

# New contributions on flora and vegetation of northeastern Portugal ultramafic outcrops

Carlos Aguiar (\*), Tiago Monteiro-Henriques (\*\*) & Daniel Sánchez-Mata (\*\*\*)

**Abstract:** Aguiar, C., Monteiro-Henriques, T. & Sánchez-Mata, D. *New contributions on Flora and Vegetation of northeastern Portugal ultramafic outcrops. Lazaroa 34: 141-150 (2013).*

In this work we present some syntaxonomic novelties on the vegetation of the referred ultramafic outcrops focused on three new associations: *Jonopsidio abulensis-Sedetum maireani*, *Armerio daveaui-Agrostietum castellanae* and *Seseli peixotoani-Avenuletum lusitanicae*; in addition, a new nomenclatural combination of an endemic taxon from the Morais massif (*Armeria langei* subsp. *marizii*) is proposed. We also clarify the phytocoenotic structure of the Portuguese vegetation series through a simple diagrammatic representation, which is then applied to one unique climatophilous vegetation series present in the ultramafic rocks of northeastern Portugal: *Genisto hystricis-Quercu rotundifoliae Sigmatum*.

**Keywords:** Ultramafic vegetation, ultramafic flora, ultramafic vegetation series, *Armeria langei* subsp. *marizii*, Portugal.

**Resumen:** Aguiar, C., Monteiro-Henriques, T. & Sánchez-Mata, D. *Nuevas contribuciones a la Flora y Vegetación de los macizos ultramáficos del noreste de Portugal. Lazaroa 34: 141-150 (2013).*

Se presentan algunas novedades sintaxonómicas referidas a la vegetación ultramáfica del noreste de Portugal proponiéndose tres nuevas asociaciones: *Jonopsidio abulensis-Sedetum maireani*, *Armerio daveaui-Agrostietum castellanae* y *Seseli peixotoani-Avenuletum lusitanicae*; además se propone una nueva combinación nomenclatural sobre un taxon endémico del macizo de Morais (*Armeria langei* subsp. *marizii*). Se clarifica, además, la estructura fitocenótica de la única serie de vegetación climatófila reconocida en las áreas ultramáficas del noreste de Portugal mediante una representación diagramática: *Genisto hystricis-Quercu rotundifoliae sigmetum*.

**Palabras clave:** Vegetación ultramáfica, flora ultramáfica, serie de vegetación ultramáfica, *Armeria langei* subsp. *marizii*, Portugal.

## INTRODUCTION

The presence of allochthonous ultramafic rocks is one of the most original characteristics of the northeastern Portugal geology (IGLESIAS & *al.*, 1983). These ultramafic rocks are spread throughout two large mafic and ultramafic massifs: Bragança and Morais (Figure 1). The altitude of the northern Bragança Massif varies between 600-1060 m asl; following the latest version of the Rivas-Martínez's Worldwide Bioclimatic Classification (RIVAS-MARTÍNEZ & *al.*, 2011), all the territory is included in the lower humid to upper humid supramediterranean bioclimatic belt. The

Morais Massif shows an upper subhumid to lower humid ombrothermic character, with a meso - to supramediterranean thermotype range. Its altitude ranges between 300 and 900 m asl (MONTEIRO-HENRIQUES & AGUIAR, 2010) (Figure 1).

The mineralogy and the chemical composition of ultramafic rocks are rather unusual and have a strong impact in soil genesis, plant evolution and vegetation assembling. Besides their meaning in the point of view of geodiversity, ultramafic rocks have an enormous social and scientific importance by their pedodiversity and as plant biodiversity refuges (SEQUEIRA & *al.*, 2010 GARCÍA-BARRIUSO & *al.*, 2012).

\*CIMO-Centro de Investigação de Montanha. Instituto Politécnico de Bragança. Apartado 1172, 5301-855 Bragança, Portugal. E-mail: cfaguiar@ipb.pt

\*\*Centro de Botânica Aplicada à Agricultura. Instituto Superior de Agronomia. Universidade Técnica de Lisboa. Tapada da Ajuda, 1349-017 Lisboa, Portugal. E-mail: tmh@isa.utl.pt

\*\*\*Department of Plant Biology II. Faculty of Pharmacy. Complutense University. E-28040 Madrid, Spain. E-mail: dsmata@ucm.es

