence is still independent from the network data (Vizentin-Bugoni et al. 2014).

Results were qualitatively the same and conclusions identical after the exclusion of these networks. We confirmed the positive relationship between abundance and generalisation in our dataset, finding a significant correlation between abundance and generalisation for degree (P = < 0.001; pseudo-R^2 = 0.65), normalised degree (P = < 0.001; pseudo-R^2 = 0.62) and the generalisation index g (Wald test: $\chi^2 = 14.94$; df = 1; $P < 0.001$; $R^2_{LMM(m)} = 0.10$; $R^2_{LMM(c)} = 0.50$).

Only a small proportion of species were abundant and specialist for all three generalisation metrics, while the proportion of species that were rare and generalist was consistently larger, particularly for the g generalisation metric (Figure A1). These differences were significant. We found that abundant specialists were significantly less than rare specialists, rare generalists and abundant generalists for all generalisation metrics (Table A1). Conversely, we found that rare generalists were significantly less than rare specialists, significantly greater than abundant specialists, and not significantly different to abundant generalists, for the degree and normalised degree metrics (Table A1). For the g generalisation index we found that rare generalists were not significantly different to rare specialists, and were significantly greater than abundant specialists and abundant generalists (Table A1). Overall, these findings support hypothesis 1, that abundance drives generalisation, and do not support hypothesis 2, that generalisation drives abundance.

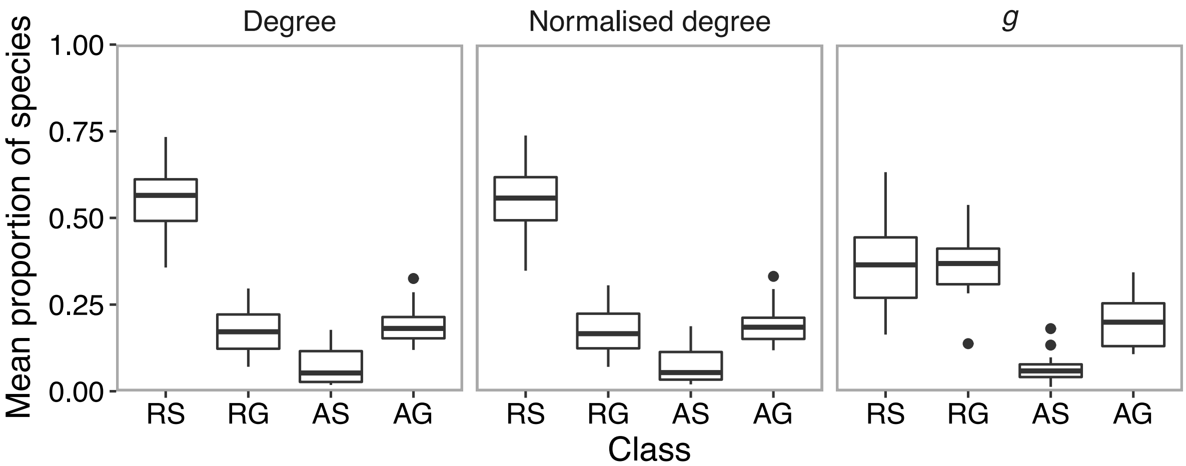

Figure A1: The mean proportion of hummingbird species classified as rare specialists ('RS'), rare generalists ('RG'), abundant specialists ('AS') and abundant generalists ('AG') across a subset of networks, for three generalisation metrics: degree, normalised degree and g. The subset excluded four networks where we used frequency of occurrence (the proportion of days of fieldwork in which a given species was recorded) as a proxy for relative abundances. The bold centre line in each box is the median; the lower and upper hinges are the first and third quartiles, respectively. The lower whisker indicates the smallest value no less than 1.5 times the inter-quartile range; the upper whisker indicates the largest value no greater than 1.5 times the inter-quartile range. Data outside the whiskers are outlying points plotted as solid black circles.

Table A1: Testing hypotheses 1 and 2 in an ANOVA framework, using abundant specialists and rare generalists as the reference contrast respectively. RS = rare specialist; RG = rare generalist; AS = abundant specialist; AG = abundant generalist. Significance codes: 0 '***' 0.001 '**', not significant 'ns'

Metric	**Class**	**Estimate**	**t value**	**P**	**Significance**
Hypothesis 1: Abundant specialist << rare specialist, rare generalist, abundant generalist Reference contrast = abundant specialist					
Degree	(Intercept)	0.08	4.15	0.00	***
	RS	0.48	18.04	0.00	***
	RG	0.09	3.46	0.00	**
	AG	0.11	4.30	0.00	***
Normalised degree	(Intercept)	0.08	4.06	0.00	***
	RS	0.48	17.36	0.00	***
	RG	0.09	3.44	0.00	**
	AG	0.11	4.15	0.00	***
g	(Intercept)	0.07	2.91	0.01	***
	RS	0.29	8.88	0.00	***
	RG	0.30	8.97	0.00	***
	AG	0.14	4.12	0.00	***
Hypothesis 2: Rare generalist << rare specialist, abundant generalist, abundant specialist Reference contrast = rare generalist					
Degree	(Intercept)	0.17	9.04	0.00	***
	RS	0.39	14.57	0.00	***
	AS	-0.09	-3.46	0.00	**
	AG	0.02	0.84	0.40	ns
Normalised degree	(Intercept)	0.17	8.92	0.00	***
	RS	0.38	13.92	0.00	***
	AS	-0.09	-3.44	0.00	**
	AG	0.02	0.71	0.48	ns
g	(Intercept)	0.36	15.59	0.00	***
	RS	0.00	-0.08	0.94	ns
	AS	-0.30	-8.97	0.00	***
	AG	-0.16	-4.84	0.00	***

The proportion of species in each of the four abundance-generalisation categories predicted by the neutrality null model closely matched the empirical proportions, particularly for degree and normalised degree where there were no significant differences between observed and predicted proportions for the majority of networks (67–87% of networks; Fig. A2). For *g*, the model correctly predicted the proportion of rare specialists and generalists for 80% of networks, but performed less well in predicting the proportion of abundant specialists and generalists, with predictions matching observed values for only 53% of networks (Fig. A2).

