



**THE PRESENCE OF *QUERCUS*
ESTREMADURENSIS O. SCHWARZ IN
IBERIAN PENINSULA - SYNTAXONOMIC
AND BIOGEOGRAPHIC ANALYSIS**

Carlos Martins Vila-Viçosa

Vila-Viçosa C., Lomba A. Almeida R., Mendes P., Pinto-
Gomes C., Meireles C., Mohedano R., Vázquez FM.



Riaño

| INDEX

- Background (Syntaxonomic and Taxonomic surveys)
 - Field work
 - Herbaria and classic bibliography research
- Problematics (Taxonomic and Syntaxonomic affiliation)
- Species Distribution Model
- Scientific questions? Proposals?
- Discussion
- Final considerations



| INTRODUCTION

Fagaceae

Quercus robur subsp. *estremadurensis* (O. Schwarz) A. Camus

Quercus estremadurensis O.Schwarz, Notizbl. Bot. Gart. Berlin-Dahlem 12: 463. (1935)
(lectotype: In JE n.v.; isotype: P06857428!)

Synonyms: =*Quercus robur* subsp. *estremadurensis* (O.Schwarz) A.Camus, Chênes, Atlas 2: 50 (1935); =*Quercus robur* var. *conimbricensis* A.Camus, Bull. Soc. Bot. France, 81: 815 (1934) (lectotype: P06857428!) =*Quercus racemosa* Brot., Fl. Lusit. 2: 31 (1804) (P06856882!) non Lamarck, Encycl. [J. Lamarck & al.] 1(2): 715 (1785)



Semi-deciduous (Marcescent) to evergreen



| INTRODUCTION

Quercus robur subsp. *estremadurensis* (O. Schwarz) A. Camus

Marcescent tree,

Anfractuous branches.

Irregular (rhomboidal) sclerophilous leaves,

Lobate (acute lobes),



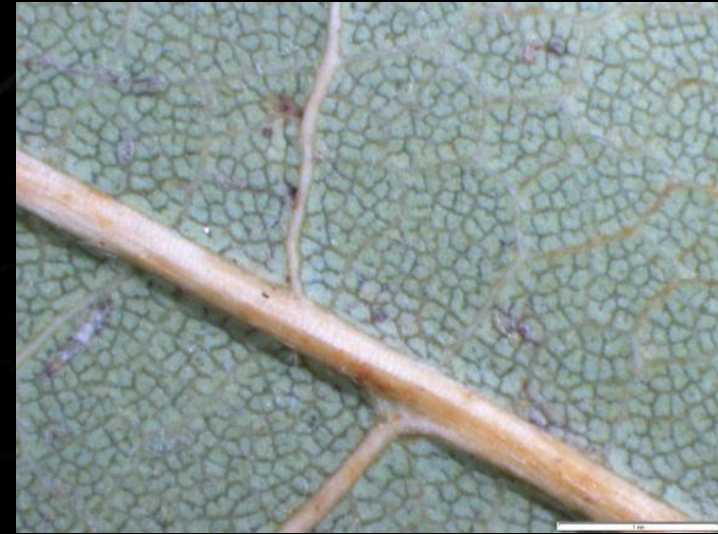
| INTRODUCTION

Quercus robur subsp. *estremadurensis* (O. Schwarz) A. Camus

Intercalary veins and very short petiole (almost null).

Adaxial surface glabrous and abaxial surface glabrous to glabrescent, sometimes with stellate trichomes, or simple, dispersed mainly in midrib and less times in secondary veins.

Pedunculate fruits



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Quercus estremadurensis O.Schwarz

Schwarz, O. 1935, *Einige neue Eichen des Mediterransgebiet und Vorderasien* Notizbl. Bot. Gart. Berlin-Dahlem 12: 463.

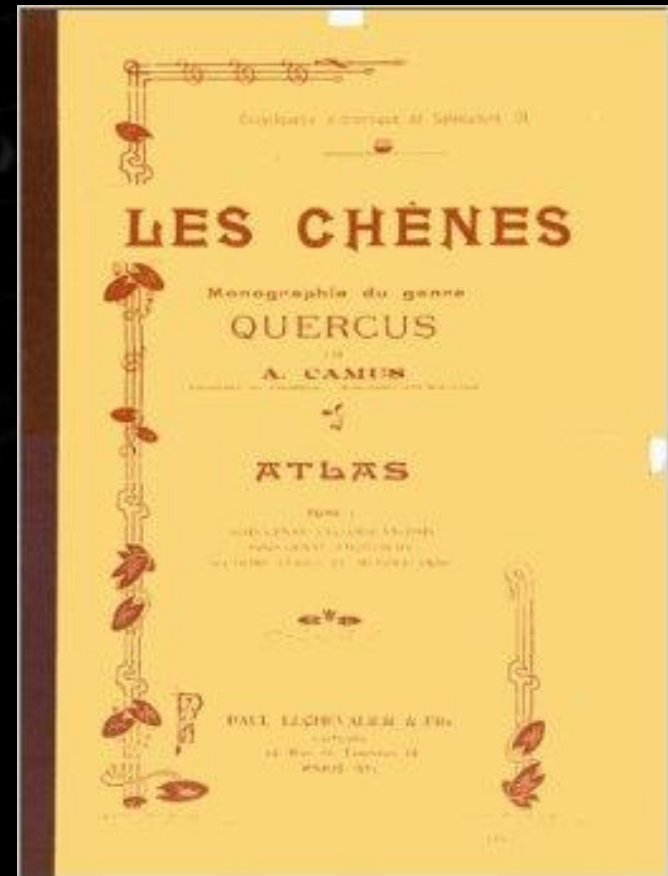
Quercus estremadurensis Schwz.

Uma árvore rara, como o *Q. canariensis*, e até agora só conhecida de Portugal. Observou-se esta espécie em Gou-

Árvores de Portugal

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veia, Bussaco, Coimbra e Sintra, sendo os exemplares desta última localidade muito bonitos. Não se sabe absolutamente nada sobre o seu porte, crescimento, madeira, etc. O seu estudo deve ser de tão grande interesse florestal como botânico. Distingue-se facilmente do *Quercus Robur* pelas folhas muito menos sinuosas e com muito mais lóbulos (mais de 8 em geral) e pelo número elevado de nervuras secundárias (9 ou mais de cada lado).



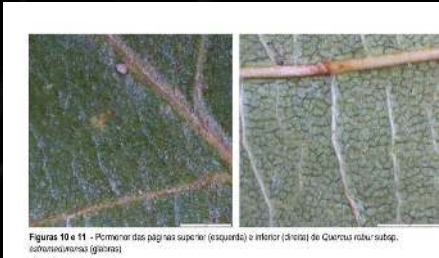
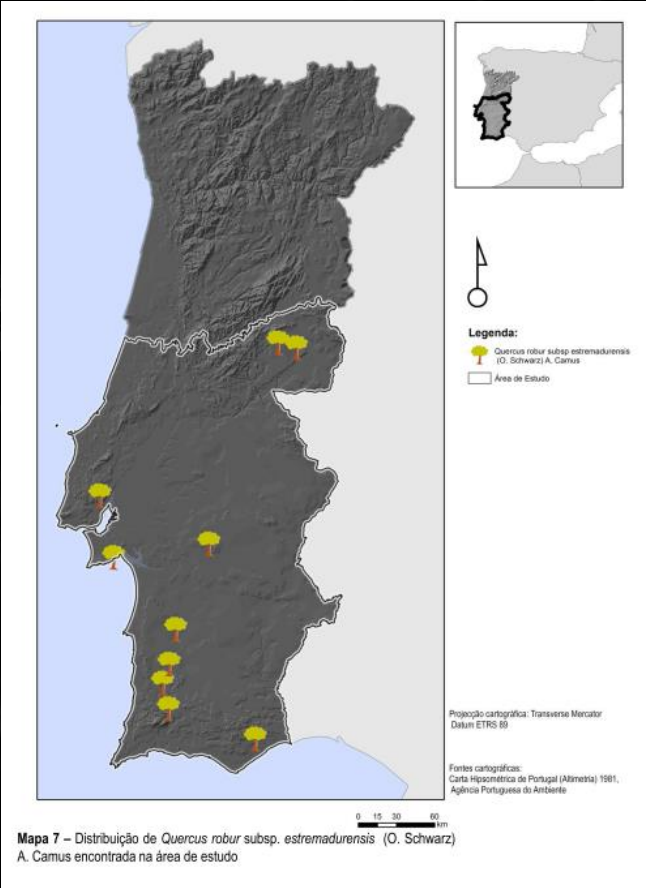
Rothmaler, W. 1941, *As Árvores de Portugal*. Bol. Soc. Broteriana. 15. 133-148.

