7TH INTERNATIONAL CONFERENCE ON

SERPENTINE ECOLOGY

PROMOTING AWARENESS OF SERPENTINE BIODIVERSITY

Flora and Vegetation of Iberian Ultramafics

Excursion Guide

A. Asensi, C. Aguiar, D. Sánchez-Mata& T. Monteiro-Henriques (eds.)

ipb INSTITUTO POLITÉCNICO DE BRAGANÇA

• U C •

7th International Conference on Serpentine Ecology, Coimbra (Portugal)

Flora and Vegetation of Iberian Ultramafics Excursion Guide

A. Asensi, C. Aguiar, D. Sánchez-Mata & T. Monteiro-Henriques (eds.)

Instituto Politécnico de Bragança

Universidade de Coimbra

12-16 June 2011

7th International Conference on Serpentine Ecology

I. Mid-conference field trip: NE Portugal ultramafic outcrops

Carlos Aguiar (coord.)

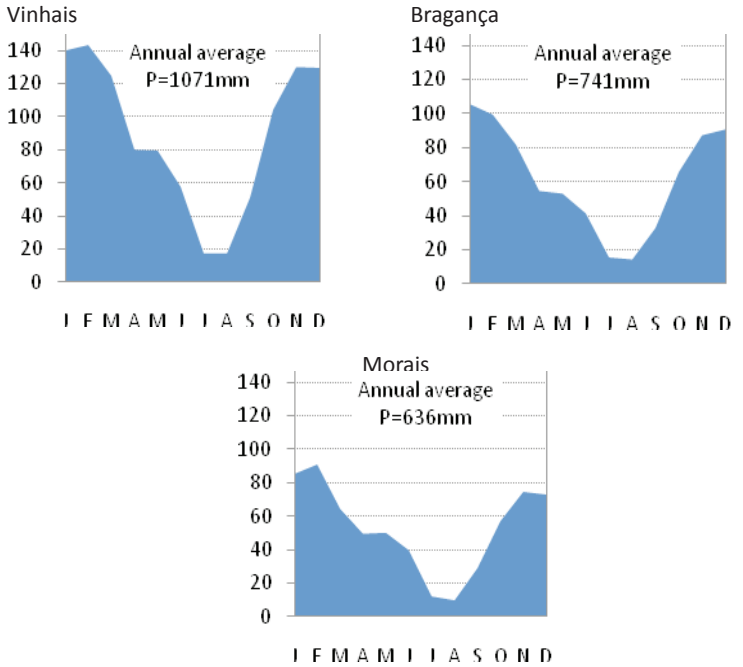

Figure 4. Monthly precipitation (P, mm) in three weather stations in the areas of the Bragança and Morais ultramafic massifs (average 1951/1980)

3. Bioclimatology, biogeography and land use of Trás-os-Montes

(by Tiago Monteiro-Henriques & Carlos Aguiar)

Bioclimatology

Frequently climate is considered the first factor influencing flora, and consequently, vegetation distribution (Walter 1986; Woodward & B. G. Williams 1987; Capelo 2003; Peinado *et al.* 2007). Bioclimatology is the science that investigates the relationship between climate and the distribution of organisms.

Rivas-Martínez's Worldwide Bioclimatic Classification (RMWBC) has been developed by Rivas-Martínez with a number of approaches since 1982 (Rivas-Martínez 1996; 2008), with close reference to vegetation distribution, and is currently the most widely applied classification by Iberian phytosociologists, as well as from other Mediterranean countries. Based on the RMWBC, Monteiro-Henriques (2010) produced a set of bioclimatological maps for mainland Portugal (1960-1990) using the climatic statistical interpolations of Silva (2005) and Nicolau (2002) as base data. Using these bioclimatological maps of Monteiro-Henriques (2010) we present thermotype and ombrotype maps for mainland Portugal following the latest version of the RMWBC (Rivas-Martínez 2008), with particular focus on the Morais-Bragança area (Figure 5 and 6).

