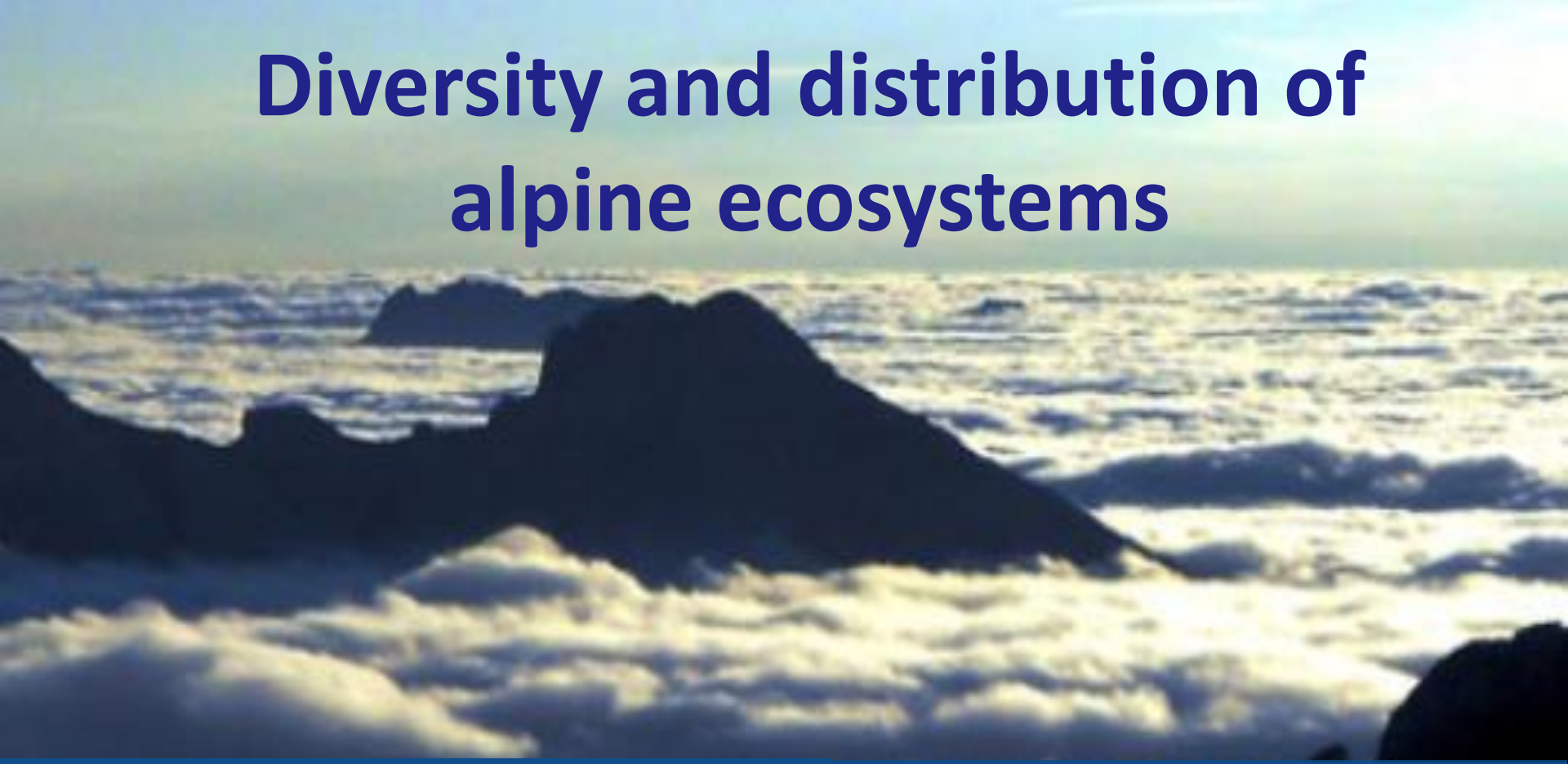
Diversity and distribution of alpine ecosystems



LifeWatch Thematic Service Workshop
Biogeography

4-5 April 2024
Bologna, Italy

Borja Jiménez-Alfaro

University of Oviedo
Biodiversity Research Institute - IMIB
(Univ.Oviedo-CSIC-Princ.Asturias)

Global Ecosystem Typology

Explore Analyse Typology

About Methods Glossary Feedback

A Global Typology for Earth's Ecosystems

The new IUCN Global Ecosystem Typology is a comprehensive classification framework for Earth's ecosystems that integrates their functional and compositional features. This new typology will help identify the ecosystems that are most critical for biodiversity conservation, research, management and human wellbeing into the future.

