SUPPORTING INFORMATION

Niche breadth, rarity and ecological characteristics within a regional flora spanning large environmental gradients

Boulangeat Isabelle, Lavergne Sébastien, Van Es Jérémie, Garraud Luc

and Thuiller Wilfried

Journal of Biogeography

Appendix S1 Sensitivity analyses using several beta diversity measures between plots and two ordination techniques.

We computed the specialization index using five other measures of beta diversity included in Manthey & Fridley (2009): the original measure named 'additive beta', the Jaccard index, two other indices based on either Simpson or Sørensen index for multiple sites (see Baselga, 2009) and one based on R.H. Whittaker's decomposition called 'multiplicative beta'. The index chosen for our study is based on Rao's quadratic entropy formula as in de Bello (2010). The comparison between indices showed little variation. Only the originally proposed index, the additive beta, really differed from the others (Table S1).

We also estimated species specialization using both indirect and direct species ordinations. For the indirect ordination, we chose a detrended correspondence analysis (DCA) because our dataset was large and heterogeneous. For the direct ordination, we used six variables (moisture index for the growing season, mean daily monthly mean temperature, winter precipitations, potential yearly global radiation, slope and topography) and we ran three analyses: canonical correspondence analysis (CCA) and redundancy analysis (RDA) (ter Braak, 1986, 1988) and outlying mean index (OMI, Dolédec *et al.*, 2000). Given that OMI explained significantly more inertia than CCA and RDA (76% for OMI, 55% for RDA and 47% for CCA), we only calculated niche specialization over the first axis of the OMI. The direct ordination differs the most from other niche breadth estimations. The DCA is similar to theta estimates except for additive beta (Table S1).

Sensitivity analysis: varying the number of plots randomly sampled to compute beta diversity.

The choice of this parameter is arbitrary. However, it determines the potential number of species to be included in the study. The species that have been recorded under the chosen value were not excluded from the community plots, but their *theta* values were not calculated. We compared the specialization index computed using three different values for this parameter (5, 10, 15) and only for species that have been recorded more than 20 times in our dataset in order to be able to estimate standard deviation for each species. The comparison showed the analysis had very limited sensitivity to this parameter (Table S2).

Tables:

Table S1 Correlation matrix (Pearson product–moment correlation coefficients) between the six specialization measures for 1216 French alpine plants, using different estimations of beta diversity and two ordination techniques.

	Rao (de Bello *et al.*, 2010)	Multiple Simpson (Baselga *et al.*, 2007)	Multiple Sørensen (Baselga *et al.*, 2007)	Jaccard	Multiplicative beta (Whittaker, 1960)	Additive beta (Lande, 1996)	Indirect ordination (DCA) (ter Braak, 1988)	Direct ordination (OMI) (Dolédec *et al.*, 2000)
Rao	1.0000	0.9541	0.9321	0.9944	0.9278	0.7718	0.7178	0.4544
Multiple Simpson	-	1.0000	0.9459	0.9679	0.9419	0.7772	0.7231	0.4916
Multiple Sørensen	-	-	1.0000	0.9557	0.9960	0.6275	0.7351	0.4522
Jaccard	-	-	-	1.0000	0.9516	0.7577	0.7214	0.4563
Multiplicative beta	-	-	-	-	1.0000	0.6273	0.7339	0.4520
Additive beta	-	-	-	-	-	1.0000	0.4640	0.4095
Indirect ordination	-	-	-	-	-	-	1.0000	0.3095

Table S2 Correlation matrix (Pearson product–moment correlation coefficients) between three specialization measures for 1216 French alpine plants, using different values for the number of plots used to compute beta diversity.

Number of plots	5	10	15
5	1.0000	0.9943	0.9945
10	-	1.0000	0.9979

REFERENCES

Baselga, A. (2009) Partitioning the turnover and nestedness components of beta diversity. *Global Ecology and Biogeography*, **19**, 134-143.

Baselga, A., Jiménez-Valverde, A. & Niccolini, G. (2007) A multiple-site similarity measure independent of richness. *Biology Letters*, **3**, 642-645.

de Bello, F., Lavergne, S., Meynard, C.N., Leps, J. & Thuiller, W. (2010) The partitioning of diversity: showing Theseus a way out of the labyrinth. *Journal of Vegetation Science*, **21**, 992-1000.

ter Braak, C.J.F. (1986) Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology*, **67**, 1167-1179.

ter Braak, C.J.F. (1988) CANOCO: an extension of DECORANA to analyze species–environment relationships. *Vegetation*, **75**, 159-160.