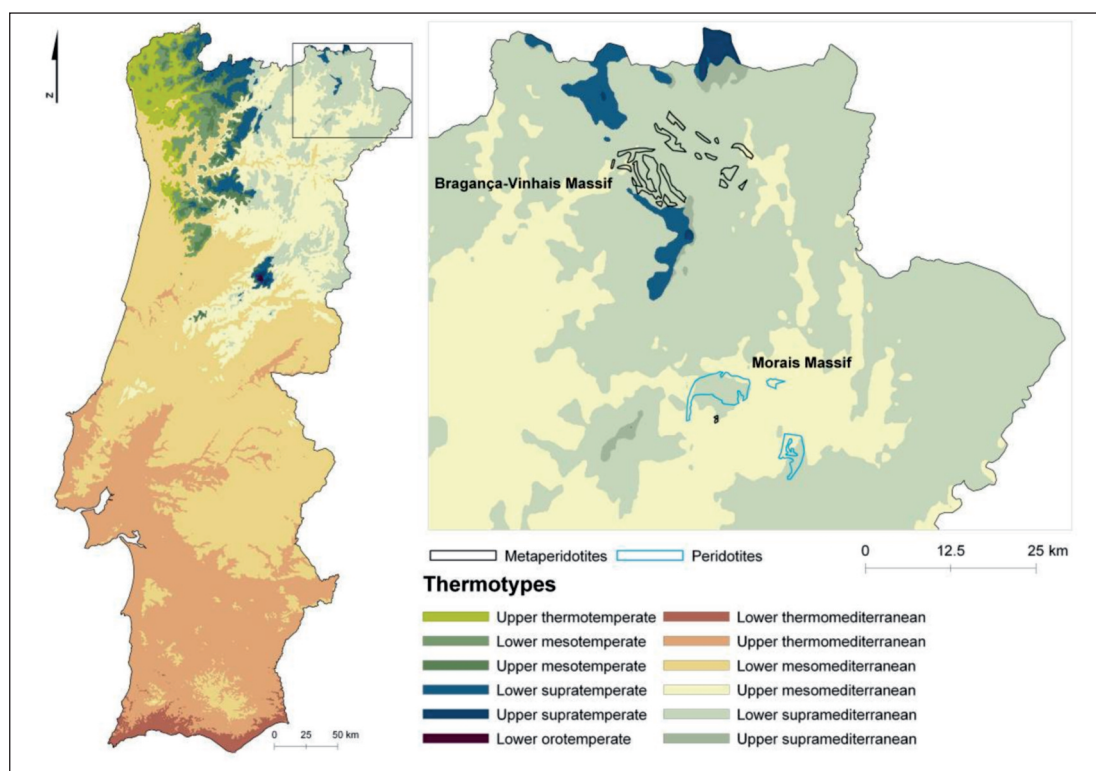


Figure 1. – Map of thermotypes of mainland Portugal according to the Rivas Martínez's Worldwide Bioclimatic Classification proposals (RIVAS-MARTÍNEZ & *al.*, 2011), with particular focus on the Morais-Bragança area. Meta-peridotites and peridotites from the Carta Geológica de Portugal 1/500000.

The main adverse factors conditioning plant life in ultramafic (serpentine) soils – the serpentine effect (KRUCKBERG, 1992) – are probably the high Mg/Ca quotient (two divalent cations with an antagonist effect), the very high Ni, and low N, P, K and Ca available (KRUCKBERG, 1986; BRADY & *al.*, 2005). These extreme ecological conditions impose a strong selective effect on the flora, which results in a widespread ecotypic differentiation among generalist plant species and in a high diversity of endemic species and biogeographical disjunctions, some of them with a relict character (KRUCKBERG, 1986).

Adding to the unfavorable soil conditions, often toxic, the Mediterranean climate of the referred Portuguese outcrops causes an additional hardship for the present flora: the shortage of rainfall in the months when the temperature reaches the highest annual values, which reduces the water availability for plants and causes increased salt concentration

from the weathering of the rock. This combination of factors is recurrent in the Mediterranean biogeographical region *sensu* RIVAS-MARTÍNEZ (2004), where, due to its complex geology, there are several belts of ophiolitic rocks placed in allochthonous position by thrust faults, representing ancient distension basins (CAVAZZA & *al.*, 2004). From a biogeographic viewpoint, these ultrabasic complexes constitute a genuine system of islands with unique characteristics and recurring in the continental matrix throughout the Mediterranean basin, from Portugal to Turkey. Thus, areas next to ultrabasic outcrops tend to share a larger number of taxa, as would be expected according to the Theory of Island Biogeography (MAC ARTHUR & WILSON, 1967). There are even some genera and species whose optimum appears to be strongly related to the presence of mafic and ultramafic rocks, spreading over the whole Mediterranean region, as it is the case of some perennial species of the genus

*Alyssum*, or even the relict *Notholaena marantae*. For the genus *Alyssum* affinities between Iberian, Italic, Balkan and North African populations are now clearly recognized. It is noteworthy that the lowering of the sea level during glacial periods and in particular the strong lowering produced during the Messinian crisis, where the level of the Mediterranean Sea fell 1.5 km (CLAUZON & al., 1996) may have contributed to a greater exchange of genetic material between the current system of islands, as ultramafic sediments may have been exposed (EMELYANOVA & al., 2005) or ophiolite

complexes which are presently submerged (EURO-GEOSURVEYS, The Geological Surveys of Europe, 2010).

The toxicity of substrate, distance to other ultramafic massifs (isolation degree), as well as their size and the complex paleobiogeography of the Mediterranean region have determined that we can now find in the northeastern Portugal ultramafic massifs some endemic taxa and other rare plants (Table 1).

In serpentine soils, serpentinofuges are eliminated or their populations depressed by soil pro-

Table 1

Endemic taxa and other rare plants of the ultramafic outcrops of northeastern Portugal (Trás-os-Montes) (AGUIAR & al., 2011a). IUCN categories of threat: Extinct, EX; Critically Endangered, CR; Endangered, EN; Vulnerable, VU; Near Threatened, NT; Least Concern, LC; Data deficient, DD.