INTRODUCTION

Quercus robur subsp. *estremadurensis* (O. Schwarz)
A. Camus



Figura 7 - Pormenor da folha de *Quercus robur* subsp. *estremadurensis* (Lobos agudos)



Figuras 10 e 11 - Pormenor das páginas superior (esquerda) e inferior (direita) de *Quercus robur* subsp. *estremadurensis* (glândulas)



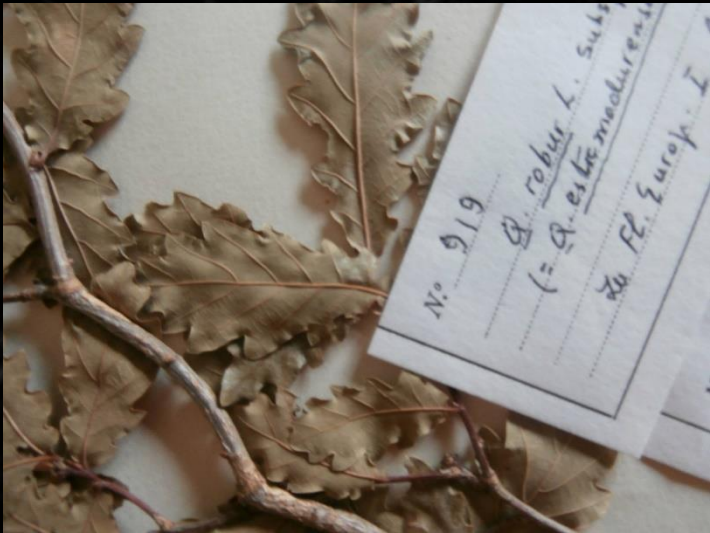
Figuras 12 e 13 - Pormenor do enclenchamento foliar de *Quercus robur* subsp. *estremadurensis* (picomas radiais dispersos, (esquerda) o simples principalmente nas nervuras (direita))



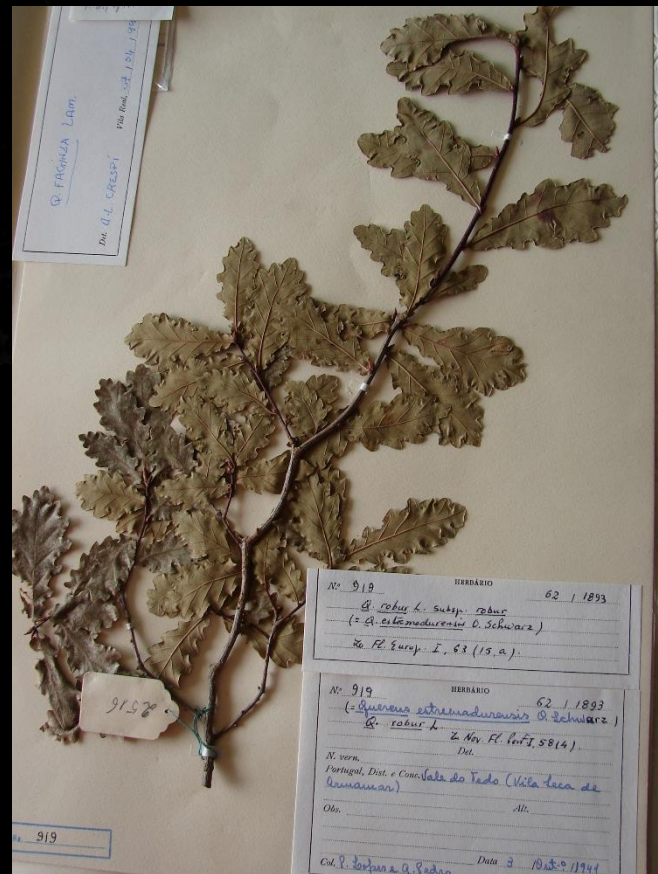
Figura 8 - Pormenor da folha de *Quercus robur* subsp. *estremadurensis* (Pecíolo curto, quase nulo)

| INTRODUCTION

Quercus robur subsp. *estremadurensis* (O. Schwarz) A. Camus



Quercus robur subsp. *estremadurensis* (O. Schwarz) A. Camus



| INTRODUCTION

Quercus × *ferreirae* A.Camus (*Q. estremadurensis* < *Q. faginea*)



Quercus × *molleri* A.Camus (*Q. estremadurensis* > *Q. faginea*)



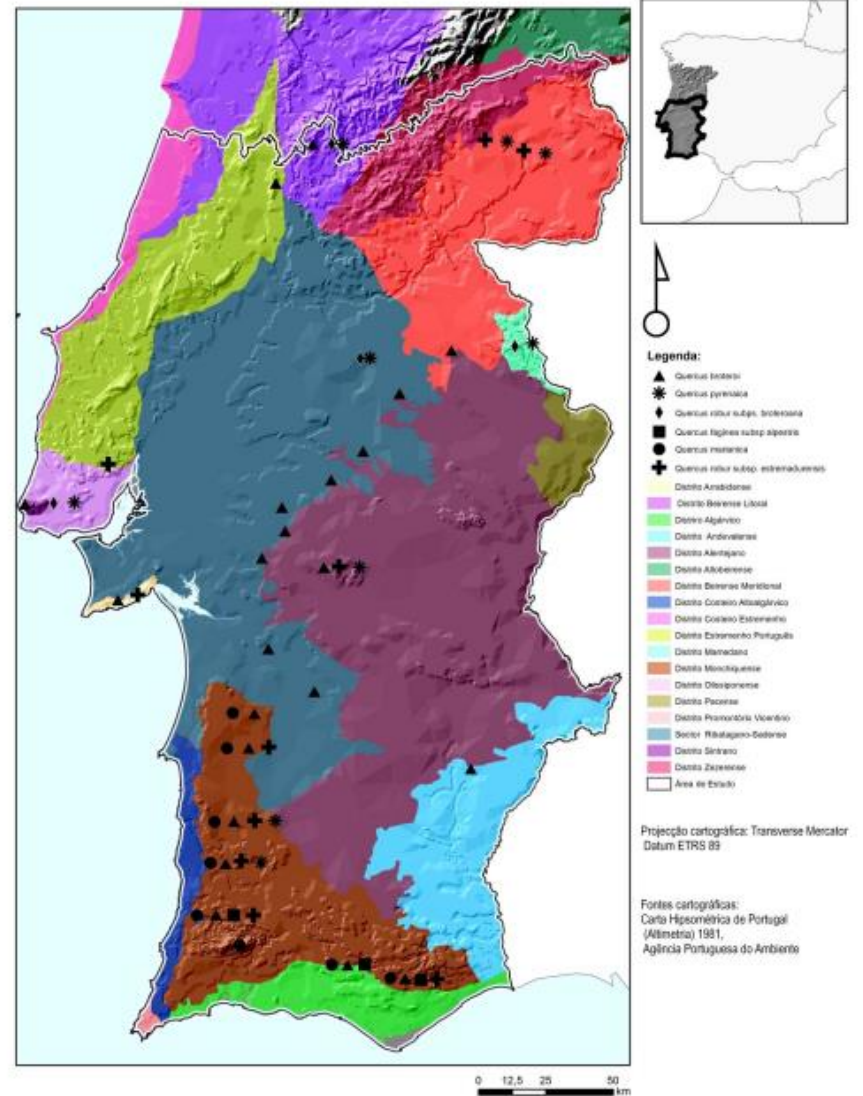
Quercus robur subsp. *estremadurensis* (O. Schwarz) A. Camus

Mediterranean Douro



INTRODUCTION

- Field Work
 - Initially Southwestern Portugal (2005)
- Mature stages (Holarctic Kingdom)
- Characteristic from typically Sub-Mediterranean ecotones (Temperate vs Mediterranean)
- Related to specific edapho-climatic envelopes



Mapa 5 – Relação biogeográfica encontrada entre táxones

| INTRODUCTION / OBSERVATION

Monchiquense District

Hyper-humid and hyperoceanic bioclimatic belt above sienitic batholith (>700 m)

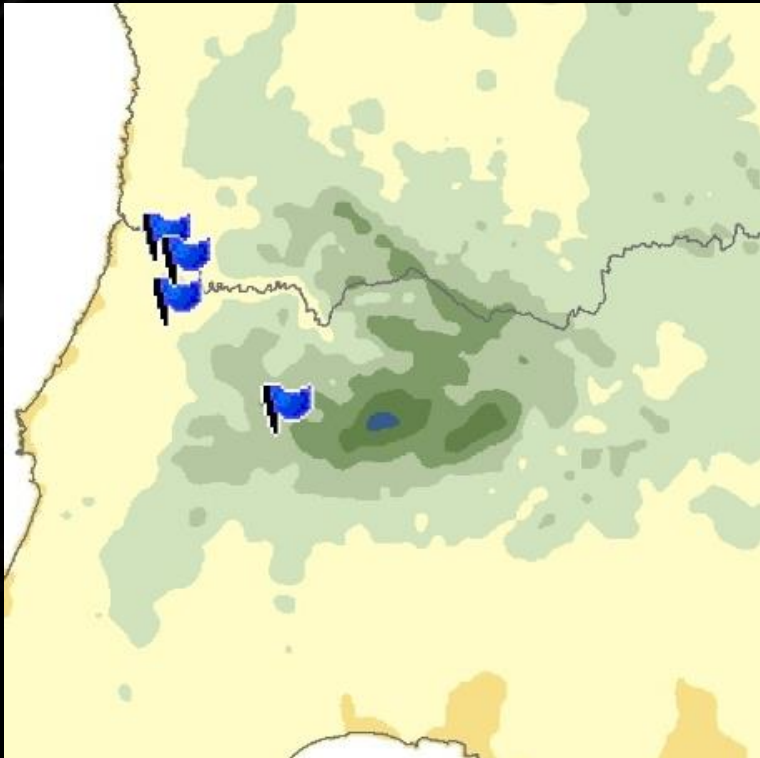
Campanulo primulifoliae-Rhododendretum pontici

