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Ecotypic variation research to achieve functional targets in the conservation management of riparian forests

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State of the art

The knowledge of **intra- and inter-specific variation of functional traits** is essential to:

- assess riparian forests diversity
- predict its demographic distribution
- establish functional targets for the conservation and management of riparian corridors.

Target species: *Alnus* spp.

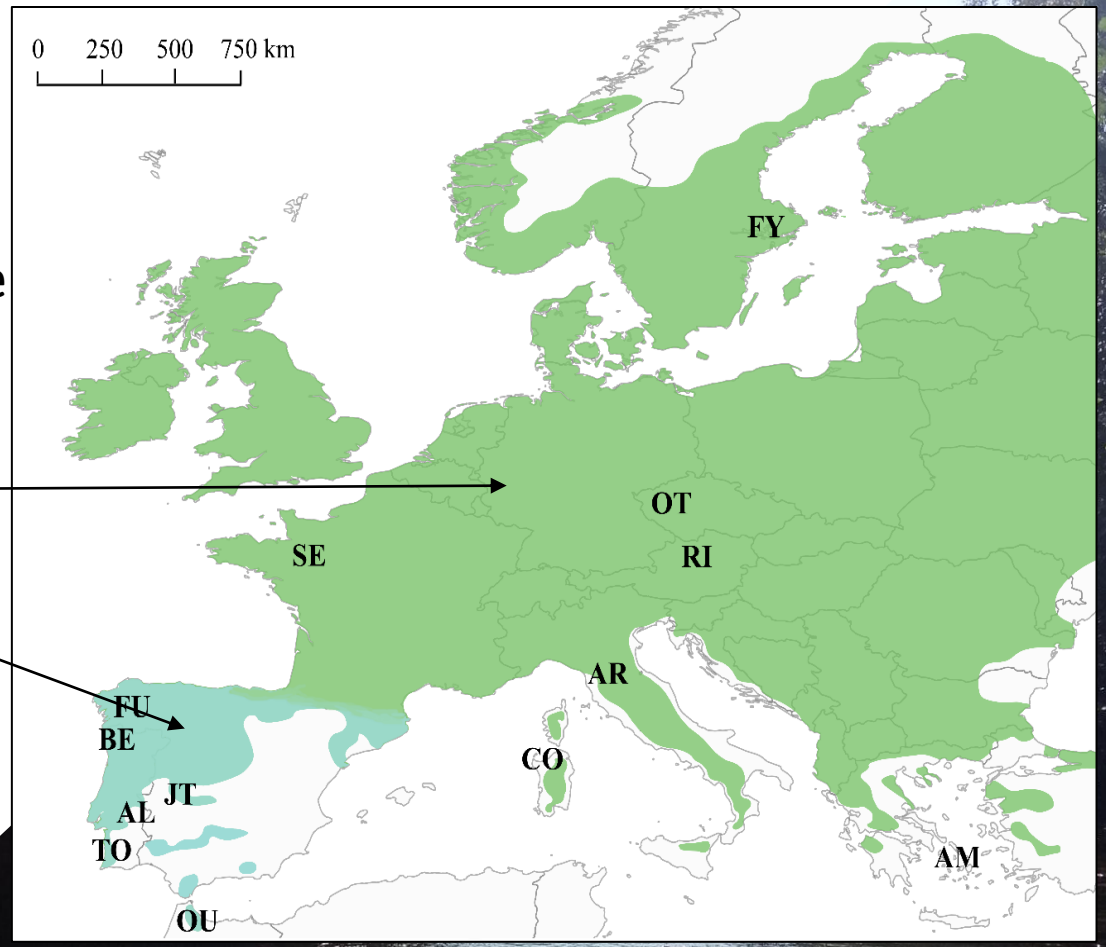
Research on morphological and physiological differences between closely related *Alnus* species and populations can benefit decision making in conservation of riparian corridors and restoration efforts.

State of the art

Why *Alnus* spp?

- Key species for riparian corridors health
- Wide latitudinal distribution
- Survival at lower latitude limits can mimick future climatic conditions
- Recent species differentiation:

Alnus glutinosa [L.] Gaertn.
Alnus lusitanica (Vít, Douda & Mandák)



Alnus lusitanica

- Tetraploid (2n=4X)
- High allelic richness and gene diversity (Havrdová, 2015)
- Rounded or obtuse apex lamina
- Longer catkin stalk
- Longer female catkins

Alnus glutinosa

- Diploid (2n=2X)
- High morphological variation
- Dorsal leaf sides lamina are glabrous

Objectives

This study aimed to

(1)
assess the phenotypic variation of target functional traits in *A. glutinosa* and *A. lusitanica*

