FRAXINO ANGUSTIFOLIAE-ULMETUM GLABRAE: AN ORIGINAL ENDEMIC AND EXTREMELY LOCALIZED FOREST FROM MAINLAND PORTUGAL

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ABSTRACT

The natural occurrence of *Ulmus glabra* in mainland Portugal has been recently recognized. These punctuated occurrences are peripheral and scattered from the main distribution area in the centre and north of Europe. *U. glabra* colonizes soils of heavy textures, relatively rich in bases, cool and frequently rocky on steep slopes (e.g. ravines, shadowy canyons), under supra to orotemperate, humid to hyperhumid bioclimates. This combination of ecological factors is rather unusual in mainland Portugal, however during an inventory excursion in the north of Portugal (Serra do Montemuro), in a small canyon of Balsemão river we detected a mesophilous/temporihygrophilous forest dominated by *U. glabra* and *Fraxinus angustifolia.* This forest is extremely localized occurring on Ordovician silty schists, under upper mesotemperate to supratemperate hyperhumid bioclimate. It probably corresponds to an interglacial refugium for the species. We ran an edaphoclimatic model within a geographical information system, in order to highlight other possible areas of occurrence for this forests and guide future efforts in finding it in mainland Portugal.

KEYWORDS: *Ulmus glabra*, *Fraxino angustifoliae-Ulmetum glabrae*, Serra do Montemuro, GIS analysis.

RIASSUNTO

È stata recentemente riconuosciuta la presenza naturale di *Ulmus glabra* nel territorio del Portogallo continentale. Questa presenza puntuale è periferica e separata dal restante areale continuo del centro e nord Europa. *U. glabra* colonizza suoli di tessitura pesante, relativamente ricchi in basi, freschi e frequentemente rocciosi di versanti molto inclinati (per es. burroni, orridi ombrosi), con bioclima da supra a orotemperato, umido a iperumido. Questa combinazione di fattori ambientali è piuttosto rara in Portogallo, però durante un'escursione per eseguire rilevamenti floristici realizzata nel nord del Portogallo (Serra do Montemuro), in un piccolo canyon del fiume Balsemão, abbiamo individuato una foresta mesofilo-temporigrofila dominata da *U. glabra* e *Fraxinus angustifolia*. Questa foresta, molto limitata, si sviluppa su suoli derivati da scisti siltitici ordoviciani, con bioclima da meso a supratemperato, iperumido, e corrisponde molto probabilmente a un rifugio interglaciale di *U. glabra.* Si presenta un modello edafoclimatico realizzato con il GIS, in modo da poter individuare altre aree di presenza potenziale di questa comunità forestale e condurre future ricerche nel Portogallo continentale.

INTRODUCTION

The natural occurrence of *Ulmus glabra* Huds. in mainland Portugal has been long debated and dubious. BROTERO (1804), WILLKOMM & LANGE (1870) and COUTINHO (1939) considered the existence of only one species of the genus *Ulmus* in Portugal (today recognized as *Ulmus minor* Mill.). FRANCO (1971) did not refer *U. glabra* in mainland Portugal, not even as cultivated. NAVARRO & CASTROVIEJO (1995) considered the species cultivated in the Portuguese Estremadura (Lisbon region). However, the data available in the NATURHISTORISKA RIKSMUSEET (2004) indicate the punctuated occurrences in the Iberian Peninsula as spontaneous, which are peripheral and scattered from the main distribution area in the centre and north of Europe. In the rest of Europe, the species is found on soils of heavy textures, relatively rich in bases, cool and frequently rocky on steep slopes (e.g. ravines, shadowy canyons), under supra to orotemperate, humid to hyperhumid bioclimates (RIVAS-MARTÍNEZ *et al*., 2002). The natural presence of this species in the north of Portugal has never been thoroughly studied.

