ÁGUA E TERRITÓRIO

UM TRIBUTO A

CATARINA RAMOS

CEG
Centro de Estudos Geográficos

ÁGUA E TERRITÓRIO:
UM TRIBUTO A CATARINA RAMOS

Editado por:

Ana Ramos-Pereira (coord.)

Miguel Leal

Rafaello Bergonse

Jorge Trindade

Eusébio Reis

Capa:

Rafaello Bergonse

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LISTA DE AUTORES

Ana Lavrador-Silva, Membro integrado da CICS.NOVA (FCSH), investigadora no IELT (FCSH) e ESBAL (FL), *ana.lavrador@sapo.pt*

Ana Ramos-Pereira, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa (CEG/IGOT-ULisboa), *anarp@campus.ul.pt*

André Fonseca, Centro de Investigação e Tecnologias Agroambientais e Biológicas, CITAB, Universidade de Trás-os-Montes, *andref@utad.pt*

André Torres, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa, *andre.rocha.torres@gmail.com*

Annalisa Bellu, CENTrum Educationis et Investigationis Oecologiae, CENTEIO, Lugar do Pragal, Campo Benfeito, 3600-371 Gosende, Portugal, *annalisabellu73@gmail.com*

António Monge Soares, Centro de Ciências e Tecnologias Nucleares, Instituto Superior Técnico, Universidade de Lisboa, *amsoares@ctn.tecnico.ulisboa.pt*

Augusto Perez Alberti, Universidade de Santiago, *augustoperezalberti@gmail.com*

Carla Mora, Professora auxiliar convidada e investigadora do CEG-IGOT da Universidade de Lisboa, *carlamora@campus.ul.pt*

Carlos Neto, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa, *cneto@campus.ul.pt*

Catarina Ramos, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa

Diamantino Insua Pereira, Instituto de Ciências da Terra, Polo da Universidade do Minho, *insuad@dct.uminho.pt*

Elisabete Nunes, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa (IGOT-ULisboa), *enunes@igot.ulisboa.pt.*

Eusébio Reis, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa, *eusebioreis@campus.ul.pt*

Glória Gonçalves, Investigadora do Centro de Estudos Geográficos da Universidade de Lisboa, Portugal, *goncalves.gloria@gmail.com*

Gonçalo Vieira, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa, *vieira@campus.ul.pt*

Helena Granja, CIIMAR, Universidade do Minho, *helenapgranja@gmail.com*

Isabel Paiva, Centro de Estudos de Geografia e Ordenamento do Território, Departamento de Geografia e Turismo da Universidade de Coimbra, *isabelrp@ci.uc.pt*

João A. Santos, Centro de Investigação e Tecnologias Agroambientais e Biológicas, CITAB, Universidade de Trás-os-Montes, *jsantos@utad.pt*

João Araújo Gomes, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa

Jorge Capelo, Instituto Nacional de Investigação Agrária e Veterinária, I.P., Herbarium, Quinta do Marquês, 2780-159, Oeiras, Portugal, *jorge.capelo@iniav.pt*

Jorge Trindade, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa e Universidade Aberta, Portugal, *jorgetrd@campus.ul.pt*; *jorge.trindade@uab.pt*.

José Brilha, Instituto de Ciências da Terra, Polo da Universidade do Minho, *jbrilha@dct.uminho.pt*

José Carlos Costa, LEAFE, Instituto Superior de Agronomia, University of Lisbon (ULisbon), Tapada da Ajuda, 1349-017 Lisboa, Portuga, *jccosta@isa.ulisboa.pt*

José Luís Zêzere, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa*, zezere@campus.ul.pt*

Luca Dimuccio, Departamento de Geografia e Turismo e Centro de Estudos de Geografia e Ordenamento do Território (CEGOT), Faculdade de Letras da Universidade de Coimbra, *luca@ci.uc.pt*

Lúcio Cunha, Centro de Estudos de Geografia e Ordenamento do Território, Departamento de Geografia e Turismo da Universidade de Coimbra, *luciogeo@fl.uc.pt*

Marcelo Fragoso, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa, *mfragoso@campus.ul.pt*

Maria Luísa Rodrigues, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, ULisboa, *rodrigues.mluisa@gmail.com*

Miguel Geraldes, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa

Miguel Leal, Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, ULisboa, *mleal@campus.ul.pt*

Mónica Santos, Centro de Investigação e Tecnologias Agroambientais e Biológicas, CITAB, Universidade de Trás-os-Montes, *monica.santos@utad.pt*

Paulo Pereira, Instituto de Ciências da Terra, Polo da Universidade do Minho, *paolo@dct.uminho.pt*

Paulo Portela, Centro de Ciências e Tecnologias Nucleares, Instituto Superior Técnico, Universidade de Lisboa

Pedro Oliveira Mestre em Geografia Física e Ambiente, professor do QND da Escola Secundária, *franzini57@hotmail.com*

Pedro Pinto Santos, Centro de Estudos Geográficos, IGOT, Universidade de Lisboa, Portugal, *pmpsantos@campus.ul.pt*

Randi Danielsen, Laboratório de Arqueociências, LARC/CIBIO/InBIO, Direção Geral do Património Cultural, Portugal. Present affiliation: Western Norway University of Applied Sciences, Bergen, Norway, *randidanielsen@gmail.com*

Ricardo A. C. Garcia, Centro de Estudos Geográficos, IGOT, Universidade de Lisboa, Portugal, *rgarcia@campus.ul.pt*

Sérgio Cruz Oliveira, Centro de Estudos Geográficos, IGOT, Universidade de Lisboa, Portugal, *cruzdeoliveira@campus.ul.pt*

Susana Pereira, Centro de Estudos Geográficos, IGOT, Universidade de Lisboa, Portugal, *susana-pereira@campus.ul.pt*

Teresa Mira de Azevêdo, Centro de Geologia do Departamento de Geologia, Faculdade de Ciências, Universidade de Lisboa, *tazevedo@fc.ul.pt*

Tiago Monteiro-Henriques, Centro de Investigação e Tecnologias Agroambientais e Biológicas, CITAB, Universidade de Trás-os-Montes e Alto Douro, UTAD, *tmh@isa.ulisboa.pt*

Ulrich Deil, Dept. of Geobotany, Faculty of Biology, University of Freiburg, Schänzlestrasse 1, 79104 Freiburg, Germany. *ulrich.deil@biologie.uni-freiburg.de*

NOTA PRÉVIA

O Grupo de Investigação em Sistemas Litorais e Fluviais – SLIF, do Centro de Estudos Geográficos, decidiu promover uma homenagem a Catarina Ramos, sob a forma de livro. Lançámos então o desafio a todos os que quisessem participar. As contribuições chegaram de colegas e amigos que se quiseram associar a esta forma de homenagem.

O livro é, por isso, variado, contendo artigos, evocações e uma tábua laudatória.

Os artigos visam especialmente temáticas relacionadas com a água, tema de investigação que a Catarina desenvolveu no seio da Geografia, mas também de Geomorfologia, Clima e Biogeografia, domínios em que a Catarina investigou e lecionou.

As evocações têm um cariz diferente e evidenciam o respeito, a camaradagem e a amizade que ela cultivou.

O Grupo de Investigação SLIF, a que a Catarina pertencia e a quem coube a organização deste livro, deseja deixar expresso um agradecimento à Direção do Centro de Estudos Geográficos/IGOT/ULisboa por todo o apoio que sempre dispensou.

Ana Ramos Pereira

2019

THE FLORISTIC DISTINCTIVENESS OF THE LOW AND MID-ALTITUDE PEAT-RICH HEATHLANDS OF THE WESTERN IBERIAN PENINSULA AND NORTHWESTERN MOROCCO

Carlos Neto[1]
Tiago Monteiro-Henriques[2]
José Carlos Costa[3]
Jorge Capelo[4]
Annalisa Bellu[5]
Miguel Geraldes[1]
Ulrich Deil, Freiburg[6]

Abstract

Peat-rich heathlands, characterized and dominated by Ericaceae and Genisteae, are the southernmost outliers of the class Calluno-Ulicetea in the Mediterranean region. They occur in small and isolated patches along the Atlantic façade of the SW Europe on acidic soils with peat formation and on hydromorphic podzols. Such sites could have acted as refugia for hygrophilous plant during dry climatic phases in earth history. Recent phylogeographic studies of the *Genista anglica-ancistrocarpa* complex showed a clear separation of a clade, distributed in Western Europe and the Northern Iberian Mountains (*Genista anglica*), and a clade of SW-Iberian and NW-Moroccan distribution (*G. ancistrocarpa*) indicating long-term isolation (possibly since the end of the Tertiary) upcoming form intricate paleogeographic and paleoclimatic patterns. In order to access if such long-term patterns are nowadays traceable at the community level, we analysed all the available data of the Genistion micrantho-anglicae from the Iberian Peninsula and NW Morocco.

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[1] Centro de Estudos Geográficos, Instituto de Geografia e Ordenamento do Território, Universidade de Lisboa (ULisboa). *cneto@campus.ul.pt*

[2] Centro de Investigação e Tecnologias Agroambientais e Biológicas, CITAB, Universidade de Trás-os-Montes e Alto Douro, UTAD. *tmh@isa.ulisboa.pt*

[3] LEAFE, Instituto Superior de Agronomia, University of Lisbon (ULisbon), Tapada da Ajuda, 1349-017 Lisboa, Portugal. *jccosta@isa.ulisboa.pt*

[4] Instituto Nacional de Investigação Agrária e Veterinária, I.P., Herbarium, Quinta do Marquês, 2780-159, Oeiras, Portugal. *jorge.capelo@iniav.pt*

[5] CENTrum Educationis et Investigationis Oecologiae, CENTEIO, Lugar do Pragal, Campo Benfeito, 3600-371 Gosende, Portugal. *annalisabellu73@gmail.com*

[6] Dept. of Geobotany, Faculty of Biology, University of Freiburg, Schänzlestrasse 1, 79104 Freiburg, Germany. *ulrich.deil@biologie.uni-freiburg.de*

The agglomerative hierarchical clustering shows a clear separation of two clusters: A) Ulici lusitanici-Genistion ancistrocarpae all. nov. hoc loco (typus: Cirsio welwitschii-Ericetum ciliaris) and B) Genistion micrantho-anglicae. This floristic differentiation is congruent with ecological and phytogeographical patterns: The first alliance is distributed along coastal areas and usually at lower altitudes within thermo- and mesomediterranean bioclimatic belts, while the associations of the latter occur at higher altitudes and in the interior and northern parts of the Iberian Peninsula, under temperate macrobioclimate. Both alliances have their own character taxa (some of them geographical vicariants) and are furthermore differentiated by transgressive species, which add further biogeographic information coming from the surrounding vegetation matrix. Finally we underline the conservation value of heathy peatlands as a refugium for the southernmost populations of Atlantic plant species in the Mediterranean region.