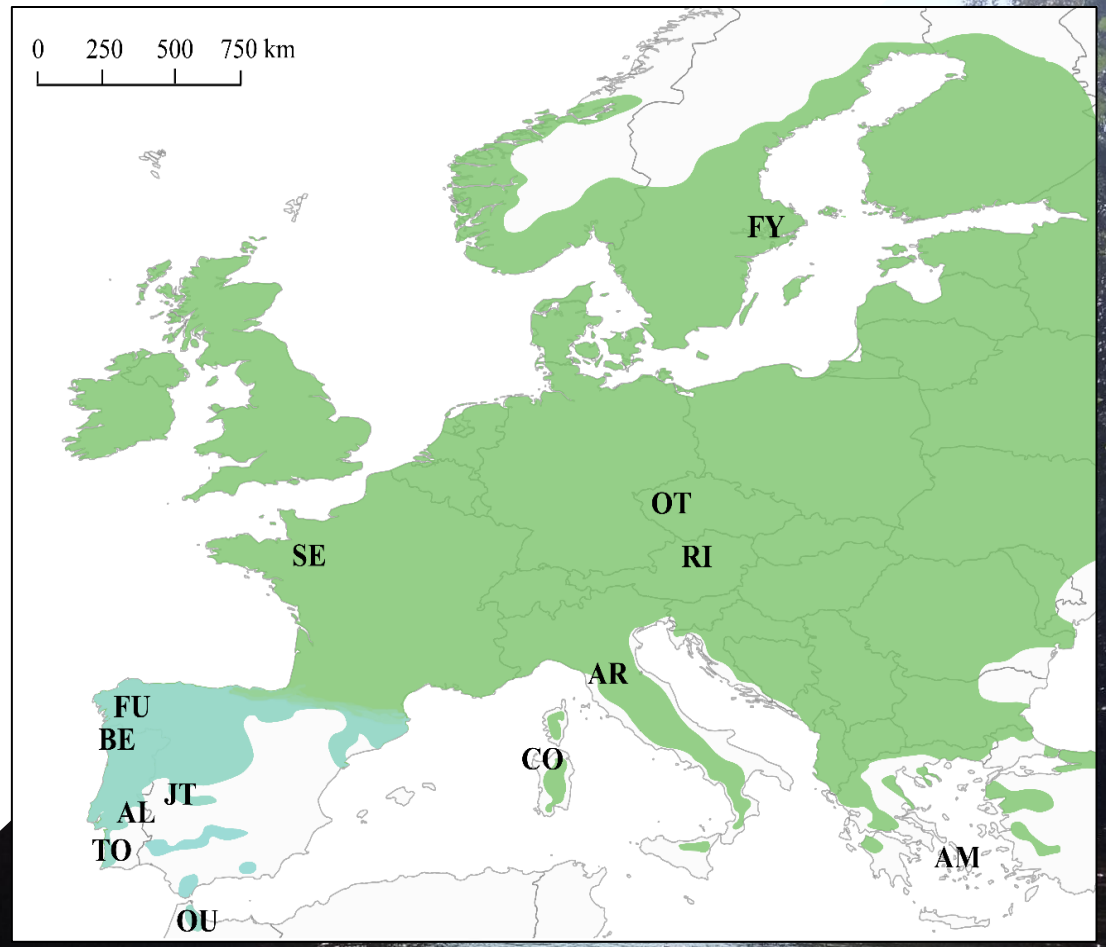
(2)
link plant growth performances to functional traits and species

To accomplish this, we

(1) measured a set of morphological, physiological and phenological functional traits from seedlings of

- 7 *A. glutinosa* populations
- 6 *A. lusitanica* populations

(2) modelled plant biomass from the functional traits



Gomes Marques et al, 2021

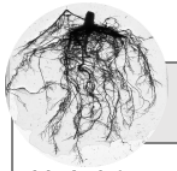
Methods

(1)

Seedlings were grown under common environmental conditions for 2 years, in a greenhouse in Oeiras, Portugal

(2)

We measured functional traits from seedlings and analyzed differences between species



Morphological

Height
Diameter
Specific leaf area (SLA)
Root Shoot Ratio (RSRatio)
Wood Dry Matter Content (WDMC)
Leaf Dry Matter Content (LDMC)
Leaf Area Ratio (LAR)
Leaf Mass Ratio (LMR)
Stem Mass Fraction (SFM)
Root Mass Fraction (RMF)
Specific Root Length (SRL)
Number of nodules
Number of leaves
Root length

Physiological

Photosynthesis
Leaf gas exchanges
Transpiration
Leaf Water Potential

Biochemical

Chlorophyll a and b
Total Chlorophyll
Carotenes
Total Phenolic compounds

Phenological

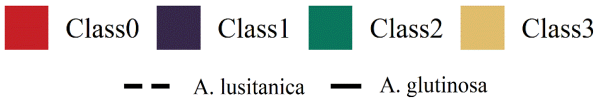
Time to reach bud break (all leaves completely expanded)

