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Nec vero terrae ferre omnes omnia possunt.
Fluminibus salices, crassisque paludibus alni
Nascuntur, steriles saxosis montibus orni;
Litora myrtetis laestissima; denique apertos
Bachhus amat colles, Aquilonem et frigora taxi.
Aspice et extremis domitum cultoribus orbem,
Eoasque domos Arabum, pictosque Gelonos.
Divisae arboribus patriae. Sola India nigrum
Fert ebenum, solis est turea virga Sabaeis.
Quid tibi odorato referam sudantia ligno
Balsamaque et bacas semper frondentis acanthi?
Quid nemora Aethiopum, molli canentia lana,
Velleraque ut foliis dessectant tenuia Seres?
Aut quos Oceano proprior gerit India lucos,
Extremi sinus orbis...

Not that all soils can all things bear alike.
Willows by water-courses have their birth,
Alders in miry fens; on rocky heights
The barren mountain-ashes; on the shore
Myrtles throng gayest; Bacchus, lastly, loves
The bare hillside, and yews the north wind's chill.
Mark too the earth by outland tillers tamed,
And Eastern homes of Arabs, and tattooed
Geloni; *to all trees their native lands*
Allotted are; no clime but India bears
Black ebony; the branch of frankincense
Is Saba's sons' alone; why tell to thee
Of balsams oozing from the perfumed wood,
Or berries of acanthus ever green?
Of Aethiop forests hoar with downy wool,
Or how the Seres comb from off the leaves
Their silky fleece? Of groves which India bears,
Ocean's near neighbour, earth's remotest nook,

Vergil. Georgics 2.109. 1st Cent. BC (English version by Grenough)

CONTENTS

INTRODUCTION AND AIMS

The idea of organising an excursion of the IAVS through Peninsular Spain and Portugal was developed in the middle of the nineties and, after obtaining the support of the Spanish and Portuguese associations of phytosociology (AEFA -Asociación Española de Fitosociología- and ALFA -Associação Lusitana de Fitossociologia-), finally was proposed at the meeting of Ceske Budejovice in 1997. This is the third time an international excursion takes place in the Iberian Peninsula. The first was in 1935 through Catalonia and was led by Josias Braun-Blanquet and organised by P. Font Quer. The conflicts of the following years hindered the progression of our science in Spain but an important seed had been planted. The second occasion was the 10th International Phytogeographical Excursion (IPE) in 1953, organised by Prof. Salvador Rivas Goday, in which many relevant phytosociologists took part: R. Tüxen, E. Oberdorfer, H. Walter, H. Gams, H. Gaussen, R. Nordhagen, W. Lüdi, J. Jalas, A. R. Pinto da Silva, etc.; that event was decisive for the development of the phytosociology in Spain in the following decades. On the present occasion we shall try to continue the splendid tradition of the IAVS's excursions as many of them have been important events in the world of vegetation science offering privileged opportunities to many colleagues to visit and know vegetation types of a considerable number of countries all over the world accompanied and guided by skilled local colleagues.

This guide tries to provide the participants with a sufficient amount of information about the plant communities found during the trip and the stops, as well as other information about the environmental conditions of the country. Certainly, the purpose of writing such a book for a 16 days excursion seems to be exaggerated but we consider that it will also be helpful to other colleagues who wish to visit the same places and follow the same route by their own means in the future.

The ***itinerary*** has been selected in order to visit in a fortnight, the most relevant and genuine vegetation types of the Iberian Peninsula. Due to the size of the country and to the shortage of time, we had to exclude the Pyrenees (special excursion has been organised to visit them) and the eastern quadrant of the Peninsula. Thus, the trip follows a clockwise itinerary crossing the eastern, southern, western and northwestern areas of the Peninsula, providing the opportunity to visit the most genuine Levantine, Baetic, Iberoatlantic and Cantabrian landscapes and to study their plant communities.

The choice of the ***stops*** has been restrictive and only the best localities are going to be visited, special attention has been paid to the quality and state of conservation of the vegetation types occuring there, as well as their representativeness and diversity. For each stop a drawing or scheme is presented, drawn by Prof. Manuel Costa or by Prof. Tomás E. Díaz, outlining the plant communities to be seen. We have tried to establish a few good stops for each day, where we can stay longer and study and reflect on the vegetation.

Every day we will have the help of one or several colleagues who will act as ***regional guides*** and who are also the authors of the corresponding chapter (or part of the chapter) in the guide. They will accompany us in their corresponding stretch.

We have tried to follow a similar pattern when describing the vegetation in all the chapters concerning the days of the excursion. The sigmatist (Braun-Blanquet) typology is followed for the plant communities in all cases. If information sources allow it, some relevés or synthetic tables from the literature are included for the plant communities to be seen in order to avoid plant lists. In the landscape descriptions, together with information about the geology or geography of the territory, the concept of Vegetation Series or Sigmetum and Geosigmetum are extensively used, with other related concepts such as Potential Natural Vegetation, seral stages, etc. (Alcaraz 1996, Rivas-Martínez 1987, 1994). Comments about bioclimate and biogeography are always refered to in the corresponding chapters.

Like the other issues of Itinera Geobotanica, this volume tries to be a useful tool for the vegatationists who visit the area wishing to have an accurate and specialized guide book, and a step in the advance of vegetation science as it represents a summarization of a considerable amount of disperse information.

The Editors

ITINERARY

In the map of figure 1 is shown the itinerary scheduled for this *Iter Ibericum A.D. MIM*. The outline of the jurney, with the visited areas, the main obseved landscapes and the local leaders, is as follows:

1st day, 9 July (Friday)
Bilbao-Ebro basin-Teruel-Valencia.
Landscape along the journey: the Basque mountains, the Ebro Basin, the Iberian system by *Salvador Rivas-Martínez & Javier Loidi*

2nd day, 10 July (Saturday)
Valencia-Javalambre summit-Valencia.
Inner Valencian landscape, Maestracean juniper and pine woodlands of supra and oromediterranean belts by *Manuel Costa & Pilar Soriano*

3rd day, 11 July (Sunday)
Valencia-Xátiva-Alcoy-Font Rocha-Xixona-Alicante-Murcia.
Valencian "carrascal" of Font Rocha, entrance to the Murcian-Almerian province by *Manuel Costa & Pilar Soriano*

4th day, 12 July (Monday)
Murcia-Sierra de Carrascoy-Barranco del Avenque-Peña del Águila-Lorca-Puerto Lumbreras-Baza.
Murcian-Almerian vegetation: "tomillares", shrublands and Tetraclinis woodlands by *Francisco Alcaraz*

5th day, 13 July (Tuesday)
Baza-Sierra de Baza-Guadix-Granada.
The landscape and plant communities of the Sierra de Baza (Guadiciano-Bacense sector) by *Francisco Valle*

6th day, 14 July (Wednesday)
Granada-Sierra Nevada-Málaga.
The vegetation belts of the Sierra Nevada, from the meso to the crioromediterranean by *Joaquín Molero*

7th day, 15 July (Thursday)
Málaga-San Pedro de Alcántara-Sierra de las Nieves-Ronda.
Serpentinic plant communities and Rondense vegetation at Sierra de las Nieves: scrub, "pinsapares" and "quejigares" by *Alfredo Asensi & Blanca Díez Garretas*

8th day, 16 July (Friday)
Ronda-Ubrique-Alcalá de los Gazules-Sevilla-Ayamonte-Faro.
Vegetation of the Parque Natural de Los Alcornocales with *Quercus suber* and *Q. canariensis* forests, Alder-Rhododendron forests, heathlads, etc by *Alfredo Asensi & Blanca Díez Garretas*
Algarvian coastal areas vegetation: woodlands, scrub, sand dunes and salt-marshes by *Mário Fernandes Lousã, José Carlos Costa, Jorge Henrique Capelo, Carlos Pinto Gomes & Carlos Neto*

9th day, 17 July (Saturday)

Faro-Grândola-Tróia-Serra da Arrábida-Évora.

Landscape of the journey from Algarve to Tróia. Sand dune ecosystems of Tróia (Sado river estuary). The vegetation of the Serra da Arrábida: sclerophylle shrublands and forests by *Mário Fernandes Lousã, José Carlos Costa, Jorge Henrique Capelo, Carlos Pinto Gomes & Carlos Neto*

10th day, 18 July (Sunday)

Évora-Badajoz-Trujillo-Monfragüe-Talavera de la Reina-Collado-Villalba.

Landscape of the Alentejo and Extremadura by *Mário Fernandes Lousã, José Carlos Costa, Jorge Henrique Capelo, Carlos Pinto Gomes & Carlos Neto*.

The Parque Natural de Monfragüe: the plant communities of the Luso-Extremadurensian subprovince by *Miguel Ladero & Ángel Amor*

11th day, 19 July (Monday)

Collado-Villalba-Puerto de Cotos-Peñalara-Segovia-Benavente.

The vegetation and landscape of the Sierra de Guadarrama: the plant communities of the Peñalara mountain, oro and crioromediterranean belts by *Salvador Rivas-Martínez, Paloma Cantó, Federico Fernández-González, José Antonio Molina, José María Pizarro & Daniel Sánchez-Mata*

12th day, 20 July (Tuesday)

Benavente-Alto del Picón-Truchas-Astorga-Ponferrada-Pedrafita do Cebreiro-Villafranca del Bierzo.

Geobotanical excursions between Benavente and Villafranca del Bierzo by *Ángel Penas & Emilio Puente.*

The vegetation of stretch Villafranca del Bierzo-Pedrafita do Cebreiro-Liñares by *Jesús Izco & Javier Amigo*

13th day, 21 July (Wednesday)

Villafranca del Bierzo-Puerto de Ventana-Mirantes de Luna-León.

The vegetation and landscape of the western Cantabrian Range by *Ángel Penas & Emilio Puente*

14th day, 22 July (Thursday)

León-Puebla de Lillo-Portilla de la Reina-Fuente Dé.

The vegetation and landscape of the central Cantabrian Range by *Ángel Penas & Emilio Puente*

15th day, 23 July (Friday)

Fuente Dé-Picos de Europa-Puerto de Piedras Luengas-Cervera de Pisuerga.

The plant communities of the Picos de Europa: montane, subalpine and alpine belts by *Tomás Emilio Díaz González & José Antonio Fernández Prieto*

16th day, 24 July (Saturday)

Cervera de Pisuerga-Páramo de Masa-Portillo de Busto-Frías-Sobrón-Bilbao.

The vegetation of the Castellan-Cantabric sector in northern Burgos: forests, scrub, and rupicolous plant communities by *Javier Loidi, Itziar García-Mijangos & Mercedes Herrera*

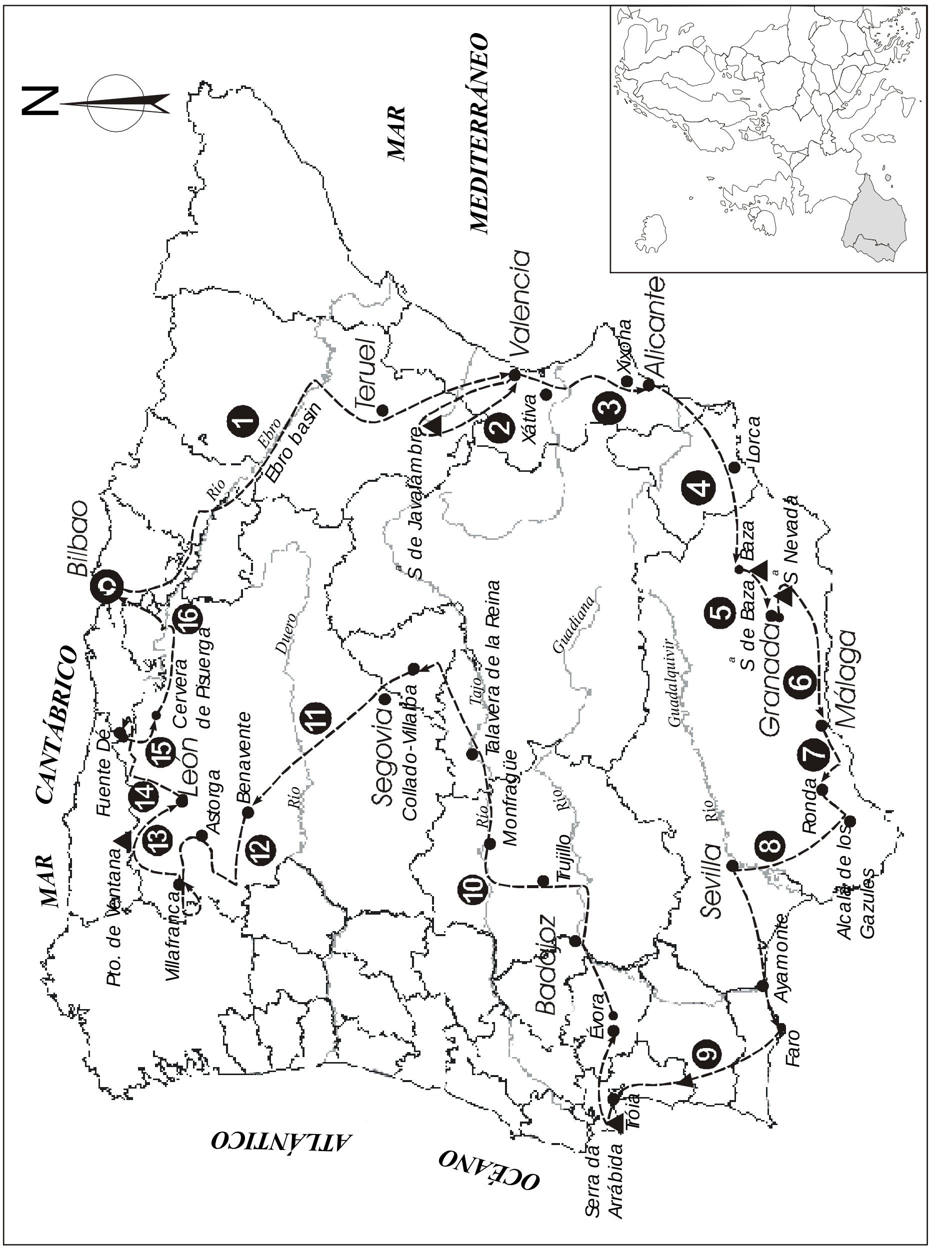


Figure 1: Map of the itinerary

GENERAL DESCRIPTION OF THE IBERIAN PENINSULA: SUSBTRATE AND RELIEF

JAVIER LOIDI ARREGUI

INTRODUCTION

In antiquity, the Iberian Peninsula attracted the attention of the civilised peoples of the eastern Mediterranean shore. They were mostly interested in its metalliferous richness and they reached the Peninsular Levantine coasts early in history. Phoenicians called "*i-sch phannim*" or rabbit coast, to the westernmost country of the Mediterranean; this is probably the oldest name known for the Peninsula and from it is derived the Roman (or Latin) Hispania. The ancient Greeks called it Ιβερια (Iberia), a name used since the IV century BC which was originally applied to the south and eastern part of the Peninsula, where the so-called Iberian people lived; later this name was applied to all the Peninsula. Until the Middle Age, Hispania and Iberia could be considered as synonyms and both included the whole Peninsular area. However, the consolidation of the two modern states which share the territory: Portugal since the XII century and Spain from the Renaissance, led to the use of Hispania being reserved for modern Spain (an evidently derived name). Portugal, derived from Portus Cale, the Roman name for a locality near Oporto, coincides to a great extent with the Roman province of Lusitania. In consequence, since the XIX century the epithet Iberian has generally been accepted for the Peninsula which occupies us, embracing both the Spanish and Portuguese territories. Another denomination for this Peninsula has been Hesperia, related to the location of the Hesperides garden in the westernmost point or country in the World, according to the Greek-Latin mythology. The anciant Greeks applied this name to Italy but when the geographical knowledge broadened, the Romans used to apply it to the Iberian Peninsula. Later it fell into disuse except in the geological and geographical literature where the term "Hesperian Shield" has been coined. In the Central European geographic literature the term Pyrenees Peninsula or Peninsula of the Pyrenees has also been used; such a name is nowadays no longer in use.

The share of the Peninsular area beteween Spain and Portugal, the two modern states which occupy almost all its territory, is:

	Km^2	%
Spain	491.258	84,7
Portugal	88.620	15,2

To these should be added the 452 Km^2 of the Principality of Andorra and the 5.5 of the British colony of Gibraltar.

The geological and geographical information has been taken from Cabo (1973), Gutiérrez Elorza (1994), Lautensach (1967), López Bermúdez et al. (1989) and Terán & Solé Sabarís (1978).

GEOGRAPHY AND GEOLOGY OF THE IBERIAN PENINSULA

LOCATION, EXTENT AND LIMITS

The Iberian Peninsula (Figure 2) is one of the three southern appendixes of the European continent which relates it to Africa and the Near East. It is a perfect physical unit where geographical position, in the southwestern extreme of Europe, makes it particularly conspicuous due to its size and regular geometry. Its extent is noteworthy (581,300 Km^2) which combined with its pentagonal shape and the low sinuosity of its coastal lines, gives it a compact aspect, like a "little continent". Between its extremes there is an average distance of 850 Km, in north-south and east-west transects; the extreme distant points oscillate between 600 and 1000 Km.

Among the three southern European peninsulas mentioned earlier, the Iberian has a more marked "peninsular" character, with a relatively narrow isthsmus, 435 Km in length, in relation to its width. Such a "narrow" connection with the continent is structured by the huge Pyrenean cordillera, a formidable mountain barrier which crosses it in a east-west direction, intervening in the Iberian-European relationship and emphasizing the Peninsular isolation. Another difference from its two sisters is that concerning its structure; its huge body is vertebrate around a large high plateau, called Meseta, which is crossed and surrounded by mountain chains. This morphology is similar to that of the Anatolian peninsula or to the Atlasic countries of the Magrib and is totally different to the Italian or Balkan peninsulas which are structured round long mountain ranges, in the manner of a backbone.

This almost-island, stout, massive and semiquadrate, has a doubly dual position: between two continents, Europe and Africa, and between two seas, the Atlantic and the Mediterranean, inserted between southern France, from which it is separated by the Pyrenees, and northwestern Africa (Morocco), from which it is separated by the 14 Km of the Strait of Gibraltar. As for the geographical longitude, its western position becomes evident as it reaches the westernmost point of the continent (9º 29' W in Cape Rocha), not far from the 11º W of the westernmost point of Ireland; its eastern extreme is Cape Creus (3º 19' E). The latitude oscillates between 43º 47' N (Estaca de Bares) and 36º 00' N in the southernmost point in Tarifa. To get an idea of its situation in the European frame, it is useful to see that its northern parallel crosses central Italy and the central Balkans, and the parallel of Gibraltar crosses north African territories (Algeria, Tunis) and south to it, Europe has no continental land, only some islands (Kriti). This indicates the definitely western and southern condition of the Iberian Peninsula inside the European continent, of which it is a clearly marginal and peripheral portion.

The Iberian coasts, extending along 5,849 Km, show a relatively regular coastline with few profound gulfs, bays and estuaries or prominent capes. There is a rocky cliff coastal front in the North, the Cantabrian coastline, east-west oriented and almost straight, which has few protuberancies, the most relevant being Cape Peñas. The Atlantic façade is perpendicular to the previous one, but it is more diverse and presents more interruptions. Both are separated by the Galician corner, whose coastal stretch presents the most jagged

Figure 2.- The Iberian Peninsula in Europe and the western Mediterranean area.

contour in the Peninsula with the deep "rias" or inlets. The Portuguese Atlantic coast is quite regular but has some accidents such as the prominence of the Portuguese Estremadura (Cape Rocha, north Lisbon), and the estuaries of the Tagus (Mar da Palha) and Sado linked to sandy low coasts. Cape San Vicente is the next inflection point; from this point and the Punta de Tarifa, the coastal perimeter draws an arch open to the southwest in which cliff stretches like the Algarve and Cádiz (Trafalgar, etc.) alternate with the long segment of low sandy coast in the Guadalquivir valley mouth. The Mediterranean shore, very diversified in low and cliff coast, draws four oval-shaped arches between Gibraltar and Catalonia; they are separated successively by the capes of Gata, Palos and La Nao. The first arch corresponds in a great part to the Costa del Sol and is southwards oriented. The second and the third are smaller and correspond to the southeastern arid façade of the Peninsula. The fourth arch is the Valencian oval ending in the Ebro mouth which forms a singularly prominent delta. The Catalonian coasts advance eastwards and become abrupt, especially in the northern part (Costa Brava) and reach their major prominent point: the Cape of Creus.

Due to its structure and morphology, the Iberian Peninsula appears as a geographically clearly invidualized unit, provided with elements which emphasize its isolation from its surroundings. Its huge nucleus, high and innaccessible from most of its coasts, makes it similar to a fortress between two seas and two continents. Theobald Fischer (1893) wrote that it was "a world in itself, an invidual country with peculiar characteristics so sharply pronounced that it cannot be overcome by any other European country". Simultaneously, the same physiographic conditions determine strong contrasts between different Peninsular regions; it is possible to cross completely different landscapes in a short trip. Such individuality and diversity is expressed by the singularity and variety of its ecosystems, its flora and its vegetation.

THE FORMATION OF THE IBERIAN PENINSULA

The individuality of the Iberian Peninsula is clearly revealed by its geological history. Since remote times (Cretaceous) it has constituted an independent secondary plate, formerly part of the Eurasian plate and later segregated from it (figure 3). During the long period of time till our days, this Iberian plate was always located in a intermediate position between the Eurasian and the African plates and experienced a complex series of compressive and distensive phases determined by their relative displacements. At the present time, after the Alpine orogeny, it has remained united to the Eurasian plate and discretely separated from Africa by the narrow Strait of Gibraltar. The terrains now appearing on the surface of the Iberian Peninsula can be grouped into three main basic assemblies: 1- the Palaeozoic materials deformed in the Hercynian orogeny, 2- the Mesozoic and the Tertiary ones deformed in the Alpine orogeny, and 3- those more recently originated and not deformed.

Palaeozoic materials outcrop in different areas of the Peninsula, forming important massifs which constitute a high percentage of the total surface. The most important of these rock masses is the so called Hesperian (or Iberian) Shield, appearing out in the western half

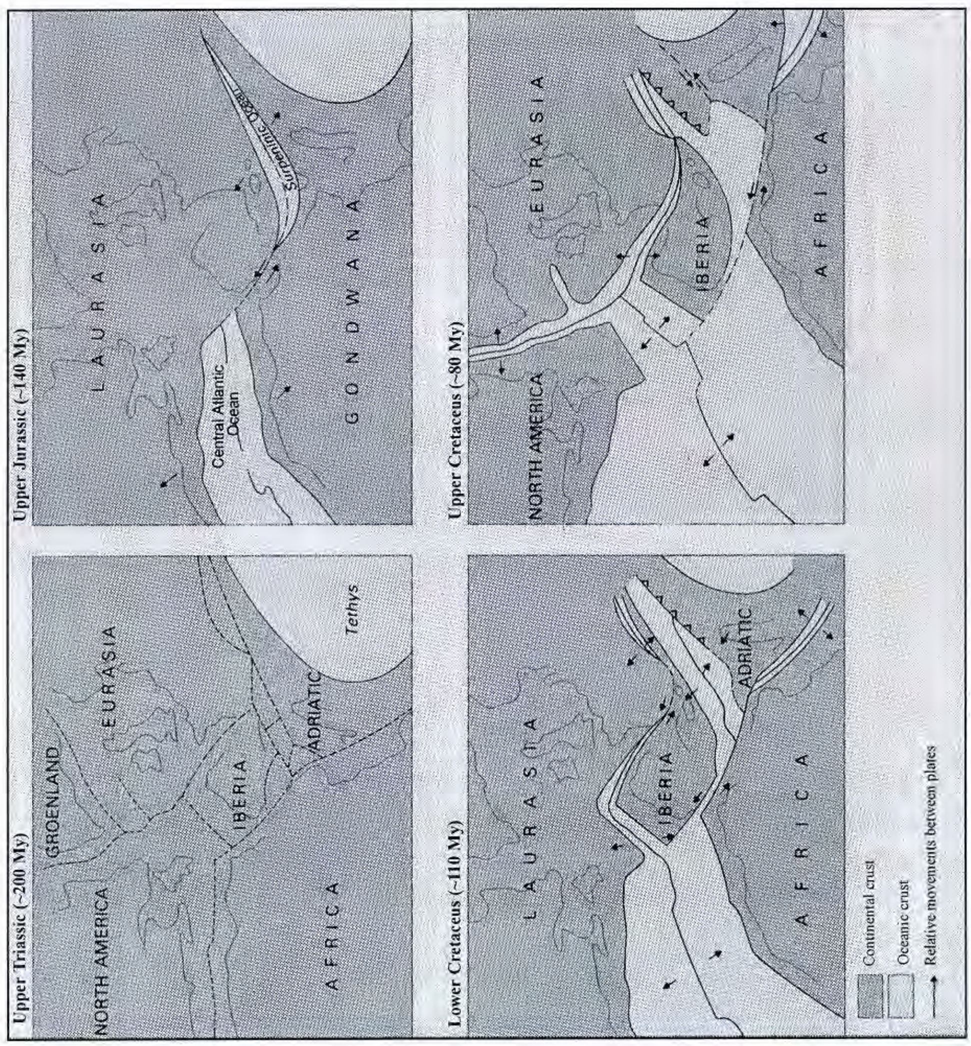


Figure 3.- Palaeographic schemes of the Iberian Peninsula

of the Iberian Peninsula; it is one of the fragments of the old European Hercynian range. So, after its uplift during the late Palaeozoic, it was subsequently peniplainized by erosion. The Hesperian Shield is the Hercynian core of the Peninsula and is the original constituent of the Iberian microplate; nowadays it is partially covered by Mesozoic and tertiary sediments although it outcrops in large areas of the western part of the Peninsula. Despite its solidity, its is fractured in blocks as a result of tardihercynic tectonic phases, in which the sunken blocks originated sedimentary basins and the uplifted ones formed outstanding reliefs. Other zones of lower importance where such old materials outcrop are the axial nuclei of important Alpine reliefs which appear after the denudation of the more recent covering materials, e.g. the Pyrenees axis, and the Nevado-Filábride, Alpujárride and Maláguide complexes in the Baetic ranges.

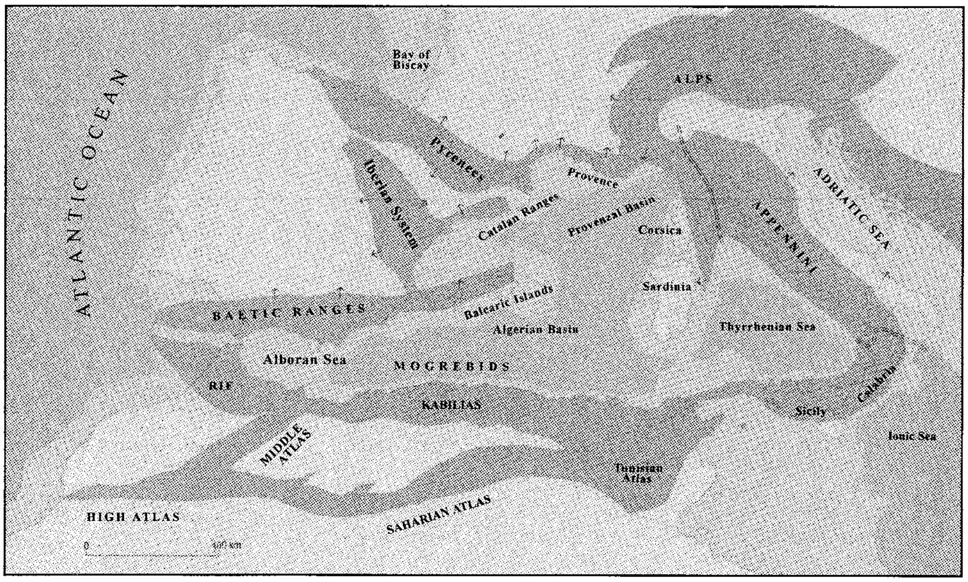


Figure 4.- The Alpine reliefs in western Europe and north Africa

At the end of the Cretaceous period, the Eurasian and African plates began to come closely, opening a compressive general regime period for the whole Iberian microplate. As a result, on the borders of the plates important mountain ranges were uplifted during the Tertiary and mostly in the Miocene, in a general tectonic event called the Alpine orogeny (figure 4). For the Iberian Peninsula, the most relevant reliefs which originated in this phase are the Pyrenees in the north and the Baetic ranges in the south. The Hesperian Shield, whose old Hercynic reliefs were already flattened during the long period of previous orogenic stability, was also affected and the compressive forces bent it in its central part and provoked the renewal of the old tardihercynic faults with the uplift of some blocks (horsts) which resulted in renewed mountain ranges like the Central Range of the Peninsula. This mountain system was limited in the north and in the south by two big basins, the Duero and the Tagus respectively. In this way, after the Alpine orogeny, the Iberian Peninsula was shaped by its old core, the Hesperian Shield, as the pedestal or base of the great high central plateau or Meseta crossed and surrounded by its renewed reliefs, the Pyrenees in the north and the Baetics in the south; between those two main Alpine mountain ranges and the Hesperian Shield, two great sedimentary basins originated: that of the Ebro and that of the Guadalquivir.

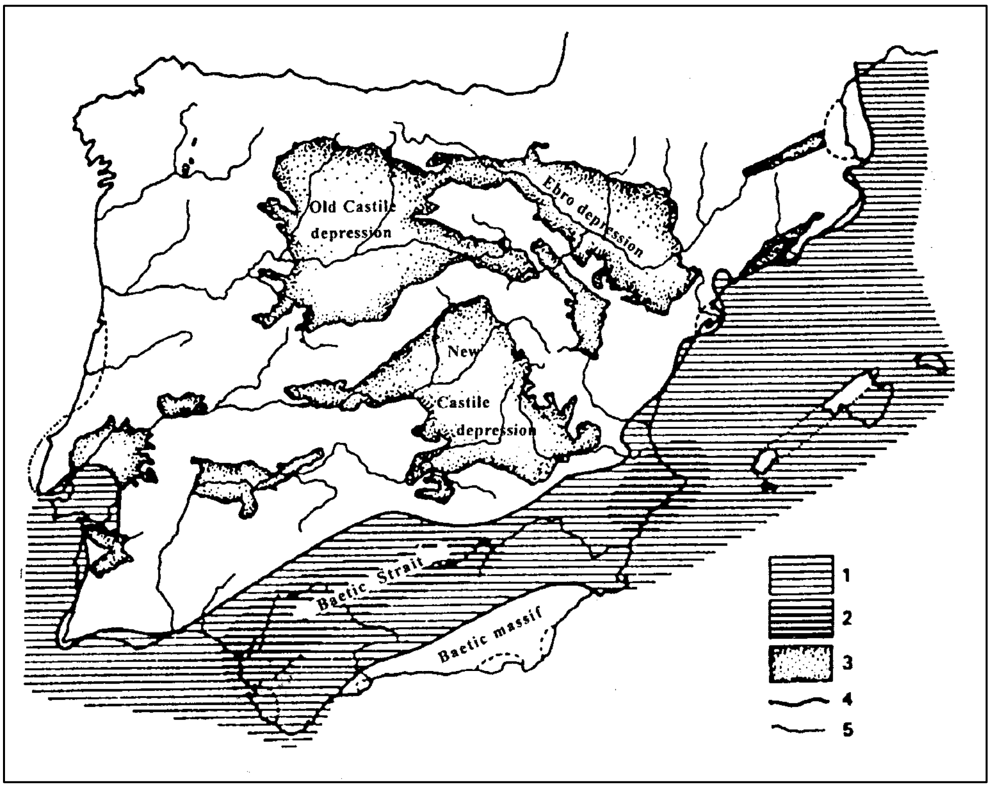


Figure 5.- Distribution of land and sea in the Miocene. 1 and 2: marine basins; 3: lacustrin continental sedimentary basins; 4 and 5: limits of the basins.

In the Tertiary, from the transition Eocene-Oligocene onwards, three great continental (interior) sedimentary basins can be differentiated: that of the Ebro, that of the Duero and that of the Tagus. The Guadalquivir basin remained open to the sea (figure 5). During the upper Pliocene take place the most vigorous tectonic phases of the Alpine orogeny and thus the most important uplifts of the mountain ranges simultaneous to the sinking of the basins. Contemporarily the exorreism of the continental basins is produced and the modern (Quaternary) fluvial network begins to be marked out.

The cold phases of the Quaternary (ice ages) affect the different parts of the Peninsula with very unequal intensity. Glaciers were larger in the Pyrenees, where they reached 40 Km length; the Cantabrian Range also had noteworthy glaciers. Southwards, the glacial traces found in the northern Iberian System, the Central Range and Sierra Nevada, lose their importance and remain restricted to higher elevations the farther south we move (figure 6).

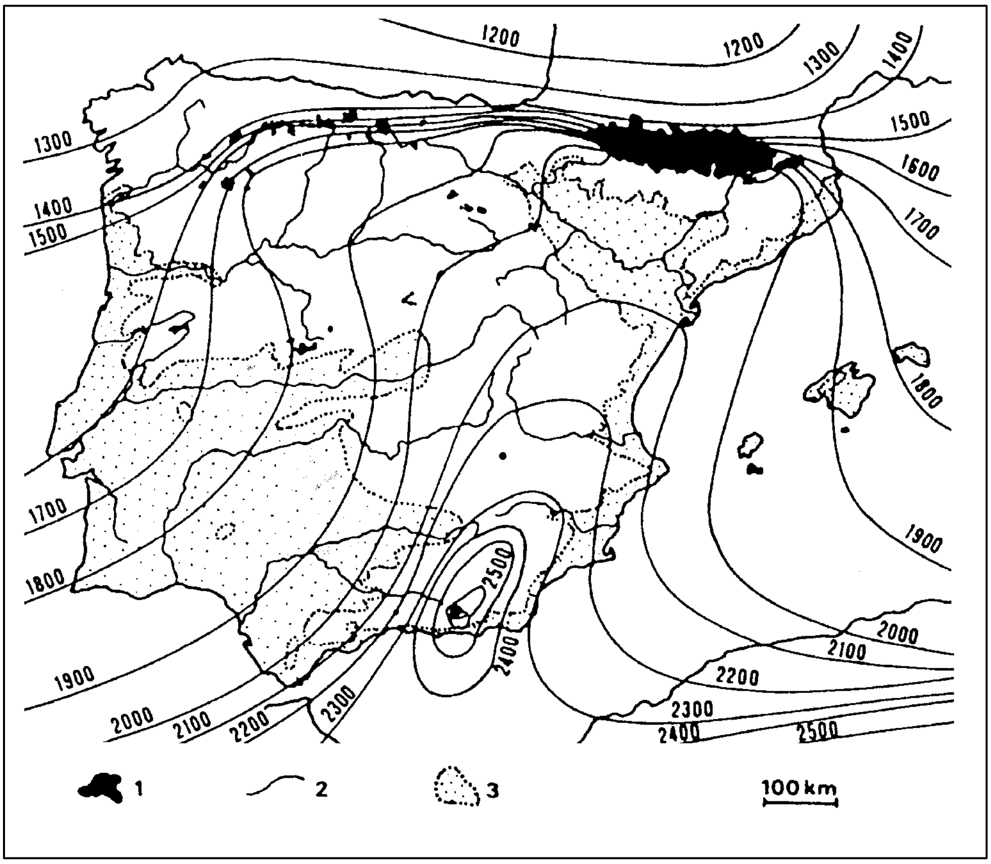


Figure 6.- Glaciers during the last ice-age. 1: area occupied by glaciers; 2: altitudinal limit of the permanent snow; 3: area free from periglacial conditions

STRUCTURE AND GEOMORPHOLOGY: THE RELIEF

Basically, the Peninsula is structured around the high central plateau or Meseta, which is surrounded by mountain systems on almost all its sides, except the western one; it also presents a series of reliefs which emerge inside it. To this Meseta two great alpine massifs are enclosed: the Pyrenees and the Baetics which entail another two depressions or basins between them and the Meseta borders (figure 7).

From the strictly lithologic point of wiev, the Iberian Peninsula can be divided into three general rock types: siliceous, limestone and marly (figure 8.)

It is a mountainous country, with a high mean altitude (660 m) by European standards, (figure 9) only beaten by Switzerland. There are many population settlements at exceptional altitudes (for these latitudes): the highest village is Valdelinares at 1,800 m, the highest city is Ávila at 1,100 m and Madrid, at 700 m, is the highest capital city of the continent.

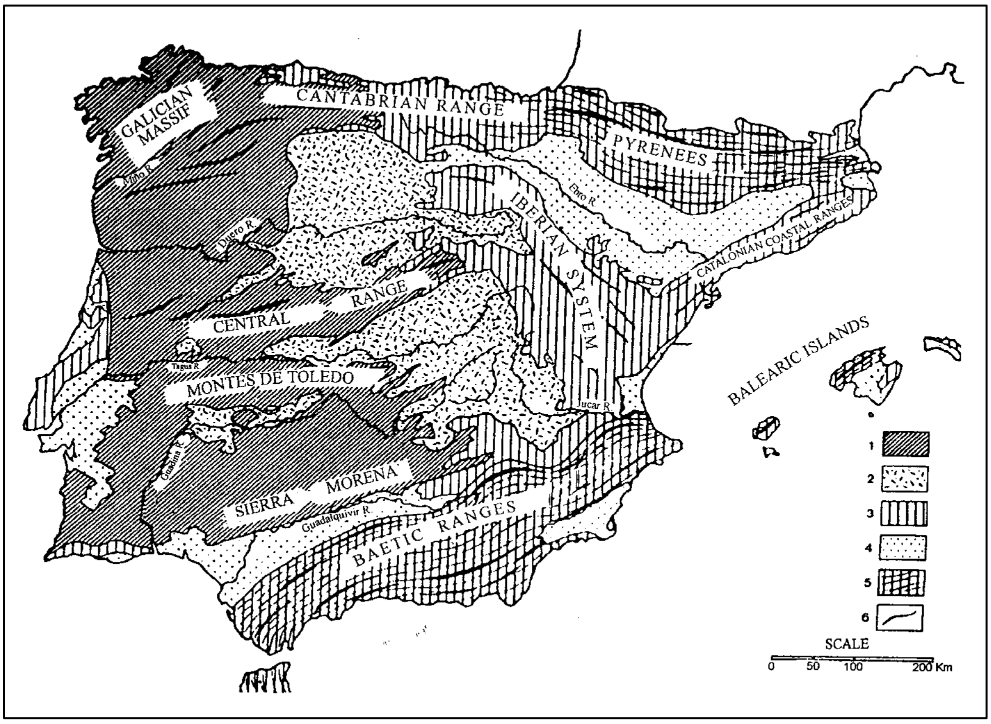


Figure 7.- Main structural assemblages of the Iberian Peninsula. 1: Hesperian Shield; 2: Tertiary depressions of the Meseta; 3: Alpine reliefs of the edge of the Meseta; 4: peripheral depressions; 5: Alpine ranges; 6: direction of the main mountain ranges.

OROGRAPHY: MASSIFS AND MOUNTAIN SYSTEMS

THE MESETA MASSIFS

The Meseta is a broad region in the center of the Peninsula (211,000 Km^2), raised above the peripheral zones and clearly differentiated from the rest, it is constituted in its base by the old Palaeozoic Hercynian materials, which form the Hesperian Shield. Its struture is made up by the high plateau, slightly tilting to the west, from which emerge several mountain systems which alternate with vast plains. Its origin goes back to the pre-Triassic peniplaination of the latest Palaeozoic Hercynian massif which constituted in origin the Hesperian Shield. During the earlier phases of the Alpine orogeny the shield fractured in blocks and the sunken ones originated sedimentary basins in which a deep series of continental deposits accumulated. During the Mesozoic, the Meseta tilted eastwards and the Levantine area was submerged into the sea and marine deposits were accumulated there. In the Eocene, the Alpine orogenic movements profoundly affected the Peninsula, which at that time was a peneplain with a flattened relief, provoking a series of fractures with uplift and sinking of blocks, convexities of the shield in some parts, etc. Those phenomena resulted in the uplift of mountain systems, like the Central Range and the Montes de Toledo, and in the formation of the two great Mesetan depressions: that of the Duero and that of the Tagus. In the Mesetan massifs we include those which are structurally and geologically part of it, comprising those which emerge inside it and those which are on its borders.

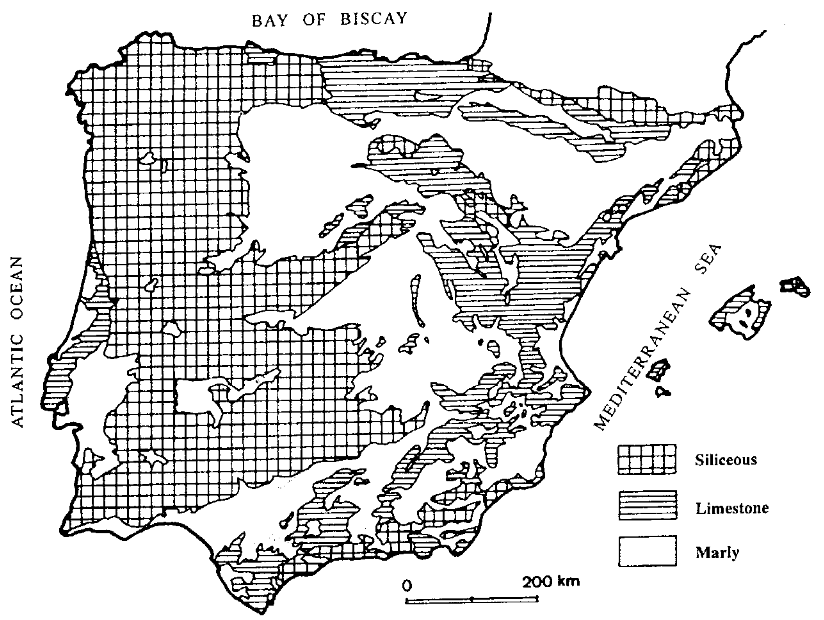


Figure 8.- Dominant lithology in the Iberian Peninsula.

THE CENTRAL RANGE

The Meseta is crossed in an approximately east-west direction by a huge mountain range from the Alcarrian páramos, in contact with the Iberian System, to central Portugal. It is the watershed between the Duero and Tagus hydrographic basins and divides the Meseta into two halves: the Northern Submeseta (Duero basin) and the Southern Submeseta (Tagus basin). The name of Central is given due to its position in the Peninsula but it has also been called Carpetan or Carpeto-Vetonian.

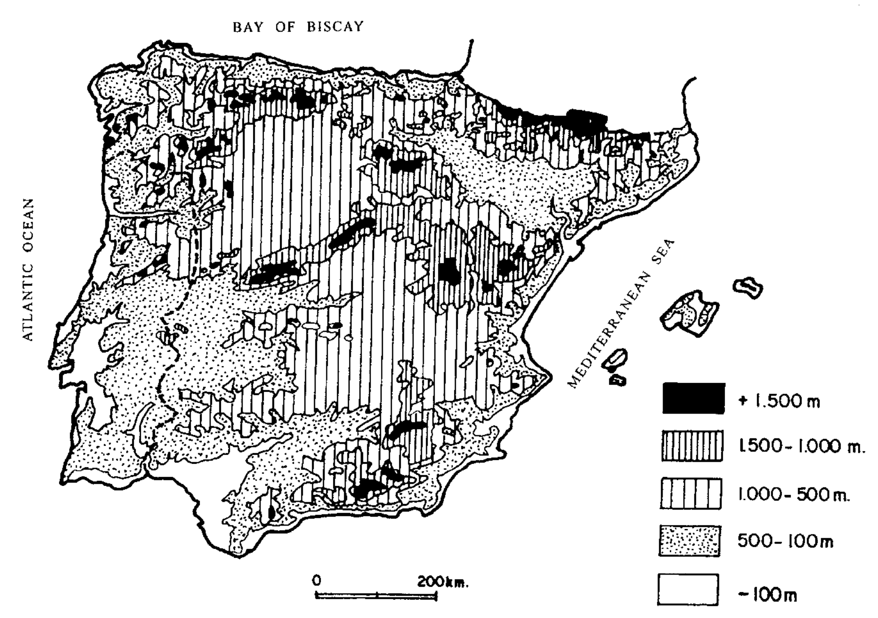


Figure 9.- Main reliefs of the Iberian Peninsula and Balearic Islands

This range or cordillera can be split up into several massifs which are aligned in a NE-SW direction along almost 500 Km, and which are often separated by corridors or fosses of tectonic origin. The easternmost of these massifs is the Sierra de Pela (Portillo 1,538 m), which continues westwards with the Sierras of Ayllón (Pico del Lobo 2,273 m) and Somosierra (Tres Provincias 2,129 m). The following massif in SW direction is Sierra de Guadarrama (Peñalara 2,430 m, Cabezas de Hierro 2,383 m, La Maliciosa 2,227 m). After some modest elevations, like the Sierra de Malagón and the Campo Azálvaro, appears the huge Gredos massif, where we find the highest peaks of the Carpetan mountains (Almanzor 2,592 m, La Galana 2,568 m, Cabeza Nevada 2,433 m, Covacha 2,399 m). In this Gredense stretch the parallel massif of Serrota-Paramera comes together and the Central Range reaches its maximal width in the N-S cross section (50 Km). The Jerte fosse interrupts the cordillera but it continues in the Candelario or Béjar massif (Calvitero 2,401 m); a new interruption is due to the Béjar corridor entailed by the Alagón river. The range continues with the Sierras of Peña de Francia (1,723 m) and Gata (1,592 m) till the Hispanian-Lusitanian frontier. In Portugal the Carpetan mountains are continued by the Serra das Mesas or Jalama (1,257 m) and the Puerta de Guarda interrupts the range again. The westernmost massifs are Serra da Estrêla (1,991 m) as well as those of Açor (1,349 m) and Lousã (1,202 m), which form the Portuguese Divisory system of the Tagus-Mondego interfluve.

This important mountainous assembley is a part of the Hesperian Shield and the geologic materials are Palaeozoic deformed in the Hercynian orogeny. The Alpine compressions convexed the Hesperian craton in its central part and renewed the tardihercynic faults, allowing the uplift and sinking of blocks. This process originated, among other elevations, the Carpetan Mountains. The lithology is predominantly siliceous; granit, gneiss, slate and schist are the most frequent rock types.

THE MONTES DE TOLEDO

Under this name we designate the mountain group which the Hispanic geographers called the Oretan mountains, which include the Montes de Toledo in a strict sense plus the inner Extremadurian mountains, connected with them, and whose main massif is the Sierra de Guadalupe. It is a wide assembley of reliefs emerging in the southern Submeseta and is part of the interfluve Tagus-Guadiana drainage systems. Altitudes are modest, the highest peak of its eastern part is the Corocho de Rocigalgo (1,447 m) and the most relevant summit of the western part, in the Sierra de Guadalupe, is the Villuercas peak (1,601 m); in addition to them, many summits are over 1,200 m. Lithology is siliceous, with granit, quartzite and slate. The northern part is formed by cristalline rocks, usually granit, while the rest is constituted by a well developed sedimentary Palaeozoic series in which quartzite and slate are frequent; the higher erosionability of the latter determines that the most prominent reliefs are usually quartzitic. In piedmonts recent Plio-Quaternary detritic deposits accumulate formed by scarcely rounded quartzitic stones included in a sand-silt-clay matrix, forming a muddy-stony conglomerate called "raña". The "rañas" are deposits typical of the region, with a horizontal or slightly tilting surface, of yellow to reddish colour, whose texture is a disordered mixture of stone blocks of unequal size and angularity surrounded by a matrix of finer materials of diverse granulation.

THE SIERRA MORENA

The southern border of the Meseta is formed by a vast morphostructural unit of great importance and extent: the Sierra Morena or Marianic range. Its length exceeds 450 Km between the eastern and western extremes and its maximal width is 120 Km in the N-S transect in the Extremadurian stretch; altitudes are modest, the highest summit is in Sierra Madona (1,323 m). It is formed by a numerous and complicated assembley of hercynic alignments which, in a general way, maintain an E-W direction, from the Serra de Monchique in the Portuguese Algarve, till the contact with Sierra de Alcaraz in its easternmost extreme.

Sierra Morena is formed by Palaeozoic materials with several types of rocks, mostly slate, quartzite and limestone, alternating with frequent eruptive intrusions, usually granitic. This reults in a dominance of acid siliceous rocks which originate base-poor soils. The relief presents a low roughness, with abundance of non-pointed hillocks which form a gentle landscape of rounded hills. Sierra Morena is the interfluve between the Guadiana and Guadalquivir valleys, but almost all the waters run towards the latter due to its lower hydrographic base level. This has been the reason of a more active erosion on the southern slope and a progressive catchement of the whole hydrographic network of the Guadiana to incorporate it into the Guadalquivir fluvial system. The vast territory represented by the Sierra Morena is a hilly country with few elevations of certain importance. Due to its low capability for agriculture exploitation (scarcity of arable land), has a low population density and has been always a quite solitary area, reinforcing its rustic (serrano) character.

THE GALICIAN-LEONESIAN MOUNTAINS

Located in the northwestern corner of the Peninsula, they are a part of the Hesperian Shield. Their uplift corresponds to the reactivation of tardihercynic faults during the Alpine orogeny, which provoked a tectonic of raised and sunken blocks which originated fosses and massifs respectively. The mountain alignments present a general E-W direction and can be divided into alignments two groups separated by the long depression of the Sil river comprising the areas of El Bierzo and Valdeorras. Noteworthy in the northern group are the Caurel (Pájaro 1,616 m) and Ancares (Peñarrubia 1,826 m, Miravalles 1,969 m) massifs, SW-NE oriented and connecting with the great Cantabrian Range of which they constitute, in a certain way, its western extreme. South of the Sil depression emerge a numerous assembly of mountain alignments which form part of the interfluve between the Sil-Miño basin and the Duero valley. One of the noteworthy reliefs is Sierra de Queixa (Cabeza de Manzaneda 1,778 m), which is continued eastwards in the huge massifs of the Montes de León with the alignments of Sierra Segundera (Peña Trevinca 2,096 m)-La Cabrera (Vizcondillo 2,144 m) and Montes Aquilianos (Cabeza de la Yegua 2,135 m)-Sierra del Teleno (2,188 m); all this group is limited in the southern side by the Sierra de la Culebra, with lower elevations (Peña Mira 1,243 m).

The lithology of these mountains is predominantly siliceous, with quartzite, slate and some granitic outcrops. In the Ancares area appear some bars of Palaeozoic limestone which originate narrow canyons when passed through by the Sil river.