Image by Shifaaz Shamoon on Unsplash

Thanks to

RED LIST OF ECOSYSTEMS

IUCN

CEM

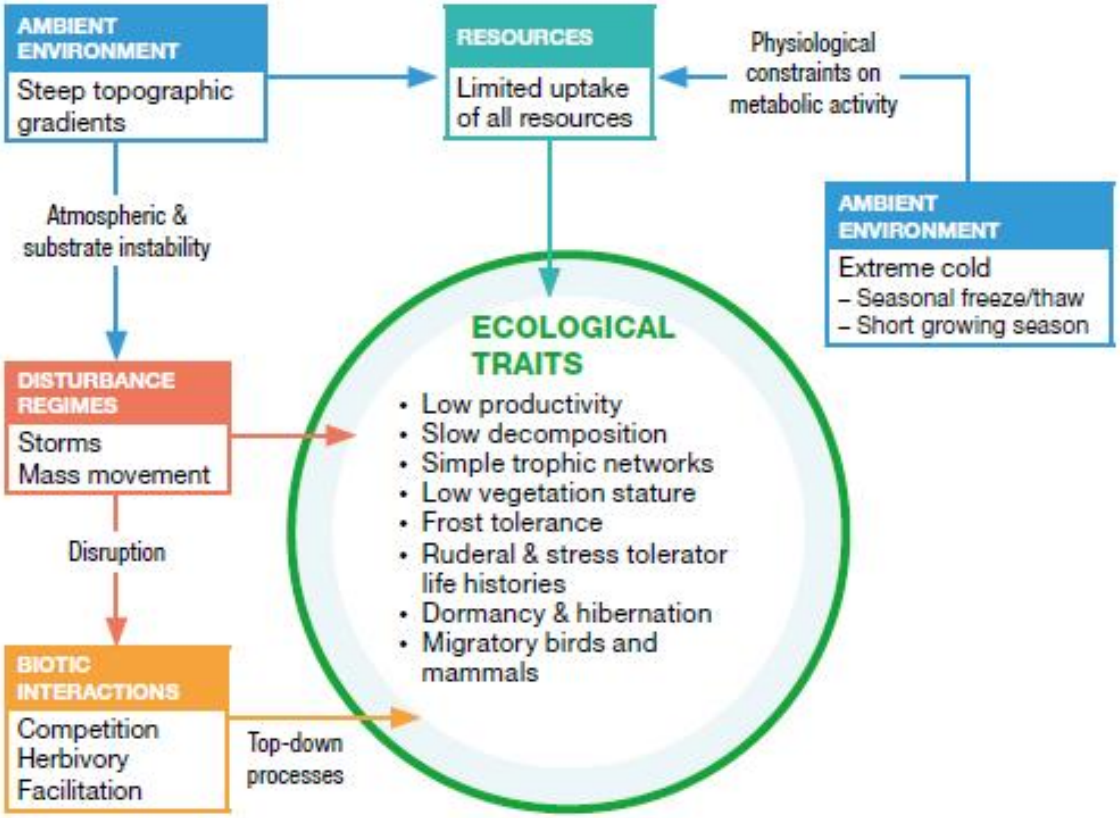
UNSW SYDNEY

Centre for Ecosystem Science

T6.4 Temperate alpine grasslands and shrublands

BIOME: POLAR-ALPINE (CRYOGENIC ECOSYSTEMS)
REALM: TERRESTRIAL

Contributors: D.A. Keith, F. Essl, K.R. Young, C.H. Körner



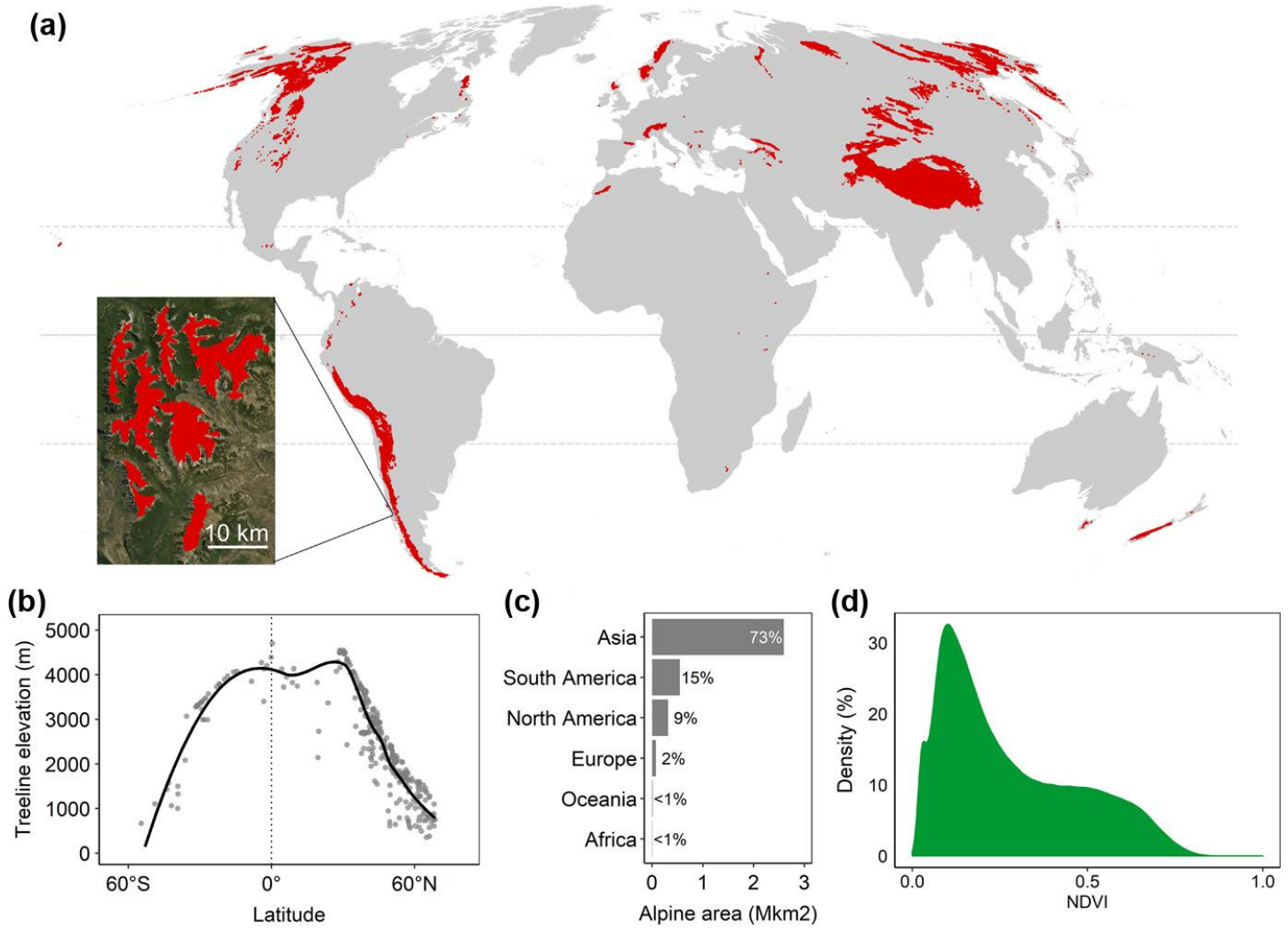
EBV classes

https://geobon.org/

Genetic composition (e.g. heterozigosity)
Species populations (e.g. distributions)
Species traits (e.g. phenology)
Community composition (e.g. diversity)
Ecosystem functioning (e.g. productivity)
Ecosystem structure (e.g. distribution)

Global distribution of alpine biomes

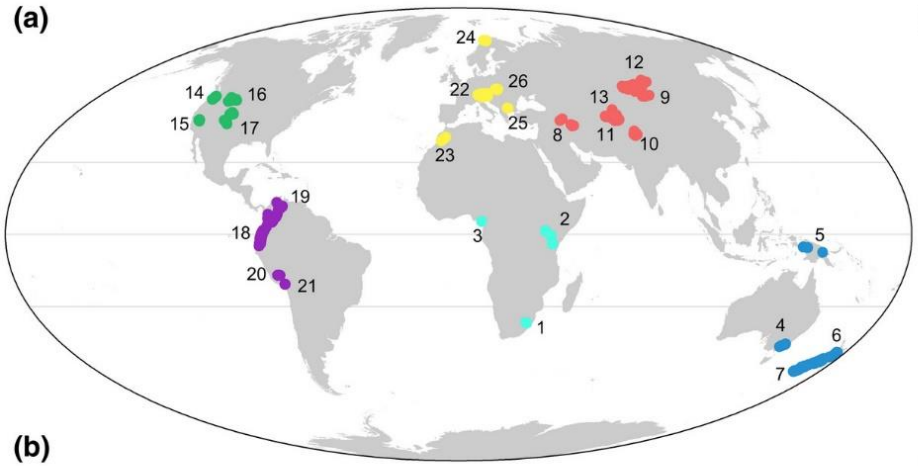
(EBV: ecosystem extent)



Testolin et al. (2021) Ecography 43: 779

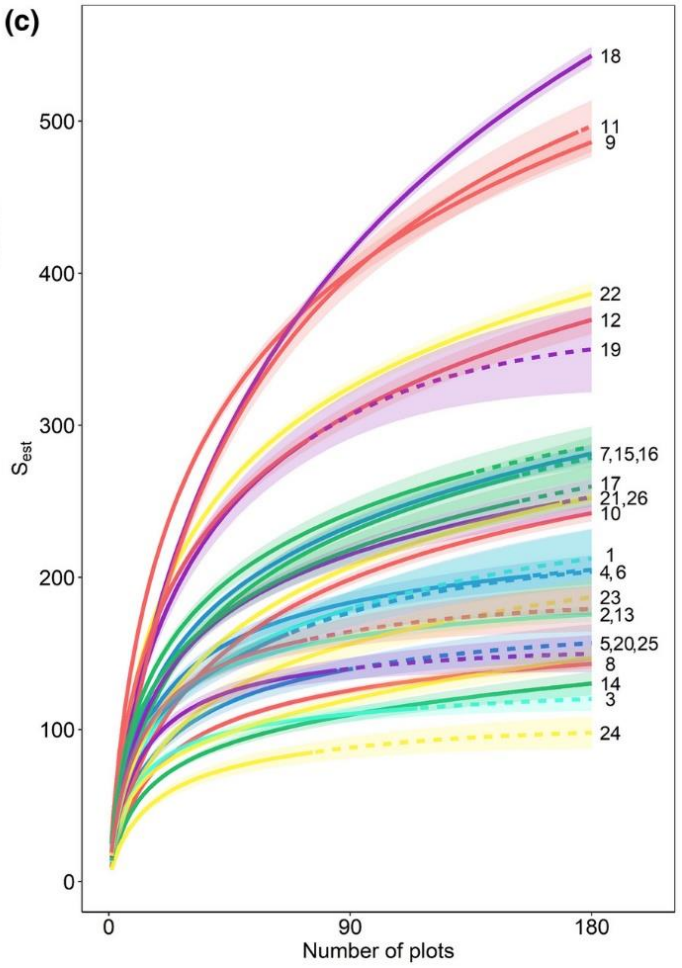
Global patterns of alpine plant richness