	Bragança massif	Morais massif	IUCN categories of threat (national scale, IUCN, 2001)
Portuguese endemic serpentinophytes			
<i>Arenaria querioides</i> Pourr. ex Willk. subsp. <i>fontqueri</i> (P. Silva) Rocha Afonso	x	x	NT
<i>Armeria eriophylla</i> Willk.	x	-	NT
<i>Armeria langei</i> Boiss. subsp. <i>marizii</i> (Daveau) C. Aguiar, Sánchez-Mata & Monteiro-Henriques comb. et stat. nov.	-	x	NT
<i>Avenula lusitanica</i> (Romero Zarco) Holub	x	x	VU
<i>Festuca brigantina</i> (Markgr.-Dann.) Markgr.-Dann.	x	-	EN
Obligate serpentinophytes endemic to Galician and northeastern Portuguese ultramafic rocks			
<i>Alyssum serpyllifolium</i> Desf. subsp. <i>lusitanicum</i> Dudley & P. Silva	x	x	LC
Obligate serpentinophytes endemic of Iberian ultramafic rocks			
<i>Asplenium adiantum-nigrum</i> L. subsp. <i>corunnense</i> (Christ) Rivas-Martínez	x	x	NT
Other Iberian endemisms and other species, which in Portugal occur exclusively on the northeastern ultramafic outcrops			
<i>Antirrhinum rothmaleri</i> (P. Silva) Amich & al.	x	x	CR
<i>Anthyllis sampaioana</i> Rothm.	x	-	VU
<i>Armeria langei</i> Boiss. subsp. <i>daveaui</i> (Cout.) P. Silva	x	x	NT
<i>Astragalus incanus</i> L. subsp. <i>nummularioides</i> (Desf.) Maire	x	-	VU
<i>Bromus squarrosus</i> L. (Poaceae)	x	-	EN
<i>Dianthus laricifolius</i> Boiss. & Reut. subsp. <i>marizii</i> (Samp.) Franco	x	x	LC
<i>Elymus hispidus</i> (Opiz) Melderis subsp. <i>barbulatus</i> (Schur) Melderis	x	-	DD
<i>Gagea pratensis</i> (Pers.) Dumort.	x	-	EN
<i>Jasonia tuberosa</i> (L.) DC.	x	-	EN
<i>Notholaena marantae</i> (L.) Desv. subsp. <i>marantae</i>	x	x	VU
<i>Reseda virgata</i> Boiss. & Reut.	x	x	LC
<i>Santolina semidentata</i> Hoffmanns. & Link.	x	x	LC
<i>Saxifraga dichotoma</i> Willd.	x	-	EN
<i>Seseli montanum</i> L. subsp. <i>peixotoanum</i> (Samp.) M. Laínz	x	x	LC
<i>Silene legionensis</i> Lag.	x	-	VU
<i>Ventenata dubia</i> (Leers) Cosson	x	-	DD

prieties, while plant populations adapted to serpentines –the serpentrophytes– have lower competitive abilities in acid and basic rocks (KRUCKBERG, 1986; BRADY & al., 2005). If the ultramafic flora is original, also are their socializations, i.e. vegetation.

The originality of the serpentine flora of northeastern Portugal probably was firstly recognized by W. Rothmaler and A.R. Pinto Silva when these two remarkable botanists visited the region in June of 1939 (AGUIAR, 2002). Pinto da Silva dedicated a large part of his professional life to northeastern ultramafic flora and vegetation that culminated in his dissertation of 1970 (PINTO DA SILVA, 1970). Since then other botanists and vegetation scientists explored the region with important contributions gathered by AGUIAR (2002).

The invaluable commented checklist of the vascular flora of the ultramafic rocks of northeastern Portugal of PINTO DA SILVA (1970) has been recently reviewed by Aguiar and Monteiro-Henriques (ined., however see AGUIAR & al., 2011a, for a prodromus). These authors' accept 569 taxa, 29% of which (165 taxa) are new additions to the original catalogue of PINTO DA SILVA (1970). Following the same trend in this paper we make a reappraisal of the vegetation (climatophilous sigmeta, permasigmeta, ephemerisigmeta and non-seral nitrophilous vegetation) of the ultramafic outcrops of northeastern Portugal.

We follow for taxonomic nomenclature basically the mentioned prodromus (AGUIAR & al., 2011a) and for syntaxonomic the compilation of AGUIAR & al., 2011b).

## MATERIAL AND METHODS

Due to its complexity, the vegetation phenomenon is not understandable without a consistent conceptual framework. In vegetation science different objectives require different methods (KENT & COKER, 1992). Classical phytosociology –the continental European vegetation school of Zurich-Montpellier– enhanced with the dynamical-catenal approach developed by S. Rivas-Martínez (RIVAS-MARTÍNEZ, 2005), adopted in this paper, offer a consistent conceptual and methodological

framework to explore the vegetation with a multipurpose output.

Vegetation series is one of the most useful but also critical concepts in dynamic-catenal phytosociology because a main question usually remains to be answered: what is a seral stage in a vegetation series? A vegetation series is a set of plant communities composed by a climax association – usually a forest in Mediterranean and Temperate macrobioclimates – and its substitution stages (RIVAS-MARTÍNEZ, 2005). Vegetation series occupies homogenous biotopes and its components –seral stages– are connected through successional processes. So semi-nitrophilous vegetation, plant communities' dependent of microtopographic features (e.g. temporary Mediterranean ponds vegetation) and functionally dependent communities (e.g. scionitrophilous forest vegetation and epiphytic vegetation) are not included in vegetation series descriptions. Successional mosaics with different phytocoenotic composition and structure are largely governed by stress (inc. nutritional stress), disturbance patterns, and diaspore availability.

Defined in this way Mediterranean vegetation series can be quite complex, in general substantially more than its Eurosiberian counterparts (Figure 2). The number of vegetation stages in the Portuguese Mediterranean vegetation series generally depends on the biogeographic and bioclimatic contexts (AGUIAR & al., 2005; PINTO-GOMES & al., 2011; RIBEIRO & al., 2012). Some of its seral stages have more than one plant community. For example, the mesotrophic perennial grasslands communities are usually distinct in landscapes with a forest or with a low scrub community matrix. The same phenomenon happens with tall shrublands structured by *Cytisus* and *Genista* species.