THE CANTABRIAN RELIEFS

The whole northern Atlantic façade of the Peninsula, from Galicia to the French border, receives the name of Cantabrian Fringe and is the northern limit of the Meseta. Its backbone is a long and complex mountain range or cordillera which connects in continuity with the Pyrenees in its eastern end and was uplifted by the Alpine compressions. This huge mountain system can be divided into two main stretches: the Cantabrian Range (sensu stricto) and the Basque-Santanderian mountains in the eastern third. The western extreme reaches the interior Galicia and is formed by the Caurel-Ancares massifs, related with the aforementioned Galician-Leonesian mountains. The axial chain continues eastward through the Somiedo (Cornión 2,188 m), Peña Ubiña (2,417 m), Peña Prieta (2,536 m), Curavacas (2,520 m) and Peña Labra (Pico Tres Mares 2,175 m) massifs. Attached to the axial range, which is the watershed between the waters flowing to the Bay of Biscay and the Duero (or Ebro) basin, there are two parallel ranges north and south to it. Among them stand out the Catoute (2,082 m) and Villabandín (Cañada 2,154 m) massifs on the southern side and the Picos de Europa on the northern, in the latter the highest peaks of the Cantabrian Range are found (Llambrión 2,617, Peña Vieja 2,613, Torre Cerredo 2,648, Peña Santa de Castilla 2,596, Cortés 2,370 m).

This vast and high mountain system is essentially formed by Palaeozoic materials corresponding to the Hesperian Shield whose lithological composition is complex. Quartzite, slate, sandstone and siliceous conglomerate form the most relevant acid rock types and dominate in the western and eastern thirds of the Cantabrian Range; Carboniferous limestone (Caliza de Montaña) is however dominant in the central stretch and in the Picos de Europa. The northern slope of this Cordillera is extremely abrupt and has a gap, between the summits to the sea level (in a distance of ca. 40-50 Km in straight line) of more than 2,000 m in some sectors. The fall in the southern slope is gentler as the gap is much smaller due to the high elevation of the Meseta.

The Basque-Santanderian mountains reach appreciably lower altitudes and are formed by burden materials belonging to the Pyrenean tectonic assemblage, not to the old Hesperian Shield. In this sense, although they continue eastwards the Palaeozoic Cantabrian Range without gap or interruption, they are part of quite another geological unit: the Pyrenees. Nevertheless we include them in this chapter because they form part of the Cantabrian Fringe from the geomorphological point of view (as well as climatically and biogeographically), and are the connecting mountains between both great mountain systems of the north of the Iberian Peninsula: the Cantabrian Range and the Pyrenees. Lithology corresponds to sedimentary rocks of the Mesozoic and Tertiary: marl, sandstone, flysch and limestone. These mountains are structured into two or three parallel alignments separated by marly depressions. The northern range is the watershed between the Atlantic side and the Ebro drainage system; it is the topmost of the mountainous country existing between the coast and its summits. In the south appear the other two alignments which are excavated in some stretches by the rivers flowing to the Ebro. The highest elevations are in the watershed range, which connect the Cantabrian Range and the Pyrenees (Castro Valnera 1,718 , Gorbea 1,481, Aizkorri 1,549, Ortzanzurieta 1,567 m). The southern chains reach slightly lower altitudes (Humión 1,434, Palomares 1,446, Beriain 1,493).

THE IBERIAN SYSTEM

Under the name of Iberian or Celtiberian mountains, an intricate and uneven assembley of mountain massifs and high plateaux displayed along 400 Km in a NW-SE direction, from the Sierra de Demanda in northern Castille to the Mediterranean sea in the Valencian region, is grouped. Its mean width is about 100 Km and constitutes the border of the three great Tertiary depressions of the Peninsula: they are the northeastern limit of the Duero basin, the southwestern and southern of the Ebro basin and the eastern limit of the Manchegan plain. Its position in the Peninsula, centred but slightly displaced eastwards, makes this mountain system its most important hydrographic knot and the headwater of some of its main rivers (Duero, Tagus and Turia).

Due to its tectonic characteristics, the Iberian Systems can be considered as an intermediate type mountain range, where co-exist, superimposed, the base and the cover (or burden). The materials of the base are old, of the Pre-Cambrian and Palaeozoic periods, and those of the burden belong to the Mesozoic carbonate series, mostly Cretaceous limestone and Jurassic and Cretaceous dolomite. The base is part of the Hercynian massif and outcrops in the northern sector of the system: Sierra de Demanda (San Millán 2,131, San Lorenzo 2,262 m), Urbión-Cebollera (2,262 m) and Moncayo (2,315 m). This group of siliceous mountains arranged in E-W alignments, constitute the interfluve between the Ebro and Duero drainage systems. The most frequent rocks are quartzite, slate, sandstone and siliceous conglomerate alternating with limestone and dolomite.

Southeastwards, the mountain ranges become less abrupt with meseta-like reliefs appearing at altitudes above 1,000 m. It is the area of the Castilian "páramos", like those of Molina, Maranchón, etc. The southern group of relevant massifs occupies a vast area and has an intricate orography. Three outstanding massifs can be distinguished: Albarracín-Montes Universales (Caimodorro 1,920, Mogorrita 1,866 m), Gúdar-Maestrazgo (Peñarroya 2,019, Penyagolosa 1,813 m) and Javalambre (2,020 m). In these areas burden materials are dominant, mostly limestone but also marl and dolomite. In some areas there are Palaeozoic outcrops (Albarracín) and in others Bundsandstein (Triassic) sandstone occupies large extents, as in Serra d'Espadá.

In this southeastern stretch of the Iberian System there is an important depression in a corridor shape in a NNW-SSE direction of more than 200 Km which connects Calatayud and Teruel and continues till Ademuz. It is a tectonic fosse originating during the distensive phases of the Alpine orogeny, filled with Miocenic marly and clay sediments with several gypsum-rich areas and some salty depressions (salt marshes). On the western side of this groove lie the Sorian and Alcarrian "páramos" and the massifs of Sierra de Albarracín-Montes Universales and on the eastern side is the Maestrazgo with the Gúdar and Javalambre massifs.

THE ALPINE MASSIFS

THE PYRENEES

The huge Pyrenean cordillera constitutes a continuous and compact unit, clearly inividualised, lying along the wide isthmus which connects the Peninsula with the European continent, from the Bay of Biscay till the Mediterranean sea. It is the great wall which separates Europe from Iberia. It is 435 Km long and its maximal width is 150 Km in the central stretch; it narrows at both extremes, to 25-30 Km width at the western end and 10 Km at the eastern one. Most of the summits are over 2,000 m and in the central part there are several peaks above 3,000 m.

The main structural units of the Pyrenees, i. e. the axial chain and the parallel ranges, are W-E oriented, and separate two great depressions, the Aquitanian plain in the north and the Ebro basin in the south. From the axial chain summits to the French plains the descent is sudden and short, as opposed to the transition to the Ebro valley, which is longer and more gradual. The hydrographic network is basically perpendicular to the direction of the mountain alignments, all the streams present a N-S direction.

From the geological point of view, the rocks of the Pyrenees can be grouped into three assemblages:

1- The base or core, formed by Pre-Cambrian and Palaeozoic rocks, up to upper Carboniferous period. They are deformed originally in the Hercynian orogeny and later also affected by the Alpine compressions; most of the rocks are sedimentary and metamorphic in a diverse lithology: quartzite, slate, schist, graywacke, limestone, dolomite and conglomerate; there are also frequent granite and granodiorite outcrops. The siliceous rocks predominate. The core outcrops in the central and eastern parts of the cordillera, remaining partially covered by the Mesozoic burden in the western extreme.

2- The burden is constituted by Mesozoic and Tertiary sedimentary rocks affected by the Alpine folding; the most frequent rocks are limestone, marl and a rhythmic alternance of sandstone and black lutites (“black flysch”).

3- The post-orogenic terrains, of the late Tertiary and Quaternary periods, not affected by the Alpine folding.

Regarding the great geomorphologic structures into which the Pyrenees can be divided, there are four main units, the first is the core or axial Pyrenees, the other three are considered as the pre-Pyrenees.

a) The Axial Zone, corresponds to the axis of the cordillera and is the watershed between the hydrographic basins of southern France and the Ebro river. It is constituted in its major part by the Hercynian base or core and, therefore, groups most of the older rocks present in the cordillera. In its central stretch the highest peaks of the whole Pyrenees are concentrated: Aneto (3,404 m), Posets (3,375 m), Vignemale (3,303 m), Monte Perdido (3,250 m), etc. However, the western extreme of this Axial Zone is formed by burden materials.

b) The Inner Ranges (Sierras) are part of the burden and girdle the Axial Zone. Materials are Mesozoic and Tertiary, usually limestone and flysch. Some rivers, when passing through these alignments, originate narrow canyons in the limestone, locally called "foces" and "congostos". Summits reach noteworthy altitudes: Peña Tendeñera (2,853 m), Telera (2,764 m), Collarada (2,886 m), Cotiella (2,912 m) or Cadí (2,561 m).

c) The Inner Depression is a broad marly syncline interposed between the Inner Ranges and the Outer Ranges. In some stretches, like in the Canal de Berdún-Val Ancha or the Conca de Tremp, this Inner Depression acquires a noteworthy width and entity.

d) The Outer Ranges (Sierras) are parallel to the Inner ones and have similar lithology. They form the periphery of the Pyrenees and mark the limit with the Aquitanian and Ebro basins. The elevations are more modest: Leyre (1,371 m), Oroel (1,769 m), Guara (2,077 m), Sis (1,759 m) and Montsec (1,678 m).

THE CATALONIAN COASTAL RANGES

They are several mountainous alignments of more than 300 Km in length, parallel to the Mediterranean coast, which connect the eastern Pyrenees with the Maestracean massifs of the Iberian System, as a backbone of the coastal fringe of Catalonia. Due to such a position they receive the name of Catalonian Coastal System or Ranges and also the older name of Catalánides. There are three units to distinguish in this mountain system: a litoral range close to the coast, another parallel to the former, called pre-litoral, and the intermediate depression. These three units are arranged along the coastline, NE-SW oriented. Among them, only the pre-litoral range crosses the whole length of Catalonia, the intermediate depression and the litoral range only reach the Camp de Tarragona and thus in the southern stretch only the pre-litoral range is present. The Ebro river passes through the pre-litoral range carving narrow canyons on its way to the Mediterranean sea. The elevations are moderate, in the north we can mention the Montseny (1,712 m) and Montserrat (1,236 m) and in the south the Caro (1,447 m) in the Ports de Beseit.

The materials which constitute these ranges are of different nature and age, there are Palaeozoic siliceous rocks, belonging to core outcrops frequent in the northern stretch as well as burden limestone dominating most of the reliefs.

THE BAETIC RANGES

They are one of the western segments of the assembley of Euro-Asian Alpine ranges which continue eastwards till the Himalayas. They constitute the structural unit of the south and southeast of the Peninsula, from Cádiz to Alicante and the Valencia coasts, extending to the Balearic islands. This vast and complex group of mountain ranges can easily be divided into several morphostructural units. First can be distinguished the *external zones*, composed by the Subbaetic and Pre-Baetic units, which occupy the wide NW strip of the total assembley. The mountainous alignments which form them are preferently NE-SW oriented and the materials correspond to ages between the Triassic and the Miocene, mostly limestone, dolomite, sandstone and marl. A long rosary of abrupt "sierras" of noteworthy elevation is displayed along the aforementioned orientation. The southwestern stretch of this unit is the Serranía de Ronda complex, composed of several ranges of limestone and dolomite with important outcrops of peridotite, as happens in the Sierra Bermeja. The highest peak is Torrecilla (1,919 m) in the Sierra de las Nieves massif; another relevant range is the Pinar de Grazalema (1,655 m). The next group of sierras northeastwards is that of Sierra de Harconera (1,570 m) and Sierra de Cabra (1,380 m) which continue in the Pandera (1,872 m) and Mágina (2,032 m) massifs, now in the province of Jaén. The next group is the huge Cazorla-Segura system with several summits above 2,000 m and whose highest elevation is La Sagra (2,383 m). The northeastern continuation are the Sierras of Calar del Mundo (1,694 m), Alcaraz (1,798 m), Espuña (1,585 m) and Pila (1,264 m). The northeastern extreme of this Subbaetic assembley are the Alicantian massifs, which form a complex group whose highest summit is Aitana (1,552 m); at this point, the Subbaetics submerge in the Mediterranean sea and emerge again to form the Balearic islands.

The *internal zones* mainly correspond to the Baetic unit in the strict sense and the limits with the external zones follow a WSW-ENE line between Estepona and the Cape of Palos. The materials are older, mostly Palaeozoic or Triassic and three main subunits can be differentiated; from the deeper (older) to the most superficial (newer): the Nevado-Filábride, Alpujárride and Maláguide. There are dominant metamorphic rocks like mica schist, phyllite, gneiss, marble and anfibolite; other rock types such as quartzite, conglomerate and Triassic limestone and dolomite are also frequent. The most importante relief inside this unit is the Sierra Nevada with relevant summits like Veleta (3,398 m) and especially Mulhacén (3,481 m), the highest elevation in the whole Iberian Peninsula. Other important massifs are Los Filabres (Calar Alto 2,168 m), Gádor (2,236 m), Baza 2,086 m) and María (2,045 m). Eastwards the continuing ranges reach lower elevations, like Alhamilla (1,387 m) and Carrascoy (1,066 m), the last one being in the Murcian area.

Together with these two great zones, two more units can be distinguished which complete the complicated assembley of the Baetics: the first one is the so-called complex of the Campo de Gibraltar, constituted by materials of the periods between the Cretaceous and the Miocene, among which are dominant the flysch rock-formations. Elevations are modest (Aljibe 1,092 m). The second is the group of internal depressions, whose development is subsequent to the Alpine structures and consists in vast intermountainous fosses, often of tectonic origin, which have been filled by marine or continental sediments (depending on the period). In those depressions are often found evaporitic deposits responsible for the occurrence of gypsaceous layers in the sedimentary series, as happens in the Baza, Guadix, Orce or Granada depressions ("hoyas").

THE GREAT DEPRESSIONS

They are considered as such those areas, more or less flat, which, from the Tertiary period onwards, have been receiving eroded materials from the surrounding reliefs which have sedimented upon them. In the Iberian Peninsula we can separate two groups of these sedimentary depressions: the first one is formed by the two inner Meseta basins which lie in the two big tectonic fosses of the Hesperian Shield: the Duero basin in the Northern Submeseta and the Tagus basin in the Southern Submeseta. They are both depressions in a relative sense because their altitude is remarkable, oscillating between 600 and 800 m. The second group is formed by the peripheral depressions: the Ebro basin in the northeast and the Guadalquivir in the southwest. They are both at a much lower altitude and are situated between the borders of the Meseta and the two huge Alpine systems of the Peninsule, the Pyrenees in the case of the former and the Baetics in the case of the latter. Nevertheless, there are many differences between them: The Guadalquivir basin, located between the Baetics and the Sierra Morena, is and has always been a valley open to the sea which has been filled by marine deposits until late in the Quaternary. On the other hand, the Ebro basin is closed to the Mediterranean sea by the Catalan Coastal Ranges and this circumstance has meant that during long periods in the Tertiary, between the Oligocene and the Pliocene, communication with the peripeninsular sea was interrupted and the basin became endorrheic, thus the lithostratigraphic facies passed from marine to lacustrine continental; for that reason gypsaceous evaporitic rocks are abundant in the Ebro basin.

The Duero depression is an assymmetric basin of about 55,000 Km^2 at 700-800 m altitude occupying most of the Northern Submeseta. It is limited by several of the important Mesetan mountain ranges: the Cantabrian Range in the north, the Central Range in the South and the Iberian System in the East. The Tagus depression, sited in the southern Submeseta, lies at a somewhat lower altitude, between 700 and 600 m. In the last part of the Tertiary (from the Miocene) both depressions constitute separate continental sedimentary basins.

HYDROGRAPHY

The Iberian Peninsula waters flow into two seas: the Atlantic ocean and the Mediterranean sea; related to this we can divide it into two vast slopes. The watershed line between them crosses the Peninsula from north to south quite displaced eastwards from its central meridian. Thus, the extent of both slopes is unequal, the Atlantic is much bigger than the Mediterranean (figure 10). The Iberian rivers, due to the dominant climatic conditions in which the precipitations are relatively scarce and have an irregular seasonal distribution, are relatively small and present a marked low water season. Also, due to the mountainous character of the country, many stretches cover big altitudinal gaps in short distances and present a rapid stream of water. However, the most important rivers flow slowly when they cross the great alluvial plains.

THE ATLANTIC SLOPE

It occupies the major part of the Peninsula and is drained by the biggest Iberian rivers.

THE CANTABRIAN FRINGE AND GALICIA

The Cantabrian Fringe is drained by numerous short rivers which have their source in the Cantabrian Range and Basque Mountains and, after covering a big altitudinal gap in 40 or 50 Km of length, flow into the Bay of Biscay. The abundant rainfall during the whole year guarantees a relatively abundant caudal and a relatively moderate low water in summer. From the Bidasoa, on the French-Spanish border, to the Eo river, we can mention the Oria, Deba, Nervión, Asón, Miera, Besaya, Sella, Nalón and Navia.

The Atlantic façade in Galicia presents some rivers with similar characteristics to the Cantabrian ones, such as the Eume, Tambre and Ulla. The Miño-Sil network, which drains a basin of 15,106 Km^2, is the most important river in the northwestern part of the Peninsula and is a frontier between Spain and Portugal in its final stretch. It empties into the Atlantic between La Guardia and Caminha after a 310 Km run.

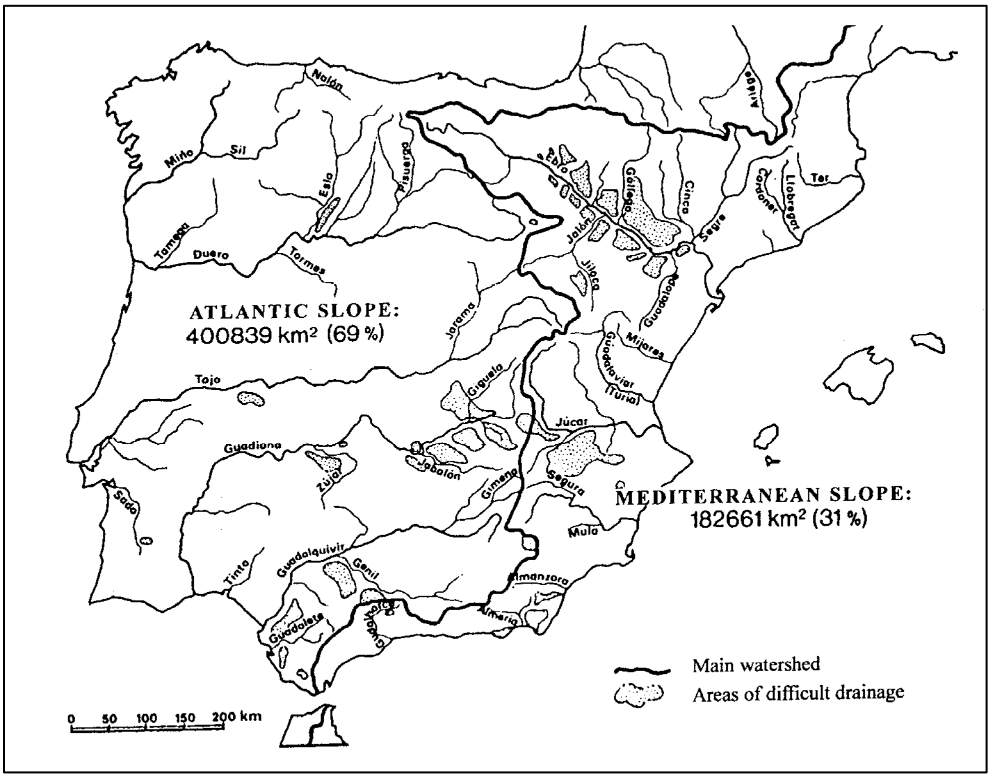


Figure 10.

THE DUERO BASIN

The Duero river is the largest of the Iberian Peninsula (675 m^3/seg. in the mouth) and the second in length (937 Km). Its basin is also the biggest of the Peninsula with about 100,000 Km^2. It springs at 2,000 m high in the Picos de Urbión in the northern Iberian System and flows into in the Portuguese city of Oporto. It crosses the northern Submeseta in lentic regime till the reliefs of the Arribes, where it falls in the Portuguese lowland and slowly crosses the last 200 Km of the Douro lowlands in a stretch which in former times used to be navigable.

The right side tributaries make the greatest water apportations because they are original from the rainy Cantabrian Range: the Pisuerga-Arlanza-Carrión network and the Esla are the most important. In the left side flow smaller rivers which source in the Central range, among them only the Tormes is noteworthy.

THE VOUGA AND MONDEGO BASINS

Both rivers are entirely Portuguese and are part of the secondary basins of the Atlantic slope. The first one starts in the Serra de la Lapa and the second in the Serra da Estrêla. After a short run, the Vouga flows into the Aveiro where it forms an estuary ("ria") as does the Mondego in Figueira da Foz.

THE TAGUS BASIN

The Tagus river is the longest of the Peninsula, with 1,120 Km in length. Its source is at 1,345 m in the Sierra de Albarracín, Iberian System, in an important hydrographical knot in which other important Iberian rivers also have their sources: Júcar, Turia nad Cabriel, which belong to the Mediterranean slope. Its basin has 81,000 Km^2 and crosses the southern Submeseta entering Extremadura and Portugal where it ends in the Atlantic through a broad estuary, the Mar da Palha, on whose right side lies Lisbon. Along a big part of its length along the western lands of the Iberian Peninsula, the Tagus river becomes confined in narrow canyons hollowed out in the hard Palaeozoic rocks, to which it probably owes its name. The water carried in the mouth is nearly 500 m^3/seg., less than the Duero in spite of it being longer. The smaller size and the markedly Mediterranen pluviometric regime causes its tributaries to bring lower water quantities. Among them the group Jarama-Henares-Manzanares, the Alberche, Tiétar and Alagón-Jerte stand out on the right side; while on the left side only the Guadiela brings significant water quantities.

THE SADO AND MIRA BASINS

South to the Tagus mouth, the southwestern corner of the Peninsula is drained by a number of small basins among which those of the Sado and Mira rivers stand out. The first is constituted by a network of little streams (Xarrama, Odivelas or Ribera de Campilha) confluent to the main channel (Sado) and drains the sandy coastal area where the Alentejo appears to the Atlantic ocean, forming an estuary on whose right side lies the city of Setúbal in the foothills of the remarkable Serra da Arrabida. The Mira river rises in the Serra do Caldeirão and empties into the south of Sines.

THE GUADIANA BASIN

It has 66,900 Km^2 and embraces a good part of La Mancha in the southern Submeseta, southern Extremadura and the Alentejo, running between the Montes de Toledo, its interfluve with the Tagus basin, and the Sierra Morena, its watershed with the Guadalquivir drainage network. The Guadiana river is 778 Km long and originates in the great aquifer of the “Mancha Occidental” which is fed by four Manchegan rivers: Záncara, Cigüela, Alto Guadiana and Azuer. In its final stretch from Badajoz onwards, it turns its course southwards and flows into Ayamonte after being a frontier between Spain and Portugal for nearly 70 Km. Among its tributaries we can mention the Jabalón, Bulaque and Zújar.

As secondary basins we should mention those of the Tinto and Odiel rivers, which empty into a common estuary near the city of Huelva.

THE GUADALQUIVIR BASIN

It is the great hydrographical basin of the south, with 57,377 Km^2 of extent, comprising almost exclusively Andalusian territory. The Guadalquivir river is 560 Km long and its water flow in the mouth is nearly 258 m^3/seg. It rises at 1,400 m high in the Sierra de Cazorla and its initial course is NE driven by the natural reliefs of the mountain range. After a short stretch it turns almost completely and begins its W and SW oriented course along the rest of its length, crossing the entire depression. After passing Córdoba and Seville, it runs into the Atlantic ocean through a broad estuarine system (“marismas”) in which dune systems as well as salt-marshes, fens, etc. (Doñana) are combined. The last 100 Km are navigable making Seville a fluvial-estuarine port. Among its tributaries stands out the Genil river from the left side, which bring the waters of the huge massifs of Sierra Neveda and others.

There are still some small secondary basins such as that of the Guadalete river which mouths in the bay of Cádiz, and that of the Barbate, which mouths close to the strait of Gibraltar.

THE MEDITERRANEAN SLOPE

Apart from the Ebro, the rivers which drain into the Mediterranean sea are short, of irregular water flow and drain a small basin. This is due to the characteristics of the relief and to the pluviometric regime of the territory. For that reason they have a pronounced low water season which often leads to a complete or almost complete drying of its bed during long periods. Such dried beds are usually surprisingly big as if they would be able to receive a much higher water flow than that suggested by the landscape aspect. In fact, they are usually suddenly flooded by the heavy and torrential rainfalls occuring occasionally, especially in autumm. This results in the name of “ramblas” for those river beds which are almost always dry but have a surprising ability of holding a large amount of water, in adaptation to the particular rainfall regime of the territory.

THE SOUTHERN BASINS

Between the strait of Gibraltar and the Segura basin there is a broad area of 18,391 Km^2 which is drained by several rivers, ravines and “ramblas” which have their sources in the high summital zone of the Baetic ranges and empty into the Mediterraean sea. We can mention the Guadiaro (3,258 Km^2), Guadalfeo (1,295 Km^2), Andarax (2,611 Km^2), and Almanzora (2,188 Km^2). The extreme low water season effect means that in most cases the aspect of these rivers is of a huge "rambla" with a little drainage channel flowing in the middle.

THE LEVANTINE BASINS, FROM THE SEGURA TO THE MIJARES

Between the Murcian region and the Ebro mouth there are several basins which drain the Levantine area of the Murcia and Valencia regions. The most important of them are those of the Segura, Júcar and Turia rivers; the Vinalopó and Mijares can also be mentioned. The Segura (325 Km long) drains a basin of 14,936 Km^2, its headwaters are the "sierra" of the same name and flows into the sea in Guardamar after irrigating the Murcian fertile fields ("huerta"). Its main tributary is the Guadalentín.

The Júcar river (498 Km long) drains a basin of 21,587 Km^2, the second of the Mediterranean slope. It springs in the Montes Universales (Iberian System), in the aforementioned hydrographic knot where the Cabriel (its main tributary) as well as the Tagus and the Turia have their source. It crosses Manchegan land and passes throug the Valencian inner mountain ranges before arriving at the coastal Quaternary plain of Valencia, the lower and upper Ribera areas. It empties into the Mediterranean near Cullera after a 498 Km run.

The Turia (also called Guadalaviar in its upper stretch) has a much smaller basin surface, 6,394 Km^2. Together with its main tributary, the Alfambra, it crosses the area of Teruel and afterwards continues southeastwards crossing Ademuz and reaching the city of Valencia, where it flows into the Mediterranean sea after a 280 Km run. In its final stretch it irrigates a vast "huerta".

Northwards, the two remaining basins of a certain importance are those of the Palancia and the Mijares rivers, the former runs into the sea near Sagunto, and the latter, in Castellón de la Plana. Both gather the waters of the Maestracean massifs of the Iberian System: Javalambre and Gúdar.

THE EBRO BASIN

It drains a surface of 85,574 Km^2; that makes it the second in extent of the Iberian Peninsula and the first of the Mediterranean slope. It is also the second in water content as its flow is of 577 m^3/s. It rises in the Pico Tres Mares, another hydrographical knot located in the eastern extreme of the Cantabrian Range where the Pisuerga (a tributary of the Duero) and the Nansa (a Cantabrian slope river) also source. In the first part of its course, the Ebro river passes through the southern ranges of the Basque Mountains hollowing out several canyons in the limestone, but during most of the course crosses the great depression in a NW-SE direction. Its final meanders hollow the Catalan Coastal ranges before empties into the Mediterranean in Amposta after 928 Km. In its final stretch originates a wide Delta which enters in the sea forming a cape of considerable size. The tributaries which contribute with most of the water rise in the Basque Mountains and in the Pyrenees and join the Ebro on its link side: the Zadorra, Ega and Gállego as well as the Arga-Irati-Aragón Cinca-Segre networks are the most important on this side. From the right side the water come from the Iberian System: Najerilla and Iregua stand out in La Rioja and Jalón and Guadalope in Aragón.

THE EASTERN PYRENEES BASINS

A group of small basins located at the NE extreme of the Peninsula and whose sources are in the Catalonian Pyrenees, are considered under this assemblage. Among them stand out those of the Llobregat and Ter rivers. The former with 4,950 Km^2, is drained by the Llobregat river which rises in the Catalonian Pre-Pyrenees and flows into the Mediterranean south of Barcelona forming a large deltic plain. The Ter river rises in the eastern exterme of the Pyrenees and empties into the Empordá coastal area after draining 3,010 Km^2. Besides to them there are still other secondary basins of lower importance which originate in the Catalonian Coastal range such as those of the Francolí, Gayá, Besós, Tordera and Muga.

BIOCLIMATOLOGY OF THE IBERIAN PENINSULA

SALVADOR RIVAS-MARTÍNEZ & JAVIER LOIDI ARREGUI

The essential factors which determine the climate of the Iberian Peninsula are its geographical position and its physiographical characteristics. Its location between the parallels 43 and 35 N, in the Atlantic façade of Europe and between the Atlantic ocean and the Mediterranean sea, rules the general regime of atmospheric perturbations affecting the Peninsula throughout the seasons of the year. On the other hand, its form and relief modulate this general regime and originate the regional and local climates of the different parts of its territory.

In a very general sense it is possible to assert that the Iberian Peninsula is located in the belt of the Northern Hemisphere where western winds (westerlies) are dominant. That means that the most important precipitations originate from the Atlantic. The fronts associated with the successive lows which cross, in a west-east run, the Northern part of the Atlantic and enter upon Europe are responsible for them. This train of lows is limited in the south by a band of highs (subtropical highs) responsible for the aridity in the westen parts of the continents in the subtropical latitudes; in our surroundings the Azores high represents this belt. All this system of highs and lows suffers a yearly seasonal oscillation: in summer the highs and lows shift northwards and in summer southwards. The Iberian Peninsula, due to its latitude, is almost entirely in this shifting band and in summer it is under the highs and in winter it is swept by the fronts associated with the lows coming from the Atlantic (Font Tullot 1983). This situation determines a strong seasonality of the rainfalls, typical of the Mediterranean pluviseasonal climate. In the northern fringe of the Peninsula, this seasonality is diminished and the summers are rainy enough to identify the temperate, non-Mediterranean, climate.

This description is very general and there are some other factors which strongly influence the climate in the Iberian Peninsula. One of them is the Mediterranean sea, influencing the eastern regions and the other is the square-shape and relief of the Peninsula itself; most of the mountain ranges are peripheral and surround the Meseta or central high plateau, which results in an increase of the continentality and aridity of the internal regions.

PRECIPITATIONS

They mainly originate from the Atlantic with the exception of the Levantine area, where they proceed from the Mediterranean sea; except of the high mountains or under exceptional weather conditions in winter, they are in the form of rain. Their distribution, in geographical and in seasonal terms, is very unequal. The rainiest areas are in the northern and the western parts due to their proximity to the ocean; in the inland territories rainfall decreases in an irregular gradient disturbed by the mountain ranges. So many mountains disturb the rainfall gradient from the coast to the interior; only the transition from the southwestern coast to the inland areas follows a gradual decrease of rainfall i. e. from central and southern Portugal to the southern half of the Meseta across Alentejo and Extremadura. All the other transitions are interrupted by mountain chains which cause strong increases of orographic precipitations in the sea-facing slopes and rain shadow on the oposite sides. So, there are several examples of aridity caused by rain shadow: the Cantabrian Range-Montes de León system is the main responsible for the aridity of the central areas of the Duero basin, the Pyrenees, the Catalan ranges and the Iberian System conceal the Ebro basin and cause the severe drought of its central part and almost all the reliefs of the Iberian Peninsula provoke the aridity of its southeastern fringe. On the other hand, high precipitations are registered in mountains like those of Campo de Gibraltar and Serranía de Ronda (Grazalema) in the south, the western massiffs of the Central range (Estrêla, Bejar, Gredos) or on the northern slopes of the Cantabrian Range and the Pyrenees.

In the Levantine fringe, the Mediterranean sea is responsible for its rainfall regime, which is usually provoked by lows originating in the area near to the coasts of southern France. For that reason precipitations are more abundant in the northern stretch (Catalonia). South of the Cape of La Nao the precipitation shows a sharp fall due to the rain shadow of the Dianic ranges, which contributes to the deep aridity of the Peninsular southeastern extreme.

The seasonal distribution of the precipitations follows, in almost all of the territory, a Mediterranean pattern with a marked summer drought; there is the exception of some small areas on the eastern Pyrenees and the Iberian System where summer is the rainiest season (Fillat Estaqué 1983). This summer minimal can be more or less pronounced and in most of the Iberian extent cannot balance the drought stress caused by the high temperatures of the same period and then a true Mediterranean climate occurs. Only in the north and the northwestern part of the Peninsula, together with the high areas of the mountains of the central regions, is the summer rainfall high enough to diminish that stress and a temperate climate can be recognised. The threshold value to separate both climatic areas is that during two summer months rainfall is lower that double the temperatures ($p<2t$). In any case, most of these temperate areas show a clear Mediterranean tendency (submediterranean).

The Peninsula can be divided into two parts depending on the influence of the corresponding sea in its seasonal rainfall regime: the western part dominated by the Atlantic ocean and the eastern one ruled by the Mediterranean sea. The first one is much bigger than the second and comprises the vast areas of the great river basins which flow westwards; in this part spring rains are important and certain and in sumer the Azores high provokes a severe drought. The Mediterranean influeced area, basically restricted to the eastern coastal fringe, presents important autumm rainfalls, often torrential.

TEMPERATURES AND CONTINENTALITY

The distribution of the thermic regimes in the Iberian Peninsula follows the latitude and altitude patterns normal in any territory as is shown in figure 11 & 12. It is important to point out that the nearness of the Gulf Stream to the northern Atlantic coasts of the Peninsula causes a substantial warming of the low winter temperatures which is reinforced by the favourable thermic conditions of the Mediterranean sea. This makes the Iberian Peninsula quite a warm area, especially in winter, because it is surrounded by relatively warm water masses. Due to its latitude and extreme position in the European continent, it is almost safe from the cold Siberian air invasion episodes in winter which affect most of central and northern Europe; winter cold waves of this origin are few and much less severe. Nevertheless, the central regions, specially those of the Meseta, are submitted to frequent winter frosts due to the altitude and continentality. On the contrary, the areas under Mediterranean macrobioclimate at low altitudes experience a torrid summer with suffocating temperatures, mostly if they are not close to the seashore.

As the influence of the Atlantic ocean is overwhelmingly higher than that of the Mediterranean sea due to the dominating zonal circulation of the winds (westerlies), the western regions have a strong oceanic influence. This is reinforced by the physiographic structure of the Peninsula where the Meseta slopes westwards and the great river valleys are open to the Atlantic. On the other hand, the Mediterranean sea has a much weaker power in moderating extreme temperatures and its influence is limited to the eastern coastal areas. The continentality maximum is reached in a north-south fringe which covers the central-eastern highlands starting in the central Pyrenees and ending in the eastern La Mancha and the Subbetic ranges. Thus, almost all the Peninsula can be included in the hyperoceanic (northern and northwestern coastal areas) or oceanic subtypes, the continental subtypes can be recognised only in some interior areas of the southeastern quadrant.

BIOCLIMATIC TYPOLOGY OF THE IBERIAN PENINSULA

In an attempt to find coincidences between the climatic types and the vegetation types, a bioclimatic classification has been developed which accurately reflects the reality and diversity of the climate of any territory and a narrow relationship with the vegetational models (Fernández-González 1997, Rivas-Martínez 1995, 1996). In table 1 climatic types are defined and in figures 11 & 12 the geographic distribution of bioclimates and thermotypes are shown.

The parameters used in the bioclimatic types definitions are:

Ic = Simple continentality index or annual temperature range

Io = Annual ombrothermic index

Ios_i = Ombrothermic index of any month of the summer quarter

Ios_2 = Ombrothermic index of the two warmest months of the summer quarter

Itc = Compensated thermicity index

M = Mean maximum temperatures of the coldest month

P = Annual precipitation in mm

T = Annual mean temperature

Table 1. CLASSIFICATION OF THE IBERIAN PENINSULA (summarized table)

MACROCLIMATES [1]	BIOCLIMATES	CLIMATIC VALUES: Ic	Io	P > 2T	Ombrotype
Mediterranean Subtropical and temperate (23° to 52° N & S). With aridity P < 2T, at least two months in summer: $Ios_2 \le 2$ and Iosc ≤ 2. At least two values: T < 25°, m < 10°, Itc < 580.	**M. pluviseasonal-oceanic**	**≤ 21**	**> 2.0**	**3-10**	**3-7**
	M. pluviseasonal-continental	**> 21**	**> 2.2**	**3-10**	**3-7**
	M. xeric-oceanic	**≤ 21**	**1.0-2.0**	**0-8**	**2**
	M. xeric-continental	**> 21**	**1.0-2.2**	**0-8**	**2-3**
	M. desertic-oceanic	**≤ 21**	**0.1-1.0**	**0-4**	**1**

Bioclimatic belt: thermotypes	Itc	Tp [2]	Bioclimatic belt: ombrotypes	Io
			1. Arid	**0.3-1.0**
1. Thermomediterranean	**350 - 450**	**2150-2450**	**2. Semiarid**	**1.0-2.0**
2. Mesomediterranean	**210 - 350**	**1500-2150**	**3. Dry**	**2.0-3.6**
3. Supramediterranean	**80 - 210**	**900-1500**	**4. Subhumid**	**3.6-7.0**
4. Oromediterranean	-	**450-900**	**5. Humid**	**7.0-14.0**
5. Cryoromediterranean	-	**1-450**	**6. Hyperhumid**	**14.0-28.0**
			7. Ultrahyperhumid	**>28.0**

MACROCLIMATES [1]	BIOCLIMATES	CLIMATIC VALUES: Ic	Io	Io .... Iosi
Temperate Subtropical, temperate (23° to 51° N & S) and cold (51° to 66° N). From 23° to 35° N & S. < 200 m. At least two values: T < 21°, M < 18°, Itc < 470. $Ios_2 > 2$, Iosc > 2 if $Ios_2 \le 2$.	**T. hyperoceanic**	**< 11**	**> 3.2**	**3.2-3.8 .... P > 2T**
	T. oceanic	**11-21**	**> 3.2**	**3.2-3.8 .... P > 2T**
	T. continental	**>21**	**> 3.2**	**3.2-3.8 .... P > 2T**
	T. xeric	**≥7**	**≤ 3.2**	**3.2-3.8 .... P ≤ 2T**

Bioclimatic belt: thermotypes	Itc	Tp [2]	Bioclimatic belt: ombrotypes	Io
1. Thermotemperate (th.coline)	**300 - 410**	**2000-2350**	**1. Semiarid**	**<2.2**
2. Mesotemperate (coline)	**180 - 300**	**1400-2000**	**2. Dry**	**2.2-3.2**
3. Supratemperate (montane)	**20 - 180**	**800-1400**	**3. Subhumid**	**3.2-6.0**
4. Orotemperate (subalpine) [4]	-	**380-800**	**4. Humid**	**6.0-12.0**
5. Cryorotemperate (alpine)	-	**1-380**	**5.Hyperhumid**	**12.0-24.0**
6. Athermic [3]	-	**0**	**6.Ultrahyperhumid**	**> 24.0**

(1) Northern and southern of ecuatorial and eutropical latitudinal belts (23°N & 23°S) if the locality is at a height of 200 m or more it is necessary to calculate the thermical values at that altitude increasing T in 0.6°, M in 0.5°, and It or Itc in 13 units, every 100 m higher than this altitude; if the locality is northern 48° N or southern 51° S the increases in the values are T in 0.4° and Tp in 12 units every 100 m higher than this altitude. **(2)** When values of Ic ≥ 21 and Itc < 120 the thermotype is calculated by values of Tp . **(3)** In the athermic thermotype the ombrotypes are: unsnowiness (< 10 mm), low-snowiness (10-200 mm), semi-snowiness (200-500 mm), high-snowiness (500-1000 mm) and hyper-snowiness (> 1000). **(4)** Northern or southern 51° N & S the hemiboreal thermotype is used against orotemperate (subalpine) in territories < 1000 m altitude and Ic > 28, Tp 380-800 and also those ones < 400 m altitude and Ic ≤ 28.

TABLE 1 (CONT.).
COMPENSATION VALUES OF IO WHICH DETERMINATE THE SUBME-DIETERRANEAN VARIANT IN THE TEMPERATE MACROCLIMATE.

Io	Ios_2	Ios_3	Ios_4
>2.0- <=3.6	> 1.9	> 1.9	>2.0
>3.6- <=4.8	> 1.8	> 1.9	>2.0
>4.8- <=6.0	> 1.7	> 1.8	>2.0
>6.0- <=8.0	> 1.5	> 1.8	>2.0
>8.0- <=10.0	> 1.2	> 1.6	>2.0
>10.0- <=12.0	> 0.7	> 1.4	>2.0
>12.0			>2.0

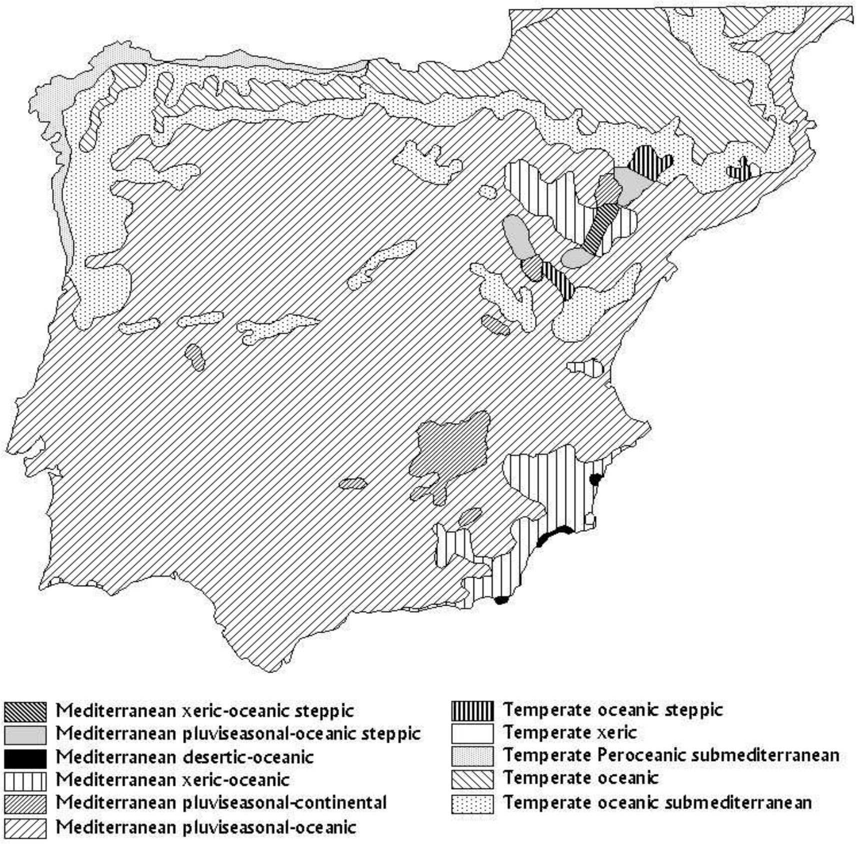


Figure 11.- Bioclimatic map of the Iberian Peninsule

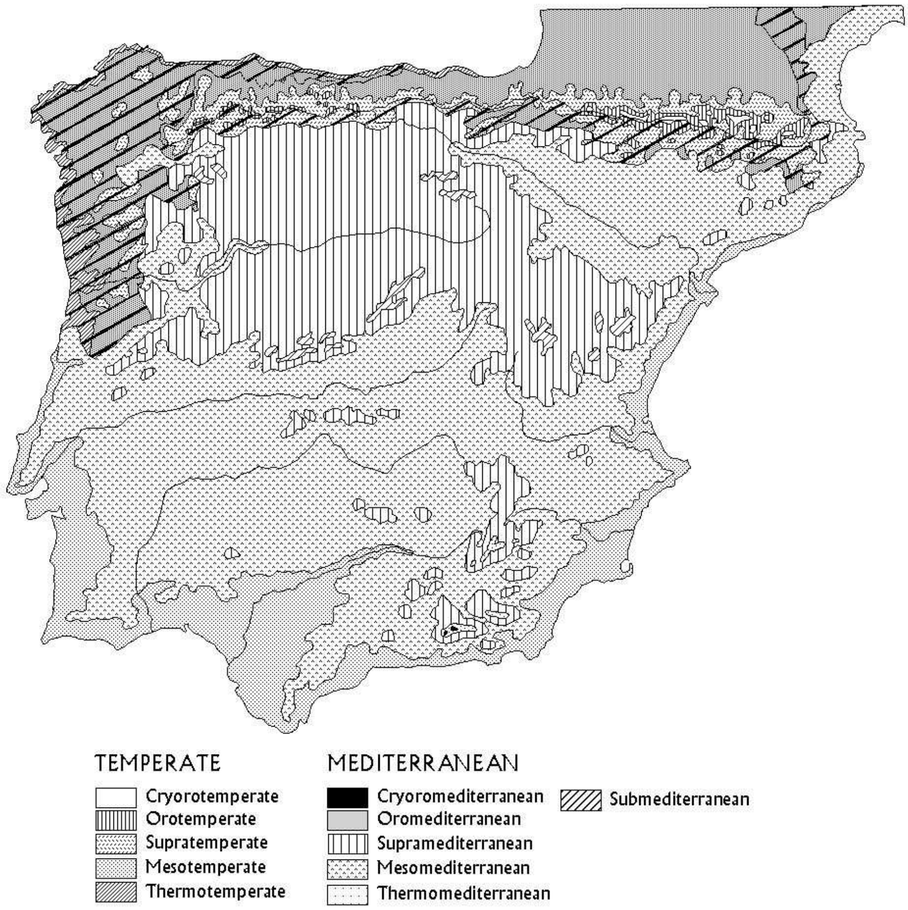


Figure 12.- Bioclimatics belts of the Iberian Peninusle

Tp = Annual positive temperature

Tp: Annual positive temperature: Is the sum, multiplied by 10, of the mean temperatures of the months in which they are above 0º; $Tp = \sum t_i$, if $t_i<0º$

Ic: Simple continentality index or annual temperature range (Ic):Difference between the mean temperatures of the warmest and the coldest months; $Ic = t_w - t_c$

Io: Ombrothermic index (Io): Is the quotient, multiplied by 10, between the sum of the monthly precipitation of the months in which their mean temperature is above 0 (positive precipitation or $Pp = \sum p_i$, if $t_i<0º$) and the sum of the mean temperatures of the same months (positive temperature or $Tp = \sum t_i$, if $t_i<0º$). $Io = 10 \times Pp/Tp$. If calculated for the whole year, the annual ombrothermic index

(Io) is obtained; it can be applied to any of the summer months (Ios_i) or to the two warmest months of the summer (Ios_2).

It: Thermicity index (It): Sum, multiplied by 10, of the annual mean temperature (T), mean maximum temperatures of the coldest month (M) and mean minimum temperatures of the coldest month (m); It = 10 x (T + M + m). It tries to assess the cold intensity which is a limiting factor for many plants and communities. In highly oceanic extratropical areas (Ic < 11) or in the very continental ones (Ic > 18), this index shows a lower correlation with the vegetation types distribution and needs to be corrected by adding a compensation value (C) which is calculated for each stretch of continentality values. Then the compensated thermicity index: Itc = It + C

BIOGEOGRAPHY OF THE IBERIAN PENINSULA

SALVADOR RIVAS-MARTÍNEZ & JAVIER LOIDI ARREGUI

THE IBERIAN FLORA

Within the European continent, the Iberian Peninsula is the country or geographical area which presents the highest floristic richness. The number of vascular plants, including subspecies, is over 7,000 (Castroviejo 1997). Due to several facts, specially its great specific diversity in plants, the taxonomic and floristic research about the Iberian flora is not yet concluded and new taxa are still being described nowadays. From all this number of plants, about 1,400 are endemic (Sainz Ollero & Hernández Bermejo 1985, Moreno Saiz & Sainz Ollero 1992), which means an endemicity rate of about 18%. Such richness and endemicity is favoured by the great diversity of habitats, the result of the high climatic variability superimposed on the lithologic variability, with the backdrop of the history of the climate and the vegetation. Historic episodes like the origin of the Mediterranean flora at the end of the Tertiary or the influence of the Quaternary ice-ages, less severe than in other parts of Europe, are also essential to understand the modern conditions of the Iberian flora and vegetation. An intricate orography with abundant mountain ranges mostly emerging at the same time as the Mediterranean flora was being formed, also favoured the high endemicity rate.

THE FLORISTIC ELEMENTS

THE EXTRAMEDITERRANEAN FLORA

Sheltered by the temperate climate dominating in the northern fringe of the Peninsula, the European non-mediterranean flora has an important representation in that area. Inside this category it is possible to distinguish several groups which concentrate in zones or altitudinal belts according to their climatic affinities.

THE BOREO-ALPINE ELEMENT

This floristic group, which also includes the artic-alpine taxa, is represented in the high mountains of the northern part of the Iberian Peninsula, mostly in their alpine (criorotemperate) and subalpine (orotemperate) belts. The modern distribution and abundance of this flora is related with the incidence of the cold episodes of the Quaternary, a period in which it migrated southwards driven by the ice advance. In the Iberian Peninsula, this boreo-alpine flora found the oromediterranean flora occupying the high levels in the mountains; this encounter produced an overlap of both and the dominance of one or the other depends on the latitude as the invasion of the boreo-alpine flora was much more intense in the north than in the southern mountains, where the oromediterranean flora was hardly displaced. In consequence the most abundant representation of the boreo-alpine element at present is in the Pyrenees thanks to the connection with the Alps through the Cevennes system. Here it was entered in contact with the oromediterranean element which occupied the area before and displaced it to the xeric habitats. Westwards it extended through the high altitudes of the Cantabrian Range and southwards it reached the Central Range, where it is less represented, and even the Sierra Nevada, where it is very scarce. Among this group we can mention *Arctostaphylos alpina*, *A. uva-ursi*, *Carex curvula*, *C. rosae*, *Dryas octopetala*, *Elyna myosuroides, Huperzia selago*, *Loiseleuria procumbens*, *Salix herbacea, Saxifraga oppositifolia*, *Silene acaulis*, *Subularia aquatica*, *Vaccinium uliginosum* subsp. *microphyllum*, etc.

THE EUROPEAN TEMPERATE FLORA

It dominates in the regions of the north and northwest, from northern Portugal to the Pyrenees, and in the mountains of the interior, where the climate is temperate. The forest vegetation is dominated by summergreen broadleaved trees such as *Acer campestre, A. pseudoplatanus*, *Fagus sylvatica*, *Fraxinus excelsior*, *Quercus robur, Q. petraea, Q. humilis*, *Ulmus glabra*, etc. These deciduous forests together with the meadows of *Arrhenatheretalia*, are the most characteristic elements of the landscape in these areas, as in the rest of temperate Europe.