(EBV: community taxonomic diversity)



(b)

		Region	N	S_{est}		Region	N	S_{est}
Afrotropic	1	Drakensberg	91	212	Nearctic	14 Central and Southern Cascades	239	130
	2	Eastern African Mountains	238	176		15 Sierra Nevada	153	279
	3	Mount Cameroon	115	120		16 South Central Rocky Mountains	136	286
Australasia	4	Australian Alps	157	205		17 Southern Rocky Mountains	153	260
	5	Central Range New Guinea	91	157	Neotropic	18 Colombian and Ecuadorian Andes	1534	543
	6	North Island Mountains New Zealand	67	204		19 Cordillera de Mérida	74	350
	7	Southern Alps New Zealand	743	281		20 Southern Cordillera Occidental Peru	85	150
Eastern Palaearctic	8	Alborz Mountains	524	143		21 Southern Cordillera Oriental Peru	168	253
	9	Altai Mountains	544	486	Western Palaearctic	22 Central and Eastern Alps	684	387
	10	Ladakh Range	452	242		23 High Atlas Range	125	187
	11	Pamir Mountains	175	497		24 Northern Scandes	76	98
	12	Sayan Mountains	314	369		25 Rila	267	147
	13	Western Tien Shan	74	179		26 Western Carpathians	1649	252

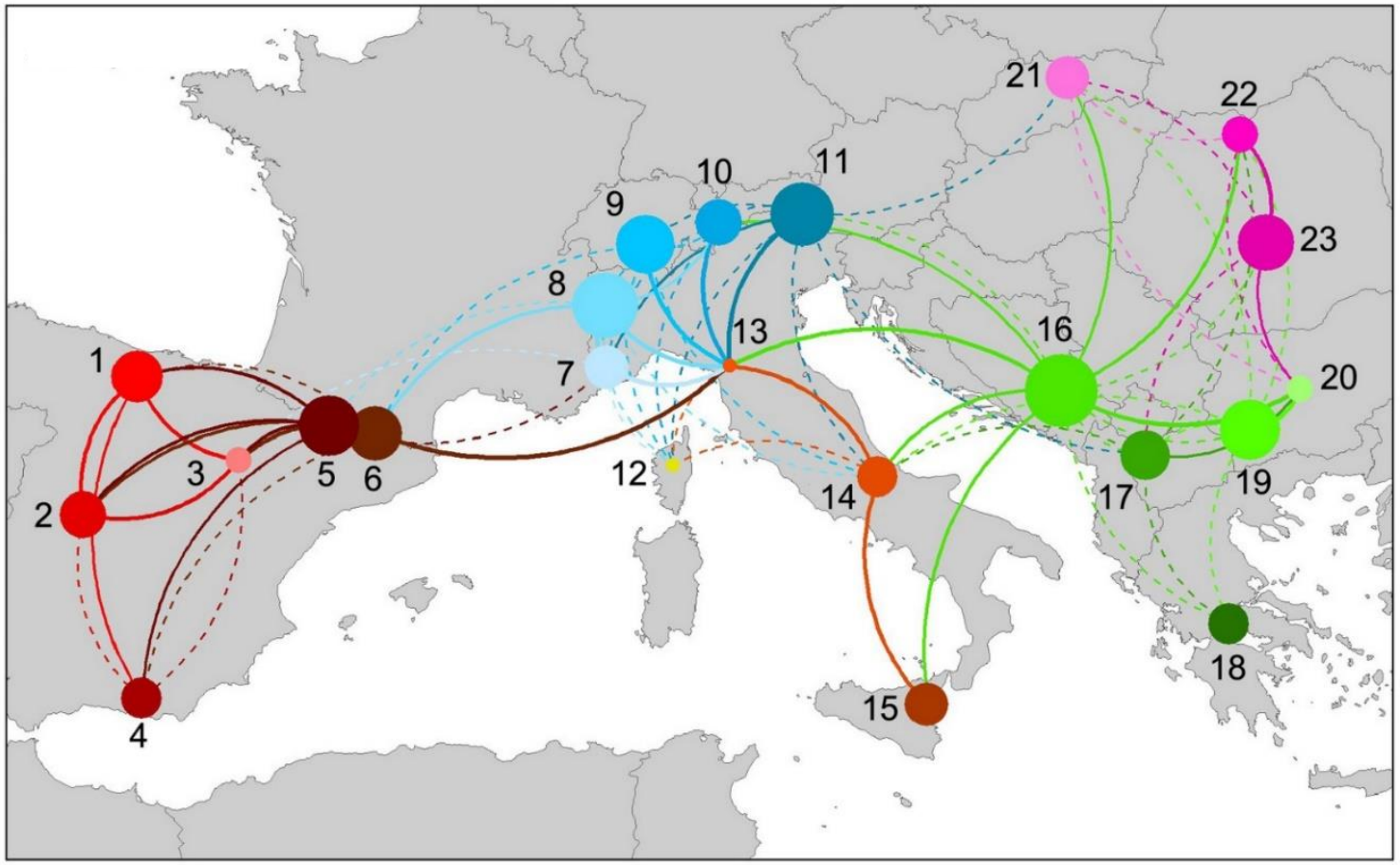


Testolin et al. (2021) Global Ecology and Biogeography 30: 1218

Continental patterns of alpine communities

(EBV: community composition)