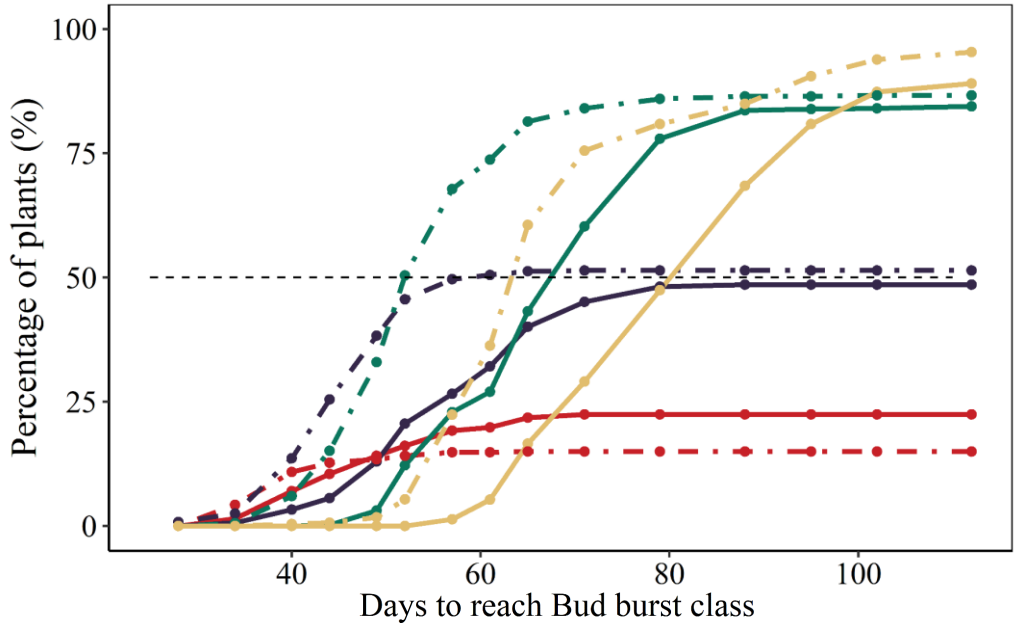
(3)

Linear mixed models were fitted to the Total Dry Biomass data from the two-year-old plants as a proxy of growth performance with ‘population’ as a random nested factor in ‘species’ using the *lmer* function in *lme4* package.

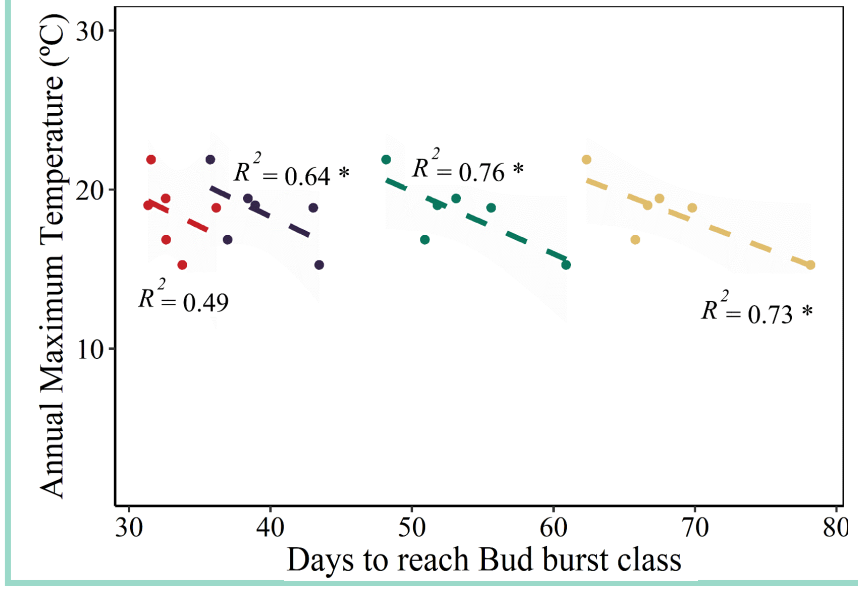
(Cornelissen et al. 2003, Santini et al, 2004, Mijnsbrugge et al, 2015)

