Influence of Bioclimatic Variables on Tree Species Distribution in Jiri & Baegun Mountains

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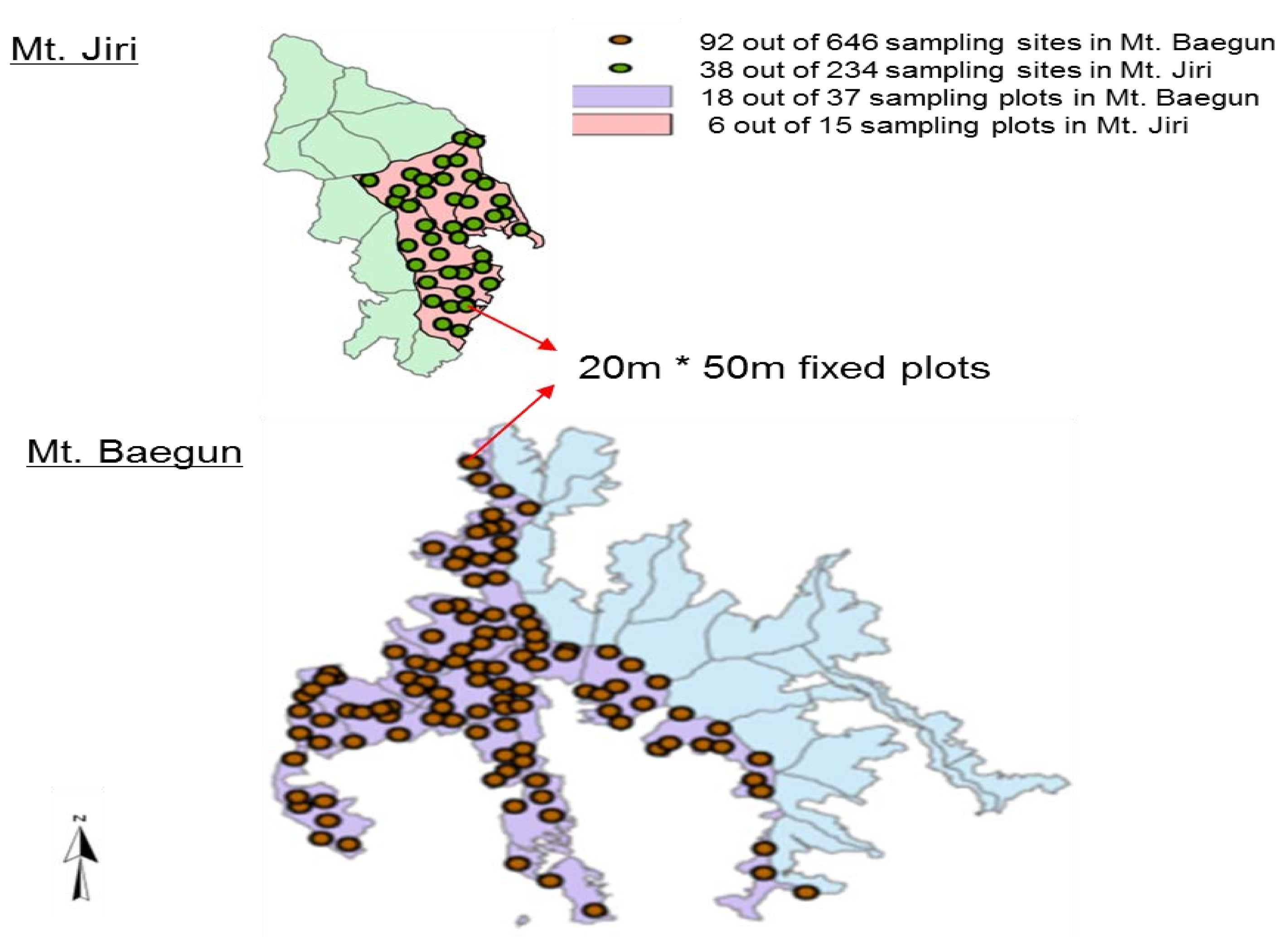
Overview