Main driver = Geographic distance



Net outbound connections

-7

0

12

Coefficients of Dispersal Direction

DD_2

.10

.15

.20

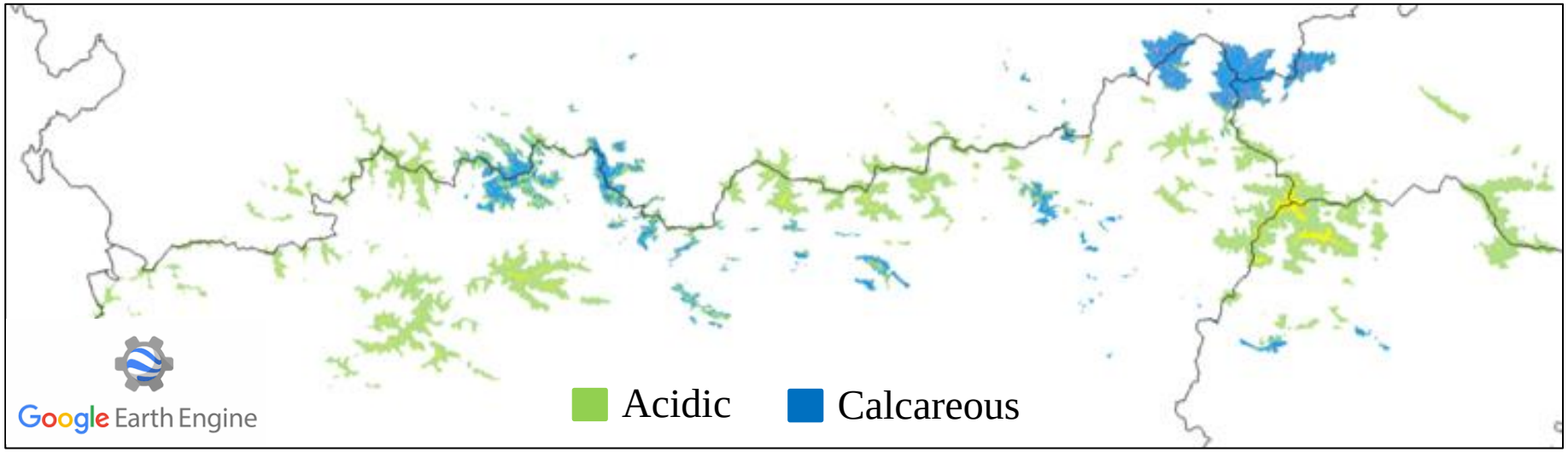
.25

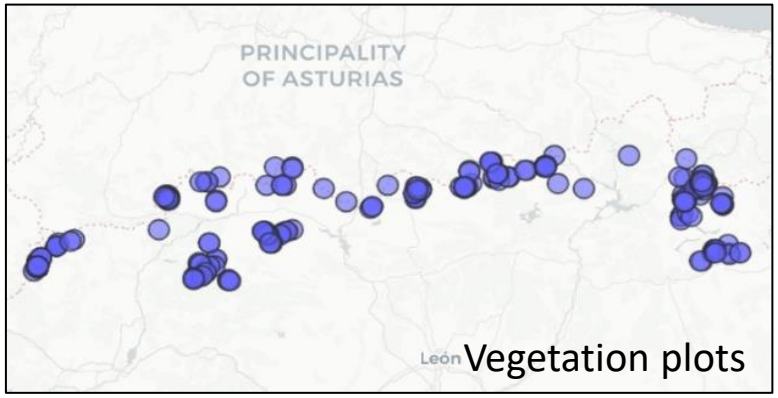
.30

Jimenez-Alfaro et al. (2021) Global Ecology and Biogeography 30: 1101

SIVIM
Sistema de Infomación de la Vegetación Ibérica y Macaronésica

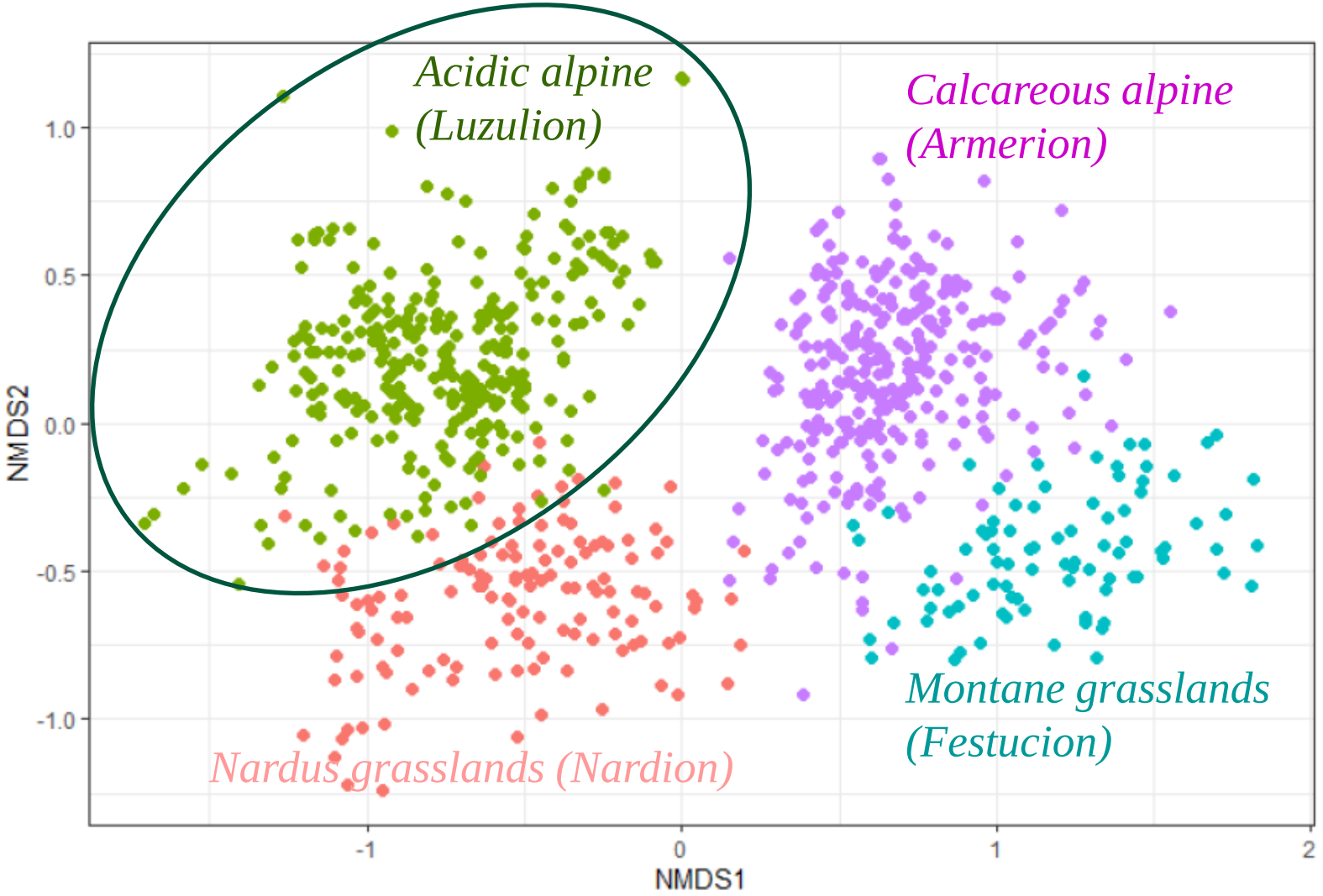
Alpine grasslands in the Cantabrian Mts





Metacommunity – same habitat

Elevation > 1750 m, acidic rocks, pH 3.8 to 4.8

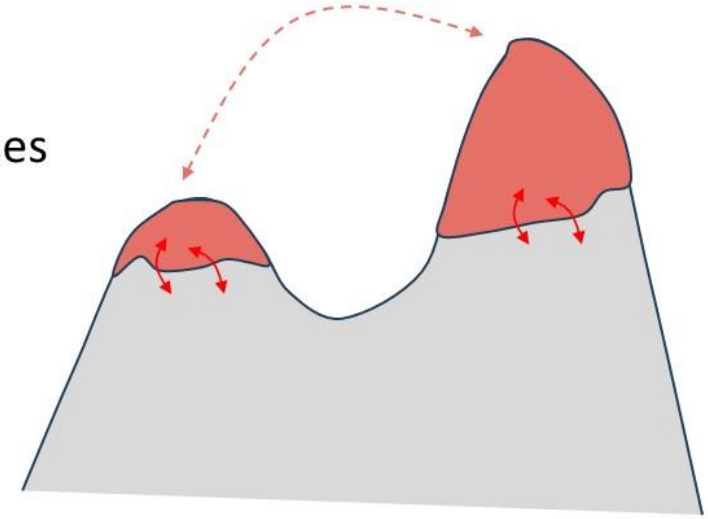


Specialists

High STOCHASTICITY
-> Random processes or different species responses

Strong ENVIRONMENTAL FILTERING
-> Elevation (and related gradients, e.g., area)

Moderate DISPERSAL LIMITATION
-> Some connectivity, but isolated patches



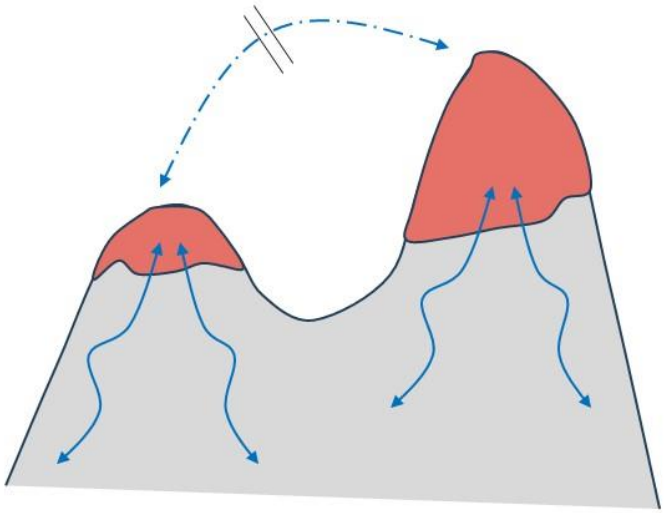
species sorting

Generalists

High STOCHASTICITY
-> Random processes? (linked to other habitats)