Results





A. lusitanica populations showed longer growing season

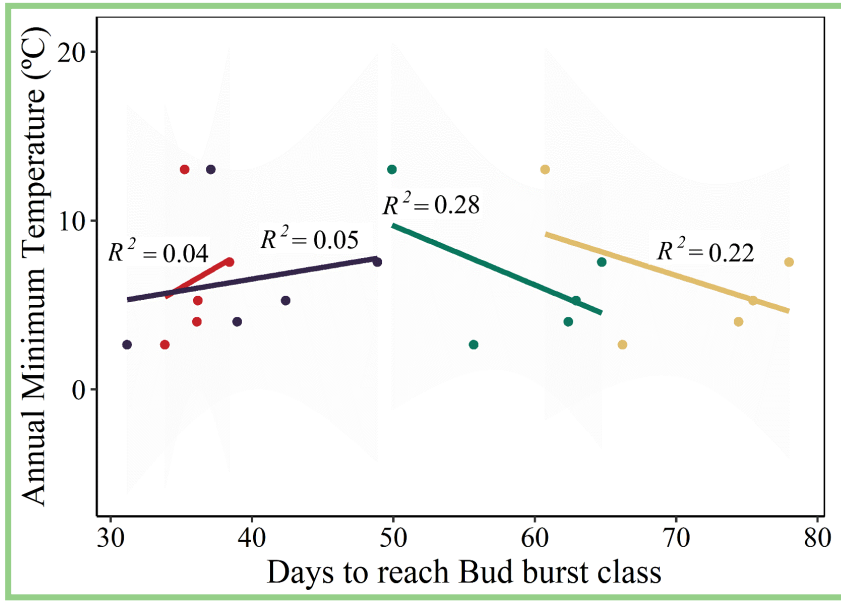


A. lusitanica

phenological response

⇕

temperature in annual **maximum** values



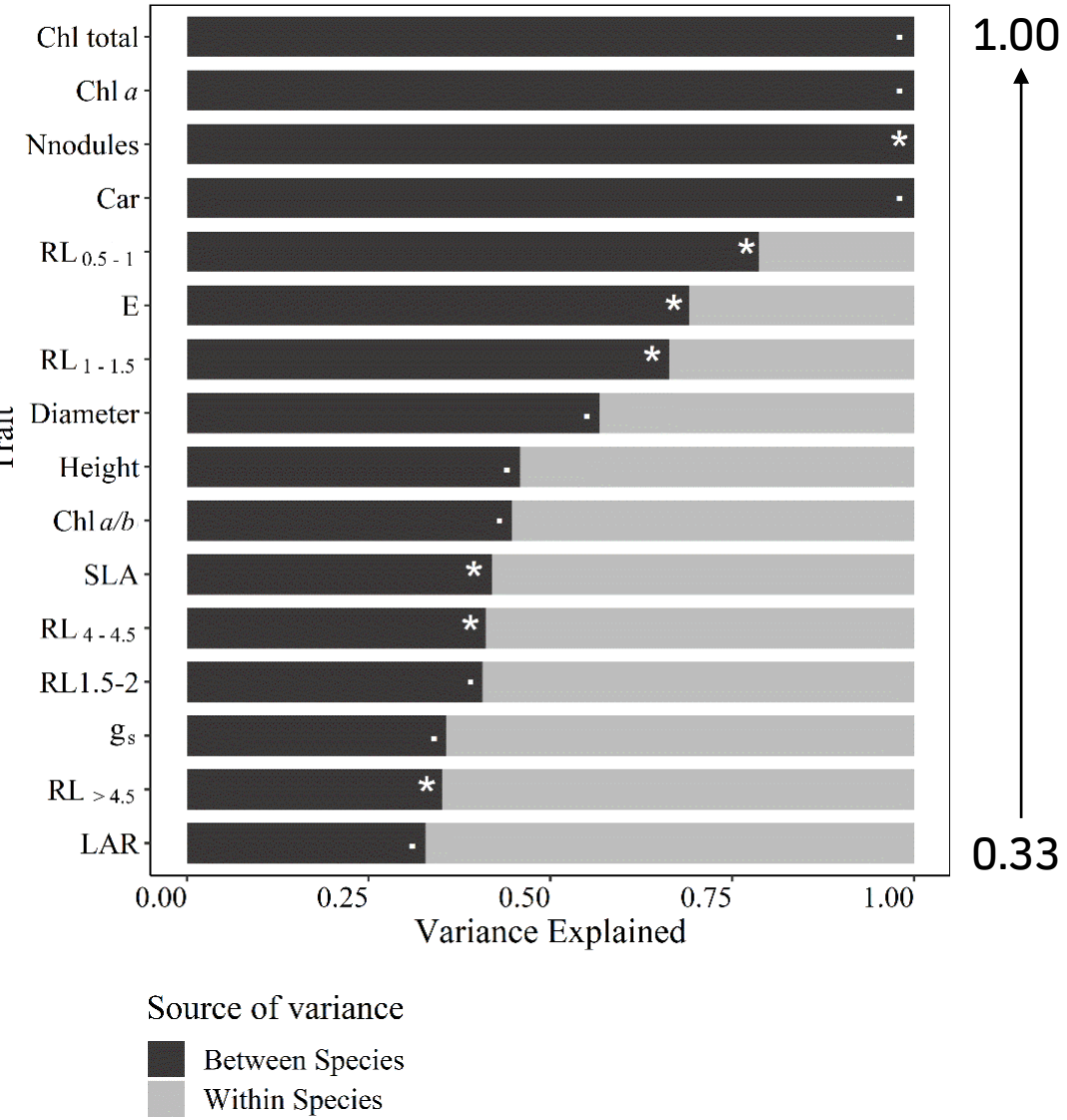
A. glutinosa

phenological response

⇕

temperature in annual **minimum** values

Results



1.00

0.33

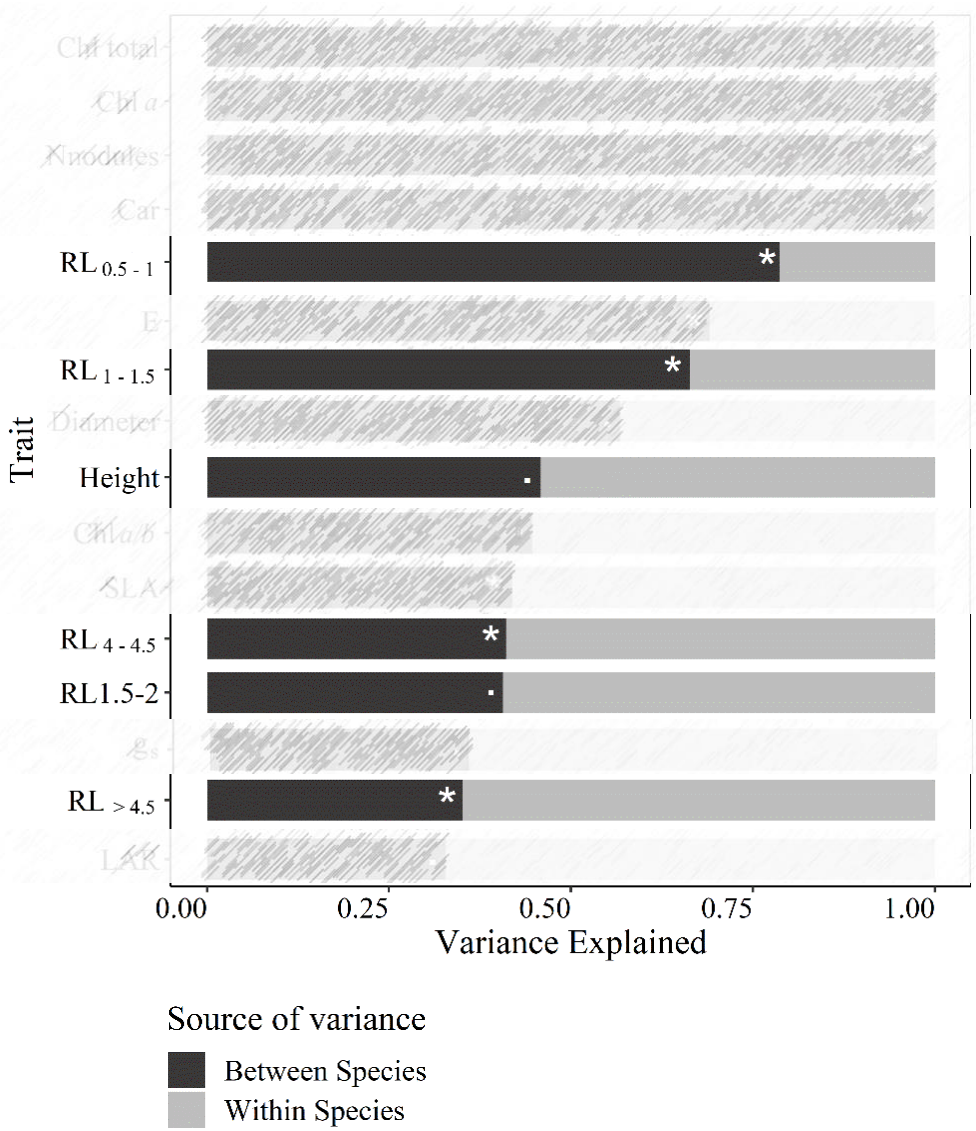
16 traits were different between species:

10 morphological
4 biochemical
2 physiological

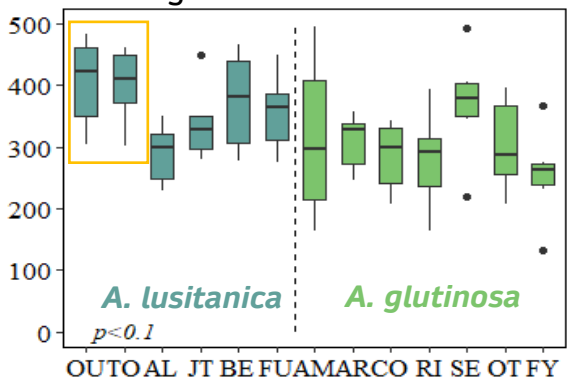
- Almost all the morphological variables related with root elongation were species-specific

- The *A. lusitanica* populations showed higher values than *A. glutinosa* for most morphological and biochemical functional traits.

