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Survival in little? Refugia of high-elevated plants in the Spanish Sierra Nevada

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Keywords

Grasslands, isolation, global warming, alpine tundra.

Abstract

Climate change is a serious threat to high-elevated plant species. There are three possible strategies to survive if they cannot exist in their inherent habitats any more: Upward shift, use of phenotypic plasticity ore movement to small-scaled local still suitable microhabitats. Furthermore, high-mountain plants are still exceptionally endangered since they are already at their ecologic limits. We analyzed future shift strategies based on possible climate scenarios considering current and future climate conditions. The study was conducted at the Spanish Sierra Nevada National Park as part of the ECOPOTENTIAL project.

Introduction

Plants at high-elevated mountains are in particular sensitive to temperature changes (KÖRNER 2003) and disproportionately high endangered in cases of fast environmental changes. Elevational gradients represent quit often strong environmental gradients – in the Spanish Sierra Nevada an increase in precipitation and a decrease of temperatures. Mountainous species seem to be limited at their elevation, upwards by increased environmental extremes, downwards by competition of more widespread species (GHALAMBOR et al. 2006). In the case of environmental changes and competition of upward-shifting species, a species at a certain elevation has several strategies to avoid extinction: (1) niche differentiation from upward-shifting species (e.g. by using phenotypic plasticity and resp. or finding micro-habitats (SCHERRER & KÖRNER 2010)) or (2) even migrate upward to find suitable, environmental similar conditions (GÓMEZ et al. 2015).

In the Sierra Nevada are plant species migrations more likely since the slopes of the Sierra Nevada are not very steep (PAULI et al. 2003). Besides climate conditions seems the yearly snow cover important: Snow protects plants during winter from frost. Moreover, snowmelts play a crucial role for the water supply during summer (PAULI et al. 2003).

We are interested in the influence of both, changes temperatures and snow cover on alpine plants of the Sierra Nevada. We investigated vascular plant species, in particular endemics, and checked their current temperature conditions to find future similar locations. We estimate their risk to get extinct based on the accessibility of future refugia.

Material and methods

We investigated vascular plants above the treeline, along an elevational gradient from 2,000 to 3,000 m a.s.l. at the southern slope of the Mulhacén in the Sierra Nevada National Park. Pseudo-abundances were calculated by presence-absence data of subplots of a hexagonal plot design (JURASINSKI & BEIERKUHNLEIN 2006). We used a local flora of Blanca et al. (2009) to identify the plants and to sort them to different classes of endemism.

We used WorldClim to get current and future spatial temperature data (HIJMANS et al. 2005). We used the CCSM4 rcp 8.5 scenario for future temperatures. All data were reprojected to the local UTM resolution. Distances between current and future temperatures were calculated as proposed by HAMANN et al. (2015).

Results

Our results show, that endemic species in the Sierra Nevada might be endangered due to environmental changes like global warming (Fig. 1 & 2). Especially arctic-alpine endemics (Fig. 2) and, from the Sierra Nevada endemics, those with the lowest temperature niches are highly endangered since there will be no refugia anymore.
We found for the highest elevations the largest distances to areas of the same temperature regime as found there today (Fig. 3).