Understanding the response of individual tree species to climate variables is important to reveal the ecosystem-level responses to climate change. To identify how climate factors influence the distribution of individual tree species across temperate mountains, here, we present our findings on effects of bioclimatic variables (annual mean monthly minimum, maximum, and mean temperatures, total annual precipitation, temperature seasonality, and precipitation seasonality) to seven tree species distributions (*Quercus mongolica*, *Carpinus laxiflora*, *Lindera erythrocarpa*, *Pinus densiflora*, *Quercus dentata*, *Betula schmidtii*, *Abies koreana*) in Mt. Jiri & Baegun, South Korea, over the past fifteen years (1998-2012) with regard to the following two perspectives;

- Identify the response curves of seven tree species distributions to bioclimatic variables
- Evaluate the relative importance of bioclimatic variables on seven tree species distributions

Data Collection

Tree species composition and DBH size were collected over the past fifteen years (Period 1: 1998-2003; Period 2: 2004-2007; Period 3: 2008-2012) in 130 quadrats (20m * 50m) of woodland communities across Mt. Jiri and Baegun, South Korea. The temperature and precipitation data were also measured at the 15 weather stations located across Mt. Jiri and Baegun.



Data Analysis

Interpolation of Bioclimatic Variables

- Six climate variables (annual mean monthly minimum, maximum, and mean temperatures, total annual precipitation, temperature seasonality, and precipitation seasonality) were generated for 130 plots through multiple linear regression models, using the plot-level topographical predictor variables (latitude, longitude, elevation, slope, sin(*aspect*), and cos(*aspect*)).

Development of Logistic Habitat Regression Model

- The species response curves to climate variables were identified by developing logistic habitat regression models as functions of the bioclimatic variables and their quadratic terms. The optimal response curves for each species fitted with stepwise logistic models as follows;

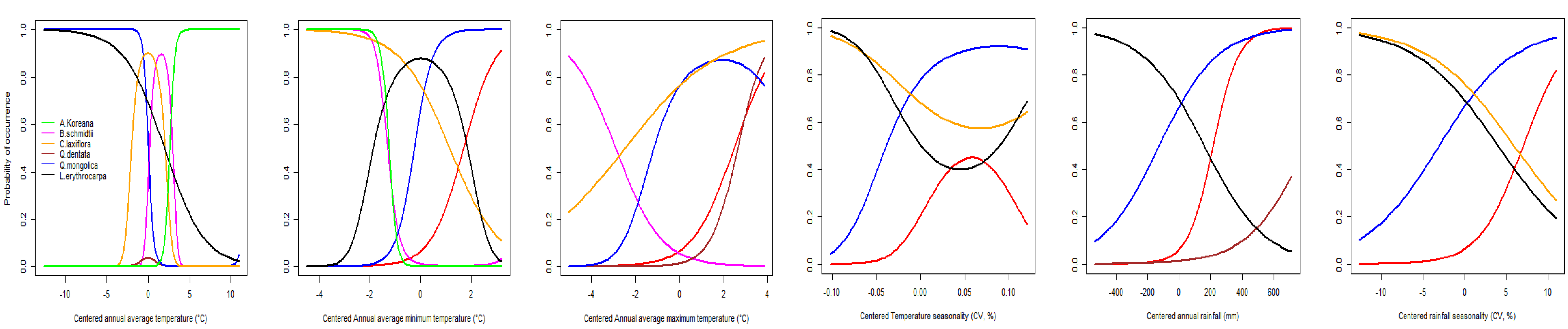
  - $y_i \sim \mathrm{Bern}(p_i)$
  - $\mathrm{logit}(p_i) = ß0 + ß1*AMT + ß3*AMT^2 + ß4*TS + ß5*TS^2 + ß6*ATP + ß7*PS + ß8*AMMT + ß9*AMMT^2 \ldots$

  where y_i is a response variable (=0 for absence of species and =1 for presence of species). Bern represents the Bernoulli distribution with the probability of success $p_i = \mathrm{prob}(y_i = 1)$ and $\mathrm{logit}(p_i) = \log(p_i / 1 - p_i)$. AMT, TS, ATP, PS, and AMMT represent annual mean temperature, temperature seasonality, annual total precipitation, precipitation seasonality, and annual mean minimum temperature.

- The relative importance of six bioclimatic variables on each of species response distributions was evaluated by a hierarchical variation partitioning analysis.