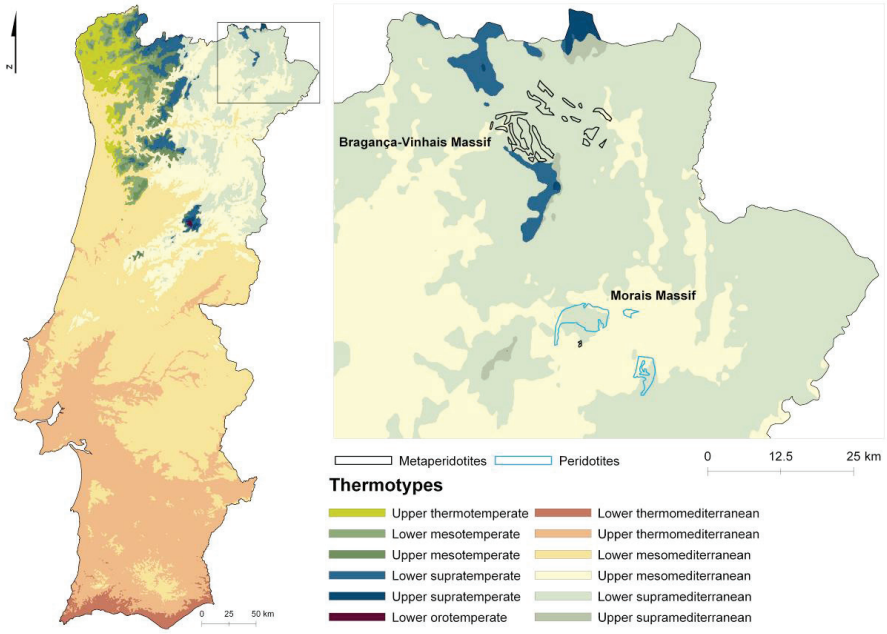

Figure 5. Thermotype map of mainland Portugal according to the latest version of Rivas Martínez's World Bioclimatic Classification (Rivas-Martínez 2008), with particular focus on the Morais-Bragança area. Metaperidoties and peridotites from the *Carta Geológica de Portugal* 1/500 000.

Figure 5 shows that the Bragança ultramafic massif is mainly under the supramediterranean thermotype (Terra-Fria). The majority of the Morais massif is also under the supramediterranean thermotype, although some parts are closely or directly under the mesomediterranean type. These results are consistent with the climatic analysis presented in Section I.2. because there is a close correspondence between the mesomediterranean and the supramediterranean thermoclimatic belts and the "Terra Quente + Terra de Transição" and "Terra Fria" climatic types of Gonçalves (1985), respectively.

Figure 6 shows that the Bragança massif presents a wider range of ombrotypes compared to the Morais massif: Bragança varying between upper subhumid to upper humid, while Morais massif varies between upper subhumid to lower humid.