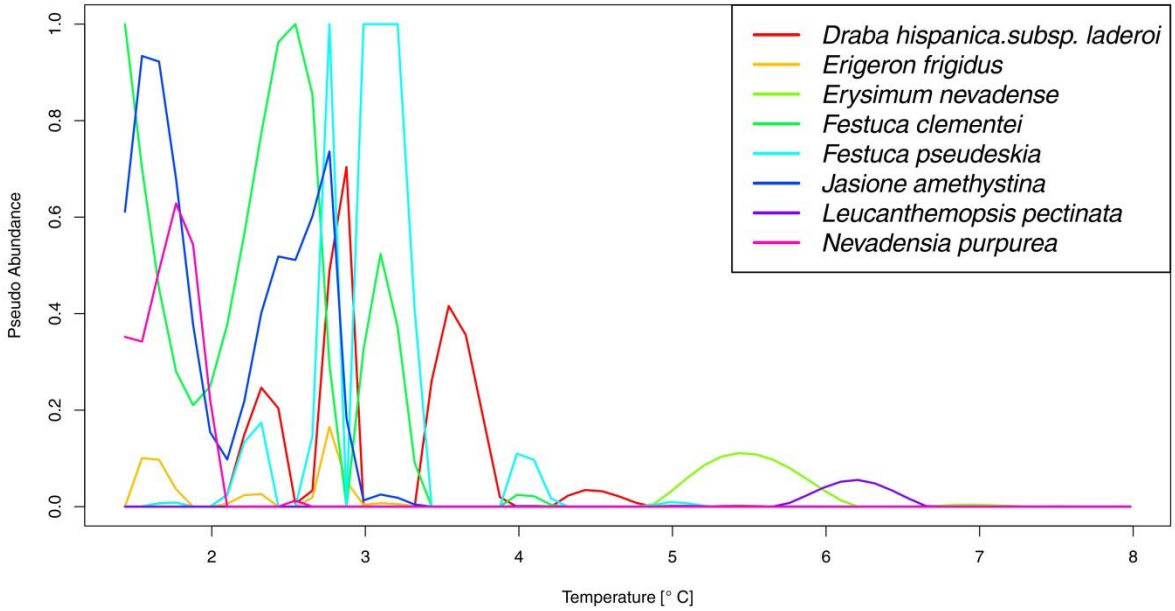

Figure 1: Pseudo-abundances of some Sierra Nevada endemits along the temperature gradient.

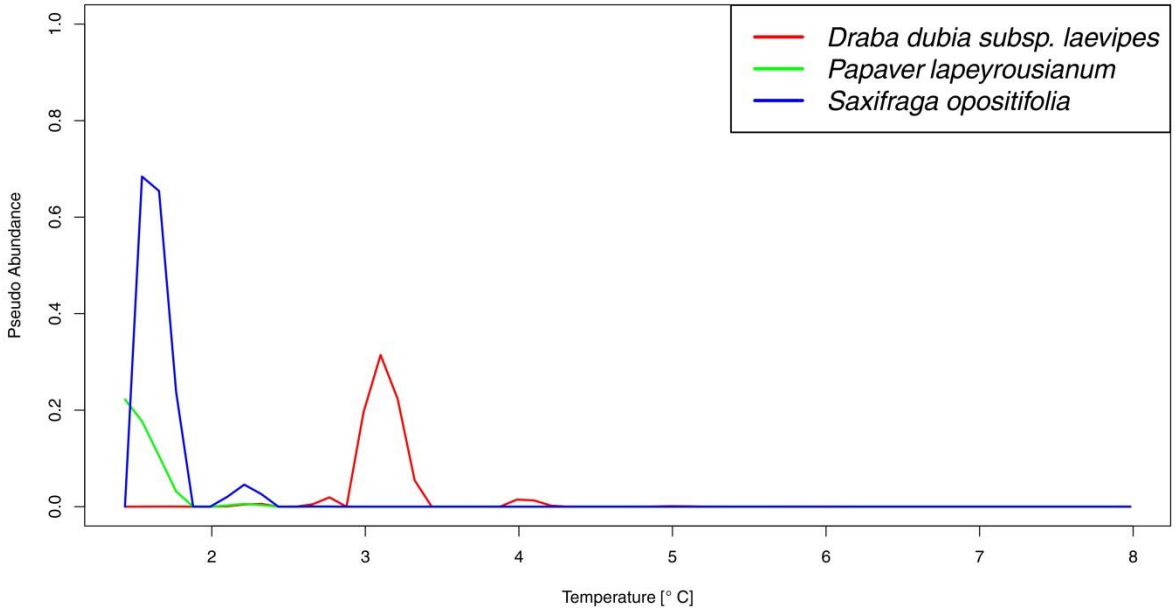

Figure 2: Pseudo-abundances of Arctic-alpine endemits along the temperature gradient.

Discussion

Endemic species in mountainous areas, especially in the Mediterranean area, are in particular threatened by global warming. Potential future refugia can be identified by distances to similar environmental sites. There is no substitute for the high-elevated summits of the Sierra Nevada.