Vila-Viçosa, J.C. Costa, Quinto-Canas & Pinto-Gomes fringes
(*Quercetum roboris* s.l.) (*Arbuto-Laurion* + *Ilex aquifolium*, *Myrica faia*)

Quercus estremadurensis and *Campanula primulifoliae* community (Vila-Viçosa, 2012)

Climatophilous??? (facing *Euphorbio-Quercetum canariensis*)

Cisto crispus-Ulicetum minoris



Adapted from Monteiro-Henriques (2010)

| INTRODUCTION / OBSERVATION

- Monchiquense District
- *Campanulo alatae-Quercetum estremadurensis* ass. nova. hoc loco (Vila-Viçosa, 2012)
- Climatophilous??? (facing *Euphorbio-Quercetum canariensis*)
- Hyper-humid and hyperoceanic bioclimatic belt above sienitic batholith (>700 m)
- *Campanulo alatae-Rhododendretum pontici* Vila-Viçosa, J.C. Costa, Quinto-Canas & Pinto-Gomes fringes (*Quercetum roboris* s.l.) (*Arbuto-Laurion* + *Ilex aquifolium*, *Myrica faia*)
- *Cisto crisp-Ulicetum minoris*



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Monchiquense District

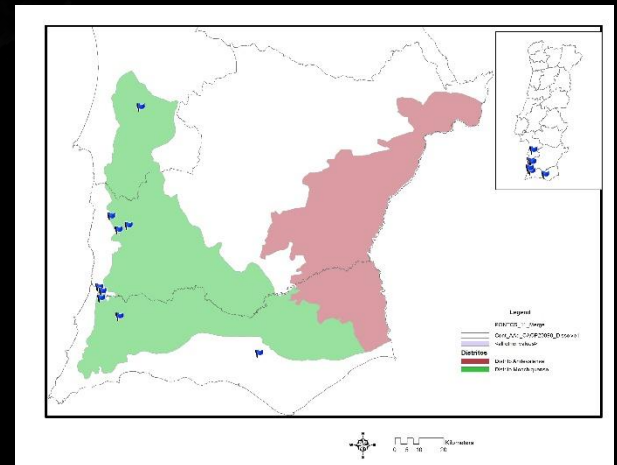
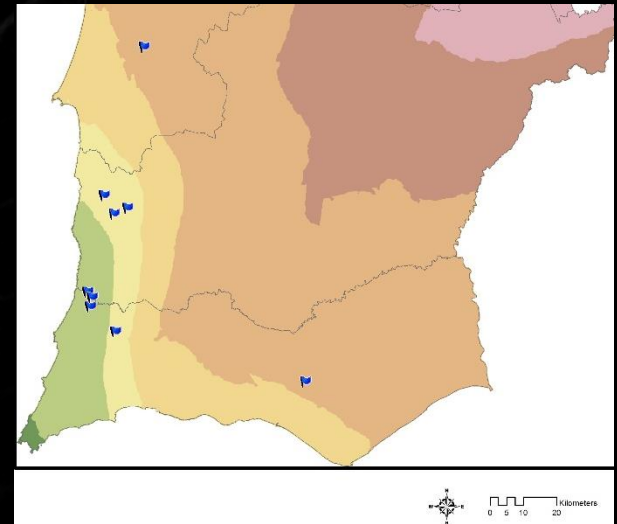
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• *Cisto crisp-Ulicetum minoris*

Adapted from Monteiro-Henriques (2010)



Adapted from Mendes et. al. inéd.

| INTRODUCTION / OBSERVATION

Monchiquense District (Vila-Viçosa, 2012)

Temporihygrophilous facing *Avenello strictae*-
Quercetum marianicae,

Upper sub-humid to humid or dry hyperoceanic
bioclimatic belts from schistose soils

Pruno-Rubion ulmifolii



| INTRODUCTION / OBSERVATION

Monchiquense District (Vila-Viçosa, 2012)

Temporihygrophilous facing *Avenello strictae*-*Quercetum marianicae*,

Upper sub-humid to humid or dry hyperoceanic
bioclimatic belts from schistose soils

Pruno-Rubion ulmifolii fringe



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- Monchiquense District (Vila-Viçosa, 2012)

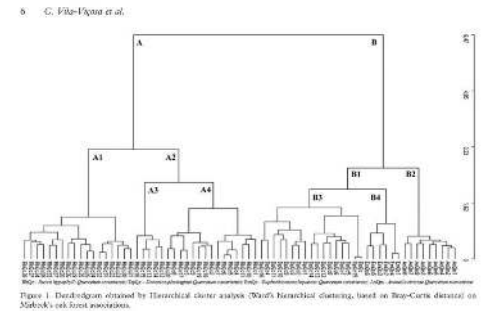


| INTRODUCTION / OBSERVATION

- Monchiquense District (Vila-Viçosa, 2012)



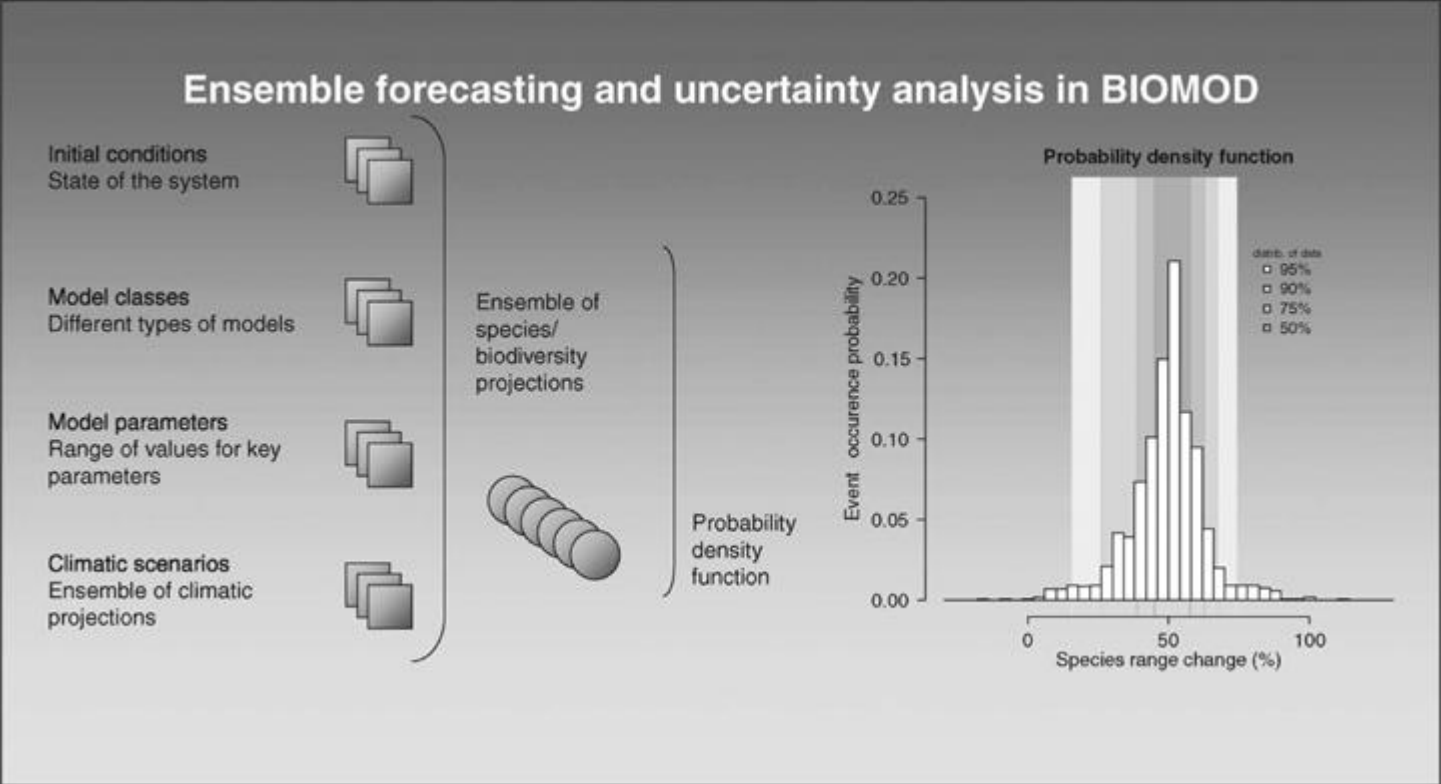
- **Phytosociological approach** (Braun-Blanquet 1979; Géhu & Rivas-Martínez 1981), Rivas-Martínez (2005), Géhu (2006), Biondi (2011)

[illegible][illegible]

| METHODOLOGY

SPECIES DISTRIBUTION MODELS (SDMs)

BIOMOD2 – A PLATFORM FOR ENSEMBLE FORECASTING OF SPECIES DISTRIBUTIONS



Ecography

Volume 32, Issue 3, pages 369-373, 29 JUN 2009 DOI: 10.1111/j.1600-0587.2008.05742.x
<http://onlinelibrary.wiley.com/doi/10.1111/j.1600-0587.2008.05742.x/full#f1>