This floristic assemblage can be divided into two main groups: the Alpine-Centraleuropean and the Atlantic. The first one reaches the Peninsula mostly in the Pyrenees, where it finds its southwestern end. This circumstance of terminal area determines a certain impoverishment in species which are common in the European Alpine-Centraleuropean flora, is the case of the lack of *Larix decidua* or *Picea abies* in the Pyrenees or the extremely scarce presence of *Carpinus betulus* (the only two Spanish populations reported at the moment). Some representatives of the Alpine-Centraleuropean group are *Abies alba*, *Acer opalus*, *Betula pendula*, *B. pubescens* or *Quercus humilis* (= *Q. pubescens*). In quite an opposite situation, the Atlantic flora finds its optimum in the northwest of the Peninsula (Dupont 1962, Roisin 1969). An important part of it is linked to the heathland vegetation such as the *Ericaceae*: *Daboecia cantabrica*, *Erica ciliaris*, *E. cinerea*, *E. mackaiana*, *E. vagans* or *E. umbellata*, and others like *Agrostis curtisii*, *Lithodora diffusa*, *L. prostrata*, *Pseudarrhenatherum longifolium*, *Ulex europaeus*, *U. minor*, *U. galli*, etc. In the forests there are also a significant pool of genuine Atlantic species like *Luzula sylvatica* subsp. *henriquesii*, *Omphalodes nitida*, *Saxifraga hirsuta*, *S. spathularis*, or even trees like *Betula pubescens* subsp. *celtiberica* and *Quercus pyrenaica*. Despite the fact that *Quercus robur* is not a strict indicator of Atlantic territories in most of Europe, in the Iberian Peninsula it is absent fom the Pyrenees and is used as a diagnostic species for the Atlantic area.

THE MEDITERRANEAN FLORA

The Mediterranean region is one of the areas of the non-tropical World with the richest flora; some estimations are about 25,000 species of vascular plants (Quézel 1985, Costa 1997). If compared with the 6,000 species living in the almost four times larger area of extramediterranean Europe, the difference of specific diversity is overwhelming. Although there is not any endemic family, 150 genera and almost 50% of the species are exclusive to the Mediterranean region (Takhtajan 1986). Between the endemic genera we can mention, *Calicotome*, *Carduncellus*, *Halimium*, *Limoniastrum*, *Rosmarinus*, *Santolina*, *Sarcocapnos*, *Staehelina* or *Stauracanthus* among those which have an important representation in the Iberian flora.

It is a relatively “young” flora, shaped during the climatic drying period of the late Tertiary; the representation of old relics prior to this time, quite abundant in Macaronesian flora, is scarce in the Iberian Peninsula. The Mediterranean flora has a double origin: on one side there is the Holarctic extratropical element, which is dominant in the northern and central belts of the Mediterranean area, and on the other the element of Paleotropical African origin, better represented in the southern fringe, mostly in the Magrib (North Africa). The latter has representatives of typical tropical families like *Capparaceae*, *Palmaceae* (*Chamaerops*, *Phoenix*), *Santalaceae* or *Sapotaceae*. Those two elements can coincide with the so called neo-mediterranean and paleo-mediterranean assemblages (Blondel & Aronson 1985, C.M. Herrera 1984). The first one appears during the Pleistocene, contemporary to the summer-aridization which occurs at that time in the subtropical latitudes. Some genera of this group are *Cistus*, *Coronilla*, *Cytisus*, *Erica*, *Fumana*, *Genista*, *Halimium*, *Helianthemum*, *Lavandula*, *Rosmarinus*, *Teucrium*, *Thymus* or *Ulex* (C. M. Herrera 1992). On the other hand, the lineages existent before the appearance of the Mediterranean climate belonged originally to the existent paleotropical or subtropical flora and later adapted to the new conditions. Among them we can mention genera like *Ceratonia* (*Cesalpinaceae*), *Chamaerops* (*Palmaceae*), *Corema* (*Coremaceae*), *Ilex* (*Aquifoliaceae*), *Juniperus* (*Cupressaceae*), *Laurus* (*Lauraceae*), *Olea* (*Oleaceae*), *Osyris* (*Santalaceae*), *Phillyrea* (*Oleaceae*), *Pinus* (*Pinaceae*), *Pistacia* (*Anacardiaceae*), *Quercus* (*Fagaceae*), *Rhamnus* (*Rhamnaceae*), *Rhus* (*Anacardiaceae*) or *Securinega* (*Euphorbiaceae*). It is remarkable that many of the families have most of their members in the tropical world.

As a result of the alpine orogeny, the uplift of the mountain ranges led to the adaptation of the existing Mediterranean flora to the high mountain conditions produced. That resulted in the formation of a high mountain Mediterranean or Oromediterranean flora (Rivas-Martínez 1969, Pons & Quézel 1985, Quézel 1985), rich in cushion-shaped chamaeophytes and adapted to the cold and summer-drought conditions charasteristic of this environment. During the Quaternary ice-ages the Boreo-Alpine flora was driven southwards and invaded mountains formerly occupied by the Oromediterranean flora, mostly in the Pyrenees and the Cantabrian Range. This encounter produced a segregation of both elements in the same areas: the Oromediterranean occupied the xeric habitats and the Boreo-Alpine the hygrophilous and chionophilous habitats. The Iberian mountains, mainly those of the centre and the south (Baetic ranges), have a numerous representation of the Oromediterranean flora.

As a result of the climatic changes of the Quaternary, there are a significant number of temperate-climate adapted plants living inside the Mediterranean region. That is the case of *Acer*, *Betula*, Corylus, *Fagus*, *Fraxinus* or Ulmus, typical deciduous trees with high water supply demands in summer. Those plants are more frequent in the northern belt of the Mediterranean region and always live in exceptionally rainy areas (mountains) or in wet habitats.

THE MEDITERRANEAN-IBEROATLANTIC ELEMENT

The western part of the Iberian Peninsula, where the Hesperian Shield crops out occupying a large extent, has a remarkable floristic assemblage which is called the Mediterranean-Iberoatlantic. This flora is dominant in the western half of the Mediterranean Iberia and irradiates northwards and penetrates into the temperate areas of the north-west (North Portugal, Galicia, etc.) and southwards it reaches the Moroccan Tingitania. The majority of this flora is silicicolous and constitutes seral stage communities like heathlands, "jarales" (*Cistus* scrub) or forest mantles. There are several *Fabaceae* species, mostly belonging to the genera *Adenocarpus*, *Cytisus*, *Echinospartum*, *Genista*, *Retama*, *Stauracanthus* and *Ulex* which participate in this floristic group and many of them constitute broom like shrub communities very characteristic of the Mediterranean Iberoatlantic area. Among the oaks, there are two, *Quercus broteroi* and *Q. lusitanica*, which can be included in this group.

THE MEDITERRANEAN-IBEROLEVANTINE ELEMENT

The eastern half of the Peninsula, an area in which base-rich substrates are dominant, is populated by a clearly different flora from that of the western part. *Lamiaceae* rich scrub (*Rosmarinetea*) lodges an important part of this floristic assemblage. There are also some trees like *Quercus faginea* and *Q. ilex*.

THE ENDEMIC FLORA

As said above, the endemic rate of the Iberian flora is very high. These endemic plants, with the exception of those with a wide geographical range throughout a big part of the Peninsula, are not regularly distributed and there are some areas in which they concentrate. The main concentration is in the mountain ranges. Among them the Pyrenees (Rivas-Martínez, Báscones et al. 1991) and the Betic ranges (Rivas-Martínez, Asensi et al. 1991) stand out; secondarily the Cantabrian Range, The Central Range and the Iberian System can also be mentioned. Other centers of endemicity are, under Mediterranean climate, certain substrates like gypsum, dolomite and serpentine. Some particular climatic conditions can also originate population isolation and lead to a higher concentration of endemics such as in the southwestern part of the Peninsula (Murciano-Almeriense). Also well known is the endemicity linked to coastal capes and promontories, particularly affecting the genus *Limonium*.

THE BIOGEOGRAPHICAL SYNTHESIS

The expression of the biogeographical nature of the different territories and the relations existing between them leads to the construction of a hierarchic typology to classify the territorial units which Takhtajan (1986) calls chorionomy and constitutes the Biogeographical Synthesis. In figure 13 (Rivas-Martínez & A. Penas 1996) are drawn the choria or units until the rank of subprovince recognised for Europe. In its definition we have used floristic and vegetational criteria. The use of vegetation as a describer of territorial units in Biogeography goes back to the beginning of this Century (Flauhault 1901, Braun-Blanquet

1919) and has been applied in the Iberian Peninsula extensively for the last three decades (Rivas-Martínez 1973, 1987). In the last synthesis a high degree of accuracy in methodological formalisation has been reached, especially in the use of vegetation complexes, sigmeta and geosigmeta (Alcaraz 1996). Figure 14 shows the biogeographical units for the Iberian Peninsula. It is observed that there are a first division of it into two great units which form part of the two regions in which the Holarctic realm is divided: the Eurosiberian and the Mediterranean regions.

THE EUROSIBERIAN IBERIA

It comprises the territories of the northern band of the Iberian Peninsule under a temperate climate with rainy summers. It includes the two main mountain ranges of the north of the Peninsula: the Cantabrian Range and the Pyrenees comprising their piedmont areas. This stretch has unequal extremes, the western one extends southwards along the northern façade of Portugal till Aveiro and the surroundings of Coimbra, while the eastern one does not reach the Mediterranean seashore as it ends in the interior zone of Catalonia. The oceanic influence upon the coastal areas of the Atlantic zone is caused by the successive frontal systems associated to the highs circulating eastwards through the north Atlantic sea. This favours rainfall abundance in the north and northwestern coasts in contrast with the rain shadow of the eastern extreme, and results in the aforementioned geographical distribution of the Eurosiberian region in the Iberian Peninsula. In comparison with the Mediterranean region, the Eurosiberian region has a minor share in the Iberian territory, but in spite of that it is not at all negligible; it covers an extent of about 100,000 Km^2 and there are nearly 1000 Km of distance between its eastern and western extremes.

The Eurosiberian territory is quite diverse in the Iberian Peninsula and can be divided into two main areas, each of them belonging to two biogeographic provinces: the Atlantic European and the Pyrenean-Cevennensian. The first, is restricted to a fringe of variable width attached to the northern Atlantic coasts of the Peninsula and influenced directly by the Ocean. The second comprises the Pyrenees and their periphery and is conditioned by a more continental climate; its orophilous flora and vegetation relates this area with the Alps, especially with its westernmost stretches.

THE ATLANTIC EUROPEAN PROVINCE

It comprises the westernmost insular and coastal territories of the Atlantic façade of the Continent, from northern Portugal to the Faroes islands, between the latitude 40º and 62º. In the continent it includes the Northlusitanian-Galician-Cantabrian fringe, vast territories in western France till the area of Calais as well as the British and Azores archipelagos. So the broad latitudinal range means that there is a marked difference between the northern and British stretch and the Ibero-Aquitanian one; in the latter the influence of the Mediterranean flora and vegetation is remarkable. However, the Atlantic character is indicated by the high oceanity of its climate and by some vegetation types like the heaths.

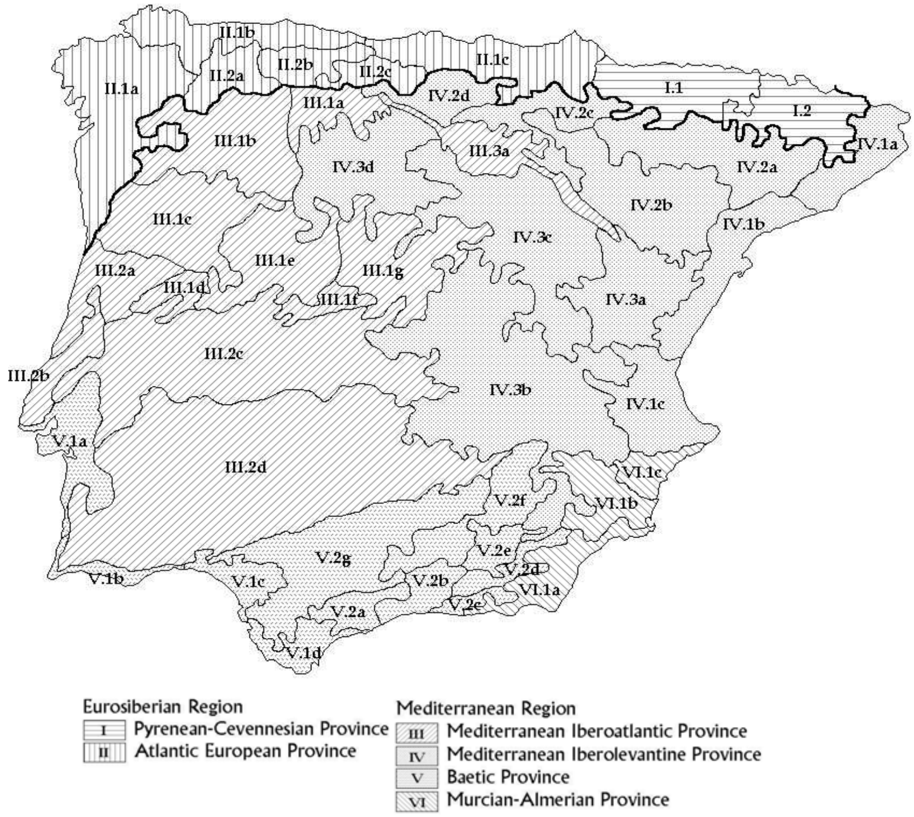


Figure 14. Biogeographical map of the Iberian Peninsule. EUROSIBERIAN Region: I. Pyrenean-Cevennean Province. I.1. Central Pyrennean Subprovince. I.2. Eastern Pyrennean Subprovince. II. Atlantic European Province. II.1. Atlantic Cantabrian Subprovince. II.1a. Galaico Portugués Sector. II.1b. Galaico Asturiano Sector. II.1c. Cántabro-Euskaldún Sector. II.2. Orocantabrian Subprovince. II.2a. Laciano-Ancarense Sector. II.2b. Ubiñense-Picoeuropean Sector. II.2c. Campurriano-Carrionés Sector. MEDITERRANEAN Region: III. Mediterranean Iberoatlantic Province. III.1. Carpetan-Leonesian Subprovince. III.1a. Leonés Sector. III.1b. Orensano-Sanabriense Sector. III.1c. Lusitano duriense Sector. III.1d. Estrellense sector. III.1e. Salmantino Sector. III.1f. Bejarano-Gredense Sector. III.1.g. Guadarrámico Sector. III.2. Luso-Extremadurenian Subprovince. III.2a. Beirense litoral Sector. III.2b. Divisorio portugués Sector. III.2c. Toledano-Tagano Sector. III.2d. Mariánico-Monchiquense Sector. III.3. Ibérian-Sorian Subprovince. IV. Mediterranean Iberolevantine Province. IV.1. Valencian-Catalonian-Provenzal Subprovince. IV.1a. Vallesano-Empordanés Sector. IV.1b. Valenciano-Tarraconense Sector. IV.1c. Setabense Sector. IV.2. Aragonesian Subprovince. IV.2a. Somontano-Aragonés Sector. IV.2b. Bárdenas-Monegros Sector. IV.2c. Riojano-Estelles Sector. IV.2d. Castellano cantábrico Sector. IV.3. Castillian-Maestracean-Manchegan Subprovince. IV.3a. Maestracense Sector. IV.3b. Manchego Sector. IV.3c. Celtibérico-Alcarreño Sector. IV.3d. Castellano duriense Sector. V. Baetic Province. V.1. Gaditan-Onubian-Algarvian Subprovince. V.1a. Ribatagano-Sadense Sector. V.1b. Algarviense Sector. V.1c. Onubense Sector. V.1d. Gaditano Sector. V.2. Baetic Subprovince. V.2a. Rondeño Sector. V.2b. Malacitano-Almijarense Sector. V.2c. Alpujarreño-Gadorense Sector. V.2d. Nevadense Sector. V.2e. Guadiciano-Bacense Sector. V.2f. Subbético Sector. V.2g. Hispalense Sector. VI. Murcian-Almerian Province. VI.1a. Almeriense Sector. VI.1b. Murciano Sector. VI.1c. Alicantino Sector.

Inside the European Atlantic province, flora and vegetation diversity concentrate in its southern sectors mostly because the incidence of the Quaternay glaciations and the species extinction was lower, but also because of the floristic enrichment due to the neighbouring Mediterranean region. For those reasons, the floristic richness and the important Mediterranean influence characterise the Atlantic part of the Iberian Peninsula. Within it there can be differentiated two main parts: 1- an abrupt area which includes the most important massifs of the Cantabrian Range and their corresponding piedmonts and valleys, ranging from the Ancares and Caurel massifs in the western extreme to the Peña Labra in the east; the Orocantabrian subprovince. 2- the rest of the Atlantic territory which is also mountanious to a great extent but the altitudes are more modest; the Cantabrian-Atlantic subprovince.

THE OROCANTABRIAN SUBPROVINCE

There are many mountains in the Atlantic territories of Europe but among them, the Cantabrian Range has a noticeable singularity with reference to its flora and vegetation. This is due to its outstanding magnitude and geographical position, permitting us to differentiate it as a particular territory with the rank of subprovince. Its floristic character is sustained mostly by the 32 Orocantabrian endemic species and subspecies. The narrow floristic relationship with the Pyrenees revealed by 17 taxa of Orocantabrian-Pyrenean distribution (Díaz González & Fernández Prieto 1988, 1994, Rivas-Martínez et al. 1984) is also important. Other floristic groups can be added to these, like that of the high mountain plants of wider distribution, occurring also in the Alps and other important European ranges, which can be used to differentiate the Orocantabrian flora from the neighbouring territories of the Cantabrian-Atlantic subprovince.

The vegetation units also show a marked personality as well as their distribution patterns in the territory. As an area characterised by its high mountains, four main altitudinal belts can be recognised. These correspond to four thermotypes: colline (mesotemperate), montane (supratemperate), subalpine (orotemperate) and alpine (criorotemperate). The first two belts are mainly dominated by deciduous broad-leaved forests. The acidic soils are occupied by *Quercus petraea*, *Q. pyrenaica* forests (*Quercion robori-pyrenaicae*), the deep nutrient-rich soils by *Fraxinus excelsior*, *Ulmus glabra*, *Acer pseudoplatanus*, etc. (*Carpinion*), and the rainiest areas by *Fagus sylvatica* and *Betula pubescens* subsp. *celtiberica* (*Fagion*, *Ilici-Fagion*). The substitution stages are formed by a diverse assembly of shrub and scrub communities; among them we can mention the broom mantles of *Genistion polygaliphyllae*, the *Prunetalia* hedges, the heathlands rich in gorses (*Daboecion*) and the basophilous scrub of *Genista occidentalis* and *G. legionensis* (*Genistion occidentalis*).

The orotemperate (or subalpine) belt has no forest vegetation, the zonal climax is a scrub of *Juniperus alpina* with *Arctostaphylos uva-ursi* ot *Vaccinium uliginosum* subsp. *microphyllum* (*Juniperion nanae*). The *Nardus stricta* grasslands (*Nardion*) also occupy a relevant extent in relation with the permanence and depth of the snow cover. The criorotemperate belt (alpine) is above 2,200 m high and thus has a scarce representation in the

Cantabrian Range. It only can be recognised in the highest summits of the Picos de Europa and in the Peña Prieta massif. Its characteristic vegetation are grasslands of *Kobresia myosuroides* (*Oxytropido-Elynion*) on limestone and of *Juncus trifidus* and *Oreochloa blanka* (*Festucion supinae*) on siliceous substrate. As in any mountainous territory, rupicolous vegetation: rock crevices (*Saxifragion trifurcato-canaliculatae*, *Saxifragion willkommianae*) and screes communities (*Linarion filicaulis*, *Linario-Senecion carpetani*) are frequent and endemic-rich. Chionopilous communities (*Armerion cantabricae*) and the several types of grasslands at higher levels are also original, like those on lithosols on limestone rocky areas (*Festucion burnatii*), or the siliceous *Festuca*-rich grasslands (*Teesdaliopsio-Luzulion caespitosae*).

The Mediterranean influence is significant in all the Cantabrian area and in this Orocantabrian subprovince it is represented by several communities of Iberian character such as the *Quercus rotundifolia* forests (*Quercenion rotundifoliae*), the Juniperus thurifera woodlands (*Juniperion thuriferae*) or the *Pinus sylvestris* var. *iberica* forests (*Avenello ibericae-Pinion ibericae*), all of them concentrated in the xeric biotopes mostly in the southern slope of the Cantabrian Range.

The Orocantabrian subprovince is divided into three sectors, from west to east: Laciano-Ancarense, Ubiñense-Picoeuropeano and Campurriano-Carrionés.

THE CANTABRIAN-ATLANTIC SUBPROVINCE

It includes all the continental territories of the European Atlantic province excluding those of the Orocantabrian subprovince, thus occupies a large area in western France and a narrower strip in Spain and Portugal. It is an area without high mountains and thus the upper thermotypes, i.e. orotemperate (subalpine) and criorotemperate (alpine), are lacking; only the themotemperate (thermocolline), mesotemperate (colline) and supratemperate (montane) thermotypes are represented. In the Iberian Peninsula it spreads out from the Basque Country to Galicia and north Portugal. In the Basque-Navarran stretch it embraces a wider band which comprises the mountains of the interior (Berastegi et al. 1997) but in Asturias it narrows to a reduced coastal corridor and in Galicia is broadened again comprising most of its territory; in Portugal it embraces the territories of Minho, Douro Litoral and Beira Litoral.

The high oceanity (oceanic and hyperoceanic types) is the main feature of the climate of these territories; as previously mentioned, the thermotypes range fron thermo- to supratemperate. The submediterranean variants in the climatic typology which are consequence of the transitional character of many of the Cantabrian-Atlantic areas bordering with the Mediterranean region are remarkable. This Mediterranean tint is more marked in the western territories (Galicia, northern Portugal and Asturias) than in the Basque Country and its surroundings.

The natural forests in the thermo- and mesotemperate levels are mostly of *Quercus robur*, some acidophilous (*Quercion robori-pyrenaicae*) and others mesophytic (*Carpi-*

nion). The beech forests (*Fagion*, *Ilici-Fagion*) are dominant in the montane belt (supra-temperate) of the Cantabrian area. The seral stages are varied: the forest-mantles can be group7ed into the broom communities (*Ulici-Cytision striati*, *Sarothamnion scopariae*) and the hedges (*Prunetalia spinosae*); the scrub types are the heathlands (*Daboecion*) and the *Genista occidentalis* communities (*Genistion occidentalis*). The Mediterranean influence on the vegetation of the Cantabrian-Atlantic subprovince is very important. The most conspicuous examples are the sclerophylic forests and shrublands present in the warm coastal areas. Remarkable among them are the *Quercus ilex* (*Quercion ilicis*) forests of the eastern stretch of the Cantabrian Fringe (between the Basque Country and the center of Asturias) living on the calcareous edaphically dry biotopes; in the siliceous west, *Quercus suber* represent a similar role (Guinea 1949, Braun-Blanquet 1967, Loidi et al. 1997, Tüxen & Oberdorfer 1958, Díaz 1975, Díaz & Fernández Prieto 1994, Izco 1987, Braun-Blanquet et al. 1956, 1964).

Such a vast territory is divided into several sectors. Only concerning its Iberian part there are, from west to east: Galaico-Portugués sector, Galaico-Asturiano sector and Cántabro-Euskaldun sector.

PYRENEAN-CEVENNENSIAN PROVINCE

It embraces the territories defined by the Pyrenean mountain range, together with the system of reliefs that in southern France connect it to the western Alps and whose most relevant part is the French “Massif Central”. It has a long southern and southeastern border with the Mediterranean region, starting in Navarre and ending in Provence; its western and northern limits are with the Atlantic European and with the Central European provinces while the eastern extreme contacts with the Alpine province. Its mountainous nature decisively determines the character of this territory presenting the typical syndrom of the orophilous biogeographical units: 1-high endemicity rate in its flora partly related to the abundance of rocky habitats, 2-abundance of refugee biotopes for relic plant populations and communities, 3-asimmetry of opposed slopes in the mountains, 4-particular local climatic conditions associated to the abrupt topography such as the Föhn effect, 5-orographic precipitations, 6-strong winds (and drought) in the narrow canyons, 7-relative drought in the inner valley bottoms and 8-altitudinal zonation culminating in the upper belts (subalpine, alpine) characteristic of the high mountains.

CENTRAL PYRENEAN SUBPROVINCE

It comprises the central and western massifs of the Pyrenees, from the Aran valley in northwestern Catalonia to the Irati river headwaters, beside the Orhi mountain in northern Navarre (Rivas-Martínez, Báscones et al. 1991). Its flora is characterised by its high number of endemics (Villar et al. 1997) as well as many Atlantic plants. The vegetation is organised in a typical Pyrenean pattern. The montane (supratemperate) belt is the largest and the most diverse of all those which occur in the Pyrenees. *Quercus humilis* (= *Q. pubescens*) is the most abundant tree species and form most of the potential forests (*Quercion pubescenti-sessiliflorae*) covering the slopes of the middle and lower levels of this belt. The beech forests, which usually intermingle with Abies alba trees, occupy a higher position, mostly in the northern-facing slopes of the cordillera under a more marked Atlantic influence with more abundant rainfalls. *Pinus sylvestris* var. *pyrenaica* also constitutes forests in the upper montane level of the southern valleys of the Pyrenees (*Junipero intermediae-Pinion catalaunicae*), under more continental and sunny conditions. *Abies alba* forests occupy modest areas on snowy slopes and in valleys at the upper montane and lower subalpine levels.

The subalpine or orotemperate belt is covered by *Pinus uncinata* forests (*Pinion uncinatae*) which include species like *Rhododendron ferrugineum* or *Juniperus alpina* depending on the depth and the length of the snow cover. The chionophilous vegetation of *Seslerietalia* (*Primulion intricatae*), the hygrophilous grasslands of *Nardion*, the xerophilous of *Festucion eskiae* (silicicolous) and *Festucion scopariae* (calcicolous) and the rupicolous communities of crevices and screes, complete the Pyrenean subalpine vegetation complex. In the alpine or criorotemperate belt, the climacic vegetation is represented by the *Kobresia myosuroides* grasslands (*Oxytropido-Elynion*) on base-rich soils, and by *Carex curvula* communities (*Festucion supinae*) on base-poor soils.

This subprovince is divided into the following sectors: Pirenaico occidental, Altopirenaico and Jacetano-Guarense (Prepirenaico)

EASTERN PYRENEAN SUBPROVINCE

A high number of endemics are characteristic of the flora of this subprovince in comparison with the preceding one. The Atlantic influence vanishes while the central European one becomes more evident. The zonation pattern of the bioclimatic belts and the vegetation is, however, similar to that of the rest of the Pyrenees (Folch 1986).

This subprovince is divided into the following sectors: Ribagorzano-Pallarés, Andorrano-Ariegense, Berguedano-Cerdanyés and Montsignático-Ripollés.

THE MEDITERRANEAN IBERIA

Among the southern peninsulas of Europe, the Iberian Peninsula has the greatest extent of Mediterranean territory, covering about 450,000 Km^2. In this vast extension it is possible to find the highest diversity of Mediterranean flora and ecosystems in the continent, due to its size, geographical position and climatic, orographic and lithologic complexity. Several groups or elements in the flora and vegetation of the Mediterranean Iberia may be distinguished: 1- The Mediterranean Iberoatlantic element, basically silicicolous and of western distribution, mostly linked to the old materials forming the territories which form the Hesperian Shield. 2- The Mediterranean Iberolevantine element, basically basophilous and of eastern distribution, mostly linked to the more recent base-rich materials like limestone, marl or gypsum; it bears relation to the Italian-Thyrrhenian flora. 3- The Baetic or southern element, very original and diverse, linked to the complex lithology occurring in the Baetic ranges and related to the north African flora.

MEDITERRANEAN IBEROATLANTIC PROVINCE

It embraces the vast territories of the western half of the Mediterranean part of the Peninsula, between the Eurosiberian (European Atlantic province) area and the Baetic province. It occupies a large part of the Hesperian Shield outcrop, dominated by Paleozoic siliceous materials (granite, quartzite, slate, gneiss). In the Iberian West the climatic regime is pluviseasonal Mediterranean, in which the summer drought is emphasized by the nearness of the Azores High, which has a tendency to stabilize on the western side of the Iberian Peninsula during the summer. Spring precipitations are more important and certain than those of autumm, making a clear difference with the east of the Peninsula.

The Iberoatlantic flora and vegetation have a marked originality, especially concerning its forests, shrublands, scrub and grasslands. The main forest species are *Quercus rotundifolia*, *Q. suber*, *Q. broteroi* (*Quercion broteroi*) and *Q. pyrenaica* (*Quercenion pyrenaicae*). These forests are often cleared by man and its understorey transformed into grassland for pasture for sheep or cows; they are transformed in the well known “dehesas” of high naturalistic value. Forest mantle communities formed mainly by shruby aphyllous *Fabaceae* (brooms) are one of the most genuine vegetation types of the western part of the Iberian Peninsula and are grouped into the class *Cytisetea scopario-striati*. The most frequent species belong to the genera *Cytisus* (*C. scoparius*, , *C. grandiflorus, C. multiflorus*, *C. striatus*), *Adenocarpus* (*A. complicatus*, *A. hispanicus, A. telonensis*), *Genista* (*G. florida*, *G. cinerascens*) and *Retama* (*R. sphaerocarpa*). The substitution stages corresponding to a more advanced degradation of the soil, are formed by *Cistus*-scrub of the class *Cisto-Lavanduletea*, with many *Halimium* and *Cistus* species as well as some *Lavandula* of the *stoechas* group. In exceptionally rainy areas, usually in mountains, the scrub is usually a heathland of *Calluno-Ulicetea* (*Ericion umbellatae*). Grassland vegetation is abundant and diverse in the Iberoatlantic province in accordance with the pastoral vocation of the territory; among the most important pasture types there are the *Poa bulbosa* communities, linked to the traditional transhumant sheep husbandry.

The Iberoatlantic province is divided into three subprovinces: Iberian-Sorian, Carpetan-Leonesian and Luso-Extremadurensian.

IBERIAN-SORIAN SUBPROVINCE

It is a relatively small territory enclosing a couple of siliceous mountain ranges in the northern part of the Iberian System; they are the Demanda and Neila-Urbión-Cebollera ranges, the Tierra de Cameros and the Moncayo massif. This subprovince occupies a particular position in the Peninsula due to its wedge-like shape which advances eastwards separating the Ebro valley and the Castilian Meseta, not far from the eastern Cantabrian area; such a location determines a particular assembley of influences affecting it (Loidi et al. 1997, Navarro 1989).

The supramediterranean area (the mesomediterranean thermotype is lacking) is dominated by the *Quercus pyrenaica* forests (*Quercenion pyrenaicae*) although in the upper levels of this belt, due to the increase in rainfall, *Fagus sylvatica* forests are also relevant

(*Fagion*, *Ilici-Fagion*). Forest mantle broom communities belong to the *Genistion polygaliphyllae* and the seral scrub are mainly heathlands formed by *Erica australis* subsp. *aragonensis* (*Ericion umbellatae*). In the upper levels of the mountains the increase in rainfall leads to an amelioration of the summer drought conditions and thus a temperate climate-type (in its submediterranean variant) can be found. Then, above 1,700 m the orotemperate (subalpine) and criorotemperate (alpine) thermotypes are found. The potential natural vegetation of the first is shrubland, with or without pines, belonging to the alliance *Cytision oromediterranei* with *Juniperus alpina*, *Vaccinium myrtillus*, *Calluna vulgaris* and *Pinus sylvestris* var. *iberica*. The criorotemperate belt (or thermotype) has grasslands of *Minuartio-Festucion curvifoliae*. *Nardus stricta* hygro-chionophilous grasslands belong to *Campanulo-Nardion*.

CARPETAN-LEONESIAN SUBPROVINCE

It is a vast territory which embraces several parts of the western upper Meseta including some of its mountainous areas. It is limited in the north by the Orocantabrian subprovince, and includes areas like the Páramo Leonés, Bierzo and Maragatería. In the west the border is with the Galaico-Portugués sector and includes the Lusitanian regions of Alto Douro and part of the Beira. The southern limits with the Luso-Extremadurensian subprovince are outlined in the piedmonts of the Central Range, embracing its formidable massifs. The eastern border with the Iberolevaltine province draws a wavy line which crosses the plains of the northern Meseta, dividing it into two halves.

Is an area of high altitude, covering a great part of the northern Meseta (with the exception of some districts in the lower Duero valley) including part of its most important surrounding siliceous mountain ranges. The most spread out thermotype is the supramediterranean, the mesomediterranean is restricted to the Bierzo and the lower Duero area. In the mountains, at higher altitudes are found the orotemperate (subalpine) and criorotemperate (alpine) thermotypes, similar to the Iberian-Sorian mountains. Due to its inner position, precipitations are less abundant than in the previously commented subprovince and the dry ombrotype is relatively spread out.

In the lowlands and the Meseta plains (meso and supramediterranean belts or thermotypes), the territory is shared by the vegetation series of *Quercus rotundifolia* (*Quercion broteroi*) and *Q. pyrenaica* (*Quercenion pyrenaicae*) forests; only on some north-facing rainy slopes of some mountains, are found *Fagus sylvatica* and *Betula pubescens* subsp. *celtiberica* forests (*Ilici-Fagion*). Broom forest-mantle communities belonging to the *Genistion floridae* and *Genistion polygaliphyllae* alliances and the seral scrub are formed by *Cistion laurifolii* communities in the driest areas or by heathlands of *Ericion umbellatae* in the rainier ones (mountains). The orotemperate (subalpine) belt is covered by the shrubland of *Cytision oromediterranei*, and in some massifs by *Pinus sylvestris* var. *iberica*. The criorotemperate (alpine) belt can be found only in the highest summital stretches (Gredos, Guadarrama) and the grasslands of the *Minuartio-Festucion curvifoliae* communities are the potential natural vegetation (Rivas-Martínez 1963, 1981; Ladero et al. 1987; Fernández-González 1991, Sánchez Mata 1989, Llamas 1984).

The Carpetan-Leonesian subprovince is divided into 7 sectors: Leonés, Orensano-Sanabriense, Lusitano-Duriense, Salmantino, Estrellense, Bejarano-Gredense and Guadarrámico.

LUSO-EXTREMADURENSIAN SUBPROVINCE

It is a vast territory occupying most of the southwestern quadrant of the Peninsula, which corresponds, in a great extent, to the lower basins of the Tagus and Guadiana rivers. It comprises central and southern Portugal (Beira Baixa, Estremadura, Ribatejo, both Alentejos and the inner Algarve), Spanish Extremadura and the mountains of the Oretan (Montes de Toledo) and Marianic (Sierra Morena) systems. It spreads out between the southern piedmonts of the Central Range in the north and the Guadalquivir valley including all the Sierra Morena in the south; in the east it penetrates deeply into the southern Meseta (La Mancha) and contacts the Subbetic ranges in the neighbourhood of the Alcaraz range. It has some abrupt areas but the altitudes of the summits are modest; the supramediterranean thermotype can scarcely be found in the most relevant mountains. On the other hand, the thermo and especially the mesomediterranean thermotypes occupy almost all of the territory. Summer drought is very marked in the southwestern quadrant of the Peninsula and this favours the sclerophylle evergreen Mediterranean vegetation and is unfavourable for the temperate-adapted deciduous broad-leaved summergreen forests. For that reason, the latter are restricted in this subprovince to some summital colder (supramediterranean) and moister plots in the higher mountains (*Quercenion pyrenaicae*) or to the river banks (*Populion*, *Osmundo-Alnion*).

Quercus rotundifolia, *Q. suber* and *Q. broteroi* (*Quercion broteroi*) constitute the forests corresponding to the mature stages of the climatophilous vegetation series in the termo and mesomediterranean areas. The forest-mantle communities are quite diverse: in the dry areas they are brooms belonging to the *Retamion sphaerocarpae*; in the moister territories madrone-arboreal heath formations occur (*Ericion arboreae*) and on base-rich substrates kermes-oak (*Quercus coccifera*) shrublands (*Asparago albi-Rhamnion oleoidis*) appear. Seral scrub are almost exclusively represented by "jarales" of *Ulici argentei-Cistion ladaniferi* with the exception of the rainiest plots where heathlands of *Ericion umbellatae* substitute them (Rivas Goday 1964, Ladero 1987, Rivas-Martínez et al. 1990).

In this Luso-Extremadurensian territory the largest extent of forested pastures called "dehesa" in Spain and "montado" in Portugal, are conserved. They consists in the combination of scattered trees, as remains of the natural forest, commonly *Quercus rotundifolia* or *Q. suber*, and the pastures covering the surface, mostly of *Poetea bulbosae* in the normal soils but also of *Molinio-Arrhenatheretea* in the wet places. It forms a landscape of high naturalistic and aesthetic value which is a sustainable combined exploitation model of a Mediterranean ecosystem; products from the husbandry (sheep, cattle, pigs or horses) are complemented with products from the exploitation of the trees (fuelwood, charcoal, cork).

Some autoctonous animal races of great value also come from these dehesas, such as the Iberian Pig, the Merino Sheep or the bulls for bullfighting.

The Luso-Extremadurensian subprovince is divided into three sectors:Beirense litoral Divisorio Portugués, Toledano-Tagano and Mariánico-Monchiquense.

MEDITERRANEAN -IBEROLEVANTINE PROVINCE

More or less symmetrical to the Iberoatlantic, this province comprises the Iberian central-eastern territories where substrates are predominantly base rich: marl, gypsum and limestone. It includes the Ebro, Duero and Tagus basins, the mountain ranges and high plateaux of the southern half of the Iberian System with the Júcar and Turia valleys and the Levantine coastal areas. The climatic conditions in this territory are quite different from those of the western half of the Peninsula due to the remoteness of the Atlantic ocean and the proximity of the Mediterranean sea. This determines a lower influence of the Azores High, especially during the summer, and a consequently less marked summer drought. The withdrawal from the Atlantic coast is also associated with an increase of the continentality, which reaches its maximum values in the high plateaux and mountains of the southern Iberian System and in eastern La Mancha as well as in the inner depressions such as in the Ebro basin.

Its flora and vegetation is very different from the Iberoatlantic due to climatic and edaphic conditions. In the Levantine territories, especially in Catalonia and Balearic Islands, the Italian-Thyrrenian influence is noticeable and is indicated by the occurrence of *Quercus ilex* forests (*Quercenion ilicis*), the maquis of *Oleo-Ceratonion* and the scrub of *Rosmarinion* (brolla). This influence vanishes quickly towards the inland areas as the altitude and continentality increase; the aforementioned vegetation is substituted by the *Quercenion rotundifoliae*, *Aceri-Quercion fagineae* and *Juniperion thuriferae* forests and the *Sideritido-Salvion* scrub ("tomillares"). The oromediterranean and orotemperate belts are found in some of the Iberian System mountains like Gúdar, Javalambre and Montes Universales, the *Pino-Juniperion sabinae* communities represent the potential natural vegetation at this level. An important part of the forest-mantle communities belong to the *Pistacio lentisci-Rhametalia alaterni*, mostly in the thermo and mesomediterranean areas. The basophilous scrub vegetation, comprised in the class *Rosmarinetea*, is diversified in a huge amount of associations, many of them endemic-rich, with a high biogeographic and bioclimatic indicator value.

There are four subprovinces in this Iberolevantine province: Valencian-Catalonian-Provençal, Aragonian, Castilian-Maestrazgo-Mancheguian and Balearic.

VALENCIAN-CATALONIAN-PROVENÇAL SUBPROVINCE

The long coastal fringe which spreads out from the southern part of the Valencian region to Provençe, including the coastal areas of Catalonia and Languedoc, constitute this unit. The maritime influence on the climate, moderating the extreme temperatures, especially the winter minimals, is the outstanding feature of the climate of this territory. The thermomediterranean thermotype, indicated by the occurence of the "palmito" (*Chamaerops humilis*), occupies the lower altitude areas of the Valencian area, in a fringe which embraces the alluvial coastal plains and the lower piedmonts of the mountains; as it progresses farther northwards, the thermomediterranean strip becomes narrower until a point near Barcelona, where it virtually vanishes remaining a tight strip close to the coast, often interrupted, which becomes somewhat more conspicuous in the capes, such as Creus Cape. The mesomediterranean thermotype occupies most of the area in the Catalonian stretch but in the Valencian one is restricted to the interior mountainous band. The supramediterranean belt is only found in some of the summital areas of the coastal Catalan Ranges. Limestone and marl, as well as some areas with recent clay deposits, are the most frequent substrata. However there are two areas of significant size in which base poor rocks predominate: red sandstone (rodenos) in the Serra d'Espadà (Valencia) and granite and schist in the Selva and Empordá areas (Catalonia).

The thermo and mesomediterranean zones are occupied by *Quercus rotundifolia* and *Q. ilex* forests (*Quercion ilicis*) and they are accompanied by a maquis of *Q. coccifera* and *Pistacia lentiscus* (*Oleo-Ceratonion*): the base-poor areas are covered by *Q. suber* forests. The seral stage on base-rich substrata is a dense and tall scrub called "brolla", in which *Ulex parviflorus*, *Erica multiflora*, *Anthyllis cytisoides*, *Rosmarinus officinalis*, etc. participate. These scrub communities are grouped into the *Rosmarinion* alliance. In the siliceous areas the scrub is a "jaral" of *Cistion ladaniferi* (Folch 1986, Bolòs 1967, 1987, Costa 1987).

The Valencian-Catalonian-Provençal subprovince is divided into the following sectors in its Iberian part: Setabense, Valenciano-Tarraconense and Vallesano-Empordanés.

ARAGONIAN SUBPROVINCE

It is a triangle-shaped area which basically embraces the Ebro basin territory, mostly formed by base-rich materials of the Tertiary or Quaternary periods: limestone, marl and gypsum. The northern border is with the European Atlantic province in the western stretch and with the Pyrenean-Cevennensian in the central and eastern one. At the east, the Catalonian Coastal ranges marks the limit with the Valencian-Catalonian-Provençal subprovince and in the south, the Iberian System marks the limit with the central Meseta. Most of the territory of this Aragonian subprovince is under mesomediterranean thermotype, i.e. from La Rioja to the Segriá and Bajo Aragón; only some areas in the Pyrenean transition (Somontano and inner Catalonia) together with northern Burgos and parts of Álava, are in the supramediterranean thermotype. The central part of the depression experiences a substantial increase in the aridity and the continentality provoked by the enclosure of the three mountain ranges which conceal the Ebro basin. Due to this circumstance, the climatic peculiarity of this subprovince is concentrated in the Ebro basin in the strict sense, i.e. the area formed by the plains of the depression occupying its central part, where the xeric-Mediterranean (oceanic and continental) as well as the pluviseasonal-Mediterranean (continental and oceanic-steppic) climatic types are found. In this central part of the basin, together with the other base-rich lithologic materials, there are also extensive deposits of evaporitic rocks rich in gypsum. They occur associated with endorrheic or poorly drained cuvettes where saline concentration increases considerably in the upper horizons of the soil (saladares or salitrales). Those climatic and lithologic peculiarities, in addition to the extensive river bank network associated to the Ebro fluvial system, makes this central part of the basin the most genuine area of the Aragonian subprovince.

With the exception of the area under xeric-Mediterranean climatic type, the natural forest vegetation in meso and supramediterranean areas is a *Quercus rotundifolia* forest (*Quercenion rotundifoliae*). In the inner part of the depression, under more severe xeric conditions, the Potential Natural Vegetation is a shrubland with *Quercus coccifera*, *Juniperus phoenicea*, *Pinus halepensis*, *Rhamnus lycioides*, etc. (*Rhamno-Quercion cocciferae*); but in the areas where continentality increases over It > 21, juniper woodlands of *Juniperion thuriferae* occur. Scrub is quite diverse in the Aragonian subprovince. On calcareous substrata (limestone, marl), in the humid-subhumid areas of its northwestern corner they correspond to *Genistion occidentalis*, in the transition to the Pyrenees and in inner Catalonia, to *Helianthemo italici-Aphyllanthion*, in the transitional fringe with the Meseta, in La Rioja and southern Navarre, to *Sideritido-Salvion lavandulifoliae*, and in the central part of the depression to *Rosmarinion officinalis*. For gypsaceous substrata there are specific units of a strongly endemic character included in *Gypsophilenion hispanicae* (*Gypsophyletalia*). The salt marshes frequent in the cuvettes and small endorrheic depressions are covered by specialized vegetation of *Suaedion braun-blanquetii* (Braun-Blanquet & Bolòs 1958, Rivas-Martínez, Báscones et al. 1991, Loidi & Báscones 1995, Molina et al. 1993).

The Aragonian subprovince is divided into four sectors: Castellano-Cantábrico, Somontano-Aragonés, Riojano-Estellés and Bardenas-Monegros.

CASTILIAN-MAESTRACEAN-MANCHEGAN SUBPROVINCE

It is the great Mesetan unit of the Iberolevantine province, and comprises the marl areas of the Duero depression, La Mancha (upper Tagus and Guadiana basins) and the high plateaux and mountain ranges of the central and southern Iberian System. Its condition of interior territory and its high mean altitude determines a substantial climatic continentalization, which is maximal at the high areas of the main Iberian massifs and in southwestern La Mancha; thermotypes are meso (La Mancha), supra and oromediterranean (mountain summits). Summer precipitations increase locally in the northern Maestrazgo area, originating a temperate submediterranean bioclimate for that restricted territory. Substrata are base-rich, mostly limestone and marl, but there are also sandy materials frequent in some areas, all of them of Secondary and Tertiary ages.

The potential natural vegetation in the meso and supramediterranean levels is dominated by the *Quercus rotundifolia* (*Quercenion rotundifoliae*) and *Quercus faginea* (*Aceri-Quercion fagineae*) forests. Forest mantle vegetation is to a great extent represented by *Rosenion carioti-pouzinii* and *Berberidenion seroi* hedges and the seral basophile scrub is grouped in *Sideritido incanae-Salvion lavandulifoliae*. In La Mancha the gypsicolous scrub of *Lepidienion subulatii*, the esparto fields of *Stipion tenacissimae* and the interior salt-marsh communities of *Suaedion braun-blanquetii* are also important (Rivas Goday & Borja 1961, Rivas Goday & Rivas-Martínez 1968, Peinado & Martínez Parras 1987, Navarro Andrés & Valle Gutiérrez 1987)

The Castilian-Maestracean-Manchegan subprovince has four sectors: Castellano-Duriense, Celtibérico-Alcarreño, Maestracense and Manchego.

MURCIAN-ALMERIAN PROVINCE

The southeastern façade of the Peninsula is a particularly original territory from the floristic, vegetational and climatic point of view and therefore, despite its relatively small size, merits the biogeographical rank of province. It embraces the lands near to the Mediterranean sea between the southern slopes of the Dianic ranges, in the area surrounding Benidorm, and the Baetic massifs of Sierra de Gádor and the Alpujarras, including the southern areas of Alicante, Murcia and Almeria. The amplitude of this fringe is variable, reaching its maximal depth in the Segura valley.

One of the the most remarkable features of this province is its climate, classified in the Mediterranean xeric type with a broad representation of the thermomediterranean thermotype; the mesomediterranean is restricted to an interior belt. This climatic aridity is a result of its sheltered position in the southeastern extreme of the Peninsula, which submits this region to a severe rain shadow in relation to the most important precipitation sources from the Atlantic and the northern Mediterranean sea. Substrata are extremely variable: limestone, marl, gypsum, volcanic rocks, etc, with a clear dominance of the base-rich materials.

The flora of this province, though essentially Mediterranean (46·9 % of the taxa), is very original, with a high percentage of endemic taxa restricted to its limits (4·18 %) and a high proportion of Iberian endemics (9·63 %); to this is added 4·88 % of taxa of the Iberian-North African distribution area. Opposed to these figures indicating endemicity, mediterraneity and relationships with North Africa, we can indicate a 1·59 % of Mediterranean-Atlantic species (Alcaraz 1984).

The potential natural vegetation, due to the extremely arid conditions, are not true forests but shrublands of *Pistacio-Rhamnetalia alaterni*, mostly of the alliances *Rhamno-Quercion cocciferae*, *Asparago-Rhamnion oleoidis* and *Periplocion angustifoliae*; this last alliance, restricted to the thermomediterranean belt, is endemic of this province. The scrub of this territory, mostly called "tomillares", is open-structured and low-sized but extremely diverse and endemic rich. The numerous associations are grouped in the *Anthyllidetalia terniflorae* order, except the gypsaceous areas where the *Gypsophyletalia* order has an endemic alliance, *Thymo-Teucrion verticillati*. Esparto fields of *Stipion tenacissimae* are also important elements in the Murcian-Almerian vegetation. The landscape of this province is quite impressive because of the degradation and erosion observed everywhere as a result of the long human pressure throughout history combined with a weak recovery capability of the aridity-adapted natural vegetation (Esteve 1973, Rigual 1972, Alcaraz 1984, Alcaraz et al. 1989, Alcaraz et al. 1991, Peinado et al. 1992).

The Murcian-Almerian province is divided into three sectors: Murciano Alicantino and Almeriense.

THE BAETIC PROVINCE

This province comprises the lands of the South of the Iberian Peninsula belonging to the complex system of mountain ranges, valleys and depressions associated to the Baetic system plus the coastal areas of the southwestern quadrant. All these territories present a high originality in their flora and vegetation with a remarkable relationship with the North-African area.

THE BAETIC SUBPROVINCE

The northern limit of this subprovince draws a long straight line along the contact of the Hesperian Shield (Sierra Morena) and the Guadalquivir basin, separating it from the Lusitanian-Extremadurensian subprovince (Iberoatlantic province). The Alcaraz and Cazorla-Segura massifs mark the eastern limits with the Manchegan Meseta and those of Gádor, María and Espuña with the Murcian-Almerian province. The western border is marked by the contact between the vertisols and the sandy substrata of the alluvial plains of the Guadalquivir mouth and between the Rondeño limestone and dolomitic rocks and the sandstone of the Aljibe area. Such limits conceal a territory comprising most of the Guadalquivir valley and its left hand tributaries (Genil) plus most of the complex of mountain ranges and tectonic depressions which constitute the Baetic system; the right hand tributaries of the Guadalquivir river flow through Sierra Morena, an area belonging to the Lusitanian-Extremadurian subprovince. The huge differences in altitude, often registered in short distances, e.g. the sea-level on the Costa del Sol and the highest summits in Sierra Nevada, give the opportunity to develop a long thermic gradient, from the thermo to the crioromediterranean thermotypes; the ombrotypes are also very diverse, from the semiarid to the hyperhumid. Substrata, as a result of the geologic complexity, are extremely varied with marl, gypsum, limestone, dolomite, peridotite, quartzite, schist, etc.; base-rich materials are dominant.

As a result of such diverse conditions, the richness and originality of the Baetic flora and vegetation is also very high, there are over 300 endemic species (Rivas-Martínez, Asensi et al. 1991). The potential natural vegetation in the thermomediterranean areas is formed by *Quercus rotundifolia* and *Olea europaea* var. *sylvestris* forests (*Oleo-Quercion rotundifoliae*) and in the meso and supramediterranean belts by *Quercus rotundifolia* (*Quercenion rotundifoliae*); *Quercus faginea* (*Aceri granatensis-Quercion fagineae*) occupies some rainy areas in the mountains. In some humid-hyperhumid areas of the Serranía de Ronda, *Abies pinsapo* forests (*Paeonio-Abietion pinsapo*) occur and in the supramediterranean siliceous areas of Sierra Nevada, *Quercus pyrenaica* woodlands (*Quercenion pyrenaicae*) are also present. The Baetic oromediterranean is populated by two units: *Pino ibericae-Juniperion sabinae* on base-rich substrata and *Genisto versicoloris-Juniperion hemisphaericae* on base-poor (Sierra Nevada and Filabres).

