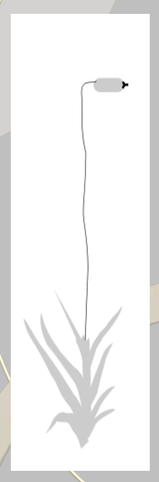
Climate shapes epiphytic bryophyte diversity in the edge of the Mediterranean

Nagore G. Medina[1,*], Belén Albertos[2], Francisco Lara[1], Vicente Mazimpaka[1], Ricardo Garilleti[2], David Draper[3], Joaquín Hortal[4]

[1] Departamento de Biología (Botánica), Facultad de Ciencias, Universidad Autónoma de Madrid. Campus de Cantoblanco, C/Darwin 2, E-28049 Madrid, Spain.
[2] Departamento de Botánica, Facultad de Farmacia, Universidad de Valencia. Avda. Vicente Andrés Estellés s/n, E-46100 Burjasot, Spain.
[3] Departamento de Biología Vegetal, Escuela Técnica Superior de Ingenieros Agrónomos, Universidad Politécnica de Madrid. Ciudad Universitaria s/n. E-28040, Madrid, Spain.
[4] Departamento de Biodiversidad y Biología Evolutiva, Museo Nacional de Ciencias Naturales (CSIC). C/José Gutiérrez Abascal 2, 28006 Madrid, Spain.



INTRODUCTION

The relative importance of the factors affecting richness across scales and the influence of biogeographical boundaries on these patterns are challenging questions. Epiphytic mosses are a good model to examine the determinants of richness gradients. Although they share some characteristics with vascular plants they have some important differences (life cycle, lack of effective water loss control) that can help to better understand the determinants of diversity in a more general framework.

OBJECTIVES

We study the relative importance of environment, regional species pool, abundance and scale for the richness of epiphytic bryophytes in the edge of the Mediterranean region

MATERIAL AND METHODS

EXTENT: NW of the Iberian Peninsula, in the transitional zone between the Atlantic and the Mediterranean regions (Fig. 1)

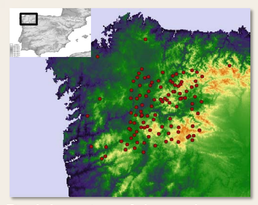


Fig. 1: Location of the study area. Red dots represent sampled forests

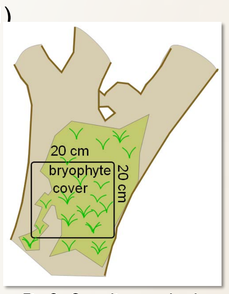


Fig. 2: Sampling method

SAMPLES: 20 samples consisting of a 400 cm^2 flexible quadrate were collected on 111 forests (Fig. 2)

We analyzed the data at different aggregation levels:
Forest richness as the total number of species found in each forest patch
Species density on the trunk as the average number of species per sample in each forest

We also calculated:
Abundance as *percentage* of moss cover per sample

ANALYSIS

- Selection and evaluation of the relative weight of the environmental variables → Remove highly correlated variables → Compare all the possible models → Select the most parsimonious one → **Multiple regression and hierarchical partitioning**
- Separating the effect of climate from the effect of regional pool → Identify the biogeographic region to which each one of the forests pertains → Include the climatic variables selected in the regression analysis → **Partial regression**
- Analyze relationships between abundance, richness, environment and region at the same time → **Partial least squares**

RESULTS

1

	Selected model	R^2	p-value	AICc wi
Forest richness	PIII; altitude	0.15	<0.0001	0.018
Tree richness	TIII;TVI;TXI; PII; PVII; PVIII; PX	0.51	<0.0001	0.041
Abundance	P;TIX	0.16	<0.0001	0.244

Table 1. Multiple regression models. Overall goodness-of-fit, and Akaike weights of the model are presented (see footnote for abbreviations)

- Richness and current climate are highly correlated
- High differences in explanatory power depending on the scale of analysis

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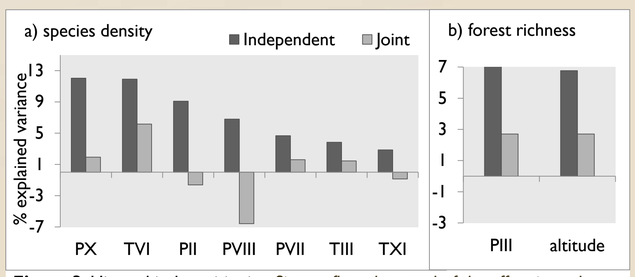

Figure 3. Hierarchical partitioning. Signs reflect the trend of the effect in each individual regression coefficient (see footnote for abbreviations)

- Precipitation and temperature variables are the ones with the highest correlation with richness
- Wet and cold forests are the richest ones in the study area
- Autumn and winter precipitation have the strongest effect on species richness

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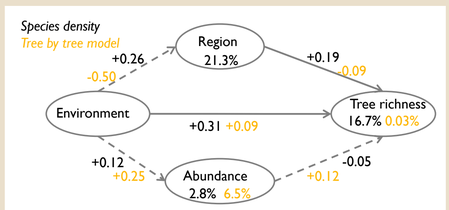

Figure 5. Partial least squares path analysis

- Positive correlation between abundance and species density (Spearman r = 0.11, p <0.001)
- No significant effect of abundance on richness when environment is taken into account

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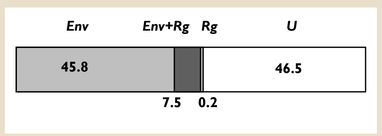

Figure 4. Variation partitioning analysis of species density. Env: environment. Rg: region; U: unexplained variation.

- There is no independent effect of region on richness: differences in the species pool among localities pertaining to different regions are mainly due to climate

DISCUSSION

1 Richness of epiphytic bryophytes correlated with climate and dependent on the scale, a common pattern in biogeography. However, conversely to the observations among vascular plants (Whittaker et al. 2001) richness is better explained at the finest scale (tree scale), a pattern has also been observed in other small sized organisms with passive dispersion (Fontaneto et al., 2006; Guil et al., 2009)

2 The influence of in autumn and, specially, winter rainfall confirms that the growing season in bryophytes includes at least some of the coldest months of the year

Rainfall in these seasons is more important than severity of the drought period (summer). It seems that summer rainfall influences less their biological activity than autumn and winter precipitation.

3 The positive correlation between richness and abundance at the finest scale suggests the existence of mutualistic processes

However, the correlation is weak and non significant after accounting for the climatic variables

4 Although climatic gradient is intense, the transition between Temperate and Mediterranean bryophyte floras is gradual

Two factors may be the cause of such transition: the complex topography of the study area and the dispersal abilities of bryophytes

Abbreviations:

P: Mean annual rainfall; PII: Mean rainfall of February; PIII; Mean rainfall of March; PVII: Mean rainfall of July; PVIII: Mean rainfall of August; PX: Mean rainfall of October; TVI: Mean temperature of June; TIX: Mean temperature of September; TXI: Mean temperature of November.

CONCLUSIONS

The correlation observed here suggests that species richness of epiphytic bryophytes may be driven by climate

The distinctive relationships with climate observed here are consistent with available data on the physiology and special characteristics of bryophytes

As in many other groups the richness-environment relationship is scale-dependent but, surprisingly, the effect is opposite to the one observed in vascular plants and large animals: meso-scale climatic variables explain better richness at the finest scale

These results open new questions : What causes such a relationship? Is this type of response to scale related to the particular characteristics of bryophytes?

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