Weak ENVIRONMENTAL FILTERING
-> Low suitability within the alpine system

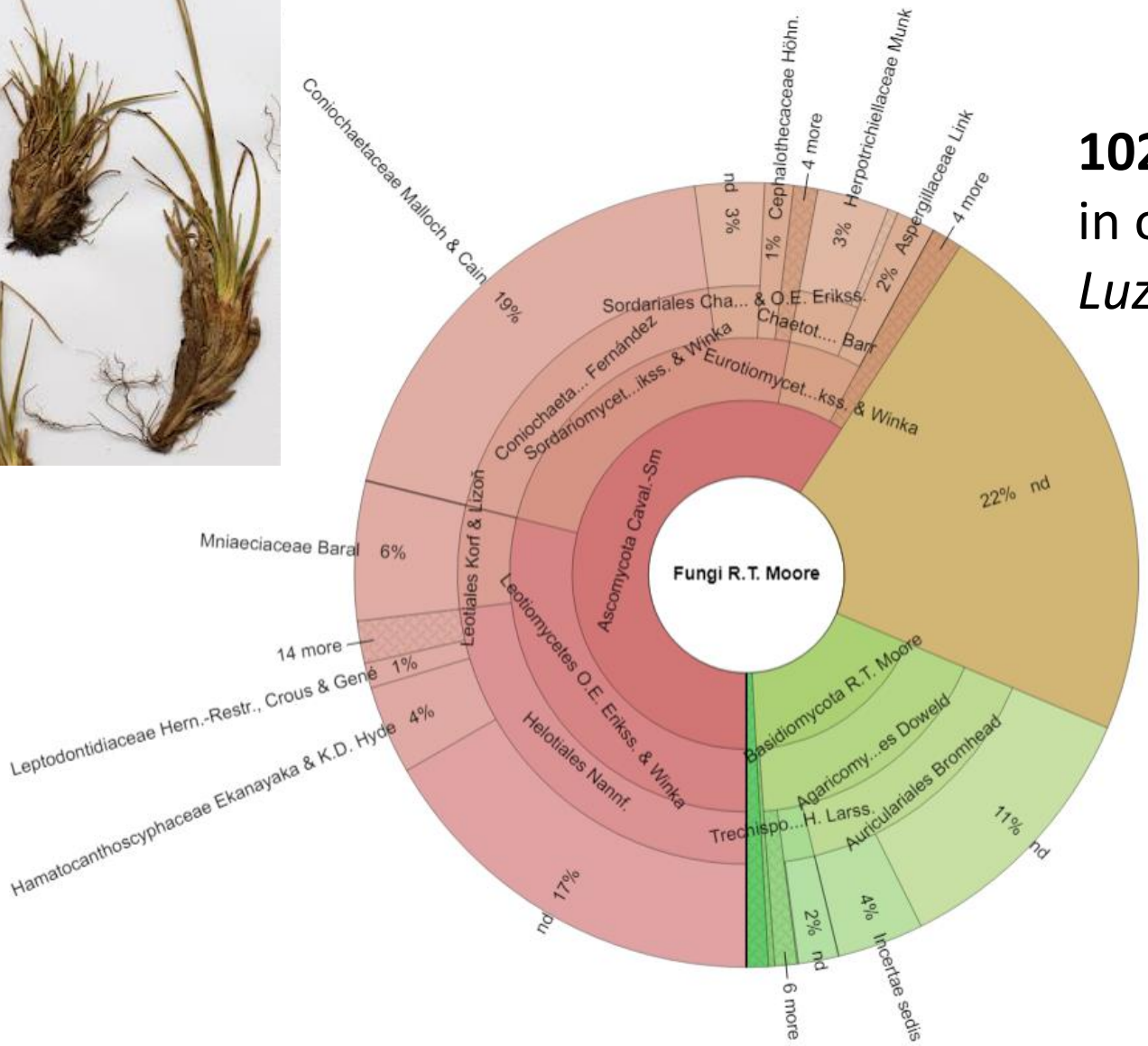
Strong DISPERSAL LIMITATION
-> No dispersal across summits
(seed rain from lower elevation)



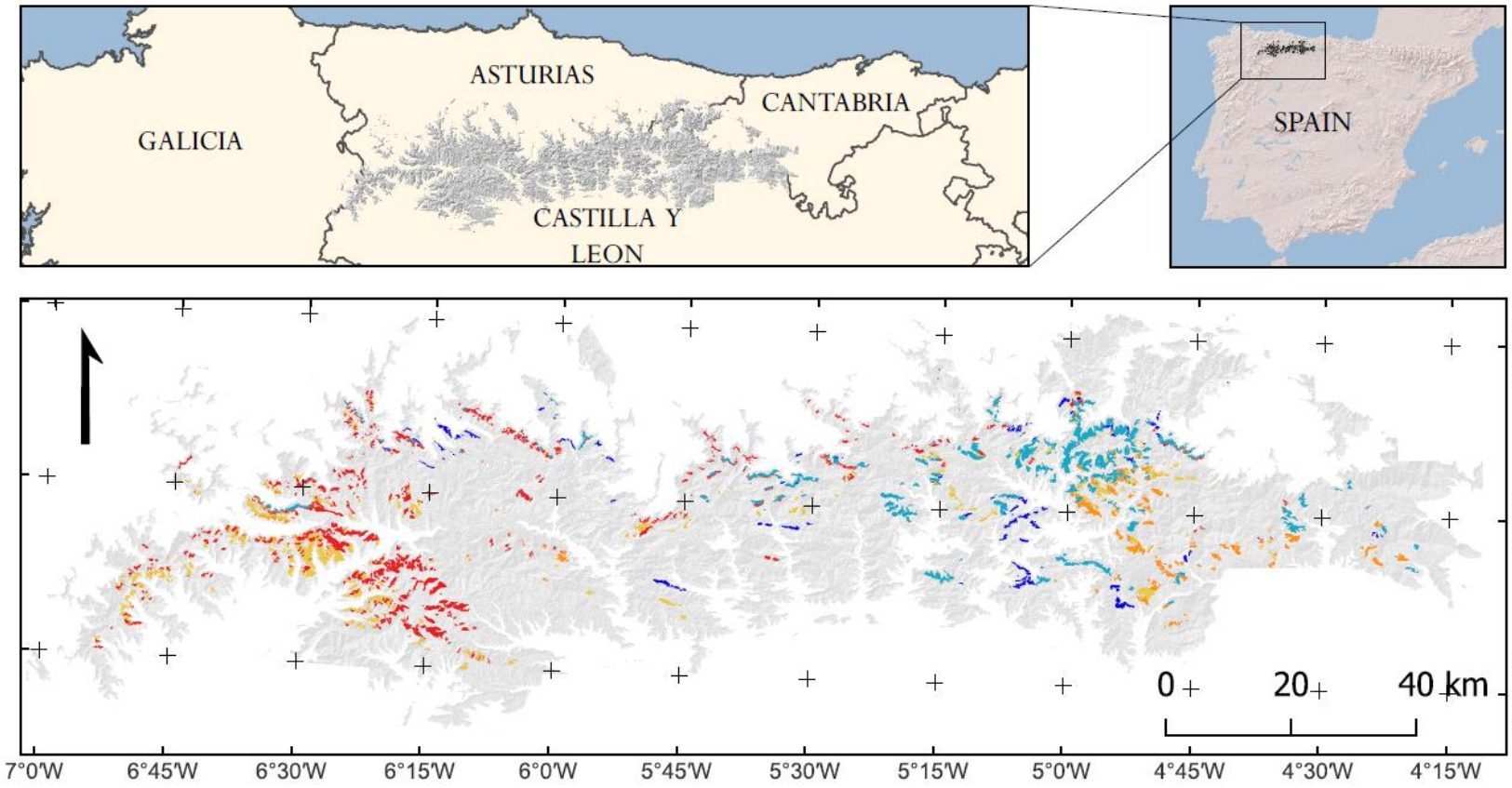
mass effects

Root-associated fungi

(EBV: community composition)