Several paleopalynological studies refer the presence of *Ulmus* sp. in the Iberian Peninsula (RAMIL-REGO *et al*., 1998; CARRIÓN GARCÍA *et al*., 2000; MUÑOZ SOBRINO *et al*., 2004; IRIARTE *et al*., 2005; ALCALDE *et al*., 2006). Particularly, RAMIL-REGO *et al*. (1998) studied several pollen sequences from the north of the Iberian Peninsula where *Ulmus* sp. was found frequently associated with Eurosiberian species and genera (e.g. *Quercus robur* type, *Corylus*, *Betula*, *Fagus*, *Castanea*). The *Ulmus* sp. pollen percentage maxima are generally associated to increases of these species, revealing moisture or moisture-cold climates. For that reason it is most probable that, in the northwest of the Peninsula, *Ulmus* sp. pollen corresponds in fact to *U. glabra* species. The same authors consider the presence of *U. glabra* in the northern Peninsula as a characteristic species of the sub-coastal mountains deciduous oak forests, occurring in the montane (>800 m; supratemperate) bioclimatic belt. Additionally, SVENNING *et al*. (2008) modelled the distribution of several tree species both for current climate and for the last glacial maximum (21,000 years ago). The model for the last glacial maximum showed the potential distribution of *U. glabra* in the north of the Iberian Peninsula.

U. glabra has been recently found by HONRADO (2003), MONTEIRO-HENRIQUES *et al*. (2005) and PORTELA-PEREIRA *et al*. (2008) in the centre and north of mainland Portugal, where systematic vegetation data collection occurred. Taking into account those paleopalynological and modelling studies, as well as the findings of the referred Portuguese authors we now accept the occurrence of *U. glabra* Huds. in mainland Portugal as natural.

The species appears mainly isolated, generally among stands of mature forests. Plant communities co-dominated by *U. glabra* were not known in mainland Portugal until an inventory excursion realized in 2005 in the Serra do Montemuro (centre-north of main-

Tab. 1 - Fraxino angustifoliae-Ulmetum glabrae ass. nova.

Relevé no.	6006	6008	6069	6070	6081	**6082**	6083
Taxa no.	24	11	18	15	31	**22**	19
Altitude (m)	779	768	810	853	818	**783**	783
Minimal area (m^2)	80	20	20	40	20	**25**	30
Aspect	NW	W	E	E	SE	**N**	N
Slope (grad)	30	30	10	50	60	**50**	50
Total coverage (%)	90	100	100	100	100	**90**	100
Order no.	1	2	3	4	5	**6**	7
Characteristic combination:							
Ulmus glabra	3	3	3	1	1	**4**	1
Lonicera periclymenum ssp. hispanica	1	2	3	1	2	**+**	1
Polystichum setiferum	2	2	+	1	2	**3**	
Fraxinus angustifolia ssp. angustifolia	.	.	+	5	4	**2**	5
Rosa canina	.	.	1	1	+	**1**	+
Helleborus foetidus	1	1	.	.	2	**+**	
Tamus communis	.	.	.	2	1	**1**	+
Stellaria holostea	.	.	.	.	1	**3**	3
Crataegus monogyna	.	.	.	1	.	**2**	+
Crepis lampsanoides	+	.	.	.	2	**1**	.
Hedera hibernica	2	.	.	.	.	**+**	1
Euphorbia amygdaloides ssp. amygdaloides	.	.	.	.	1	**+**	+
Prunus avium	.	.	.	.	2	**1**	.
Polygonatum odoratum	.	.	.	.	.	**+**	2
Sambucus nigra ssp. nigra	+	.	2	.	.	.	.
Dryopteris dilatata	+	1	.	.	.	.	.
Quercus pyrenaica	.	.	.	.	+	**1**	.
Acer pseudoplatanus	+	.	+	.	.	.	.
Hyacinthoides hispanica	.	.	.	.	+	.	+
Silene latifolia	.	.	.	.	+	.	+
Viola riviniana	+	.	.	.	+	.	.
Asplenium onopteris	.	.	.	.	.	.	1
Corylus avellana	.	1	.	.	.	.	.
Laurus nobilis	.	.	1	.	.	.	.
Phyllitis scolopendrium ssp. scolopendrium	1	.	.	.	.	.	.
Athyrium filix-foemina	.	+	.	.	.	.	.
Castanea sativa	.	.	+	.	.	.	.
Fraxinus angustifolia ssp. angustifolia (frut.)	.	.	.	.	+	.	.
Teucrium scorodonia ssp. scorodonia	+	.	.	.	.	.	.
Companion species:							
Anthriscus sylvestris	+	3	2	.	+	+	.
Galium aparine ssp. aparine	2	.	+	.	+	+	+
Rubus ulmifolius	2	.	.	3	+	.	2
Lamium maculatum	2	.	1	.	.	+	+
Geranium robertianum	+	.	.	2	.	+	.
Pteridium aquilinum ssp. aquilinum	+	.	.	2	+	.	.
Pentaglottis sempervirens	1	.	+	.	+	.	.
Geranium purpureum	.	.	.	+	+	.	+
Arrhenatherum elatius ssp. bulbosum	.	.	.	2	1	.	.
Rubus sp.	1	1	.	.	.	.	.
Arum italicum	+	1	.	.	.	.	.
Polypodium interjectum	.	.	.	.	.	1	+
Urtica dioica	.	1	+	.	.	.	.
Epilobium obscurum	.	.	+	.	+	.	.
Frangula alnus	.	.	.	.	3	.	.
Thapsia villosa	.	.	.	1	.	.	.
Agrostis stolonifera	.	.	.	.	+	.	.
Bidens aurea	.	.	.	.	.	+	.
Bidens frondosa	.	.	.	.	.	+	.
Chelidonium majus	+	.	.	.	.	.	.
Cytisus grandiflorus ssp. grandiflorus	.	.	.	+	.	.	.
Dactylis glomerata ssp. lusitanica	.	.	.	.	+	.	.
Digitalis purpurea ssp. purpurea	+	.	.	.	.	.	.
Eupatorium cannabinum ssp. cannabinum	.	.	.	.	.	.	+
Heracleum sphondylium	.	.	+	.	.	.	.
Linaria aeruginea ssp. aeruginea	.	.	.	.	+	.	.
Picris hieracioides ssp. longifolia	.	.	.	.	+	.	.
Poa trivialis ssp. trivialis	.	.	+	.	.	.	.
Saxifraga fragosoi	.	.	.	.	+	.	.
Sonchus asper ssp. asper	.	.	+	.	.	.	.
Urtica urens	+	.	.	.	.	.	.
Vicia angustifolia	.	.	.	+	.	.	.
Vicia sativa ssp. sativa	.	.	.	.	+	.	.

