Ecography

E5165

Jiménez, I., Distler, T. and Jørgensen, P. M. 2009. Estimated plant richness pattern across northwest South America provides similar support for the species-energy and spatial heterogeneity hypotheses. – Ecography 32: 433–448.

Supplementary material

Appendix S1

Note A: to estimate the difference in the relative importance of the logarithm of elevation range between the fit of the IGM2 to data from our study region (Table 2) and the global specification of the IGM2 (Field et al. 2005) we used the marginal rate of substitution of logarithm of elevation range for annual precipitation (MRS_{PT}). MRS_{PT} is the amount of annual precipitation needed to substitute a logarithmic unit of elevation range and maintain the same species richness in a grid cell. Thus, in the state space determined by the logarithm of elevation range in the abscissa and annual precipitation in the ordinate, richness isopleths can be defined as combinations of values of these two variables that, according to the IGM2, yield a constant richness value, R:

$S(\cdot) = R$

where S is richness and (·) is shorthand for the variables that determine richness according to the IGM2: annual precipitation, minimum monthly potential evapotranspiration, its square, and the logarithm of range in elevation (Field et al. 2005). The negative of the slope of these richness isopleths is the marginal rate of substitution of the logarithm of elevation range for annual precipitation, and can be defined as the quotient of the partial derivative of richness with respect to the logarithm of elevation range over the partial derivative of richness with respect to annual precipitation:

$$MRS_{PT} = \frac{\frac{\partial S(\cdot)}{\partial \log(\text{elevation range})}}{\frac{\partial S(\cdot)}{\partial \text{annual precipitation}}}.$$

According to the IGM2, none of these two partial derivatives vary with changes in any of the predictor variables, because annual precipitation and the logarithm of elevation range have a constant positive effect on richness, independent of each other and of minimum monthly potential evapotranspiration (Field et al. 2005). Therefore, MRS_{PT} can be estimated as the ratio of the regression coefficients of the logarithm of elevation range and annual precipitation. Assuming that the MRS_{PT} is a ratio in which the sampling variance of the numerator and the denominator are not correlated, we draw a parametric bootstrap sample (Efron and Tibishirani 1993) of size 1 000 000 for both, the regression coefficient of elevation range (8.33077, standard error = 2.50506) and annual precipitation (0.00883, standard error = 0.00331), assuming a normal distribution with standard deviation equal to the standard error of the coefficient. Then we combined the values from both bootstrap samples, in the order in which they were drawn, to produce 1 000 000 values of MRS_{PT} and, thus, calculate the 2.5 and 97.5 percentiles of MRS_{PT}. Field et al. (2005) did not provide standard errors for the coefficients of the globally specified IGM2, so it was not possible to estimate the respective confidence intervals for MRS_{PT}.

Note B: higher gamma diversity in topographically complex areas than in lowland Amazonia could be an artifact of the internal patterning of diversity within sampling units. This idea predicts that the slope relating the aggregation of herbarium specimen records within sampling units (in the abscissa) and the estimated relative plant richness (in the ordinate) will be more negative across sampling units located in lowland Amazonia than across those located in montane areas. In other words, as aggregation of herbarium specimen records increases, more plant richness might go undocumented from lowland sampling units than from topographically complex sampling units. To test this prediction we calculated an aggregation index for each 100 × 100 km sampling unit in our study region. To do so we first divided each sampling unit into one hundred 10 × 10 km grid cells. We then calculated the coefficient of dispersion (CD) in each sampling unit by taking the ratio of the variance to the mean of number of herbarium specimen records across the one hundred 10 × 10 km grid cells within each 100 × 100 km sampling unit. We categorized montane or Amazonian sampling units using dummy variables. Montane sampling units were those with over 50% of their area occurring at elevations ≥ 1000 m. Amazonian sampling units were those with over 50% of their area at < 1000 m in elevation and within the Amazon subregion as defined by Morrone (2001). We performed three quantile regressions using relative plant richness estimates rarefied at 500 collections as the response variable. In the first regression model we used as independent variables CD and two dummy variables distinguishing Amazonian and montane sampling units from other sampling units. In addition, we used interaction terms between the dummy variables and CD to allow for differences in the slope across montane and Amazonian sampling units. The second regression model included as explanatory variables CD and the dummy variables, but not interaction terms. Finally, the third regression model included only CD as explanatory variable. Our results indicated that there was no significant relationship between aggregation of herbarium specimen records and estimates of relative plant richness (Table S1). Relevant descriptive statistics are reported in Table S2.

