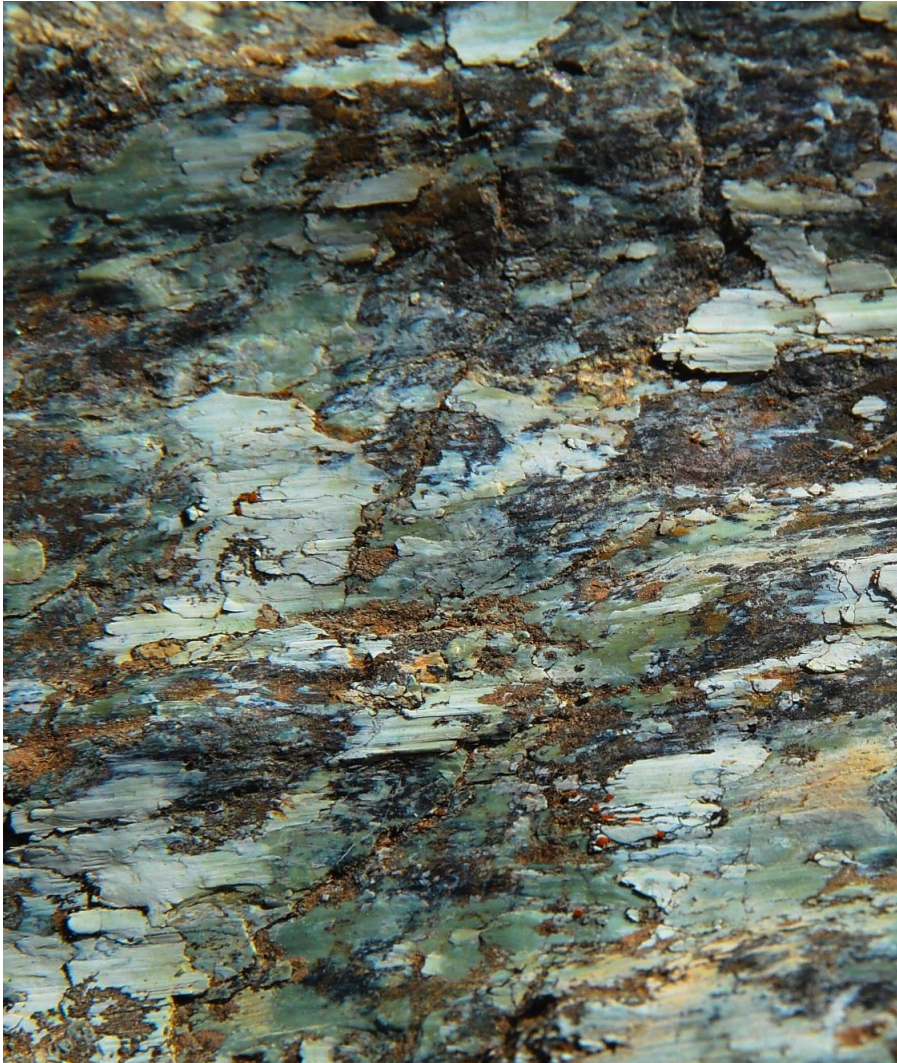


VII ICSE, Coimbra (Portugal)

**Flora and Vegetation of Iberian Ultramafics
Excursion Guide**

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Seventh International Conference on Serpentine Ecology

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

Carlos Aguiar (coord.)

1. Introduction

Ultramafic rocks are rare lithotypes in Portugal. The main Portuguese ultramafic areas are restricted to the districts of Bragança and Portalegre, respectively located in the Trás-os-Montes (NE Portugal) and Alentejo (SE Portugal). These are regions that have kept the name of their former provinces (as also Minho mentioned below), but which nowadays lack any administrative significance. A few small weathered outcrops, without a peculiar flora or vegetation cover, appear scattered in the Minho region (NW Portugal). Although the ultramafic rocks of the Alentejo are reported to have a few interesting plant species, like the Iberian endemics *Armeria linkiana* and *Reseda virgata* (Castro Antunes & Aguiar ined.), the ultramafic rocks of the Trás-os-Montes are the largest and the richest in endemic species within Portugal (Section 1.6).