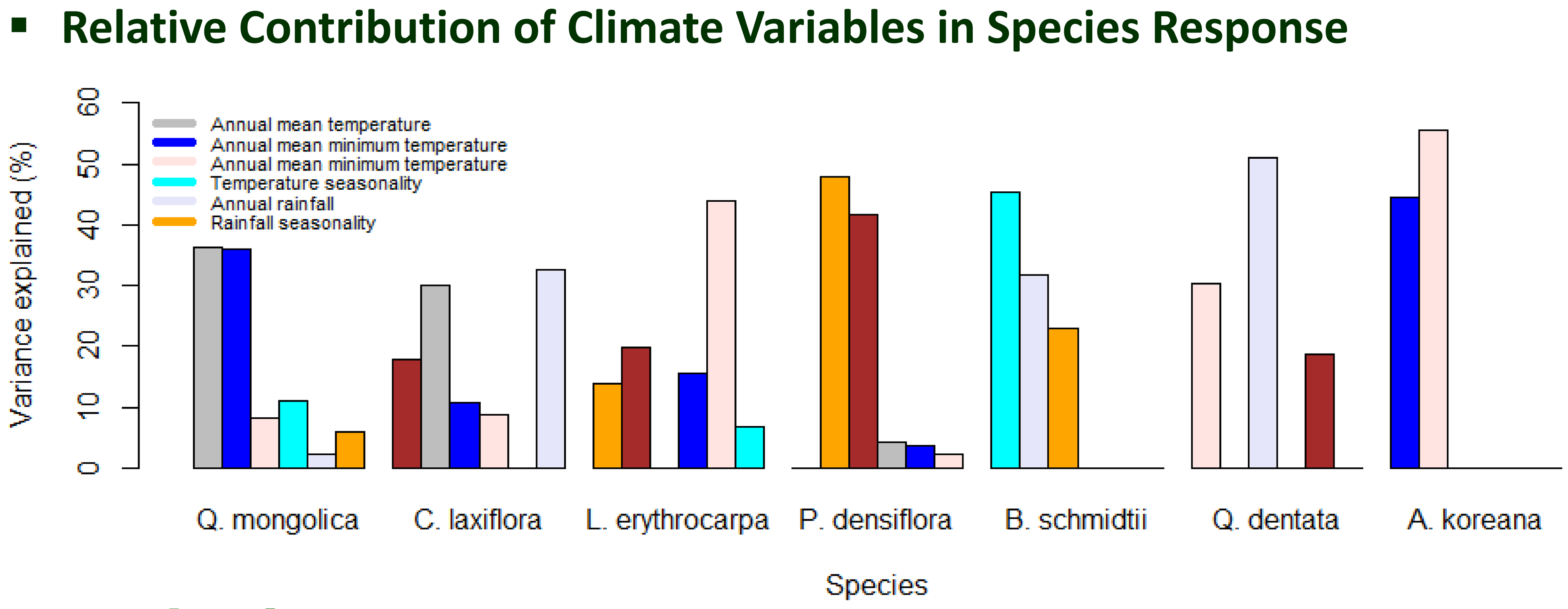
Results

Species Response to Climate Variables



- Seven tree species showed a different shape of response curves to six climate variables: unimodal, decreasing, increasing, and flat response curves.
- Seven tree species showed distinct optimal distributions to six climate variables. For example, *Pinus densiflora* showed up to 45% survival at 3.2% of temperature seasonality.

Relative Contribution of Climate Variables in Species Response



- The species occurrence was significantly associated with annual mean minimum and mean temperatures, explaining on average 32% (range=20-56%) and 27% (range=14-45%) variation in species distribution, respectively, followed by annual mean maximum temperature (19%, range=8-50%), total annual precipitation (10%, range=2-44%), precipitation seasonality (7%, range=2-33%), and temperature seasonality (6%, range=4-16%).

Conclusion

- *Abies koreana* was found to have a higher survival under the climate change if annual mean minimum temp is kept below 5.9℃ in Mt. Jiri and Baegun.
- *Lindera erythrocarpa* was found to have a higher drought tolerance among seven tree species in Mt. Jiri and Baegun.

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