Keywords: Heathy peatlands; Ulici lusitanici-Genistion ancistrocarpae, phytosociology; Calluno-Ulicetea; *Genista*, syntaxonomy.

1. Introduction

The class Calluno-Ulicetea, dominated by dwarf-shrubs communities from the Ericaceae family and from the Genisteae tribe, is distributed along the Atlantic façade of Europe up to NW Africa, i.e. from Norway (Dierßen, 1996; Fremstad, 1997; Cross, 2003; Tveraabak, 2004) to Northern Morocco (Benito Cebrián, 1948; Deil, 1984; Quézel *et al.*, 1988; Díaz González, 1998). In the Euro-Siberian region, these heathland and moorland communities can be a climatic climax in coastal areas exposed to strong wind (e.g. in Cornwall or Brittany), or are the pedoclimax on shallow, base-poor siliceous soils, on ferric podzols with a very acid humus layer, on eroded dystric cambisols and, occasionally, on gley soils with stagnant moisture and peat accumulation. Most of the actual stands however occur on sites with a climax of deciduous woodlands (Querco-Fagetea, especially Quercetalia roboris). They have been expanded by man to previously forested sites since the Neolithic period by clearing, burning and extensive grazing without manuring (van der Knaap & Leeuwen, 1997, Sobrinho *et al.*, 2004, Gomes, 2007, Danielsen, 2008). Bioclimatically, they are zonal in the humid climate of temperate Western Europe. Biogeographically their optimum lays in the Atlantic European province.

The occurrence of Calluno-Ulicetea communities in the Mediterranean biome is azonal, close to the Atlantic façade (thermo-, meso- and supramediterranean, subhumid to hyper-humid bioclimatic belts), and on edaphically particular physiotopes, which are humid all year round despite a Mediterranean precipitation regime lacking summer rain. The increasing thermic and hydric stress towards the south is limiting the heathy peatlands to soils receiving gravitational water from the surrounding area (Neto, 2002; Vila-Viçosa *et al.*, 2012). The permanent water supply, related to permeable substrates lying over impermeable ones, promotes water infiltration but hinders its loss during the summer (Neto *et al.*, 2007; Neto *et al.*, 2009). This allows the presence of peat-rich/fen habitats in a territory where annual rainfall is concentrated around the winter and seldom rises above 700 mm (Loidi *et al*. 2007, Ojeda *et al*. 1998). Phytogeographically, they occur in the Cévennean-Pyrenean, Mediterranean West Iberian, Oroiberian, Coastal Lusitanian-Andalusian and Tingitanean territories (Costa el al. 2012).

The floristic and ecological diversity of the Calluno-Ulicetea is highest in Brittany (Botineau & Géhu, 2005; Deil *et al.*, 2010). On the Iberian Peninsula, the highest species richness of Calluno-Ulicetea and the maximum of associations are found in the Cantabrian-Atlantic province, under temperate bioclimatic conditions (Loidi *et al.*, 1997; Loidi *et al.* 2007), with a floristic impoverishment towards the interior of the Peninsula. From these patterns of diversity and the actual optimal climatic conditions for heathlands in the NW of the Iberian Peninsula, Loidi *et al.* (2010) conclude that this area has been a southern refuge during the Pleistocene cold stages from which the post-glacial northward expansion has originated. That hypothesis was recently confirmed by an analysis of molecular data of Iberian and European populations of *Genista anglica* and *G. ancistrocarpa*: the phylogram showed a proximity among the European populations (from Britain to Asturias), but also a clear genetic separation of the southernmost populations corresponding to *G. ancistrocarpa* (Fonseca *et al.*, 2014; Geraldes *et al.*, 2014), suggesting a long-term isolation, possibly since the end of the Tertiary Period (Miocene and final Pliocene), certainly relating to intricate paleogeographical and paleoclimatic patterns. These conclusions reinforced the keystone role of hygrophilous Genisteae taxa, in fen and bog plant communities, mainly in their southernmost boundaries.

At the present moment, the Calluno-Ulicetea communities on peaty soils and dominated by *Erica* and *Genista* species are clustered in the Genistion micrantho-anglicae Rivas-Martínez 1979, an alliance including associations distributed from Brittany to the Tangier Peninsula in NW Morocco (Loidi *et al.*, 2007; Deil *et al.*, 2010; Rivas-Martínez *et al.*, 2011; Costa *et al.*, 2012). In the light of the above mentioned phylogenetic studies about the speciation in the *Genista anglica-ancistrocarpa*-complex we want to analyse the floristic differentiation within the Iberian and northwest Moroccan heathy peatlands (where both *G. anglica* and *G. ancistrocarpa* occur), exploring the effects that such paleogeographical and paleoclimatic patterns might have imprinted into the vegetation. To achieve this objective, all the published Genistion micrantho-anglicae relevés, from the Iberian Peninsula and the Tangier Peninsula (NW Morocco) were collected from the SIVIM database (http://www.sivim.info/) and five additional relevés from Neto *et al.* (2014).

The analysis of floristic similarity and the discussion of the causal factors must take into consideration the following remarks:

(1) The floristic composition of heathy peatlands is not only influenced by the actual acting environmental filters, but represent (at least in part) historical effects of allopatric speciation as a result of long-term isolation and separation of ancestor populations, caused by climatic shifts and by shrinking and expanding distribution areas of the populations during the cyclic changes in temperature and precipitation in the Pliocene and Pleistocene. Heathy peatlands are to a certain extent independent from fluctuations

and trends in the amount of precipitation and can serve as refugia during dry and warmer climatic phases (Rodríguez-Sánchez *et al.*, 2008, Deil *et al.*, 2010). Therefore regional endemics are expected (such as *G. ancistrocarpa*, *U. lusitanicus*, *C. welwitschii*, among others) and vicariant taxa on the NS-gradient at different taxonomic levels (from varieties to species). These taxa will act as character species at the community level (annex 1 photo 1).

(ii) Especially under Mediterranean bioclimate, heathy peatlands occupy small and scattered patches. A strong diaspore pressure from the surrounding matrix vegetation might be effective. When such neighbourhood effects are responsible for the dissimilarity in the data set, one should expect a significant presence of transgressive *taxa* from the surrounding communities, which often act as differential species at the community level.

2. Study area

The study area corresponds to the northern and western parts of the Iberian Peninsula and the Tangier Peninsula in NW Morocco, i.e. (i) the regions of the SW Mediterranean region, which are under an Atlantic climatic influence, favouring the occurrence of heathy peatlands and (ii) those parts of the Iberian Peninsula which belong to the Euro-Siberian phytochorion.

3. Material and methods

All published data of heathy peatlands, sampled according to the phytosociological approach (= relevés) and classified within a hierarchical system of floristic similarity (Braun-Blanquet, 1964; Rivas-Martínez, 1976; Géhu & Rivas-Martínez, 1981; Rivas-Martínez, 2005), were gathered from the SIVIM database (http://www.sivim.info/), except for five relevés coming from Neto *et al*. (2014). The localities of all the records are illustrated in Figure 2 of the Results section. Therefore, for a numerical syntaxonomic analysis and for presenting a synoptical table attempting to depict the maximal phytocoenotical variation, we used, respectively, two distinct sets of relevés: set #1, the one including the original protologue tables alone (including the types); and set #2, a general one using all the collected relevés (Portugal, Spain, Morocco). The reasoning behind it is that two distinct objectives in classifying are sought: 1st) to construct a syntaxonomic typology: the use of just the relevé set corresponding surely to the authors original concepts (set #1) is assured. By doing so, we rule out heterodox interpretations of syntaxa; 2nd) the set #2 is used to express fully the phytocoenologial variation of the vegetation for which we used all the collected relevés.

Set #1 consists in a matrix of 281 relevés x 347 species, which was prepared for statistical analysis. Floristic nomenclature was standardized according to Coutinho (1939), Franco (1971, 1984), Franco & Rocha Afonso (1994, 1998, 2003), and Castroviejo (1986-2012).

With this matrix, an agglomerative hierarchical cluster analysis using Bray-Curtis dissimilarity and complete linkage as cluster strategy was performed (Figure 1), using R statistical software (R Core Team 2013) functions *agnes* and *vegdist* respectively from packages cluster (Maechler *et al.*, 2013) and vegan (Oksanen *et al.*, 2013).

All the data on set #2 were included in the synoptic table (Table 1), documenting a total number of 481 relevés.

A syntaxonomic scheme with full names including authors is presented, applying the International Code of Phytosociological Nomenclature (Weber *et al.*, 2000) and adapted from Costa *et al.* (2012). The bioclimatic differentiation nomenclature follows the Worldwide Bioclimatic Classification System of Rivas-Martínez *et al.* (2011).

4. Results

4.1. Syntaxa of higher rank (= clusters within the dendrogram)

The cluster analysis resulted in two well-separated groups of relevés (group A and B), which are visible in the dendrogram (Figure 1). The same two groups are reflected in the synoptic table (Table 1). Considering the floristic composition and the distribution of the communities and their relation to altitude and bioclimate, a clear phytogeographical, ecological and bioclimatic segregation emerges (Figures 1, 2 and 3). Group A aggregates a set of associations from the south-western and western parts of the Iberian Peninsula and from NW Morocco, predominantly occurring in coastal areas and in lower altitudes with a Mediterranean bioclimate. The following associations belong to group A: (1) Genisto ancistrocarpae-Ericetum ciliaris; (2) Gentiano pneumonanthe-Genistetum ancistrocarpae; (3) Erico erigenae-Schoenetum nigricantis; (4) Erico tetralicis-Myricetum gale (pro parte); (5) Lavandulo viridis-Ericetum lusitanici; (6) Cisto psilosepali-Ericetum lusitanicae; (7) Cirsio welwitschii-Ericetum ciliaris; (8) Erico ciliaris-Ulicetum lusitanici; (9) Drosero intermediae-Ericetum ciliaris; (10) Genisto berberideae-Ericetum tetralicis.

In group B, we find the associations growing in mid and high altitudes respectively under temperate bioclimatic conditions: (4) Erico tetralicis-Myricetum gale (pro parte); (11) Genisto anglicae-Ericetum scopariae; (12) Euphorbio polygalifoliae-Ericetum tetralicis; (13) Agrostio hespericae-Ulicetum minoris; (14) Genisto anglicae-Ericetum tetralicis; (15) Gymnadenio-Ericetum tetralicis; (16) Potentillo herminii-Callunetum; (17) Thymelaeo dendrobryi-Genistetum carpetanae; (18) Genisto anglicae-Ericetum vagantis; (19) Genisto anglicae-Daboecietum cantabricae.

Table 1. Synoptic table of communities of the alliances Genistion micrantho-anglicae and Ulici lusitanici-Genistion ancistrocarpae (Calluno-Ulicetalia minoris, Calluno vulgaris-Ulicetea minoris) on the Iberian Peninsula and in northwest Morocco. (All the references in the table legend are available in digital annex online).