This text is a tour companion to the ultramafic rocks of northeastern Portugal. It starts with a description of the physiography, climate (Section 1.2), bioclimatology and land use of the Trás-os-Montes (Section 1.3). The ultramafic rocks of this territory appear assembled in two massifs: Bragança, not far away from the Portuguese-Spanish border, and Morais, further south (Figure 1). An introduction to the geology of the two massifs is presented (Section 1.4), followed by a description of the ultramafic rock weathering processes and soils, and a few notes about the ecophysiology of northeastern Portugal serpentinophytes (Section 1.5). The ultramafic flora (Section 1.6) and vegetation (Section 1.7) are then discussed. The last chapter contains a description of the itinerary of the field visit (Section 1.8).

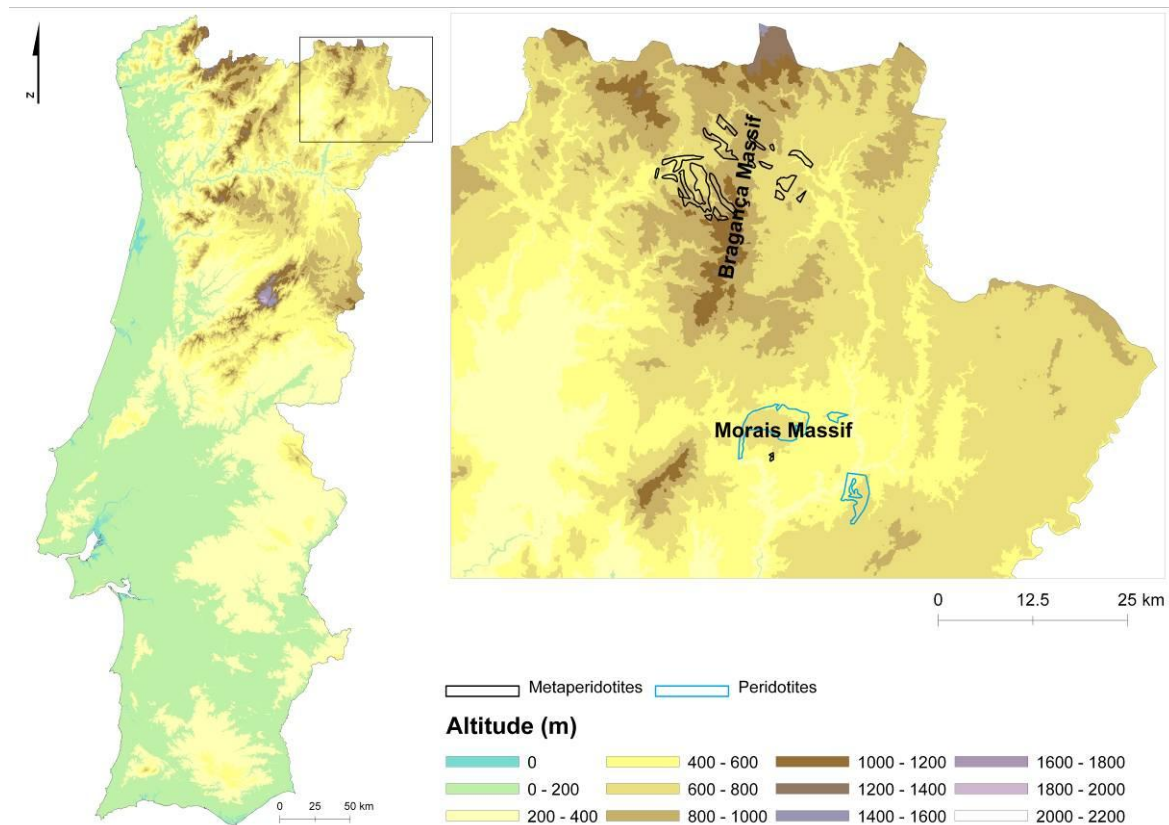


Figure 1. Massifs of Morais and Bragança.

2. Physiography and climate of Trás-os-Montes (by Dionísio Gonçalves & Tomás de Aquino Figueiredo)

Physiography

The region where ultramafic rocks outcrop in NE Portugal is a rather peculiar physiographic territory, labelled as the Bragança–Miranda plateau, on the most south-easterly boundaries of the NW of the Iberian Peninsula (Figure 2). The region, a gently tilted surface, is cut through by the Douro River, which is called ‘International’ where it is on the Portugal-Spain border. The Internacional Douro River runs towards SSE in an impressive gorge for 122 km, in places cutting the plateau to a depth of nearly 300 m. The right bank main tributary catchments and stream networks drain and dissect the surface in that same direction and in similar, yet less impressive, deep V-shaped valleys: the Sabor River and the Tua River valleys. Both rivers feed the Douro where it becomes entirely Portuguese, which crosses the country from east to west for 208 km, and defines the regional base level for stream networks.