## RESULTS

### CLIMATOPHILOUS VEGETATION SERIES (SIGMETA)

There is one unique climatophilous vegetation series in the ultramafic rocks of northeastern Portugal –*Genisto hystricis-Quercus rotundifoliae sigmetum*– lead by forests of *Quercus rotundifolia* (*Genisto-Quercetum rotundifoliae*) (AGUIAR &

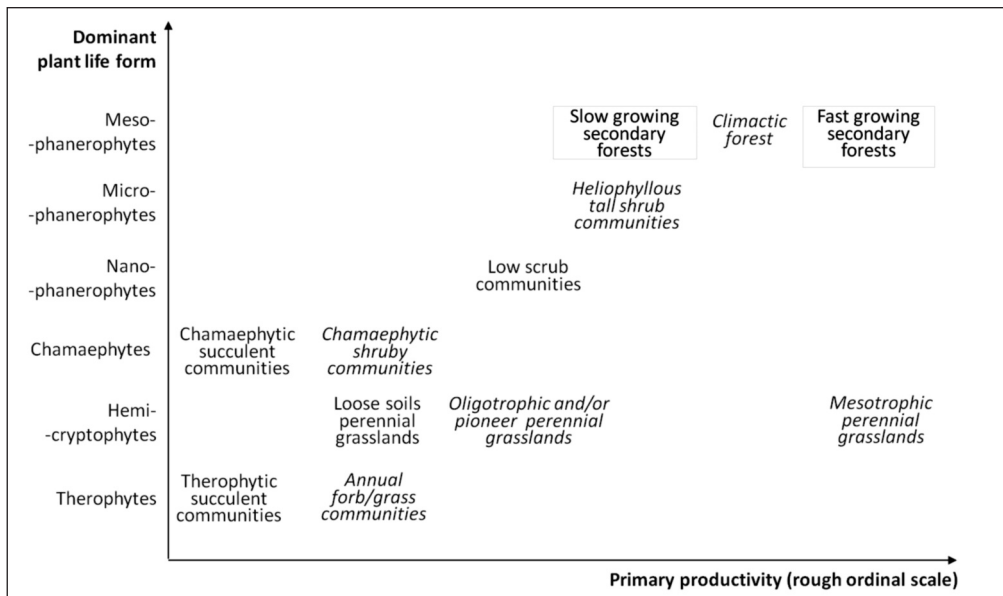


Figure 2. – Diagrammatic representation of the Portuguese vegetation series phytocoenotic structure. In italics: seral stages present in the climatophilous vegetation series of the ultramafic rocks of northeastern Portugal.

al., 2011b). The holm oak (*Quercus rotundifolia*) is the only *Quercus* species that withstands harsh serpentine effects. Substratum toxicity has a depressive effect on tree cover, height and productivity, as well as in *Quercus rotundifolia* forest resilience and resistance to disturbance. Consequently, heliophilous shrubs like *Cistus ladanifer* and *Genista hystrix* reach a high cover naturally in these forests and increase their proneness to wildfires. The low forest resilience, and the severity and short recurrence cycles of wildfires and herbivory disturbances, through a complex cause-effect chain, increase soil erosion susceptibility and soil toxicity, and slow down pedogenesis. Consequently, ultramafic cover vegetation and landscapes are composed of diversified successional vegetation mosaics (Figure 3).

In fact besides the unfavourable chemical soil proprieties, the flora and vegetation is also controlled by other environmental conditions like the dominance of thin soils, high soil temperatures and severe summer water shortage (SEQUEIRA & PINTO DA SILVA, 1992; KRUCKBERG, 2002). The dominance of thin soils in the ultramafic is also due to the dominance of dissolution processes in rock chemical weathering (SEQUEIRA & PINTO DA SILVA, 1992).

The most conspicuous seral stage of the ultramafic *Q. rotundifolia* forests is a shrub formation of *Cistus ladanifer* (*Cisto ladaniferi-Genistetum hystricis*). This heliophilous, aromatic and highly inflammable vegetation is poor in shrub species. In addition to *C. ladanifer* (*Cistaceae*) there are common *Helichrysum stoechas* (*Asteraceae*) and a few Lamiaceae like *Lavandula pedunculata* and *Thymus mastichina* that have also a medicinal use (GONZALÉZ & al., 2012). Deeper soils derived from ultramafic rocks, chiefly in concave physiographies in the midst of forest-dominated seral mosaics, under low disturbance regimes, are more suitable to tall shrub communities composed of nanophanerophytes of *Genistea* tribe (family *Fabaceae*, e.g. *Cytisus scoparius* and *C. multiflorus*), of the *Genisto hystricis-Cytisetum multiflori* community (AGUIAR & al., 2011b; GAVILÁN & al., 2011).

It is a common characteristic of many serpentine areas around the world, to find large areas of rocky soil surfaces stripped of large biomass vegetation (KRUCKBERG, 1992). In northeastern Portugal these soils –leptosols– harbour two important endemics-rich vegetation types:

- i) the pioneer tall perennial grasslands of the *Seseli-Avenuletum lusitanicae* ass. nova hoc loco

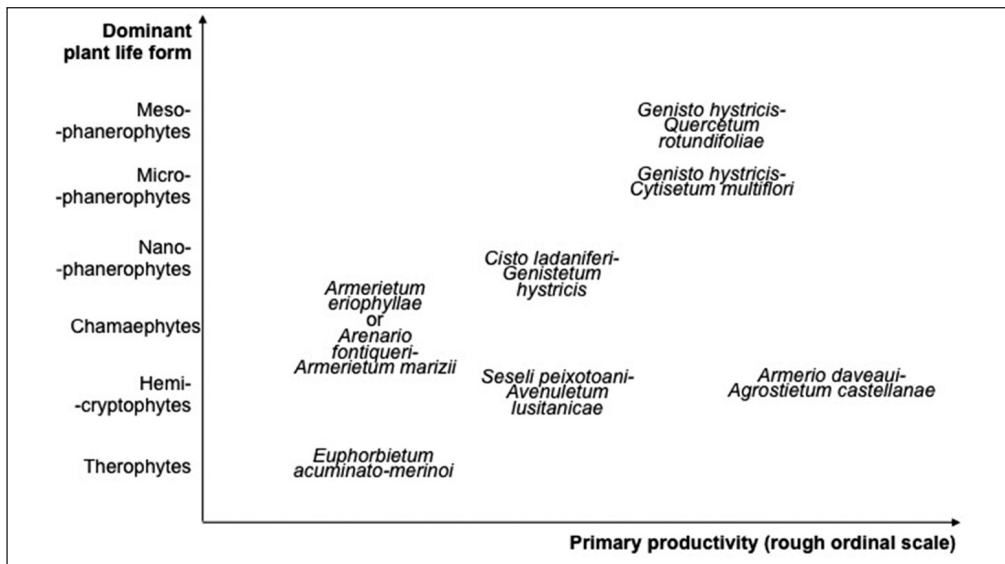


Figure 3. – Diagrammatic representation of the *Genisto hystricis-Quercus rotundifoliae* Sigmoidetum, the climatophilous vegetation series of the ultramafic rocks of northeastern Portugal.