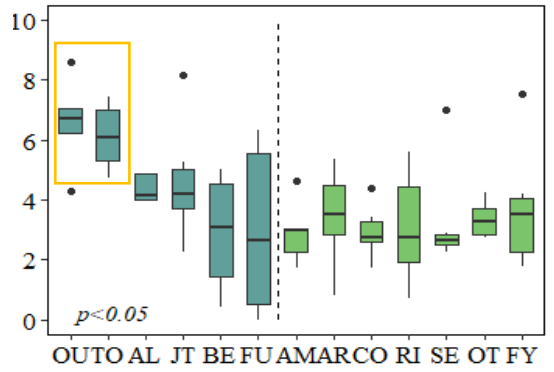
Results



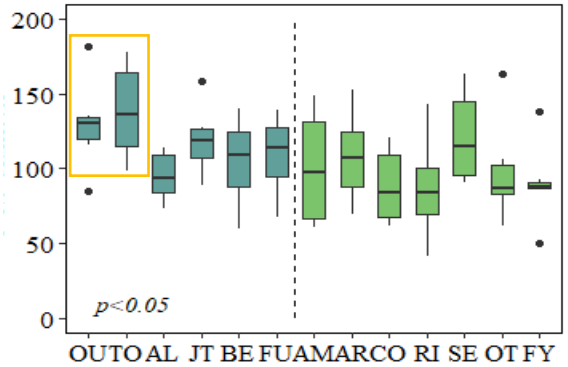
Root length with diameter 0.5-1mm



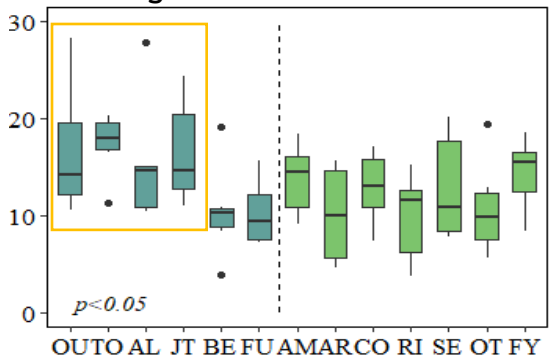
Root length with diameter 4-4.5mm



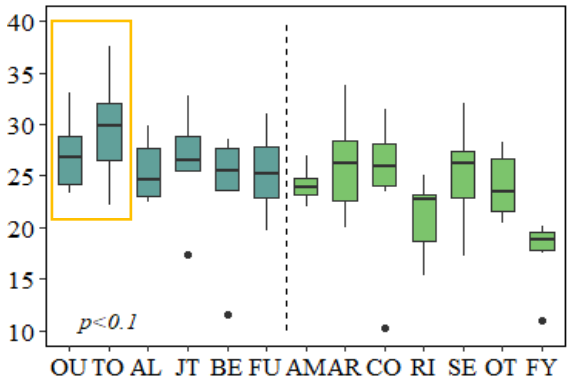
Root length with diameter 1-1.5mm



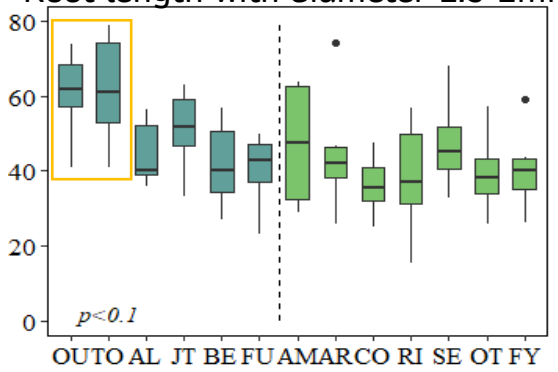
Root length with diameter >4.5mm



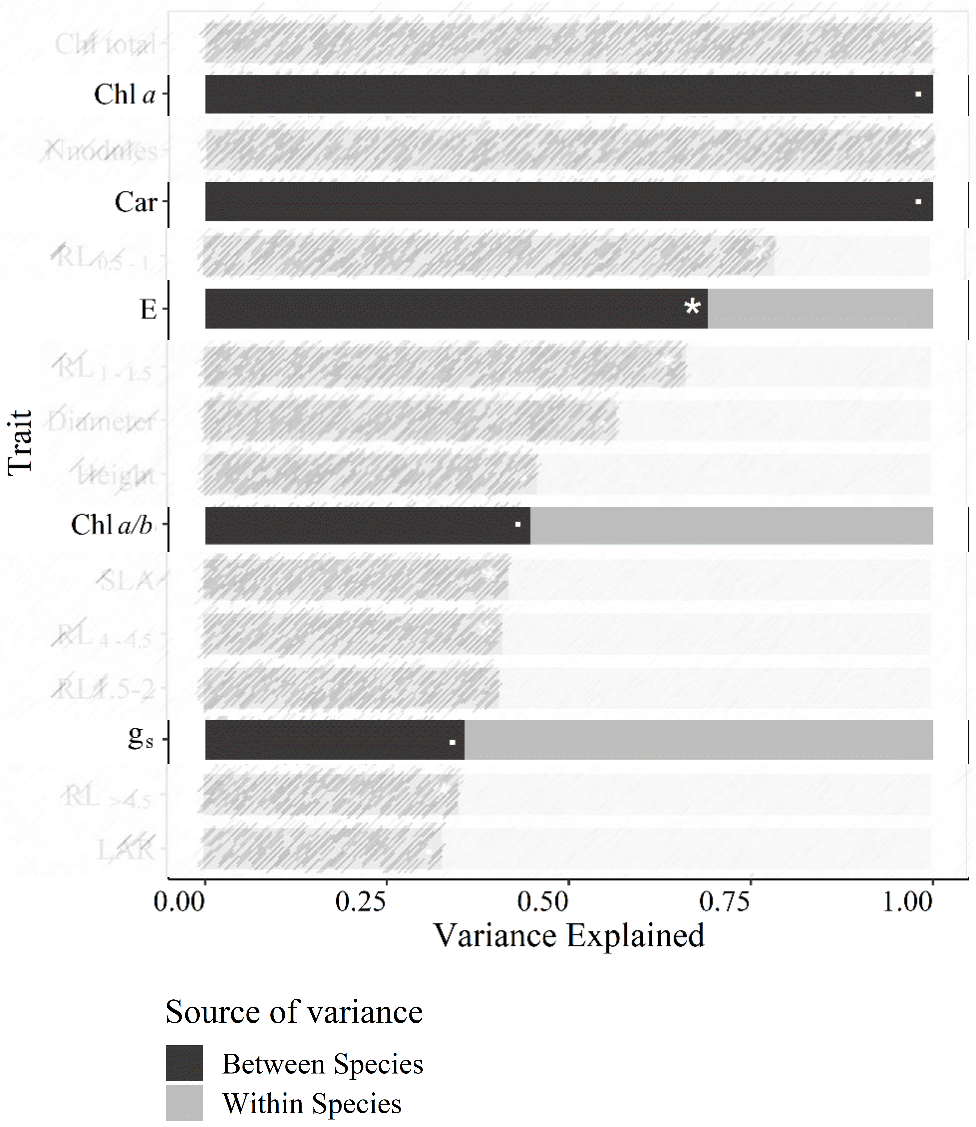
Height

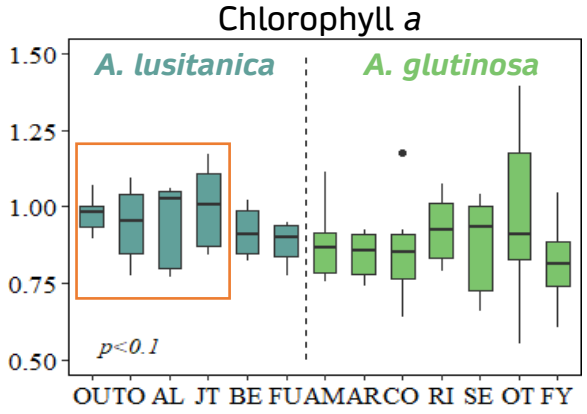


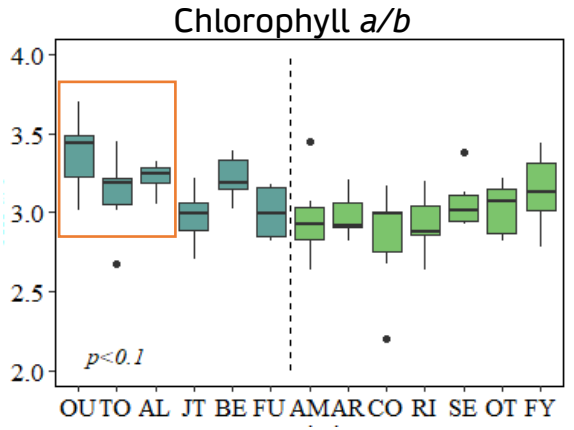
Root length with diameter 1.5-2mm



Results


Chl a
Car
E
Chl a/b
gs
Trait
0.00
0.25
0.50
0.75
1.00
Variance Explained
Source of variance
Between Species
Within Species


Chlorophyll a
A. lusitanica
A. glutinosa
p<0.1
OU TO AL JT BE FU AM AR CO RI SE OT FY


Chlorophyll a/b
p<0.1
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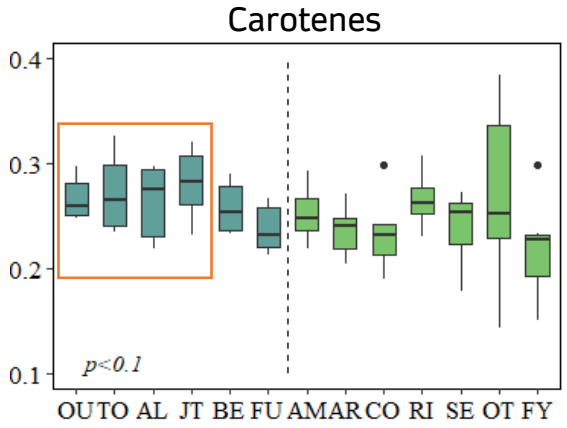
Carotenes
p<0.1
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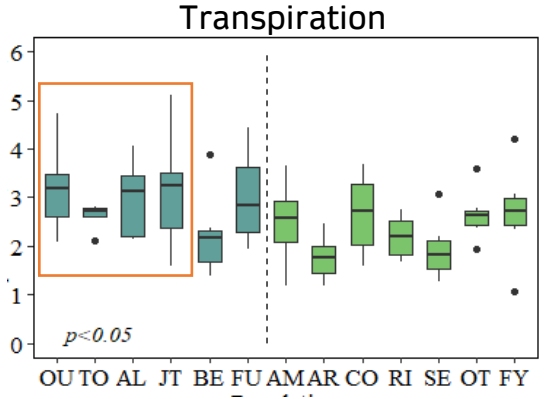
Transpiration
p<0.05
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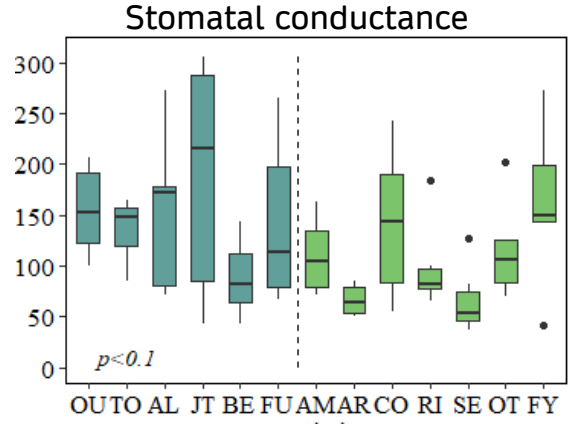

Stomatal conductance
p<0.1
OU TO AL JT BE FU AM AR CO RI SE OT FY

Results

Model	Dependent variable	Indepedent variables	Estimates	Std Error	AICc	P-value
1	Total Dry Biomass	Intercept	1.39454	2.20659	202.4901	<0.001***