METHODOLOGY

Climate

TMIN | Minimum temperature of the coldest month

PREC | Precipitation



Land-use

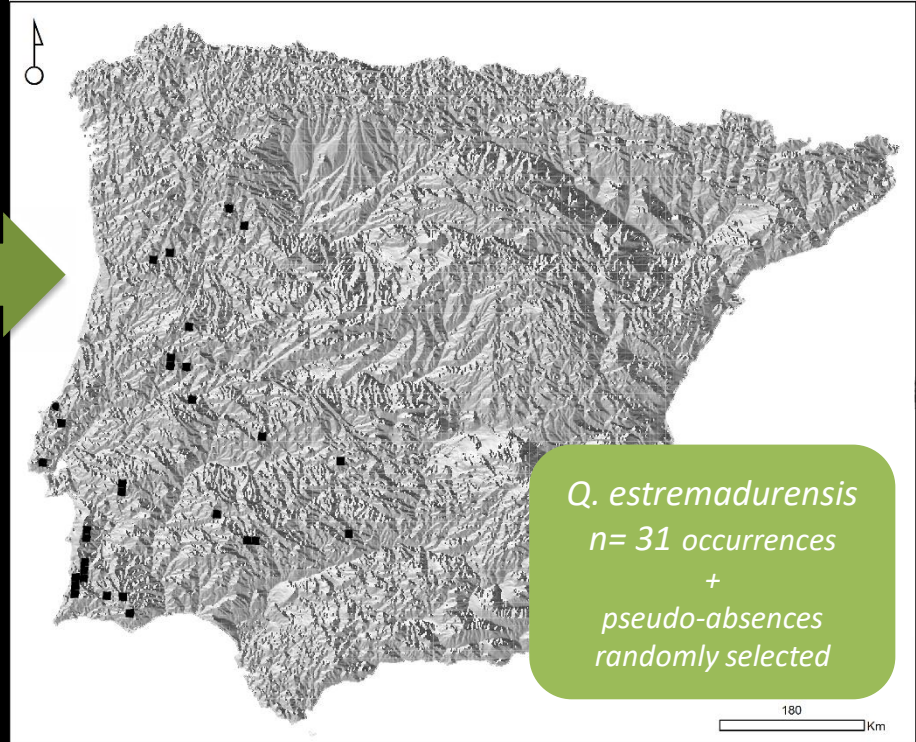
For | Percentage cover of forests



Terrain complexity

Rugg | Ruggedness index

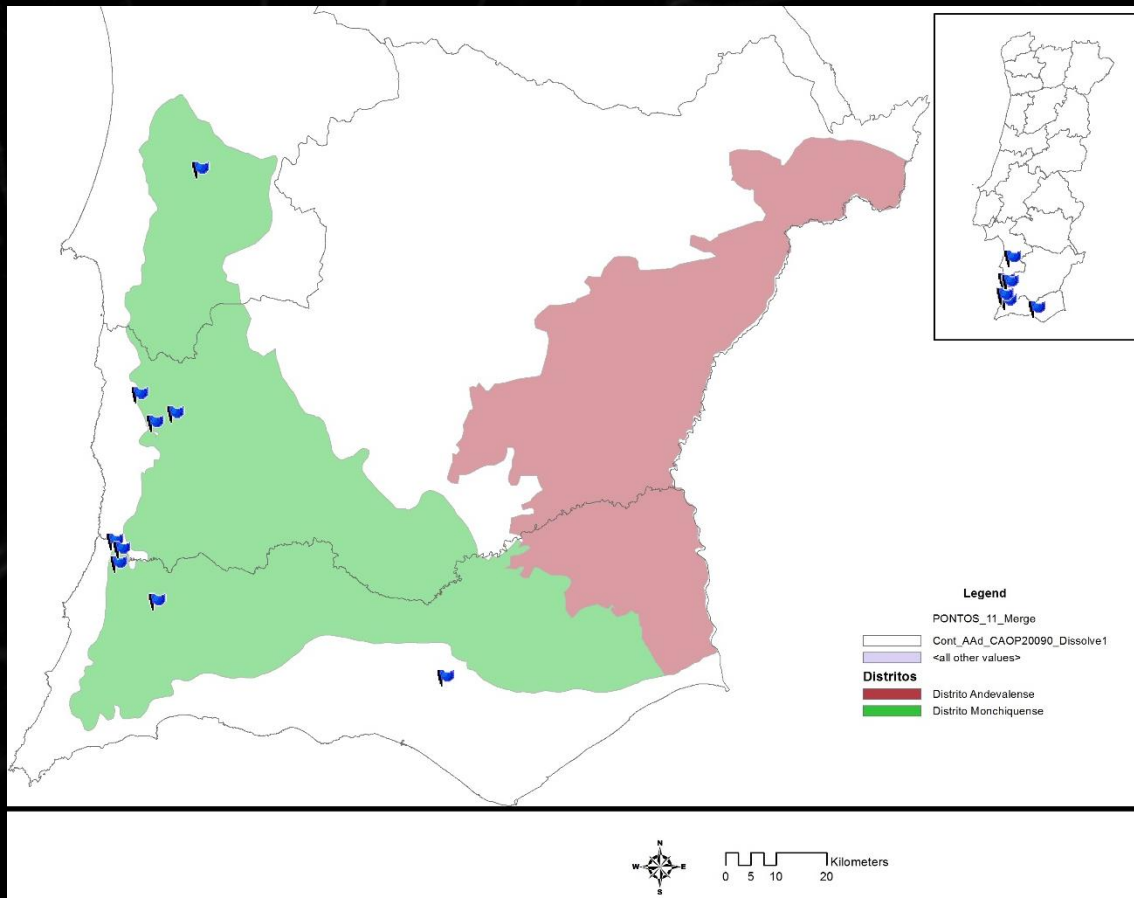
Quantitative measurement of terrain heterogeneity summarizes change in elevation



- All environmental predictors tested for correlation ($\rho < 0.7$), using STATISTICA 12;
- BIOMOD2 package for R© software– 10 cutting-edge modelling techniques (GLM, GAM, GBM, MAXENT, RF, ANN, CTA, MARS, FDA,SRE), replicated 30 times;
- Pseudo-absences selected randomly from background (excluding species occurrences);
- Data split according to a 80/20 subset (due to the lack of confirmed absences) for evaluation (ROC);
- Outcome: ensemble model of *Q. estremadurensis* potential distribution produced by weighting the best models (AUC>0.7)

| RESULTS

Phytosociological reléves *Quercus estremadurensis* community 2012-2014



Adapted from
Mendes et. al. inéd.

RESULTS

[illegible]

Relevé number	1	2	3	4	5	6	7	8	9	10	11	P
Area	200	350	500	600	450	300	250	400	350	400	450	R
Altitude	150	75	90	45	250	255	251	79	49	32	55	E
Cover	100	100	100	100	100	100	100	100	100	100	100	S
Aspect	E	E	NE	N	NW	W	SW	W	N	NW	W	E
Slope	25	15	25	5	15	5	10	15	5	20	5	N
Height	8	10	12	15	10	12	15	15	12	15	10	C
Characteristics												E
<i>Quercus robur subsp. estremadurensis</i>	2	3	2	4	2	+	-	4	2	1	3	V
<i>Quercus marianica</i>	1	2	4	+	3	+	1	1	1	4	3	V
<i>Quercus broteroi</i>	4	2	+	1	1	3	4	1	2	+	+	V
<i>Avenella stricta</i>	1	1	2	-	1	1	2	1	+	-	+	V
<i>Luzula forsteri subsp. baetica</i>	+	1	-	-	+	2	+	1	1	-	1	V
<i>Quercus xbeturica</i>	+	-	+	-	+	1	-	+	+	+	+	IV
<i>Campanula alata</i>	-	-	1	1	-	+	+	2	-	+	-	III
<i>Rhododendron ponticum</i>	-	-	1	-	-	1	1	+	-	+	-	II
<i>Quercus rivasmartinezii</i>	-	-	+	+	-	-	-	1	-	+	-	II
<i>Quercus lusitanica</i>	-	-	1	-	-	+	-	+	-	1	-	II
<i>Laurus nobilis</i>	-	-	1	-	+	-	-	1	+	+	1	II
<i>Frangula baetica</i>	-	-	1	-	-	-	-	2	-	+	+	I
<i>Lavandula viridis</i>	-	-	-	+	+	-	-	-	-	-	-	I
<i>Myrica faia</i>	-	-	-	-	-	-	+	1	-	1	-	I
<i>Quercus xwewitschii</i>	-	-	-	-	+	-	-	-	-	-	+	I
<i>Quercus xlousae</i>	-	-	+	-	-	-	-	+	-	-	-	I
<i>Quercus xrosa-pintii</i>	-	-	+	-	-	-	+	-	-	-	-	I