(Table 2, *holotypus* relevé no. 4), which inhabits heavily fractured and fragmented rock outcrops with a gentle slope, establishing complex mosaics with *Armerion eriophyllae* alliance communities, perennial grasslands of *Agrostion castellanae* alliance and annual grasslands of *Brachypodium distachyi* alliance, and

ii) the chamaephytic shrubby communities of the *Armerietum eriophyllae* in the Bragança ultramafic outcrops, or of the *Arenario fontqueri-Armerietum marizii* in the Morais massif (AGUIAR & al., 1998).

An immediate conclusion of the fact that endemic-rich associations are occupying incipient soils is that successional progression, achieved through fire and herbivory suppression, can endanger these endemic plant populations. Chamaephytic shrubby communities of the *Armerion eriophyllae* have a low plant cover and are composed of prostrate perennial plants adapted to colonize small soil pockets in near horizontal, thin, rocky soils. These plants usually have a strong root system, capable of resisting the effects of sheet erosion. The chamaephytic shrubby communities coexist with highly diverse annual oligotrophic forb/grass communities like the *Euphorbietum acuminato-merinoi*. The dominant plants of tall pioneer perennial grasslands (*Seseli-Avenuletum lusitanicae*) –e.g. *Koeleria crassipes* and the en-

demic *Avenula lusitanica*– display a phalanx strategy in colonial growth (LOVETT DOUST, 1981). The tightly packed colonial ramets spread slowly from putative seed growths, conquering space and gathering soil around them brought from above by rainwater superficial flow. With time, these small fertility islands coalesce and appear to have a facilitating effect on the species of other successional stages (e.g. mesotrophic perennial grasslands of the *Agrostion castellanae* alliance). This slow (secular?) course leads to the exclusion of chamaephytic shrubby community species, unless herbivore, fire or landslide disturbance resets the process.

Mesotrophic perennial grassland species are much more productive and palatable to mammal herbivores than pioneer communities' characteristic plants. Frequently occurring in forest clearings, the *Armerio daveauji-Agrostietum castellanae* *ass. nova hoc loco* consists in a supramediterranean, meso-xerophilous, mesotrophic perennial grassland of *Armeria langei* subsp. *daveauji*, *Agrostis castellana* and *Centaurea langei*, endemic of the ultramafic rock outcrops of northeastern Portugal. Particularly frequent in holm oak forest clearings (*Genisto-Quercetum rotundifoliae*) and rock platforms covered with a thick layer of soil, in the Bragança-Vinhais massif.

Table 2  
*Seseli peixotoani-Avenuletum lusitanicae* ass. nova  
(Potentillo montanae-Brachypodienion rupestris, Potentillo montanae-Brachypodion rupestris,  
Brometalia erecti, Festuco-Brometea)

Altitude (m asl)	681	680	679	683	678	681	699
Exposure	N	-	-	N	N	N	NE
Area (m <sup>2</sup> )	10	16	10	20	25	15	20
N. species	10	8	12	13	14	14	17
Relevé N.	1	2	3	4	5	6	7
Characteristics							
<i>Avenula lusitanica</i>	3	3	2	4	3	4	3
<i>Seseli peixotoanum</i>	1	2	1	1	1	1	1
<i>Koeleria crassipes</i>	1	+	1	1	1	1	2
<i>Allium paniculatum</i>	.	.	1	+	+	.	.
<i>Filipendula vulgaris</i>	1	+	.	.	.	.	.
<i>Tulipa australis</i>	+	.	.	.	.	.	+
<i>Reseda virgata</i>	.	.	1	.	.	1	.
<i>Phleum bertolonii</i>	.	.	.	+	+	.	.
<i>Asperula scabra</i>	.	.	.	.	+	1	.
Companions							
<i>Agrostis castellana</i>	3	3	3	3	3	2	3
<i>Centaurea langei</i>	2	1	2	1	1	1	+
<i>Ashodelus serotinus</i>	2	1	1	2	1	.	.
<i>Dactylis hispanica</i>	2	1	1	.	1	.	+
<i>Allium sardoum</i>	.	.	+	1	1	+	1
<i>Genista hystrix</i>	.	.	.	2	1	1	+
<i>Dianthus marizii</i>	.	.	.	+	1	+	1
<i>Thapsia minor</i>	1	1	+	.	.	.	.
<i>Alyssum lusitanicum</i>	.	.	.	1	.	+	+
<i>Allium sphaerocephalon</i>	.	.	1	.	1	.	.
<i>Arenaria fontqueri</i>	.	.	.	+	.	.	+
<i>Santolina semidentata</i>	.	.	.	.	1	1	.
<i>Plantago holosteum</i>	.	.	.	.	.	1	2

Other species: *Helichrysum stoechas* 1 in 6; *Anthoxanthum odoratum*, *Centaureum majus*, *Cistus ladanifer* and *Cistus salvifolius* + in 7.