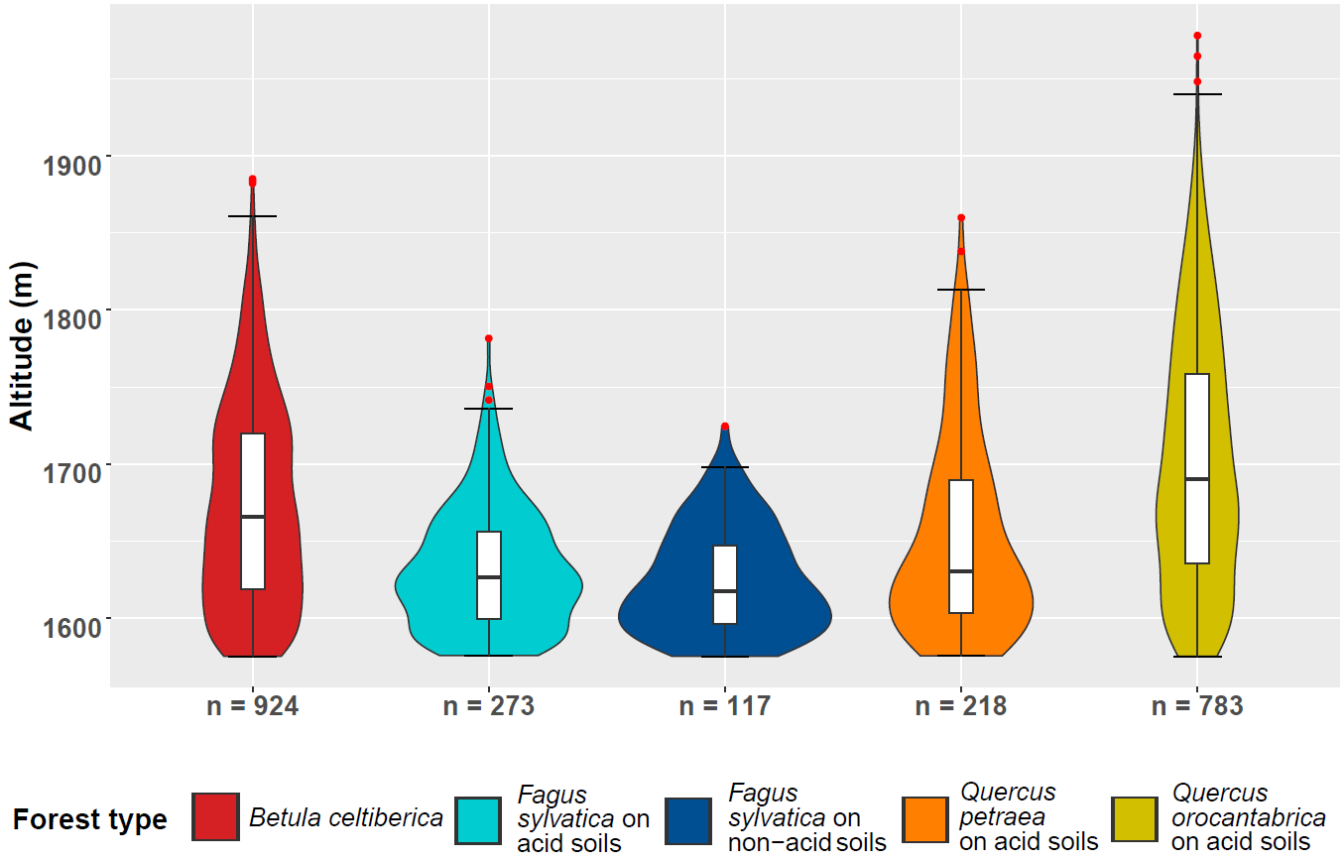


102 species of fungi in one individual of *Luzula caespitosa*


ASTURIAS
CANTABRIA
GALICIA
CASTILLA Y
LEON
SPAIN
43°15'N
43°0'N
42°45'N
0
20
40 km
7°0'W
6°45'W
6°30'W
6°15'W
6°0'W
5°45'W
5°30'W
5°15'W
5°0'W
4°45'W
4°30'W
4°15'W
Montane Forest Type
Betula celtiberica forests
Fagus sylvatica forests on acid soils
Fagus sylvatica forests on non-acid soils
Quercus petraea forests on acid soils
Quercus orocantabrica forests on acid soils

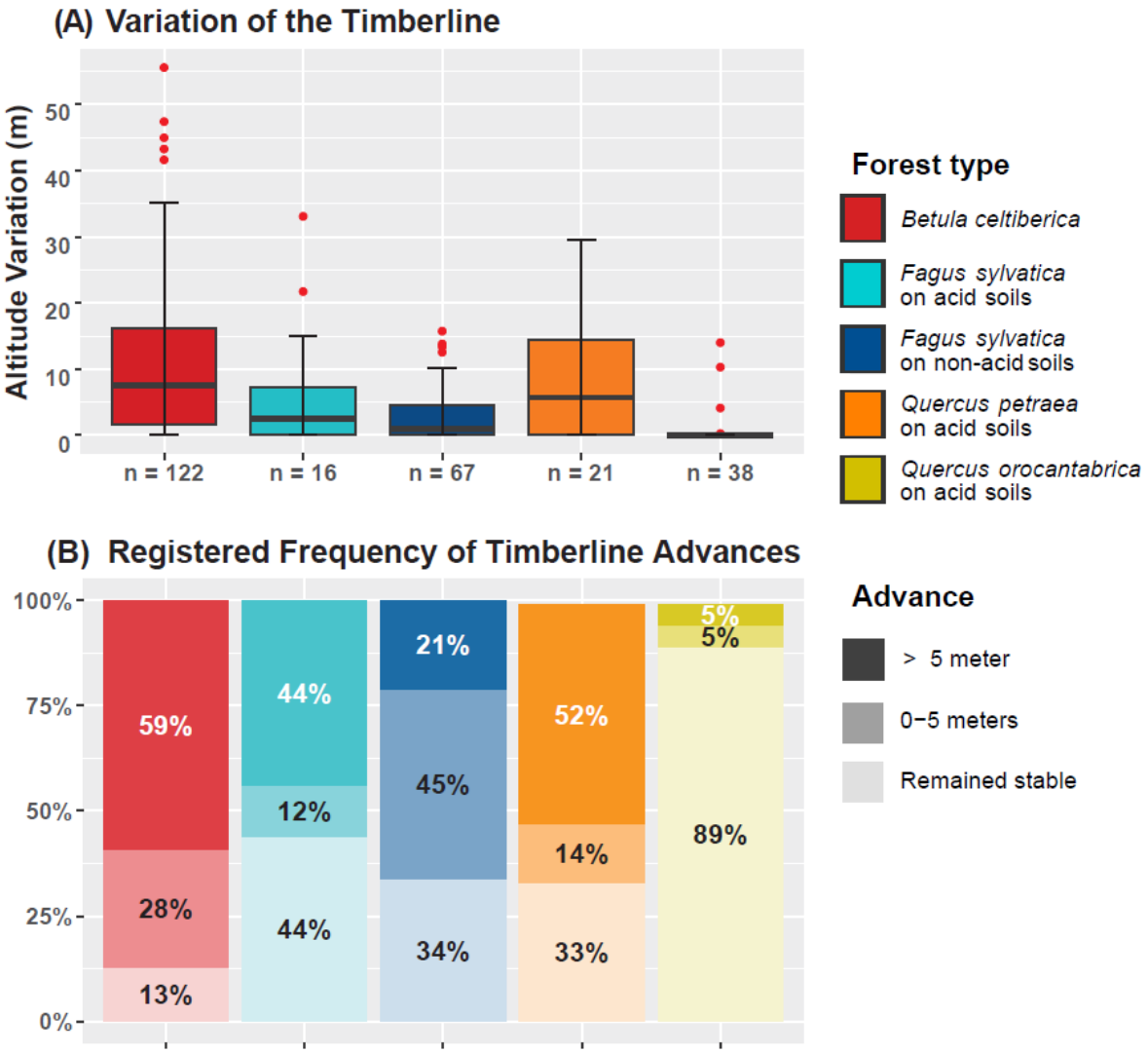
Regional patterns of timberline (and treeline)

(EBV: ecosystem distribution; ecosystem vertical profile)



Changes in timberline in the last 70 years

(EBV: ecosystem distribution)



Review

Why Is the Alpine Flora Comparatively Robust against Climatic Warming?