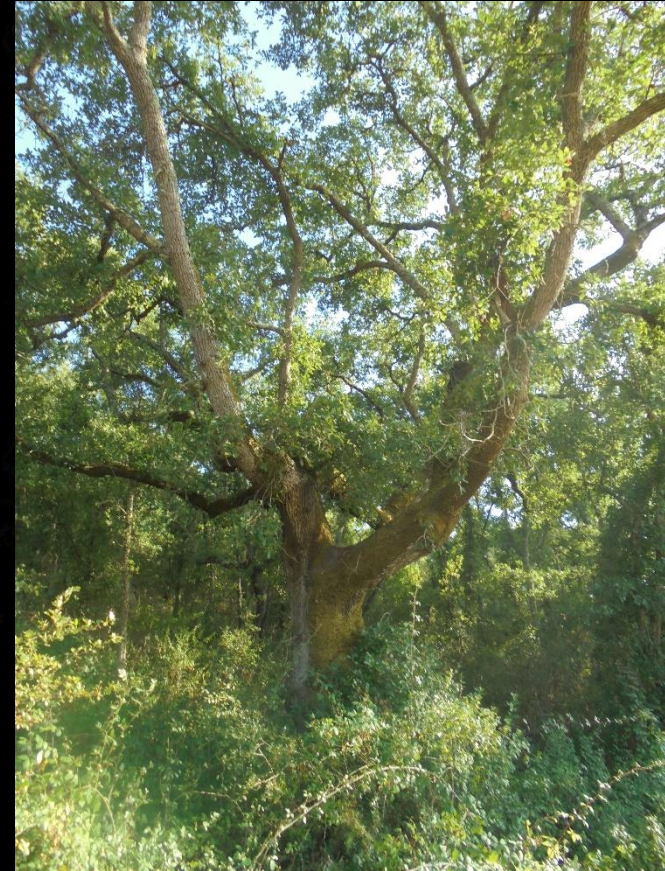
RESULTS

Alliance and upper units characteristics												
<i>Olea europea</i> subsp. <i>sylvestris</i>	1	+	-	1	2	+	+	1	-	1	1	V
<i>Ruscus aculeatus</i>	2	1	-	1	-	+	1	2	+	1	1	V
<i>Rubia peregrina</i>	+	1	-	+	-	+	+	1	+	1	-	IV
<i>Carex dystachia</i>	1	2	1	-	+	-	+	1	-	+	+	IV
<u><i>Viburnum tinus</i></u>	1	+	2	1	1	1	-	3	1	1	1	IV
<i>Smilax aspera</i> var. <i>altissima</i>	-	+	-	+	-	-	+	2	-	1	1	IV
<i>Pyrus bourgaeana</i>	1	-	2	1	+	-	-	+	-	1	+	II
<i>Rhamnus alaternus</i>	1	+	-	+	-	+	-	2	-	+	+	II
<i>Asplenium onopteris</i>	1	+	-	1	+	-	-	1	+	-	-	II
<i>Hedera hibernica</i>	-	1	1	+	-	-	+	1	-	-	1	II
<i>Arisarum simorrhinum</i>	-	1	-	+	-	+	-	+	-	-	+	II
<i>Phillyrea latifolia</i> .	-	-	1	1	-	-	-	1	-	-	+	II
<i>Sanguisorba hybrida</i>	+	-	-	-	-	-	-	1	1	-	+	I
<i>Paeonia broteroi</i>	-	-	-	+	-	-	-	-	1	+	-	I
<i>Daphne gnidium</i>	-	-	+	-	+	-	+	-	-	-	-	I
<i>Lonicera implexa</i>	-	-	-	-	-	+	+	-	-	-	-	I

[illegible]

| RESULTS

<i>Rhamno-Prunetea</i> characteristics												
<i>Rubus ulmifolius</i>	2	1	1	2	3	3	2	1	+	1	2	V
<i>Crataegus monogyna</i> subsp. <i>brevispina</i>	1	2	1	+	+	1	+	1	+	+	+	V
<i>Dioscorea communis</i>	-	1	1	-	1	-	+	1	+	+	-	IV
<i>Lonicera periclymenum</i> subsp. <i>hispanica</i>	-	+	-	+	2	1	+	1	+	1	1	IV
<i>Rosa pouzinii</i>	-	1	+	-	+	-	-	1	-	-	+	II
<i>Rosa canina</i>	-	-	+	-	-	-	+	-	+	+	-	II

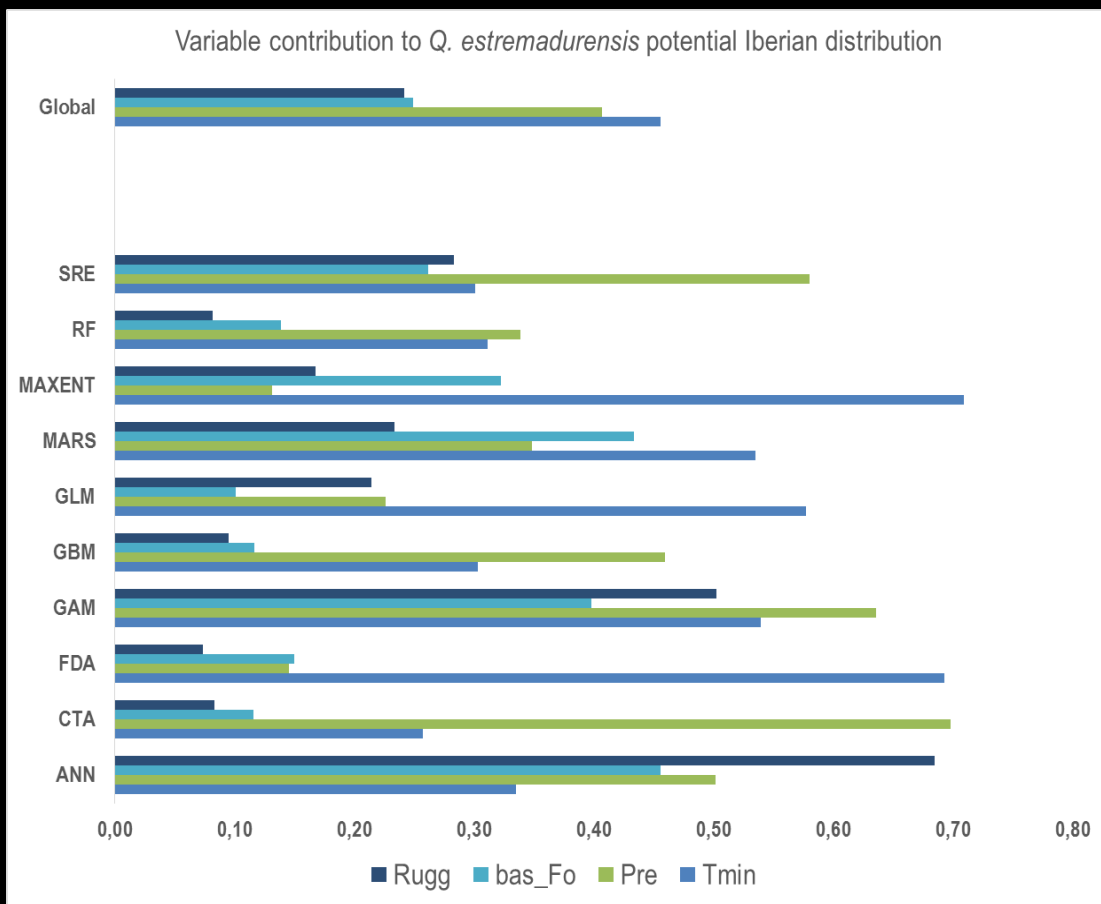


RESULTS

Companions												
<i>Arbutus unedo</i>	2	1	1	1	+	1	1	2	1	1	+	V
<i>Erica arborea</i>	+	1	2	3	2	1	+	1	1	+	2	V
<i>Dactylis hispanica</i> subsp. <i>lusitanica</i>	1	-	+	+	+	+	-	-	+	+	-	V
<i>Asparagus aphyllus</i>	+		1	+				1	1	+	1	IV
<i>Bellis sylvestris</i>	+		1		1			1		+	+	IV
<i>Phyllirea angustifolia</i>	1	1	-	1	-	+	-	1	+	1	1	IV
<i>Brachypodium phoenicoides</i>	1	-	+	-	1	-	+	-	1	1	1	IV
<i>Brachypodium sylvaticum</i>		2	+	+		1		1	+		1	IV
<i>Myrtus communis</i>	1		1		+	1		1			+	III
<i>Genista triacanthos</i>	-	-	+	-	+	-	-	+	1	-	+	III
<i>Osyris alba</i>	-	+	1	-	1	-	-	+	-	-	+	III
<i>Teucrium scorodonia</i>	-	1	+	-	1	+	-	1	-	-	-	III
<i>Thapsia villosa</i>	1	-	-	+	-	+	-	-	1	+	-	II
<i>Holcus mollis</i>	2	-	-	-	1	1	-	1	-	-	-	II
<i>Leontodon tuberosus</i>	1	-	+	-	+	-	-	-	-	-	+	II
<i>Magydaris panacifolia</i>	1	-	-	-	+	-	-	1	-	-	+	II
<i>Erica lusitanica</i>	-	-	+	-	-	-	+	1	-	+	+	II
<i>Cynara algarbiensis</i>	-	+	-	+	1	-	-	-	-	-	+	II
<i>Arum italicum</i> subsp. <i>neglectum</i>	-	+	-	+	-	+	-	1	-	-	+	II
<i>Pistacia lentiscus</i>	-	-	-	-	+	+	-	-	-	+	1	II
<i>Hyacinthoides hispanica</i>	-	-	-	+	-	+	-	+	-	-	-	II
<i>Scilla monophyllos</i>	-	+	-	-	-	+	-	-	+	-	-	II
<i>Osyris quadripartita</i>	-	-	+	+	-	-	-	-	-	+	-	II
<i>Ulex minor</i> var. <i>lusitanicus</i>	+	-	-	-	-	-	-	+	-	-	-	I
<i>Erica australis</i>	-	-	-	-	+	+	-	-	-	-	-	I
<i>Arenaria montana</i>	-	-	-	-	+	-	-	+	-	-	+	I
<i>Asphodelus aestivus</i>	-	-	-	-	-	+	-	-	-	-	+	I
<i>Ditrichia viscosa</i> subsp. <i>revoluta</i>	-	-	-	-	-	-	-	-	-	-	+	I
<i>Lavandula xalportelensis</i>	-	-	-	+	-	+	-	-	-	-	-	I
<i>Scrophularia scorodonia</i>	-	-	-	-	-	+	-	+	-	-	-	I
<i>Fraxinus angustifolia</i>	-	-	+	-	-	-	-	+	-	-	-	I
<i>Arrhenatherum album</i>	-	-	-	+	+	-	-	-	-	-	-	I
<i>Salix atrocinerea</i>	-	+	-	-	-	-	-	+	-	-	+	I
<i>Geum sylvaticum</i>	-	-	-	-	-	+	-	-	+	-	+	I
<i>Vitis sylvestris</i>	-	+	-	-	-	-	-	1	-	-	-	I
<i>Scolymus hispanicus</i> subsp. <i>occidentalis</i>	-	-	-	+	-	-	-	-	-	-	+	I
<i>Bupleurum fruticosum</i>	-	-	-	-	-	+	-	-	-	-	1	I
<i>Erica scoparia</i>	-	-	-	-	-	-	-	+	-	-	-	I
<i>Adenocarpus anisochillus</i>	-	-	-	-	-	-	-	+	-	-	-	I
<i>Euphorbia paniculata</i> subsp. <i>monchiquensis</i>	-	-	-	-	-	-	-	+	-	-	-	I
<i>Staurachanthus boivinii</i>	-	-	-	-	+	-	-	-	-	-	-	I
<i>Clematis flammula</i>	-	-	-	-	+	-	-	-	-	-	-	I
<i>Salix australis</i>	-	-	-	-	+	-	-	-	-	-	-	I
<i>Pulicaria odora</i>	-	-	-	-	+	-	-	-	-	-	-	I