The regional main catchment divides are actually flattened surfaces, above which rise some highly eroded mountain ranges (Serras in Portuguese). Serras de Mogadouro and Lagoaça, to the east, and Serra de Reboredo, in the south, are the most important examples for Internacional Douro-Sabor catchment. In the central meridian belt of this region, in the Sabor-Tua catchment divide, rise,

successively from north to south, the Serras de Montesinho, Nogueira and Bornes, and, further south, the Carrazeda plateau. The main mountain ranges in the west are the Serra da Coroa, on the upper Tuela river basin (near the northern border with Spain), Serra de Santa Comba, some 60 km south, and the Serra da Padrela and Serra de S. Domingos, that bound the region in the southwest, and drain towards the Tinha and Pinhão rivers, two much smaller Douro tributaries than the Sabor and Tua.

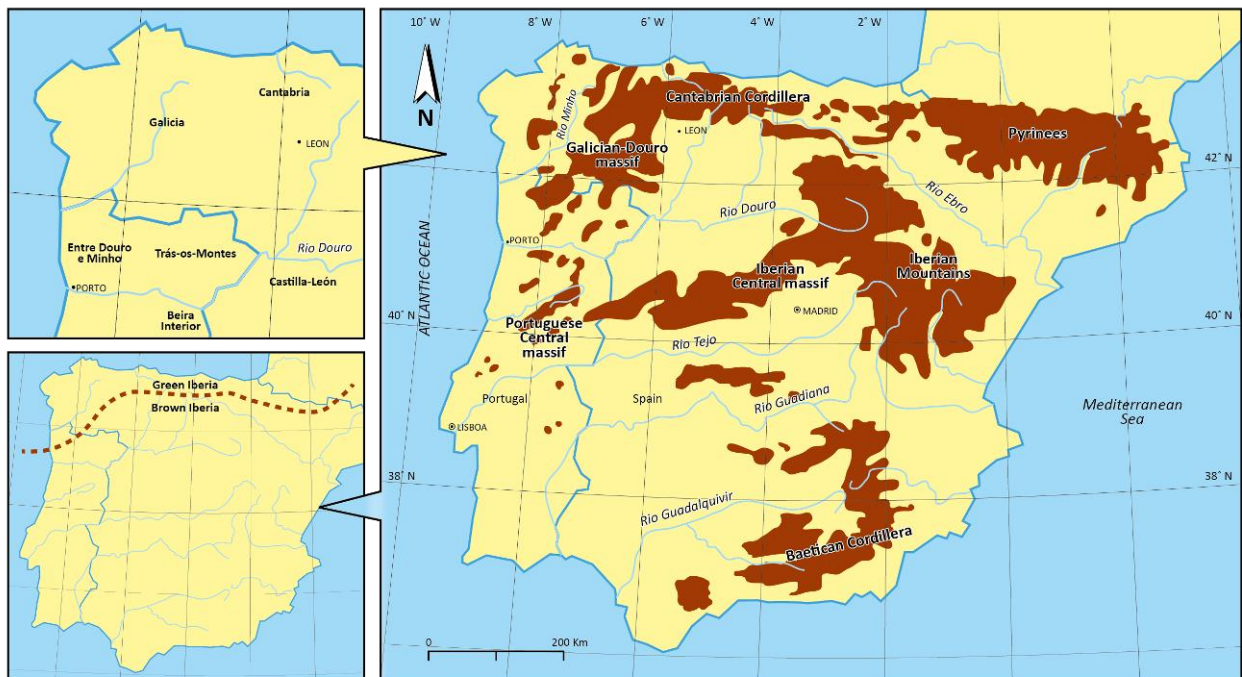


Figure 2. The regional physiographic context.

This Bragança-Miranda plateau is also part of a larger physiographic unit, the Iberian Meseta northern block, as it is located in the north-western corner of the Central Peninsula (Figure 2). The Meseta is a very wide plateau, its northern block reaching the Cantabrian Cordillera at N and NW, westerly bounded by the Galicia-Douro massif, actually a coastal mountain range comprising the Serras of Peneda-Gerês, Alvão-Marão (both north of the Douro River) and Montemuro (south of the Douro). South of the Douro, a plateau again characterizes the regional relief: the Beirão plateau, reaching southwards to the Portuguese Central massif, with the Serra da Estrela, the highest peak in the Continental territory (1993 m elevation). Similarly, the Meseta northern block is bounded to the south by the Iberian Central massif and to the east by the Iberian Mountains, where the Douro has its sources, at Serra de Urbion (2228 m).