The forest-mantle mostly corresponds to a maquis of *Asparago albi-Rhamnion oleoidis* in the lowlands and to *Lonicero-Berberidion hispanicae* hedges in the upper levels (supra and oro). Scrub are grouped into several units though most of them belong to the *Rosmarinetea officinalis* class: the thermo and mesomediterranean are included in *Eryngio-Ulicion erinacei*, the supramediterranean in *Lavandulo lanatae-Echinospartion boissieri* and the oromediterranean in *Xeroacantho-Erinaceion*. *Lepidion subulatii* communities develop on gypsaceous soils, the peculiar dolomiticolous *Andryalion aghardii* vegetation live on dolomite stony slopes (screes, etc.) and the *Staehelino-Ulicion baetici* (*Cisto-Lavanduletea*) heavy metal adapted communities on serpentinic substrata.

The summits of the Sierra Nevada reach altitudes sufficiently high to develop the crioromediterranean thermotype, where *Ptilotrichon purpurei* communities are the climatic zonal vegetation. The characteristic Nevadense oro crioromediterranean vegetation complex includes a number of communities which occupy the usual habitats of the high mountains, e.g. humid *Nardus stricta* grasslands (borreguiles) belonging to *Plantaginion thalackeri*, the scree communities of Holcion caespitosi, etc. (Asensi & Díez Garretas 1987, Martínez Parras & Peinado Lorca 1987, Rivas-Martínez et al. 1997, Pérez Raya et al. 1990, Molero Mesa & Pérez Raya 1987, Quézel 1953).

The Baetic subprovince is divided into seven sectors: Hispalense, Rondeño, Malacitano-Almijarense, Subbético, Guadiciano-Bacense, Nevadense and Alpujarreño-Gadorense.

THE GADITAN-ONUBIAN-ALGARVIAN SUBPROVINCE

It is a eminently coastal unit which forms a long strip of land about 700 Km long spread out from the surroundings of Fuengirola, on the Costa del Sol, to the Troia peninsula, in the Sado mouth, south of the city of Setúbal. It comprises the mountains of the Campo de Gibraltar, the sandy plains of the lower Guadalquivir and Huelva, the coastal fringe of the Algarve and continues northwards along the Vicentinian coast until the sandy deposits of the Sado. Substrata are mostly base-poor and formed by sand or sandstone. Only in the Algarve are there relevant limestone outcrops (barrocal). Most of the area is thermomediterranean, only in the Aljibic mountains upper levels the mesomediterranean is found, and precipitations are abundant but present a marked Mediterranean seasonal distribution pattern.

The potential natural vegetation is mostly formed by cork-oak forests (*Quercus suber*); only in the Algarvian "barrocal" does *Quercus rotundifolia* dominate. The scrub is a characteristic *Cistus* and *Halimium* species rich (*Coremion albi*) called "jaguarzal". One of the most relevant features of the vegetation of this coastal area is the abundance and diversity of the sand dune vegetation complexes, with some relevant places like Doñana or Troia. Together with the *Ammophiletea* vegetation, the *Juniperion turbinatae* communities are well represented. Salt-marsh complexes also find important places where they can develop, mostly in southern Portugal (Rivas-Martínez et al 1980, 1990).

The Gaditan-Onubian-Algarvian subprovince has four sectors,Gaditano Onubense, Algarviense and Ribatagano-Sadense.

VALENCIA-JAVALAMBRE-VALENCIA (10 July)

(Geobotanical excursion from Valencia to the Javalambre summit)

MANUEL COSTA TALENS & PILAR SORIANO GUARINOS

With this day's itinerary starts the Iter Ibericum MIM. In it we will try to show a diverse Mediterranean territory, from sea level to 2,000 m altitude in a stretch of 150 Km. This will mean that we are going to pass from the thermomediterranean to the oromediterranean thermotype and will study different vegetation series, climatophilous and edaphophilous. Also during the journey attention will be paid to the land use and to cultural and historic aspects.

INTRODUCTION

Valencia is the third city of Spain, with a metropolitan area inhabited by ca. 1,000,000 people. Although its Iberic origin is not clear, the Roman foundation of *Valentia* in the year 138 BC meant the consolidation of the *Via Augusta* as it could be established near the coastline. This provoked the decline of another important Roman city, *Saguntum*, specially after the IV century. The city was built on an alluvial terraced platform formed by the Turia (or Guadalaviar) river. In the year 718 it was occupied by the moslems and conserves remains from that period. It returned to Christian hands in 1238 and in 1356, the king Peter the Ceremonious began the enlargement and urban modernization of the city. He enlarged the walled part of the city; walls which persisted until 1863, the year in which they were demolished. The prosperity of Valencia as an important European city was already noteworthy by 1483; at that time its population reached 75,000 inhabitants thanks to its intense trade activity, similar to an "hanseatic" city. The outstanding falmigerous-gothic style bulding of the Silk Market indicated the economic importance of the city at that time. In the second half of the XIX century it experienced a clear decadence due to the decline of the silk trade. Nowadays, the city of Valencia, limited to the east by the sea, expands northwards and westwards absorbing old fertile arable land (the Huerta) of great historical and agricultural importance.

VALENCIA-BARRACAS STRETCH

1- Valencia-Sagunto: We leave the city of Valencia from its northern side and follow the road towards Barcelona, parallel to the sea, for about 20 Km till the city of Sagunto (*Saguntum*). In this first part of the journay, the road runs close to the sea, which is on the right hand side. On the left lie the Quaternary sediments on which an intense agricultural activity has taken place since Atiquity, generating great richness. The crops cultivated in this area, known as "L'Horta Nord", are divided between the herbaceous crops and the citrics, all of them irrigated by an old network of originally Roman and Moslem period channels. The herbaceous crops concentrate mainly on seasonal products: tomato, pepper, aubergine, artichoke, melon, watermelon, etc. produced in two or three harvests every year.

The potential natural vegetation has very few remains in the area. Inland, on sediments with the water table near the surface, it corresponds to elm forests, nowadays disappeared and replaced by agricultural land. Near the sea, the old dune-systems and marshes have been destroyed by urban areas or by the road itself. However, some remains of the old potential vegetation can still be seen in places of particular interest such as El Morro del Puig marsh, with good examples of *Phragmito-Magnocaricetea, Salicornietea fruticosae, Thero-Suaedetea,* etc. vegetation.

On the left side of the road going inland, the monastery of Puig is observed as well as the group of mountains belonging to the Sierra del Garbí and Sierra Calderona. Those mountain ranges are interesting because they are formed by Bundsandstein sandstone and the potential natural vegetation corresponds to alcornocales (cork oak forests) of the Asplenio onopteridis-Querco suberis sigmetum. The alconnocales are mixed with pine-*Cistus* woods of *Pinus pinaster* (*Cisto-Pinetum pinastri*) and heathlands of *Cytiso villosi-Ericetum arboreae*.

2- Sagunto-Barracas: After 20 Km, approaching Sagunto, the ancient Roman *Saguntum*, we leave the national road to Barcelona (motorway A-7) and take the N-234 in a NW direction. To the left of the road a huge castle is seen whose origin goes back to 1248 when the village was converted to christianity. The castle, of great proportions, is a strategic ridge 172 m high surrounded by a wall 750 m long, protecting the town which is placed on the northern slope.

The N-234 road follows the Palancia river valley and represents the ancient comunication way between Valencia and Aragón. The road climbs gently till the Ragudo, or Herragudo, pass. The lower stretch of the Palancia river valley is in the thermomediterranean thermotype and its landscape is eminently agricultural: citrics dominate the bottom of the valley and the slopes are devoted to secano crops such as olive trees (*Olea europaea*), almonds (*Prunus amygdalus*) and carob trees (*Ceratonia siliqua*). Some fruit trees, mostly medlars (*Eryobotrya japonica*), are also grown. Outside the Quaternary sediments, the vegetation series corresponds to *Rubio longifoliae-Querco rotundifoliae* sigmetum.

In the thermomediterranean level, in occasionally flooded areas near the drainage channels and rivers, on pebble river beds the adelfares (*Nerium oleander* shrublands) develop bearing plants like *Rubus ulmifolius, Foeniculum vulgare* subsp. *piperitum*, *Scirpus holoschoenus, Equisetum ramosissimum, Arundo donax,* etc. and constituting the association *Rubo ulmifolii-Nerietum oleandri.* Those adelfares occupy the drier biotopes on the river beds but when moisture is conserved in the soil longer, especially in summer, then other plants such as *Coriaria myrtifolia*, *Myrtus communis* and even *Salix eleagnos* appear. On the edges and banks bordering the roads cane formations of Arudo donax share the space with nitrophilous communities of *Asphodelo fistulosi-Hordeetum leporini* (*Stellarietea mediae*), together with *Andropogonetum hirto-pubescentis* (*Thero-Brachypodietea*). Those communities at the edge of the road will accompany us along all the thermomediterranenan although the construction of motorways has provoked its extinction in many stretches.

Segorbe is the most important town in the whole valley, episcopal see and commercial center. It is an historical town with outstanding monuments such as the cathedral and the castle, together with a number of aristocratic houses and palaces. After Segorbe, which is surrounded by huertas or irrigated crop fields, the road climbs gaining altitude. In the Viver-Barrcas stretch the slope steepens covering an important altitudinal gap which constitutes the Ragudo pass. After this slope we enter the Barracas plain, in the supramediterranean thermotype, which lies at about 900 to 1000 m altitude. Mudejar-style towers, which are so frequent in the Teruel area, appear in the villages.

The Ragudo or Herragudo pass (stop 1) represents an important biogeographical limit because it crosses the limit between the Valenciano-Tarraconense sector (with the *Rubio longifoliae-Querco rotundifolia* sigmetum) to the Maestracense sector (which bears the *Hedero helicis-Querco rotundifoliae* sigmetum). In the latter can appear some Quercus faginea individuals representing an advance of the deciduous summergreen forests of *Violo-Quercetum fagineae*, which occupy deep base rich soils in the Iberolevantine supramediterranean. The landscape is dominated by carrascales (*Quercus rotundifolia* forests), coscojares (*Q. coccifera* shrublands) and, on the north-facing lopes and valley bottoms, quejigares (*Q. faginea* forests).

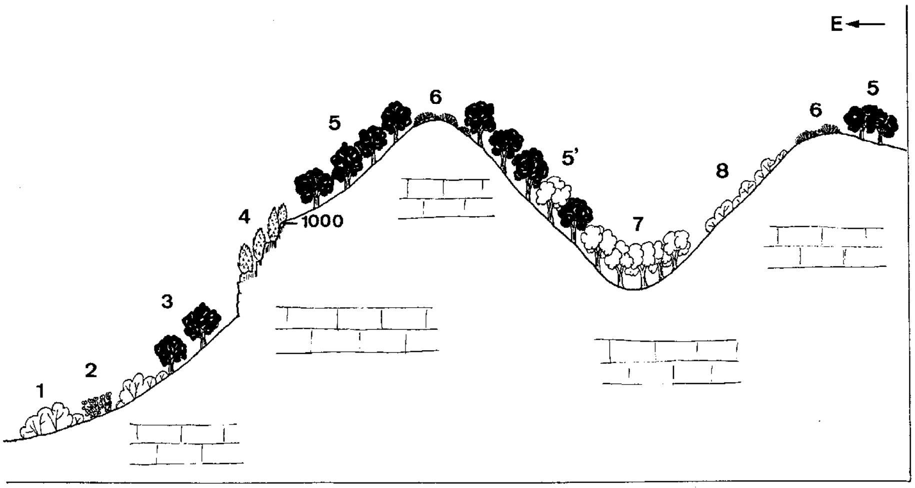
3- Ragudo pass-Sarrión-Puebla de Valverde: Once we cross the Ragudo pass, we enter the so called rasa de Barracas", a high plateau at an average of 950 m altitude, and which brings a complete change in the landscape. The agriculture becomes towards cereals and sheep and pigs are bred, the latter mostly on farms. The climate becomes more continental although the oceanic influence of the Mediterranean sea reaches the Ragudo pass, and even Barracas, bringing humid winds which originate frequent fogs; this causes the appeareance in those places, of many plants of the coastal areas such as *Ulex parviflorus*.

Bioclimatically this area is in the supramediterranean thermotype and in the dry ombrotype, while biogeographically the Valenciano-Tarraconense sector is abandoned and we enter the Maestracense (Castilian-Maestracean-Manchegan subprovince). The increasing abundance of Quercus faginea as well as the pulvinate scrub of the *Sideritido-Salvion* alliance, bearing the attractive *Erinacea anthyllis*, indicate this change. But the most outstanding feature of this landscape are the populations of the splendid white juniper (*Juniperus thurifera*) which markedly characterises it. This juniper usually lives in this area associated to the *carrasca,* forming the *Junipero thuriferae-Quercetum rotundifoliae*, which is the potential natural vegetation on which the scrub of *Genisto hispanicae-Erinaceetum anthyllidis* develops. On deep soils the occurrence of *Genista cinerea* subsp. *ausetana* stands out.

The landscape of this stretch presents a striking originality and hardness it is worth noting the remains of the natural vegetation on the borders limiting the cereal fields and the plots devoted to forage crops of *esparceta* (*Onobrichys viciifolia*). Recently crops of carrasca are being developed in order to harvest the truffles which grow associated to this tree; this is becoming one of the economic resource of the supramediterranean Iberolevantine area.

PICTURE 1

Locality: Ragudo Pass
Altitude: 1.000 m
Biogeography: Maestracense sector, Castilian-Maestracean-Manchegan subprovince.
Thermotype: Supramediterranean
Ombrotype: Dry
Lithology: Jurassic limestone



1. *Querco cocciferae-Pistacietum lentisci*
2. *Helianthemo glabrati-Globularietum alypii*
3. *Ruhio longifoliae-Quercetum rotundifoliae*
4. *Rhamno lycioidis-.Juniperetum phoeniciae*
5. *Hedero helicis-Quercetum rotundifoliae*

Characteristics of association and alliance: *Quercus rotundifolia* V, *Hedera helix* V, *Viola reichenbachiana* V, *Viola odorata* IV, *Lonicera etrusca* III, *Cruciata glabra* III, *Hieracium praecox* III, *Helleborus foetidus* III, *Epipactis helleborine* II, *Cephalanthera rubra* II; Differentials of subassociation and variants: *Quercus coccifera* II, *Ulex parviflorus* I, *Quercus* x *ambigua* I, *Phillyrea media* I, *Viola willkommii* II, *Quercus faginea* II, *Acer opalus* I, *Juniperus thurifera* I; Characteristics of order and class: *Rubia peregrina* V, *Teucrium pinnatifidum* V, *Juniperus oxycedrus* V, *Juniperus phoenicea* III, *Rhamnus alaternus* II, *Cytisus patens* II, *Colutea arborescens* I, *Asparagus acutifolius* I; Companions: *Brachypodium retusum* V, *Genista hispanica* V, *Carex halleriana* V, *Silene mellifera* V, *Prunus spinosa* IV, *Amelanchier* ovalis III, *Brachypodium phoenicoides* II, *Thalictrum tuberosum* II, *Euphorbia nicaeensis* I, *Galium maritimum* III, *Helianthemum marifolium* III. (Costa, Peris & Stübing 1987, tab. 1, 13 relevés.)

5'. *Hedero helicis-Quercetum rotundifoliae* variant of *Quercus faginea*

6. *Genisto hispanicae-Erinacetum anthyllidis*

Characteristics of association and alliance: *Genista hispanica* V, *Erinacea anthyllis* IV, *Thalictrum tuberosum* III, *Aphyllanthes monspeliensis* III, *Teucrium expansum* III, *Helianthemum apenninum* III, *Erysimum grandiflorum* II, *Globularia vulgaris* II, *Fumana procumbens* II, *Satureja montana* II, *Catananche coerulea* II, *Euphorbia mariolensis* II, *Thymelaea thesioides* II, *Inula montana* II, *Crepis albida* II, *Lotus villosus* II, *Potentilla tabernaemontani* I, *Salvia lavandulifolia* I, *Potentilla cinerea* I, *Digitalis obscura* I, *Odontites viscosa* I, *Iris lutescens* I. Diferenttials: *Arctostaphyllos uva-ursi* I. Characteristics of order and class: *Thymus vulgaris V, Lavandula latifolia* I*V, Euphorbia nicaeensis* IV, *Genista scorpius* III, *Biscutella valentina* III, *Leuzea conifera* III, *Linum narbonense* III, *Staehelina dubia* II, *Helianthemum glabratum* II, *Hippocrepis glauca* II, *Helianthemum marifolium* II. *Lithodora fruticosa* II, *Argyrolobium zanonnii* I, *Ononis pusilla* I; Companions: *Avenula mirandana* III, *Santolina squarrosa* III, *Koeleria vallesiana* III, *Carduncellus monspelliensium* II, *Carex humilis* II, *Polygala cesalpinii* II, *Centaurea pinae* II, *Asphodelus ramosus* I, *Echinops ritro* I, *Eryngium campestre* I, *Avenula bromoides* I, *Ononis repens* I, *Teucrium chamaedris* I, *Prunus spinosa* I, *Arrhenatherum elatius* I, *Bromus erectus* I. (Aguilella 1985. tab. 63, 19 relevés)

7. *Violo willkommi-Quercetum fagineae* (bottom of valley)

Characteristics of association and upper units**:** *Quercus faginea* V, *Tanacetum corymbosum* V, *Silene nutans* IV, *Pimpinella gracillis* IV, *Stachys officinalis* III, *Viola willkommii* III, *Acer monspessulanum* III, *Vicia teniufolia* II, *Primula columnae* II, *Cytisus patens* II, *Geranium sanguineum* II, *Stachys heraclea* III, *Polygonatum odoratum* I, *Hepatica nobilis* I, *Cephalanthera rubra* I, *Solidago virgaurea* I, *Sorbus torminalis* I, *Hieracium murorum* I, *Geum sylvaticum* I, *Hieracium praecox* I, *Helleborus foetidus* I, *Inula salicina* I, *Campanula trachelium* I; Differentials**:** *Quercus rotundifolia* V, *Rubia peregrina* IV, *Odontites viscosa* III,Cistus laurifolius I, *Pinus pinaster* I, *Veronica officinalis* I, *Cytisus reverchonii* I, Companions*: Juniperus hemisphaerica* IV, *Viola alba* IV, *Thalictrum tuberosum* IV, *Prunus spinosa* IV, *Bupleurum rigidum* III, *Hedera helix* III, *Genista hispanica* III, *Amelanchier ovalis* III, *Quercus coccifera* II, Senecio lagascanus II, *Ruscus aculeatus* II. (Aguilella 1985,. tab. 79, 14 relevés)

8. *Quercetum rotundifoliae*

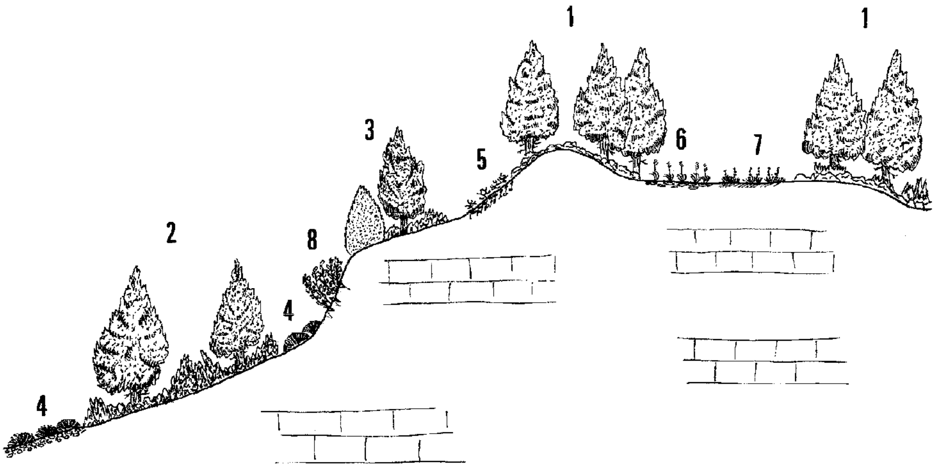
In this stretch, after Barracas we enter the Autonomous Community of Aragón.

4- Puebla de Valverde-Camarena de la Sierra: Near Puebla de Valverde we leave the N-234 and take a road towards Camarena de la Sierra and the Javalambre summit. This little road climbs rapidly and at about 1,200 m the carrasca (*Quercus rotundifolia*) begins to fail while the white juniper (*Juniperus thurifera*) becomes dominant. The latter, together with Juniperus communis subsp. hemisphaerica is the main species of the association *Juniperetum hemisphaerico-thuriferae*, which is the potential natural vegetation in the Iberian supramediterranean sabinares vegetation series. In this stretch we can distinguish two faciations, one with black sabina (*Juniperus phoenicea*) on eroded soils, and the other with dwarf sabina (*Juniperus sabina*) common on ridges and over 1,300 m, representing the transition to the pine (*Pinus sylvestris*) woodlands of the oromediterranean belt. The landscape is no longer agricultural, but devoted to forestry and husbandry.

The sabinar as seral stages has the scrub of *Saturejo montanae-Erinacetum anthyllidis* and the grasslands of *Festuco hystricis-Ononidetea striatae* begin to appear. In pastured areas submitted to a certain nitrification some interesting taxa such as *Artemisia assoana* y *Potentilla cinerea* subsp. *velutina* appear.

PICTURE 2

Locality: Puebla de Valverde-Camarena de la Sierra
Altitude: 1,300 m
Biogeography: Maestracense sector, Castilian-Maestracean-Manchegan subprovince
Termotype: Upper supramediterranean
Ombrotype: dry
Lithology: limestone ans Jurassic marly limestone



1. *Juniperetum hemisphaerico-thuriferae juniperetosum sabinae*

Juniperetum hemisphaerico-thuriferae juniperetosum sabinae: Characteristics of association and upper units: (E_1) *Juniperus thurifera* V, *Pinus salzmannii* I, *Pinus sylvestris* I. *(E_2) Juniperus hemisphaerica* V, *Juniperus thurifera* V; Differentials of subassociation and variant: *Juniperus sabina* III, *Juniperus phoenicea* I, *Juniperus oxycedrus* I; Companions: *Thymus vulgaris* V, *Genista scorpius* V, *Lavandula latifolia* V, *Carex halleriana* IV, *Silene legionensis* II, V*iola rupestris* III, *Sedum sediforme* IV, *Avenula bromoides* III, *Potentilla tabernaemontani* III, *Scabiosa turolensis* III, *Euphorbia nicaeensis* III, *Erysimum grandiflorum* III, *Helianthemum apenninum* III, *Leuzea* *conifera* III, *Eryngium campestre* III, *Brachypodium retusum* II, *Thymus godayanus* II, *Koeleria vallesiana* II. (Costa, Pérez-Badia & Soriano 1990. tab. 1, 11 relevés)

2. *Juniperetum hemisphaerico-thuriferae*
3. *Juniperetum hemisphaerico thuriferae* variant of *Juniperus phoenicia*
4. *Saturejo-Erinacetum anthyllidis*

***Saturejo-Erinacetum anthyllidis*:** Characteristics of association and alliance: *Erinacea anthyllis* V, *Thymus zapateri* V, *Fumana procumbens* IV, *Erysimum grandiflorum* IV, *Helianthemum canum* IV, *Arenaria grandiflora* III, *Satureja montana* III, *Globularia vulgaris* III, *Potentilla cinerea* II, *Euphorbia mariolensis* II, *Dianthus brachyanthus* II, *Tulipa australis* II, *Teucrium expansum* II, *Astragalus muticus* II, *Potentilla tabernaemontani* I, *Aphyllanthes monspelliensis* I, V*iola rupestris* I, *Coronilla minima* I, *Ptilotrichum lapeyrousianum* I; Differentials: *Genista pumila* II. *Genista cinerea* I; Characteristics of upper units: *Lavandula latifolia* V, *Euphorbia nicaeensis* IV, *Thymus vulgaris* IV, *Genista scorpius* II, *Leuzea conifera* II, *helianthemum marifolium* I, *Linum narbonense* I; Companions: *Festuca hystrix* V, *Santolina squarrosa* IV, *Carduncellus monspelliensium* IV, *Koeleria vallesiana* III, *Juniperus sabina* II. (Aguilella, 1985. tab. 65, 10 relevés)

5. *Astragalo-Erinacetum anthyllidis*
6. *Festucetum hystricis*
7. *Paronychio-Artemisietum pedemontanae*
8. Community of *Amelanchier ovalis*

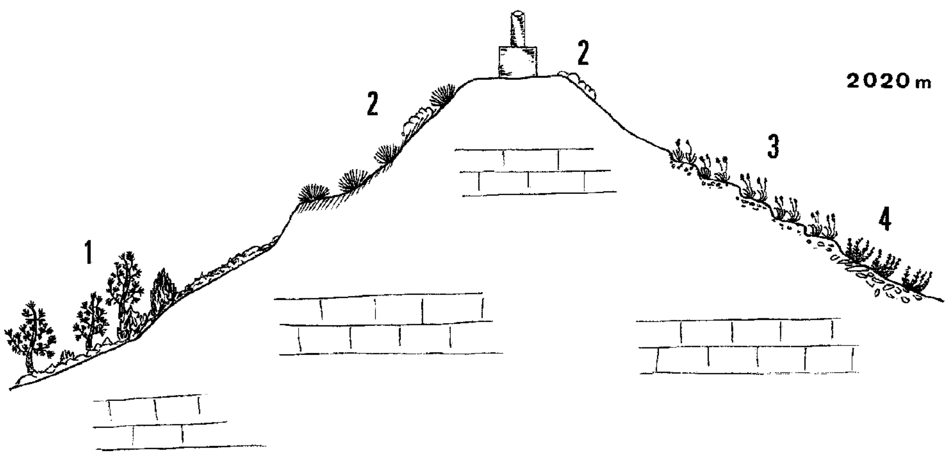
5- Javalambre summit: After the third stop, the last stretch of today's excursion will cover the gap between 1,300 to 2,020 m of the summit of the Javalambre mountain. This will mean passing from the suprameditarranean thermotype to the oromediterranean, i. e. from the sabinares and quejigares to the pinares of the Mediterranean high mountain. The oromediterranean thermotype starts above 1,600 m when Pinus sylvestris var. iberica dominates in the landscape, together with *Juniperus sabina* and *Juniperus hemisphaerica*, which form the association *Junipero sabinae-Pinetum ibericae*, the head of the vegetation series of the pinares of white pine on limestone Mediterranean high mountain.

As seral stage, appearing in the pine woodland gaps, grasslands of *Festuco hystricis-Ononidetea striatae* are found, its association *Festucetum hystricis* being the most widespread in this area, together with the dwarf scrub of *Astragalo-Ononidetum cenisiae*.

The Javalmabre summit, at 2,020 m, represents an excellent point where the vegetation is submitted to strong wind and low winter temperatures; thus, the phenomena of solifluction and cryoturbation are regular. This hinders the development of arboreal vegetation and pulvinate communities occupy the area. They are of a great interest as they bear endemic taxa such as *Sideritis javalambrensis* and *Erodium celtibericum*, together with some Alpic-Pyrenean disjunctions such as V*italiana primuliflora* subsp. *assoana* and *Draba hispanica* forming this cryoromediterranean topographic vegetation of those mountains.

PICTURE 3

Locality: Javalambre summit
Altitude: 2,020 m
Biogeography: Maestracense sector, Castilian-Maestracean-Manchegan subprovince
Termotype: oromediterranean
Ombrotype: dry
Lithology: Jurassic limestone and sandstone



1. *Junipero sabinae-Pinetum sylvestris*
2. *Erodio celtibericae-Erinacetum anthyllidis*
3. *Festucetum hystricis*

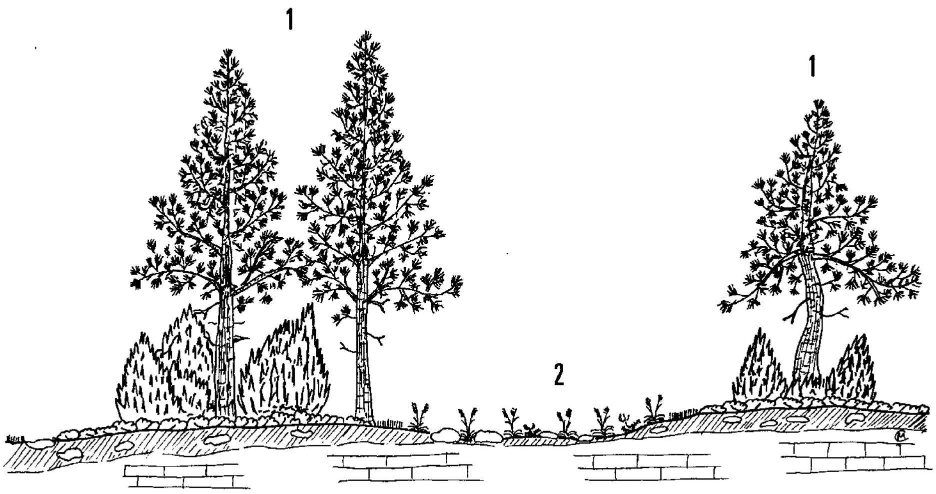
   Festucetum hystricis: Characteristics of association and upper units: *Poa ligulata* V, *Festuca hystrix* III; Companions: *Festuca hervieri* V, *Koeleria vallesiana* V, *Eryngium campestre* V, *Carduncellus monspelliensium* V, *Sedum micranthum* IV, *Potentilla cinerea* IV, *Hieracium pilosella* IV, *Hieracium salicifolium* IV, *Thymus zapateri* IV, *Convolvulus lineatus* IV, *Sedum acre* III, *Sedum tenuifolium* II, *Centaurea pinae* II, *Dianthus costae* II, *Minuartia hybrida* II, *Helianthemum apenninum* II, *Plantago sphaerostachya* II, *Medicago leiocarpa* II, *Phlomis lychnitis* II, *Saxifraga tridactylites* II, *Galium verum* II, *Potentilla tabernaemontani* III, *Erodium cicutarium* II, *Minuartia hamata* II. (Aguilella 1985. tab. 57, 13relevés)
4. Community of *Sideritis javalambrensis*

PICTURE 4

Locality: Oromediterranean Valencian-Maestracean vegetation
Biogeography: Castilian-Maestracean-Manchegan subprovince
Termotype: oromediterranean
Ombrotype: dry
Lithology: Jurassic limestone and sandstone

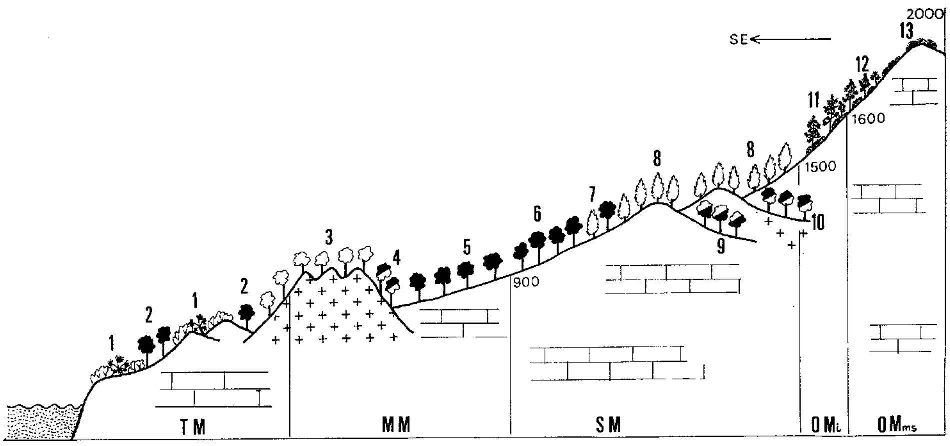
1. *Junipero sabinae-Pinetum sylvestris*
   2 *Pinus sylvestris var. iberica,* 1 *Pinus sylvestris x uncinata,* 4 *Juniperus sabina,* 2 *Juniperus hemisphaerica,* 2 *Ribes alpinum,* 1 *Euphorbia nicaeensis,* 1 *Helleborus foetidus,* 2 *Arrhenatherum elatius,* 1 *Coronilla minima,* 1 *Poa flaccidula,* 1 *Viola willkommii,* + *Potentilla neumanniana,* + *Thymus godayanus.* (Relevé taken at the Sierra de Javalambre)

2. *Poo ligulatae-Festucetum hystricis*



PICTURE 5

Zonation of the vegetation from the sea level (Valencia) to 2,000 m (Javalambre Peak)



1. Thermomediterranean coscojares: *Querco cocciferae-Pistacietum lentisci*
2. Thermomediterranean carrascales with palmito (*Chamaerops humilis*): *Rubio longifoliae-Quercetum rotundifoliae*
3. Thermo and mesomediterranean alcornocales on red sandstone (rodenos): *Asplenio onopteridis-Quercetum suberis*
4. Scattered bushes of *Quercus pyrenaica* on rodenos
5. Lower mesomediterranean carrascales without *Chamaerops humilis* (palmito): *Rubio longifoliae-Quercetum rotundifoliae*
6. Supramediterranean carrascales: *Hedero helicis-Quercetum rotundifoliae*
7. Supramediterranean continental carrascales with juniper (*Juniperus thurifera*): *Junipero thuriferae-Quercetum rotundifoliae*

   Characteristics of association alliance and order: *Quercus rotundifolia* V, *Juniperus thurifera* V, *Viola alba* IV, *Juniperus hemisphaerica* III, *Juniperus sabina* I, *Piptatherum paradoxum* I, *Ruscus aculeatus* I; Characteristics of class: *Rubia peregrina* V, *Hedera helix* IV, *Rumex intermedius* II, *Juniperus phoenicea* II, *Juniperus oxycedrus* II, *Rhamnus alaternus* I, *Euphorbia characias* I; Differentials: *Silene nutans* III, *Tanacetum corymbosum* II, *Helleborus foetidus* II, *Pimpinela gracilis* II, *Vicia teniufolia* I, *Quercus faginea* I, *Stachys officinalis* I, Aquilegia vulgaris I, *Acer monspessulanus* I; Companions: *Brachypodium retusum* III, *Genista hispanica* III, *Teucrium chamaedrys* II, *Carex halleriana* II, *Saponaria ocymoides* II, *Genista scorpius* II, *Galium maritimum* II. (Aguilella 1985. tab. 83, 10 relevés)
8. Supramediterranean juniper woodlands (sabinares albares): *Juniperetum hemisphaerico-thuriferae*

9. Supramediterranean quejigares: *Violo willkommi-Quercetum fagineae*
10. Supramediterranean Iberolevantine melojares: *Cephalanthero rubrae-Quercetum pyrenaicae*
11. Lower oromediterranean pine forests: *Junipero sabinae-Pinetum sylvestris* variant of *Pinus nigra*
12. Oromediterranean pine forests: *Junipero sabinae-Pinetum sylvestris*
13. High mountain pulvinate scrub: *Erodio celtibericae-Erinaceetum anthyllidis*

VALENCIA-MURCIA (11 July)

(Geobotanical excursion from Valencia to the Font Roja and Murcia)

MANUEL COSTA TALENS & PILAR SORIANO GUARINOS

INTRODUCTION

This journey will take place in thermomediterranean and mesomediterranean areas crossing one of the most fertile and rich territories of Spain, the area of Quaternary sediments of the so called La Ribera districts in the Júcar (Xúquer) river valley.

1- Valencia-La Ollería pass stretch: This trip starts in a S-SW direction along the N-340 motorway, the old road to Madrid called "Camino Real". The landscape, once we leave behind the industrial and commercial areas surrounding the city of Valencia, is eminently agricultural. First the dominance corresponds to the irrigated "huerta" which is later transformed into citric and other fruit tree crops. The latter will become dominant from the town of Alginet, at the entrance of the Ribera Alta district, an area of enormous economic potential due to agriculture and derived transforming industry. Horticolous crops alternate in winter and summer crops. Winter crops are *Brassica oleracea*, specially its most common cultivated varieties such as cabbage (var. *capitata*) and cauliflower (var. *botrytis*), artichoke (*Cynara scolymus*), cardoon (*Cynara cardunculus*), etc. In summer are grown onions (*Allium cepa*), broad beans (*Vicia faba*), tomatoes (*Solanum lycopersicum*), aubergines (*Solanum melongena*), melons (*Cucumis melo*), etc. Among the arboreal crops, the most frequent are apricot (*Prunus armeniaca*), plums (*Prunus domestica*), medlars (*Mespilus germanica*) and, recently expanded, khakis (*Diospyros kaki*). But, above all, the citrus fruits are the most extended and, economically, the most important crop of this area; their cultivation started in Carcaixent in the year 1781.

A typical feature of the landscape of this area is the date palm (*Phoenix dactylifera*), a tropical tree grown since ancient time.

On Quaternary sediments, with humid soils with a shallow water table, the potential natural vegetation corresponds to elm forests of the *Acantho molli-Ulmetum minoris* association; on the river banks occur riparian poplar woods (choperas) of *Vinco difformis-Populetum albae*, with the white poplar (*Populus alba*) and other trees such as the ash (*Fraxinus angustifolia*) and a herb layer formed by *Vinca difformis, Arum italicum, Brachypodium sylvaticum, Hedera helix,* etc. The river bank areas are usually devoted to poplar plantations for timber production. The preferred poplar is *Populus nigra* var. *italica* (*Populus pyramidalis*) whose plantations occupy wide areas on the edges of the rivers. This type of cultivations can be seen when crossing the Xúquer at Gabarda and Benexeida. On normal soils the potential natural vegetation corresponds to the carrascales of the *Rubio longifoliae-Querco rotundifoliae* sigmetum, which have almost disappeared nowadays although remains can still be found in some spots of the surrounding sierras. Within this vegetation series occur the coscojares with lentisco of *Querco cocciferae-Lentiscetum (Querco-Pistacietum lentisci)* and the tomillares of *Thymo piperellae-Helianthemetum marifolii*.

After crossing the Xúquer river, the road begins to ascend leaving the broad sedimentary plain of the river. Beyond the Cárcer pass we enter the Canyoles river valley, a tributary of the Albaida, which flows into the Xúquer. The Canyoles valley clearly limits the district known as Costera, a transitional area between two of the big mountain systems of the Peninsula: the Iberian System in the north, and the Baetic Ranges in the south. The thermotype is upper thermomediterranean, which is indicated by the lack of *Chamaerops humilis* (palmito). At this level, although citrus trees are still maintained in depressions, *secano* (not irrigated) crops begin to appear. When reaching the top of the Cárcer pass Triassic marls covered by gypsaceous scrub of *Gypsophilo struthium-Ononidetum edentulae* appear.

***Gypsophilo struthium-Ononidetum edentulae**:* Characteristics of association alliance and order: *Gypsophila struthium* V*, Ononis edentula* V*, Helianthemum squamatum* V*, Herniaria fruticosa* II*, Launaea fragilis* II*;* Characteristics of class: *Rosmarinus officinalis* V*, Helianthemum lavandulifolium* V*, Fumana laevis* V*, Cistus clusii* III*, Fumana glutinosa* II*, Atractylis humilis* II*;* Companions*: Brachypodium retusum* V*, Stipa tenacissima* III*, Hyparrhenia hirta* II*, Eryngium campestre* II. (Costa & Peris 1984, 11 relevés)

2- La Ollería pass-Alcoi stretch: La Ollería pass is the crossing path of the Sierra Grossa, after which we enter the district of La Vall d'Albaida, where the agriculture is of *secano* type and the landscape, strongly transformed by human activities, is dominated by crops of carob trees (*Ceratonia siliqua*), almond trees (*Prunus amygdalus*) and vines (*Vitis vinifera*), the latter mostly devoted to produce grapes for direct consumpion. The potential natural vegetation is still represented by the thermomediterranean carrascales (by its cooler version) in the Albaida valley. As soon as we abandon this area, leaving behind the Sierras of Benicadell and Aguillent, we enter the districts of L'Alcoiá and El Comptat, where the landscape becomes more abrupt with big mountain ranges such as theSierra Mariola with the highest peaks of Montcabrer of 1,390 m and Aitana of 1,558 m. On the summit of those mountains is found a characteristic pulvinate scrub with interesting plants such as *Vella espinosa*, *Erinacea anthyllis* y *Genista longipes* (*Erinaceo anthyllidis-Genistetum longipedis*).

***Erinaceo anthyllidis-Genistetum longipedis**:* Characteristics of association and upper units**:** *Genista longipes* V*,* V*ella spinosa* V*, Teucrium homotrichum* V*, Erinacea anthyllis* V*, Thymus vulgaris* III*, Ptilotrichum spinosum* III*, Scabiosa turolensis* III*, Arenaria aggregata* III*, Helianthemum appeninum* III*, Fumana procumbens* III*, Thymus gadorensis* II*, Salvia mariolensis* II*, Arenaria grandiflora* II*, Bupleurum fruticescens* II*, Helianthemum paniculatum* II*, Lavandula latifolia* II*, Centaurea mariolensis* II*, Herniaria suffruticosa* II*, Paronychia kapella* II. Companions**:** *Festuca hystrix* IV*, Helictotrichon filifolium* IV*, Koeleria vallesiana* IV*, Anthyllis vulneraria* IV*, Brassica maritima* IV*, Crepis scorzoneroides* III. (Solanas 1996, 4 relevés)

It is worth noting the occurrence in Sierra de Mariola of a relic wood of yews, *Taxus bacatta.*

In those areas of the interior the dominant thermotype is the lower mesomediterranean, which is mostly occupied by potential carrascales of *Quercus rotundifolia* with *Ulex parviflorus*; the latter indicates the influence of the humid air masses coming from the Mediterranean sea which enter as far as those valleys of the Alcoi (Serpis) and Gallinera rivers. Biogeographically we enter the Alcoyano-Diánico subsector of the Setabense sector (Valencian-Catalonian-Provençal subprovince).

After passing the town of Alcoi, an important industrial centre, we leave the N-340 road and take a little local road towards the foothills of the Sierra del Menejador; there is one of the most interesting relic Mediteranean forest of the eastern part of the Peninsula. It is a mixed forests in which coexist *Quercus rotundifolia*, *Quercus gracilis, Quercus faginea, Fraxinus ornus, Acer granatense,* etc. It belongs to the vegetation series of Fraxino orni-Querco fagineae sigmetum**.**

INTRODUCTION

The Sierra del Carrascal de Alcoi, also called Sierra de la Font Roja has the largest (in extent) mixed forest of carrascas and ashes to be found in the Valencian Autonomous Community. It is located in the northern part of the Alicante (administrative) province and its area belongs to the municipalities of Alcoi and Ibi. It has been a protected area for centuries. There are documents from 1499 prohibiting the extraction of wood for charcoal and fuel. Since that time till now it has been under different regulations until it was declared a Natural Park.

Traditionally it has been a recreational and religious area, due to the hermitage of the Virgen de los Lirios, built in 1653 after the discovery of an image of the Virgin. On the slopes secano crops are cultivated, mostly fruit trees, olive trees, vines and cereals. Another traditional exploitation of the sierra (abandoned today) was the extraction of lime from the limestone as a building material. Another activity, related with the recent historical changes in the climate, is the winter harvesting of snow, transformed into ice by pressure, which led to the construction, in the XVII and at the beginning of the XIX century, of many iceboxes or *neveras* (locally called *cavas*) to store the snow. This activity continued till the beginning of this century and give us an idea about the frequency and amount of the snowfalls. This is related with the Little Ice Age, which in Valencia had significant episodes such as the freezing of the Albufera lake.

The highest elevation of this range is the Menejedor summit at 1,352 m, which is a part of the east-west ridge together with other summits such as the Alto de la Ginebra (1,321 m), San Benet (1,255), Teixereta (1,340) and Penyes del Mirador de Pilat (1,340). This ridge is assymetrical as is bears steeper slopes with screes on the north-facing side and a more gentle relief on the opposite side.

GEOLOGY AND SOILS

Alltogether, this sierra in an Oligocene nummulithic massif whic is covered, in its lower part, by Miocenic marl and Quaternary materials. Karstic structures are remarkable such as little caves produced by the solution of the limestone.

In the summital part and on the southern slope predominate “terra rossa” type soils while on the north-facing slope rendzinas and regosols are the common types.

BIOCLIMATOLOGY

The meteorological data were provided by the thermopluviometric stations of Alcoi (562 m) and Ibi (816 m) and were elaborated by Pérez de Cueva (1994). Also, extrapolations were carried out by Ballester & Stübing (1990) using data from the stations of Font Roja (1,050 m) and Cumbre de Menejador (1,352 m), on the northern slope and Mas de Foyadoretes (1,090 m) and Cumbre de Menejador (1,352 m), for the southern slope. After all those studies it has been concluded that the territory of the sierra is shared between the mesomediterranean and supramediterranean thermotypes.

As for rainfalls, the effect of rain shadow provoked by the east-west orientation of the range is remarkable, with the clouds being retained on the northern slope. Thus, in the stations of Alcoi, Font Roja or Cumbre del Menejedor, located on the northern slope, 494 mm, 703 mm and 842 mm of mean annual rainfall are registered respectively, while, on the other hand, in Ibi and on the southern side of Cumbre del Menejedor, are collected 379 mm and 649 mm respectively. Those precipitations have a seasonal distribution pattern with a maximum in October and two other secondary peaks in December and April.

Plant communities

Fraxino orni-Quercetum fagineae

Marcescent-leaved forests, with a supramediterranean and mesomediterranean optimum of at least subhumid ombrotype occurring on the north-facing slope of the Sierra, occupying favoured enclaves. Those forests, characteristic of the Setabense sector, have their best representation at the Sierra del Carrascal de Alcoi, from which the relevés of the following synthetic table are taken:

Those forests have been considered by other authors as on edaphohygrophile subassociation (*viburnetosum tini*) of the sclerophyllic forests of *Quercetum rotundifoliae*, due to the abundance of *Quercus rotundifolia*, indicated by a high indice, in the lectotype chosen by Rivas-Martínez (1987:160).

Quercetum rotundifoliae *subass.* ***ulicetosum parviflori***

Sclerophyllous evergreen mesomediterranean forests, mostly distributed in the Setabense sector, in dry, and exceptionally in subhumid, ombrotypes. They are the most frequent forest type in this Sierra, where they occupy the driest areas on the southern slope unfavourable for the mixed forest.

The followng synthetic table representing these communities is made using the relevés of Solanas (1996) taken in the area near the Carrascal de Alcoi.

Quercetum rotundifoliae ulicetosum parviflori: Characteristics of association and upper units: *Quercus rotundifolia* V, *Rubia peregrina* V, *Hedera helix* IV, *Rhamnus alaternus* IV, *Lonicera implexa* IV, *Quercus coccifera* III, *Juniperus oxycedrus* III, *Arenaria intricata* IV, *Carex halleriana* III, V*iola dehnhardtii* II, V*iburnum tinus* I, *Pistacia terebinthus* I, *Asplenium onopteris* I, *Smilax aspera* I, *Asparagus acutifolius* I, *Clematis flammula* I, *Daphne gnidium* I, *Rhamnus lycioides* I, *Teucrium chamaedrys* I, *Juniperus phoenicea* I; Differentials of subassociation and variants: *Fraxinus ornus* III, *Teucrium homotrichum* II, *Leucanthemum gracilicaule* II, *Helianthemum rotundifolium* I, *Salvia mariolensis* I, *Biscutella montana* I; Companions: *Ulex parviflorus* V, *Brachypodium retusum* IV, *Festuca capillifolia* IV, *Bupleurum fruticescens* IV, *Cistus albidus* III, *Erica multiflora* II, *Pinus halepensis* II, *Homalothecium sericeum* II, *Orobanche hederae* II, *Erysimum gomez-campoi* II, *Koeleria vallesiana* II, *Euphorbia nicaeensis* II, *Euphorbia characias* II, *Crepis scorzoneroides* II, *Lavandula latifolia* II. (Solanas 1996, 8 relevés)

Hedero-Cytisetum patentis *subass.* ***fraxinetosum orni***

The mantle of the *Quercetea ilicis* forests in this territory is a community formed by nanofanerophytes, among which *Cytisus heterochrous* dominates. This association has its optimum in the mesomediterranean thermotype and subhumid ombrotype; the *fraxinetosum orni*, subassociation is characteristic of the Setabense sector and is also found in the thermomediterranean thermotype, where it is enriched with some thermophilous elements.

Rhamno-Juniperetum phoeniceae

Subrupicolous juniper woods (sabinares) of Baetic-Manchegan-Alcarrian distribution with Maestracense, Valenciano-Tarraconense and Setabense irradiations. Their optimum is at the mesomediterranean and lower supramediterranean thermotypes, where they play the role of permanent communities, living in places with shallow soils, steep slopes, ridges, etc. They are formed by the black juniper, *Juniperus phoenicea*, and other plants such as *Juniperus oxycedrus, Rhamnus alaternus, Rhamnus lycioides*, etc.

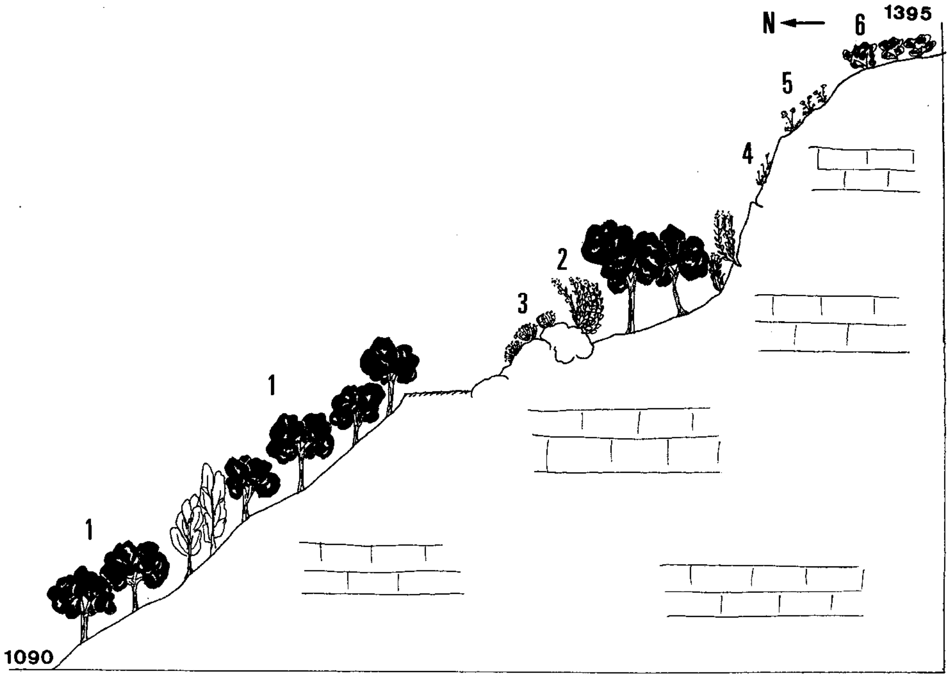
Armerio alliaceae-Salvietum mariolensis

Scrub of Salvia and brooms described in the nearby Sierra de Mariola, whose optimum is in the upper mesomediterranean and supramediterranean thermotypes of the Alcoyano-Diánico subsector and is characterized by *Salvia blancoana* subsp. *mariolensis*.