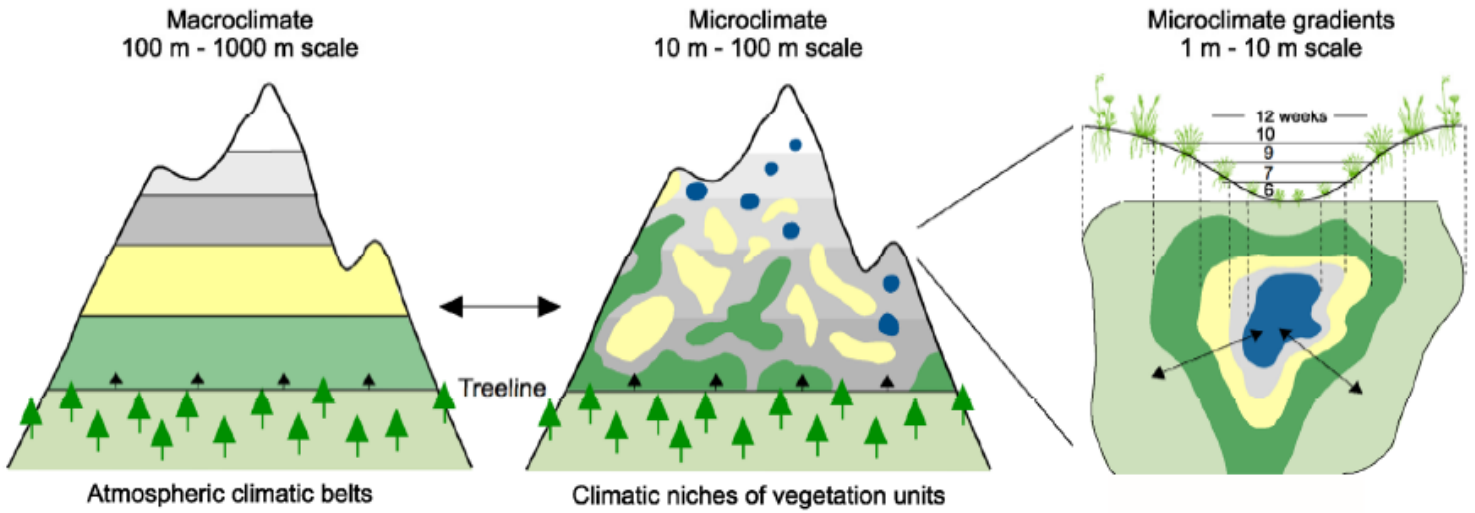
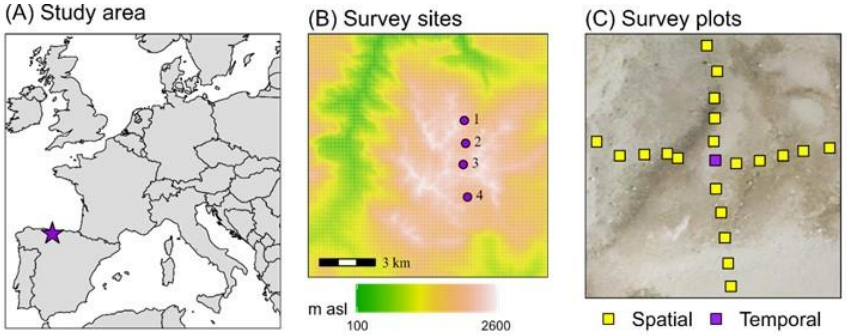


Figure 1. Above the treeline, the alpine vegetation follows the patterns of life conditions created by topography (microclimate) not captured by air temperatures obtained from weather stations (macroclimate). The mosaics of thermal habitats provides steep climatic gradients at very small scales (zoomed-in example to the right). Snow accumulation in snowbeds can cause the length of the growing season to vary by 6 weeks across a distance of 10 m, with even larger differences across exposure gradients (e.g., N-S aspect, wind edges).

Körner & Hiltbrunner 2021, Diversity 13

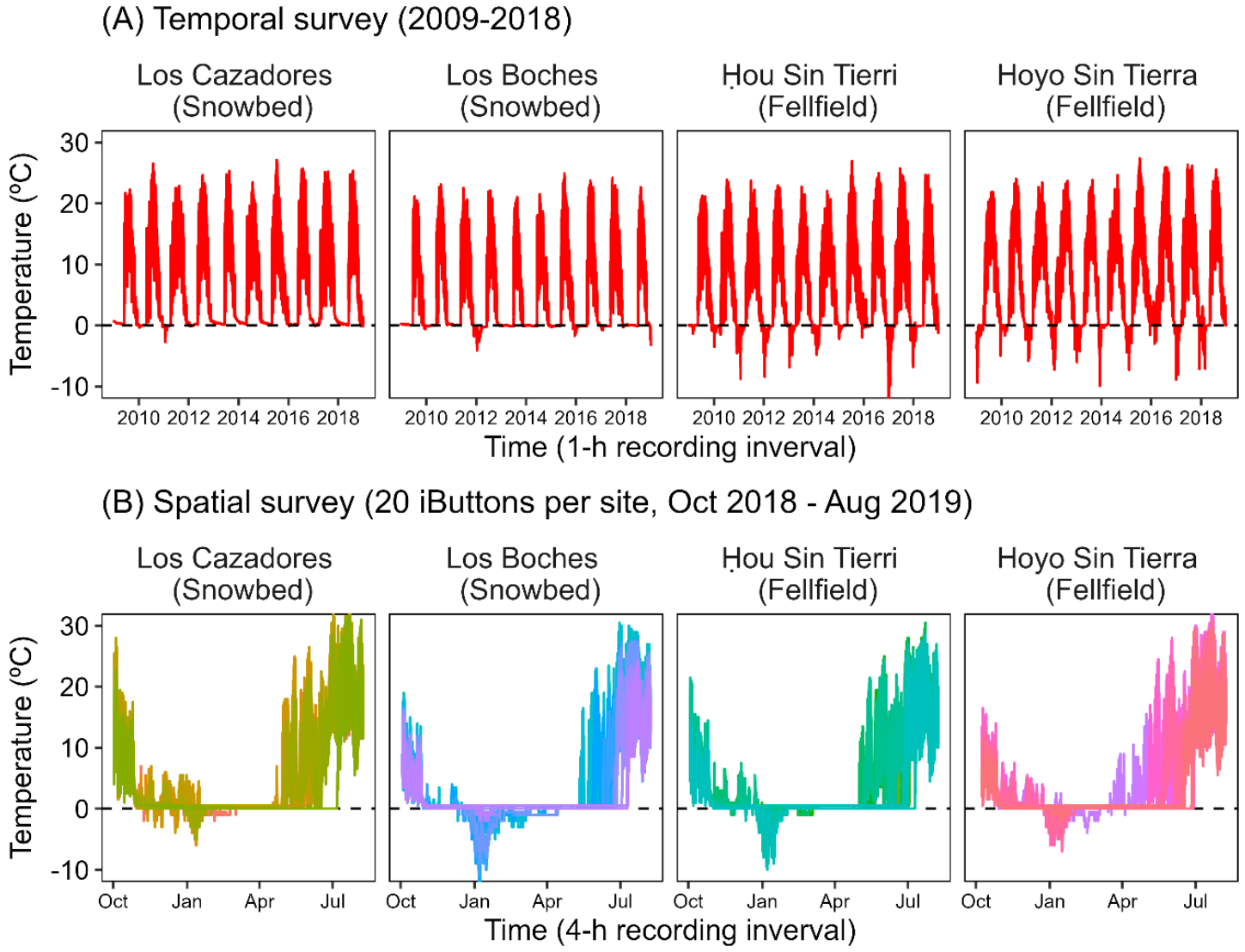
Spatiotemporal patterns of microclimatic buffering in relict alpine communities



