PROJECT INFORMATION

Project title: **Understanding global patterns of fern diversity and diversification**

Project ID: 100

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PROJECT DESCRIPTION

Introduction

Understanding the causes of variation of community richness and composition is one of the longest standing and at the same time most current topics in ecological and biogeographical research. Patterns like the latitudinal diversity gradient have been known for more than 200 years (Darwin 1859, Wallace 1878), yet the evolutionary processes behind it are still not fully understood. Especially important in fern diversity is the elevational gradient in mountainous areas – a topic that my research group has been involved with since the 1990s.

During the last 20 years, my research network has assembled a unique, near-global dataset of around 3500 plots (see Fig. 1), with a strong focus on elevational gradients in tropical and subtropical regions. All plots have been recorded with the same methodology and include information on presence (implied absence) of all fern species (terrestrial and epiphytic), number of individuals, fertility, microhabitat preference, and environmental information such as canopy height and cover, moss cover, rock occurrence, exposition and inclination. However, despite some data from Germany and Switzerland, we have very limited data from Europe or other north-temperate regions. With the inclusion of the European Forest Plots (ICP Forests), we would reach sufficient coverage to analyse the diversity patterns of ferns on a global scale.

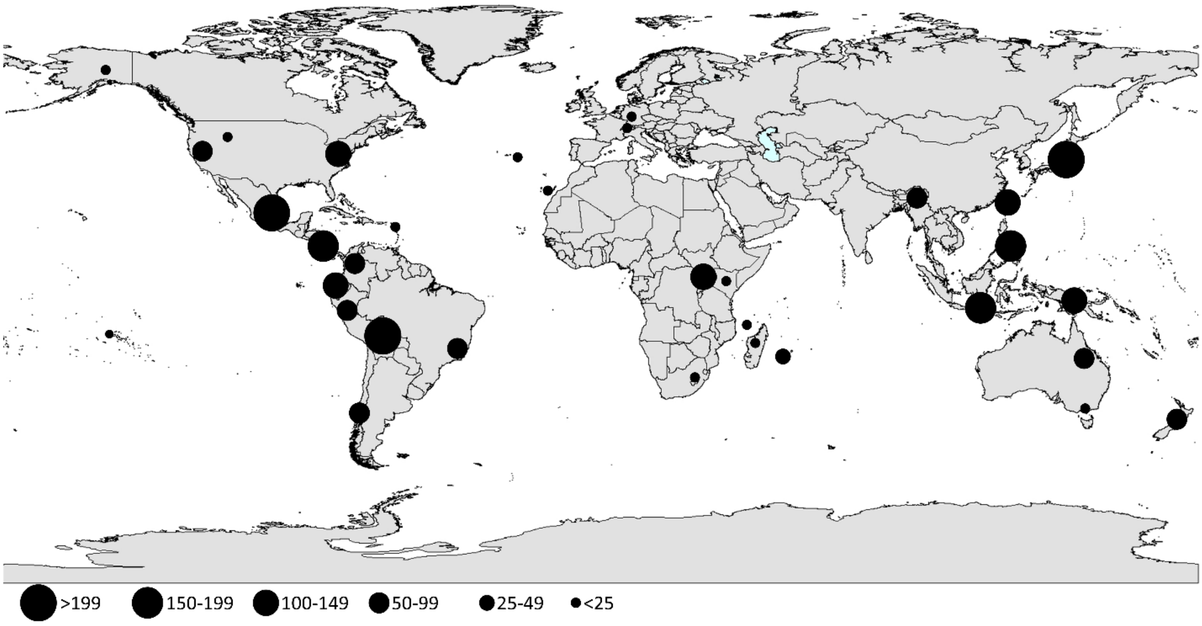

Figure 1 Geographical distribution of fern plots available in June 2016.

