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RESEARCH PAPER

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Global fern and lycophyte richness explained: How regional and local factors shape plot richness

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Abstract

Aim: To disentangle the influence of environmental factors at different spatial grains (regional and local) on fern and lycophyte species richness and to ask how regional and plot-level richness are related to each other.

Location: Global.

Taxon: Ferns and lycophytes.

Methods: We explored fern and lycophyte species richness at two spatial grains, regional (hexagonal grid cells of 7,666 km^2) and plot level (300–500 m^2), in relation to environmental data at regional and local grains (the 7,666 km^2 hexagonal grid cells and 4 km^2 square grid cells, respectively). For the regional grain, we obtained species richness data for 1,243 spatial units and used them together with climatic and topographical predictors to model global fern richness. For the plot-level grain, we collated a global dataset of nearly 83,000 vegetation plots with a surface area in the range 300–500 m^2 in which all fern and lycophyte species had been counted. We used structural equation modelling to identify which regional and local factors have the biggest effect on plot-level fern and lycophyte species richness worldwide. We investigate how plot-level richness is related to modelled regional richness at the plot's location.

Results: Plot-level fern and lycophyte species richness were best explained by models allowing a link between regional environment and plot-level richness. A link between regional richness and plot-level richness was essential, as models without it were rejected, while models without the regional environment-plot-level richness link were still valid but had a worse goodness-of-fit value. Plot-level richness showed a hump-shaped relationship with regional richness.

Main conclusions: Regional environment and regional fern and lycophyte species richness each are important determinants of plot-level richness, and the inclusion of one does not substitute the inclusion of the other. Plot-level richness increases with regional richness until a saturation point is reached, after which plot-level richness decreases despite increasing regional richness, possibly reflecting species interactions.

KEYWORDS
big data, macroecology, pteridophytes, regional-local richness relationship, saturation curves, structural equation modelling

1 | INTRODUCTION

One of the most fundamental questions in plant ecology and biogeography deals with the processes determining species richness patterns at different spatial scales. Even though the importance of scale (i.e. extent and resolution/grain size) in ecological analyses has been acknowledged since the 1950s (e.g. Chase et al., 2019; Hutchinson, 1953; Levin, 1992; Rahbek, 2005; Ricklefs, 1987; Whittaker, 1977), the full implementation of scale effects in global analyses has been hindered by lack of both data and appropriate methods (Beck et al., 2012). Today, advanced statistical methods (e.g. Keil & Chase, 2019) and comprehensive datasets of global extent, fine resolution and