Temporal survey
- Central plot per site
- 10-year soil temperatures
- Vascular plants recorded 2009, 2018

Spatial survey
- 20 plots per site
- 10 m transects
- 1-year soil temperatures
- Vascular plants recorded 2018

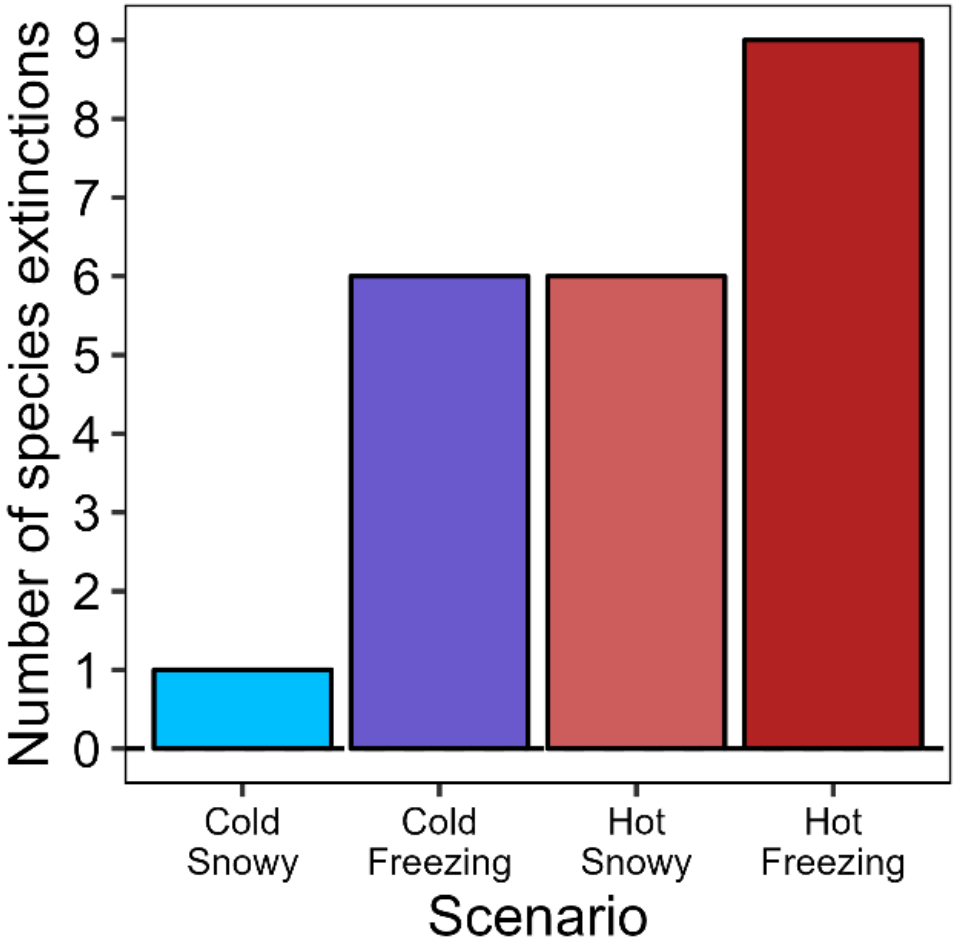
Jiménez-Alfaro et al. 2024. J of Veg Sci 35: e13242



Jiménez-Alfaro et al. 2024. J of Veg Sci 35: e13242

Predictions of plant extirpations

(EBV: population trends)



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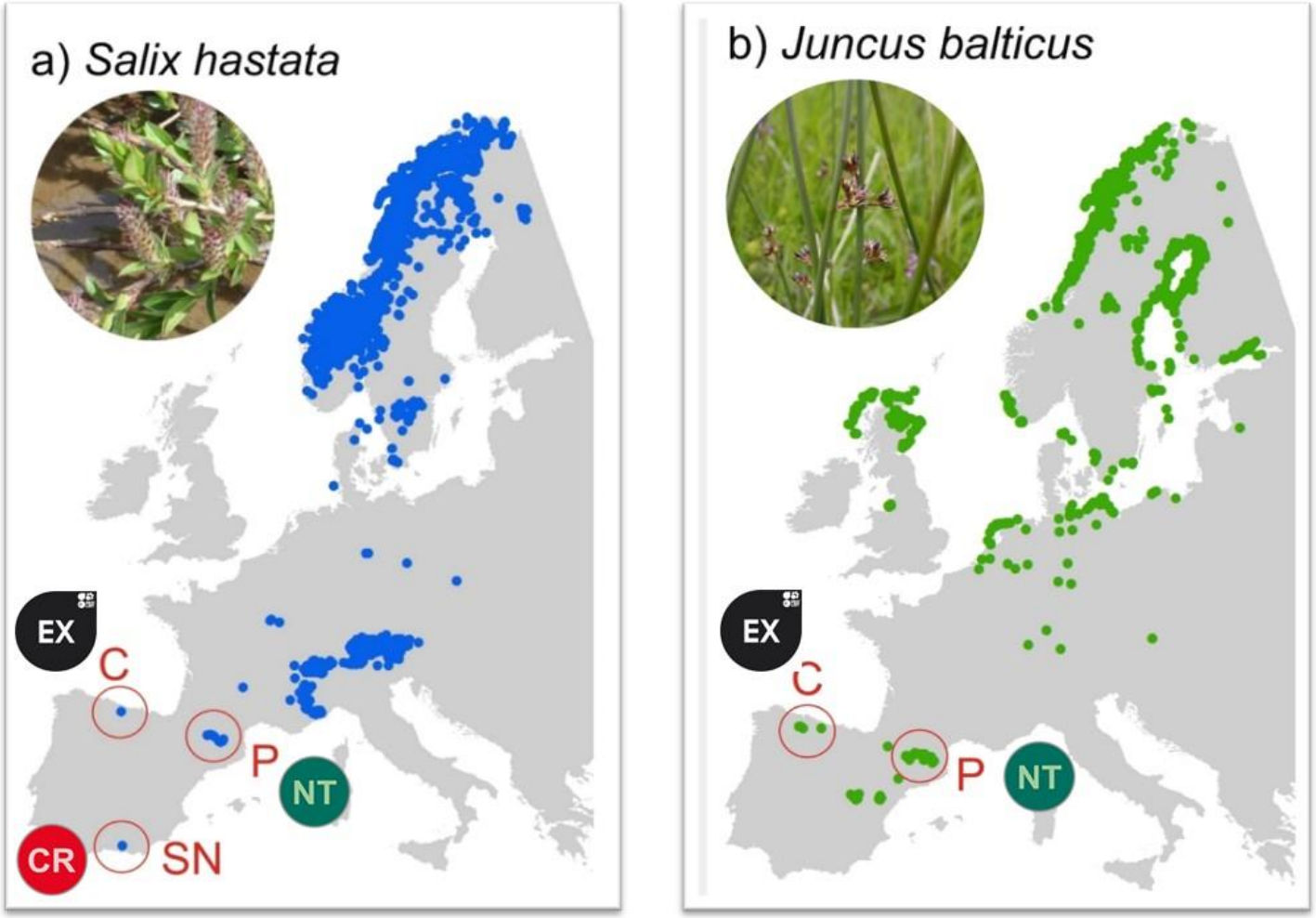
Detected extirpations (functional extinction)

(EBV: genetic diversity, species reproduction)



Jiménez-Alfaro et al. 2016. Biol Conserv 201: 243