Localities: 1, 3, and 4: Vinhas, Monte de Morais, between Limãos and Sobreda (Macedo de Cavaleiros); 2, 5, and 6: Vinhas, Monte de Morais, between Castro Roupal and Sobreda (Macedo de Cavaleiros); 7; Morais, Monte de Morais, Sobreda (Macedo de Cavaleiros). *Holotypus* ass. rel. 4.

The *holotypus* of this newly proposed association is the following: Bragança: Carrazedo, ultramafic rocks, 640 m, 9 m<sup>2</sup>. Characteristic species: 5 *Agrostis castellana*, 2 *Armeria langei* subsp. *daveaui*, 1 *Centaurea langei*, + *Dactylis hispanica*, + *Allium sphaerocephalon*. Companion species: 1 *Seseli montanum* subsp. *peixotoanum*, + *Alyssum serpyllifolium* subsp. *lusitanicum*.

#### TEMPORARY WET SOILS EPHEMEROSIGMETA

In wet years, in the middle of spring, the small depressionary areas between the endemic-rich

chamaephytic communities are filled with the lilac flowers of the succulent leaved *Sedum maireanum* (Crassulaceae). This species is generally accompanied by other annuals adapted to temporarily wet soils, like *Spergularia segetalis* (Caryophyllaceae), several species of annual *Juncus* (Juncaceae) and *Molineriella laevis* (Poaceae). The new association proposed here, *Jonopsidium abulensis-sedetum maireani* ass. nova *hoc loco* (Table 3, *holotypus* relevé no. 5). It occupies, supramediterranean, humid bioclimate areas and presents a unusual muscicolous habit. Being an ephemeral community with a precise vegetation dynamic, it

Table 3  
*Jonopsidio abulensis-Sedetum maireani* ass. nova hoc loco  
 (Cicendion, Isoetalia, Isoeto-Nanojuncetea)

	91	84	87	90	87	90	90	88	105	90
Altitude (1=10 m asl)	91	84	87	90	87	90	90	88	105	90
Area (m <sup>2</sup> )	2	4	4	4	4	2	2	2	4	1
N. species	7	12	10	12	13	10	7	10	10	5
Relevé N.	1	2	3	4	5	6	7	8	9	10
Characteristics										
<i>Sedum maireanum</i>	2	2	2	3	2	3	1	2	2	2
<i>Spergularia segetalis</i>	1	+	.	.	.	+	1	1	+	.
<i>Juncus capitatus</i>	.	.	.	.	+	+	1	1	1	+
<i>Molineriella laevis</i>	.	.	.	.	+	1	2	1	.	.
<i>Jonopsidium abulense</i>	.	+	+	+	+	.	.	.	.	.
Companions										
<i>Rumex gallicus</i>	1	2	1	+	2	+	.	2	2	.
<i>Asterolinon linum-stellatum</i>	.	1	+	+	.	+	.	1	.	+
<i>Moenchia erecta</i>	+	.	.	+	.	+	1	1	+	.
<i>Teesdalia coronopifolia</i>	.	.	+	1	+	1	+	.	.	+
<i>Arenaria querioides</i>	1	.	+	.	1	+	.	.	.	+
<i>Leontodon longirostris</i>	.	1	1	+	+	1	.	.	.	.
<i>Cerastium diffusum</i>	.	+	+	+	1	.	.	.	1	.
<i>Logfia minima</i>	.	1	.	+	1	.	.	.	+	.
<i>Herniaria scabrida</i>	.	1	.	+	1	.	.	.	.	.
<i>Linaria amethystea</i>	.	+	+	.	+	.	.	.	.	.
<i>Mibora minima</i>	.	.	.	+	+	.	+	.	.	.
<i>Trifolium arvense</i>	.	.	.	.	.	.	.	+	+	.

Other species: *Ranunculus paludosus* and *Scleranthus polycarpus* + in 1; *Tuberaria guttata* 2, *Galium parisiense* + in 2; *Spergularia purpurea* + in 3; *Spergularia morisonii* + in 4; *Plantago major* 3, *Carex divisa* 1 in 8; *Plantago radicata* 2, *Crassula tillaea*, *Euphorbia merinoi* and *Sagina apetala* 1 in 9.

Localities: 1: Alimonde (Bragança); 2: Vilarinho da Cova de Lua (Bragança); 3 and 5: Espinhosela, Sardeal (Bragança); 4, 6, 7, and 10: Oleiros, Serro (Bragança); 8: Ousilhão (Vinhais); 9: Nogueira, estradão das Corriças (Bragança). *Holotypus* ass. rel. 5.

fits the recent concept of ephemerisigmetum proposed by Monteiro-Henriques (2010). This curious plant community can also be occasionally observed in holm oak (*Q. rotundifolia*) clearings, after the disturbance of the bryophyte covering by wild boars: an interesting ecological interaction between wild mammals and vascular plants.

## FLORISTIC APPENDIX

*Armeria langei* Boiss. subsp. *marizii* (Daveau) C. Aguiar, Sánchez-Mata & Monteiro-Henriques comb. et stat. nov. [Basionyme: *Armeria eriophylla* var. *marizii* Daveau in Bol. Soc. Brot. 6: 174. 1889].