After visiting this interesting place, we return to the N-340 road which we later leave to go in the direction of Ibi, Castalla and Sax and enter the valley of the Vinalopó river, an interesting area placed in rain shadow from the moist air masses coming from the Mediterranean sea and characterized by its climatic aridity su aridez and endorrheism phenomena. Today’s excursion ends in the city of Murcia.

PICTURE 6

Locality: Font Roja shrine-Menechador summit
Altitude: 1,395 m



1. *Fraxino ornii-Quercetum fagineae*

   Characteristics of association and alliance*: Fraxinus ornus* V*, Acer granatense* V*, Quercus faginea* V*, Geum sylvaticum* III*; Diferenciales de subasociación y variantes: Quercus rotundifolia* II*,* V*iburnum tinus* I*;* Characteristics of upper units: *Polygonatum odoratum* V*, Sorbus aria* IV*, Rubus ulmifolius* V*, Taxus baccata* IV*, Crataegus monogyna* IV*, Rosa micrantha* II*;* Companions: *Amelanchier ovalis* V*, Hedera helix* V*, Lonicera etrusca* V*, Rubia peregrina* V*, Ononis aragonensis* V*, Silene mellifera* III. (Ballester & Stübing 1990)

2. *Hedero helicis-Cytisetum patentis fraxinetosum orni*

   Characteristics of association and upper units: *Cytisus heterochrous* V*, Asparagus acutifolius* V*, Lonicera implexa* V*, Rhamnus alaternus* IV*, Euphorbia characias* IV*, Clematis flammula* IV*, Pistacia terebinthus* III*, Quercus coccifera* III*, Ruscus aculeatus* III*,* V*iburnum tinus* III*, Tamus communis* III*, Smilax aspera* III*, Daphne gnidium* III*, Teucrium flavum* III*, Silene mellifera* III*, Chamaerops humilis* II*, Asplenium onopteris* II*, Rubia longifolia* II*, Colutea atlantica* II*, Euphorbia squamigera* II*, Hedera helix* II*, Pistacia lentiscus* II; Companions: *Brachypodium retusum* IV*, Crataegus monogyna* IV*, Calamintha ascendens* II*, Rubus ulmifolius* II*, Cephalaria leucantha* II. (Pérez-Badia 1997, tab. 6, 6 relevés)

3. *Scrophulario sciafilae-Iberidetum hegelmaieri* and com. of *Iberis saxatilis*
4. *Saxifragetum cossonianae*
5. *Saxifrago-Hornungietum patraeae*
6. *Armerio alliaceae-Salvietum mariolensis*

Characteristics of association and alliance: *Erinacea anthyllis* V, *Salvia mariolensis* V, *Scabiosa turolensis* IV, *Centaurea mariolensis* III, *Armeria alliacea* III, *Arenaria aggregata* II, *Thymus gadorensis* I, *Daphne hispanica* I, *Euphorbia nevadensis* I; Characteristics of order and class: *Teucrium homotrichum* V, *Thymus vulgaris* V, *Helianthemum rotundifolium* V, *Helianthemum appeninum* V, *Ononis minutissima* III, *Lavandula latifolia* III, *Bupleurum fruticescens* II, *Dianthus hispanicus* III, *Erysimum gomez-campoi* IV, *Fumana ericifolia* I, *Globularia valentina* II, *Jurinea humilis* I, *Linum narbonense* I, *Genista scorpius* I, *Staehelina dubia* I, *Atractylis humilis* I, *Lithodora fruticosa* I, *Linum suffruticosum* I, *Aphyllanthes monspeliensis* I, *Arenaria grandiflora* I, *Calamintha meridionalis* I, *Paronichya suffruticosa* I; Companions: *Brachypodium retusum* III, *Festuca capillifolia* III, *Koeleria vallesiana* III, *Cirsium valentinum* III, *Carduncellus monspelliensium* II, *Helictotrichon filifolium* II, *Euphorbia characiuas* II, *Crepis scorzoneroides* III, *Eryngium campestre* II, *Sedum sediforme* II, *Avenula bromoides* II, *Euphorbia flavicoma* II, *Silene mellifera* II, *Leucanthemum gracilicaule* II, *Hormatophylla spinosa* II; (Solanas & Crespo 1998, tab. 1, 13 relevés)

MURCIA-BAZA (12 July)

(The vegetation of the Murcian area)

FRANCISCO ALCARAZ ARIZA

Located in southeastern Spain, the city of Murcia lies by the Segura river whose waters and muds, brought by repeated floods, allowed the developement of a rich agriculture. Founded by the Arabs, there are important remains of this culture and of the rest who have ruled this territory throughout centuries.

Since its historical foundation, the town has evolved into a modern city but, simultaneously, its most outstanding cultural features have been obscured and many of its peculiarities have been lost. One of them is related to the Segura river, perhaps this communiy's backbone. It no longer produces the periodical floods as in ancient times because it has been canalized and the flow has been regulated by means of several dams upstream. These floods, caused by the extremely irregular rainfall regime of the area, together with the catastrophic effects associated with them, fertilised the land of the river banks, in a modest emulation of the Nile. Today, the water of the Segura river is severely polluted by the urban and industrial wastes of the numerous towns along the river. Perhaps in the future we will understand that the conservation of the environment and of the traditional cultural values is not incompatible with economic developement.

The climate of the area is mild and permits the cultivation of many garden plants of subtropical, and even tropical, origin. Some of those plants have even naturalised and now participate in the local ruderal and weed flora.

Arboreal and herbaceous crops are very important in all the areas irrigated by the waters of the Segura river; some of them are prosperous, as the citrics (oranges and especially lemons) and others, such as figs and mulberries, are declining although they were relevant not so long ago. When soil salinty increases, cotton, pepper (in its numerous varieties), tomato and even pomegranate can still be cultivated, while along the divisory borders of the properties palm trees grow succesfully.

The green colour of the irrigated valley bottom contrasts strongly with the aridity of the surrounding landscape. Certainly, mountains, slopes and plains above the techtonic fosse through which the Segura flows are characterized by their ochre colour as the scanty covering of the vegetation, which, still submitted to the pressure of sheep and goat husbandry, leaves a high proportion of the soil uncovered.

On the river banks and the fluvial terraces surrounding the Segura, it is possible to see some remains, not many, of the riparian vegetation, which is more related to that of the north African rivers than with European ones (Ríos 1996; Alcaraz & al. 1997).

On the slopes, away from the influence of the river, the potential natural vegetation corresponds to sclerophyllous shrublands (*Chamaerops humilis, Pistacia lentiscus, Quercus coccifera*) with pines (*Pinus halepensis*) or even in marly areas, to communities dominated by brooms, particularly *Genista valentina* subsp. *murcica*. However, the most characteristic feature of the vegetation of the territory we are going to visit this day are the espartales (*Stipa tenacissima*) and the tomillares where many of the endemic taxa (ca. 64) which characterize this biogeographic territory known as Murcian-Almerian province, live.

This stop is made in an area submitted to traditional land-use, basically almond and other "secano" (cereal, etc.) crops and sheep and goat husbandry. This not so intensive management has allowed, together with the nitrophilous ruderal and weed vegetation, there to be important remains of more natural plant communities, including patches of potential natural vegetation, grasslands and scrub. The secano crops are grown in small plots and harvesting is performed without using heavy machinery. This has permitted the terrace structure in the agricultural landscape with banks separating them to be maintained. Those steep banks are covered by semi-natural vegetation which seize the soil and ensure a quick re-colonisation of the agricultural land in the case of abandonment. This pattern of land cultivation is disappearing due to its low productivity and, consequently, a significant number of traditional varieties of crops, of high interest, as well as a system of sustainable exploitation of the land.

In this are we can distinguish two types of potential natural vegetation: the general one is the lentiscar of the association *Chamaeropo humilis-Rhamnetum lycioidis*, and on the clay-rich soils (usually built on marl) occurs the piornal dominated by *Genista valentina* subsp. *murcica (Rhamno lycioidis-Genistetum murcicae*).

Endemisms and ibero-magrebian taxa of main interest: *Artemisia barrelieri, Avenula gervaisii* subsp. *murcica, Bupleurum gibraltaricum, Genista valentina* subsp. *murcica, Helichrysum decumbens, Lapiedra martinezii, Salsola genistoides, Satureja obovata* subsp. *canescens, Sideritis murgetana* subsp. *murgetana, Teucrium capitatum* subsp. *gracillimum, Teucrium carolipaui* subsp. *carolipaui, Teucrium murcicum.*

After crossing the Sierra de Carrascoy mountain range, the excursion runs through the Campo de Cartagena, an area in which, thanks to the water brought from the Tagus river, a prosperous agriculture of irrigation under favourable climatic conditions with an almost total absence of frosts has developed. Summer-crops such as artichoke, celery, melon and watermelon among others are mainly grown.

The Campo de Cartagena is limited in the east by the Mar Menor, a salt water body separated from the sea by a sand barrier (La Manga del Mar Menor) transformed nowadays into a tourist resort. Some salt marshes appear in the contact area with the Mar Menor and some remains of the volcanic activity when happened at the end of the Tertiary period stand out, such as the hills called El Carmolí, Beaza, Ventura and Roche.

The traditional agriculture of this area exploited an important subterranean aquifer for irrigation by means of windmills for the extraction of the water; some of them still remain. Even if the climate is favourable and water is available, there are some places where the main problem for agriculture is the wind, especially for citrics which have begun to be cultivated using the water from the Tagus river. In this case rows of cypresses are used as barricades on the borders of the fields to moderate the wind speed.

When reaching to the Sierra de Cartagena the effects of the mining industry, today in clear decadence, are observed. The mineral richness of this area, iron, zinc, lead and silver, has attracted many people since pre-Roman times; the regeneration of this zone is a duty for the future in this region.

This area is included in the Calblanque, Monte de las Cenizas and Peña del Águila Regional Park although the nearness to a large golf course is a permanent threath to the adequate protection of the zone. It is also a traditional pilgrimage area and this provokes a number of wildfires every year due to the people who cook in the country without control. Fortunately, it is an area with high air humidity and the recovery of the vegetation after the fires is relatively rapid, as is possible to appreciate when observing the vigorous growth of the perennial plants or the seed regeneration of the pines.

The most important botanical jewel of the park is, undoubtedly, *Tetraclinis articulata* (loclly called *sabina*). About 90% of the European population of this plant are inside this park. This plant was formerly extensively used to prop up the mines and its seedlings were usually eaten by the livestock, provoking a considerable reduction of its population; the relative disappearance of the mining industry and the control of husbandry is favouring a rapid recovery of the populations of this species. This can be checked by observing the high numbrer of seedlings and young individuals present in the area. *Tetraclinis articulata* is an edaphoxerophile plant in this territory and grows in more or less rocky places.

Endemismes and ibero-magrebian taxa of main interest: *Asphodelus tenuifolius, Calicotome infesta* subsp. *intermedia, Helianthemum almeriense* subsp. *scopulorum, Periploca angustifolia, Plantago ovata, Serratula flavescens* subsp. *mucronata, Sideritis marminorensis, Tetraclinis articulata, Teucrium carthaginense.*

On the way to today's third stop, the effects of the mines can be appreciated, particularly in the filling of the Portman bay. On the way we can observe a Roman road.

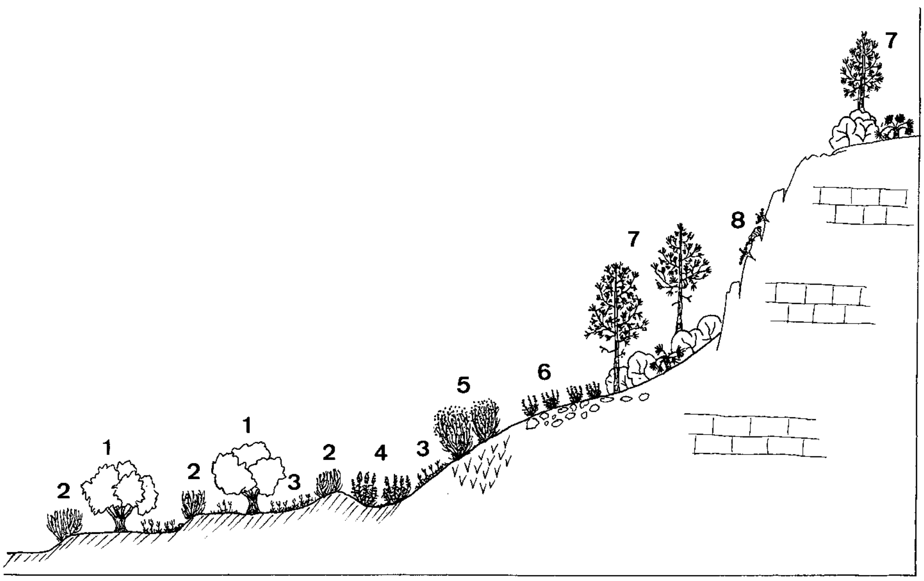
The gastronomy of this area is particularly interesting. It is based on the Mediterranean cuisine in which fish is always present; the dish called *caldero* (rice with fish), stands out.

Outside the regional park where we had our last stop, there are some of the best examples of cornical *(Periploca angustifolia)* shrubland of southeastern Spain. The influence of the maritime air increases as we approach the coast from the last stop and, in the substrata, phyllites become progressively more frequent and they retain salt more effectively than limestone.

Endemismes and ibero-magrebian taxa of main interest: *Anabasis hispanica, Caralluma europaea, Centaurea saxicola* subsp. *jimenezii, Cosentinia vellea* subsp. *bivalens, Dactylis glomerata* subsp. *santai, Frankenia corymbosa, Genista umbellata* subsp. *umbellata, Lafuentea rotundifolia, Launaea arborescens, Lavandula dentata, Limonium carthaginense, Limonium cossonianum, Lithodora fruticosa* var. *intricata, Maytenus senegalensis* subsp. *europaeus, Osyris lanceolata, Periploca angustifolia*, *Rhamnus borgiae, Teucrium freynii, Withania frutescens.*

PICTURE 7

Locality: vicinity of Puerto de San Pedro, Murcia.
Coordinates: 37º 55' 21" N, 0º 57' 50" W.
Altitude: 131 m.
Bioclimatic belt: Thermomediterranean, Semiarid.
Climatophilous vegetation series (sigmetum): *Chamaeropo humilis-Rhamno lycioidis* sigmetum.
Biogeography: Murciano-Alicantino sector, Murcian-Almerian province.
Lithology: mainly marl, sandstone and conglomerate of Tertiary period.
Humane Influence: crops and grazing.



1. Dry farming with almond and olive trees
2. *Atriplici glaucae-Salsoletum genistoidis (*Scrubland on slopes between crop fields)
   Artemisia barrelieri, Atriplex glauca, Ballota hirsuta, Fagonia cretica, Moricandia arvensis, Plantago albicans, Salsola genistoides.
3. *Teucrio pseudochamaepitys-Brachypodietum ramosi avenuletosum murcicae* (Xerophilous grasslands)
   Allium pallens, Avenula gervaisii subsp. *murcica, Brachypodium retusum, Carex halleriana, Dactylis hispanica, Gagea iberica, Gladiolus illyricus, Helictotrichon filifolium, Hyparrhenia sinaica, Lapiedra martinezii, Phagnalon saxatile, Stipa parviflora.*
4. *Thymelaeo hirsutae-Artemisietum barrelieri* (Scrubland on old crop fields)
   Artemisia barrelieri, Artemisia herba-alba, Ballota hirsuta, Thymelaea hirsuta.
5. *Rhamno lycioidis-Genistetum murcicae* (Broom community on marly soils)

Arisarum vulgare, Asparagus horridus, Brachypodium retusum, Chamaerops humilis, Genista valentina subsp. *murcica, Pistacia lentiscus, Rhamnus lycioides* subsp. *lycioides.*

6. *Paronychio suffruticosae-Sideritetum murgetanae* (Thyme-scrub)

   Anthyllis cytisoides, Cistus albidus, Fumana ericoides, Globularia alypum, Helianthemum syriacum, Helianthemum violaceum, Helianthemum viscarium, Helichrysum decumbens, Rosmarinus officinalis, Sedum sediforme subsp. *sediforme, Sideritis murgetana* subsp. *murgetana, Stipa tenacissima, Teucrium capitatum* subsp. *gracillimum, Teucrium carolipaui* subsp. *carolipaui, Teucrium murcicum, Thymus hyemalis* subsp. *hyemalis, Thymus zygis* subsp. *gracilis.*

7. *Chamaeropo humilis-Rhamnetum lycioidis* (Sclerophilous shrubland on non clay-rich soils)

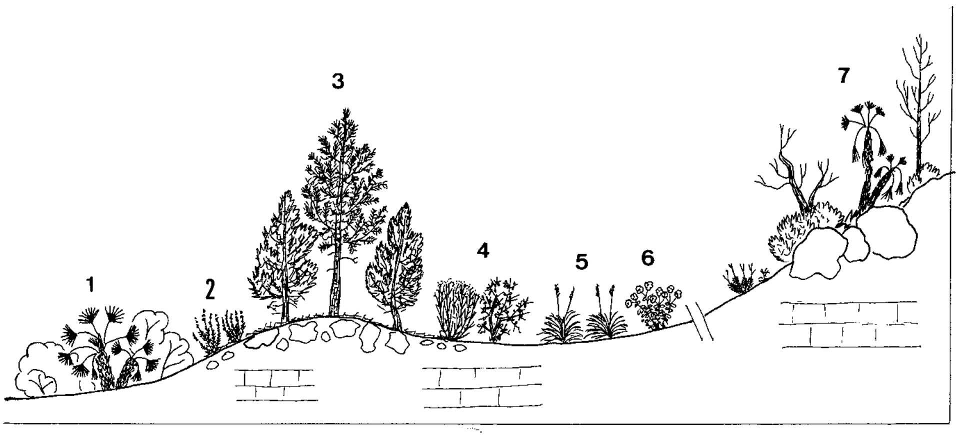
   Arisarum vulgare, Asparagus albus, Asparagus horridus, Bupleurum gibraltaricum, Chamaerops humilis, Daphne gnidium, Ephedra fragilis, Juniperus oxycedrus, Olea europaea, Pinus halepensis, Pistacia lentiscus, Quercus coccifera, Rhamnus lycioides subsp. *lycioides, Rhamnus oleoides* subsp. *angustifolia, Rubia peregrina* subsp. *longifolia.*

8. *Rhamno borgiae-Teucrietum rivasii* (Communities on rocky soils)

   Dianthus broteri subsp. *valentinus, Polygala rupestris, Satureja obovata* subsp. *canescens, Teucrium buxifolium* subsp. *rivasii*.

PICTURE 8

Locality: Atamaría, close to La Manga Golf course, Cartagena (Murcia).
Coordinate: 37º 35' N, 0º 49' 45" W.
Altitude: 141 m
Bioclimatic belt: Thermomediterranean Semiarid.
Climatophilous series (sigmetum): *Chamaeropo humilis-Rhamnetum lycioidis* Sigmetum.
Biogeography: Almeriense sector.
Lithology: Limestones
Human Influence: mining, fires, tourist development, including golf course.



1. *Chamaeropo humilis-Rhamnetum lycioidis*
2. *Sideritido marminorensis-Thymetum hyemalidis* (Thyme-scrub)
   Atractylis humilis, Bupleurum fruticescens, Carlina hispanica, Fumana laevipes, Fumana thymifolia, Helianthemum almeriense subsp. *scopulorum, Helianthemum violaceum, Helichrysum decumbens, Paronychia suffruticosa* subsp. *suffruticosa, Phagnalon rupestre, Phagnalon saxatile, Rosmarinus officinalis, Satureja obovata* subsp. *canescens, Serratula flavescens* subsp. *mucronata, Sideritis marminorensis, Teucrium capitatum* subsp. *gracillimum, Teucrium carthaginense, Thymus hyemalis* subsp. *hyemalis.*
3. *Arisaro vulgaris-Tetraclinietum articulatae* (*Tetraclinis articulata* woodland)
   Arisarum vulgare, Calicotome infesta subsp. *intermedia, Chamaerops humilis, Genista valentina* subsp. *murcica, Pinus halepensis, Rhamnus oleoides* subsp. *angustifolia, Rubia peregrina* subsp. *longifolia, Tetraclinis articulata.*
4. *Rhamno lycioidis-Genistetum murcicae calicotometosum intermediae* (Broom community with arto (*Calicotome infesta* subsp. *intermedia*)
   Calicotome infesta subsp. *intermedia, Chamaerops humilis, Genista valentina* subsp. *murcica, Olea europaea, Pinus halepensis, Rhamnus oleoides* subsp. *angustifolia.*
5. *Lapiedro martinezii-Stipetum tenacissimae* (Espartal (*Stipa tenacissima* grassland)

Asphodelus cerasiferus, Avenula gervaisii subsp. *murcica, Brachypodium retusum, Carex halleriana, Convolvulus althaeoides, Dactylis hispanica* subsp. *santai, Elaeoselinum tenuifolium, Lapiedra martinezii*, *Lobularia maritima, Sedum sediforme* subsp. *sediforme, Stipa parviflora, Stipa tenacissima, Teucrium pseudochamaepitys.*

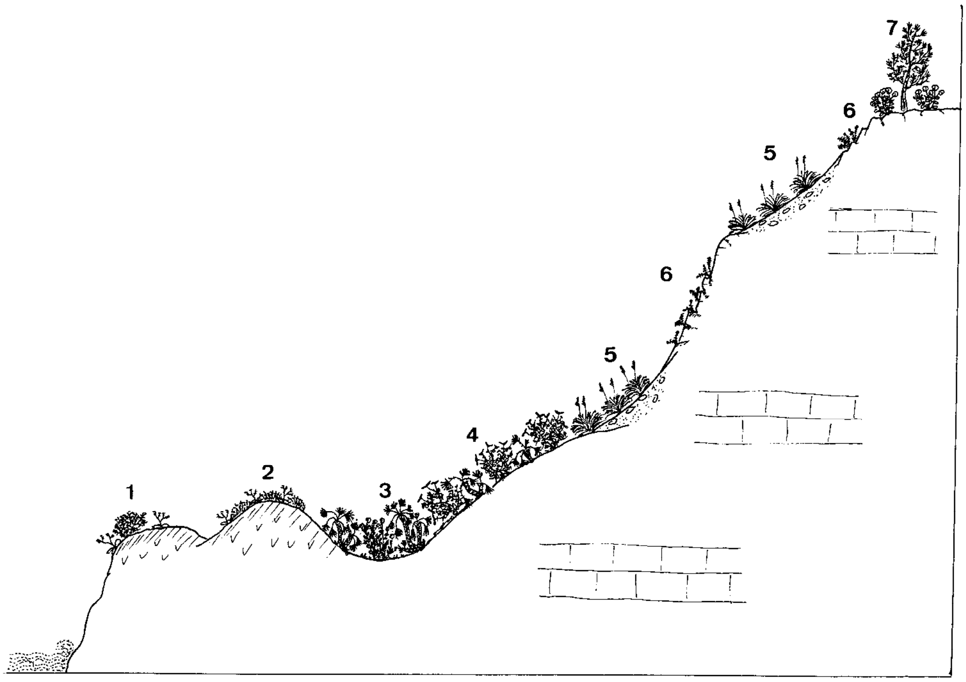
6. *Saturejo canescentis-Cistetum albidi* Rupiculous thyme-scrub

Fumana ericoides, Fumana laevipes, Fumana thymifolia, Genista umbellata subsp. *umbellata, Helichrysum decumbens, Lavandula dentata, Lithodora fruticosa* var. *intricata, Paronychia suffruticosa* subsp. *suffruticosa, Phagnalon rupestre, Rosmarinus officinalis, Satureja obovata* subsp. *canescens, Teucrium capitatum* subsp. *gracillimum, Teucrium carthaginense, Thymus hyemalis* subsp. *hyemalis, Viola arborescens.*

7. *Arisaro-Tetraclinietum articulatae* in recuperation after fire

PICTURE 9

Locality: Gorguel ravine, near Portman, Cartagena (Murcia).
Coordinates: 37º 35' N, 0º 49' 45" W.
Altitude: 50 m.
Bioclimatic belt: Inframediterranean Semiarid-Arid.
Climatophilous series (sigmetum): *Mayteno europaei-Periplocetum angustifoliae Sigmetum.*
Biogeography: Almeriense sector.
Lithology: Triasic limestones and phillites.
Human Influence: mining and rubbish.



1. *Limonio cymuliferi-Lycietum intricatae* (Cliffy-brushwood)
   Asteriscus maritimus, Crithmum maritimum, Limonium cossonianum, Lycium intricatum.
2. *Salsolo papillosae-Limonietum carthaginensis* (Thyme scrub of coastal zones affected by salty rain)
   Anabasis hispanica, Anthyllis cytisoides, Asparagus albus, Asparagus horridus, Asteriscus maritimus, Atractylis humilis, Frankenia corymbosa, Fumana ericoides, Fumana thymifolia, Helianthemum almeriense subsp. *scopulorum, Helichrysum decumbens, Launaea arborescens, Launaea nudicaulis, Lavandula dentata, Limonium carthaginense, Lycium intricatum, Lygeum spartum, Ruta angustifolia, Teucrium carthaginense.*
3. *Chamaeropo humilis-Myrtetum communis* (Myrtle shrubland)

Arisarum vulgare, Calicotome infesta subsp. *intermedia, Chamaerops humilis, Daphne gnidium, Myrtus communis, Osyris lanceolata, Pistacia lentiscus, Rhamnus alaternus, Scirpus holoschoenus, Smilax aspera* var. *aspera.*

4. *Mayteno europaei-Periplocetum angustifoliae* (Cornicalar (*Periploca angustifolia* shrubland)

   Arisarum vulgare, Asparagus albus, Asparagus horridus, Calicotome infesta subsp. *intermedia, Chamaerops humnilis, Maytenus senegalensis* subsp. *europaeus, Osyris lanceolata, Periploca angustifolia, Pistacia lentiscus, Rhamnus alaternus, Rhamnus oleoides* subsp. *angustifolia, Rubia peregrina* subsp. *longifolia, Withania frutescens.*

5. *Lapiedro martinezii-Stipetum tenacissimae*
6. *Cosentino bivalentis-Teucrietum freynii* (Rupiculous small bush community)

   Centaurea saxicola subsp. *jimenezii, Cosentina vellea* subsp. *bivalens, Polygala rupestris, Polygala rupestris, Rhamnus borgiae, Teucrium freynii.*

7. *Saturejo canescentis-Cistetum albidi*

BAZA-GRANADA (13 July)

(The vegetation of the Sierra de Baza)

FRANCISCO VALLE TENDERO

The Sierra de Baza is a mountainous massif located in the central zone of the Baetic ranges emerging from the encircling depressions and high plateaux except on its eastern side where it is continued by the Sierra de los Filabres. It is also surrounded by other Baetic massifs among which it plays the role of ecological and biological knot, for which it has a biogeographically outstanding position.

In biogeographical terms it mainly belongs to the Guadiciano-Bacense sector (Serrano-Bacense district) with the exception of its eastern part which belongs to the Nevadense sector (Filábrico district). In the former the highest altitudes are reached in the Calar de Santa Bárbara (2,270 m), a limestone-dolomitic summit; in the siliceous part (Filábrico) rocks such as schist, mica schist and quartzite are dominant.

Biogeographically, there are 3 thermotypes represented in the area: meso, supra and oromediterranena, the latter is of considerable extent in comparison with the rest of the Baetic ranges. Ombrotypes are dry and subhumid although in the lower piedmont semiarid patches can be detected and on the summits the humid ombrotype can appear.

ITINERARY

The trip starts in the city of Baza taking the A-92 highway and leaving the Baza river valley on the right. There we can observe the riverine mesomediterranean geoseries of the Guadiciano-Bacense sector (*Thypho-Schoenoplecto glauci S.* and *Rubo-Nerio oleandri S.)*. On dry soil the communities of the *Rhamno lycioidis-Querco cocciferae Sigmetum* vegetation series develop, in a faciation with *Ephedra fragilis*. The landscape is, however, dominated by the "espartales" of *Thymo gracile-Stipetum tenacissimae.*

After 15 Km of highway, a track is taken to enter the Sierra de Baza Natural Park where we ascend to the summital zone (2,000 m) through base-rich terrains. First we cross the mesomediterranean belt, occupied by the *Paeonio coriaceae-Querco rotundifoliae* S. and then the supramediterranean belt occupied by the *Berberido hispanicae-Querceto rotundifoliae* S. On the moister north-facing slopes the *Daphno larifoliae-Acereto granatensis* S. is found and the oromediterranena belt is covered by the *Daphno hispanicae-Pino sylvestris* S.

The vegetation series of the *Berberido hispanicae-Querceto rotundifoliae* Sigmetum occurs in a range between 1,300 and 1,850 m approximately, with variations depending on exposition and thermic inversion phenomena. Together with the rest of the potential natural vegetation, other communities of this vegetation series are the forest mantle belonging to *Genisto speciosae-Cystisetum reverchonii*, the grasslands of *Helictotricho filifolii-Festucetum scariosae*, the scrub of *Santolino canescentis-Salvietum oxyodonti* and the nitrophilous scrub of *Artemisio glutinosae-Santolinetum canescentis*.

The vegetation series of the Baetic "quejigares", *Daphno latifoliae-Aceretum granatensis*, occurs on the north-facing slopes on deep soils in the upper levels of the supramediterranean belt, between 1,750 and 1,850 m. They participate in the forest-mantle of *Lonicero splendidae-Berberidetum hispanicae* and the herbaceous communities of *Vicio onobrychioidis-Hypericetum callithyrsi*.

The oromediterranean pine-juniper woodlands of *Daphno hispanicae-Pinetum sylvestris* appear above 1,850 m accompanied by mantle of *Berberido hispanicae-Juniperetum sabinae* and the xeroachantic scrub of *Saturejo intricatae-Velletum spinosae*. The humid soils of depressions on phyllites are covered by grasslands of *Plantago granatensis-Festucetum ibericae*.

The potential natural vegetation in this limestone-dolomitic area corresponds to the pine-juniper woodland of *Daphno oleoidi-Pinetum sylvestris.* There are also "quejigales" of *Daphno latifoliae-Aceretum granatensis*.

The seral stages best represented in this place are: *Lonicero splendidae- Berberidetum hispanicae, Saturejo intrincatae-Velletum spinosae* and the rupicolous communities of *Kernero boissieri-Teucrietum rotundifoliae alyssetosum cadavalliani*.

Adjacent to the forest-mantle communities of *Lonicero splendidaeae-Berberidetum hispanicae* occurs a herb community whose floristic combination is represented in the following relevé:

***Vicio onobrychioidis-Hypericetum callithyrsi*:** 4m^2. 1,800 m. North. *Vicia onobrychioides* 4, *Hypericum callithyrsum* 2, *Cynoglosum gr. creticum* 1, *Bromus squarrosus* 1, *Cerastium gibraltaricum* 2, *Acinos meridionalis* 2, *Helleborus foetidus* +, *Viola* sp. +, *Bunium macuca* 1.

The pine-juniper woodland of this basophilous oromediterranean belt of the Baetic subprovince is well represented in this place:

Daphno hispanicae-Pinetum sylvestris: 100 m^2. 1,980 m. 25º North. *Pinus sylvestris nevadensis* 5, *Juniperus hemisphaerica* 4, *Berberis hispanica* 2, *Ononis aragonensis* 2, *Festuca nevadensis* 4, *Lonicera splendida* 1, *Luzula nutans* +, *Polygala boissieri* 1, *Crepis oporinoides* 3, *Solidago virgaurea* 1, *Campanula hispanica* 2, *Cerastium gibraltaricum* 2, *Eryngium bourgatii* +.

The cushion-shaped (pulvinate) xeroacanthic scrub characteristic of the oromediterranean belt is represented in the following relevé:

Astragalo boissieri-Festucetum hystricis: 1,980 m. North. *Vella spinosa* 2, *Alyssum spinosum* 3, *Ononis aragonensis* 2, *Satureja intrincata* 2, *Astragalus gienennsis* 1, *Astragalus granatensis* 2, *Campanula hispanica* 1, *Dactylis hispanica* +, *Cerastium gibraltaricum* 1, *Helianthemum canum* 2, *Seseli montanum* +, *Arrhenatherum baeticum* 1, *Silene mellifera nevadensis* +, *Berberis hispanica* 1, *Cirsium gregarium* +, *Teucrium lerrouxi* +, *Koeleria vallesiana* +, *Jurinea humilis* +, *Helianthemum croceum* +.

The grasslands which replace the pine-juniper woodland in eroded plots where cryoturbation takes place are represented in the following relevé:

***Coronillo minimae-Astragaletum nummularioides*:** *Festuca hystrix* 2, *Festuca rivas-martinezi* (*indigesta*) 2, *Plantago granatensis* 2, *Koeleria humilis* 1, *Pimpinella litophila* 2, *Astragalus nummularioides* 3, *Ononis cristata* 2, *Helianthemum canum* 3, *Carduncellus araneosus* 2, *Seseli montanum* 2, *Erigeron major* +, *Dactylis hispanica* 2, *Arenaria murcica* 1, *Jurinea humilis* 1, *Serratula nudicaulis* +, *Ononis aragonensis* 1, *Draba hispanica* +, *Avenula iberica* 1, *Asperula aristata* 1, *Dianthus brachyanthus* 1.

Prados del Rey is an area of high mountain Mediterranean grasslands with special singularity and ecological value. They appear in intramountainous fosses above which clouds accumulate and release heavy precipitations. The rock type is determinant for the type of grassland: phyllites are impermeable and favour the flooding of the soil during a substantial part of the year. Several associactions distribute along the soil mosture gradient as shown in the following scheme:

Some relevés of the hygrophilous communities are presented:

Deschampsia hispanica* community*: 10 m^2. *Deschampsia hispanica* 4, *Apera interrupta* 1, *Festuca iberica* 3, *Sagina procumbens* 3, *Crepis oporinoides* 2, *Hipochaeris radicata* 1, *Saxifraga carpetana* 1, *Hieracium pilosella* 2, *Carex cariophyllea* 2, *Cerastium fontanum vulgare* 1, *Agrostis castellana* 1, *Lotus glareosus* 1, *Plantago granatensis*, *Deschampsia abreviata.*

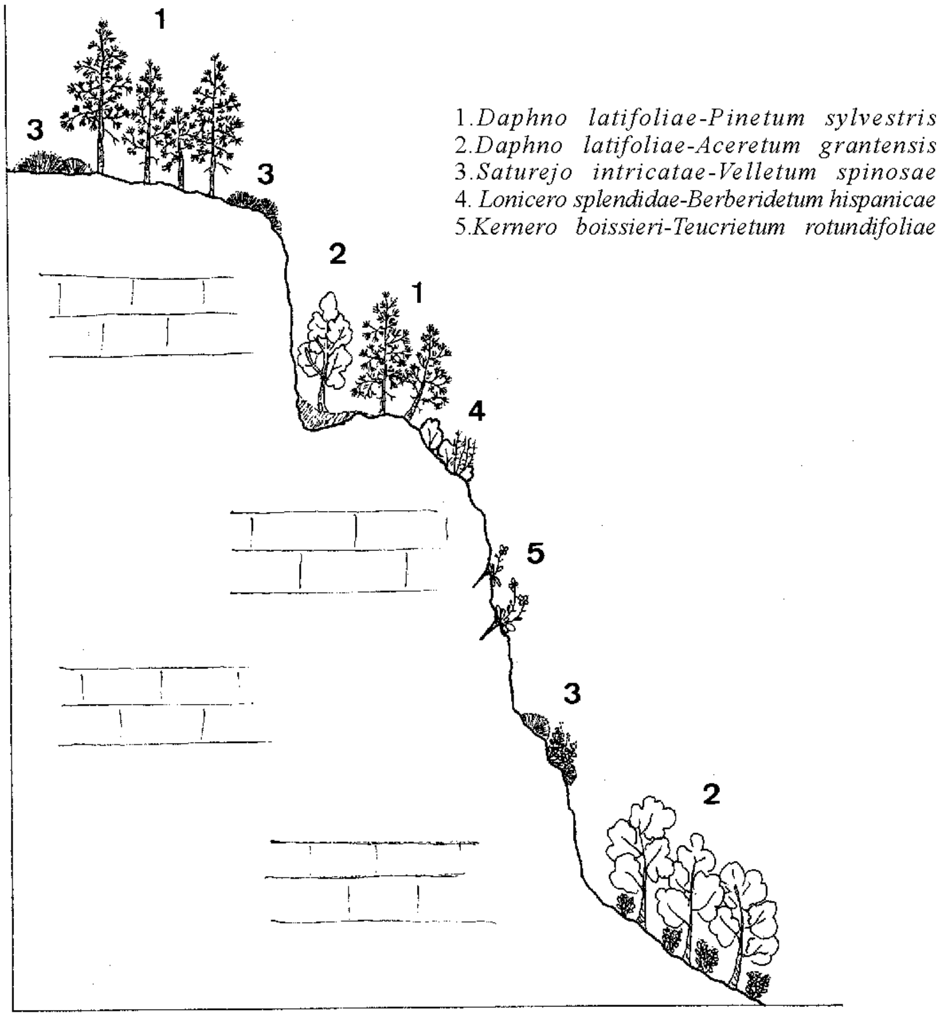
***Glycerio-Eleoscharidetum palustris*:** 1 m^2. *Eleocharis quinqueflora* 4-4, *Plantago granatensis* 2-2, *Carex leporina* 1-1, *Juncus articulatus* 2-., *Ranunculus bulbosus* 1, *Leontodon nevadensis 2, Deschampsia hispanica* 1

In the area surrounding Prados del Rey, the substitution shrubland of the potential pine-juniper woodland appear on dry non-hydromorphic soils on dolomite, as shown in the following relevé:

***Berberido hispanicae-Juniperetum sabinae*:** 1,970 m. 25º South. 200 m^2. *Juniperus sabina* var. *humilis* 4, *Juniperus hemisphaerica* 3, *Berberis hispanica* 2, *Poa flaccidula* 2, *Arrhenatherum baeticum* 2, *Silene mellifera nevadensis* 1, *Festuca elegans* 2, *Ononis aragonensis* 1, *Astragalus granatensis* +, *Erysimum baeticum* +, *Prunus ramburii* +, *Polygala boissieri* 1, *Rosa sicula* +, *Alyssum spinosum* +, *Helleborus foetidus* +.

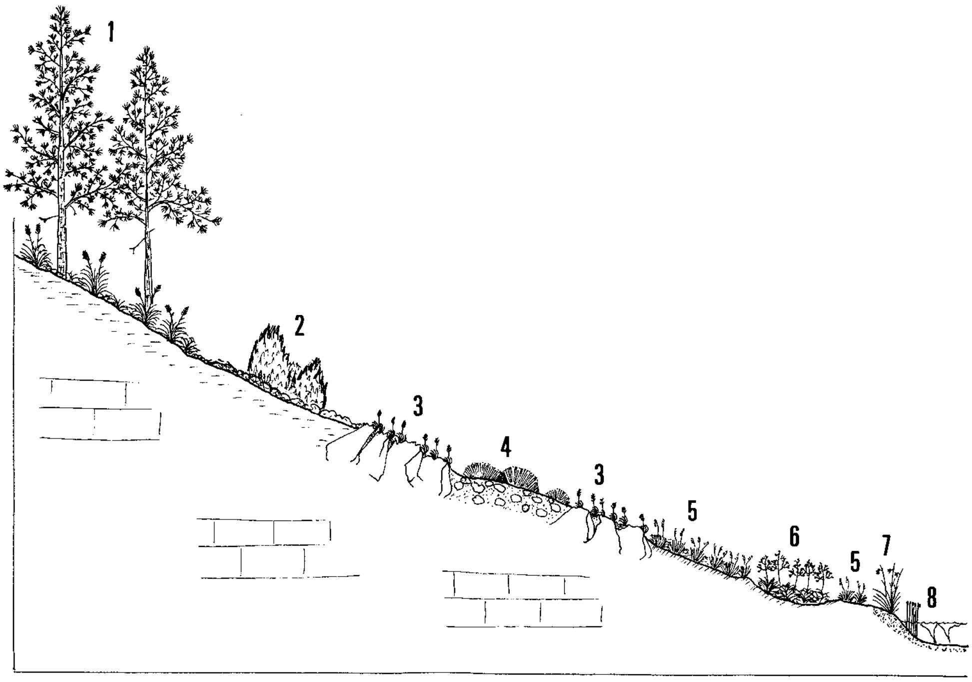
PICTURE 10

Locality: Sierra de Baza. Barranco de la Mina
Altitude: 1,870 m
Biogeography: Betic Province
Thermotype: Oromediterranean
Ombrotype: Humid
Lithology: Limestone dolomitic



PICTURE 11

Locality: Sierra de Baza. Prados del Rey
Altitude: 1,980 m
Biogeography: Betic Province
Thermotype: Oromediterranean
Ombrotype: Humid
Lithology: Limestone dolomitic



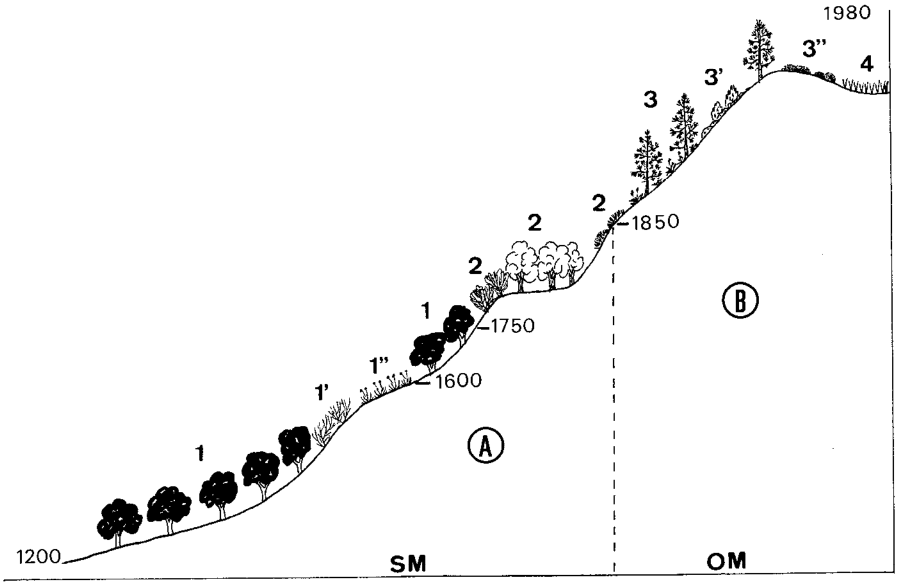
1. *Daphno latifoliae-Pinetum sylvestris*
2. *Berberido hispanicae-Juniperetum sabinae*
3. *Seselido-Festucetum hystricis* (cryoturbation)
4. *Saturejo intricatae-Velletum spinosae* (eroded soils)
5. *Plantago granatensis-Festucetum ibericae*
6. *Deschampsis hispanicaa* subsp. ligulata community (leached soils)
7. *Juncus inflexus*-community
8. *Glycerio-Eleocharitetum palustris*

PICTURE 12

Zonation of the vegetation in Sierra de Baza, 1980 m

A: Dolomite and limestone; **B**: Dolomite and phyllite.

SM: Supramediterranean, **OM**: Oromediterranean.



1. *Berberido hispanicae-Quercetum rotundifoliae*
   1'. *Cytisetum reverchonii*-mantle
   1". *Artemisio glutinosae-Santolinetum canescentis*-scrub
2. *Daphno latifoliae-Aceretum granatense*
   2'. *Pruno ramburei-Berberidetum hispanicae*-mantle
   2". *Santolino canescentis-Salvietum oxyodonti erinacetosum anthyllidis*-scrub
3. *Daphno latifoliae-Pinetum sylvestris*
   3'. *Berberidi hispanicae-Juniperetum sabinae*
   3". *Saturejo intricatae-Velletum spinosae*-scrub
4. Edapho-hygrophile grasslands of *Plantaginion nivalis* (*Nardetalia*)

GRANADA-MÁLAGA (14 July)

(The vegetation of Sierra Nevada)

JOAQUÍN MOLERO MESA

ويتّصل جبال مالقة بجبال ريّة حتّى تختلط بالجبل المسمّى شكير. وهذا الجبل من أحد عجائب الدنيا لأنّه جبل لا يخلو من الثلج صيفا وشتاء. ولقد يوجد فيه الثلج من عدّة أعوام قد أسود واشتدّ وصار مثل الحجر الأسود فاذا كسر وجد في قلبه ثلج أبيض. وهذا الجبل لا ينبت في رأسه نبات ولا يعيش فيه حيوان، وطرفه الاسفل معمور كلّه بالسكن متصل بعضه ببعض مسير ستة أيّام. وهو كثير الثمار والنبات: وفيه من الجوز واللّوز والقسطل والتفاح والغرصاد كثير. وهو أكثر بلاد اللّه حريرا.

ويخرج من هذا الجبل خمسة وعشرون نهرا، ينصبّ منها الى البحر الروميّ ثمانية عشر نهرا وينجلب منها سبعة انهار الى الوادي الكبير. ولا يقدر أحد أن يدخل هذا الجبل ولا أن يمشي فيه الا في ايّام الحر عند حلول الشمس في رأس الرطان، وربّما يمكن دخوله. وتوجد فيه عصافير السنبل والتربص وعنب العقاب وغيرها من الأعشاب الكثيرة النفعة. وليس لهذا الجبل مسلك الا من ثلاثة أماكن خاصة، فاذا صعد عليه أحد من هذه الجهات رأى منه بلادا عبيدة كارض تلمسان وغيرها. ويخاف على الداخل اليه من تلك الطرق في شدة الحرّ لانّ فيه نباء كبير عظيم يقوم في بعض الاحيان كما يقوم البحر. وتجري فيه ريح باردة تهلك كلّ من مرّ به وسار فيه من بني آدم وغيرهم من سائر الحيوانات، ولقد هلك خلق كثير من شدّة هذه الريح الباردة في زمن الصيف. وفي أسفل هذا الجبل في ناحية المغرب مدينة غرناطة - حفظها الله تعالى- وهي مدينة من أحسن مدن الأرض.

And the Málaga mountains are contiguous to those of Rayyo, till they unite with the mountain known as Sulayr (1). And this mountain is one of the wonders of the world because it is never free from snow neither in winter nor in summer. There can be found snow from many years which, blackened and solidified, looks like black stone; but when it is broken open white snow is found inside. On the summit of this mountains no plants grow and animals cannot live; but its slope is dotted with villages, very close together, in a stretch of six days' march, there being a great abundance of plants and fruits: plums, almonds, chestnuts, apples and rather a lot of grapes. And it is the richest city in silk production. From this mountain spring twenty five rivers, from which eighteen flow into in the Roman Sea (2) and seven into the Guadalquivir. Nobody can climb this mountain nor walk on it, except in the warm season, when the sun is in the sign of Scorpio, being then possible its access. There is found lavender of Genil (3), turbit (4), mountain stumps and many other useful plants. This mountain is only accessible by three special places (5) and when one ascends by one of them and reaches the summit, many regions can be seen, such as the land of Tremecen (6) and others. Even when climbing under the intensity of the warmth and by one of the indicated ways, there is a great danger to fear: the huge and thick fogs which appear there and rise like on the sea. An icy wind blows on it and kills any man or animal which passes through, many people have already died at the height of summer due to the harshness of this wind. At the foot of this mountain, on its western side, it lies the city of Granada -God, be praised, may it be preserved- which is one of the most beautiful cities in the world.

1- Arabic name for Sierra Nevada, taken from the Latin *solorius* or *solaris*, mountain of the sun, "*... because it shines, dazzling the sight, reflected in the everlasting snow of our mountain, whose summits can see it half an hour later than the city of Granada, making the days longer and the evenings lighter. It seems that God wishes to distinguish Granada from the other cities making the the evenings longer and giving them more illumination*" (Plinius, Historia Naturalis).
2- Mediterranean sea
3- the main tributary of the Guadalquivir river
4- a purgative plant of the Convolvulaceae
5- passes
6- North Africa

Fragment of Kitãb al-Yagrãfiyya
Muhammad b. Abî Bakr al-Zuhrî (Granada, 532/1137)

INTRODUCTION

Sierra Nevada is the most outstanding massif of the Baetic Ranges. It was formed about 20 million years ago and is located between the administrative provinces of Granada and Almería. It bears fourteen peaks above 3,000 m, among them the summit of Mulhacén, with 3,481 m of altitude, the highest of the Iberian Peninsula. Recently (December 1998) it was declared a National Park, specially because of its floristic richness and rarity, climatic diversity and originality of its vegetation. The National Park only comprises the area of a higher elevation, with an extent of 86,000 Has. Superimposed onto it, since 1989, there is the Sierra Neveda Natural Park, with 171,600 Has. In 1986 it was also declared a Biosphere Reserve in an extent of 190,000 Has.

Most of its territory is siliceous, with metamorphic rocks; there are, however, scattered outcrops of basic rocks such as marble, gneiss and serpentine. On the borders of Sierra Neveda, especially in the NW near the city of Granada, appear calcareous reliefs, limestone and dolomite, the latter very characteristically techtonised in some areas, where it disintegrates into white sands which are the habitat of very many local endemic taxa.

ITINERARY

The road will take us from the fertile and continental valley bottom of Granada to an altitude of over 3,000 m and will follow the Genil river valley, the biggest of those which originate in the massif, passing through a tunnel which crosses the interfluvial range of the Genil and Monachil river basins, following the route known as "camino de los neveros" which was the way used by the ancient collectors of ice and snow.

The ascend starts in the lower mesomediterranean thermotype, although the thermophilic elements (*Pistacia lentiscus, Nerium oleander*, ...), indicators of this lower horizon, soon disappear. During the first stretch in which we cross the mesomediterranean belt, i,e. till ca. 1,300-1,400 m, the landscape is dominated by the Baetic, Marianense and Araceno-Pacense dry-subhumid basophylous vegetation series of the carrascales *(Paeonio coriaceae-Querco rotundifoliae sigmetum)*, whose potential natural vegetation is a *Quercus rotundifolia* forest (carrascal); its floristic composition is shown in the following synthetic table:

Paeonio coriaceae-Quercetum rotundifoliae: *Quercus rotundifolia* V, *Rubia peregrina* V, *Asparagus acutifolius* V, *Daphne gnidium* V, *Paeonia broteroi* II, *Quercus faginea* I, *Quercus coccifera* I, *Juniperus oxycedrus* I, *Lonicera implexa* I, *Clematis flammula* I,*Piptatherum paradoxum I* (Losa Quintana & al. 1986, Pérez Raya 1987).

The geologic materials of this first stretch are basically schist and quartzitic debris carried down from upper levels, which are included in a compact matrix of a basic character, together with rocky substrates of limestone and dolomite. The intensively cultivated valley bottoms and depressions are occupied by marly limestones.