In summary, the Trás-os-Montes is a plateau, extensively and deeply dissected by a dense drainage network, with some significant mountain ranges, which all have a strong influence on the

regional climatic characteristics. The physiographic features within the Iberian Peninsula context, above schematically described, together with its planetary position (41°/42° latitude N) are indeed decisive in defining the Atlantic/Mediterranean climatic regime that prevails in this region.

Climate

The Trás-os-Montes is under a general westerly influence, typical of these latitudes, which is characterized by the frequent unstable conditions caused either by the polar front oscillation or by sub-tropical anticyclones (the Azores anticyclone). The region's latitudinal location favours the influence of the polar front oscillations, typically in the cold season, when most of the yearly precipitation occurs (around 60% of the annual total). In the summer, the polar front retreats to the higher latitudes, leaving this region under the influence of sub-tropical anticyclones, and this is the reason for very scarce precipitation in this season.

This large scale picture is, in turn, modified by the regional physiography, adding continental climatic features to the ones imposed by the atmospheric conditions determined by this geographic location. In fact, the mountain ranges in NW, that roll from the Cantabrian Cordillera southwards, define two clearly different domains, regarding precipitation levels and seasonal distribution. The green Iberia, in the NW Peninsula and the brown Iberia, in the remainder, are the most expressive labels for these climatic and ecological domains (Figure 2). The former, a sharply different landscape when compared to the latter, is determined by a much lesser concentrated rainfall pattern, and shows similarities with western European mid-latitude regions. North facing hill-slopes of the Cantabria range, Galicia and the Portuguese northwest (the Entre Douro e Minho region) form the green Iberia. To the south and east, environments are much affected by continentality and mediterraneity. The typical long and severe summer drought of Mediterranean climates is reflected in ecosystems and landscapes, ecological conditions that become harsher in central Meseta and in the lower lying areas, either the narrow river valleys (the Douro itself included) or the wide tectonic basins as those, in NE Portugal, of Mirandela and Vilaríça. Hence, with reference to annual precipitation values throughout the region, annual values are as high as 3000 mm on the NW Upper Minho mountain tops, and drop to less than 400 mm in the Upper Douro valley, in less than 120 km.

This very wide range in climatic conditions, together with the very varied physiographic conditions, explains in turn the marked landscape diversity, which has also been affected by land use history.

This regional climatic diversity is also found in the ultramafic massifs, influencing the geomorphological, geochemical and pedogenetic processes and features that characterize these outcrops (Section I.5), and which is related to a large extent to their such peculiar flora and vegetation (Sections I.6 and I.7). In this location, as well as throughout the Central-north eastern

Portuguese territory, there occur the climatic conditions regionally labelled as Terra-Fria (Cold Land) and Terra-Quente (Warm Land), to a certain extent their geographical ex-libris.

Figure 3 depicts the distribution and general characteristics of the regional climatic zones, according to Gonçalves (1985a) with small revisions by the same author, presented in later published works (Gonçalves 1991a; Gonçalves 1991b; Agroconsultores e Coba 1991). These zones correspond to different land use patterns (Section I.3) and depict sharply different landscapes over short distances, generally identified as a “Patchwork Landscape”, so typical of the Trás-os-Montes.

Areas where ultramafic rocks outcrop (the Bragança and the Morais massifs) fall into the climatic zones indicated in Table 1.

Table 1. Climatic zones of Bragança and Morais ultramafic outcrops (see Figure 4 for details of climatic type names and symbols)

Climatic Type	Bragança	Morais
	Sub-Type Symbol	
Terra-Fria de Montanha	M1, M2	
Terra-Fria de Planalto	F2, F3, F4	F3, F4
Terra de Transição	T4	T3, T4, T5
Terra-Quente		Q4, Q5

As shown in Table 1, only the Bragança massif has a Terra-Fria de Montanha type of climate, corresponding to the Serras of Montensinho and Nogueira. Precipitation ranges from 1000 to 1200mm, the latter limit being overcome only in mountain top areas. The sub-type F2 (Terra-Fria de Planalto with precipitation ranging from 1000 and 1200mm) occurs in the Bragança massif, in the above-mentioned Serras but at lower altitudes than sub-type M2. Transitional climatic conditions (T) dominate in the Morais massif, but are also found in the southward facing slopes of Serras da Nogueira and Coroa, in the Fervença/Sabor river valley downstream from Bragança and in the Tuela River, west of Vinhais. Terra-Quente is typical of east and west facing slopes of the Morais massif and of the deep valleys of the Sabor and Tuela rivers (Figure 3).