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Ulex australis	.	.	.	.	.	I	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium welwitschii	.	.	.	.	.	.	.	II	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus rugosus	.	.	.	.	.	.	.	II	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhynchospora modesto-lucenoi	.	.	.	.	.	.	.	II	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ulex welwitschianus	.	.	.	.	.	.	.	.	.	X	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Drosophyllum lusitanicum	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lavandula viridis	.	.	.	.	.	.	.	.	.	.	.	IV	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lavandula x alportelensis	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sibthorpia europaea	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Genista berberida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Erica mackaiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cistus ladanifer	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	x	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachypodium sylvaticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	1	x	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Euphorbia polygalifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	X	III	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Daboecia cantabrica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	I	3	X	V	X	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	2	.	3	.	.	.	2	.	.	.	.	2	1	.	.	.	.	.	.
Genista tinctoria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla erecta herminii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	V	.	V
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Characteristics and differentials of the *Ulici lusitanici -Genistion ancistrocarpae* alliance																																																																									
Erica ciliaris	IV	V	5	3	V	IV	V	V	X	X	V	.	X	2	4	III	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
Ulex minor var. *lusitanicus*	.	.	.	.	V	V	V	V	X	X	V	II	X	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Genista ancistrocarpa	IV	.	3	3	III	.	I	II	X	X	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erica lusitanica	.	.	.	.	.	.	.	I	X	.	IV	V	X	.	.	.	.	.	V	5	x	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Genista triacanthos (dif al.)	.	II	.	.	+	III	I	II	.	.	IV	.	X	1	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Drosera intermedia (dif al.)	.	.	.	.	.	.	.	r	X	X	III	.	.	.	1	IV	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pinguicula lusitanica (dif. al.)	.	II	2	2	.	.	.	.	.	.	III	.	X	2	.	.	3	2	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Myrica gale (dif. al.)	.	.	.	.	.	.	.	II	X	.	.	.	.	.	.	II	1	3	.	.	.	.	3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Molinia coerulea arundinacea (dif. al.)	.	V	.	.	IV	.	II	.	.	.	.	.	X	1	.	.	.	.	.	.	.	.	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cheirolophus uliginosus	.	.	.	.	I	I	.	I	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia uliginosa	.	.	.	.	.	.	.	III	X	X	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erica erigena	.	.	.	.	.	.	.	.	X		IV	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cistus populifolius major (dif al.)	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pterospatium tridentatum tridentatum (dif al.)	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Characteristics and differentials of the Genistion *micrantho-anglicae alliance*																																																																									
Genista anglica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	3	X	.	V	2	.	V	X	2	4	X	V	3	1	I	V	V	X	.	X	2	2	4	IV	X	.	1	.	V	5	.	V	3	V	3	X	1	5	1	V	V	2	1	.	.	III	V	IV	.
Genista micrantha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	X	V	3	X	.	.	.	5	.	V	1	2	V	V	III	.	X	.	.	4	3	V	X	X		X	V	5	2	V	2	IV	5	X	2	5	2	IV	.	2	2	.	.	.	.	III	IV
Nardus stricta (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X		III	1	.	.	.	1	2	.	V	3	.	I	V	IV	.	X	X	2	4		IV	X	X	1	X	I	.	.	II	2	r	1	X	3	3		III	.	.	1	V	5	V	V	V	I
Erica vagans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	V	4	X	V	X	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	V	X	X	1	X	V	5	2	V	5	V	5	X	4	5	2	V	IV	2	2	.	.	.	.	.	.

Table 1 (continuation)

	a1a	a1b	a2a	a2b	ba	bb	bc	ca	cb	cc	d	e1	e2a	e2b	f	g1	g2	h	ia	ib	ic	id	j	l	m	n1a	n1b	n2a	n2b	ao	ob	oc	pa	pb	pc	pd	pe	pf	pg	ph	pi	p1a	p1b	p1c	p2	qa	qb	qc	qd	qe	qf	qg	qh	qi	qj	ql	qm	qn	q1	q2a	q2b	q2c	q2d	q3	q4	q5	q6	ra	rb	sa	sb	t	u
Galium verum (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	1	X	I	.	.	.	.	.	.	.	.	.	.	.	X	.	.	3	.	.	X	.	1	.	II	.	.	.	1	.	.	.	.	.	.	.	I	1	1	III	2	.	.	II	.
Anthoxanthum odoratum (al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	X	III	.	.	.	.	II	1	.	I	.	r	.	.	.	.	1	.	.	.	.	.	.	II	1	.	.	.	r	.	.	2	.	.	.	I	.	.	II	3	.	.	.	.
Potentilla montana (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	1	X	V	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	I	X	.	.	.	III	5	.	.	.	V	5	.	.	.	.	III	III	.	1	.	.	.	.	.	.
Succisa pratensis (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	V	2	.	.	.	.	.	.	.	2	.	+	.	I	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	III	2	.	.	.	+
Chamaespartium sagittale (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	I	X	X	.	.	I	.	.	.	1	I	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Vaccinium myrtillus (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	1	.	+	.	r	.	X	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	3	.	.	.	III	.	.	.	.	II	.	.	I
Arenaria montana intricata (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	1	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	II	3	.	.	.	.	.	III	1	.	.	.	I	.	.	.
Halimium umbellatum (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	X	.	.	2	I	4	III	.	.	.	.	.	.	I	.	1	.	.	.	.	.	.
Deschampsia flexuosa (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	II	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	IV	.	.	I	.	r	I	.	.
Genista hispanica occidentalis (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	I	2	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	I	2	.	I	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Genista pilosa (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	X	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	r	.	.	.	.	.	.	IV	.	.	+	.	.	.	.	.
Pterospartum tridentatum cantabricum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	I	I	r	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Genista carpetana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2	.	.	.	.	.	V	.
Thymelaea broteriana (dif. al.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	III	1	.	.	.	II
Thymelaea coridifolia ssp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Characteristics of the class																																																																										
Calluna vulgaris	I	III	1	3	III	IV	IV	III	X	X	V	I	X	2	.	.	.	3	.	1	.	V	.	4	3	X	X	III	3	X	V	X	1	.	X	V	2	2	V	V	V	X	X	.		4	.	V	X	X	.	X	V	4	2	V	5	V	5	X	4	4	2	V	V	2	2	V	5	V	V	V	V
Erica scoparia	III	V	.	.	IV	IV	V	II	X	X	IV	II	X	2	.	.	.	1	II	2	x	III	.	4	3	.	.	.	.	.	.	.	.	.	X	I	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X		1		V	.	.	.	.	.	.	.	.	.
Erica tetralix	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	4	2	.	.	.	.	3	4	.	X	X	V	1	.	.	.	2	5	X	V	3	2	V	V	V	X	X	X		.	.	.	.	.	.	.	.	1	.	.	.	.	.	X	4	5	2	II	.	.	1	V	5	.	.	I	V
Erica cinerea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	I	2	X	V	X	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	III	.	.	1	.	II	1	.	V	.	V	5	.	.	1	.	I	V	.	.	.	.	.	.	.	+
Agrostis curtisii	I	IV	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	I	.	X	.	.	.	.	.	III	.	.	.	I	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	II	2	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Pedicularis sylvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	III	.	.	I	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	3	.	.	.	1	.	II	.	+	.	.	.
Halimium lasianthum alyssoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	4	.	IV	.	.	II	III	II	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	I
Erica umbellata	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	III	I	.	II
Lithodora prostrata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	1	.	I	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	I
Simethis mattiazzi	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I	1	.	.	.	.	.	.	.	1	.	II	II	.	.	.	.	.	.	.	.
Ulex minor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	V
Cirsium filipendulum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III
Pseudarrhenatherum longifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Serratula seoanei	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			IV
Ulex europaeus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Halimium ocymoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex asturica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.
Laserpitium prutenicum dufourianum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tuberaria lignosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Erica aragonensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Genista triacanthos scorpioides	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Luzula lactea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.
Pedicularis sylvatica lusitanica	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ulex latebracteatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Principal Companions																																																																										
Potentilla erecta	IV	III	5	3	III	I	I	III	X	X	IV	.	.	.	4	.	.	3	.	.	.	.	3	4	.	X	X	V	4	X	III	X	.	5	X	IV	2	1	V	V	V	X	X	X		4	.	IV	.	X	.	.	.	1	2	III	2	II	1	X	4	5	2	III	I	1	1	V	5	.	.	.	.
Danthonia decumbens	.	III	1	3	.	.	+	.	.	.	.	.	X	2	.	.	.	3	.	.	.	.	.	2	.	X	.	III	.	.	V	.	.	3	.	II	.	.	II	.	II	.	X	X	.	4	3	.	.	X	.	X	III	3	.	III	1	II	2	X	2	1	2	I	I	.	1	V	4	.	I	.	III
Avenula marginata sulcata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	.	.	.	.	.	.	.	X	X	.	1	.	IV	X	.	.	.	.	.	.	I	.	+	.	.	.	.	4	3	V	.	X	.	X	IV	3	2	II	4	IV	3	.	4	2	1	IV	III	2	.	.	4	.	.	III	.
Juncus squarrosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	2	X	.	I	1	.	.	.	1	4	.	V	2	1	II	V	II	X	X	X	1	1		IV	.	.	.	.	.	1	.	.	.	r	.	.	2	2	.	.	.	.	.	.	.	V	IV	III	III