Table S1. Results from median regression models testing the relationship between relative plant richness and aggregation of herbarium specimen records within sampling units. Aggregation of herbarium specimen records was measured by the coefficient of dispersion (CD). Under the column labeled "t" is the t-statistic for each regression coefficient and under the column labeled "p-value" are the respective p-values. A measure of goodness of fit, R^1, is shown after the name of each model.

Variables	t	p-value
Model 1, $R^1 = 0.031$		
CD	1.072	0.286
Montane	0.200	0.842
Amazonian	0.879	0.381
CD × Montane	0.722	0.472
CD × Amazonian	–1.126	0.262
Model 2, $R^1 = 0.009$		
CD	0.566	0.573
Montane	0.974	0.332
Amazonian	0.090	0.928
Model 3, $R^1 = 0.001$		
CD	0.501	0.617

Table S2. Descriptive statistics for the distribution of herbarium specimen records within 100 × 100 km sampling units. Montane sampling units were those with > 50% of their area within elevations ≥ 1000 m. Amazonian sampling units were those with over 50% of their area at < 1000 m in elevation and within the Amazon subregion as defined by Morrone (2001).

Statistic	Montane	Amazonia	Total
Number of sampling units	42	36	125
Mean number of herbarium specimen records	2634	2962	2584
Mean coefficient of dispersion	216.115	765.05	417.41
Number of sampling units with > 2000 herbarium specimen records	16	12	45