## SYNTAXONOMIC SCHEME

*QUERCETEA ILICIS* Br.-Bl. ex A. & O. Bolòs 1950

*Quercetalia ilicis* Br.-Bl. ex Molinier 1934 em. Rivas-Martínez 1975

*Quercion broteroi* Br.-Bl., P. Silva & Rozeira 1956 corr. V. Fuente 1986 em. Rivas-Martínez 1975

*Paeonio broteroi-Quercenion rotundifoliae* Rivas-Martínez in Rivas-Martínez, Costa & Izco 1986

*Genisto hystricis-Quercetum rotundifoliae* P. Silva 1975

*CYTISETEA SCOPARIO-STRIATI* Rivas-Martínez 1975

*Cytisetalia scopario-striati* Rivas-Martínez 1974



- Genistion polygalaephyllae* Rivas-Martínez, T. E. Díaz, F. Prieto, Loidi & Penas 1984  
*Genisto hystricis-Cytisetum multiflori* Rivas-Martínez, T. E. Díaz, F. Prieto, Loidi & Penas 1984  
*Ulici europaei-Cytision striati* Rivas-Martínez, Báscones, T.E. Díaz, Fernández-González & Loidi 1991  
*Lavandulo sampaianae-Cytisetum multiflori* Br.-Bl., P. Silva & Rozeira 1956
- CISTO-LAVANDULETEA* Br.-Bl. in Br.-Bl., Molinier & Wagner 1940  
*Lavanduletalia stoechadis* Br.-Bl. in Br.-Bl., Molinier & Wagner 1940 *em.* Rivas- Martínez 1968  
*Cistion laurifolii* Rivas Goday 1956  
*Cisto ladaniferi-Genistetum hystricis* P. Silva 1970
- STIPO GIGANTEAE-AGROSTIETEA CASTELLANAE* Rivas-Martínez, Fernández-González & Loidi 1999  
*Agrostietalia castellanae* Rivas Goday in Rivas-Martínez, Costa, Castroviejo & E. Valdés 1980  
*Agrostion castellanae* Rivas Goday 1958 *corr.* Rivas Goday & Rivas-Martínez 1963  
*Armerio daveaui-Agrostietum castellanae* Aguiar, Monteiro-Henriques & Sánchez-Mata *ass. nova*
- FESTUCO-BROMETEA* Br.-Bl. & Tüxen *ex* Br.-Bl. 1949  
*Brometalia erecti* Br.-Bl. 1936  
*Potentillo montanae-Brachypodion rupestris* Br.-Bl. 1967 *corr.* Rivas-Martínez, T.E. Díaz, Fernández-González, Izco, Loidi, Lousã & Penas 2002  
*Potentillo montanae-Brachypodienion rupestris* J. Guitán, Izco & Amigo 1989  
*Seseli peixotoani-Avenuletum lusitanicae* Aguiar, Monteiro-Henriques & Sánchez-Mata *ass. nova*
- FESTUCETEA INDIGESTAE* Rivas Goday & Rivas-Martínez 1971  
*Jasiono sessiliflorae-Koelerietalia crassipedis* Rivas-Martínez & Cantó 1987  
*Armerion eriophyllae* P. Silva 1970  
*Armerietum eriophyllae* Pinto da Silva 1965  
*Arenario fontqueri-Armerietum marizii* Aguiar, Penas & Lousã 1998 *corr.* Aguiar, Monteiro-Henriques & Sánchez-Mata *corr. hoc loco*
- HELIANTHEMETEA* (Br.-Bl. in Br.-Bl., Roussine & Nègre 1952) Rivas Goday & Rivas-Martínez 1963 *em.* Rivas-Martínez 1978  
*Trachynietalia distachyae* Rivas-Martínez 1978  
*Trachynion distachyae* Rivas-Martínez 1978  
*Euphorbietum acuminato-merinoi* Aguiar & Penas 2002
- ISOETO-NANOJUNCETEA* Br.-Bl. & Tüxen *ex* Westhoff, Dijk & Passchier 1946  
*Isoetalia* Br.-Bl. 1936 *em.* Rivas Goday 1970  
*Cicendion* (Rivas Goday in Rivas Goday & Borja 1961) Br.-Bl. 1967  
*Jonopsidio abulensis-Sedetum maireani* Aguiar, Monteiro-Henriques & Sánchez-Mata *ass. nova*

## REFERENCES

- Aguiar, C. —2002— Flora e Vegetação da Serra de Nogueira e do Parque Natural de Montesinho — Mem. Doc. (ined.). Inst. Sup. Agron., Univ. Téc. Lisboa, Lisboa.
- Aguiar, C., Monteiro-Henriques, T., Pereira Coutinho, X. & Sánchez-Mata, D. —2011a— Flora — In: Asensi, A. & al. (Eds.). Flora and Vegetation of Iberian Ultramafics. Excursion Guide. Pp: 28-39. Inst. Politéc. Bragança. Univ. Coimbra.
- Aguiar, C., Monteiro-Henriques, T. & Sánchez-Mata, D. —2011b— Vegetation — In: Asensi, A. & al. (Eds.). Flora and Vegetation of Iberian Ultramafics. Excursion Guide. Pp: 40-54. Inst. Politéc. Bragança. Univ. Coimbra.
- Aguiar, C., Penas, A., Costa, J.C. & Lousã, M. —1998— Vegetación endémica, no rupícola, de las rocas ultrabásicas de "Trás-os-Montes" (NE de Portugal) — Itinera Geobot. 11: 249-262.