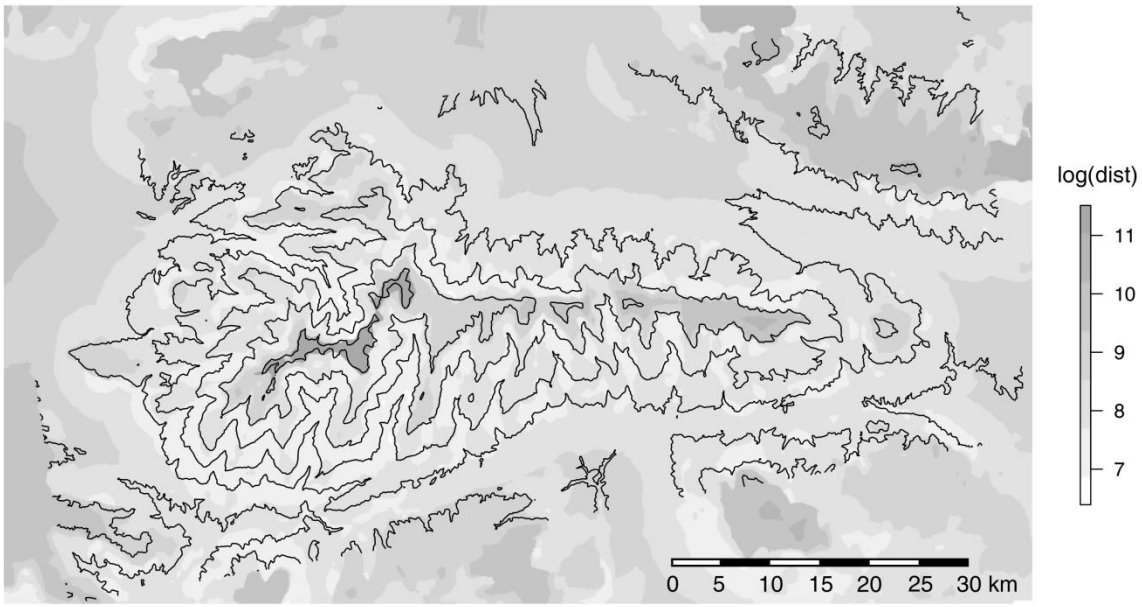

Figure 3: Nearest distances between current areas and future areas with unique temperatures. Isoclines are elevational steps in 250 m intervals.

References

BLANCA, G., CUETO, M., MARTÍNEZ-LIROLA, M. J., MOLERO-MESA, J. 1998. Threatened vascular flora of Sierra Nevada (Southern Spain). Biological Conservation 85, 269–285.

GHALAMBOR, C. K., HUEY, R. B., MARTIN, P. R., TEWKSBURY, J. J., WANG G. 2006. Are mountain passes higher in the tropics? Janzen's hypothesis revisited. Integrative and Comparative Biology 46, 5–17.

GÓMEZ, J. M., GONZÁLEZ-MEGÍAS, A., LORITE, J., ABDELAZIZ, M., PERFECTTI, F. 2015. The silent extinction: climate change and the potential hybridization-mediated extinction of endemic high-mountain plants. Biodiversity and Conservation 24, 1843–1857.

HAMANN, A., ROBERTS, D. R., BARBER, Q. E., CARROLL, C. AND NIELSEN, S. E. 2015. Velocity of climate change algorithms for guiding conservation and management. Global Change Biology 21, 997–1004.

HIJMANS, R. J., CAMERON, S. E., PARRA, J. L., JONES, P. G., JARVIS, A. 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25, 1965-1978.

JURASINSKI, G., BEIERKUHNLEIN, C. 2006. Spatial patterns of biodiversity-assessing vegetation using hexagonal grids. Biology and Enwironment 106B, 401–411.

KÖRNER, C. 2003. Alpine Plant Life: Functional Plant Ecology of High Mountain Ecosystems. Springer, Berlin.

PAULI, H., GOTTFRIED, M., DIRNBÖCK, T., DULLINGER, S., GRABHERR, G. 2003. Assessing the Long-Term Dynamics of Endemic Plants at Summit Habitats. Alpine Biodiversity in Europe. In: Grabherr, G., Körner, C. (ed.) Springer, Berlin.

SCHERRER, D., KOERNER, C. 2010. Infra-red thermometry of alpine landscapes challenges climatic warming projections. Global Change Biology 16, 2602-2613.

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