Table 1 (continuation)

	a 1 a	a 1 b	a 2 a	a 2 b	ba	b b	bc	ca	c b	cc	d	e1	e2 a	e2 b	f	g1	g2	h	ia	ib	ic	id
Molinia caerulea	.	.	.	.	.	I	.	V	2	X	V	.	.	.	4	.	3	3	.	.	.	.
Agrostis capillaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Holcus lanatus	.	.	.	.	1	II	I	II	X	X	.	I	X	1	.	.	.	.	I	.	.	.
Carum verticillatum	I	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Pteridium aquilinum	I	I	2	3	V	III	II	III	.	.	.	I	X	.	.	.	.	.	II	.	.	III
Lotus pedunculatus	.	.	.	.	.	.	r	r	.	.	.	I	X	2	1	.	.	.	.	.	x	I
Gentiana pneumonanthe	.	.	.	.	.	.	.	.	x	x	.	.	.	.	3	.	.	3	.	.	.	.
Polygala vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca rubra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.
Lotus corniculatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Briza media	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex flacca	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Erica arborea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	3	x	V
Juncus effusus	.	.	.	.	+	.	r	.	.	.	III	.	.	.	.	.	.	2	.	.	.	.
Stachys officinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pilosella officinarum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex echinata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.
Luzula campestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.
Cruciata glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylorhiza maculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.
Cistus salviifolius	II	I	.	.	III	IV	I	.	.	.	.	III	.	.	.	.	.	.	II	.	.	I
Juncus acutiflorus	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.
Achillea millefolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex pilulifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Drosera rotundifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	1	.	.	.	.
Hypericum pulchrum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus ulmifolius	.	I	.	.	IV	II	II	III	.	X	.	V	.	.	.	.	.	.	V	3	x	V
Scirpoides holoschoenus	.	.	.	.	.	I	II	III	.	.	IV	V	X	1	.	.	.	.	IV	3	x	I
Carex panicea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.
Parnassia palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	3	2	.	.	.	.
Quercus pyrenaica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypochaeris radicata	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Ranunculus bulbosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	4	.	.	1	.	.
Anagallis tenella	.	.	1	3	I	.	II	.	.	.	IV	.	.	.	.	.	4	2	.	.	.	.
Luzula multiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygala serpyllifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	2	.	.	.	.
Prunella grandiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viola palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	4	.	.	.	.	.
Arnica montana atlantica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	3	.	.	.	.
Carex demissa		.	2	2	.	.	.	+	.	X	III	.	.	.	.	.	.	3	.	.	.	.
Digitalis parviflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypericum elodes	.	.	.	.	+	III	I	r	.	.	III	.	.	.	1	.	.	.	.	.	.	.
Schoenus nigricans	III	II	.	.	.	I	II	IV	.	.	IV	.	.	.	.	.	3	3	.	.	.	.
Thesium pyrenaicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachypodium rupestre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex nigra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eleocharis multicaulis	I	.	.	.	.	II	I	I	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Erythronium dens-canis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

	j	l	m	n1 a	n 1 b	n 2 a	n 2 b	a o	o b	oc	pa	p b	p c	p d	p e	p f	pg	p h	pi	p1 a	p1 b	p 1 c	p 2	q a	q b	q c	q d	q e	q f	q g	q h	qi	qj	q l	q m	q n	q1	q 2 a	q 2 b	q 2 c	q 2 d	q 3	q4	q 5	q6	ra	rb	sa	sb	t	u
Molinia caerulea	.	.	2	.	.	V	.	.	.	.	.	.	X	.		1	III	.	II	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	2	.	.	.	.	.	V	2	.	.	.	II
Agrostis capillaris	.	.	.	.	.	II	1	.	II	.	.	4	.	.	1	1	.	.	IV	.	X	.	.	3	1	.	X	.	1	X	II	.	.	.	3	.	.	.	.	.	2	.	III	1	1	II	4	.	.	.	.
Holcus lanatus	.	4	2	.	.	.	.	.	+	.	.	.	X	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	III	1	.	.	.	r	1	v	1	.	2	.	.	.	.	.	.	.	.	.	.
Carum verticillatum	.	.	.	X	.	II	.	.	.	.	.	.	X	IV	.	.	II	I	II	.	X	X	2	1	.	.	.	.	1	.	.	.	.	.	.	.	.	X	.	.	1	.	.	.	1	.	.	.	.	.	.
Pteridium aquilinum	.	4	.	.	.	.	.	X	IV	.	.	.	.	.	.	.	I	.	+	.	.	.	.	.	.	I	.	.	1	.	.	3	.	.	.	.	.	.	.	1	.	.	II	.	.	.	.	.	.	.	.
Lotus pedunculatus		4	1		X	I	.	.	.	.	2	3	.	.	.	1	r	.	.	.	.	.	.	.	.	.	.	.	.	.	I	1	.	.	.	.	.	.	1	.	.	II	.	.	.	.	.	.	.	.	.
Gentiana pneumonanthe	.	.	.	X	.	III	.	.	.	.	.	.	.	.	1	.	II	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	I	.	III	III
Polygala vulgaris	.	.	.	.	.	.	1	.	.	X	.	.	.	V	.	.	.	.	r	.	.	.	.	2	.	.	X	.	1	.	IV	3	.	II	.	II	.	.	.	3	.	V	I	.	1	.	2	r	.	.	+
Festuca rubra	.	.	.	.	.	.	.	.	+	.	.	.	.	III	.	.	.	III	+	.	.	X	1	.	.	.	.	.	.	X	II	.	.	V	2	.	2	.	.	.	.	.	IV	1	1	IV	.	II	.	.	.
Lotus corniculatus	.	.	.	.	.	I	.	X	IV	.	.	.	.	.	.	.	.	.	III	.	X	.	.	.	.	.	X	.	.	X	III	1	2	.	3	III	1	.	.	.	.	III	r	.	1	IV	.	+	.	.	.
Briza media	.	.	.	.	X	I	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	2	2	III	X	X	.	.	II	2	1	.	2	.	.	.	1	1	.	.	.	1	.	II	3	.	.	.	.
Carex flacca	.	.	.	.	X	II	.	.	II	.	.	1	.	.	.	.	.	.	I	.	.	.	.	1	1	.	.	.	1	.	II	.	.	.	.	.	.	.	1	.	.	.	.	1	1	II	1	.	.	.	.
Erica arborea	.	.	.	.	.	.	.	X	+	.	1	4	.	.	.	.	3	.	II	.	.	.	.	.	.	.	.	.	.	X	.	1	.	.	3	.	.	.	.	1	.	.	.	1	.	.	.	V	.	.	II
Juncus effusus	.	.	.	.	.	II	.	.	.	.	2	1	.	.	.	1	I	.	+	.	.	.	.	.	.	.	.	.	.	.	I	1	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	I	.	+
Stachys officinalis	.	.	1		X	II	1	X	II	.	.	.	.	.	.	.	+	.	r	.	.	.	.	.	.	.	X	.	.	.	.	.	.	I	1	.	.	.	1	.	.	II	I	1	.	.	.	.	.	.	.
Pilosella officinarum	.	.	.	.	.	.	.	X	II	.	.	.	.	I	.	1	.	.	II	.	.	.	.	1	.	.	.	.	.	X	.	.	1	I	1	II	2	.	.	.	.	.	r	.	.	IV	.	.	.	I	.
Carex echinata	3	2	.	.	.	.	.	.	.	.	1	1		III		1	I		+	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	I	.	I	.	.	.
Luzula campestris	.	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	x	.	.	.	.	.	.	.	1	.	II	1	.	II	.	r	1	.	.	1	.	II	.	.	.	.	.	.	.	.	.
Cruciata glabra	.	.	.	.	.	II	.	.	II	X	.	1	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	IV	3	.	.	.	III	2	X	.	.	.	III	r	.	.	III	.	.	.	.	.
Dactylorhiza maculata	.	.	.	.	X	.	.	.	.	.	.	1	.	.	.	.	II	.	I	.	X	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	2	3	.	.	r	.	.	III	5	.	.	.	.
Cistus salviifolius	.	.	1	.	.	.	.	.	II	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus acutiflorus	.	.	.	X	.	III	.	.	.	.	2	.	.	.	.	.	.	.	II	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	1	.	.	.	1	2	.	.	.	.	.	.
Achillea millefolium	.	.	.	.	X	.	1	.	I	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	II	X	.	.	.	.	.	.	.	1	r	.	.	.	.	.	.	r	.	.	I	3	.	.	.	.
Carex pilulifera	.	.	.	.	.	.	.	X	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	.	II	.	r	.	X	1	2	.	.	.	.	.	II	.	.	.	II	.
Drosera rotundifolia	2	.	.	.	.	I	.	.	.	.	1	.	X	II	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	r	.	.	.
Hypericum pulchrum	.	.	.	.	X	.	1	X	II	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	X	III	.	.	I	.	I	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Rubus ulmifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.
Scirpoides holoschoenus	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex panicea	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	r	.	.	.	.	X	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	III	2	.	.	.	I
Parnassia palustris	.	.	.	X	.	III	.	.	.	.	.	.	.	.	.	1	.	.	+	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Quercus pyrenaica	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	1	.	.	2	.	.	.	III	2	.	.	.	1	II	II	.	.	.	.	.	.	.	.
Hypochaeris radicata	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	I	.	.	I	.	.	.	.	.	.	.	.	.	.	.	II	1	+	.	.	.
Ranunculus bulbosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	1	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	1	I	.	.	.
Anagallis tenella	3	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Luzula multiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	II	.	r	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	3	+	.	.	I
Polygala serpyllifolia	.	.	.	.	.	II	.	X	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	I	.	.	+
Prunella grandiflora	.	.	.	.	X		1		I	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	X	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	r	1	.	.	.	.	.	.	.
Viola palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	3	r	.	.	II
Arnica montana atlantica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	II
Carex demissa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Digitalis parviflora	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	III	.	.	.	1	r	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Hypericum elodes	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schoenus nigricans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thesium pyrenaicum	.	.	.	.	X	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	III	1	.	.	.	.
Brachypodium rupestre	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	1	.	I	.	.	.	.	.	.	.	.
Carex nigra	2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	X	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	r	.	.	.
Eleocharis multicaulis	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erythronium dens-canis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	I	.	.	I	.	.	.	.	+

Table 1 (continuation)

	a 1 a	a 1 b	a 2 a	a 2 b	ba	b b	bc	ca	c b	cc	d	e1	e2 a	e2 b	f	g1	g2	h	ia	ib	ic	id	j	l	m	n1 a	n 1 b	n 2 a	n 2 b	a o	o b	oc	pa	p b	p c	p d	p e	p f	pg	p h	pi	p1 a	p1 b	p 1 c	p 2	q a	q b	q c	q d	q e	q f	q g	q h	qi	qj	q l	q m	q n	q1	q 2 a	q 2 b	q 2 c	q 2 d	q 3	q4	q 5	q6	ra	rb	sa	sb	t	u
Filipendula vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	II	2	.	.	.	.	.	.	.	.	.	II	I	.	.	.	.	.	.	.	.
Galium saxatile	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	I	.	r	.	.	.	.	.	.	.	.	.	.	.	III	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.
Halimium halimifolium multiflorum	I	.	.	.	.	I	I	II	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juniperus communis alpina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	II	.	IV	IV	.	.
Lathyrus linifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	r	.	.	.	.	.	.	I	.	.	.	1	.	.	.	.
Lythrum salicaria	.	.	.	.	.	.	+	III	X	X	.	I	X	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Myrtus communis	I	V	.	.	I	II	II	.	.	.	.	II	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Serratula tinctoria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.
Trifolium pratense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	1	.	.	.	r	.	.	III	4	.	.	.	.
Centaurea nigra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	1	.	I	.	.	.	.	.
Festuca rivularis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.
Gymnadenia conopsea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	III	r	.	.	IV	2	.	.	.	.
Hypericum richeri burseri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	.	.	.	.
Juncus bulbosus	.	.	.	.	.	.	.	.	.	X	III	.	X	1	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scilla verna	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	r	.	.	X	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.
Stellaria graminea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	1	.	.	.	.
Thymus pulegioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	III	.	.	.	.	I	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scirpus cespitosus germanicus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dittichia revoluta	.	.	.	.	.	.	.	.	.	.	.	.	X	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oenanthe maroccana	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