My research group is currently also setting up the new global climate model CHELSA (Climatologies at High resolutions for the Earth's Land Surface Areas), which is not based on interpolation of station data as other currently available climate models (WorldClim), but on quasi-mechanistical downscaling of combined global climate predictors, such as the global circulation model (ERA-interim), cloud condensation levels or cloud water content. Especially predictions in mountainous systems will be much more reliable than with current climate models (see Fig. 2)

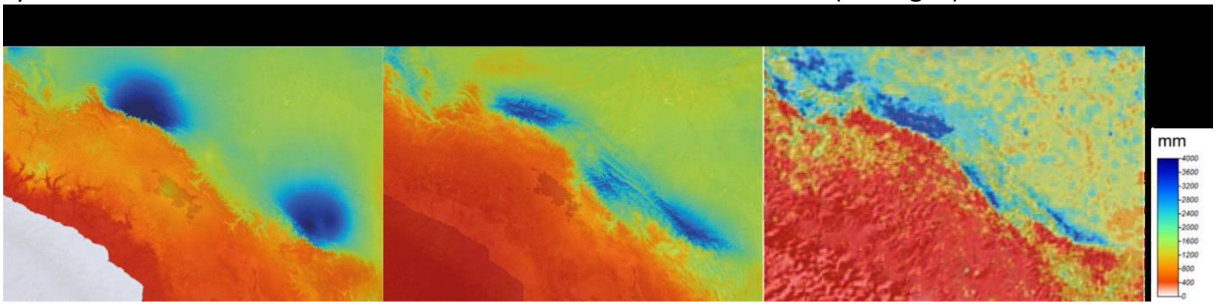

Figure 2 *Comparison of the patterns of mean annual precipitation in the WorldClim and CHELSA models with actual rainfall measured by the TRMM rainfall satellite for a portion of the central Andes from Peru to Bolivia and the Pacific Ocean. Note that the patterns in CHELSA are much closer to the real patterns than WorldClim.*

Project description

The aim of the project is to link plot data of fern occurrences with the new climate model and additional data, such as soil information from the Harmonized World Soil Database (Nachtergaele et al. 2008), to model fern species richness on a global scale using regression and species distribution modelling tools.

Based on this model, we will analyse the reasons (and their relative importance) for the observed patterns. Different theories have been proposed to explain diversity gradients in general (e.g. Qian & Ricklefs 2011, Lethonen et al. 2015). They involve historical factors such as the age and present/past area of a certain region, mountain range or vegetation type (Rosenzweig 1995, Stephens & Wiens 2003), *climatic variables* such as humidity, temperature or ecosystem productivity (Evans et al. 2005, Goldie et al 2010, Kessler et al. 2014), *evolutionary factors* such as including higher speciation rates in given environments (Allen et al. 2002) and their function as a source of new species for other regions

(Cardillo 1999, Jablonski et al. 2006), or *ecological interactions* influencing species numbers by competition driven extinction or speciation (Chown & Gaston 2000). Many of these factors have been found to be important for one specific study group or area but irrelevant for others. Using a global dataset of all fern species will be a novel approach, which will give us the opportunity to identify the relative importance of different factors on different scales, time periods or geographic units.

Since our plots include information on presence/absence and fertility, we will be able to analyse the local community composition and its relation to regional species pools. These analyses becomes especially interesting when combined with phylogenetic information that our own as well as collaborating working groups (S. Lehtonen (Univ. of Turku, Finland), N. Salamin (Univ. of Lausanne, Switzerland), M. Lehnert (Univ of Bonn, Germany), M. Sundue (Univ. of Vermont, USA)) are currently working on. Interesting questions are for example: Are communities composed of closely or distantly related species? Does the degree of relatedness change in dependence on environmental factors, such as elevation, latitude, age of a certain area or impact of climate change since the last glacial maximum ("climate change velocity" (Loarie et al. 2009, Sandel et al 2011))? Is the relatedness scale-dependent – are local species pools less closely related than regional species pools?

With the inclusion of the European forest plots of IPC Forests, our dataset will include an extraordinary amount of data which allows as to tackle fundamental questions of general interest to ecologists, biogeographers and biodiversity researchers and managers.

Data requested

We would like to include exclusively the fern records of the IPC Forest database at the spatial scale of 20 m x 20 m, as well as selected plot descriptors such as geographical coordinates, elevation, aspect, inclination, tree height and forest cover.

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