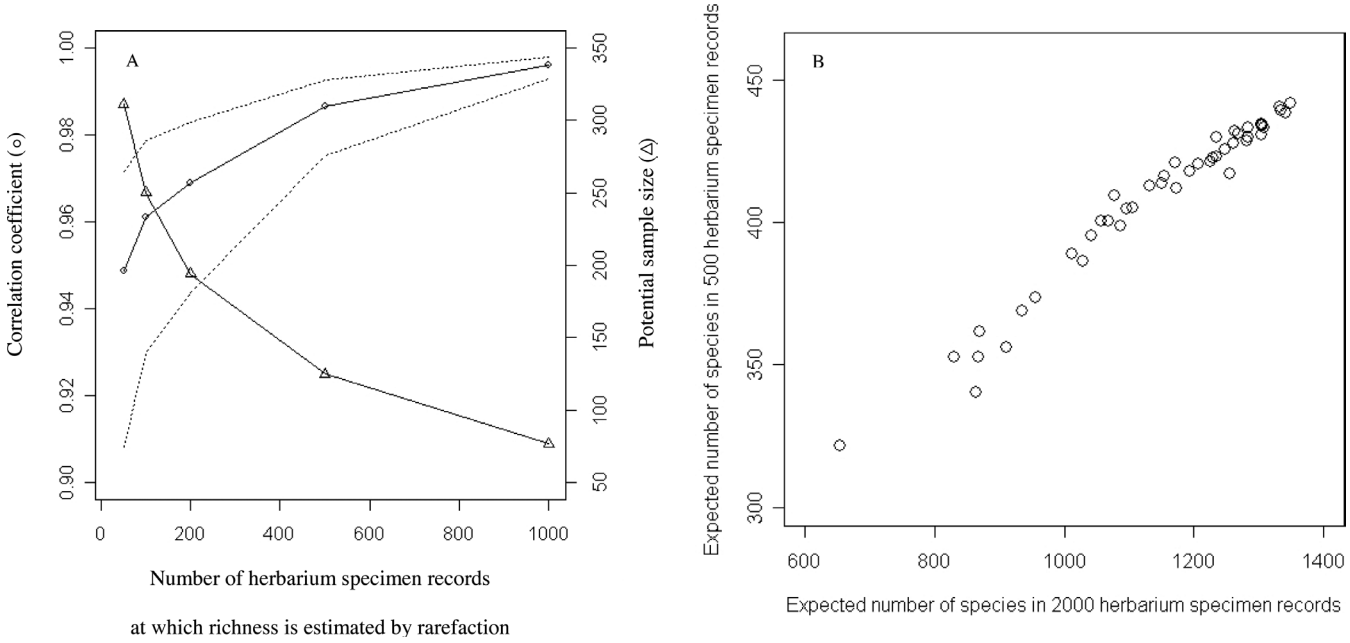

Figure S1. Trade-off between the precision of relative plant richness estimates and the number of sampling units available for analysis. (A) Pearson's correlation coefficients (line and circles) and their 95% confidence intervals (dotted lines) for the relationship between richness estimated by rarefaction as the expected number of species in 2000 herbarium specimen records and richness estimated by rarefaction at various other numbers of herbarium specimen records: 1000, 500, 200, 100 and 50. The sample for all these comparisons was a set of 42 sampling units of 100 × 100 km, each with at least 2000 specimen records. Also shown is the potential sample size (line and triangles), that is, the number of sampling units in our study region that would be available for analysis if richness estimates based on rarefaction at a given number of herbarium specimen records were deemed acceptable. The whole study region was covered by 573 grid cells. By deciding to estimate richness at 500 specimen records we adopted a somewhat conservative approach, trading off increases in potential sample size above 125 sampling units for the precision of relative richness estimates. (B) Relationship between relative plant richness estimated by rarefaction at 2000 herbarium specimen records (in the abscissa) and 500 herbarium specimen records (in the ordinate) across 42 sampling units of 100 × 100 km, each with at least 2000 specimen records.

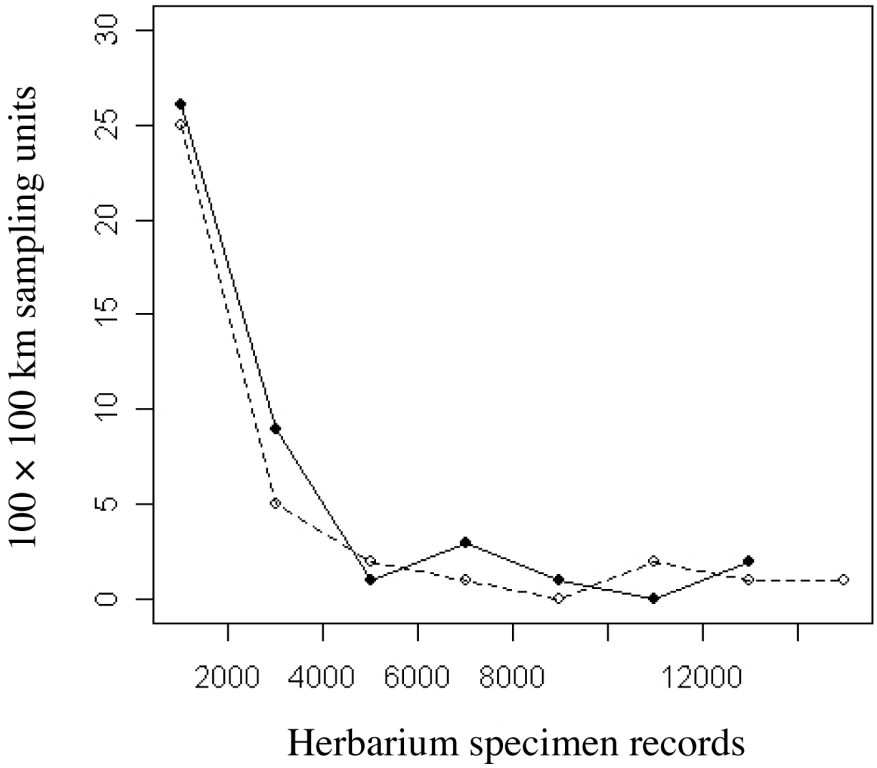

Figure S2. Frequency of montane (closed symbols and solid line) and Amazonian (open symbols and dashed line) sampling units used in the analysis classified according to their number of herbarium specimen records. Montane sampling units were those with > 50% of their area within elevations ≥ 1000 m. Amazonian sampling units were those with over 50% of their area at < 1000 m in elevation and within the Amazon subregion as defined by Morrone (2001). There were 42 montane and 36 Amazonian sampling units.

References

Efron, B. and Tibshirani, R. J. 1993. An introduction to the bootstrap. – CRC Press.

Field, R. et al. 2005. Global models for predicting woody plant richness from climate: development and evaluation. – Ecology 86: 2263–2277.

Morrone, J. J. 2001. Biogeografía de América Latina y el Caribe. – Manuales y Tesis SEA, Zaragoza.