a - Genisto ancistrocarpae-Ericetum ciliaris: a1a - (Quézel et al., 1988) - (tab. 14, relevés 1-6); a1b - Genisto ancistrocarpae-Ericetum ciliaris: (Galán de Mera, 1993) - (tab. 26, relevés 1-7); a2a - Genisto ancistrocarpae-Ericetum ciliaris pinguiculetosum lusitanicae: (Romo, 2009) - (tab. 5, relevés 1-5); a2b - (C Neto, J C Costa, J P Fonseca & M Geraldes 2012 ined.) - (Marocco) Mountains of W Rif, Bou Hassim, above Boubiyene and Bou Hassim, above El Maouzki; b - Erico ciliaris-Ulicetum lusitanici: ba - (Rivas Martínez et al. 1980) - (tab. 60, relevés 1-12); bb - (Heras Pérez, 2007) - (tab. 45, relevés 1-10); bc - (López Albacete, 2009) - (tab. 44, relevés 1-15); c - Cirsio welwitschii-Ericetum ciliaris: ca - (Neto, 2002) - (tab. 30, relevés 1-22); cc – (M.Porto, J.C.Costa, C.Neto. M.Geraldes 2012, Ined.) - (Ribeira da Landeira - Sado); cd – (C. Neto, M. Geraldes, J.C.Costa, J.P.Fonseca 2011, ined.) - (Texugueiras - Sado); d - Drosero intermediae-Ericetum ciliaris: (Antunes, 1994) - (tab. 4, 1-9); e - Lavandulo viridis-Ericetum lusitanici: e1 – (Vila-Viçosa et al 2012) - (tab. 1, 11 inv.); e2a - Lavandulo viridis-Ericetum lusitanici pinguiculetosum lusitanicae: (Neto et al 2014) – (tab. 1, relevé 6); e2b - (Deil et al 2010) - (tab. 1, relevés 1-2); f - Gentiano pneumonanthe-Genistetum ancistrocarpae: (Honrado et al 2002) - (tab. 3 relevés 1-4); g - Genisto berberidae-Ericetum tetralicis: (Bellot Rodríguez, 1966) - (tab. 8 relevés 1-4); h - Erico-Schoenetum nigricantis: (Rivas Goday & Mansanet, 1972) - (tab. 1 relevés 1-4); i - Cisto psilosepali-Ericetum lusitanicae: ia- (Pérez Latorre et al 2002) - (tab. 2 relevés 1-6); ib – (Quesada, 2010) - (tab. 106, relevés 1-5); ic – (Rivas-Martínez,1979) - (tab. 8, 1 relevé); id – (Valdés Franzi,1984) – (tab. 5 relevés 1-7); j - Erica tetralix-Myrica gale community: (Rivas Goday, 1964) – (tab. without number - page 470, 3 relevés); l - Erico tetralicis-Myricetum gale: (Negueruela, 1980) - (tab. 1, relevés 1-4); m - Genisto anglicae-Ericetum scopariae: (Amor, 1991) - (tab. 91, relevés 1-3); n -Euphorbio polygalifoliae-Ericetum tetralicis: n1a - (Fernández Prieto & Loidi 1983) - (tab. 5, relevé 1); n1b - (Herrero Cembranos, 1989) - (tab. 43, relevé 1); n2 -Euphorbio polygalifoliae-Ericetum tetralicis ericetosum vagantis: n2a (Fernández Prieto & Loidi, 1983) - (tab. 5, relevés 2-8); n2b - (Herrero Cembranos, 1989) - (tab. 43, relevés 2-5); o - Genisto anglicae-Daboecietum cantabricae: oa - (Loidi et al 1997) - (tab. In text); ob- (Peralta de Andrés, 1997) - (tab. 02, relevés 1-14); oc - (Tarazona, 1984) - (tab. 4, relevé 22); p - Genisto anglicae-Ericetum tetralicis: pa - (Amor, 1991) - (tab. 93, relevés 1-2); pb - (Llamas Garcia,1984) - (tab. 30, relevés 1-5); pc - (Loriente Escallada,1974) (relevé in text); pd - (Navarro Andrés & Valle Gutiérrez, 1983) - (tab. 5, relevés 1-6); pe - (Ortiz, 1986) - (tab. 74, relevés 1-3); pf - (Puente García, 1988) - (tab. 63, relevés 1-2); pg - (Pulgar, 1999) - (tab. 19, relevés 1-18); ph - (Rivas-Martínez, 1979) - (tab. 20, relevés 1-7); pi - (Santos del Castillo & Díaz González, 1987) - (tab. 1, relevés 1-20); p1 - Genisto anglicae-Ericetum tetralicis scirpetosum germanici: p1a - (Ortiz, 1986) - (tab. 74, relevés 4); p1b - (Santos del Castillo & Díaz González, 1987) - (tab. 1, inv. 21); p1c - (Silva Pando, 1990) - (tab. 36, relevés 2); p2 - Genisto anglicae-Ericetum tetralicis euphorbietosum polygalifoliae: (Rivas-Martínez, 1979) - (tab. 20 relevés 8-9); q - Genisto anglicae-Ericetum vagantis ericetosum vagantis: qa - (Alonso, 2002) - (tab. 76, relevés 1-4); qb - (Fernández Prieto & Loidi 1983) - (tab. 4, relevés 1-4); qc - (García González, 1990) - (tab. 68, relevés 1-8); qd - (Herrero Cembranos, 1989) - (tab. 52, 1 relevé); qe - (Lence Paz, 2001) - (tab. 76, relevés 1); qf - (Loidi et al 1997) - (tab. 3, relevé 4); qg - (López Pacheco, 1988) relevé in text; qh - (Medrano, 1994) - (tab. 34, relevés 1-7); qi - (Navarro, 1986) - (tab. 43 relevés 1-5); qj - (Pérez Morales, 1988) - (tab. 59, relevés 1-2); ql - (Rivas-Martínez, 1979) - (tab. 19, relevés 1-8); qm - (Santos del Castillo & Díaz González 1987) - (tab. 2, relevés 1-5); qn - (Tarazona & Zaldívar, 1987) - (tab. 6, relevés 1 -19); q1 - Genisto anglicae-Ericetum vagantis cistetosum laurifolii: (Tarazona & Zaldívar 1987) - (Tab 6, Inv. 20-24); q2a - Genisto anglicae-Ericetum vagantis ericetosum tetralicis: (Loidi et al 1997b) - relevé in text; q2b - (Alonso, 2002) - (tab. 76, relevés 5-8); q2c - (Navarro, 1986) - (tab. 51 - relevés 1-5); q2d - (Santos del Castillo & Díaz González 1987) - (tab. 2, relevés 8-9); q4 - Genisto anglicae-Ericetum vagantis ericetosum scopariae: (Navarro, 1986) - (tab. 43, relevés 6-12); q5 - Genisto anglicae-Ericetum vagantis arctostaphyletosum crassifoliae : (Peralta de Andrés & Báscones Carretero, 1997) (tab. 1, relevés 1-25); q6 - Genisto anglicae-Ericetum vagantis genistetosum occidentalis: (Santos del Castillo & Díaz González, 1987) - (tab. 2, relevés 6-7); q7 - Genisto anglicae-Ericetum vagantis deschampsietosum hispanicae: (Santos del Castillo & Díaz González, 1987) - (tab. 2, relevés 10-11); r - Gymnadenio-Ericetum tetralicis: ra - (Ballesteros et al. 1983) - (tab. 7, relevés 1-12); rb - (Carreras et al 1993) - (tab. 56, relevés 1-5); s - Potentillo herminii-Callunetum: sa -(Jansen, 2011) - (tab. 2, relevés 1-35); sb - (Rivas-Martínez, 1981) - (tab. 11, relevés 1-6); t -Thymelaeo dendryobryi-Genistetum carpetanae: (Rivas-Martínez, 1979) - (tab. 18, relevés 1-7); u - Agrostio hespericae-Ulicetum minoris: (Honrado et al 2003) - (tab. 13.11, relevés 1-11).

4.2. Ulici lusitanici-Genistion ancistrocarpae

Based upon the floristic, phytogeographical and bioclimatic consistency of the two clearly separated groups, we conclude, that a new alliance within the Calluno-Ulicetalia minoris (class Calluno-Ulicetea) is justified, the Ulici lusitanici-Genistion ancistrocarpae *all*. *nova hoc loco* [holotypus allianciae: Cirsio welwitschii-Ericetum ciliaris Neto, Capelo, J.C. Costa and Espírito-Santo in Neto, Capelo, J.C. Costa and Lousã 1996]. This new alliance (see group A) is characterized by the occurrence of the following taxa (see Table 1): *Cheirolophus uliginosus*, *Erica lusitanica*, *Drosera intermedia* (annex 1 photo 4)*, Euphorbia uliginosa*, *Genista ancistrocarpa*, *Gentiana pneumonanthe* var. *pneumonanthe*. *Myrica gale* and *Ulex minor* var. *lusitanicus* Beside these character species, the Ulici-Genistion ancistrocarpae is further differentiated from group B (the alliance Genistion micrantho-anglicae) by the occurrence of transgressive taxa, coming from the surrounding matrix vegetation of better drained, non-peaty soils, namely: *Cistus populifolius* subsp. *major, Genista triacanthos*, *Halimium halimifolium* subsp. *multiflorum*, *Juncus rugosus*, *Lavandula* x *alportelensis*, *Lavandula viridis*, *Molinia caerulea* subsp. *arundinacea*, *Myrtus communis Pinguicula lusitanica*, *Pterospartum tridentatum* subsp. *tridentatum*, *Rhynchospora modesto-lucenoi* and *Ulex welwitschianus*.

The Ulici-Genistion ancistrocarpae includes the peaty heathland communities from the lower and mid-altitudes of the western Iberian Peninsula and in north-western Morocco, growing mainly under thermo- and mesomediterranean bioclimatic conditions, but ranging also marginally into mesotemperate bioclimates. The communities colonize depressions, permanently water-fed from subsurface table springs, hence water-logged or w*et al*l year round. Such physiotopes with a high water table during most parts of the year are rare under a Mediterranean precipitation regime. They occur occasionally on sandy substrates, conglomerates and gravel beds in the littoral zone (e.g. interdunal wetlands) and in lowlands, and in the more interior parts of the Iberian Peninsula on ranãs (Pliocene torrential deposits originated in a semi arid climate). The soils have a thick organic layer (peat) or can be classified as hydromorphic podzols (annex1 photo 2).