The criteria devised to differentiate between the two climatic types, Terra-Fria and Terra-Quente, are obviously based on thermal parameters, namely the mean annual temperature thresholds referred to above (Figure 3). They effectively match the geographical distribution of regional ecological domains and land use types that characterize the region (Section I.3). It should be added that the differences between the Terra-Fria and Terra-Quente climatic domains are not so clear during the colder months, when similar records are found in both types, and this is due to the very frequent thermal inversions in the topographical depressions where the Terra-Quente type prevails. Long term average minima of coldest month daily temperatures (1951/1980) is 2.0°C in

Mirandela, 0.9°C in Bragança, and 0.4°C in Montalegre (the former located in the heart of Terra-Quente, the latter two representing Terra-Fria). In line with these, similar observations are notable when comparing absolute minima recorded in Mirandela (-9.5°C), in Bragança (-11.4°C), and in Montalegre (-11.6°C).

Actually, the main thermal differences of the two climatic domains are quite evident in the spring months, at the beginning of the vegetative growing season for crops and non-crop vegetation. Plant growth and development are much faster and occur much earlier in Terra-Quente when compared to Terra-Fria, meaning a delay of about two months until full development stages in the latter, which increases to about three months in mountain areas. In contrast with the narrow range in the minima of the coldest month, average maxima of daily temperatures, computed for March, April and May, are distinctly different in weather stations located in Terra-Fria and in Terra-Quente (Table 2).

Table 2. Long term average (1951/1980) of maxima daily temperatures in spring months in three weather stations representing the main regional climatic types (INMG 1991)

Climatic Type	Weather station	Average maxima of daily temperatures in spring		
		March	April	May
Terra-Fria de Montanha (M)	Montalegre	9.5°C	12.1°C	15.6°C
Terra-Fria de Planalto (F)	Bragança	12.9°C	15.4°C	19.3°C
Terra-Quente (Q)	Mirandela	15.9°C	18.9°C	23.0°C

As depicted in Table 2, the mean daily maximum in March at Mirandela is higher than the Bragança April value and the Montalegre May value. These are the fundamentals for explaining such a sharp climatic and ecological contrast between Terra-Fria and Terra-Quente that characterize a not so huge territory as Trás-os-Montes. In fact, summers are hot throughout the region and cold winters are the prevailing condition for NE Portugal, well grounded in climatic records as shown.

As a Mediterranean regime area, the region has a seasonal rainfall distribution characterized by summer water scarcity, which has much wider ecological consequences in Terra-Quente than in Terra-Fria, generally affecting vegetation and specifically the agri-environments in this land of contrasts (Figure 3). Figure 4 illustrates these data comparing rainfall distribution throughout the year in the areas of the Bragança and Morais ultramafic massifs.