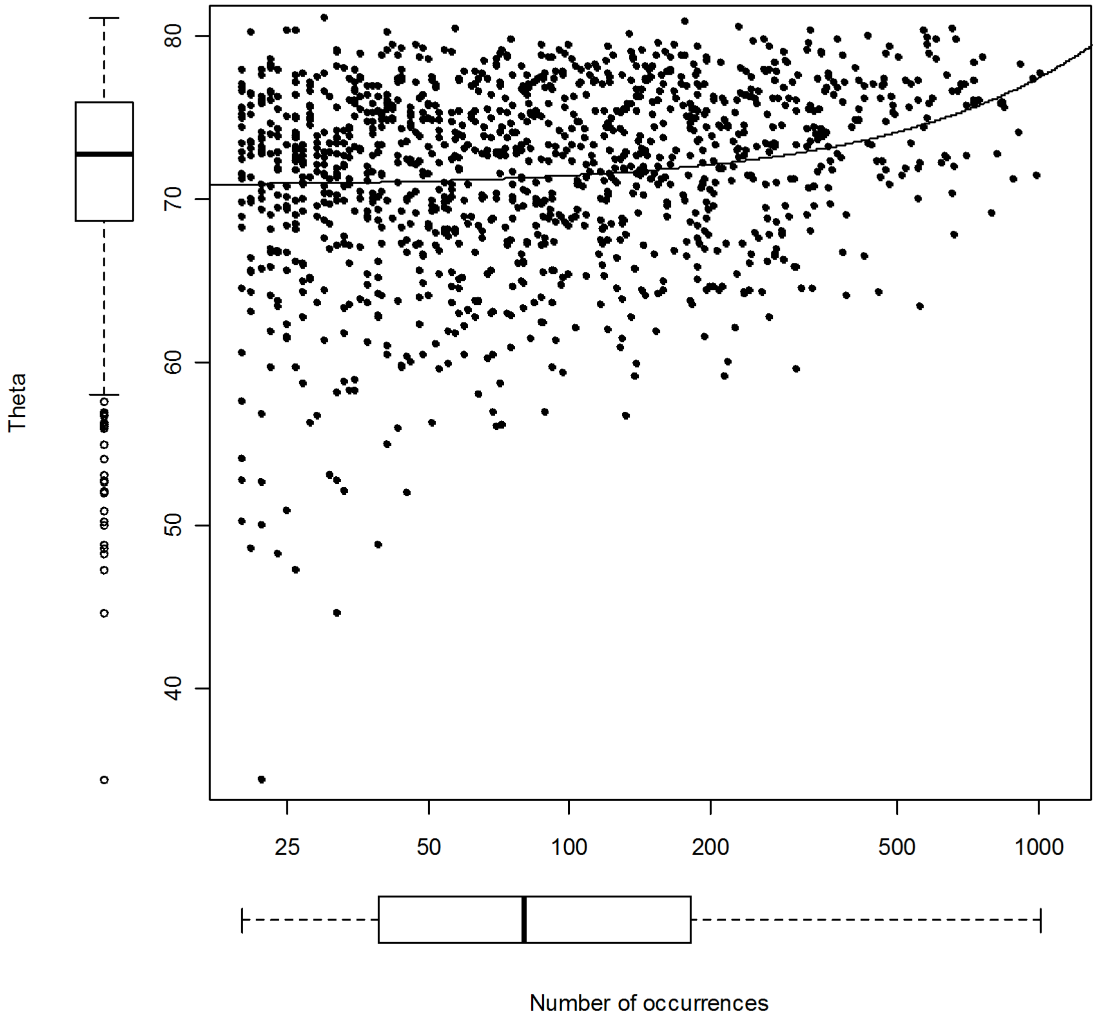
Dolédec, S., Chessel, D. & Gimaret-Carpentier, C. (2000) Niche separation in community analysis: a new method. *Ecology*, **81**, 2914-2927.

Lande, R. (1996) Statistics and partitioning of species diversity, and similarity among multiple communities. *Oikos*, **76**, 5-13.

Manthey, M. & Fridley, J.D. (2009) Beta diversity metrics and the estimation of niche width via species co-occurrence data: reply to Zeleny. *Journal of Ecology*, **97**, 18-22.

Whittaker, R.H. (1960) Vegetation of the Siskiyou Mountains, Oregon and California. *Ecological Monographs*, **30**, 280-338.

Appendix S2 Specialization index for 1216 French alpine plants according to the number of occurrences in the dataset. The solid grey line indicates the generalized least square regression fit. The *x*-axis is log-scaled. The slope is significantly different from zero (*P*-value <0.001). Adjusted R^2 = 4.6%. The boxes on the axes represent the distribution of the variables for each axis.



Appendix S3 Specialization index for 1216 French alpine plants, according to the number of habitats in which a species occurs in the dataset. The ten habitat classes are the same as those used in the rest of the study. Box plots show quartiles. Widths are proportional to the square root of number of species in each class. Theta index ranges from 0 (specialist) to 100 (generalist). The difference between mean theta values across the number of habitats is significant (Kruskal–Wallis rank sum test: *P*-value $< 2.2 \times 10^{-16}$). Very generalist species (high theta) are species occurring in numerous habitats, whereas very specialist species occur in few habitats.