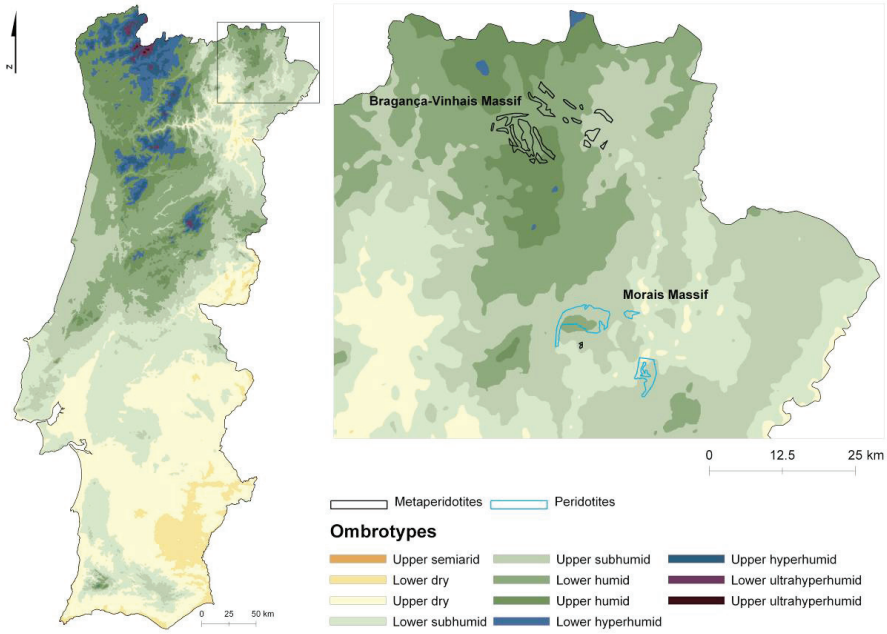

Figure 6. Ombrotype map of mainland Portugal according to the latest version of Rivas Martínez's World Bioclimatic Classification (Rivas-Martínez 2008), with particular focus on the Morais-Bragança area. Metaperidotites and peridotites from the *Carta Geológica de Portugal* 1/500 000.

Biogeography

The widely used Iberian Peninsula biogeographical typology of Rivas-Martínez (2001) (see Figure II.34 of Díaz Garretas & Asensi in this book) places the majority of the Trás-os-Montes in the Mediterranean region, the Mediterranean West Iberian province and Carpetan-Leonese sector. In the Biogeographical Map of Portugal of Costa *et al.* (1998), the Carpetan-Leonese sector encompasses three subsectors (Figure 7): Ourensean-Sanabrian (2A), Salmanticensian (2B) and Lusitanian-Duriensean (2C). The western corner of the Trás-os-Montes has a supratemperate bioclimate and already belongs to the Euro-Siberian floristic region (Atlantic-European province and Cantabro-Atlantic sector, areas marked with 1 in Figure 7). The biogeographical units of Trás-os-Montes are easily identified in the field through their natural forest remnants and their subseral stages.

The relief of the Trás-os-Montes is characterized by a succession of supratemperate or supramediterranean (Terra-Fria, see II.2) granitic plateaus of more than 650-700 m altitude, the fragments of an ancient peneplain lifted up since the Pliocene, dissected by mesomediterranean (Terra-Quente, see II.2) deep valleys or small neotectonic basins (see Cabral 1995, Gutiérrez Elorza 1994). The supramediterranean Terra-Fria belongs to the Ourensean-Sanabrian subsector, and is the domain of the sub-continental *Quercus pyrenaica* (*Fagaceae*) woodlands, nowadays largely substituted by arable land, chestnut groves, heathlands dominated by *Erica australis* (*Ericaceae*) or broom (*Cytisus* sp.pl., *Fabaceae*) shrublands. Mixed forests of

Q. robur-Q. pyrenaica, riparian woodlands with *Betula celtiberica* (*Betulaceae*) and scrublands with *Ulex minor* (*Fabaceae*) and *Pterospartum tridentatum* subsp. *cantabricum* (*Fabaceae*) are the main components of the vegetal landscape of the western Trás-os-Montes supratemperate peneplains. Species-rich hay-meadows are well represented in both these territories – Carpetan-Leonese and Cantabro-Atlantic sectors – just like herbaceous perennial or biennial oligotrophic pastures dominated by oligotrophic grasses like *Agrostis curtisii*, *A. x fouilladei* [*A. castellana x A. capillaris*], *A. truncatula* subsp. *commista*, *Arrhenatherum elatius* subsp. *bulbosum*, *Pseudarrhenatherum longifolium* or *Nardus stricta*.