4.3. Genistion micrantho-anglicae

The associations belonging to this alliance (see group B) are characterized by the occurrence of the following taxa: *Erica vagans, Genista micrantha, G. anglica, G. carpetana, Potentilla erecta* var. *herminii, Thymelaea coridifolia* subsp. *dendrobryum,* and *Serratula seoanei.* This alliance is further differentiated by a large number of transgressive taxa (differential species), occurring in the surrounding vegetation matrix like: *Achillea millefolium*, *Anthoxanthum odoratum*, *Carex pilulifera*, *Chamaespartium sagittale*, *Cruciata glabra*, *Deschampsia flexuosa*, *Digitalis parviflora*, *Erythronium dens-canis*, *Galium verum*, *Genista hispanica* subsp. *occidentalis*, *Genista pilosa, Halimium umbellatum, Nardus stricta*, *Pilosella officinarum*, *Potentilla montana*, *Pterospartum tridentatum* subsp. *cantabricum, Thymelaea broteriana, Thesium pyrenaicum*, *Vaccinium myrtillus*, among others. In the catenal sequence, the heathy peatlands of the Genistion micrantho-anglicae are often in contact with Nardetea communities, which never happen alongside the Ulici-Genistion ancistrocarpae communities. According to Deil *et al.* (2010), the transgressive taxa (*i.e.* with an optimum in neighbouring syntaxa of the vegetation catena) additionally reflect the phytogeographic contrast between the Euro-Siberian and the Mediterranean phytochorion.

4.4. Transitional character of the Erico tetralicis-Myricetum gale

The relevés of this association are scattered between the two clusters. In heathy peatland in the Montes de Toledo (Velasco Negueruela 1980), where *Genista anglica* occurs, the relevés were placed in group B (4.2 in Figure 1). The relevés from Rivas Goday (1964), in Valle de la Viuda are relatively poor in taxa, lacking the presence of *Genista anglica* and were placed in group A (4.1 Figure 1). However the presence of *Genista anglica* in this region is acknowledge by Rivas Goday (1964), which led us to place this community in the Genistion micrantho-anglicae, despite its transition character shown by the presence of *Erica scoparia*, *Myrica gale* or *Pinguicula lusitanica*.

4.5. Altitudinal niches

The Genistion micrantho-anglicae and the Ulici-Genistion ancistrocarpae have different altitudinal niches, a phenomenon that is a direct expression of their linkage to different hygro- and thermoclimates (Figure 3): The Genistion micrantho-anglicae occurs in mid and high altitudes. The lowest records of its communities lies at 770 m a.s.l. and 90 % of the relevés were sampled above 950 m, with an average altitude of 1330 m. Ulici-Genistion communities are found almost exclusively below 900 m a.s.l. 80% of the relevés were sampled under 600 m a.s.l., with 320 m as average altitude of the sample plots. Only far to the south (in NW Morocco), stands of the Genisto anglicae-Ericetum ciliaris pinguiculetosum lusitanicae (Romo 2009) occur also in the higher altitude in the outer ranges of the Western Rif Mountains in Morocco. This can be related to the fact that in drier or more deeply Mediterranean areas, the higher regional temperatures and summer drought conditions are compensated at higher elevation as local temperatures and precipitation yield in comparable evapotranspiration rates. The increase of altitude of the vegetation belts towards the south is a general pattern in the Mediterranean biome. This increase can apparently compensate the decrease in precipitation and the increase in mean temperature towards the south, and this hold also true for the heathy peatland.

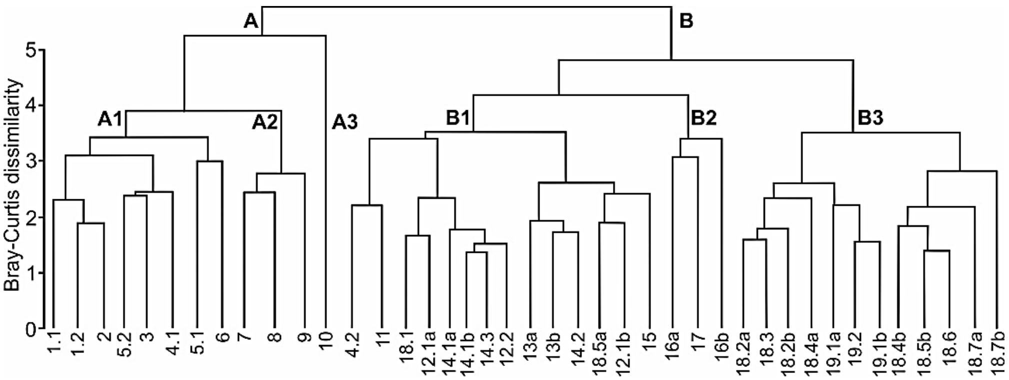


Figure 1. Floristic dissimilarity of heathland communities on peaty soils on the Iberian Peninsula and NW Africa.(Dendrogram using Bray-Curtis dissimilarity of a total of 281 relevés)

A - *Ulici lusitanici-Genistion ancistrocarpae*; B *Genistion micrantho-anglicae*.

Community names, bibliographic sources and number of relevés: 1 (13 relevés) - **1.1** Genisto ancistrocarpae-Ericetum ciliaris (Quézel *et al.* 1988) Tab. 14 (relevés 1-6); **1.2** Genisto ancistrocarpae-Ericetum ciliaris pinguiculetosum lusitanicae (Romo, 2009) Tab. 5 (relevés 1-5). **2 (4 relevés)** - Gentiano pneumonanthe-Genistetum ancistrocarpae (Honrado 2002) Tab. 3 (relevés 1-4). **3 (4 relevés)** - Erico erigenae-Schoenetum nigricantis (Goday & Mansanet 1972) Tab. 1 (relevés 1-4). **4 (7 relevés)** - Erico tetralicis-Myricetum gale **4.1** (Rivas Goday 1964) Tab. without number, pag. 470 (3 relevés); **4.2** (Velasco Negueruela 1980) Tab. 1 (relevés 1-4). **5 (14 relevés)** – **5.1** Lavandulo viridis-Ericetum lusitanici (Vila-Viçosa 2012) Tab. 1 (relevés 1-11), **5.2** Lavandulo viridis-Ericetum lusitanici pinguiculetosum lusitanicae (Deil *et al.* 2010) Tab. 1 (relevés 1-2). **6 (8 relevés)** - Cisto psilosepali-Ericetum lusitanicae (Valdés Franzi 1984) Tab. 5 (relevés 1-7), (Rivas-Martínez 1979) Tab. 8 (1 relevé). **7 (12 relevés)** - Erico ciliaris-Ulicetum lusitanici (Rivas-Martínez *et al.* 1980) Tab. 60 (relevés 1- 12). **8 (22 relevés)** Cirsio welwitschii-Ericetum ciliaris (Neto *et al.* 2002) Tab. 30 (relevés 1-22). **9 (9 relevés)** - Drosero intermediae-Ericetum ciliaris (Antunes 1994) Tab. 4 (relevés 1-9). **10 (29 relevés)** - Genisto berberideae-Ericetum tetralicis (Casaseca 1959) Tab. 8 (relevés 1-4), (Bellot Rodríguez 1966) Tab. 11 (relevés 1-25). **11 (3 relevés)** - Genisto anglicae-Ericetum scopariae (Amor 1991) Tab. 91 (relevés 1-3). **12 (7 relevés) - 12.1** Euphorbio polygalifoliae-Ericetum tetralicis ericetosum vagantis (Fernández Prieto & Loidi 1983) Tab. 5 (**12.1a** relevés 2 and 5-8, **12.1b** relevés 3 and 4); **12.2** Euphorbio polygalifoliae-Ericetum tetralicis ericetosum tetralicis (Fernández Prieto & Loidi 1983) Tab. 5 (relevé 1). **13 (11 relevés)** - Agrostio hespericae-Ulicetum minoris (Honrado 2003) Tab. 13.11 (**13a** relevés 1,2,5,6,7,9; **13b** 3,4,8,10,11). **14 (11 relevés) - 14.1** Genisto anglicae-Ericetum tetralicis ericetosum tetralicis (7 relevés) (Rivas-Martínez 1979) Tab. 20 (**14.1a** relevés 1-4; **14.1b** relevés 5-7); **14.2** Genisto anglicae-Ericetum tetralicis scirpetosum germanici (1 relevé) (Santos del Castillo & Díaz González 1987) Tab. 1 (relevé 21); **14.3** Genisto anglicae-Ericetum tetralicis euphorbietosum polygalifoliae (2 relevés) (Rivas-Martínez 1979) Tab. 20 (relevés 8-9). **15 (12 relevés)** - Gymnadenio-Ericetum tetralicis (Ballesteros *et al.* 1983) Tab. 7 (relevés 1-12). **16 (41 relevés)** - Potentillo herminii-Callunetum (Rivas-Martínez 1981) Tab. 11 (**16a** relevés 1-6), (Jansen 2011) Tab. 2 (**16a** relevés 12-35; **16b** relevés 1-11). **17 (7 relevés)** - Thymelaeo dendryobryi-Genistetum carpetanae (Rivas-Martínez 1979) Tab. 18 (relevés 1-7). **18 (54 relevés) - 18.1** (6 relevés) Genisto anglicae-Ericetum vagantis ericetosum tetralicis (Navarro, 1986) Tab. 51 (relevés 1-5), (Loidi *et al.* 1997b) relevé in text; **18.2** Genisto anglicae-Ericetum vagantis ericetosum vagantis (8 relevés) (Rivas-Martínez 1979) Tab. 19 (**18.2a** relevés 1,2,3,4,6; **18.2b** relevés 5,7,8); **18.3** Genisto anglicae-Ericetum vagantis cistetosum laurifolii (5 relevés) (Tarazona & Zaldívar 1987) Tab. 6 (relevés 20-24); **18.4** Genisto anglicae-Ericetum vagantis ericetosum scopariae (7 relevés) (Navarro 1986), Tab. 43 (**18.4a** relevés 6,7,8,11,12; **18.4b** relevés 9,10); **18.5** Genisto anglicae-Ericetum vagantis deschampsietosum hispanicae (2 relevés) (Santos del Castillo & Díaz González 1987) Tab. 2 (**18.5a** relevé 10; **18.5a** relevé 11); **18.6** Genisto anglicae-Ericetum vagantis genistetosum occidentalis (2 relevés) (Santos del Castillo & Díaz González 1987) Tab. 2 (relevés 6-7); **18.7** Genisto anglicae-Ericetum vagantis arctostaphyletosum crassifoliae (25 relevés) (Peralta de Andrés & Báscones Carretero 1997) Tab. 1 (**18.7a** relevés 21-25; **18.7b** relevés 1-21). **19 (15 relevés) - 19.1** Genisto anglicae-Daboecietum cantabricae (Peralta de Andrés & Báscones Carretero 1997) Tab. 2, (relevés 1-14) (**19.1a** relevés 1-4, 6, 11-14; **19.1b** relevés 5,7-10). **19.2** Genisto anglicae-