land Portugal), where a mesophilous/ temporihygrophilous forest dominated by *U. glabra* and *Fraxinus angustifolia* was found in a small canyon of Balsemão river, nearby Magueija (MONTEIRO-HENRIQUES, 2010). The result of that excursion is presented here, where we propose the first association co-dominated by *U. glabra* in Portugal.

In order to highlight other possible areas of occurrence of this forests and guide future efforts in finding it in mainland Portugal, we ran an edaphoclimatic model within a geographical information system.

The *Fraxino angustifoliae-Ulmetum glabrae* probably corresponds to an interglacial refugium for the species, the only one known in mainland Portugal, for now.

METHODS

The phytosociological relevés here presented followed Braun-Blanquet methodology (vide BRAUN-BLANQUET, 1932; MÜLLER-DOMBOIS & ELLENBERG, 1974; KENT & COKER, 1992): in each registered phytocoenosis, all the occurring plant taxa were recorded, moreover, synthetic minimal area (see MÜLLER-DOMBOIS & ELLENBERG, 1974; VAN DER MAAREL, 2005; MONTEIRO-HENRIQUES, 2010), slope, aspect (using a digital compass) and total vegetation cover (%) were estimated. A value of abundance-dominance was specified for each taxon, adopting Braun-Blanquet scale. Successional and zonation aspects presented here are discussed following the landscape sigmatist school terminology (GÉHU & RIVAS-MARTÍNEZ, 1981; RIVAS-MARTÍNEZ, 2005; RIVAS-MARTÍNEZ, 2007). Bioclimatic terminology follows RIVAS-MARTÍNEZ (2008).

For the modelling exercise, a geographic information system (GIS) was used (ArcMap™ 9.3 SP1) to highlight the combination of ecological factors where the *U. glabra* co-dominated communities were found. Therefore, for the centre-north of mainland Portugal we selected areas with:

1) Slope greater than 10 grads (the smaller slope where the community was found);
2) Areas presenting upper mesotemperate to orotemperate thermotype;
3) Areas presenting humid to ultrahyperhumid ombrotype;
4) Rock types relatively rich in bases and capable of forming heavy textured soils, namely: schists from the Supergroup Dúrico-Beirão, basic rocks (amphibolite, calc-schist, limestone etc.),

biotitic granodiorites, shale-schists and silty shale-schists, among others.