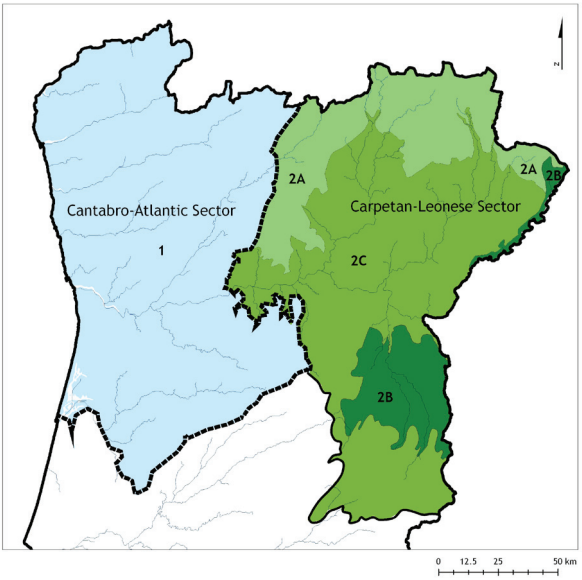

Figure 7. Biogeographical map of northern Portugal (Costa *et al.* 1998). Legend updated according to the typology of Rivas-Martínez (2001). Euro-Siberian region: Cantabro-Atlantic sector (1). Mediterranean region: Carpetan-Leonese sector (2), Ourensean-Sanabrian subsector (2A), Salmanticensian subsector (2B) and Lusitanian-Duriensean subsector (2C). Dashed line represents the boundary between Euro-Siberian and Mediterranean regions

Mesomediterranean Terra-Quente perennial sclerophyllous woodlands with changeable combinations of *Quercus suber*, *Q. rotundifolia*, *Q. faginea* subsp. *faginea* (*Fagaceae*) and *Juniperus oxycedrus* (*Cupressaceae*) constitute the Natural Potential Vegetation of the Lusitanian-Duriensean and Salmanticensian valleys and neotectonic basins. Roughly in the geographic centre of the Trás-os-Montes persists a relevant area of the *Q. suber-Q. faginea* subsp. *faginea* woodlands more or less simplified into a "montado" (human- made savannah- like vegetation, "dehesa" in Spanish) structure. The mixed woodlands of *Q. suber*, *Q. rotundifolia*, *Q. faginea* subsp. *faginea* and *Juniperus oxycedrus*, a quite unusual tree combination, are recurrent in deep coluvial soils of the drier Lusitanian-Duriensean subsector valleys. In zonal soils these complex forest communities are replaced by *Q. rotundifolia-J. oxycedrus* woodlands. The low shrub communities of *Cistus ladanifer* (*Cistaceae*) are

the most conspicuous substitution stage of perennial sclerophyllous woodlands in the Trás-os-Montes. *Retama sphaerocarpa* (*Fabaceae*) tall shrublands and pioneer scrub communities of *Cytisus multiflorus* (*Fabaceae*), *Lavandula pedunculata* (*Lamiaceae*) and *Halimium umbellatum* subsp. *viscosum* (*Cistaceae*) are also common.

In the "Introduction" (Section I.1) and in the "Physiography and climate of the Trás-os-Montes" (Section I.2) it is stated that the ultramafic rocks of northeastern Portugal are grouped into two massifs: Bragança and Morais (Section I.4). The first one is located in Ourensean-Sanabrian subsector, and the second in the Lusitanian-Duriensean subsector. In the flora and vegetation chapters (Sections I.6 and I.7) it will be demonstrated that their flora and vegetation show a few, although relevant, dissimilarities.

Land use

Land use in northeastern Portugal is strongly correlated with bioclimate and, implicitly, with vegetation belts (Costa *et al.* 1998). The agriculture systems of the Terra-Quente are based on the archetypal Mediterranean cultivated plants: the olive tree, almond tree and vineyards. The olive tree cultivated area is actually growing due to an expansion of the crop towards higher altitudes in former wheat or rye cultivated land. In contrast, almond and olive tree orchards of inaccessible steep slopes are being actively abandoned and rewilded. The Douro wine region extends to the furthest south part of the Trás-os-Montes' Terra-Quente through the National and International Douro Valley and the final stretches of its tributariess. Created by royal decree in 1756 it is the third oldest protected wine region in the world. With a total surface of approximately 250.000 ha only 26.000 ha are vineyards authorised for Port Wine.

Until the entry of Portugal to the European Community in 1986, wheat was an important crop in the Terra-Quente agricultural systems. Since then large areas of cereal land have been abandoned and colonized by shrub vegetation, still extensively grazed by small domestic herbivores (sheeps and goats). Cork oak (*Quercus suber, Fagaceae*) "montado" is an important source of income in the Terra-Quente. In recurrent cycles of nine or ten years, at the beginning of summer, the cork is detached manually along the phellogen (cork cambium) leaving untouched the vascular cambium. Tree production plantations suffer a long soil water deficit and thrive only with difficulty in the mesomediterranean areas. Consequently, the success of *ab initio Pinus pinaster* (*Pinaceae*), *Cupressus lusitanica* (*Cupressaceae*), *Q. suber* and *Q. rotundifolia* (*Fagaceae*) plantations in the Terra-Quente is poor, except in the valleys near the west supratemperate plateaus.