Daboecietum cantabricae ulicetosum gallii (Loidi 1997a) Table in text. **(All the references are available in digital annex online).**

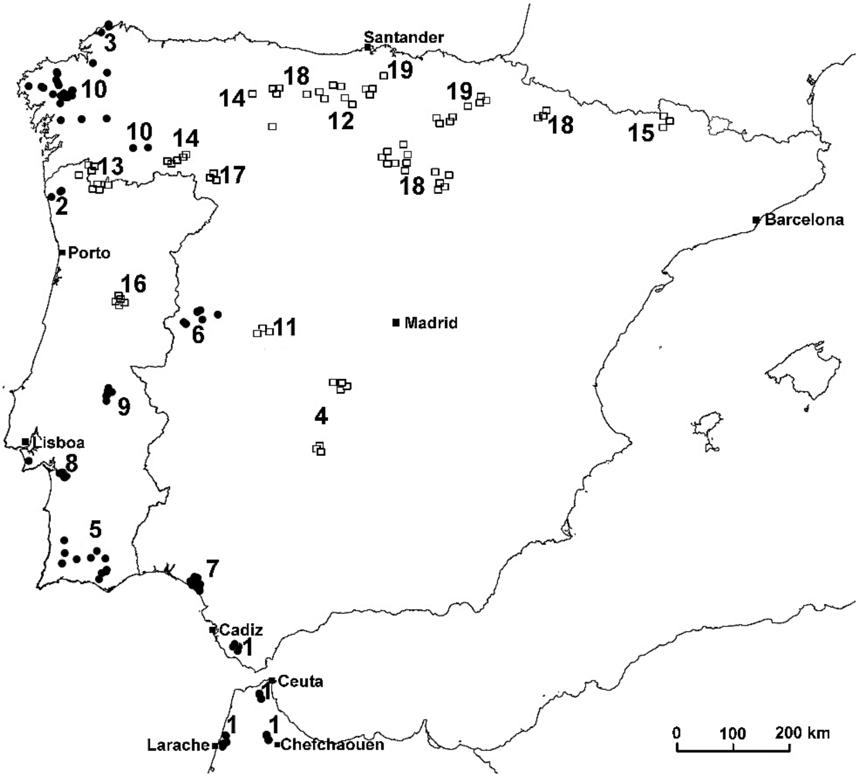
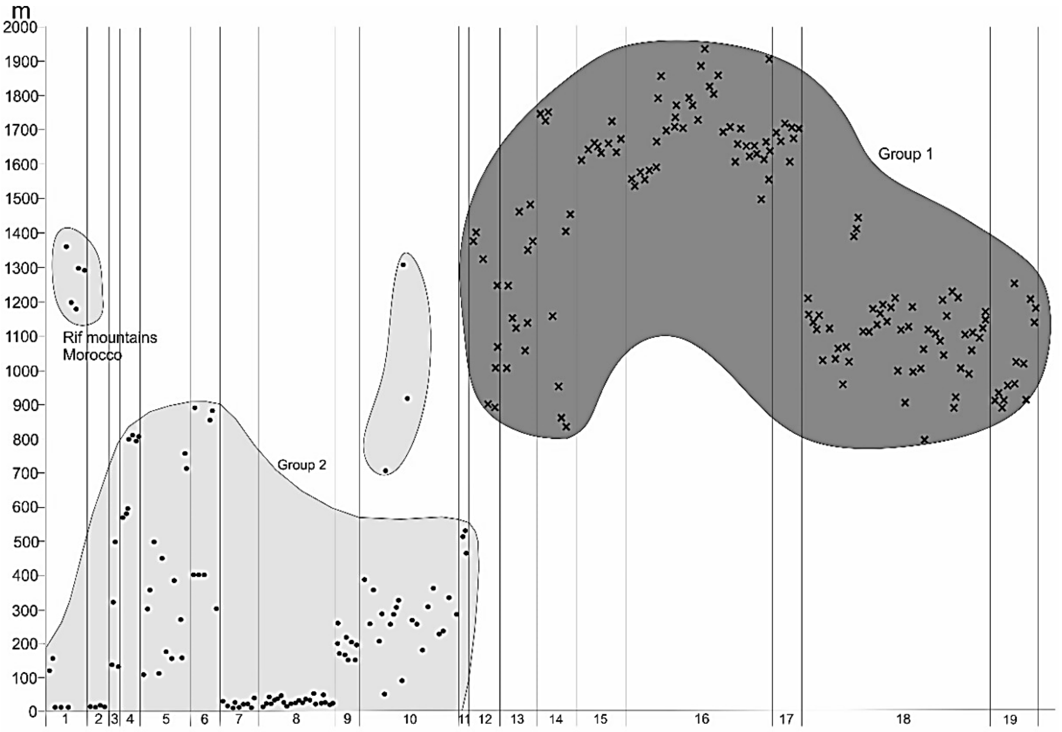


Figure 2. Location of the communities and relevés, used for the cluster analysis. Circles communities belonging to the Ulici lusitanici-Genistion ancistrocarpae, squares to the Genistion micrantho-anglicae (community numbers and names see legend to Figure 1).

4.6. Patterns within the alliances

Ulici-Genistion communities, growing on peaty slacks over sandy substrate in the south-western parts of the Iberian Peninsula, form an own subgroup (branch A2; 7 - Erico ciliaris-Ulicetum lusitanici, 8 - Cirsio welwitschii-Ericetum ciliaris, 9 - Drosero intermediae-Ericetum ciliaris), while other communities occur on different substrates (alluvia, schists, quartzites, etc. - branch A1). Within the Genistion micrantho-anglicae (branch B), there is a separation between a cluster formed by the *Erica tetralix* dominated communities (branch B1) and the other two clusters (branches B2, B3), where this taxon is rare or absent. Branch B3 is defined by the dominance of *Erica vagans*, *E. cinerea*, and by *Daboecia cantabrica* (species common in Northern Iberian mountain ranges under Atlantic influence) and the absence or rarity of *Juncus squarrosus*, dominant in branches

B1 and B2 though. These floristic patterns might indicate suballiances, but floristic support (characteristics and differentials *taxa*) for such syntaxa is relatively weak and might benefit from a dedicated study.



1 - *Genisto ancistrocarpae-Ericetum ciliaris*; 2 - *Gentiano pneumonanthe-Genistetum ancistrocarpae*; 3 - *Erico erigenae-Schoenetum nigricantis*; 4 - *Erico tetralicis-Myricetum gale*; 5 - *Lavandulo viridis-Ericetum lusitanici*; 6 - *Cisto psilosepali-Ericetum lusitanicae*; 7 - *Erico ciliaris-Ulicetum lusitanici*; 8 - *Cirsio welwitschii-Ericetum ciliaris*; 9 - *Drosero intermediae-Ericetum ciliaris*; 10 - *Genisto berberideae-Ericetum tetralicis*; 11 - *Genisto anglicae-Ericetum scopariae*; 12 - *Euphorbio polygalifoliae-Ericetum tetralicis*; 13 - *Agrostio hespericae-Ulicetum minoris*; 14 - *Genisto anglicae-Ericetum tetralicis*; 15 - *Gymnadenio-Ericetum tetralicis*; 16 - *Potentillo herminii-Callunetum*; 17 - *Thymelaeo dendryobryi-Genistetum carpetanae*; 18 - *Genisto anglicae-Ericetum vagantis*;19 - *Genisto anglicae-Daboecietum cantabricae.*

Figure 3. Altitude of sample plots used in the cluster analysis. Dark grey (Genistion micrantho-anglicae: mid and high altitudes); light grey (Ulici lusitanici-Genistion ancistrocarpae: lowlands).

4.7. Syntaxonomic scheme, resulting from the data analysis

CALLUNO VULGARIS-ULICETEA MINORIS Br.-Bl. & Tüxen ex Klika & Hadač 1944

CALLUNO-ULICETALIA MINORIS Quantin ex Tüxen 1937

A. Genistion micrantho-anglicae Rivas-Martínez 1979

(characteristic species: *Erica vagans, Festuca querana, Genista anglica, G. carpetana, G. micrantha, Potentilla erecta* var. *herminii, Thymelaea coridifolia* ssp. *dendrobryum, Serratula seoanei*)

a. **Agrostio hespericae-Ulicetum minoris** J. Honrado & Ortiz in Honrado, P. Alves, Nepomuceno & B. Caldas 2004

b. **Erico tetralicis-Myricetum gale** Ladero & A. Velasco 1980

c. **Euphorbio polygalifoliae-Ericetum tetralicis** F. Prieto & Loidi 1984

- **c1. ericetosum tetralicis**
- **c2. ericetosum vagantis** F. Prieto & Loidi 1984

d. **Genisto anglicae-Daboecietum cantabricae** Báscones & Peralta in Loidi, Berastegi & García-Mijangos 1996

e. **Genisto anglicae-Ericetum tetralicis** Rivas-Martínez 1979

- **e1. ericetosum tetralicis**
- **e2. euphorbietosum polygalifoliae** Rivas-Martínez 1979
- **e3. scirpetosum germanici** Santos del Castillo & Díaz González 1987

f. **Genisto anglicae-Ericetum scopariae** Ruiz 1979

g. **Genisto anglicae-Ericetum vagantis** Rivas-Martínez & Tarazona in Rivas-Martínez 1979

- **g1. ericetosum vagantis**
- **g2. arctostaphyletosum crassifoliae** Peralta 1992
- **g3. cistetosum laurifolii** Tarazona 1984
- **g4. deschampsietosum hispanicae** Santos del Castillo & Díaz González 1987
- **g5. ericetosum scopariae** Navarro 1986
- **g6. ericetosum tetralicis** G. Navarro in Loidi 1997
- **g7 genistetosum occidentalis** Santos del Castillo & Díaz González 1987

h. **Gymnadenio conopseae-Ericetum tetralicis** Ballesteros, Baulies, Canalís & Sebastià ex Rivas-Martínez & Costa 1988

i. **Potentillo herminii-Callunetum** Rivas-Martínez 1981

j. **Thymelaeo dendrobryi-Genistetum carpetanae** Rivas-Martínez 1979

B. Ulici lusitanici-Genistion ancistrocarpae Neto, J.C. Costa, Monteiro-Henriques, Capelo, Geraldes, Bellu & Deil all. nova hoc loco (holotypus: Cirsio welwitschii-Ericetum ciliaris)