		Chl b	-3.21236	2.88873		
		Total phenolic compounds	-1.60473	0.56853		
		LDMC	5.78292	5.96792		
		Root-shoot ratio	1.00731	0.33978		
		Species (*A. lusitanica*)	**1.03140**	**0.35791**		
		$RL_{1.5\text{-}2}$	0.06260	0.01108		
2	Total Dry Biomass	Intercept	1.37847	2.1158	204.4374	<0.001***
		Chl b	-4.34560	2.78545		
		Total phenolic compounds	-1.82303	0.55637		
		LDMC	6.28892	5.69844		
		Nnodules	0.07736	0.02974		
		Root-shoot ratio	0.92920	0.32529		
		Species (*A. lusitanica*)	**0.89090**	**0.39252**		
		$RL_{1.5\text{-}2}$	0.06101	0.01059		
3	Total Dry Biomass	Intercept	1.14324	2.19429	204.862	<0.001***
		Total phenolic compounds	-1.65382	0.57463		
		LDMC	4.36271	5.85360		
		Root-shoot ratio	0.89917	0.33385		
		Species (*A. lusitanica*)	**0.99953**	**0.37582**		
		$RL_{1.5\text{-}2}$	0.06214	0.01112		
4	Total Dry Biomass	Intercept	1.76178	2.17002	205.9851	<0.001***
		Chl b	-4.10134	2.82951		
		Total phenolic compounds	-1.64822	0.56359		
		LDMC	5.58538	5.81352		
		Nnodules	0.08817	0.03015		
		Root-shoot ratio	0.81451	0.33230		
		$RL_{1.5\text{-}2}$	0.06391	0.01065		

The species factor was a significant contributor to growth performance in the best ranked models, with higher biomass accumulation associated to the *A. lusitanica* populations.