In practice, this corresponds to a distribution model of the synhabitat of that community. The slope map was obtained within the used GIS using data from SRTM4 (CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH - CONSORTIUM FOR SPATIAL INFORMATION, 2008). Bioclimatologic maps where obtained as in MONTEIRO-HENRIQUES (2010) but for the most recent publication of Rivas-Martínez's World Bioclimatic Classification (RIVAS-MARTÍNEZ, 2008). Lithologic data was obtained from the Carta Geológica de Portugal Continental at 1:500,000 (INSTITUTO NACIONAL DE ENGENHARIA, TECNOLOGIA E INOVAÇÃO, 2007).

RESULTS

In Tab. 1 we present the phytosociological relevés realized on the communities co-dominated by *U. glabra* and *F. angustifolia*. For the typification of those forests we propose the new syntaxa *Fraxino angustifoliae-Ulmetum glabrae ass. nova hoc loco* (typus: relevé n. 06082), with the following characteristics:

DISTRIBUTION

The association is only known to occur on a small canyon of the Balsemão River valley, nearby Magueija.

SYNECOLOGY

Mesophilous to temporihygrophilous forest, supra to upper mesotemperate, hyperhumid, euoceanic. On deep soils derived in very steep slopes. In the visited locations the substratum corresponds to Ordovician silty schists.

CONTACTS

Climactic forest contacting catenally with *Galio broteriani-Alnetum glutinosae scrophularietosum scorodoniae* hygrophilous forests. It also contacts with *Holco mollis-Quercetum pyrenaicae* mesophilous forests, which occurs on nearby granites.

DESCRIPTION

Deciduous mesoforest dominated by *U. glabra* and *F. angustifolia*. *Prunus avium*, *Crataegus monogyna*, *Corylus avellana*, *Sambucus nigra*, *Laurus nobilis*, *Acer pseudoplatanus* occur in the underwood, together with nemoral species as *Polystichum setiferum*, *Helleborus foetidus*, *Stellaria holostea*, *Polygonatum odoratum*, *Crepis lampsanoides*, *Dryopteris dilatata*, *Omphalodes nitida*, *Phyllitis scolopendrium* subsp. *scolopendrium*, *Teucrium scorodonia* subsp. *scorodonia*, *Arum italicum*, *Viola riviniana*, *Athyrium filix-foemina*, among others and lianas like *Lonicera periclymenum* subsp. *hispanica*, *Rosa canina*, *Hedera hibernica*, *Tamus communis*, *Rubus ulmifolius* etc. (Tab. 1).