(characteristic species: *Cheirolophus uliginosus*, *Erica lusitanica*, *Euphorbia uliginosa*, *Genista ancistrocarpa*, *G. berberidea, Ulex minor* var. *lusitanicus*)

a. **Cirsio welwitschii-Ericetum ciliaris** Neto, Capelo, J.C. Costa & Espírito-Santo in Neto, Capelo, J.C. Costa & Lousã 1996

b. **Cisto psilosepali-Ericetum lusitanici** Ladero ex Rivas-Martínez 1979

c. **Drosero intermediae-Ericetum ciliaris** Antunes 1994

d. **Erico ciliaris-Ulicetum lusitanicae** Rivas-Martínez & Costa in Rivas-Martínez, Costa, Castroviejo & E. Valdés 1980

e. **Erico erigenae-Schoenetum nigricantis** Rivas Goday & Mansanet 1972

f. **Genisto ancistrocarpae-Ericetum ciliaris** Quézel, Barbero, Benabid, Loisel & Rivas-Martínez 1988 corr. Neto, J.C. Costa, J.P. Fonseca, Monteiro-Henriques & Deil 2014

  f1. ericetosum ciliaris

  f2. pinguiculetosum lusitanicae Romo 2009

g. **Genisto berberideae-Ericetum tetralicis** Bellot & Casaseca in Casaseca 1959

h. **Gentiano pneumonanthes-Genistetum ancistrocarpae** Honrado & P. Alves in Honrado, P. Alves, Nepomuceno & B. Caldas 2002

i **Lavandulo viridis-Ericetum lusitanici** Vila-Viçosa, Quinto-Canas, Mendes, Cano-Ortiz, Rosa-Pinto, Pinto-Gomes 2012

  i1. ericetosum lusitanicae

  i2 pinguiculetosum lusitanicae Neto, J.C. Costa & Deil 2014

5. Discussion

Clusters of heathy peatland communities: The Atlantic façade of the western Iberian Peninsula and north-western Morocco harbours scattered and isolated patches of associations, dominated by hygrophilous *Genista* and *Erica* species (annex 1 photo 3). Based on the genetic studies carried out in the last decades, this isolation is ancient and, as will be discussed, it is mainly related to biogeographical drivers (associated with climatic changes) and to a less extent to anthropic actions. The inspection of some old documents and maps show a large presence of these habitats on the western coast of Portugal to about 1900 mainly associated with the Little Ice Age, cooling that occurred after the Medieval Warm Period (Medieval Climate Optimum) (1300 a 1850) (Lamb, 1972; Mann, 2003; Grove, 2004; Matthews & Briffa, 2005). During the 20th and 21st century we verify a huge reduction of the habitat area due to anthropic action documented in Daveau (1902), Fraga da Silva (2006), and Arsénio (2011). However the differentiation of the new alliance is clearly materialized by the presence of some lowland peaty *taxa* characteristic of the occidental facade of the Iberian Peninsula and NW Morocco representing ancient speciations due to genetic isolation owing to climatic changes (*Genista ancistrocarpa*, *Ulex minor* var. *lusitanicus*, *Gentiana pnemonanthe* var. *pnemonanthe*, among others) (Fonseca *et al.*, 2014; Fonseca *et al.*, 2015a; Fonseca *et al.*, 2015b; Geraldes *et al.*, 2014) (annex 1 photo 3). So, it seems evident that the biogeographic effect associated to climatic changes (probably at the top of Tertiary age), induced the genetic isolation of the populations of some characteristic *taxa* that support the cluster A, which correspond to the new alliance. The anthropic effect is felt in the reduction of habitat patches (number and area), yet not showing any clear contribution to the floristic segregation of the new alliance. These patches are the southernmost outliers of the class Calluno-Ulicetea, stretching as azonal vegetation into the Mediterranean biome. A number of character taxa of SW-Iberian and NW-Moroccan distribution such as *Genista ancistrocarpa*, *Ulex minor* var. *lusitanicus*, *Erica lusitanica*, *Cheirolophus uliginosus*, among others, clearly separate the Ulici lusitanici-Genistion ancistrocarpae from the Genistion micrantho-anglicae (annex 1 photo 4 and 5). The latter alliance is distributed in the Atlantic parts of the temperate climatic zone of Western Europe and in the Euro-Siberian part of the Iberian Peninsula, and it shifts up in altitude in the central parts of the Peninsula. Both alliances have their own character species and their clear separation in the classification process is not the result of a simple neighbourhood effect coming from transgressive taxa. But, of course, transgressive taxa from the surrounding vegetation matrix further differentiate both alliances, as the catenal context is different: Ulici-Genistion communities are often in contact to Quercetea ilicis and Cisto-Lavanduletea, while Genistion micranthae-anglicae to Querco-Fagetea and Nardetea communities.

Species richness in the north-south-gradient: The Ulici-Genistion has a lower average number of species per relevé (12 species) in comparison with the Genistion micrantho-anglicae (16 species). This decrease in species richness toward the south and southwest of the Iberian Peninsula is a common feature within all Calluno-Ulicetea communities (Loidi *et al.*, 2007). The centre of phytodiversity of the class on the Iberian Peninsula is in the NW (in Asturias). It decreases further inland and towards the south and southwest. The Mediterranean climatic conditions, and - in consequence - a reduction in patch size and an increasing isolation of the habitats might have resulted in a floristic impoverishment of the Ulici-Genistion communities, both by dry phases of the late Tertiary and by cold stadia during the Quaternary.

Phylogeographic patterns and speciation processes: Isolation of populations and changing climatic conditions throughout the Pleistocene have stimulated speciation processes and resulted in a number of geographical vicariant taxa within the Calluno-Ulicetea (Loidi *et al.*, 2007). As stated, this was recently shown for the *Genista anglica-G. ancistrocarpa* group by an analysis based upon molecular data (Fonseca *et al.*, 2014; Geraldes *et al.*, 2014), supporting the morphological variability within the group and the

SW Iberian-NW Moroccan phytogeographical sector, sensu Galán de Mera *et al.* (2003). *G. anglica* has a wider range: It is a lowland species from Denmark and Sweden down to the Pyrenean foothills, becoming a mountain species inside the Iberian Peninsula. The two species appear to be clearly allopatric and their separation seems to date back to the Miocene. The geographical separation of both clades on the Iberian Peninsula is congruent with the distribution limit between the two alliances. Furthermore, similar biogeographical patterns have been observed on the basis of molecular data in a number of other taxa (plant and animals) such as *Ulex* (Cubas *et al.*, 2005), *Stauracanthus* (Pardo *et al.*, 2008), the Iberian Lizard (Paulo *et al.*, 2001) and the Golden-striped Salamander (Alexandrino *et al.*, 2000). We conclude from these biogeographical patterns, that the floristic differentiation between Ulici-Genistion and Genistion micrantho-anglicae is the result of historical events dating back to the Miocene, and to expansion and reduction of the distribution areas of some keystone species during the climatic fluctuations of the Pleistocene. The local hydrological conditions of heathy peatlands can buffer dry paleoclimatic periods and such physiotopes can act as refugia for hygrophilous plants. This has been shown in more detail for the peninsulas on both sides of the Strait of Gibraltar by Rodríguez-Sánchez *et al.* (2008).

Conservation aspects: The heathy peatlands in SW Europe and NW Africa shelter the southernmost occurrences of Atlantic plant species, relicts of former climates. For the NW Morocco, this fact has already been underlined by Sauvage (1961) and Dahlgren & Lassen (1972). The existence of the Ulici-Genistion-communities under Mediterranean climates is linked to particular geological and geomorphological features (for details see Figure 3 in Neto *et al.*, 2014). On the one hand, such physiotopes are relatively resistant to changes of the macroclimate; on the other hand they are extremely sensitive to any changes in their hydrological conditions. The small patches and isolated sites of the wet heath-gorse-communities need strong efforts of protection to conserve the small and vulnerable plant populations.

According to Pérez Latorre *et al.* (2007), Atlantic heathlands exist in the Mediterranean under suboptimal environmental conditions and show low resilience after human impacts. They have declined mainly because of the agricultural use of the territory (mostly rice paddies) and the eutrophication of many coastal and sublittoral wet slacks. Daveau (1902) for example documented the occurrence of species such as *Myrica gale*, *Gentiana pneumonanthe*, *Cirsium palustre*, *Erica ciliaris*, *E. tetralix*, *Cirsium welwitschii*, *Centaurea uliginosa*, and *Euphorbia uliginosa* on sandy substrates of the Portuguese central coast in the Leiria region (Lusitanian-Andalusian Coastal Province). The presence of *Erica tetralix* at that time is noteworthy, since the species is currently presumed to be extinct in that area, possibly due to its limited regeneration rate after ploughing or burning (Calvo *et al.*, 2002). South of Lisbon (the Alentejo coast - Vincentine Coastal district according to Costa *et al.*, 1999), heathy peatland was still quite common in the 50's of the 20th century after historical maps. It suffered a significant reduction in the last decades due to expansion and intensification of agriculture and forestry plantation. Similar processes occurred also in other parts of Europe, e.g. in Belgium (Piessens & Hermy, 2006) and NW Europe (Gimingham, 1992).

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References

Alexandrino, J., Froufe, E., Arntzen, J.W., & Ferrand, N. (2000). Genetic subdivision, glacial refugia and postglacial recolonization in the golden-striped salamander, Chioglossa lusitanica (Amphibia: Urodela). *Mol. Ecol.*, 9, 771-781.

Arsénio, P. (2011). *Landscape quality and phytodiversity: Contribution to spatial planning and management of coastal areas with high natural value*. (Doctoral thesis). Universidade de Lisboa, Lisboa.

Benito Cebrián, N. (1948). *Brezales y brezos. Síntesis geobotánica de las formaciones de Ericoideas y resumen monográfico de las especies españolas.* Madrid: Inst. Forest. Invest. Experiencias.

Botineau, M., & Géhu, J.M. (2005). Les landes atlantiques. *Coll. Phytosoc.*, 26, 131-149.

Braun-Blanquet, J. (1964). *Pflanzensoziologie*. Wien: Grundzüge der Vegetationskunde.

Calvo, L., Tárrega, R., & Luis, E. (2002). Regeneration patterns in Calluna vulgaris heathland in the Canabrian Mountains (NW Spain): effects of burning, cutting and ploughing. *Acta Oecol.*, 23,81-90.

Castroviejo, S. (coord. gen.). (1986-2012). *Flora iberica* (1-8, 10-15, 17-18, 21). Madrid: Real Jardín Botánico, CSIC.

Costa, J.C., Aguiar, C., Capelo, J., Lousã, M., & Neto, C. (1999). Biogeografia de Portugal Continental. *Quercetea*, 0, 5-55.

Costa, J.C., Neto, C., Aguiar, C., Capelo, J., Espírito Santo, M.D., Honrado, J., Pinto-Gomes, C., Monteiro-Henriques, T., Sequeira, M., & Lousã, M. (2012). Vascular plant communities in Portugal (continental, the Azores and Madeira). *Global Geobotany*, 2(1), 1-180.

Coutinho, A.P. (1939). *Flora de Portugal. Plantas Vasculares, 2ªed*. Lisboa: Livraria Bertrand.