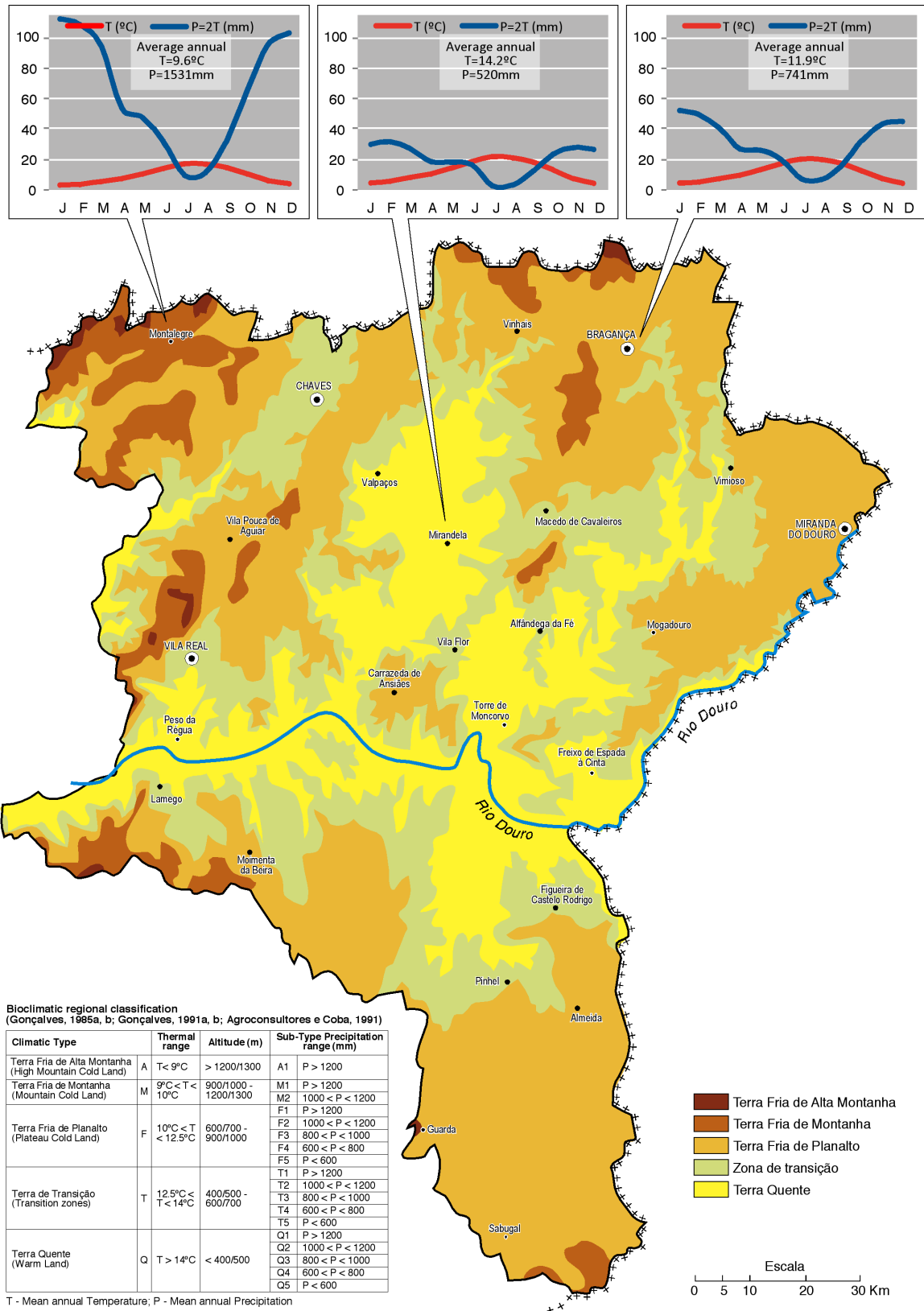


Figure 3. The Terra-Fria and Terra-Quente regional climatic domains (in graphs average 1951/1980). Note: The map includes also the Beirão plateau, the eastern part of Beira Interior region, in the Douro River left bank.

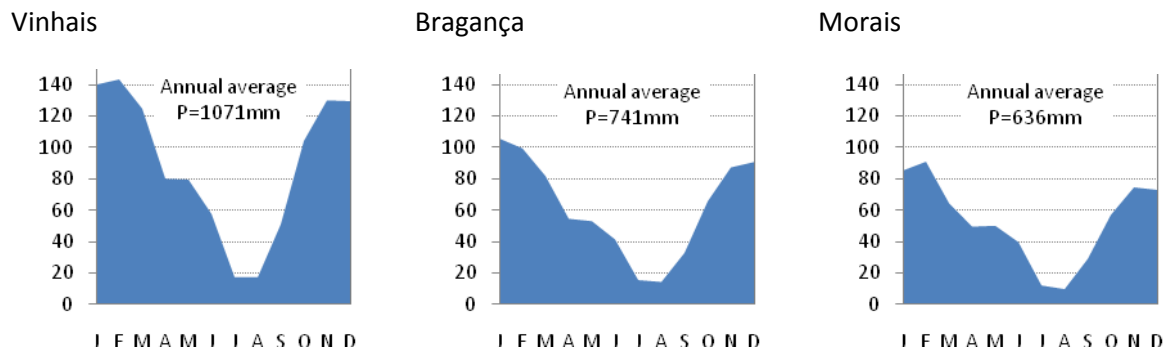


Figure 4. Monthly precipitation (P, mm) in three weather stations in the areas of the Bragança and Morais ultramafic massifs (average 1951/1980)

3. Bioclimatology, biogeography and land use of Trás-os-Montes (authors: 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).

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