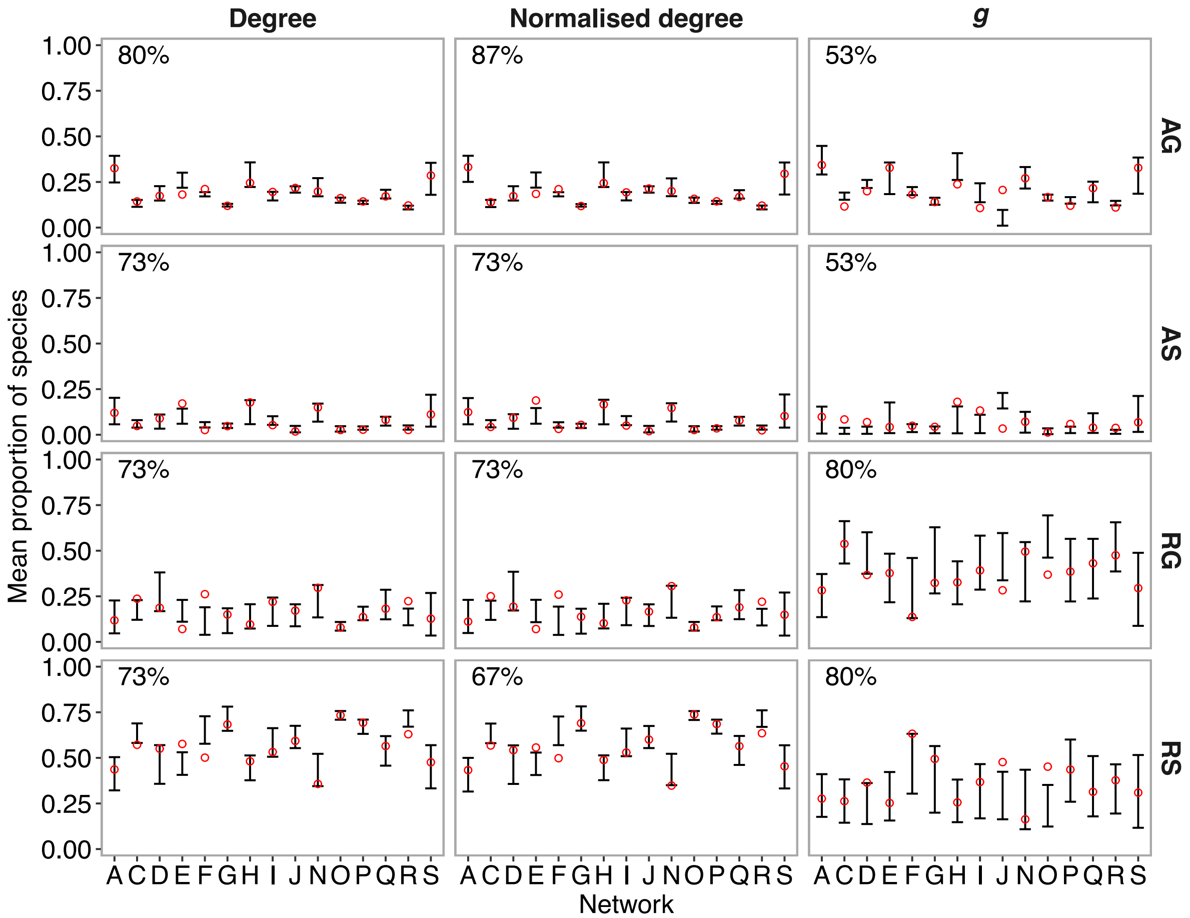

Figure A2: Comparisons between empirical networks and null model networks in the proportions of species in each of the abundance-generalisation categories 'RS' (rare specialists), 'RG' (rare generalists), 'AS' (abundant specialists) and 'AG' (abundant generalists). Four networks (B, K, L, M) where we used frequency of occurrence (the proportion of days of fieldwork in which a given species was recorded) as a proxy for relative abundances were excluded. Error bars represent the 95% confidence intervals of the mean proportion of hummingbird species in each abundance-generalisation category as predicted by 1000 null networks. Red circles show the empirically observed mean proportion of hummingbird species in each category. If the red circle is within the error bars, there were no significant differences between the observed proportions and the neutrality null model proportions. Percentages in the top left of each panel give the proportion of networks where empirical proportions were not significantly different from the null model proportions. Results are shown for each network (A-S, excluding B, K, L and M) and for each generalisation metric (Degree, Normalised degree, *g*).

References

Vizentin-Bugoni, J. et al. 2014. Processes entangling interactions in communities: forbidden links are more important than abundance in a hummingbird-plant network. - Proc. R. Soc. B Biol. Sci. 281: 20132397.