| RESULTS – VARIABLE CONTRIBUTION

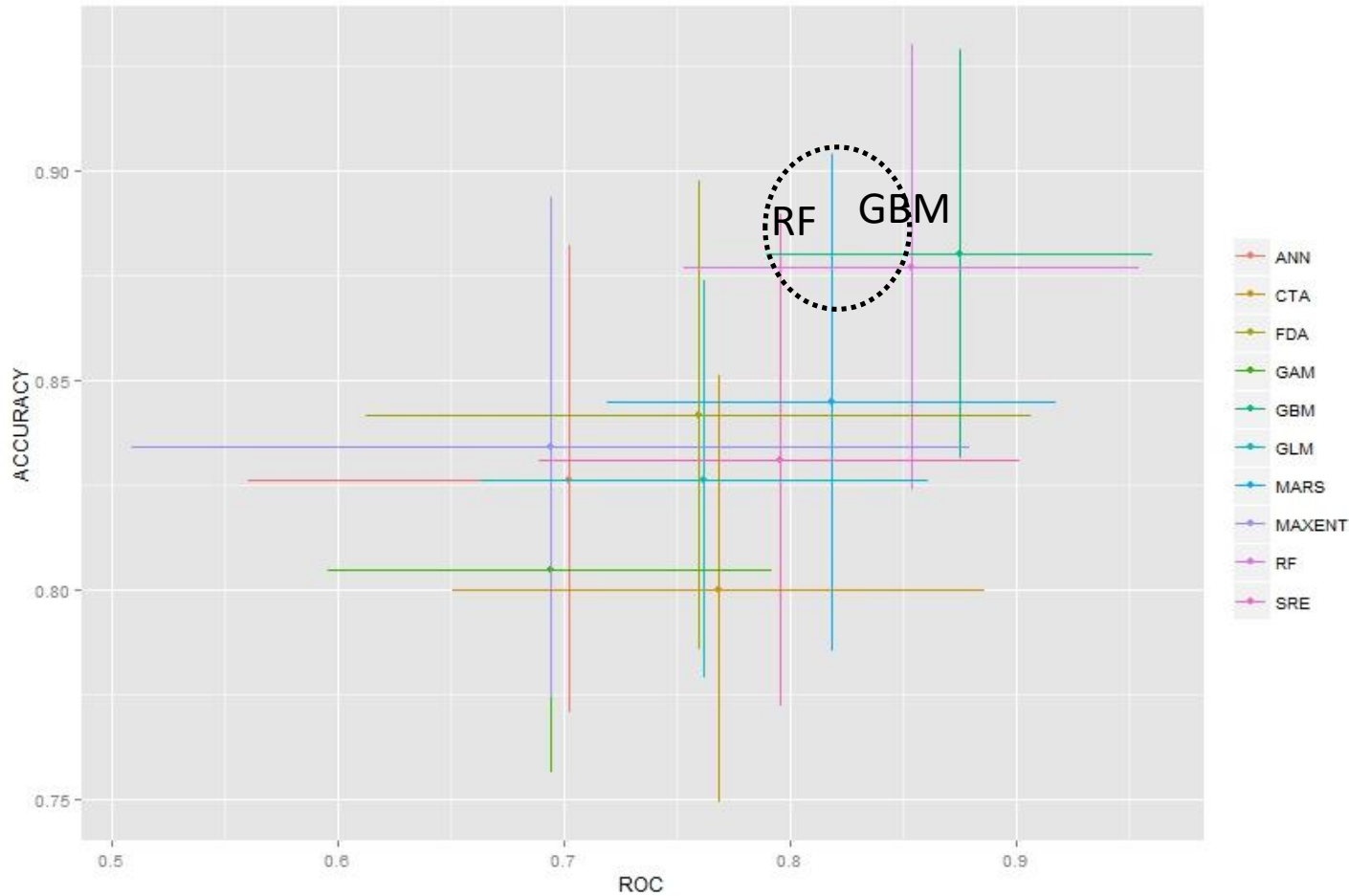
	Tmin	Pre	bas_Fo	Rugg
Global	0,46	0,41	0,25	0,24
SRE	0,30	0,58	0,26	0,28
RF	0,31	0,34	0,14	0,08
MAXENT	0,71	0,13	0,32	0,17
MARS	0,53	0,35	0,43	0,23
GLM	0,58	0,23	0,10	0,21
GBM	0,30	0,46	0,12	0,10
GAM	0,54	0,64	0,40	0,50
FDA	0,69	0,15	0,15	0,07
CTA	0,26	0,70	0,12	0,08
ANN	0,33	0,50	0,46	0,68



-Overall, climatic variables appear to be more determinant for *Q. estremadurensis* Iberian distribution (Tmin: 0,46; Prec: 0,41), followed by the percentage of forests (0,25) and terrain ruggedness (0,24);

-High variation among individual modelling techniques and runs;

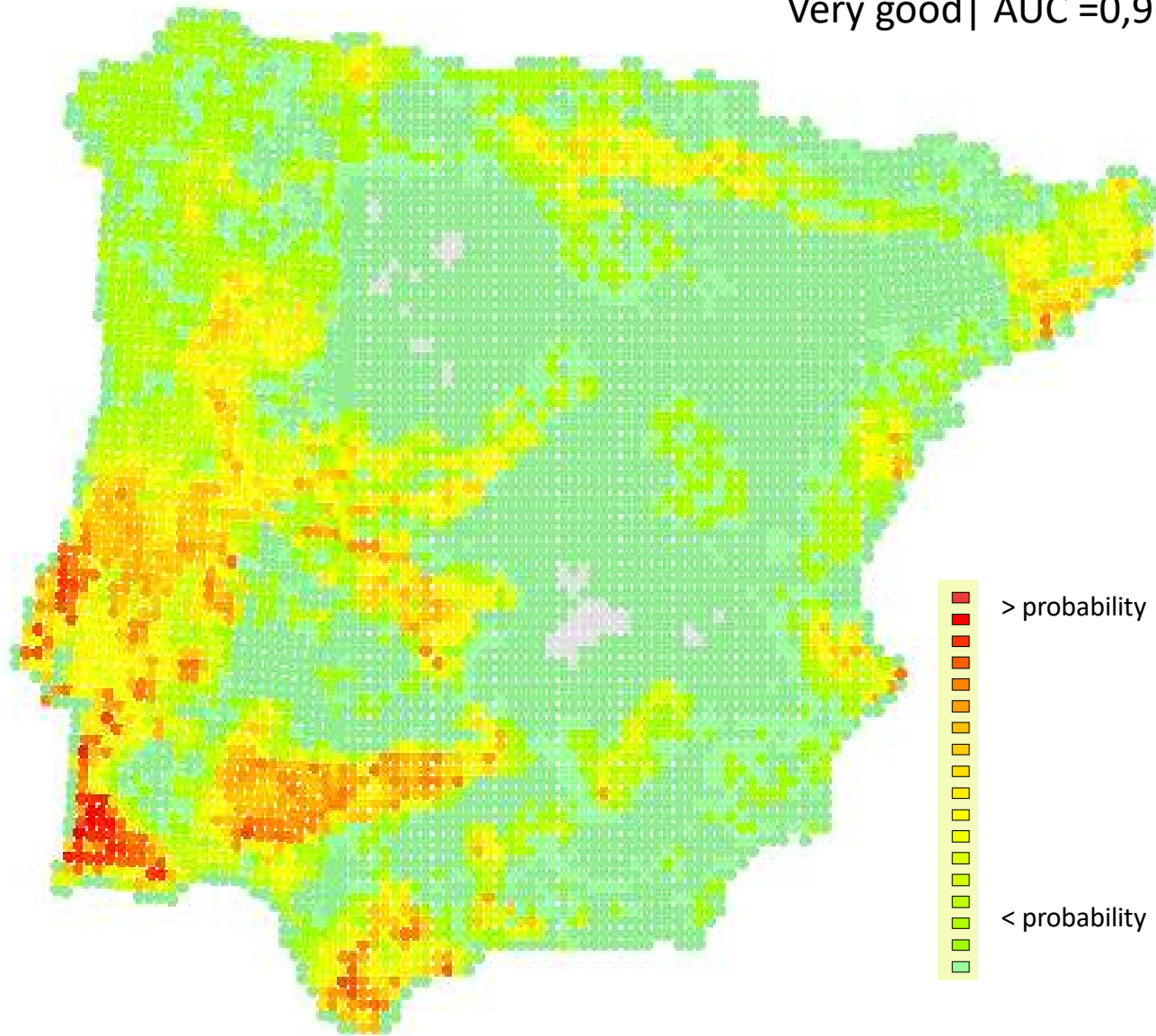
| RESULTS –EVALUATION & ACCURACY ACROSS MODELS