- Aguiar, C., Capelo, J., Sequeira, M., Honrado, J. & Mesquita, S. — 2005 — Floristical and Phytocenotical Diversity at the Climactical Dominion — 48th International Association for Vegetation Science Symposium. Marginal landscapes and nutrient-poor ecosystems - processes and adaptations. Lisboa.
- Brady, K. U. B., Kruckeberg, A.R. & Bradshaw Jr., H.D. — 2005 — Evolutionary ecology of plant adaptation to serpentine soils — *Annu. Rev. Ecol. Evol. Syst.* 36: 243–66.
- Cavazza, W., Roure, F., Spakman, W., Stampfli, G.M., Ziegler, P.A. & TRANSMED Project Working Groups — 2004 — The TRANSMED Atlas: geological-geophysical fabric of the Mediterranean region - Final report of the project — *Episodes* 27(4): 244–254.
- Clauzon, G., Suc, J.-P., Gautier, F., Berger, A. & Loutre, M.-F. — 1996 — Alternate Interpretation of the Messinian Salinity Crisis: Controversy Resolved? — *Geology* 24(4): 363–366.
- Emelyanov, E.M., Shimkus, K.M. & Kuprin, P.N. — 2005 — Explanatory Notes to the IBCM-SED Map Series Unconsolidated Sediments of the Mediterranean Sea (Scale 1:1,000,000) and the Black Sea (Scale 1:2,000,000) — In: Hall, J.K., Krashennnikov, V.A., Hirsch, F., Benjamini, C. & Flexer A. (Eds.). *Geological Framework of the Levant, Volume II: The Levantine Basin and Israel*. Pp:155–186. Historical Productions-Hall Ltd. Jerusalem.
- EuroGeoSurveys, The Geological Surveys of Europe — 2010 — 1:5 Million International Geological Map of Europe and Adjacent Areas — [www.bgr.de/karten/igme5000/igme5000.htm](http://www.bgr.de/karten/igme5000/igme5000.htm).
- García-Barruso, M., Crespi, A.L., Nabais, C., Bernardos, S. & Amich, F. — 2012 — Mineral element composition in *Antirrhinum* subsection *Streptosepalum* (Plantaginaceae) in Western Europe (Iberian Peninsula) — *Lazaroa* 33: 19–26.
- Gavilán, R.G., Vilches de la Serna, B. & Fernández-González, F. — 2011 — Syntaxonomical review of *Cytisetea scopario-striati* communities in central Spain — *Lazaroa* 32: 29–72.
- González, J.A., García-Barruso, M., Ramírez-Rodríguez, R., Bernardos, S. & Amich, F. — 2012 — Plants used in folk cosmetics and hygiene in the Arribes del Duero Natural Park (western Spain) — *Lazaroa* 33: 9–18.
- Iglesias, M.P.L., Ribeiro, M.L. & Ribeiro, A. — 1983 — La interpretación aloctonista de la estructura del oeste peninsular. *Libro Jubilar J.M. Rios — Geología de España* 1: 459–467.
- IUCN — 2001 — IUCN Red List Categories and Criteria: Version 3.1. — IUCN Species Survival Commission. IUCN. Gland, Switzerland and Cambridge. UK.
- Kent, M. & Coker, P. — 1992 — *Vegetation Description and Analysis* — J. Wiley & Sons. Chichester.
- Kruckeberg, A.R. — 1986 — An essay: The stimulus of unusual geologies for plant speciation — *Syst. Bot.* 11: 455–463.
- Kruckeberg, A.R. — 1992 — Plant life of western North American ultramafics — In: Roberts, B. A. & Proctor, J. (Eds.). *The ecology of areas with serpentinized rocks* — Kluwer Acad. Publ. Netherlands.
- Kruckeberg, A.R. — 2002 — *Geology and Plant Life* — University of Washington Press.
- Lovett Doust, L. — 1981 — Population dynamics and local specialization in a clonal perennial (*Ranunculus repens*). I. The dynamics of ramets in contrasting habitats — *J. Ecol.* 69: 743–755.
- Mac Arthur, R.H. & Wilson, E.O. — 1967 — *The Theory of Island Biogeography* — Princeton Univ. Press. Princeton.
- Monteiro-Henriques, T. — 2010 — Landscape and phytosociology of the Paiva River's hydrographical basin — Mem. Doc. (ined.). Inst. Sup. Agron., Univ. Téc. Lisboa, Lisboa. [home.isa.utl.pt/~tmh/](http://home.isa.utl.pt/~tmh/)
- Monteiro-Henriques, T. & Aguiar, C. — 2011 — Bioclimatology, biogeography and land use of Trás-os-Montes — In: Asensi, A. & al. (Eds.). *Flora and Vegetation of Iberian Ultramafics. Excursion Guide*. Pp. 13–18. Inst. Politéc. Bragança. Univ. Coimbra.
- Pinto da Silva, A.R. — 1970 — A flora e a vegetação das áreas ultrabásicas do nordeste transmontano — *Agron. Lusit.* 30: 175–364.
- Pinto-Gomes, C., Paiva-Ferreira, R. & Meireles, C. — 2010 — New Proposals on Portuguese Vegetation (II) — *Lazaroa* 31: 59–65.
- Ribeiro, S., Gonçalves, P. & Espírito-Santo, M.D. — 2012 — Land-use influence on Mediterranean perennial swards of *Poa bulbosa*: a case study in the International Tagus Region — *Lazaroa* 33: 51–64.
- Rivas-Martínez, S. — 2004 — Mapas bioclimáticos y biogeográficos. [www.ucm.es/info/cif/form/maps.htm](http://www.ucm.es/info/cif/form/maps.htm).
- Rivas-Martínez, S. — 2005 — Notions on dynamic-catenal phytosociology as a basis of landscape science — *Plant Biosyst.* 139(2):135–144.
- Rivas-Martínez, S., Rivas Sáenz, S. & Penas, A. — 2011 — Worldwide bioclimatic classification system. *Global Geobot.* 1(1): 1–638.
- Sequeira, E.M., & Pinto da Silva, A.R. — 1992 — Ecology of serpentinized areas of North-East Portugal — In: Roberts, B. A. & Proctor, J. (Eds.). *The ecology of areas with serpentinized rocks. A world view*. Pp. 169–197. Kluwer Academic Publishers. Netherlands.
- Sequeira, E., Aguiar, C. & Meireles, C. — 2010 — Ultramafics of Bragança Massif: soils, flora and vegetation — In: Evelpidou, N., de Figueiredo, T., Mauro, F., Vahap, A. & Vassilopoulos, A. (Eds.). *Natural Heritage from East to West*. Pp. 143–149. Springer Verlag. Berlin.

Received: 3 December 2012

Accepted: 4 February 2013