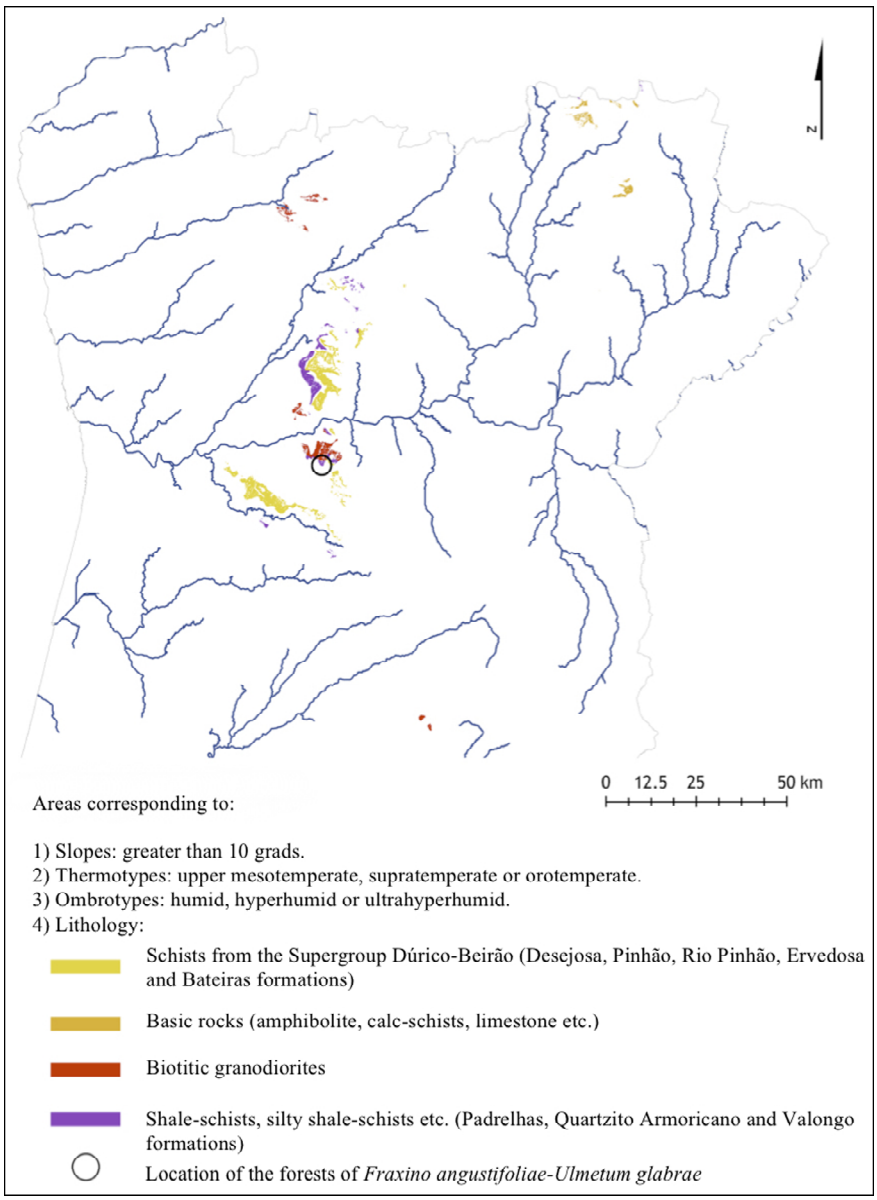

Fig. 1 - GIS model of the areas environmentally similar to those where *Fraxino angustifoliae-Ulmetum glabrae* was found.

SYNTAXONOMY

Even if the forest dominated by *U. glabra* and *F. angustifolia* found nearby Magueija is extremely localized, we propose its typification as an association due to the great consistency between the ecology of the found community and the other communities where the species is present in Europe. Therefore, we propose to place this association in the *Tilio-Acerion* Klika 1955 alliance, *Fagetalia sylvaticae* Pawłowski in Pawłowski, Sokołowski et Wallisch 1928 order, from the *Querco-Fagetea* Braun-Blanquet et Vlieger in Vlieger 1937 class, mainly due to the synhabitat similarities to the Alpine and Pyrenean communities from steep slopes/ravines dominated by *U. glabra*, and also for the presence of *Crepis lampsanoides*, *Dryopteris dilatata*, *Euphorbia amygdaloides* subsp. *amygdaloides*, *Helleborus foetidus*, *Stellaria holostea*, *Prunus avium* and, of course, *U. glabra.*

Finally, the GIS analysis highlighted the areas environmentally similar to those where *Fraxino angustifoliae-*

Ulmetum glabrae was found, in the centre-north of mainland Portugal (Fig. 1). Those environmental characteristics resulted rather unusual in mainland Portugal, as the areas of potential occurrence correspond to small areas from the mountain ranges of Estrela, Montemuro, Marão-Alvão, Montalegre, Nogueira and Montesinho.

DISCUSSION

The recognition of the *Tilio-Acerion* alliance in mainland Portugal implies also the presence of the Natura 2000 priority "natural habitat" *9180 *Tilio-Acerion* forests of slopes, screes and ravines. These communities underwent regression due to Dutch elm disease (*Ophiostoma ulmi* and *Ophiostoma novo-ulmi*), nevertheless, many mature *U. glabra* trees still exist on the found stands. As *U. glabra* is intolerant to dryness, climate change represents also a threat to this community, as it exists on the southwestern boundary of the distribution of *U. glabra*, and also close to the boundary between Eurosiberian and Mediterranean region. Thus, monitoring and active protection measures are certainly justified.

According to the paleopalynological studies referred in the introduction, in particular the models implemented by SVENNING *et al.* (2008), we believe that it is highly probable that the very localized canyon of Balsemão river correspond to an interglacial refugium for *U. glabra*, giving it even more value for Nature Conservation.

APPENDIX

Tab. 1 - 1 Viseu: Lamego, Magueija, right margin of Balsemão River; 2 Viseu: Lamego, Magueija, Relampa; 3 Viseu: Lamego, Magueija, Magueija; 4, 5, 6 and 7 Viseu: Lamego, Magueija, between Reconcos bridge and Magueija.

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