-High variation among individual modelling techniques and runs in relation to all evaluation metrics (e.g. AUC and Accuracy)

| RESULTS –ENSEMBLE MODEL OF *Q. ESTREMADURENSIS* DISTRIBUTION

Very good | AUC =0,96



| DISCUSSION / BIOGEOGRAPHIC INFERENCES

- Biogeographic assumptions (not detected) or corresponding to *Quercus robur* subsp. *broteroana*, *Quercus xcouthoi* Samp. and *Q. faginea*



| DISCUSSION / BIOGEOGRAPHIC INFERENCES

Biogeographic assumptions (not detected) or corresponding to *Quercus robur* subsp. *broteroana*, *Quercus xcouthoi* Samp. and *Q. faginea*

LUSO-EXTREMADURENSE Subprovince

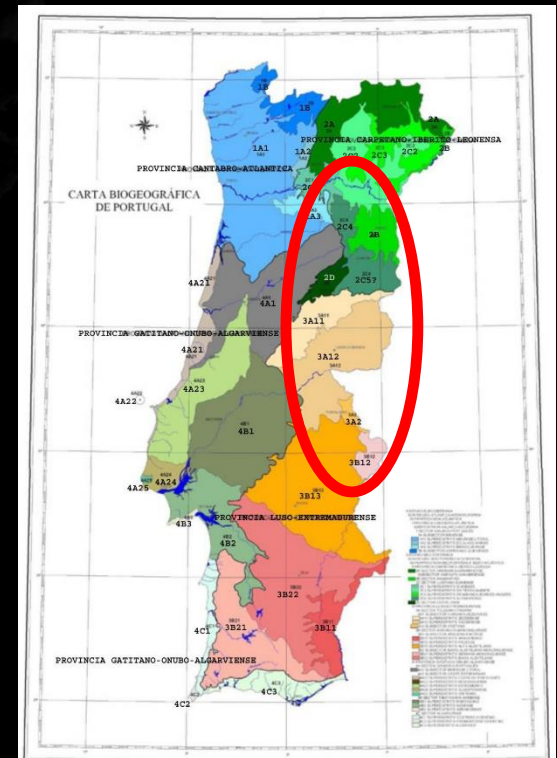
Mamedan District

South Beirense District

Temporihygrophilous facing *Arisaro-Quercetum pyrenaicae* and *Pistacio-Quercetum broteroi*

(*Quercenion pyrenaicae* and *Quercion broteroi*)

Quercus estremadurensis and *Prunus spinosa* community



| DISCUSSION / BIOGEOGRAPHIC INFERENCES

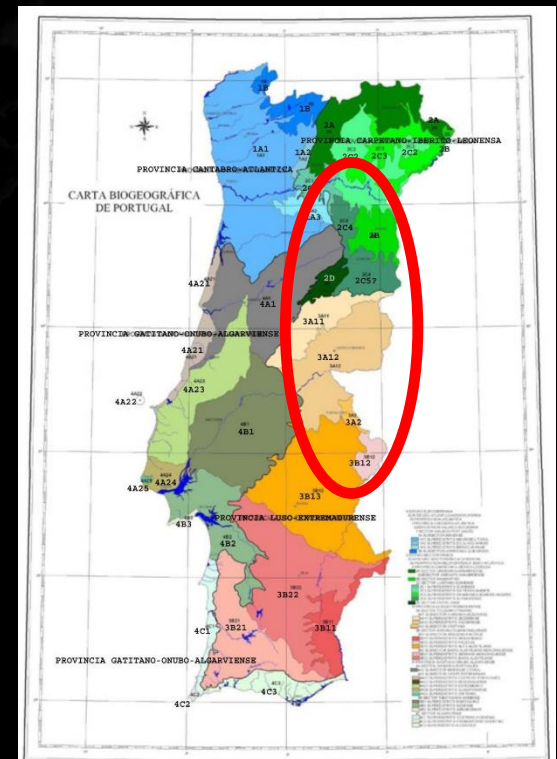
- Biogeographic assumptions (not detected) or corresponding to *Quercus robur* subsp. *broteroana*, *Quercus xcouthoi* Samp. and *Q. faginea*

• **MONTEMURO AND ESTRELA SIERRAN** Sector

- Montemuro and Caramulo Sierran District
- High Beirese District
- Estrela Sierran District
- Guardan District
- Zezerese District

Temporihygrophilous facing *Arbuto Quercetum pyrenaicae*
and *Holco-Quercetum pyrenaicae*
(*Quercenion pyrenaicae*)

Quercus estremadurensis and *Prunus spinosa* community



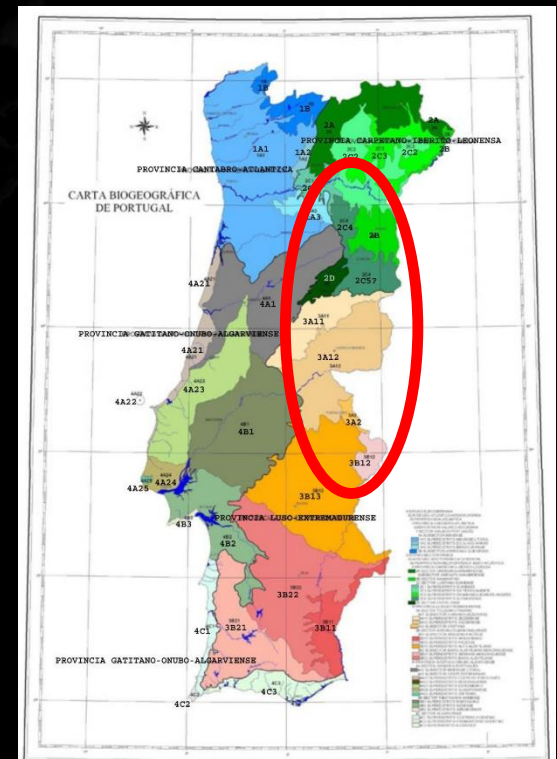
DISCUSSION / BIOGEOGRAPHIC INFERENCES

- Biogeographic assumptions (not detected) or corresponding to *Quercus robur* subsp. *broteroana*, *Quercus xcouthoi* Samp. and *Q. faginea*

- *DURIESE LUSITANIAN Sector*
- *Braganzan District*
- *Vilarealense-Verinense District*
- *Terraquentense District*
- *Low Duriense Lusitanian District*

**Temporihygrophilous facing *Hedero-Quercetum faginea* and
Epipacto duriensis-Quercetum faginea Alves, Vila-Viçosa,
Aguar inéd.
(*Aceri-Quercion faginea*)**

***Quercus estremadurensis* and *Prunus spinosa* community**



| DISCUSSION / BIOGEOGRAPHIC INFERENCES

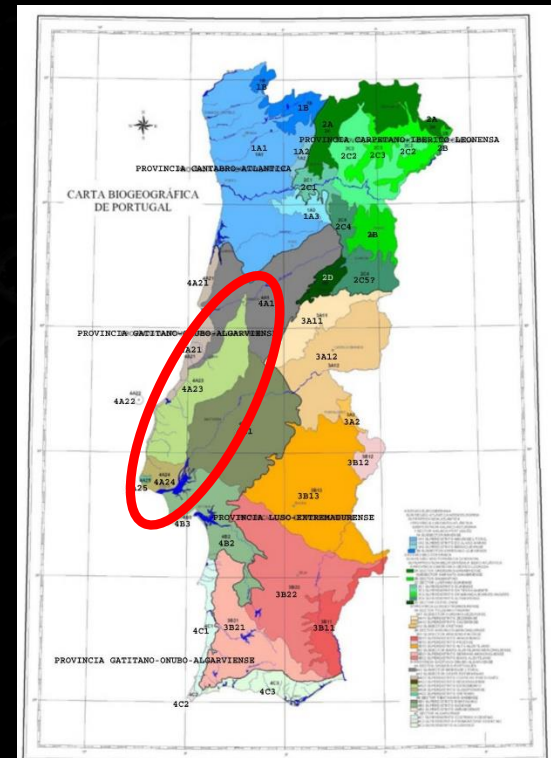
- Biogeographic assumptions (not detected) or corresponding to *Quercus robur* subsp. *broteroana*, *Quercus xcouthoi* Samp. and *Q. faginea*

- PORTUGUESE DIVISORIAN Sector
 - Extremenian Portuguese District,
 - Littoral Beirense District
 - Sintra Sierran District
 - Olissiponense District

Temporihygrophilous facing *Arisaro-Quercetum broteroi*

Quercus estremadurensis and *Prunus insititioides* community

(*Quercion broteroi*)



| SCIENTIFIC PROBLEMATICS

- Facing Morphological with Molecular Data
- Featuring introgression
- Trichome analysis validation (Environmental vs Genetics)
- Taxonomic inflation??
- Overestimated hybridization??