Conclusions

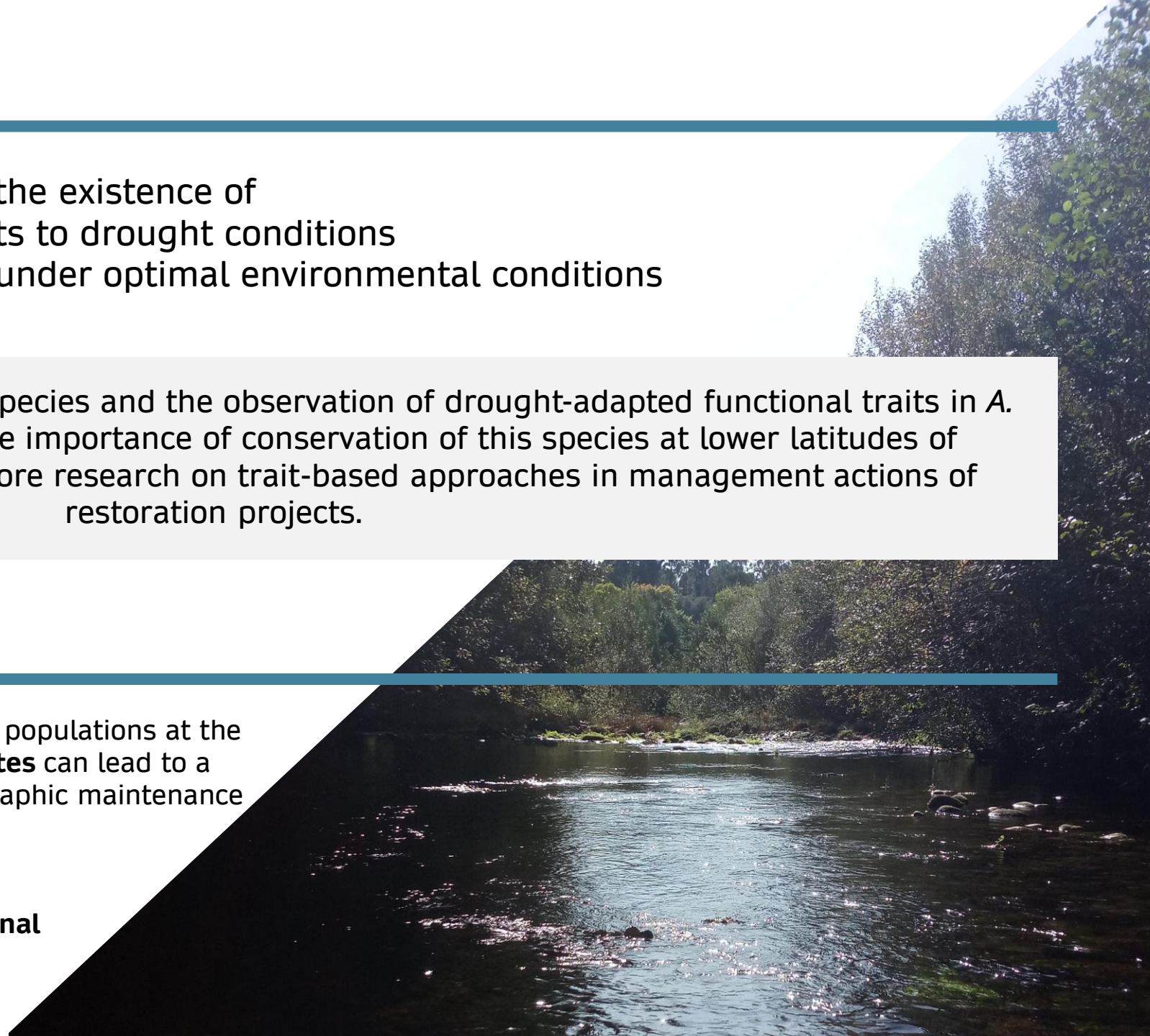
The *A. lusitanica* populations suggest the existence of
- adaptation of functional traits to drought conditions
- higher growth performance under optimal environmental conditions

The high ecotypic distinction between species and the observation of drought-adapted functional traits in *A. lusitanica* populations underlines the importance of conservation of this species at lower latitudes of distribution and paves the way for more research on trait-based approaches in management actions of restoration projects.

Next steps

Study **ecotypic variation** in functional traits of the populations at the southern limit of the genus distribution **at drier sites** can lead to a better understanding of their potential for demographic maintenance under future climatic conditions.

Study **genotypic variation in relation with functional traits** for conservation of adaptive traits



Thank you for listening!

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