The carrascal has almost entirely disappeared due to human influence: agriculture, wood cutting for fuel, etc., the same as its forest mantle, the coscojar of the association *Crataego monogynae-Quercetum cocciferae*, which is even more scanty. The broom community or retamar is more frequent as well as the espartal *(Thymo gracilis-Stipetum tenacissimae)* and the thyme scrub of lithosols and stony places *(Thymo gracilis-Lavanduletum lanatae)*; their floristic compsition is shown in the following synthetic tables:

Retamo sphaerocarpae-Genistetum speciosae: *Retama sphaerocarpa* IV, *Genista cinerea speciosa* IV, *Quercus rotundifolia* I, *Daphne gnidium, I* (Losa Quintana & al. 1986)

Thymo gracilis-Stipetum tenacissimae: *Stipa tenacissimae* V, *Dactylis hispanica* IV, *Avenula bromoides* III, *Anthyllis cytisoides* III, *Arrhenaterum erianthum* I, *Helictotrichon filifolium I: Thymus* *zygis subsp. gracilis* IV, *Rosmarinus oficcinalis IV* (Pérez Raya 1987, Pérez Raya & Molero Mesa 1988a)

***Thymo gracilis-Lavanduletum lanatae**: Lavandula lanata* V, *Ulex parviflorus* V, *Cistus clusii* IV, *Rosmarinus officinalis* IV, *Thymus zygis subsp. gracilis* IV, *Fumana thymifolia* IV, *Helianthemum rubellun* III, *Leuzea conifera* II, *Digitalis obscura* I, *Ptilostemum hispanicum* I, *Paronychia suffruticosa* I, *Helianthemum lavandulifolium* I, *Fumana ericoides I* (Pérez Raya 1987, Pérez Raya & Molero Mesa 1988b).

In the calcareous rocks there are three rupicolous associations: *Jasonio glutinosae-Teucrietum rotundifoliae*, *Sarcocapnetum crassifoliae* and *Asplenietum hispanici*, while in the cliffs and talus of the sandstone rocks and siliceous debris *Campanulo velutini-Phagnaletum intermedii* and the extremely interesting *Anthirrhino hispanici-Putorietum calabricae* are found.

***Antirrhino hispanici-Putorietum calabricae**: Putoria calabrica* V, *Phagnalon sordidum* III, *Andryala ramosissima* III, *Jasonia glutinosa* III, *Dianthum malacitanus* II, *Campanula velutina* II, *Anthirrhinum hispanicum* II (Pérez Raya 1987).

The road runs along the left bank of the Genil river. rom the Balcón de Canales there is a good view of the Genil basin, which is partially occupied by a recently built dam.

A few kilometres further on, the road begins to cross the limestone-dolomite border of Sierra Nevada. At about 1,400 m, starts the supramediterranean thermotype and thus the supramediterranean Baetic basophile vagetation series of the carrascales or *Berberidi hispanicae-Querco rotundifoliae sigmetum*. A good example of the potential forest and the forest mantle is given in the following tables:

***Berberidi hispanicae-Quercetum rotundifoliae**: Quercus rotundifolia* V, *Rubia peregrina* III, *Helleborus foetidus* III, *Daphne gnidium* II, *Paeonia coriacea* II, *Arctostaphylus uva-ursi* subsp. *crassifoliae* II, *Berberis hispanica* V, *Amelanchier ovalis* IV, *Crataegus monogyna IV* (Losa Quintana & al. 1986, Pérez Raya 1987).

***Lonicero splendidae-Berberidetum hispanicae**: Berberis hispanica* V, *Crataegus monogyna* V, *Prunus ramburii* IV, *Cotoneaster granatensis* III, *Lonicera splendida* III, *Rhamnus myrtifolius* III, *Amelanchier ovalis* II, *Clematis vitalba* II, *Lonicera arborea* II, *Rosa pouzinii* II, *Rhamnus saxatilis infectoria* II, *Rosa spinosissima* I, *Prunus mahaleb I* (Asensi & Rivas Martínez 1979, Martínez Parras & Molero Mesa 1983b, Pérez Raya 1987).

The seral tall grasslands on limestone:

***Helictotricho filifolii-Festucetum scariosae**: Festuca scariosa* V, *Avenula bromoides* IV, *Dactylis hispanica* III, *Arrhenatherum album* II, *Helictotrichon filifolium* II, *Brachypodium retusum* II, *Piptatherum miliaceum* I, *Helictotrichon sarracenorum* I, *Stipa offneri* I (Losa Quintana & al. 1986, Pérez Raya 1987, Pérez Raya & Molero Mesa 1988a)

on dolomite:

Helictotricho sarracenori-Brachypodietum boissieri: *Brachypodium boissieri* V, *Helictotrichon sarracenorum* V, *Koeleria vallesiana* IV, *Avenula bromoides* III, *Festuca nevadensis* II, *Stipa dasy-*

vaginata II, *Arrhenaterum bulbosum* I, *Trisetum velutinum* I, *Festuca paniculata moleroi* I (Pérez Raya 1987, Pérez Raya & Molero Mesa 1988a).

and the seral thyme scrub (tomillar) on lithosols:

Convolvulo lanuginosi-Lavanduletum lanatae: *Salvia lavandulifolia* V, *Erinacea anthyllis* IV, *Lavandula lanata* IV, *Linum narbonense* III, *Euphorbia nicaeensis* III, *Linum suffruticosum* III, *Bupleurum spinosum* II, *Helianthemum rubellum* II, *Ulex parviflorus* II, *Thymus granatensis* II, *Thymus mastichina* II, *Scabiosa turolensis* II, *Phlomis crinita composita* I, *Thymelea elliptica* I, *Ptilostemum hispanicum* I (Pérez Raya 1987).

The rupicolous vegetation is formed by the following associations:

In the limestone rock crevices:

Kernero boissieri-Teucrietum rotundifolii: *Teucrium rotundifolium* V, *Chaenorrhinum villosum* IV, *Kernera boissieri* III, *Hormathophylla longicaulis* III, *Potentilla petrophila* II, *Linaria verticillata* II, *Draba hispanica* II (Quézel 1953, Pérez Raya 1987, Losa Quintana & Pérez Raya 1986).

In the fixed screes:

Erodio daucoidis-Saxifragetum erioblastae: *Saxifraga erioblasta* V, *Festuca hystrix* V, *Erodium daucoides* IV, *Arenaria grandiflora* IV, *Poa ligulata* IV, *Erysimum nevadense* II (Losa Quintana & Pérez Raya 1986, Pérez Raya 1987).

In the dolomitic white sands the endemic-rich dwarf thyme scrub (tomillar):

Andryalo agardhii-Convolvuletum boissieri: *Thymus granatensis* IV, *Asperula scabra* IV, *Arenaria armerina caesia* IV, *Anthyllis argyrophilla* IV, *Helianthemum viscidulum* III, *Alyssum malacitanum* III, *Pterocephalus spathulathus* III, *Santolina elegans* III, *Convolvulus boissieri* III, *Scabiosa pulsatilloides* III, *Rothmaleria granatensis* III, *Paronychia aretioides* II, *Erodium boissieri* II, *Anthyllis tejedensis* I, *Globularia spinosa* I (Quézel 1953, Losa Quintana & al. 1986, Martínez Parras & Peinado 1987).

After the fork the road climbs rapidly and changes side. At about 1,800 m, under the Dornajo peak, the Monachil valley can be seen as well as a broad view of the high summits: the Veleta and the Tajos de la Virgen (where the Fraile de Capileira can be distinguished) in the upper part of the valley and opposite the Dornajo, is the Loma de Dílar separating the basins of the Monachil and Dílar river valleys.

From this point and on the whole south-facing slope of the Dornajo which covers ca. 5 Km, we can observe the different aspects of the vegetal landscape. The distribution of the supra, oro and crioromediterranean belts on the mountain slopes is very clear. In the Loma de Dílar the change in the geological substratum is observed: to the left, towards the summits, the metamorphic materials, mostly micaschist, crop out, while near the Collado de las Matas, close to the Pico del Tesoro, the substrata become calcareous with a dominance of dolomites, easily disintegrating into white sands. In this dolomitic outcrop the southernmost *Pinus sylvestris* population of this area can be observed; the populations of this area, as well as those of Sierra de Baza, belong to a particular race: *Pinus sylvestris* subsp. *nevadensis*. At the bottom of the Monachil river valley there is a good representation of the melojar of this Nevadense territory; it extends till the Benalcázar ravine:

Adenocarpo decorticantis-Quercetum pyrenaicae: *Quercus pyrenaica* V, *Crataegus monogyna* V, *Doronicum plantagineum* IV, *Campanula rapunculus* IV, *Lonicera arborea* III, *Luzula forsteri* III, *Rosa corymbifera* II, *Rosa pouzinii* II, *Sorbus aria* I, *Sorbus torminalis* I, *Cephalantera longifolia* I, *Festuca elegans* IV, *Adenocarpus decorticans IV* (Martínez Parras & Molero Mesa 1983a, Losa Quintana & al 1986)

After the Fuente de Don Manuel, the limestone-dolomotic substrata are replaced by siliceous rocks, predominantly micaschist. In this area pine afforestations have been intense. Among the pines develop the different communities of the supramediterranean Nevadense silicicolous vegetation series of the melojares or *Adenocarpo decorticantis-Querco pyrenaicae* sigmetum which disappears above 2,100 m at the entrance of the ski resort. However, during this stretch the regeneration of the natural *Quercus pyrenaica* forest can be appreciated as well as the piornal which forms its forest mantle: *Cytiso scoparii-Adenocarpetum decorticantis*, and the seral scrum or jaral: *Halimio viscosi-Cistetum laurifolii*. Their floristic composition is shown in the following tables:

Cytiso scoparii-Adenocarpetum decorticantis: *Adenocarpus decorticans* V, *Cytisus scoparius* IV, *Genista baetica* II (Losa Quintana & al 1986, Pérez Raya 1987)

Halimio viscosi-Cistetum laurifolii: *Cistus laurifolius* V, *Halimium viscosum* III, *Cistus salvifolius* II, *Thymus mastichina* II, *Helichrysum serotinum* II, *Lavandula stoechas I* (Martínez Parras & Molero Mesa 1983a, Losa Quintana & al 1986).

In the rocky places occurs the endemic association:

Diantho lusitani-Antirrhinetum rupestris: *Antirrhinum rupestre* IV, *Dianthus lusitanus* IV, *Phagnalon saxatile* II, *Hieracium amplexicaule* II, *Crambe hispanica* II, *Biscutella sempervirens,* II (Losa Quintana & al 1986).

In the oromediteranean belt the road turns abruptly to the left leaving the way towads the ski resort and climbs rapidly towards the Collado de las Sabinas. At this point, at 2,200 m, appear again the the limestone-dolomitic substrata, which contact with the siliceous ones, bearing the the oromediterranean Baetic baophilous vegetation series of the dwarf juniper and pine woodlands: *Daphno oleoidi-Pino sylvestris sigmeum*. There we find the potential natural vegetation *(Daphno oleoidi-Pinetum sylvestris),* the spiny mantle *(Lonicero splendidae-Berberidetum hispanicae),* the cushion-shaped *(xeroacanthic)* scrub *(Astragalo boissieri-Festucetum hystricis),* the dwarf thyme scrub (tomillar) on dolomitic white sands (*Andryalo agardhii-Convolvuletum boissieri*), the nanochamaephytic grassland *(Coronillo minimae-Astragaletum nummularioides),* the grassland *(Seseli granatensis-Festucetum hystricis)* and the moist grasslands of *Nardetea strictae (Plantagini granatensis-Festucetum ibericae)* of the Baetic high mountains; the floristic composition of some of those associations is shown in the following tables:

Daphno oleoidis-Pinetum sylvestris: *Juniperus sabina* V, *Juniperus communis hemisphaerica* IV, *Daphne oleoides* II, *Geum heterocarpum* II, *Prunus prostrata* II, *Ononis aragonensis* II, *Hypericum hyssopifolium* I, *Odontites granatensis* I (Losa Quintana & al 1986, Pérez Raya 1987, Molero Mesa 1998).

Astragalo biossieri-Festucetum hystricis: *Astragalus granatensis* V, *Erinacea anthyllis* V, *Vella spinosa* V, *Bupleurum spinosum* IV, *Teucrium montanum* IV, *Arenaria armerina caesia* IV, *Jurinea humilis* III, *Erysimum nevadensis* III, *Hormathophylla spinosa* III, *Centaurea granatensis* II, *Ononis aragonensis* II, *Scabiosa turolensis* II, *Marrubium supinum* II, *Polygala boissieri* II, *Erysimum myriophyllum* II (Quézel 1953, Losa Quintana & al 1986, Pérez Raya 1987).

Coronillo minimae-Astragaletum nummularioidis: *Astragalus nummularioides* V, *Coronilla minima* V, *Ononis cristata* V, *Poa ligulata* V, *Koeleria nevadensis* V, *Festuca hystrix* IV, *Arenaria armerina* III, *Astragalus vesicarius* II (Pérez Raya 1987, Pérez Raya & Molero Mesa 1990).

Seselido granatensis-Festucetum hystricis: *Festuca hystrix* V, *Seseli granatense* V, *Poa ligulata* V, *Jurinea humilis* IV, *Koeleria vallesiana* II (Martínez Parras & al 1987a, Pérez Raya 1987).

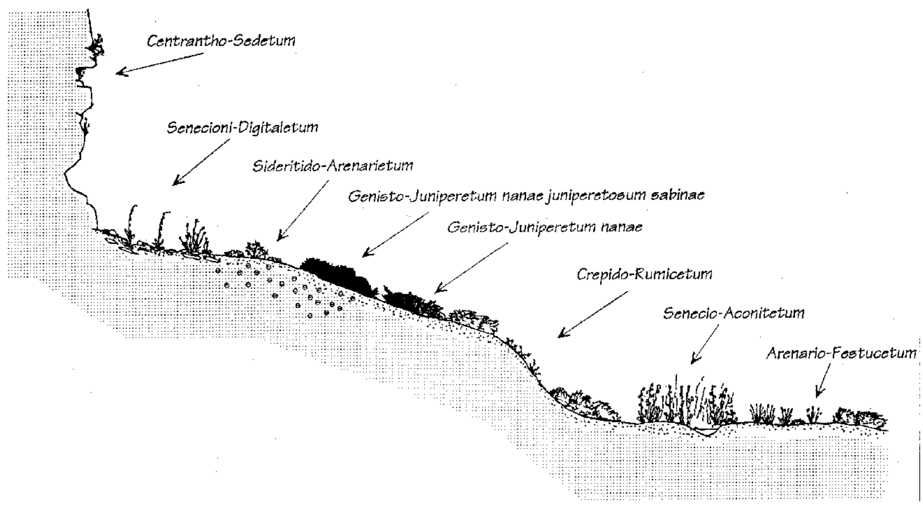


Figure 15: Oromediterranean Nevadense communities (*Genisto-Junipero nanae sigmetu*m)

On the rocks, *Kernero boissieri-Teucrietum rotundifolii*, and in their basis, *Erodio daucoidis-Saxifragetum erioblastae* appear. It is seen for the first time a small example of a *Nardetea strictae* association: *Plantagini granatensis-Festucetum ibericae*, typical of the high Baetic calcareous mountains (Gómez & al 1995).

From this point onwards the road crosses siliceous lands belonging to the Nevadense sector. The vegetation is organised in the oromediterranean Nevadense silicicolous vegetation series of the dwarf juniper or *Genisto baeticae-Junipereto nanae sigmetum* (Fig. 15), which covers the area up to 2,800-3,000 m. The potential natural vegetation corresponds to the dwarf juniper shrublands of *Genisto baeticae-Juniperetum nanae*, which presents two variants or subassociations: *juniperetosum sabinae* in base-rich substrata, and species poor *cytisetosum galianoi* in eroded soils. Their floristic composition is shown in the following table:

Genisto versicoloris-Juniperetum nanae: *Juniperus hemisphaerica* V, *Genista versicolor* III, *Deschampsia iberica* III, *Thlaspi nevadense* II. Differentials for ***juniperetosum sabinae***: *Juniperus sabina* V, *Teucrium lerrouxii* IV, *Prunus prostrata* III, *Thymus gadorensis* II, *Astragalus sempervirens nevadensis* II. Differentials for ***cytisetosum galianoi***: *Cytisus galianoi* V, *Avenula laevis,* II. (Quézel 1953, Losa Quintana & al. 1986, Molero Mesa 1990).

The seral stages are represented by the hard grassland *(Arenario granatensis-Festucetum indigestae)* and the thyme scrub (tomillar) linked to base-rich outcrops such as marble, carbonates accumulations and ultrabasic rocks *(Sideritido glacialis-Arenarietum pungentis)*. Their floristic composition is as follows:

Arenario granatensis-Festucetum indigestae: *Festuca indigesta* V, *Thymus serpylloides* V, *Arenaria imbricata* IV, *Jurinea humilis* IV, *Teucrium lerrouxii* III, *Leucanthemopsis pectinata* III, *Leontodon boryi* III, *Plantago radicata granatensis* II, *Senecio boissieri* II, *Herniaria boissieri* II (Losa Quintana & al 1986, Martínez Parras & al 1987b).

Sideritido glacialis-Arenarietum pungentis*: Sideritis glacialis* IV, *Arenaria pungens* III, *Festuca indigesta* V, *Thymus serpylloides* V, *Hormathophylla spinosa* IV, *Arenaria imbricata* IV, *Draba hispanica* subsp. *laderoi* III, *Erodium cheilanthifolium* III, *Dianthus brachyanthus* III, *Anthyllis vulneraria nivalis* III, *Androsace vitaliana* subsp. *assoana* II, *Erysimum grandiflorum* II (Quézel 1953, Losa Quintana & al 1986, Martínez Parras & al 1987b).

The snow-patch communities are included in the association *Omalotheco pusillae-Lepidietum stylati* and appear covering scatterd plots in the oromediterranean thermotype, as well as the sandy slopes grasslands of the association *Festucetum moleroi-pseudoeskiae*. Both become more frequent at the upper level of this thermotype.

The screes are inhabited by the communities of *Senecioni granatensis-Digitaletum nevadensis* while in the broad fissures between big rocky blocks live the communities of *Campanulo willkommii-Polystichetum lonchitidis* and in the rock crevices the association *Centrantho nevadensis-Sedetum brevifolii*. The following tables show their floristic composition:

Senecioni granatensis-Digitaletum nevadensis: *Digitalis purpurea nevadensis* V, *Senecio pyrenaicus granatensis* IV, *Reseda complicata* V, *Crepis oporinoides* V, *Coincya monensis nevadensis* IV, *Cirsium gregarium* III, *Solidago virga-aurea minuta* III, *Holcus caespitosus* III, *Galium rosellum* II, *Euphorbia nevadensis* II, *Hormathophylla spinosa* II (Quézel 1953, Martínez Parras & al 1987c).

Campanulo willkommii-Polystichetum lonchytidis: *Cryptogramma crispa* V, *Polystichum lonchytis* V, *Dryopteris filix-mas* V, *Cystopteris fragilis* IV, *Polystichum aculeatum* III, *Murbeckiella boryi* II, *Campanula willkommii* II, *Cerastium alpinum nevadensis I* (Losa Quintana & al 1986).

Centrantho nevadensis-Sedetum brevifolii: *Centranthus nevadensis* V, *Sedum brevifolium* V, *Sempervivum minutum* V, *Hieracium amplexicaule* IV, *Androsace vandellii* IV, *Asplenium septentrionale* IV, *Silene rupestris* IV, *Rhamnus pumila* II, *Murbeckiella boryi* II, *Asplenium viride* II, *Polypodium vulgare* I, *Alchemilla saxatilis* I (Quézel 1953, Losa Quintana & al. 1986, Martínez Parras & al 1987c).

The stony debris and talus are inhabited by a *Rumici-Dianthion* association: *Crepido oporinoides-Rumicetum indurati*, and the nitrophilous vegetation is represented by *Festuco coerulescentis-Verbascetum nevadensis*.

Crepido oporinoidis-Rumicetum indurati: *Rumex induratus* V, *Crepis oporinoides* V, *Echium flavum* IV, *Digitalis purpurea nevadensis* III, *Eringium bourgattii hispanicus* III (Rivas Martínez & al. 1986).

Festuco coerulescentis-Verbascetum nevadensis: *Verbascum nevadense* IV, *Artemisia glutinosa* IV, *Artemisia absinthium* IV, *Chondrilla juncea* IV, *Lactuca scariosa* IV,*Rumex induratus* III, *Cirsium odontolepis* III, *Marrubium supinum* II, *Festuca caerulescens* II (Esteve & López Guadalupe 1973).

Aquatic vegetation is diverse in this belt. Reed communities are quite frequent *(Carici camposii-Juncetum effusi)* as well as the helophytic herb communities *(Glycerio declinatae-Apietum noiflorii* and *Caricetum paniculatae)*. In some ponds occasionally appear the *Ranunculetum hederacei* and, if they dry out in summer, the *Juncetum perpusilli* covers the bottom. Megaforbic vegetation is represented by *Senecio elodis-Aconitetum nevadensis* and in the water springs the little helophytes association *Sedo melanantheri-Saxifragetum alpigenae* lives. The floristic composition of all of them is as follows:

Carici camposii-Juncetum effusi: *Juncus effusus* V, *Holcus lanatus* V, *Carum verticillatum* IV, *Leontodon carpetanus nevadensis* III, *Carex camposii* III, *Poa trivialis* III, *Anthoxanthum odoratum* II, *Carex leporina* I, *Agrostis capilaris* I (Molero Mesa 1998).

Glycerio declinatae-Apietum nodiflorae: *Glyceria declinata* V, *Veronica becabunga* III, *Veronica anagallis-aquatica* II, *Apium nodiflorum* II, *Rorippa nasturtium-aquaticum* I, *Lythrum salicaria* I, (Molero Mesa 1998).

caricetum paniculatae*:* *Carex paniculata* V, *Veronica becabunga* II, *Epilobium parviflorum* II (Molero Mesa 1998).

Ranunculetum hederacei: *Ranunculus hederaceus* V, *Callitriche stagnalis* III (Molero Mesa 1998).

Juncetum perpusilii: *Juncus perpusillus* IV, *Juncus bufonius* IV, *Lythrum portula* III, *Scirpus setaceus* II (Molero Mesa 1998).

Senecio eloidis-Aconitetum nevadensis: *Aconitum burnatii nevadense* IV, *Aconitum vulparia neapolitanum* III, *Primula elatior lofthouse* III, *Cirsium pyrenaicum* II, *Alchemilla xanthoclora* II, *Rumex acetosa* I, *Senecio elodes* I, *Cochlearia megalosperma* I, *Chaerophyllum hirsutum* I (Quézel 1953, Losa Quintana & al. 1986, Martínez Parras & al. 1987c).

Sedo melanantheri-Saxifragetum alpigenae: *Saxifraga stellaris alpigena* V, *Veronica langei* V, *Sedum melanantherum* V, *Festuca rivularis* IV, *Stellaria alsine* III *Epilobium alsinifolium* III (Martínez Parras & al. 1986).

There are areas of different size in which, due to topography, the accumulation of water in the soil occurs. This causes the development of a particular vegetation in these high Nevadense mountains, in which *Nardus* grasslands (cervunales) occupy most of the area and often there is also a small sedge mire with a *Scheuchzerio-Caricetea fuscae* community (Fig. 16). Those summergreen grassland assemblages are called “borreguiles” and they usually to have a particular zonation in their plant communities.

1-The driest belt, in contact with the non-hydromorphic grasslands of *Festucetea indigestae*, is occupied by not very dense *Nardus* grassland of the association *Armerio splendentis-Agrostietum nevadensis*

2- In more hydromorphic soils the humid *Nardus* grasslands of *Nardo strictae-Festucetum ibericae* develop; there are two variants for the contact with the mire, one with *Carex intricata* if the contact is abrupt and another with *Carex nevadensis* if the transition is progressive as a result of a slow filling of the mire.

3- Sedge fen.

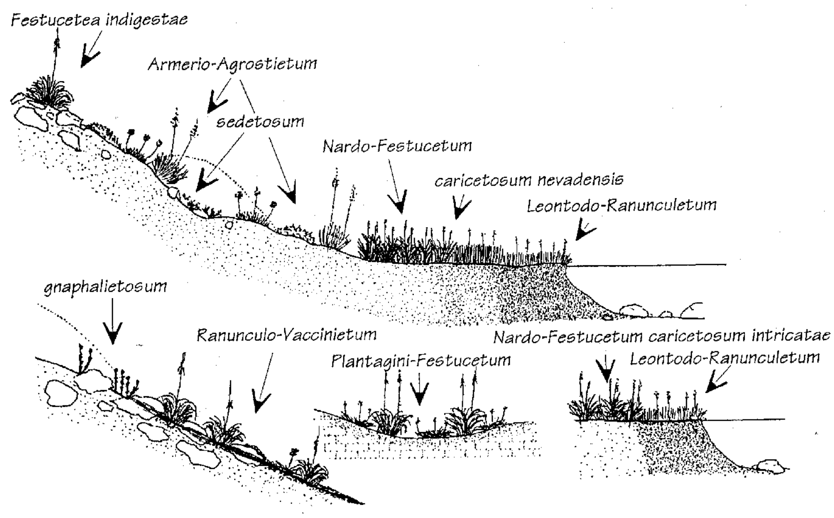


Figure 16. *Plantaginion thalackeri (Nardetea strictae)* communities

The floristic composition of those associations is shown in the following tables

Armerio splendentis-Agrostietum nevadensis: *Armeria splendens* V, *Plantago radicata granatensis* V, *Arenaria imbricata* IV, *Herniaria boissieri* IV, *Leucantemopsis pectinata* IV, *Nardus stricta* V, *Plantago nivalis* IV, *Sagina nevadensis* IV, *Lotus boissieri* IV, *Campanula herminii* III, *Festuca iberica* II (Quézel 1953, Losa Quintana & al. 1986, Martínez Parras & al 1987b, Rivas Martínez 1998).

Nardo strictae-Festucetum ibericae: *Festuca iberica* V, *Nardus stricta* V, *Trifolium repens nevadense* V, *Plantago nivalis* V, *Euphrasia willkommii IV*, *Sagina nevadensis* IV, *Campanula herminii* IV, *Luzula campestris nevadensis* IV, *Lotus boissieri* IV, *Meum athamanticum* III (Quézel 1953, Losa Quintana & al. 1986, Martínez Parras & al 1987b, Molero Mesa 1998, Rivas Martínez & al. 1998).

There are three associations which can occupy the centre of the borreguil: *Festuco rivularis-Veronicetum turbicolae* in initial mires, *Leontodo microcephali-Ranunculetum uniflori* in well structured and developed mires (variants with *Cerastium cerastioides* for places where water flows slowly, with *Polytrichum juniperinum* for pioneer stages common in the small depressions of the cervunal and with *Vaccinium uliginosim* subsp. *nanum* of the little peat bogs) and *Eleocharidetum quinqueflorae*, a species poor and low cover association, in initial pioneer situations of muddy mires with unstable substratum.

Festuco rivularis-Veronicetum turbicolae: *Festuca rivularis* V, *Leontodon microcephalus* V, *Phleum abbreviatum* IV, *Veronica turbicola* IV, *Carex camposii* III, *Carex nigra intrincata* III, *Carex nevadensis* III, *Viola palustris* III, *Cerastium cerastioides* III, *Pinguicula nevadensis* II (Quézel 1953, Losa Quintana & AL. 1986, Martínez Parras & al. 1987b, Rivas Martínez & al. 1998).

Leontodo microcephali-Ranunculetum uniflori: *Carex nigra intrincata* V, *Leontodon microcephalus* V, *Festuca frigida* IV, *Ranunculus angustifolius uniflorus* IV, *Carex echinata* III, *Pinguicula nevadensis* III, *Viola palustris* III, *Agrostis canina granatensis* II, *Carex furva* II (Prieto 1971, Losa Quintana & al. 1986, Martínez Parras & al. 1987b).

Eleocharidetum quinqueflorae: *Eleocharis quinqueflora* V, *Juncus alpino articulatus* III, *Triglochin palustris* II (Molero Mesa 1998, Rivas Martínez & al. 1998).

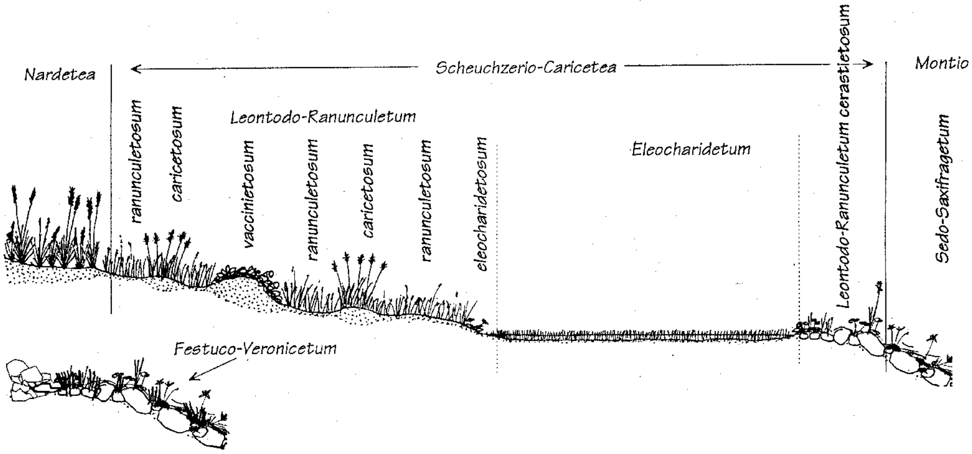


Figure 17. *Caricion fuscae (Scheuchzerio-Caricetea fuscae)* communities

After passing the Peñones de San Francisco and the upper part of the ski resort, called borreguiles, at about 2,800-3,000 m we enter the crioromediterranean belt or thermotype. From this level till the 3,481 m of the Mulhacén summit there is a gap of almost 700 m for this thermotype, the broadest of the Iberian Peninsula. The climactic vegetation is a psychroxerophilous grassland of the *Festucetea indigestae* class which is the potential natural vegetation of the crioromediterranean Nevadense silicicolous vegetation series of the *Festuca clementei* grasslands or *Erigeronto frigidi-Festuco clementei sigmetum*.

The association *Erigeronto frigidi-Festucetum clementei* has a fragmentary scattered distribution occupying the scanty soil patches available. It presents several variants depending on the ecological conditions: on soil depressions and north-facing slopes where snow remains longer, is found the *Vaccinium uliginosum* var. *nanum* variant; on non acidic or slightly basic substrata, is found the *Arenaria pungens* variant and on stony slopes, the variant with *Alyssum spinosum*.

Erigeronto frigidi-Festucetum clementei: *Festuca clementei* V, *Arenaria imbricata* V, *Jasione crispa amethystina* V, *Alyssum purpureum* V, *Trisetum gñlaciale* IV, *Erigeron frigidus* III, *Luzula hispanica* III, *Leontodon boryi* III, *Erigeron major* III, *Leucanthemopsis pectinata* II, *Anthyllis vulneraria nivalis* II, *Artemisia granatensis* II (Quézel 1953, Rivas Martínez & al. 1986, Losa Quintana & al. 1986, Molero Mesa 1998).

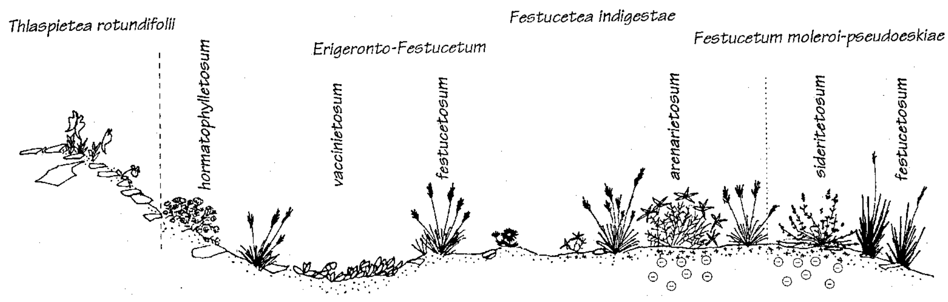


Figure 18. *Ptilotrichion purpurei (Festucetea indigestae)* communities

The hard grassland of *Festucetum moleroi-pseudoeskiae* occupies sunny slopes on sandy substrate; it has a silicibasicolous variant with *Sideritis glaciale*.

Festucetum moleroi-pseudoeskiae: *Festuca pseudoeskia* V, *Arenaria imbricata* IV, *Jasione crispa amethystina* IV, *Hormathophylla spinosa* IV, *Leontodon boryi* III, *Eryngium glaciale* III, *Leucanthemopsis pectinata* III, *Biscutella glacialis* II, *Silene boryi* II (Quézel 1953, Losa Quintana & al. 1986, Molero Mesa 1998).

On unstable screes is found the *Violo nevadensis-Linarietum glacialis* association while in the fissures between big rock blocks live the communities of *Campanulo wilkommii-Polystichetum lonchitidis* in a somewhat impoverished version. The crevices of the rocky cliffs are inhabited by the *Saxifragetum nevadensis* communities.

Violo nevadensis-Linarietum glacialis: *Viola crassiuscula* V, *Linaria glacialis* V, *Coincya monensis nevadensis* IV, *Holcus caespitosus* IV, *Crepis oporinoides* IV, *Reseda complicata* III, *Chaenorrhinum glareosum* III, *Euphorbia nevadensis* II, *Eryngium glaciale* II, *Galium rosellum* II, *Papaver suaveolens* I (Quézel 1953, Losa Quintana & al. 1986).

Saxifragetum nevadensis: *Saxifraga nevadensis* V, *Asplenium viride* IV, *Androsace vandellii* IV, *Asplenium septentrionale* IV, *Murbeckiella boryi* IV, *Cardamine resedifolia* IV, *Silene rupestris* IV, *Poa nemoralis* III, *Saxifraga oppositifolia* II, *Alchemilla saxatilis* II, *Draba dubia nevadensis* II, *Cerastium alpinum nevadense* II, *Arabis alpina* I, *Valeriana apula* I (Quézel 1953, Losa Quintana & al. 1986).

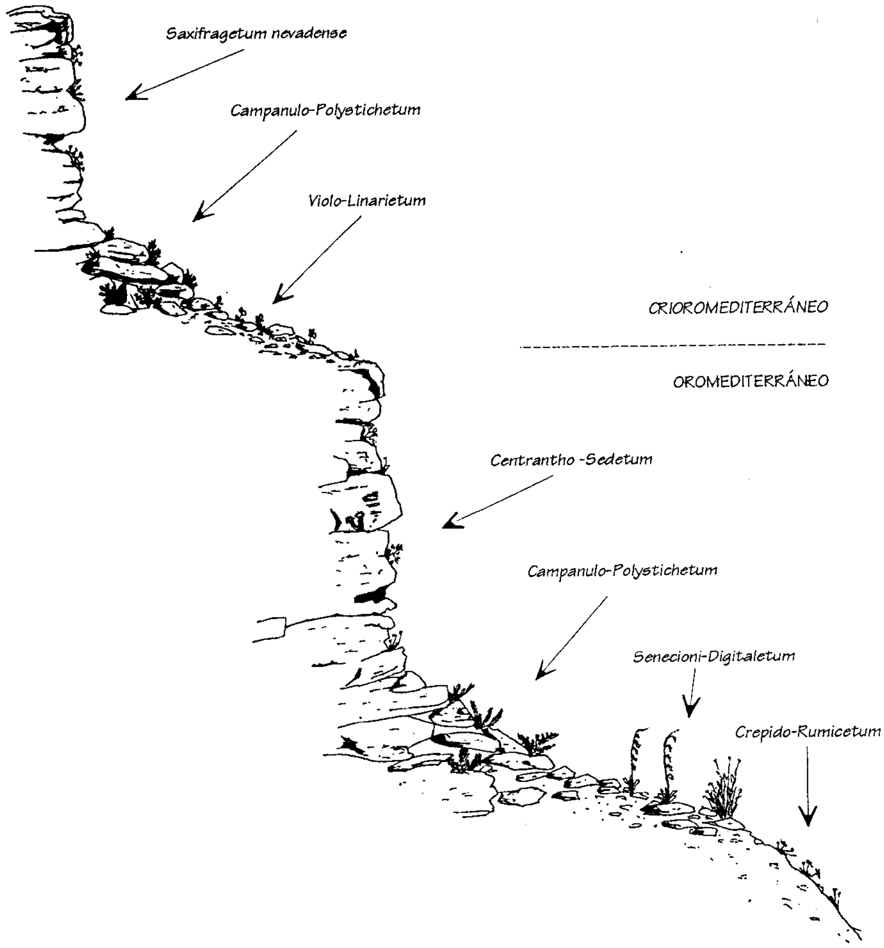


Figure 19: Distribution of the rupicolous, scree and crevices communities *(Asplenietea, Thlaspietea, Phagnalo-Rumicetea)*

The aquatic vegetation is structured in a similar way to that in the oromedierranean belt, although they show a slightly impoverishment in the number of species. On the border of the streams lives *Sedo melanantheri-Saxifragetum alpigenae*, but as soon as the water flow decreases it gives way to the cervunal of *Ranunculo acetosellifolii-Vaccinietum uli-*

ginosi, an association which replaces the oromediterranean *Nardo strictae-Festucetum ibericae* in that crioromediterranean belt; it has a chyonophile variant with *Omalotheca pusilla*. In slow waters mires of *Festuco rivularis-Veronocetum nevadensis* develop and in ponds with stagnant water the communities of *Eleocharidetum uinqueflorae* develop.

The driest borreguil, *Armerio splendentis-Agrostietum nevadensis* appears dispersely on the borders of the cervunales or in the small depressions where moisture increases due to the longer snow cover or to the water accumulation by the drainage of the slopes. The snow patches with a long snow cover are inhabited by the small communities of *Omalotheco pusillae-Lepidietum stylati*.

Ranunculo acetosellifolii-Vaccinietum uliginosi: *Vaccinium uliginosum nanum* V, *Nardus stricta* V, *Festuca iberica* V, *Leontodon microcephalus* V, *Lotus boissieri* V, *Gentiana boryi* IV, *Plantago nivalis* IV, *Ranunculus acetosellifolius* III, *Antennaria dioica congesta* II, *Gentiana alpina* II, *Phleum abbreviatum* II, *Galium nevadense* II, *Cerastium alpinum aquaticum* I, *Pedicularis verticillata* I (Quézel 1953, Molero Mesa 1998).

Omalotheco pusillae-Lepidietum stylati: *Sedum candollei* V, *Omalotheca supina pusilla* V, *Lepidium stylatum* IV, *Epilobium anagallidifolium* IV, *Sagina nevadensis* IV, *Veronica alpina* II, *Sibbaldia procumbens* I (Martínez Parras & al 1987b).

MÁLAGA-RONDA (15 July)

(The vegetation of the Serranía de Ronda)

ALFREDO ASENSI MARFIL & BLANCA DÍEZ GARRETAS

Under this name are grouped several mountain alignments and depressions which form part of the Baetic Ranges, a complex orographic system extending from Cádiz to Alicante areas. The Serranía de Ronda is a natural area limited in the north by the Antequera Depression, in the west by the mountains and hills of the Campo de Gibraltar and the Jerez countryside, in the south by the coastal fringe of the Mediterranean shore and in the east by the Hoya (vale) of Málaga.

The Serranía de Ronda belongs almost completely to the Rondeño biogeographical sector, in the Baetic subprovince. Three mountain alignments can be distinguished: one on the northwestern side, formed by the Grazalema (1,654 m) and Líbar (1,401 m) ranges, and another two, separated from the latter by the Guadiaro river, which constitute the core of the range and high plateau (meseta) of Ronda. They describe two parallel NE-SW oriented archs, which are united in their central part by the Sierra de Tolox, the highest massif of the whole Serranía (1,919 m). In the first arch, beside the coast, stand out the peridotitic massifs (Bermeja 1,450 m, Palmitera 1,472 m, Real 1,335 m). The second arch is made up of limestone (La Nieve unit) or limestone-dolomite (Oreganal 1,100m, Blanquilla 1,420 m, Prieta 1,505 m) reliefs. Surrounding these high reliefs are other sierras of lower elevation such as Blanca (1,217 m), Alpujata (1096 m), Mijas (1,150 m), de Aguas (949 m), Torremolinos (700 m), etc. The most frequent rock types of this Rondeño sector, peridotite and dolomitic-limestone, constitute its main geological feature; however, some siliceous metamorphic rocks like schist, mica schist, gneiss, graywacke, quartzite, etc. can be found.

The Serranía shows a marked influence of the neighbouring Mediterranean sea on its southern-facing slopes which benefit from its thermic regime; the thermomediterranean thermotype occupies a wide altitudinal range on those slopes, reaching 900 m. The mesomediterranean belt occupies a broad belt in the inner areas of the Serranía and Meseta of Ronda. The supramediterranean is less represented and can only be found above 1,600 m in some areas in the higher mountains. The oromediterranean is only topographicaly represented on some summits of the Sierra de Tolox (1,919 m).

Rainfalls are quite high, increasing westwards. Dry ombrotype is registered in the eastern stretch while subhumid and humid are the dominant types in most of the Serranía. The hyperhumid is restricted to the western part and in the higher elevations (Cortijo de los Quejigales 1,180 m, Io=11·6).

ITINERARY

The trip starts in the city of Málaga going along, in its first stretch, the coastal road till San Pedro de Alcántara, crossing the coastal area known as “Costa del Sol”, a heavily populated area where almost all the natural ecosystems are profoundly altered.

The first stretch, Málaga-Punta de Calaburras (Fuengirola), crosses the Quaternary deltaic terrains of the Guadalhorce river mouth and the piedmont areas of the Torremolinos and Mijas ranges, formed on travertine rock substrate (Malacitano-Almijarense sector). From the Punta de Calaburras onwards starts the Aljíbico sector (Gaditan-Onubian-Algarvian subsector) on the coastal strip. In general terms, the climatophilous Potential Natural Vegetation of this stretch corresponds to several *Quercus rotundifolia* and *Q. suber* forest-types, in the frame of three main Vegetation Series: *Smilaco mauritanicae-Querceto rotundifoliae* S. in thermophilic areas on limestone substrate, *Myrto communis-Querceto suberis* S. on hard siliceous rock substrates or *Oleo sylvestris-Querceto suberis* S. on palaeodunes.

From San Pedro Alcántara we start the transect till the high part of the Serranía de Ronda (Quejigar de Tolox 1,800 m). During the first part we drive across an area where the soils are built on siliceous metamorphic rocks (gneiss and leucogranite) and thus the Vegetation Series corresponds to that of the thermomediterranean cork-oak forests (*Myrto communis-Querceto suberis* S.). The cork-oak formations themselves are rare and *Quercus suber* is found scattered in the territory. However, seral stages are more frequent such as the mantle communities (*Asparago aphylli-Calycotometum villosae*), and especially the *Cistus ladanifer* scrub (*Calicotomo villosae-Genistetum hirsutae*). The floristic combination and the relative frequency of species in this last association is shown in the following synthetic table:

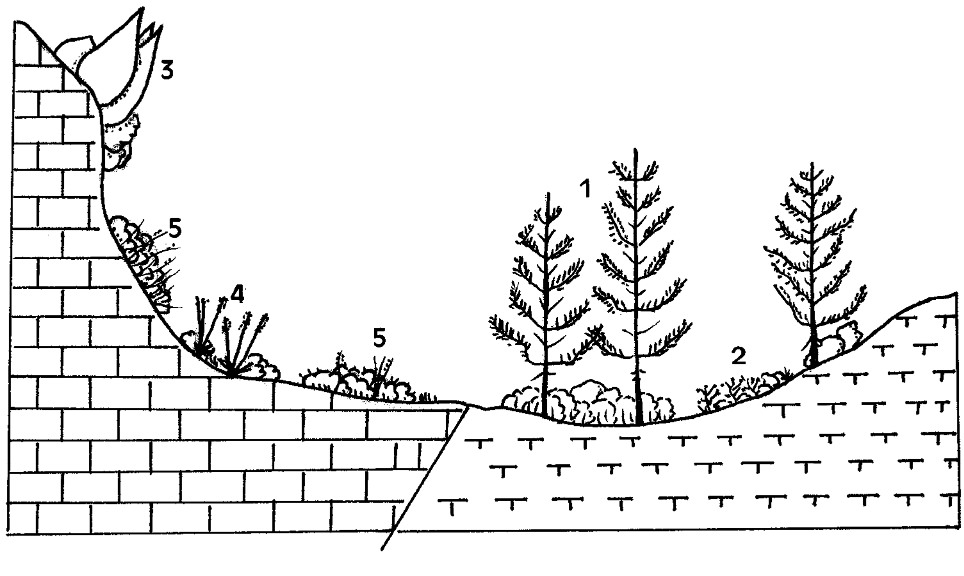
Calicotomo villosae-Genistetum hirsutae: Characteristics: *Ulex borgiae* V, *Calicotome villosa* V, *Cistus ladanifer* V, *C. salvifolius* IV, *Lavandula stoechas* IV, *Cistus monspeliensis* III, *C. crispus* III, *Halimium atriplicifolium* subsp. *serpentinicola* III, *Adenocarpus grandiflorus* II, *Genista hirsuta* II, *Lithodora diffusa* subsp. *lusitanica* I, *Genista lanuginosa* I. Other taxa: *Pistacia lentiscus* IV, *Dactylis glomerata* subsp. *hispanica* IV, *Phlomis purpurea* IV, *Chamaerops humilis* IV, *Daphne gnidium* IV, *Cistus albidus* III, *Phillyrea angustifolia* III, *Myrtus communis* III, *Brachypodium retusum* III, *Hyparrhenia sinaica* II. (Asensi & Díez-Garretas, 1988).

At a certain point the serpenized peridotites appear and this determines a radical change in the Vegetation Series and, in consequence, in the landscape. Peridotites are ultrabasic igneous rocks which present a bad edaphization and thus soils develop with difficulty and lithosols are very frequent. Under those circumstances, the dominant vegetation corresponds to the edaphoxerophylle Vegetation Series dominated *by Pinus pinaster* subsp. *acutisquamae* (*Pino acutisquamae-Querceto cocciferae* S.). This pine is an authoctonous taxon linked to peridotitic and dolomitic substrata. However, in the present days a great part of these areas have been afforested with *Pinus pinaster* although there are scattered individuals of the authoctonous subespecies; introgression between them is frequent. The floristic composition of these pine forests is shown in the following table:

Pino acutisquamae-Quercetum cocciferae: Subida al Puerto del Madroño, Benahavís (Málaga), 600 m, SW, 100 m^2. Characteristics: *Pinus pinaster* subsp. *acutisquama* 4, *Quercus coccifera* 2, *Chamaerops humilis* 1, *Smilax aspera* var. *altissima* 1, *Juniperus oxycedrus* +, *Phillyrea angustifolia* +, *Rubia peregrina* subsp. *longifolia* +, *Ruscus aculeatus* +. Other taxa: *Halimium atriplicifolium* subsp. *serpentinicola* 2, *Dactylis glomerata* subsp. *hispanica* 1, *Staehelina baetica* +, *Genista lanuginosa* +, *Ulex baeticus* +, *Lavandula stoechas* +.

PICTURE 13

Locality: Puerto del Madroñal, Benahavís (Málaga)
Altitude: 920 m
Biogeography: Contact between Bermejense and Rodense districts
Thermotype: Thermomediterranean in transition to mesomediterranean
Ombrotype: Subhumid/humid
Lithology: Contact between peridotitic and dolomitic substrata



1. *Pino acutisquamae-Quercetum cocciferae*
2. *Halimio atriplicifolii-Digitaletum laciniatae*
3. *Rhamno myrtifoliae-Juniperetum phoenicae*
4. *Thymo gracile-Stipetum tenacissimae*
5. *Ulici baetici-Lavanduletum lanatae*

The scarce edaphization permits the development of a scrub rich in endemic species and with open structure (*Halimio atriplicifolii-Digitaletum laciniatae*); an example is shown in the next table:

Halimio atriplicifolii-Digitaletum laciniatae: Carretera S. Pedro-Ronda, Benahavís (Málaga), 450 m, SW, 80 m^2. Characteristics: *Halimium atriplicifolium* subsp. *serpentinicola* 4, *Genista lanuginosa* 2, *Lavandula stoechas* 2, *Galium boissieranum* 2, *Ulex baeticus* 2, *Digitalis obscura* subsp. *laciniata* 1, *Alyssum serpyllifolium* subsp. *malacitanum* 1, *Staehelina baetica* 1, *Lithodora diffusa* subsp. *lusitanica* 1, *Cistus monspeliensis* 1, *C. ladanifer* 1, *C. salvifolius* +, *Serratula baetica* +, *Adenocarpus grandiflorus* +. Other taxa: *Brachypodium retusum* 2, *Chamaerops humilis* 1, *Phlomis purpurea* 1, *Myrtus communis*, 1, *Phillyrea angustifolia* 1, *Coris monspeliensis* 1, *Sanguisorba minor* subsp. *muricata* 1.

This serpentinicolous Vegetation Series will structure the vegetation in the landscape until the Puerto (pass) del Madroñal (920 m) where a sudden lithologic change occurs: peridotite gives way to limestone, at the same time a bioclimatic change occurs: it passes from the thermomediterranean thermotype to the mesomediterranean. This results in the change of the biogeographical unit: the Bermejense district is left and we enter the Rondense district.

This area is formed by limestone and dolomitic rocks and is shared by two Vegetation Series, the climatophilous Betic *mesomediterranean Paeonio coriaceae-Querceto rotundifoliae* S. and the edaphoxerophilous *Rhamno myrtifoliae-Junipereto phoeniceae* S; thus, the climatophilous Potential Natural Vegetation is a *Quercus rotundifolia* forest. The seral stages are of several types, kermes-oak maquis (*Crataego monogynae-Quercetum cocciferae*), scrub (*Ulici baetici-Lavanduletum lanatae*), esparto fields (*Thymo gracile-Stipetum tenacissimae*) and xeric grasslands (*Festuci scariosae-Helictotrichetum arundani*).

The entrance to the Sierra de las Nieves Natural Park is by the track which leads to the place called Llanos de la Nava and further on to the Cortijo de los Quejigales, Sierra de Tolox and Torrecilla.

The Llanos de la Nava is an intermontane depression surrounded by ridges and rocky bars of Triassic dolomites and massive Liassic limestone, both partially metamorphised. Nowadays, this depression or "llano" (plain) is drained in part by the Carboneras stream and by holes ("ponors") despite the fact that in the rainy season drainage is inefficient and the depression becomes partly flooded. The Llanos de la Nava can thus be considered as an open polje or semipolje the borders of which are strongly karstified with well developed lapiés and good examples of dolines. It is on one of these borders where a good example of basophilous Baetic mesomediterranean *Quercus rotundifolia* forest (*Paeonio coriaceae-Quercetum rotundifoliae*), together with some of its seral stages, can be seen. In some seasonally flooded areas *Agrostis castellana* and *Brachypodium phoenocoides* grasslands occur.