In the supramediterranean or supratemperate bioclimatic belts, i.e. the Terra-Fria, the temperature integrals and soil water deficits are smaller than in the Terra-Quente (Section I.2). This mountain territory is more suitable to less nutrient demanding species, which are tolerant of winter cold and spring chilling. The main features of the Terra-Fria traditional (organic) agricultural systems are depicted in Figure 8. Here, the wheat crop is substituted by rye, and the vineyards and the olive trees by chestnuts. The farm animals had, and still have, a large importance to farmer's incomes. Hay-meadows and communal shrublands were an indespensable component in these mountain agricultural systems. Recent plantations of cherry-tree (*Prunus avium*, *Rosaceae*), *Fraxinus* sp.pl. or chestnut trees on agriculture abandoned lands show varying degrees of success.

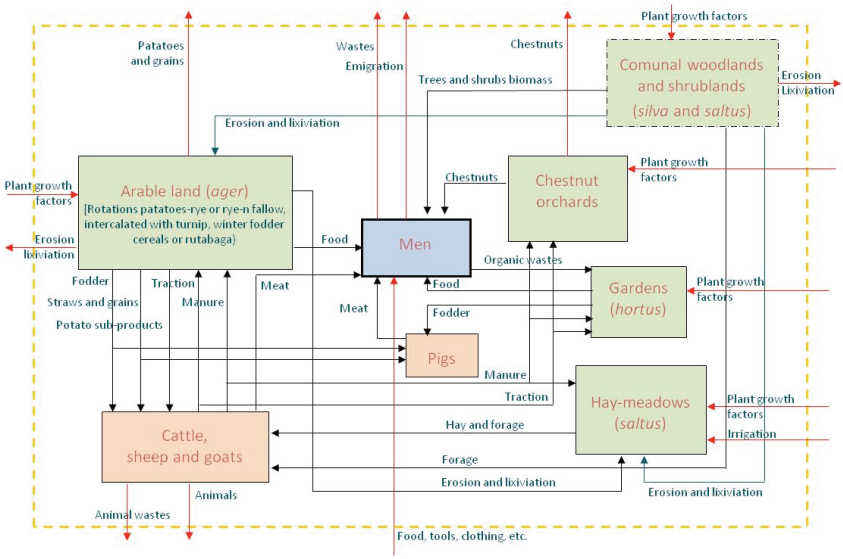

Figure 8. Diagrammatic representation of Terra-Fria traditional (organic) agricultural systems (inspired in Moreira 1984). Dashed line (- - - -) represents the limits of the system.

4. Geology of the ultramafic area of the Trás-os-Montes

Morais massif

(by Eurico Pereira)

Introduction to geological concepts

The Morais massif can be considered as a geological singularity. However, it is not an isolated case in the geology of Iberia, where there are equivalent massifs. Indeed, the sequence of massifs from Cabo Ortegal, Ordenes and the Malpica-Tui band, in Galicia, and the Bragança and Morais massifs in the eastern Trás-os-Montes contain the key elements of an 'orogeny'. In other words, the process that leads to the formation of a mountain chain. In this case, it is the Variscan Orogenic Chain that in Europe extends from Iberia to the Urals.

The formation of a mountain chain, like the Alps or the Himalayas, represents the final stage of a geological cycle, called the Wilson Cycle, lasting for hundreds of millions of years (Ma). This cycle begins with the gradual rupture of a continent and the opening up of an ocean. As the ocean expands, sediments accumulate from the erosion of the continental margins (sediment genesis phase). But the oceans and the formation of oceanic crust are ephemeral. Their capacity for expansion is limited, and after a reversal of the crustal mechanical stresses begins a process of contraction, and they close. The oceanic crust, denser than the continental crust, is partially destroyed by returning to the earth's mantle that produced it and, in the final stage, the continents that bordered the ocean, collide (tectonic genesis phase).