Taxonomic Validation

Genetics and Evolution NGS

- **Phylogeographic essay**
 - Relationships between taxa
 - Ancestry??
- Hybridization (*Q. robur* x *Q. faginea* s.l.)
 - Heavily “introgressed” ones
 - Biological invasion of hybrids?? (hybrid vigor)
 - Factors promoting the occurrence of Hybrid-zones?
 - Vicariant hybridization?
 - Bottleneck effect related to paleoclimatic constrains,

- ***Quercus estremadurensis* O. Schwarz**
 - Most threatened tree in Europe
- Genetic diversity
- Conservation threats
 - Introgression
 - Climatic shift
 - Anthropoc action

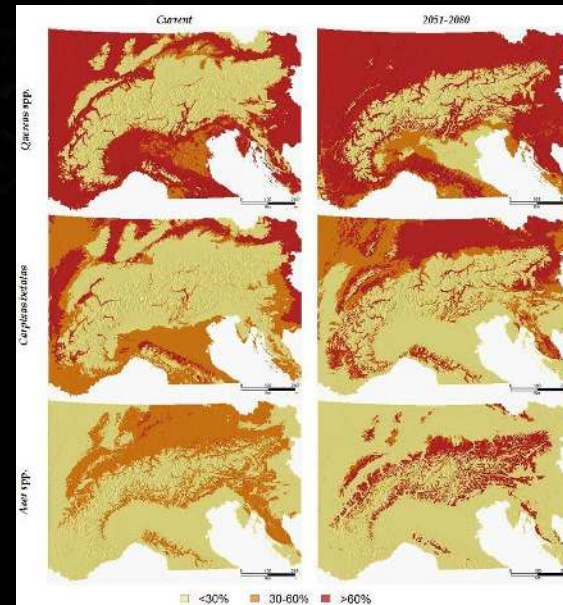
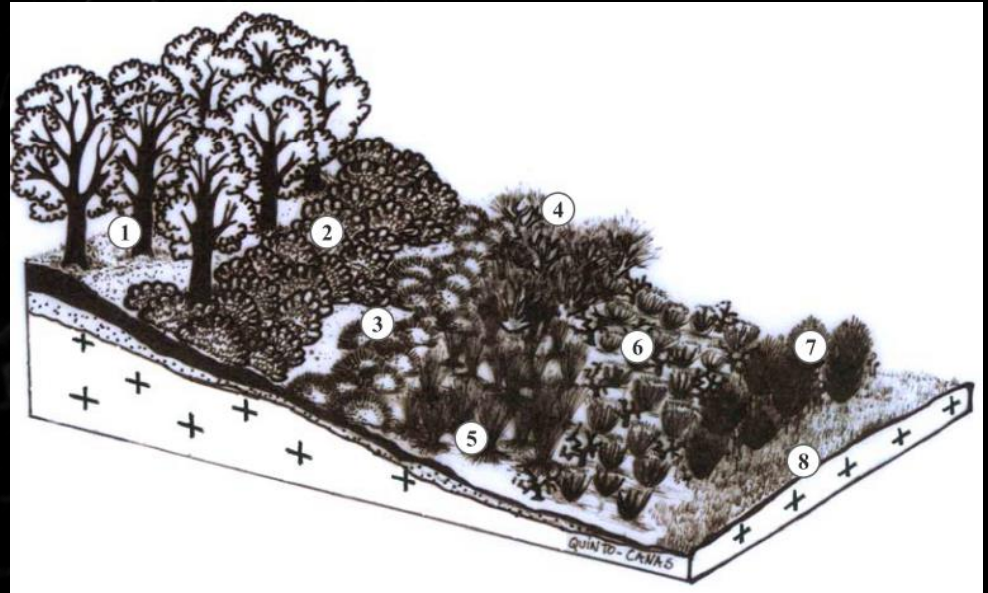
Conservation

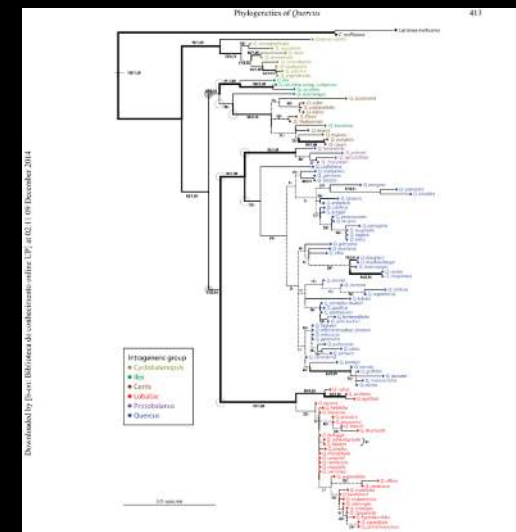
DISCUSSION / FINAL CONSIDERATIONS

Landscape Ecology

Catenal Dynamic models

SDM





Landscape genomics

Study of massive amounts of markers from a single-species genome to identify regions under selection and population structuring.

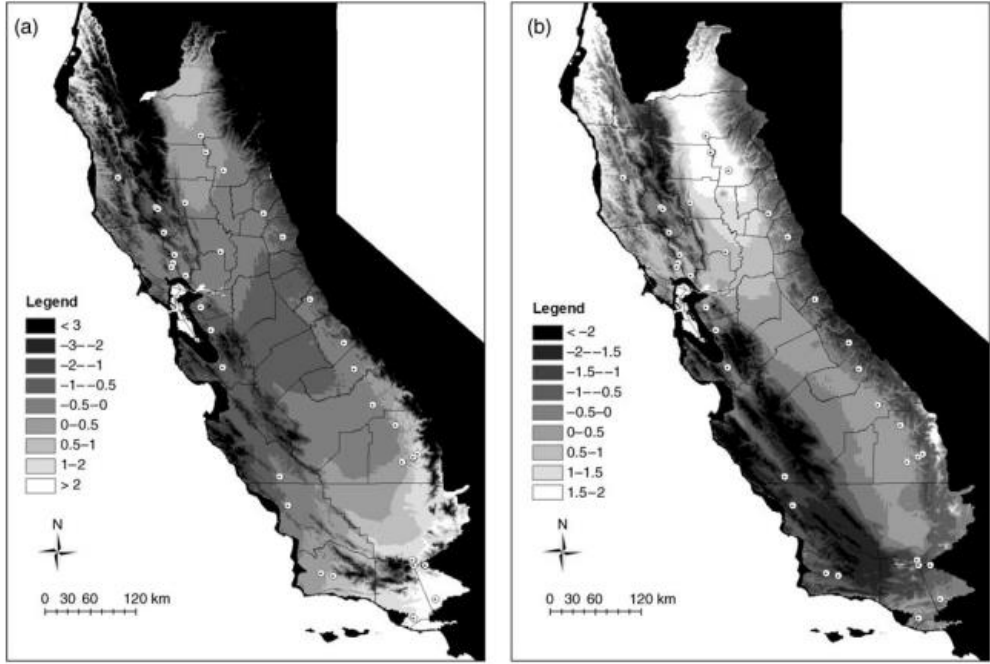
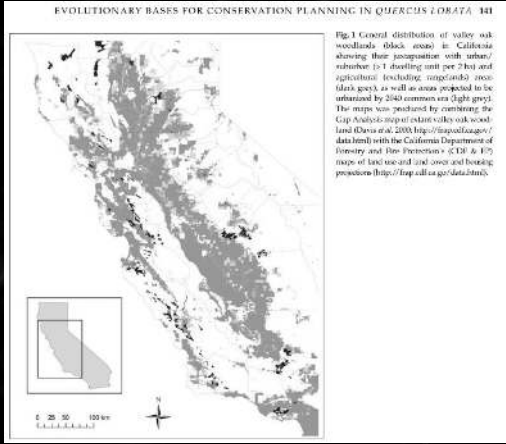
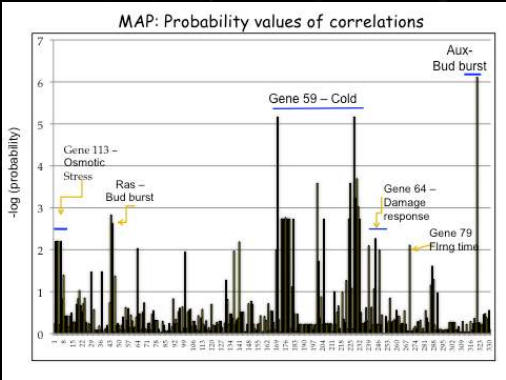


Fig. 3 Spatial trends in chloroplast genetic markers using the population mean standardized canonical scores based on the canonical correlation analysis of multivariate chloroplast genotypes vs. geographical variables. (a) Trend surface of the first canonical axis. (b) Trend surface of the second canonical axes. See Table 2 for statistical results. The shadings indicate the classes of canonical scores (see legends); dark colours represent negative values, and light colours positive values around the population mean, but no biological significance is attached to having