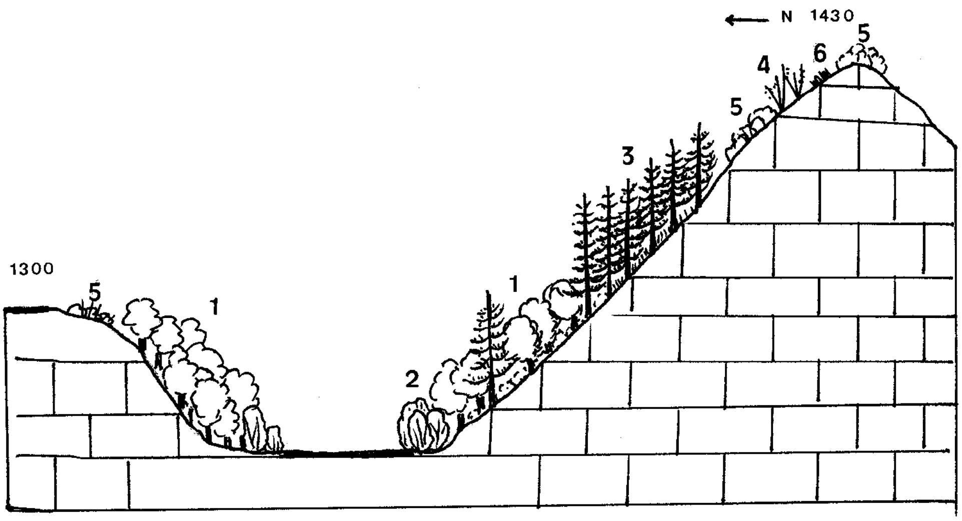
In La Nava one of the most original and characteristic vegetation types of the Serranía de Ronda is represented; it is the pinsapar of the *association Paeonio broteroi-Abietetum pinsapo*, which range between the meso and supramediterraean belts. The following relevé is an example of this vegetation:

Paeonio broteroi-Abietetum pinsapo: Cerro del Alcor, Parauta (Málaga), 1135 m, N, 100 m^2. Characteristics: *Abies pinsapo* 4, *Quercus rotundifolia* 2, *Rubia peregrina* subsp. *longifolia* 2, *Paeonia*

coriacea 2, *P. broteroi* 1, *Doronicum plantagineum* 1, *Hyacinthoides hispanica* 1, *Daphne laureola* subsp. *latifolia* 1, *Ruscus aculeatus* +, *Daphne gnidium* +, *Rosa micrantha* +, *Asplenium onopteris* +
Other taxa: *Conopodium thalictrifolium* 1, *Cistus albidus* 1, *Pteridium aquilinum* 1, *Cistus laurifolius* +, *Asphodelus ramosus* +.

PICTURE 14

Locality: Way from the Llanos de la Nava up to the Los Quejigales
Altitude: 1,300 m
Biogeography: Rondense district
Thermotype: Mesomediterranean
Ombrotype: Humid
Lithology: Dolomites



1. *Paenio coriaceae-Quercetum rotundifoliae*
2. *Crataego-Quercetum cocciferae*
3. *Paeonio broteroi-Abietetum pinsapo*
4. *Festuco scariosae-Helictotrichetum arundani*
5. *Ulici baetici-Lavanduletum lanatae*
6. *Galio baetici-Thymetum granatensis*

On the way from the Llanos de la Nava up to the Cortijo de los Quejigales (1.180 m) there is a good example of those pinsapares as well as some of its seral stages such as "coscojares" (*Crataego monogynae-Quercetum cocciferae*), dry grasslands or "lastonares"

(*Festuco scariosae-Helictotrichetum arundani*), esparto fields or “espartales” (*Thymo gracile-Stipetum tenacissimae*), scrub or “matorrales” (*Ulici baetici-Lavanduletum lanatae*), thyme scrub or “tomillares” on dolomitic substrate (*Galio baetici-Thymetum granatensis*) and therophytic grasslands (*Violo demetriae-Jonopsidietum prolongi*). Those communities are represented in the following synthetic tables:

Festuco scariosae-Helictotrichetum arundani: Characteristics: *Helictotrichon filifolium* subsp. *arundanum* V, *Avenula bromoide*s subsp. *arundana* V, *Festuca scariosa* V, *Dactylis glomerata* subsp. *hispanica* V, *Melica minuta* III, *Stipa gigantea* III, *Brachypodium retusum* III, *Arrhenatherum album* III, *Piptatherum paradoxum* I, *Festuca capillifolia* I. Other taxa: *Phlomis crinita* nothosubsp. *malacitana* IV, *Thymus x arundanus* III, *Phlomis purpurea* III, *Paeonia broteroi* II, *Campanula rapunculus* II, *Ptilostemon hispanicus* II, *Lavandula lanata* II, *Teucrium similatum* II, *Ulex baeticus* II, *Brachypodium phoenicoides* II, *Melica magnolii* II, *Agrostis castellana* II, *Linum suffruticosum* I, *Aphyllanthes monspeliensis* I, *Phlomis lychnitis* I. (Asensi et al. 1993).

Ulici baetici-Lavanduletum lanatae: Characteristics: *Ulex baeticus* V, *Bupleurum spinosum* V, *Lavandula lanata* III, *Echinospartum boissieri* III, *Ptilostemon hispanicus* III, *Phlomis crinita* nothosubsp. *malacitana* III, *Hormathophylla spinosa* II, *Erinacea anthyllis* II, *Teucrium similatum* I. Other taxa: *Helictotrichon filifolium* subsp. *arundanum* IV, *Cistus albidus* II, *Poa ligulata* II, *Helleborus foetidus* I, *Cirsium echinatum* I, *Picnomon acarna* I. (Asensi & Díez-Garretas 1991).

Galio baetici-Thymetum granatensis: Characteristics: *Thymus granatensis* V, *Ulex baeticus* IV, *Arenaria erinacea* IV, *Anthyllis vulneraria* subsp. *argyrophylla* IV, *Asperula scabra* IV, *Helianthemum cinereum* subsp. *rotundifolium* IV, *H. oelandicum* subsp. *incanum* IV, *Jurinea pinnata* II, *Galium baeticum* II. Other taxa: *Koeleria crassipes* var. *humilis* IV, *Lavandula lanata* III, *Teucrium similatum* II, *Helictotrichon filifolium* subsp. *arundanum* II, *Poa ligulata* I, *Carex hallerana* +, *Leuzea conifera* +, *Echinospartum boissieri* +, *Acinos alpinus* subsp. *meridionalis* +, *Hormathophylla spinosa* +, *Ononis pusilla* +, *Echium albicans* +. (Mota & Valle 1992).

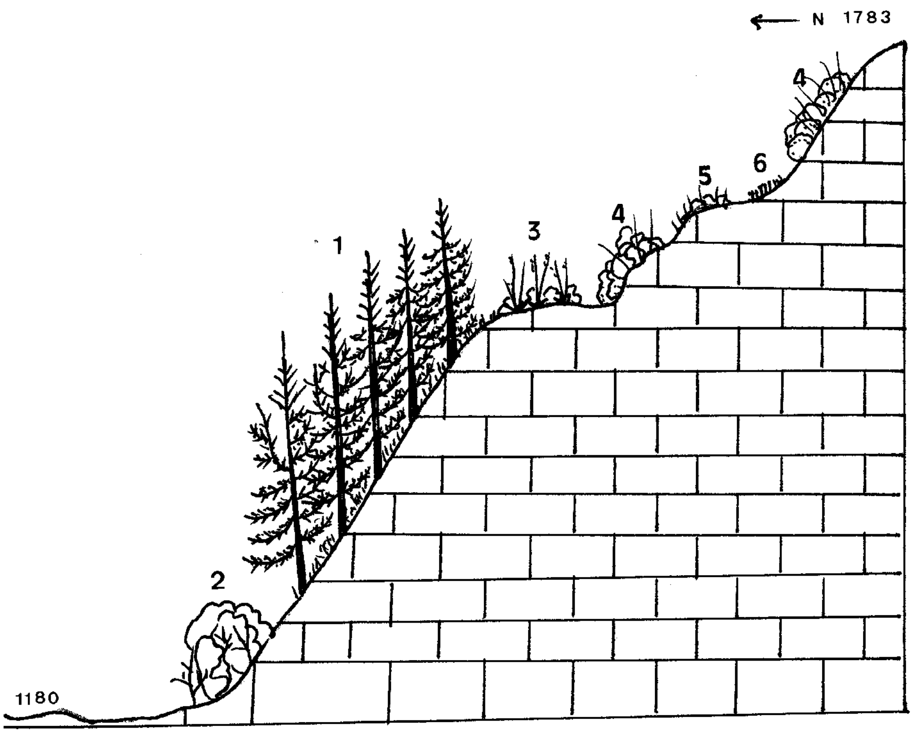
From the Cortijo de los Quejigales (supramediterranean hyperhumid) you climb to the place called Quejigar de Tolox and to the slope of the Torrecilla pike (oromediterranean). The trek crosses the Cañada del Cuerno, Cañada de las Ánimas, and allows us to observe the supramediterranena forest-mantle of the pinsapares (*Pruno mahalebo-Berberidetum hispanicae*) of which a relevé is shown:

Pruno mahalebo-Berberidetum hispanicae: Los Quejigales, Tolox (Málaga), 1300 m, N, 50 m^2. Characteristics: *Crataegus monogyna* 3, *Berberis hispanica* 2, *Prunus mahaleb* 2, *Rosa canina* 2, *R. spinosissima* 1. Other taxa: *Daphne laureola* subsp. *latifolia* 1, *Helleborus foetidus* 1, *Ononis aragonensis* 1, *Abies pinsapo* + *Lonicera etrusca* +, *Rubia peregrina* subsp. *longifolia* +, *Paeonia broteroi* +, *Acer granatense* +.

On the upper part of the ascent, Puerto de los Pilones (1,800 m), there is an original supramediterranean *Quercus faginea* forest or “quejigar” (*Daphno latifoliae-Aceretum granatensis*). It is formed by a group of contemporary old trees, with small tops, a reduced height and a very thick trunk, alternating with some younger oaks more recently planted. Other elements are some individuals of *Acer granatense, Daphne laureola* subsp. *latifolia*, *Taxus baccata*, *Sorbus aria* and *Helleborus foetidus*. These *Quercus faginea* forests and their seral stages are usually submitted to intense anthropogenic pressure, mostly to traditional husbandry and charcoal making, which results in severe degradation.

PICTURE 15

Locality: Cañada de las Animas, Tolox (Málaga)
Altitude: 1,600 m
Biogeography: Rondense district
Thermotype: Supramediterranean
Ombrotype: Hyperhumid
Lithology: Calcareous and dolomitic substrata



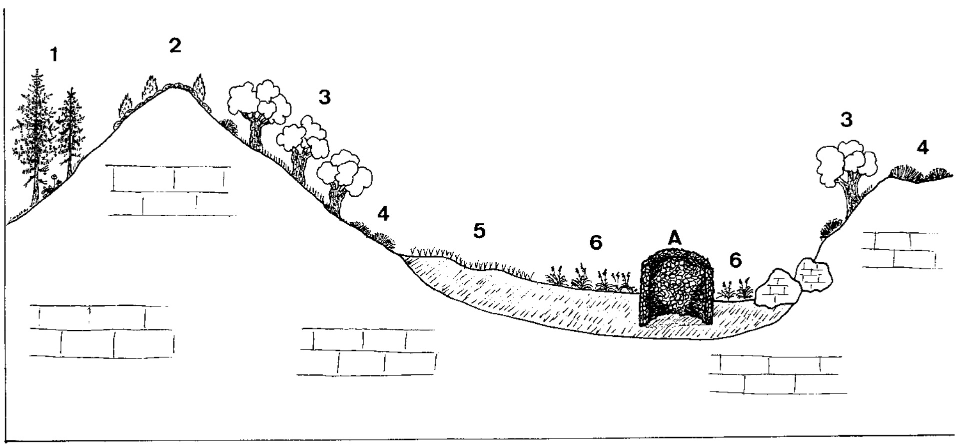
1. *Paenio broteroi-Abietetum pinsapo*
2. *Pruno mahalebo-Berberidetum hispanicae*
3. *Festuco scariosae-Helictotrichetum arundani*
4. *Ulici baetici-Lavanduletum lanatae erinaceetosum anthyllidis*
5. *Galio baetici-Thymetum granatensis*
6. *Violo demetriae-Jonopsidietum prolongoi*

The quejigar is really forming a mosaic with the oromediterranean sabinar (*Rhamno infectoriae-Juniperetum sabinae*) which penetrates down into the supramediterranean belt in this rondense mountain. A relevé shows its floristic composition:

Rhamno infectoriae-Juniperetum sabinae: Puerto del Oso, Tolox (Málaga) 1800 m, N, 100 m^2. *Juniperus sabina* 4, *Juniperus communis* subsp. *hemisphaerica* 2, *Rhamnus infectoria* 2, *Berberis hispanica* 1, *Daphne laureola* subsp. *latifolia* 2, *Helleborus foetidus* 1, *Crataegus granatensis* +, *Prunus prostrata* +.

PICTURE 16

Locality: Sierra de las Nieves (Ronda): Pozo de la Nieve
Altitude: 1,750 m
Biogeography: Rondense district
Thermotype: Supra-oromediterranean
Ombrotype: Hyperhumid
Lithology: Calcareous and dolomitic substrata



1. *Paenio broteroi-Abietetum pinsapo*
2. *Rhamno infectoriae-Juniperetum sabinae* (permanent community)
3. *Quercus alpestris*-dehesa with *Festuco hystricis-Poetalia ligulatae* grasslands
4. *Astragalo andres-molinae-Erinacetum anthyllidis*
5. *Trifolio subterranei-Periballion* and *Thero-Airion* pastures
6. *Agrostis castellana* pastures

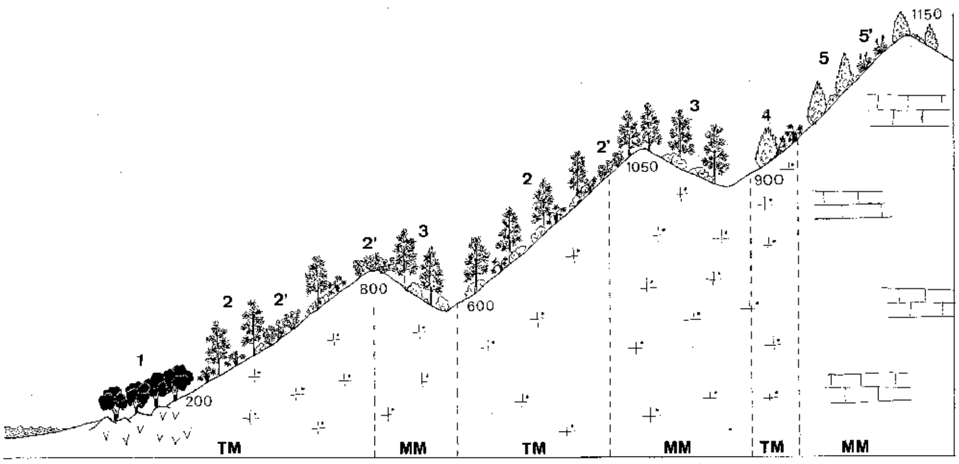
A: Icebox or "pozo de nieve"

The first seral stage of these quejigales and sabinares are the hedges (*Roso siculae-Berberidetum hispanicae*), which under certain conditions (edaphoxerophile biotopes) can be considered as permanent communities. The next stage are the seral scrub (*Astragalo andresmolinae-Erinaceetum anthyllidis*), which floristic combination is observed in the following relevé:

Astragalo andresmolinae-Erinaceetum anthyllidis: Puerto del Oso, Tolox (Málaga), 1800 m, N, 80 m^2. *Erinacea anthyllis* 4, *Hormathophylla spinosa* 2, *Astragalus andresmolinae* 2, *A. granatensis* 2, *Bupleurum spinosum* 2, *Helleborus foetidus* 1, *Picnomon acarna* 1, *Poa ligulata* 1, *Arenaria erinacea* +, *Teucrium similatum* +, *Helichrysum stoechas* +, *Prunus prostrata* +, *Rhamnus infectoria* +, *Berberis hispanica* +, *Juniperus communis* subsp. *hemisphaerica* +.

PICTURE 17

Altitudinal zonation between San Pedro de Alcántara and Torrecilla



1. *Myrto communis-Quercetum suberis*
   Asparrago aphylli-Calicotometum villosae
   Ulici borgiae-Cistetum ladaniferi

2. *Pino acutisquami-Quercetum cocciferae* thermomediterranean variant with *Chamaerops humilis*
   Halimio atriplicifolii-Digitalietum laciniatae (2')
   Asperulo asperrimae-Brachypodietum retusae
   Onphalodion brasicaefoliae
   Andryalo laxyfoliae-Hyparrhenietum hirtae

3. *Pino acutisquamae-Quercetum cocciferae* mesomediterranean variant without *Chamaerops humilis*

4. *Rhamno myrtifoliae-Juniperetum phoeniciae* thermomediterranean variant with *Chamaerops humilis*

5. *Rhamno myrtifoliae-Jumiperetum phoeniciae* mesomediterranean variant without *Chamaerops humilis*

   Ulici baeticae-Lavanduletum lanatae
   Thymo gracilae-Stipetum tenacissimae brachypodietosum boissieri (5')
   Violo demetriae-Inopsidetum prolongoi

RONDA-FARO (16 July)

(The vegetation of Los Alcornocales Natural Park)

ALFREDO ASENSI MARFIL & BLANCA DÍEZ GARRETAS

لاحَتْ قُراها بين خُضْرَةِ أيْكِها   كالدُّرِّ بينَ زَبَرْجَدٍ مَكْنونِ

Las aldeas de Andalucía aparecen en medio de la verdura de los vergeles como perlas (blancas) engastadas en medio de esmeralaldas.

(El visir Ibn al-Hammara: al-Maqqari, *Nafh al-tibb,* I, 205)

From the city of Ronda to the Natural Park of Los Alcornocales the itinerary is: Ronda-Grazalema-Villaluenga del Rosario-Benaocaz-Ubrique-Puerto de Galis-Garganta de Puerto Oscuro.

The first part of the trip is made through the Ronda depression which is crossed by the Guadalcobacín and the upper stretch of the Guadiaro rivers. On the Neogene calcareous sandstone the Vegetation Series corresponds to the mesomediterranean basophilous *Quercus rotundifolia* forests (*Paeonio coriaceae-Querceto rotundifoliae* S.) but on the Aljibe sandstone outcropping between the Puerto de Montejaque and Puerto de los Alamillos, the Vegetation Series is that of the *Quercus suber* forests or "alcornocales" (*Teucrio baetici-Quercetum suberis*). As forest mantle appear the broom communities of *Cytiso baetici-Genistetum monspessulanae* and the seral scrub (jaral) of *Calicotomo villosae-Genistetum hirsuti*. Those alcornocales enrich themselves with *Quercus canariensis* in the moist valley bottoms and piedmonts. Those vegetation types mark the limit between the Rondeño sector (Baetic subprovince) and the Aljíbico sector (Gaditan-Onubian-Algarviensian subprovince).

Between Grazalema and Ubrique the road crosses the area called Manga de Villanueva; on the right side lie the Benacoaz and Caillo ranges and on the left the Líbar range, all of them made of very karstified limestone with abundant caves. Their Potential Natural vegetation is the aforementioned mesomediterranean basophilous *Quercus rotundifolia* forests.

On the severely karstifed rocky surfaces of this area, usually lapiés, occurs a particular edafoxerophile Vegetation Series dominated by the *Ceratonia siliqua*, or "algarrobo", woodlands (*Clematido cirrhosae-Ceratonietum siliquae phlomidetosum purpureae*), which is easy to observe in the area near Benacoaz and Ubrique. Its substitution stages are the shrubland of *Asparago-Rhamnetum oleoidis* and the scrub of *Asperulo hirsutii-Ulicetum scabri*. The following tables are representative of those associations:

Clematido cirrhosae-Ceratonietum siliquae phlomidetosum purpureae: Characteristics: *Ceratonia siliqua* V, *Clematis cirrhosa* V, *Pistacia lentiscus* V, *Olea europaea* subsp. *sylvestris* V, *Rubia peregrina* subsp. *longifolia* V, *Chamaerops humilis* V, *Phlomis purpurea* V (dif. subas.), *Crataegus monogyna* subsp. *brevispina* IV (dif. subas.), *Smilax aspera* var. *altissima* IV, *Daphne gnidium* III, *Aristolochia baetica* II, *Jasminum fruticans* II, *Quercus rotundifolia* II, *Asparagus albus* II, *A. acutifolius* I, *Phillyrea latifolia* I, *Rhamnus oleoides* subsp. *oleoides* I, *Teucrium fruticans* I, *Quercus coccifera* I, *Arbutus unedo* I, *Calicotome villosa* I, *Ruscus aculeatus* I. Other taxa: *Vinca difformis* V, *Arum italicum* III, *Tamus communis* II, *Urginea maritima* II, *Bryonia cretica* subsp. *dioica* I, *Ulex baeticus* subsp. *scaber* I. (Martín Osorio et al. 1992).

Asperulo hirsuti-Ulicetum scabri: Characteristics: *Ulex baeticus* subsp. *scaber* V, *Asperula hirsuta* V, *Aphyllanthes monspeliensis* III, *Micromeria graeca* subsp. *micrantha* II, *Origanum compactum* II, *Dorycnium hirsutum* II, *D. pentaphyllum* II, *Fumana laevis* II, *Hedysarum humile* I, *Coridothymus capitatus* I, *Helichrysum stoechas* I, *Staehelina dubia* I, *Polygala rupestris* +. Other taxa: *Cistus albidus* IV, *Brachypodium retusum* IV, *Phlomis purpurea* IV, *Anagallis monelli* III, *Linum setaceum* III, *Melica arrecta* II, *Centaurium erythraea* subsp. *majus* II, *Teucrium fruticans* II, *Cistus monspeliensis* II, *Salvia sclareoides* II, *Sedum sediforme* I, *Cistus salvifolius* I, *Bupleurum paniculatum* I, *Dactylis glomerata* subsp. *hispanica* I, *Coronilla juncea* I, *Carex flacca* subsp. *serrulata* I. (Galán de Mera 1993).

Between Ubrique and the Mojón de la Víbora, vertic soils occur and there are wild olive woodlands, or “acebuchales”, of *Tamo communis-Oleetum sylvestris*, of which a table is shown:

Tamo communis-Oleetum sylvestris: Characteristics: *Olea europaea* subsp. *sylvestris* V, *Pistacia lentiscus* V, *Clematis cirrhosa* IV, *Arum italicum* IV, *Aristolochia baetica* IV, *Arisarum simorrhinum* var. *subexertum* IV, *Tamus communis* III, *Smilax aspera* var. *altissima* III, *Phlomis purpurea* III, *Chamaerops humilis* III, *Daphne gnidium* III, *Asparagus albus* III, *Rhamnus oleoides* subsp. *oleoides* II, *R. alaternus* II, *Calicotome villosa* II, *Quercus coccifera* II, *Eryngium tricuspidatum* II, *Aristolochia paucinervis* I, *Crataegus monogyna* subsp. *brevispina* I, *Quercus suber* I, *Phillyrea latifolia* +, *Rubia peregrina* subsp. *longifolia* +, *Myrtus communis* +, *Teucrium fruticans* +, *Asparagus aphyllus* +, *Ruscus aculeatus* +, *Piptatherum thomasii* +, *Viburnum tinus* +. Other taxa: *Bryonia cretica* subsp. *dioica* IV, *Asphodelus ramosus* IV, *Vinca difformis* IV, *Echium plantagineum* +, *Calamintha sylvatica* subsp. *ascendens* +, *Cistus salvifolius* +. (Galán de Mera 1993).

Almost all the Aljibic sector can be included in the thermomediterranean thermotype, only the highest mountains reach the mesomediterranean. The thermo-pluviometric data do not reflect exactly the climatic conditions of the area especially those related to the rainfalls. The main distorting factor is the abrupt relief of the Campo de Gibraltar mountains in contrast with the Gaditan flat or hilly land. Those reliefs form a N-S oriented wall which opposes the cloud masses coming from the Atlantic ocean and provokes heavy orographic precipitations. The nearness of the sea in this area of the Strait of Gibraltar moderates the extreme temperatures and determines a high humidity. In conclusion, the whole Aljibic territory presents temperatures with diminished oscillations and a high humidity rate which is responsible for frequent criptoprecipitations in some areas which, due to this can reach the hyperhumid ombrotype.

The most abundant climacic vegetation of this Aljibico sector are the alcornocales of *Teucrio baetici-Quercetum suberis*, extended in the thermo and mesomediterranean thermotypes under humid and hyperhumid ombrotypes. The soils are distric and eutric cambisols derived from the Aljibe sandstone.

In areas where the slope is not very steep, the forests are "cleaned" as a treatment to stimulate cork production by the trees and in consequence a madrone community occupies the cleared areas and the *understorey (Phyllireo angustifoliae-Arbutetum unedonis*) on the well humified soils; it plays the role of forest-mantle vegetation. If the soil loses part of its humic horizon and shows a tendency to podsolization, the madrone community is substituted by a peculiar *Quercus lusitanica* shrubland (*Phillyreo angustifoliae-Quercetum fruticosae*). The regeneration of those cork-oak forests is clearly indicated in the Aljibico sector by the broom community *Cytiso baetici-Genistetum monspessulanae*, which develops on deep and well humified siliceous soils.

Cytiso baetici-Genistetum monspessulanae: Characteristics: *Genista linifolia* V, *G. monspessulana* IV, *Cytisus baeticus* IV, *Adenocarpus telonensis* III, *Pteridium aquilinum* II, *Cytisus striatus* subsp. *welwitschii* I. Other taxa: *Crataegus monogyna* subsp. *brevispina* III, *Calicotome villosa* III, *Rubus ulmifolius* II, *Olea europaea* subsp. *sylvestris* II, *Pistacia lentiscus* II, *Smilax aspera* var. *altissima* II, *Genista tridens* I, *Phlomis purpurea* I, *Rosa sempervirens* I, *Phillyrea latifolia* +, *Cistus salvifolius* +, *Ulex borgiae* +. (Galán de Mera 1993).

Husbandry, clear cuts and fire erode soils and favour the development of a heathland with spiny legumes grouped in the association *Genisto tridentis-Stauracanthetum boivinii*, endemic of the Aljíbico sector. It is a dense chamaephytic scrub dominated by *Stauracanthus boivinii* where *Erica australis* subsp. *australis* is abundant in places in the mesomediterranean belt specially if they have been recently burned. If site conditions are locally xeric, the seral stage is a "jaral" or *Cistus ladanifer* scrub (*Calicotomo villosae-Genistetum hirsutae*).

When soil moisture conditions increase locally, a humid heathland occurs, usually in contact with the latter associations. It is dominated by *Erica ciliaris and E. scoparia* and called *Genisto anglicae-Ericetum ciliaris*; it often contacts with hygrophytic communities of *Hyperico-Sparganion* or *Glycerio-Sparganion*. The floristic composition of those humid heathlands in the surroundings of the Puerto de Galis and the Garganta de Puerto Oscuro, can be seen in the following table:

Genisto anglicae-Ericetum ciliaris: Characteristics: *Erica ciliaris* V, *E. scoparia* V, *Genista tridens* IV, *Stauracanthus boivinii* IV, *Calluna vulgaris* III, *Cistus populifolius* subsp. *major* II, *Genista triacanthos* II, *Potentilla erecta* II, *Anagallis crassifolia* II, *Pinguicula lusitanica* I, *Genista anglica* +, *Pedicularis sylvatica* subsp. *lusitanica* +. Other taxa: *Molinia arundinacea* IV, *Myrtus communis* IV, *Agrostis curtisii* II, *Schoenus nigricans* I, *Danthonia decumbens* I, *Pteridium aquilinum* +, *Eleocharis multicaulis* +. (Galán de Mera 1993).

Another heathland association *is Stauracantho boivinii-Drosophylletum lusitanicae*, similar in floristic composition to *Genisto tridentis-Stauracanthetum boivinii* but occupying rocky or earthy steep slopes where the water flows periodically in the soil surface.

In rainier areas there is a particular stage in the succession on very poor and eroded soils which is formed by the spiny legume *Calicotome villosa* (*Asparago aphylli-Calicotometum villosae*).

Other communities linked to this alcornocales environment are the *Gaudinio fragilis-Agrostietum castellanae* grasslands which occur in some of the gaps of the cork-oak forests. *Plantago serraria* is a plant which indicates a transition towards the *Poetea bulbosae* communities on clay trampled soils. On hydromorphic soils, those *Agrostis* grasslands are substituted by rush communities of *Juncetum rugoso-effusi*.

The herbaceous fringe of those humid and hyperhumid forest of *Quercus suber* and *Q. canariensis* is represented by the association *Clinopodio arundani-Digitaletum bocquetii*, characterised by the Aljibic endemic sciophyte *Digitalis purpurea* subsp. *bocquetii*.

Cormophytic vegetation is also characteristic, i.e. living in broad rock fissures stuffed with earth, small moist and shady shelfs in rocky walls and on the forks of the branching trees. It is grouped in the association *Davallio canariensis-Sedetum baetici* which is formed by many briophytes and characterized by the Mediterranean-Atlantic fern *Polypodium cambricum* subsp. *serrulatum* and the Aljibic and Tingitanian (northern Moroccan) endemic *Sedum hirsutum* subsp. *baeticum*, in addition to some other plants of tropical and Macaronesian distribution such as *Davallia canariensis* and *Psilotum nudum*.

Another of the typical plant communities of the Natural Park are the *Quercus canariensis* forests (quejigar) which are grouped in the association *Rusco hypophylli-Quercetum canariensis*. They are relic forests of other periods when the climate was a rainier and warmer Mediterranean type than today. They occupy the narrow and foggy valley locally called “canutos” on district cambisols and chromic luvisols preferently in the thermomediterranean belt (they also reach the supramediterranean). Their seral stages mostly coincide with those of the “alcornocales”.

As for the riparian silicicolous vegetation, in the Park can be distinguished: willow shrublands (saucedas) of *Equiseto telmateiae-Salicetum pedicellatae*, alder-rhododendron forests (alisedas) of *Frangulo baetici-Rhododendretum baetici* and ash forests (fresnedas) of *Ranunculo ficariae-Fraxinetum angustifoliae*.

The willow shrublands of Salix pedicellata colonize the river beds with intermittent flow often forming mosaic with the alder-rhododendron forests. The latter are mostly found in the small narrow canyons carved out the sandstone (canutos) and their floristic ground is constituted by the remarkable Aljibic and Monchiquean-Lower Alentejan endemic *Rhododendron ponticum* subsp. *baeticum* together with a couple of subtropical ferns (*Culcita macrocarpa*, *Diplazium caudatum*, *Pteris incompleta*). *Frangulo-Rhododendretum baetici* are gallery-forests of closed canopy present in the banks of the steep rivers and rivulets of this sector. In the Aljíbico sector, the Iberian Mediterranean-Atlantic ash forests (fresnedas) of the association *Ranunculo ficariae-Fraxinetum angustifoliae* develop on fluvisols which have an upper horizon rich in sand of fluvial origin, and a pseudogley horizon. They are seldom flooded and the main tree is *Fraxinus angustifolia* which sometimes forms a dense canopy. The understorey has plenty of lianas and shrubs among which *Quercetea ilicis* elements are not rare.

As seral stages we can mention bramble hedges (zarzales) of *Lonicero-Rubetum ulmifolii*), the dense rush communities of *Juncus acutus* of *Holoschoeno-Juncetum acuti* and the hygrophile oligotrophic rush communities of *Juncetum rugoso-effusi*. In this riparian forest the scionitrophilous and humicolous spring-flowering therophytic communities of *Geranio rotundifolii-Theligonietum cynocrambis* are frequent. The almost monoespecific communities of *Oenanthe croccata* (*Glycerio declinatae-Oenanthetum croccatae*) and the tufted sedge communities of *Caricetum mauritanicae* are also frequent in the shallow water of stony and rocky river beds in the canutos and other rivulets.

The Garganta del Puerto Oscuro is a good example of all that has been described. The alcornocal (*Teucrio baetici-Quercetum suberis*) occupies the steep and dry areas. A relevé of this association:

Teucrio baetici-Quercetum suberis: Garganta de Puerto Oscuro, Alcalá de los Gazules (Cádiz), 500 m, 100 m^2. Characteristics: *Quercus suber* 3, *Teucrium scorodonia* subsp. *baeticum* 1, *Erica arborea* 1, *Smilax aspera* var. *altissima* 1, *Olea europaea* subsp. *sylvestris* 1, *Daphne gnidium* 1, *Phillyrea latifolia* 1, *P. angustifolia* +, *Calicotome villosa* +. Other taxa: *Genista tridens* 1, *G. linifolia* 1, *Cistus salvifolius* 1, *Ulex borgiae* 1, *Adenocarpus telonensis* 1, *Lavandula stoechas* 1, *Pteridium aquilinum* 1, *Briza maxima* +, *Calamintha sylvatica* subsp. *ascendens* +.

Towards the bottom of the valleys, on moister biotopes, the quejigar of *Quercus canariensis* occurs. A relevé of it:

Rusco hypophylli-Quercetum canariensis: Garganta de Puerto Oscuro, Alcalá de los Gazules (Cádiz), 600 m, NE, 100 m^2. Characteristics: *Quercus canariensis* 3, *Smilax aspera* var. *altissima* 1, *Phillyrea latifolia* 1, *Erica arborea* 1, *Arbutus unedo* 1, *Rubia peregrina* subsp. *longifolia* +, *Quercus suber* +, *Daphne gnidium* +. Other taxa: *Hedera helix* 1, *Rubus ulmifolius* +, *Genista tridens* +, *Ulex borgiae* +, *Lavandula stoechas* +, *Cistus salvifolius* +.

In the canutos the alder-rhododendron riparian forests are found. As an example, we present the following relevé:

Frangulo baetici-Rhododendretum baetici: Garganta de Puerto Oscuro, Alcalá de los Gazules (Cádiz), 600 m, NW, 50 m^2. Characteristics: *Rhododendron ponticum* subsp. *baeticum* 5, *Frangula alnus* subsp. *baetica* 2, *Alnus glutinosa* 2, *Blechnum spicant* 1, *Polystichum setiferum* 1, *Rubus ulmifolius* 1, *Hedera helix* 1, *Carex pendula* 1, *Osmunda regalis* 1, *Ranunculus ficaria* +, *Ilex aquifolium* +, *Tamus communis* +. Other taxa: *Viburnum tinus* 1, *Smilax aspera* var. *altissima* 1, *Pteridium aquilinum* 1, *Ruscus hypophyllum* +, *Erica arborea* +, *Cytisus villosus* +.

When ascending in altitude toward the Aljibe summits (800 and 900 m) the alcornocal (*Quercus suber* forest), a vegetation with high oceanic requirements, is replaced by the cold resistent melojar (*Q. pyrenaica* forest). The latter, represented by the association *Cytiso triflori-Quercetum pyrenaicae* occupies places exposed to the Atlantic winds in some summital areas of the Sierra del Aljibe and, as a relic, in the Algeciras ranges, Genal valley and mountains of Cortes de la Frontera. In most of the cases, *Q. pyrenaica* is found in a shrubby growth-form, although it can reach a height of 3-4 m. They develop on eutric and distric cambisols. In these summital zones, a seral stage particular of these melojares is found, it is the association *Deschampsio strictae-Agrostietum curtisii* of xerophile mesomediterranean grasslands which develop on ranker soils. Next, we present two relevés of the commented associations:

Cytiso triflori-Quercetum pyrenaicae: Garganta de Puerto Oscuro, Alcalá de los Gazules (Cádiz), 1,000 m, N, 50 m^2. Characteristics: *Quercus pyrenaica* 4, *Luzula forsteri* subsp. *baetica* 1, *Avenula sulcata* subsp. *albinervis* 1, *Cytisus villosus* 1, *Senecio lopezii* 1, *Prunus spinosa* 1, *Carex distachya* 1, *Smilax aspera* 1, *Arbutus unedo* +. Other taxa: *Erica scoparia* 1, *Ulex borgiae* +, *Cistus salvifolius* +.

Deschampsio strictae-Agrostietum curtisi: Cumbre del Aljibe, Alcalá de los Gazules (Cádiz), 950 m, 2 m^2. Characteristics: *Agrostis curtisii* 5, *Avenula sulcata* subsp. *albinervis* 1, *Festuca baetica* 1, *Deschampsia stricta* +. Other taxa: *Aira caryophyllea* subsp. *uniaristata* 1, *Gastridium ventricosum* 1, *Logfia gallica* +.

As substitution community-types bramble-hedges with honeysuckle (*Lonicero hispanicae-Rubetum ulmifoliae*) and heathlands with spiny legumes (*Genisto tridentis-Stauracanthetum boivinii*) can be observed. The next relevés show the local floristic composition of those associations.:

Lonicero hispanicae-Rubetum ulmifolii: Garganta de Puerto Oscuro, Alcalá de los Gazules (Cádiz). 650 m, 100 m^2. Characteristics: *Rubus ulmifolius* 5, *Lonicera periclymenum* subsp. *hispanica* 1, *Vitis vinifera* subsp. *sylvestris* 1, *Tamus communis* +, *Scrophularia scorodonia* +. Other taxa: *Clematis cirrhosa* 2, *Cytisus villosus* 1, *Genista triacanthos* +.

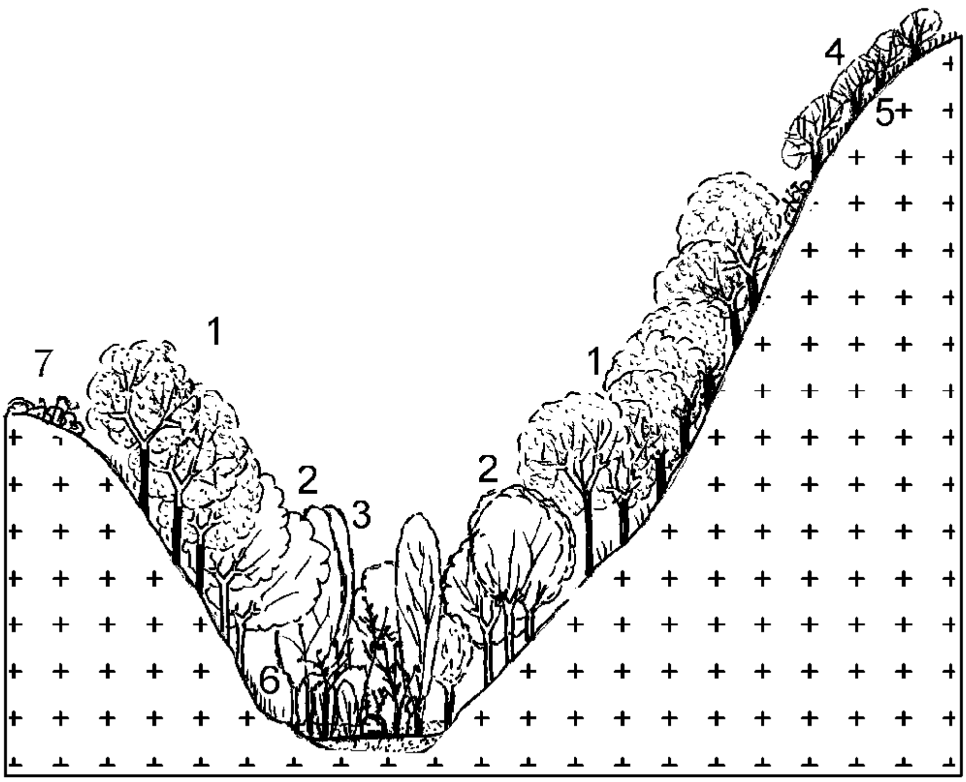
Genisto tridentis-Stauracanthetum boivinii: Garganta de Puerto Oscuro, Alcalá de los Gazules (Cádiz). 550 m, 100 m^2. Characteristics: *Stauracanthus boivinii* 4, *Calluna vulgaris* 3, *Erica scoparia* 2, *Halimium alyssoides* subsp. *lasianthum* 1, *Erica umbellata* 1, *Genista tridens* 1, *G. triacanthos* 1, *Quercus lusitanica* +, *Tuberaria lignosa* + Other taxa: *Cistus salvifolius* 2, *Holcus grandiflorus* 1, *Pteridium aquilinum* 2, *Lavandula stoechas* 1, *Arbutus unedo* +, *Daphne gnidium* +, *Holcus lanatus* +.

Other communities which can be seen in the stretch from the Puerto de Galis to the Garganta de Puerto Oscuro are: *Cytiso baetici-Genistetum monspessulanae* which represents the pre-forest stage of alcornocales and quejigares, and *Clinopodio arundani-Digitaletum bocquetii,* a shade-tolerant community which represents the herbaceous forest fringe of alcornocales and quejigares:

Clinopodio arundani-Digitaletum bocquetii: Characteristics: *Digitalis purpurea* subsp. *bocquetii* V, *Brachypodium gaditanum* III, *Clinopodium vulgare* subsp. *arundanum* II, *Campanula rapunculus* +, *Hypericum perforatum* +. Other taxa: *Pteridium aquilinum* IV, *Rubia peregrina* subsp. *longifolia* IV, *Scrophularia scorodonia* III, *Rubus ulmifolius* III, *Cytisus villosus* II, *Cistus salvifolius* II, *Pteridium aquilinum* II, *Dactylis glomerata* subsp. *hispanica* I, *Vinca difformis* +, *Ranunculus ficaria* +. (Galán de Mera 1993)

PICTURE 18

Locality: Garganta de Puerto Oscuro, Alcalá de los Gazules (Cádiz)
Altitude: 500 m
Biogeography: Aljibico sector
Thermotype: Thermo-mesomediterranean
Ombrotype: Hyperhumid
Lithology: Aljibe sandstone



1. *Teucrio baetici-Quercetum suberis*
2. *Rusco hypophylli-Quercetum canariensis*
3. *Frangulo baetici-Rhododendretum baetici*
4. *Cytiso triflori-Quercetum pyrenaicae*
5. *Deschampsio strictae-Agrostietum curtisii*
6. *Lonicero hispanicae-Rubetum ulmifolii*
7. *Genisto tridentis-Stauracanthetum boivinii*

(Overview of the vegetation and landscape of the lower Algarve (southern Portugal): siliceous ecosystems, schist, sandy substrata, dunes and saltmarshes.)

MÁRIO FERNANDES LOUSÃ , JOSÉ CARLOS COSTA, JORGE HENRIQUE CAPELO, CARLOS PINTO GOMES & CARLOS NETO SILVA

LITTORAL WOODLAND TERRITORIES

Entering the portuguese territory of the Gaditan-Onubian-Algarvian subprovince the landscape is formed by a small range, where soils derived from schist dominate. Most of these soils are in an advanced state of erosion due to ancient agricultural practices. These strongly eroded soils are covered by a *Cistus ladanifer, Cistus monspeliensis* and *Genista hirsuta* subsp. *hirsuta* scrub (*Genisto hirsutae-Cistetum ladaniferi cistetosum monspeliensis* (*Cisto-Lavanduletea, Lavanduletalia stoechadis, Ulici-Cistion ladaniferi*). This community is a substitution stage of the thermomediterranean dry to subhumid holly oak forests *Myrto communis-Quercetum rotundifoliae* (*Quercetea ilicis, Quercetalia ilicis, Querco-Oleion sylvestris*). Moving westwards, while in the thermomediterranean stage, the ombroclimate is wetter (humid) and a cork oak vegetation series stands for the climatophyllous vegetation: *Myrto communis-Querco suberis sigmetum* . The low-scrub *Cisto ladaniferi-Ulicetum argentei*, the strawberry-tree high-scrub *Phillyreo angustifoliae-Arbutetum unedonis rhododendretosum baetici* are the most outstanding stages of these series, appearing in mosaic with remains of the ancient forest.

The recent littoral sandy *substrata* of the Miocene and Plio-Pleistocene are included in the Algarviense sector, which is again of dry ombrotype and still in the thermomediterranean stage. The potential vegetation is represented by the psamophyllous cork oak forests *Oleo sylvestris-Querco suberis sigmetum* . Most of these natural forests have been replaced by *Pinus pinea* afforestations, although some remains and mostly its subserial stages are found. The *Asparago aphylli-Myrtetum communis* and a basal community of *Cytisus grandiflorus* subsp. *cabezudoi* (*Cytisetea scopario-striati, Retamion sphaerocarpae*) are the most frequent high-scrub formations as the first stages of the series. The low-scrub phase of the regressive succession in this series is the *Cistetum bourgaeani* (*Cisto-Lavanduletea, Stauracantho-Halimietalia, Coremion albi*). The most frequent taxa are: *Cistus libanotis* (= *C. bourgaeanus*), *Ulex argenteus* subsp. *subsericeus*, *Thymus albicans, Armeria macrophylla, Halimium calycinum, Lavandula sampaioana* subsp. *lusitanica*. In the western extreme of its biogeographical area, rare stands of the *Halimio halimifolii-Stauracanthetum genistoidis* can be found (*Stauracanthus genistoides, Armeria velutina, Thymus albicans* subsp. *donyanae*, etc.). Where the erosion of the sandy levels reaches the miocenic rocks or the paleopodzols (würmian paleodunes) with iron-oxide rich “orstein” horizons, an endemic community can be found on the scope of these series: *Tuberario majoris-Stauracanthetum boivinii* (*Calluno-Ulicetea, Ulicetalia minoris, Stauracanthion boivinii*). The floristical combination defining the association is: *Stauracanthus boivinii, Tuberaria major, Thymus lotocephalus*. Also, the annual community *Tolpido barbatae-Tuberarietum bupleurifoliae* (*Helianthemetea, Malcomietalia, Anthyllido-Malcomion lacerae*) is specific of this series.

Synthetic table of saltmarsh communities of Ria Formosa

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Zostera noltii	V	.	.	.	.	.	.	.
Spartina maritima	.	V	+	III	II	II	.	.
Spartina densiflora	.	+	V	I	.	.	I	+
Limonium vulgare	.	III	.	III	III	II	.	.
Sarcocornia perennis	.	III	II	V	II	II	.	.
Puccinellia convoluta	.	II	.	IV	II	I	.	.
Halimione portulacoides	.	III	IV	III	V	V	V	IV
Sarcocornia alpini	.	.	III	III	V	I	IV	II
Sarcocornia fruticosa	.	I	I	I	III	V	II	II
Cistanche phelypaea	.	.	II	I	III	IV	III	I
Triglochin bulbosa ssp. *barrelieri*	.	.	.	I	II	+	II	II
Spergularia maritima	.	.	I	.	III	.	II	I
Puccinellia foucaudii	.	.	.	.	II	.	III	.
Arthrocnemum macrostachyum	.	.	III	.	II	+	V	V
Limonium algarvense	.	.	II	.	I	+	III	III
Limonium ferulaceum	.	.	II	.	II	II	III	III
Inula crithmoides	.	.	II	.	II	I	III	III
Limonium diffusum	.	.	.	.	II	+	III	II
Juncus subulatus	.	.	.	.	.	.	.	III
Scirpus maritimus var. *compactus*	.	.	.	.	.	.	.	I
Suaeda vera	.	.	III	.	.	I	III	III
Polygonum equisetiforme	.	.	.	.	.	.	I	II
Limonium lanceolatum	.	.	.	.	.	.	II	.
Limoniastrum monopetalum	.	.	II	.I	III	II	III	III
Elymus elongatus	.	.	.	.	.	.	I	.
Juncus maritimus	.	.	III	.	I	II	.	IV
Juncus acutus	.	.	II	.	I	.	.	II
Carex extensa	.	.	.	.	.	.	.	.
Spergularia salina	.	.	.	.	I	.	.	.
Centaurium spicatum	.	.	.	.	.	.	.	.
Centaurium tenuiflorum	.	.	.	.	.	.	.	.
Frankenia boissieri	.	.	.	.	.	.	.	.
Sonchus maritimus	.	.	.	.	.	.	.	.
Oenanthe lachenalli	.	.	.	.	.	.	.	.
Aster tripolium ssp. *pannonicus*	.	.	.	.	.	.	.	.
Lactuca saligna	.	.	.	.	.	.	.	.
Apium graveolens	.	.	.	.	.	.	.	.
Tamarix africana	.	.	.	.	.	.	.	.
Frankenia laevis	.	.	.	.	.	.	I	II
Salsola vermiculata	.	.	.	.	.	.	.	.
Atriplex halimus	.	.	.	.	.	.	.	.
Beta vulgaris ssp. *maritima*	.	.	.	.	.	.	.	.
Elymus farctus ssp. *boreali-atlanticus*	.	.	.	.	.	.	.	.
Plantago macrorhiza	.	.	.	.	.	.	.	.
Plantago coronopus ssp. *ceratophylla*	.	.	.	.	.	.	.	.

I	J	K	L	M	N	O	P	Q	R	S	T
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IV	III	II	II	I	.	.	II	.	.	.	.
.	II	.	.	.	.	.	II	.	.	.	.
.	II	I	III	I	.	.	.	III	.	.	.
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I	+	I	.	.	.	.	.	.	.	.	.
.	V	III	.	I	I	.	.	II	.	.	.
III	III	IV	II	.	I	.	.	.	.	.	.
V	I	II	II	II	.	.	.	I	.	III	+
III	I	+	III	.	+	.	.	.	.	.	.
IV	II	II	II	.	r	.	.	.	.	.	.
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+	V	IV	II	I	IV	.	.	.	.	.	.
+	+	IV	IV	V	I	.	.	.	.	.	+
.	II	II	.	.	.	.	.	.	.	.	.
V	III	.	III	.	.	.	.	.	.		
.	I	III	II	.	.	.	.	.	.	.	.
I	r	I	V	IV	.	.	.	.	.	.	.
I	r	I	V	V	.	.	.	.	.	.	.
.	.	.	II	.	.	.	.	.	.	.	.
III	.	.	IV	.	.	.	.	.	I	II	I
.	.	.	III	II	.	.	.	.	.	II	.
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IV	I	IV	III	V	V	.	.	I	.	IV	V
.	+	III	.	.	V	.	.	.	.	.	.
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.	.	.	.	.	III	.	.	.	.	.	.
.	.	.	.	.	II	.	.	.	.	.	.
+	.	II	III	II	IV	.	.	.	III	III	IV

Salicornia lutescens	.	I	.	.	.	.	.	.
Salicornia patula	.	I	.	II	I	I	.	.
Suaeda maritima	.	III	II	III	III	II	III	II
Suaeda spledens	.	.	.	.	.	.	.	.
Salsola soda	.	.	.	.	.	.	.	.
Cressa cretica	.	.	.	.	.	.	.	.
Crypsis aculeata	.	.	.	.	.	.	.	.
Parapholis filiformis	.	.	.	.	.	.	II	I
Hordeum marinum	.	.	.	.	.	.	I	I
Polypogon maritimus	.	.	.	.	.	.	+	II
Parapholis incurva	.	.	.	.	.	.	.	.
Beta macrocarpa	.	.	.	.	.	.	.	.
Lophochloa hispida	.	.	.	.	.	.	.	.
Hainardia cylindrica	.	.	.	.	.	.	.	.
Frankenia pulverulenta	.	.	.	.	.	.	.	.
Sphenopus divaricatus	.	.	.	.	.	.	.	.
Sporobolus pungens	.	.	.	.	.	.	I	I
Spergularia bocconei	.	.	.	.	.	.	+	.
Mesembryanthemum nodiflorum	.	.	.	.	.	.	+	.
Atriplex prostrata	.	.	.	.	.	.	+	II
Sonchus tenerrimus	.	.	.	.	.	.	.	.
Oxalis pes-caprae	.	.	.	.	.	.	.	.
Hedypnois cretica	.	.	.	.	.	.	.	.
Avena barbata	.	.	.	.	.	.	.	.
Cotula coronopifolia	.	.	.	.	.	.	.	.
Phragmites australis	.	.	.	.	.	.	.	.
Dittrichia viscosa ssp. *revoluta*	.	.	.	.	.	.	.	.
Aster squamatus	.	.	.	.	.	.	.	.
Melilotus messanensis	.	.	.	.	.	.	.	.
Hordeum leporinum	.	.	.	.	.	.	.	.
Anacyclus radiatus	.	.	.	.	.	.	.	.
Scolymus hispanicus	.	.	.	.	.	.	.	.
Piptatherum miliaceum	.	.	.	.	.	.	.	.
Phalaris paradoxa	.	.	.	.	.	.	.	.
Lotus creticus	.	.	.	.	.	.	.	.
Vulpia alopecurus	.	.	.	.	.	.	.	.
Malcolmia littorea	.	.	.	.	.	.	.	.
Silene nicaeensis	.	.	.	.	.	.	.	.
Emex spinosa	.	.	.	.	.	.	.	.
Echium gaditanum	.	.	.	.	.	.	.	.
Juncus hybridus	.	.	.	.	.	.	.	.

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.	.	.	+	.	.	.	.	.	.	I	.
.	.	.	.	.	.	.	.	III	II	II	.
IV	+	I	III	I	II	.	.	II	V	V	III
II	.	+	II	.	II	.	.	II	III	V	IV
II	.	r	III	III	I	.	.	III	III	V	.
II	.	.	.	.	.	.	.	II	V	II	III
I	.	r	.	.	I	.	.	.	II	.	III
.	.	.	.	.	.	.	.	I	.	I	.
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.	.	.	.	.	.	.	.	.	III	.	.
III	II	II	.	.	+	.	.	.	I	.	.
II	.	r	I	.	I	.	.	III	III	V	IV
.	r	.	.	.	I	.	.	.	.	.	V
.	.	r	V	III	I	.	.	II	.	II	II
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A ***Zosteretum noltii*** **(Costa 1991);** B ***Spartinetum maritimae*** **(Costa et al.1997);** C ***Spartinetum densiflorae*** **(Costa et al.1997);** D ***Sarcocornio perennis-Puccinellietum convolutae*** **(Costa et al.1997);** E ***Halimiono portulacoidis-Sarcocornietum alpinii*** **(Costa et al. 1997);** F ***Cistancho phelypaeae-Arthrocnemetum fruticosae*** **(Costa et al.1997);** G ***Inulo crithmoidis-Arthrocnemetum glauci*** **(Costa et al.1997);** H ***Arthrocnemo glauci-Juncetum subulati*** **(Costa et al.1997);** I ***Inulo crithmoidis-Limonietum ferulacei*** **(Costa 1991);** J ***Cistancho phelypaeae-Suaedetum verae*** **(Costa et al.1997);** K ***Polygono equisetiformis-Limoniastretum monopetali*** **(Costa et al.1997);** L ***Polygono equisetiformis-Juncetum maritimi*** **(Costa et al.1997);** M ***Polygono equisetiformis-Tamaricetum africanae*** **(Costa 1991);** N ***Frankenio laevis-Salsoletum vermiculatae*** **(Costa et al.1997);** O ***Salicornietum fragilis*** **(Costa 1991);** P ***Halimiono portulacoidis-Salicornietum patulae*** **(Costa et al.1997);** Q ***Suaedo splendentis-Salicornietum patulae*** **(Costa et al.1997);** R ***Parapholido incurvae-Frankenietum pulverulentae*** **(Costa et al.1997);** S ***Polypogo maritimi-Hordeetum marini*** **(Costa et al. 1997)** T ***Spergulario bocconei-Mesembryanthemetum nodiflori*** **(Costa et al.1997);**

DUNE ECOSYSTEMS

In the algarvic territories the dune ecosystems have a great wealth of plant communities which, in short, are described here.

In the first band closer to the sea the annual community *Salsolo kali-Cakiletum maritimae* is found in the short nitrified band where organic remains accumulate. The following band of very mobile sand is occupied by the *Euphorbio paraliae-Agropyretum junceiformis* dominated by the grass *Elymus farctus* subsp. *boreo-atlanticus*. In turn, in the mobile crests of dunes the *Loto cretici-Ammophilletum australis* is found. The stabilized sand biotopes are occupied by the chamaephytic community *Artemisio chrithmifoliae-Armerietum pungentis*. In the clearings of the former low-scrub, the psamophillous annual association *Ononido variegatae-Linario pedunculatae* (*Helianthemetea, Malcomietalia, Linarion pedunculatae*) appears. In the equivalent biotopes of the easternmost part of the Superdistrict another microphanerophytic community is found: *Pycnocomo rutifolii-Retametum monospermae* (*Cytisetea, Retamion sphaerocarpae*). The somewhat anthropic character of the later formation is also testified by the semi-nitrophyllous grass community *Chamaemelo mixti-Vulpietum alopecuris* (*Stellarietea mediae, Bromenalia rubenti-tectori, Linario-Vulpion alopecuris*). In the depressions between dunes, where the water-table is frequently near the surface, two rush-communities can be found. The *Holoschoeno-Juncetum acuti* and the *Galio palustris-Juncetum maritimi* (both belong to *Molinio-Arrhnatheretea, Holoschoenalia, Molino-Holoschoenion*). The later association is of biotopes where the water content of soil is higher and permanent throughout the year. When grazed, these rush communities give rise to the *Trifolio resupinati-Caricetum chaetophyllae* (*Molinio-Arrhnatheretea, Plantaginetalia majoris, Trifolio-Cynodontion*).

The natural potential vegetation of dunes is represented by a juniper community which is very rare in the Algarve: *Osyrio quadripartitae-Juniperetum turbinatae*. Probably most of the stands of this *Juniperus turbinata* subsp. *turbinata* dominated community have disappeared due to human activity.

SALTMARSH ECOSYSTEMS

Three main ecological factors seem to control the spatial distribution of saltmarsh communities in the Algarviense sector: salinity, the level of the water-table and the submersion period. The later is strongly in relation to the microtopography of the biotopes. In relation to sodium chloride in soil solution, the higher positions of the saltmarsh have the higher contents due to greater distance to the water table. Progressively, a decreasing salt gradient follows towards the sea. Under the water surface, the first community in the saltmarsh *catena* is the *Cymodoceetum nodosae* (*Halodulo-Thalassietea*). In higher positions, occupying the first mud band of the low tides the *Zosteretum noltii* appears (*Zosteretea marinae*). The first truly emerged plant community is the *Spartinetum maritimae*, which has a pioneer character in the saltmarsh ecosystem. In the same biotopes the annual community *Salicornietum fragilis* is also found. The greater extent of the lower part of the saltmarsh is occupied by the *Sarcocornio perennis-Puccinelietum convolutae* (*Salicornietea fruticosae*) being under submersion with sea-water twice a day. It is dominated *by Sarcocornia perennis* subsp. *perennis* and *Limonium vulgare*. The next higher community is the *Halimiono portulacoidis-Sarcocornietum alpini* (*Salicornietea fruticosae*). The later is dominated by *Sarcornia perennis* subsp. *alpini*. In the banks of the saltmarsh canals another community appears: *Cistancho phelypaeae-Arthrocnemetum fruticosae* which is dominated by the nanophanerophyte *Sarcocornia fruticosa*. The clearings of this community are frequently occupied during the summer and autumn by the *Halimiono portulacoidis-Salicornietum patulae* (*Thero-Suaedetea*). In turn, in higher positions, the *Inulo crithmoidis-Arthrocnemetum glauci* (*Salicornietea fruticosae*), dominated by *Arthrocnemum macrostachyum, Limonium algarvense, Halimione portulacoides*, etc. only is covered by the highest tides. Other communities include: *Cistancho phelypaeae-Suaedetum verae* (biotopes rich in organic debris left by excepcionally high tides) and the *Polygono equisetiformis-Limonastrietum monopetali* which only is influenced by equinoctial tides and supports the highest degree of sodium chloride concentration due to small influence of the water-table there.

The halo-nitrophyllous vegetation has also a great development in algarvic saltmarshes. The *Frankenio laevis-Salsoletum vermiculatae* (*Pegano-Salsoletea*) and the *Inulo chrithmoidis-Limonietum ferulacei*. The later occurs mostly by animal grazing of the saltmarsh. Other associated communities to the saltmarsh are: *Arthrocnemo glauci-Juncetum subulati* (*Salicornietea fruticosi*) is of brackish low –salt waters that dry up during the summer months; *Polygono equisetiformis-Juncetum maritimi* which is frequent as a pioneer stage of abandoned agricultural practices within the saltmarsh influence; *Polygono equisetiformis-Tamaricetum africanae* (*Nerio-Tamaricetea*) in the margin of freshwater streams with some influence of salt in its water table. Also in freshwaters near the saltmarsh, the *Spartinetum compacto-littoralis* can also be found. A large wealth of annual communities can also be found in the saltmarsh surroundings during the spring, namely: *Parapholido incurvae-Frankenietum pulverulentae* (*Saginetea maritimae), Polypogo maritimae-Hordeetum marinae* which in the summer are replaced by the *Suaedo plendentis-Salicornietum patulae* (*Thero-Suaedetea*)v or by the *Damasonio alismae-Crypsietum aculeatae* (*Isoeto-*

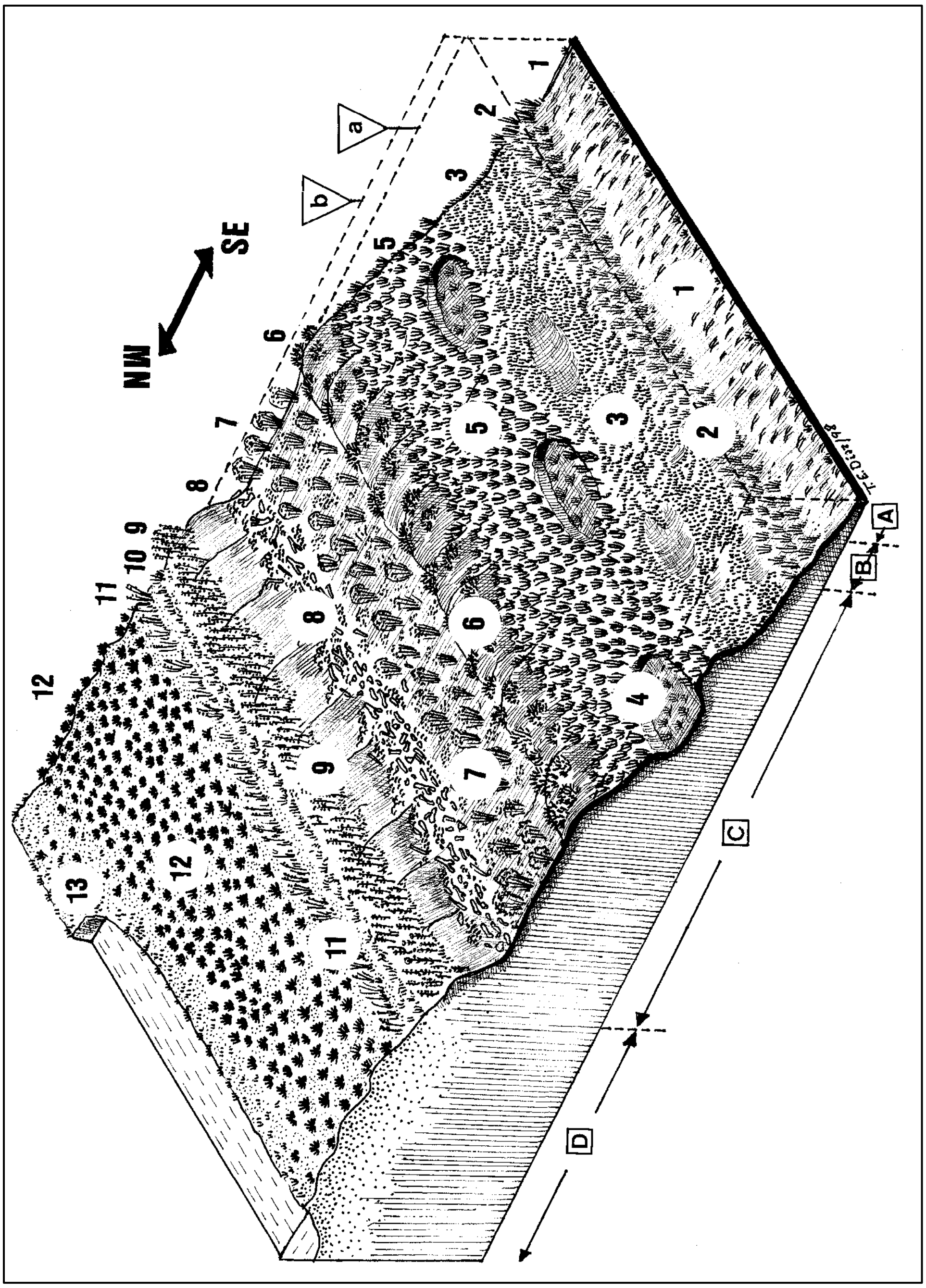
Nanojuncetea). In more nithrophyllous spots the *Spergulario bocconei-Mesembryanthemetum nodiflori* (*Stellarietea media*) is found.

PICTURE 19

Locality: Quinta de Marim. Parque Ría Formosa Natural Park (Algarve). Portugal.
Altitude: 0-5 m
Date: 16-VII-1999
Biogeography: Algárvico superdistrict (Algarviense sector).
Bioclimatic belt: Lower thermomediterranan, dry.
Lithology: Saline alluvial deposits.

1. Z*osteretum noltii* and *Cymodoceetum nodosae* communities
2. S*partinetum maritimae* perennial grass-communities
3. Sapinares halófilos de *Sarcocornia perennis* halophile communities flooded during the high tide (*Sarcocornio perennis-Puccinellietum convolutae*).
4. S*arcocornia alpini* halophile communities of ponds (*Halimio-Sarcocornietum alpini*).
5. Daily flooded *Sarcocornia fruticosa* communities (*Cistancho phelypaeae-Arthrocnemetum fruticosae*).
6. A*rthrocnemum macrostachyum* halophytic communities located in upper levels and submitted to ephemeral floods (*Inulo crithmoidis-Arthrocnemetum glauci*).
7. S*uaeda vera* communities on disturbed and relatively elevated soils (*Cistancho phelypaeae-Suaedetum verae*).
8. Marine loess deposits.
9. L*imoniastrum monopetalum* scrub of the sandy salt-marsh edges (*Polygono equisetiformis-Limomiastretum monopetali*).
10. Nitrophilous vegetation (*Frankenio laevis-Salsoletum vermiculatae*).
11. Hard grasslands of the embrionary flat dunes (*Euphorbio paraliae-Agropyretum junceiformis*).
12. *Helichrysum picardii* chamaephytic scrub of the grey dunes (*Crucianelletalia maritimae*), alternating with ephemeral therophytic communities of the dunes (*Ononidi variegatae-Linarietum pedunculatae*) and psammophilic-subnitrophilous therophytic communities (*Chamaemeli mixti-Vulpietum alopecuris*).
13. Dry and sandy salt marshes vegetation of disturbed sites dominated by *Limonium ferulaceum* (*Inulo crithmoidis-Limonietum ferulacei*).

A: *Halodulo-Thalassietea* y *Zosteretea marinae*.
B: *Spartinetea maritimae*
C: *Sarcocornietea.*
D: *Ammophiletea*.
a: level at high tide; b: maximum level at high tide.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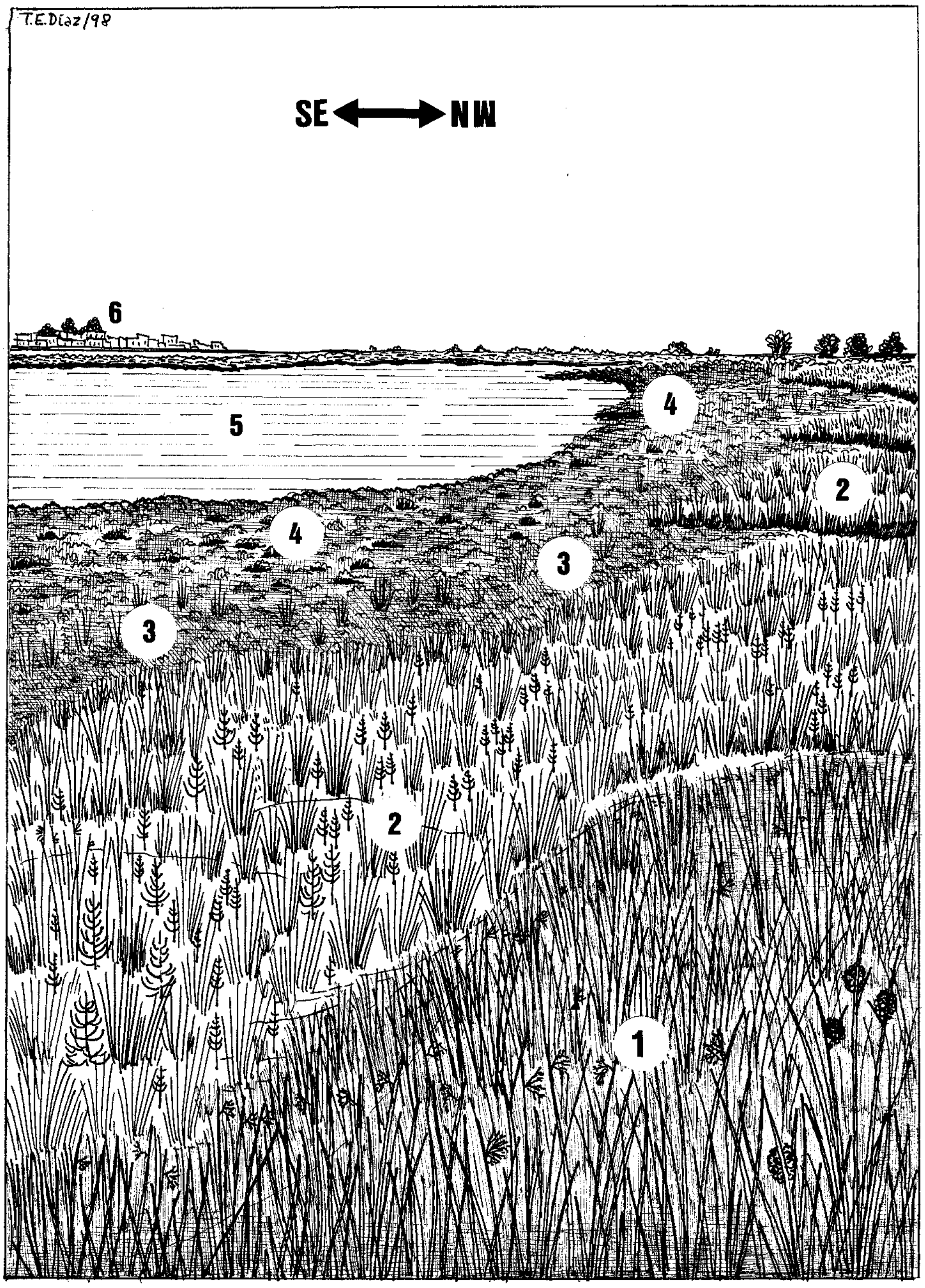
PICTURE 20

Locality: Quinta de Marim. Parque Ría Formosa Natural Park (Algarve). Portugal.
Altitude: 5 m
Date: 16-VII-1999
Biogeography: Algárvico superdistrict (Algarviense sector).
Bioclimatic belt: Lower thermomediterranan, dry.
Lithology: Saline alluvial deposits.

1. Subhalophile *Juncus maritimus* and *Juncus acutus* reed communities on brackish soils (*Polygono equisetiformis-Juncetum maritimi*).
2. Halophile reed communities (*Arthrocnemo-Juncetum subulati*)
3. and 4: *Sarcocornia alpini* halophile communities with (3) and without (4) *Juncus maritimuss* (*Halimiono-Sarcocornietum alpini*).
5. Pool
6. Armona island.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FARO-ÉVORA (17 July)

(The vegetation of the stretch between Faro and Évora)

MÁRIO FERNANDES LOUSÃ , JOSÉ CARLOS COSTA, JORGE HENRIQUE CAPELO, CARLOS PINTO GOMES & CARLOS NETO SILVA

SKETCH OF THE PLANT LANDSCAPE IN THE JOURNEY FROM FARO TO SÃO BARTOLOMEU DE MESSINES

The journey begins in National Road 125, crossing the littoral plain where the irrigated herbaceous cultures and the citrus orchards are predominant. However, when sand is over gravels the pinewoods of *Pinus pinaster* are dominant.

About seven kilometers north of Faro (São João da Venda) the domain of limestone *substrata* give the landscape a moderately wavy relief, composed of Cretaceous and Jurassic substrata, presenting a vegetation covering whose floristic composition and community types are almost exclusive. This landscape is known by "Barrocal Algarvio".

"Barrocal Algarvio" is situated between the siliceous mountains and the littoral (from north to south) and from São Vicente cape till near Castro Marim (from west to east). This landscape shows great diversity. The slopes succeed in paralell bands, from littoral to the siliceous mountains, covered by fragmentary woodlands and its substitution stages (strawberry-tree high-scrub and communities of *Asparago albi-Rhamnion oleoidis* and *Saturejo-Coridothymion*) and cultivated lands of carobo and almond trees, inserted in low altitude points by watercourses, often bordered by riparian vegetation: ash-groves (*Fraxino angustifoliae-Ulmenion minoris*), willow-groves (*Salicion triandro-neotrichae*), tamarisk-groves (*Tamaricion africanae*) and oleander-groves (*Rubio ulmifolii-Nerion oleandri*).

Though the natural vegetation belongs to holly oak, thermomediterranean, calcareous, Betic series of *Smilaco mauritanicae-Querco rotundifoliae sigmetum*, (algarvish type with *Juniperus turbinata*), in the wetter places the holly oak series gives way to the oakwood of *Querco alpestris-broteroi sigmetum*, thermomediterranean, calcareous, relic vegetation series. In the dryer places specially over the summit points, cliffs and rocky slopes, another series appears: the juniper-groves in thermomediterranean, dry to subhumid, calcareous soil and belongs to *Querco cocciferae-Junipero turbinatae sigmetum,* with seaside distribution from Algarve to Figueira da Foz (center of Portugal).

The existence of large spots of thyme and gorse low-scrub and tree-quermes oak high-scrub denotes the farming, cut of scrub, fire and recently the legal and illicit urbanization, specially in the small hills near the sea and in the towns surroundings.

Nevertheless there are still some more inaccessible places to the human activity where it´s possible to find testimonies of ancient potential formations very important for nature conservation. On the other hand, the vegetation dinamics due to neglected farming activity leads to the reorganization of the potential vegetation serial stages which is also important for conservation. It´s in these habitats that the following portuguese endemic plants can be found: *Arabis lusitanica, Bellevalia hackelli, Centaurea occasus, Dittrichia viscosa* subsp. *revoluta, Doronicum plantagineum* subsp. *tournefortii, Genista hirsuta* subsp. *algarbiensis, Linaria haenseleri, Narcissus calcicola, N. gaditanus, N. obesus, N. wilkommii, Ophrys vernixia, Plantago algarbiensis, Serratula baetica* subsp. *lusitanica, Sideritis arborescens* subsp. *lusitanica, Teucrium algarbiense, Thymus lotocephalus, Ulex argenteus.*

SKETCH OF THE PLANT LANDSCAPE IN THE JOURNEY FROM SÃO BARTOLOMEU DE MESSINES (ALGARVE) TO TRÓIA (SADO RIVER).

After leaving the limestone range of "Barrocal" in the Algarve, a small strip of sandstone followed by schisteous soils can be found. This small strip still belongs to the thermomediterranean stage where the cork-oak series *Myrto communis-Querco suberis* sigmetum corresponds to the climatophyllous vegetation. These thermophyllous forests are rich in lianas (*Smilax aspera, Rubia peregrina*, and a wealth of shinny-leaved thermophyllous shrubs is found on the understory (*Phillyrea latifolia, Ceratonia siliqua, Myrtus communis*, etc.). Nevertheless, little can be seen of this community since most of the territory is covered by its substitution stages. A gorse community - *Cisto ladaniferi-Ulicetum argentei* - dominates the landscape, while small patches of the *Phillyreo-Arbutetum unedonis rhododendretosum baetici* is seen as the second stage in the series.

A rise in altitude and also a greater distance from the sea, leads to the lower mesomediterranean stage of the Caldeirão range. The mesomediterranean Luso-Extremadurensian series *Sanguisorbo agrimonioidis-Querco suberis* sigmetum appears. The mature stage of the series is a cork-oak forest -*Quercus suber* -of a more continental character - and has as diagnostic main stages the *Phillyreo-Arbutetum unedonis viburnetosum tini*, which differs from the termophillous race of this association by the absence of a wealth of taxa*: Bupleurum fruticosum, Lavandula viridis, Phlomis purpurea*, etc. The low- scrub stage is the *Erico australis-Cistetum populifolii*, where heath is co-dominated by cistuses (*Cistus populifolius* and *C. ladanifer*). Also, a community of *Adenocarpus complicatus* subsp*. anisochilus* is characteristic of this series.

A short way through the mesomediterranean dry stage follows, where the holly-oak vegetation series, *Pyro bourgaeanae-Querco rotundifoliae sigmetum* , is found. The scattared *Quercus rotundifolia* are found among its main substitution stage: *Genisto hirsutae-Cistetum ladaniferi* (*Cisto-Lavanduletea*). Also, the *Retamo sphaerocarpae-Cytisetum bourgaei*, the annual meadows of *Trifolio cherleri-Plantaginetum bellardii* (*Helianthemetea guttati*) and the grazed perennial community *Trifolio subterranei-Poetum bulbosae* (*Poetea bulbosae*) are diagnostic of this series.

Approaching the coastal plains again, we re-enter the thermomediterranian stage and again the *Myrto communis-Querco suberis sigmetum* vegetation series. In this *facies*, the series occupies mostly the upper sub-humid ombric stage, and the low-scrub stage of the series found here is the *Querco lusitanicae-Stauracanthetum boivinii* heath community. Still, the most outstanding seral stage seen is *the Phillyreo-Arbutetum unedonis* in its thermophyllous ecological race *: rhododendretosum baetici*.

Approaching the Sado basin, the pliocenic and pleistocenic substrata dominates and the *Oleo sylvestris-Querco suberis* sigmetum re-appears. *The Asparago aphylli-Myrtetum communis* and mostly the communities of the *Coremion albi* alliance dominate the landscape: *Thymo capitellati-Stauracanthetum genistoidis* and *Thymo camphorati-Stauracanthetum spectabilis*. The *Chamaemelo mixti-Vulpietum alopecuroris* nitrophillous annual community is also a constant feature in the landscape.

Finally, to what concerns vegetation associated with streams and rivers, the *Salix* spp.-dominated communities are the most evident features: *Viti viniferae-Salicetum atrocinereae* and *Salicetum atrocinero-australis*.

AN OVERVIEW OF THE PLANT COMMUNITIES AND LANDSCAPE OF TRÓIA (SADO RIVER ESTUARY) DUNE ECOSYSTEMS.

The whole of the Sado basin (Sadense sector) is included in the thermomediterranean stage where the *Oleo sylvestris-Querco suberis* sigmetum develops on Pleistocenic and Holocenic sands. The artificial park structure (montados) still maintain some remanent tree cover of cork-oak, while its substitution stages dominate the landscape. An important dune system and aquatic vegetation (both freshwater and saltmarsh) is also well represented in the area. In the *Oleo-Querco suberis* sigmetum vegetation series, the most outstanding subseral stages are the *Asparago aphylli-Myrtetum communis* (high-scrub) and the low-scrub *Thymo capitellati-Stauracanthetum genistoidis*. A large amount of endemics are found in the later community: *Thymus capitellatus, Armeria royuana, Malcomia lacera* subsp. *gracilima*. In biotopes where the miocenic harder level approaches the surface another low-scrub appears: *Erico umbellatae-Ulicetum welwitschiani* (*Calluno-Ulicetea, Ericion umbellatae*) where the gorse *Ulex australis* subsp. *welwitschianus* is dominant. In the clearings, the annual community *Anachorto-Arenarietum algarbiensis* (*Anthyllido-Malcomion*) is found. A community dominated by nitrophyllous shrubs appears in the soils that suffered ancient agricultural activity. It is dominated by the endemic *Santolina impressa* and *Artemisia campestre* subsp. *campestre* (*Santolinetum impressae, Pegano-Salsoletea*).

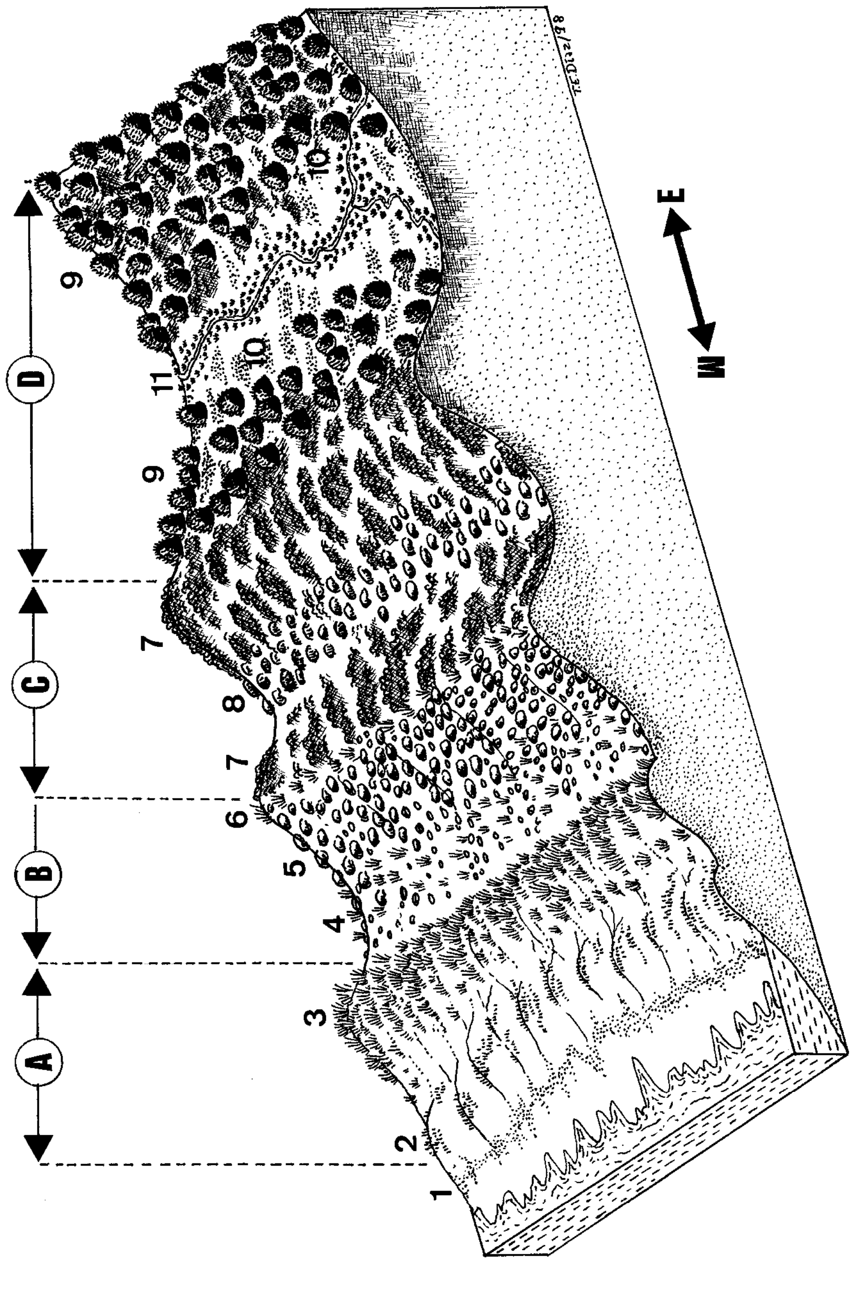
Since most of the territory is found on the dry ombric stage, the appearance of the *Oleo-Querco suberis* sigmetum vegetation series is only possible by the presence of the water table near the surface in a short part of the year. That fact arises from the underlying hard Miocenic layer under the sand *strata*. In places where the soil is formed on deeper paleo-dunes (formed during the würmian regression of the coast) the water table never compensates summer draught and the cork-oak series never reaches its full development. Thus, an high-scrub community dominated the endemic juniper *Juniperus navicularis* appears as permanent climax vegetation (*Daphno gnidii-Juniperetum navicularis*).

PICTURE 21

Locality: Tróia Peninsula, Estuário do Sado Nature Reserve. Portugal.
Altitude: 1-20 m
Date: 17-VII-1999
Biogeography: Sadense superdistrict; Sadense sector
Bioclimatic belt: Lower thermomediterranean, dry.
Lithology: Dunes

1. Halo-nitrophilous therophytic community (*Salsolo kali-Cakiletum maritimae*)
2. Perennial grass community of embrionary dunes (*Euphorbio-Agropyretum junceiformis*).
3. Dune-crest community (*Loto cretici-Ammophiletum australis*)
4. Secondary *Ammophiletum*.
5. Chamaephytic community of grey dunes (*Artemisio crithmifoliae-Armerietum pungentis linarietosum lamarckii*).
6. Residual *Ammophiletum*.
7. Fixed dunes community with *Corema album* (*Rubio longifoliae-Coremetum albi*)
8. Secondary *Artemisio crithmifoliae-Armerietum pungentis* community (facing the sea) alternating with ephemeral dune therophyte communities on inaltered dunes (*Herniario algarvicae-Linarietum ficallhoanae*).
9. Juniper woodland of litoral fixed dunes influenced by the sea wind (*Osyrio-Juniperetum turbinatae*) with mantle of *Rubio-Coremetum albi* and scionitrophilous communities of *Scrophularia sublyrata*.
10. *Stauracantho-Halimietalia* communities, alternating with therophytic vegetation of *Linarion pedunculatae* and terricolous lichen communities of *Cladonietum mediterraneum*.
11. Subnitrophilous community of the roadsides on disturbed soils with *Santolina impressa* (*Santolinetum impressae*).

Potential Natural Vegetation: A. *Loto-Ammophiletum*; B. *Artemisio crithmifoliae-Armerietum pungentis;* C. *Rubio-Coremetum albi;* D. *Osyrio-Juniperetum turbinatae*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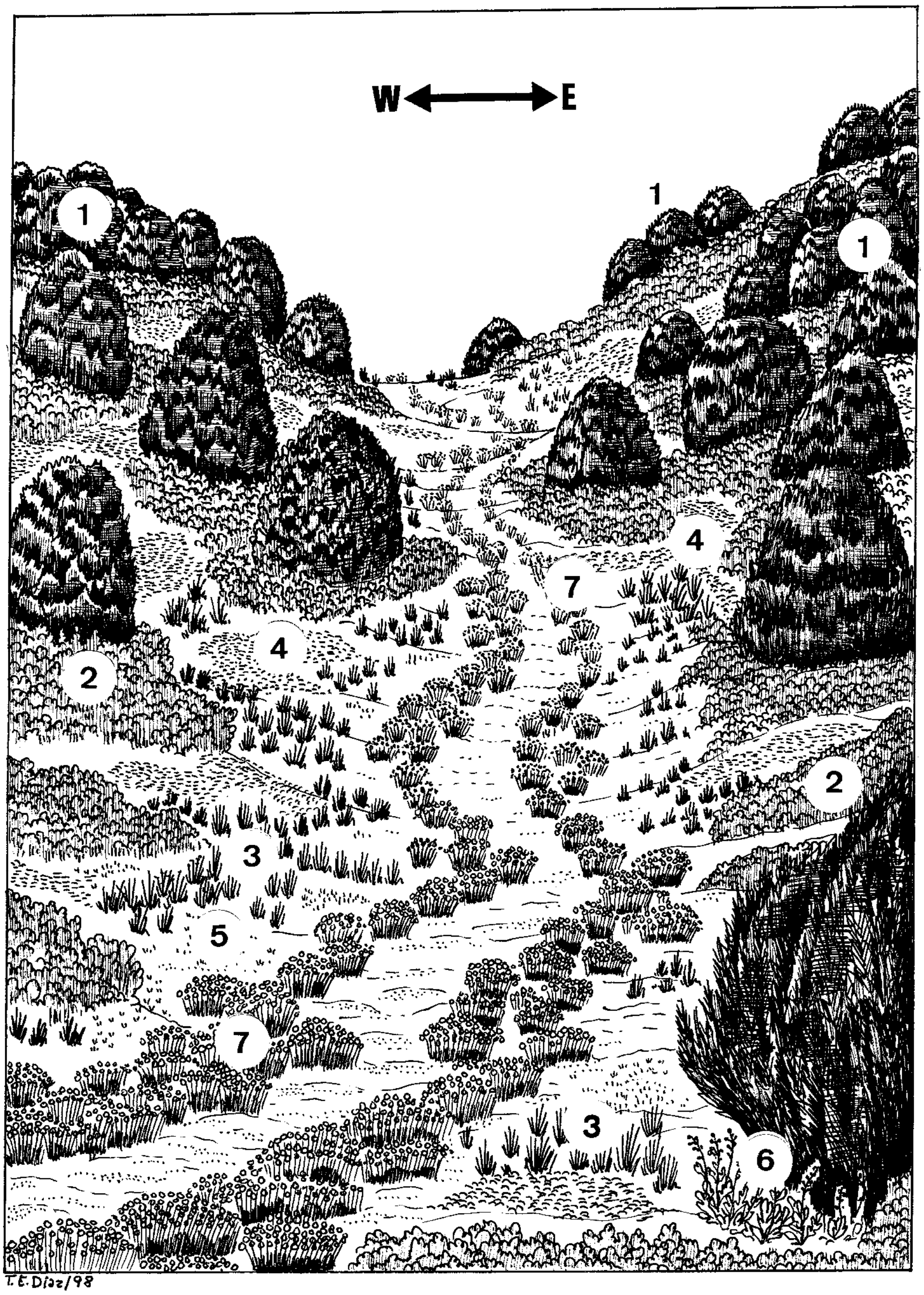
PICTURE 22

Locality: Tróia Peninsula, Estuário do Sado Nature Reserve. Portugal.
Altitude: 1-20 m
Date: 17-VII-1999
Biogeography: Sadense superdistrict; Sadense sector
Bioclimatic belt: Lower thermomediterranean, dry.
Lithology: Dunes

1. Juniper woodland of litoral fixed dunes influenced by the sea wind (*Osyrio-Juniperetum turbinatae*).
2. Mantle of *Rubio-Coremetum albi.*
3. Communities of *Stauracantho-Halimietalia.*
4. Lichen community *(Cladonietum mediterraneum).*
5. Ephemeral therophytic community of *Herniario-Linarietum ficalhoanae (Linarion pedunculatae)*.
6. Scionitrophilous community of the juniper woodland with *Scrophularia sublyrata*.
7. Subnitrophilous community of the roadsides on disturbed soils with *Santolina impressa* (*Santolinetum impressae*).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Synthetic table of dune communities of Sadense Superdistrict

	A	B	C	D	E	F	G	H	I	J	K
Cakile maritima ssp. *maritima*	V	II	.	.	.	.	.	.	.	.	.
Salsola kali	IV	+	.	.	.	.	.	.	.	.	.
Polygonum maritimum	+	+	I	.	.	.	.	.	.	.	.
Elymus farctus ssp. *boreali-atlanticus*	.	V	III	.	.	.	.	.	.	.	.
Eryngium maritimum	.	IV	III	.	.	.	.	.	.	.	.
Otanthus maritimus	.	III	III	+	.	.	.	.	.	.	.
Euphorbia paralias	.	II	II	.	.	.	.	.	.	.	.
Calystegia soldanella	.	II	II	II	.	.	.	.	.	.	.
Medicago marina	.	II	II	I	.	.	.	.	.	.	.
Ammophila arenaria ssp. *australis*	.	I	V	III	.	I	.	.	.	.	.
Pancratium maritimum	.	III	III	III	.	.	.	.	.	.	.
Lotus creticus	.	.	IV	V	I	III	I	.	.	.	.
Crucianella maritima	.	.	III	V	.	III	.	.	.	.	.
Armeria pungens	.	.	III	V	.	IV	III	.	.	.	.
Artemisia crithmifolia	.	.	II	IV	.	.	.	.	.	.	.
Cyperus capitatus	.	.	+	II	.	.	.	.	.	.	.
Malcolmia littorea	.	.	II	IV	.	III	.	.	.	.	II
Helichrysum picardi var. *picardi*	.	.	II	IV	.	II	III	.	.	.	II
Scrophularia frutescens	.	.	I	II	.	.	.	.	+	.	I
Ononis natrix ssp. *ramosissima*	.	.	I	V	.	III	II	.	+	.	.
Thymus carnosus	.	.	.	V	.	I	I	.	.	.	.
Linaria lamarckii	.	.	.	III	.	.	.	.	.	.	.
Herniaria maritima	.	.	.	III	.	.	.	.	.	.	.
Euphorbia portlandica	.	.	.	III	.	.	I	.	.	.	.
Anagallis monelli var. *microphylla*	.	.	.	III	.	.	.	.	+	.	I
Aetheorhiza bulbosa	.	.	.	I	.	.	.	.	.	.	.
Carpobrotus edulis	.	.	II	III	.	II	III	.	II	.	.
Calendula suffruticosa ssp. *algarbiensis*	.	.	II	III	.	.	I	.	.	.	I
Reichardia gaditana	.	.	I	III	II	.	.	.	.	.	.
Anchusa calcarea	I	III	II	.	.	.	.	.	I		
Verbascum litigiosum	.	.	I	I	.	.	.	.	.	.	II
Sedum sediforme	.	.	.	III	.	.	II	II	III	.	I
Corynephorus canescens var. *maritimus*	.	.	.	II	I	.	.	.	+	.	III
Pimpinella villosa	.	.	.	II	.	.	I	.	I	.	II
Vulpia alopecurus	.	.	.	II	II	.	.	.	.	.	.
Centaurea sphaerocephala	.	.	.	+	.	+	.	.	I	I	.
Linaria ficalhoana	.	.	.	.	V	.	.	.	.	.	.
Silene littorea	.	.	.	.	V	.	.	.	.	.	.
Polycarpon alsinifolium	.	.	.	.	V	.	.	.	.	.	.
Medicago littoralis	.	.	.	.	V	.	.	.	.	.	.
Hedypnois arenaria	.	.	.	.	IV	.	.	.	.	.	.
Erodium aethiopicum ssp. *pilosum*	.	.	.	.	IV	.	.	.	.	.	.
Cutandia maritima	.	.	.	.	III	.	.	.	.	.	.
Pseudorlaya minuscula	.	.	.	.	III	.	.	.	.	.	.
Rumex bucephalophrus ssp. *gallicus*	.	.	.	.	II	.	.	.	.	.	.

Tuberaria guttata	.	.	.	.	II	.	.	.	.	.	.
Ornithopus pinnatus	.	.	.	.	I	.	.	.	.	.	.
Senecio gallicus	.	.	.	.	IV	.	.	.	.	.	.
Papaver setigerum	.	.	.	.	III	.	.	.	.	.	.
Centranthus calcitrapae	.	.	.	.	II	.	.	.	.	.	.
Silene colorata	.	.	.	.	II	.	.	.	.	.	.
Smilax aspera var. *nigra*	.	.	.	.	.	I	II	.	.	.	.
Osyris quadripartita	.	.	.	.	.	I	II	.	.	.	.
Rhamnus oleoides	.	.	.	.	.	III	III	.	.	.	.
Antirrhinum cirrhigerum	.	.	.	II	.	V	IV	.	.	.	.
Corema album	.	.	.	II	.	V	IV	II	IV	.	I
Pistacia lentiscus	.	.	.	.	.	III	V	II	.	I	.
Rubia peregrina var. *longifolia*	.	.	.	.	.	III	I	+	.	.	.
Asparagus aphyllus	.	.	.	.	.	III	III	II	I	I	.
Daphne gnidium	.	.	.	.	.	II	II	V	II	III	.
Phillyrea angustifolia	.	.	.	.	.	II	II	III	+	I	.
Juniperus turbinata	.	.	.	.	.	.	V	I	.	.	.
Rhamnus alaternus	.	.	.	.	.	.	II	.	.	.	.
Olea europaea var. *sylvestris*	.	.	.	.	.	.	II	.	+	.	.
Lonicera implexa	.	.	.	.	.	.	I	.	.	.	.
Quercus coccifera	.	.	.	.	.	.	I	III	.	.	.
Juniperus navicularis	.	.	.	.	.	.	.	V	.	I	.
Anemone palmata	.	.	.	.	.	.	.	II	II	I	.
Scilla monophyllos	.	.	.	.	.	.	.	I	I	.	.
Anagyris foetida	.	.	.	.	.	.	.	+	.	.	.
Scrophularia sublyrata	.	.	.	.	.	.	I	.	.	.	.
Cistus salvifolius	.	.	.	.	.	III	III	IV	III	IV	II
Iberis linifolia ssp. *welwitschii*	.	.	.	.	.	III	I	II	II	.	I
Halimium halimifolium	.	.	.	.	.	II	I	IV	V	V	+
Halimium calycinum	.	.	.	.	.	I	II	IV	V	II	II
Thymus capitellatus	.	.	.	.	.	I	.	IV	V	II	III
Lavandula sampaiona ssp. *lusitanica*	.	.	.	.	.	+	I	IV	IV	I	II
Thapsia villosa	.	.	.	.	.	.	II	.	II	.	.
Helichrysum picardii var. *virescens*	.	.	.	.	.	.	.	II	III	.	IV
Lavandula luisieri	.	.	.	.	.	.	.	I	I	III	.
Cistus crispus	.	.	.	.	.	.	.	I	I	III	.
Armeria rouyana	.	.	.	.	.	.	.	II	IV	.	I
Stauracanthus genistoides	.	.	.	.	.	.	.	II	V	.	I
Dianthus hinoxianus	.	.	.	.	.	.	.	I	II	.	.
Cistus libanotis	.	.	.	.	.	.	.	.	I	.	.
Malcolmia lacera ssp. *gracilima*	.	.	.	.	.	.	.	.	II	.	II
Helianthemum stoechadifolium	.	.	.	.	.	.	.	.	II	.	.
Lithodora prostrata ssp. *lusitanica*	.	.	.	.	.	.	.	.	III	II	.
Euphorbia baetica	.	.	.	.	.	.	.	.	I	.	.
Asphodelus ramosus	.	.	.	.	.	.	.	.	I	II	.
Stipa gigantea	.	.	.	.	.	.	.	I	I	I	.
Ulex australis ssp. *welwitschianus*	.	.	.	.	.	.	.	IV	III	V	II
Calluna vulgaris	.	.	.	.	.	.	.	II	+	IV	.

Erica umbellata	.	.	.	.	.	.	.	I	I	IV	.
Tuberaria lignosa	.	.	.	.	.	.	.	.	I	II	.
Cistus psilosepalus	.	.	.	.	.	.	.	.	+	II	.
Genista triacanthos	.	.	.	.	.	.	.	.	+	V	.
Chamaespartium tridentatum	.	.	.	.	.	.	.	.	.	IV	.
Erica scoparia	.	.	.	.	.	.	.	.	.	IV	.
Erica australis	.	.	.	.	.	.	.	.	.	IV	.
Agrostis curtisii	.	.	.	.	.	.	.	.	.	II	.
Simethis mattiazi	.	.	.	.	.	.	.	.	.	II	.
Thymus villosus	.	.	.	.	.	.	.	.	.	II	.
Erica erigena	.	.	.	.	.	.	.	.	.	+	.
Pulicaria odora	.	.	.	.	.	.	.	.	.	III	.
Cistus ladanifer	.	.	.	.	.	.	.	.	.	III	.
Rosmarinus officinalis	.	.	.	.	.	.	.	.	.	II	.
Santolina impressa	.	.	.	.	.	.	.	.	II	.	V
Scrophularia canina	.	.	.	.	.	.	.	.	.	.	II
Ononis natrix ssp. *hispanica*	.	.	.	.	.	.	.	.	.	.	II
Artemisia campestris ssp. *campestris*	.	.	.	.	.	.	.	.	.	.	I
Solanum sodomaeum	.	.	.	.	.	.	.	.	.	.	I
Euphorbia terracina	.	.	.	.	.	.	.	.	.	.	IV
Dittrichia viscosa ssp. *viscosa*	.	.	.	.	.	.	.	.	.	.	III
Verbascum thapsus ssp. *crassifolium*	.	.	.	.	.	.	..	.	.	.	II
Arrhenatherum album	.	.	.	.	.	.	.	.	III	II	I
Cytisus grandiflorus	.	.	.	.	.	.	.	.	I	.	.
Carlina corymbosa	.	.	.	.	.	.	.	.	I	.	II

A ***Salsolo Kali-Cakiletum maritimae* (Costa et al.1994b);** B ***Euphorbio paraliae-Agropyretum juceiformis* (Costa et al.1994b)** C ***Loto cretici-Ammophiletum australis* (Costa et al.1994b);** D ***Artemisio crithmifoliae-Armerietum pungentis* (Diez Garretas 1984, Costa et al.1994b)** E ***Herniario algarvicae-Linarietum ficalhoanae* (Diez Garretas 1984, Costa et al. 1994b);** F ***Rubio longifoliae-Coremetum albi* (Costa et al.1994b);** G ***Osyrio quadripartitae-Juniperetum turbinatae* (Costa et al.1994a,b);** H ***Daphno gnidii-Juniperetum navicularis* (Rivas-Martínez et al. 1990, Costa et al. 1994a);** I ***Thymo capitellatti-Stauracanthetum genistoidis* (Rivas-Martínez et al.1990);** J ***Erico umbellatae-Ulicetum welwitschianii* (Costa et al. 1997);** K ***Santolinetum impressae* (Costa et al. 1999)**

Another original feature of this area is the peat-bog vegetation which appears in depressions that accumulate fresh water all year round, formed in the sand levels reaching the hard miocenic strata. The class *Alnetea glutinosae* is present by means of an *Salix atrocinerea* community (*Carici lusitanicae-Salicetum atrocinereae*) which includes the southernmost localities of *Myrica gale* and *Thelypteris palustris*, for instance. Peat-bog low scrub of gorse (*Ulex minor*) is also found: *Cirsio welwtschii-Ericetum ciliaris* (*Calluno-Ulicetea, Genistion micrantho-anglicae*). In these relictual peat-bogs the vegetation of the classes *Scheuzerio-Caricetea fuscae* and *Littoreletea uniflorae* can also be found (*Utriculario gibbae-Sphagnetum auriculatae* and *Hyperico elodis-Rhynchosporetum rugosae* respectively).

The saltmarsh ecosystem is similar to that described for the Algarve excluding the *Polygono equisetiformis-Limonastrietum monopetali*.

The dune ecosystems are similar (vicariant) to those of the Algarve. The community sequence is basically: *Salsolo kali-Cakiletum maritimae*; *Euphorbio paraliae-Agropyretum junceiformis*; *Loto cretici-Amophylletum autralis*; *Artemisio chrithmifoliae-Armerietum pungentis*. In the clearings of the later association, a vicariant annual community appears: *Herniario algarvicae-Linarietum ficalhoanae*. The potential woody vegetation of dunes has in the Sadense Superdistrict its *optimum*: *Osyrio quadripartitae-Juniperetum turbinatae*. These juniper formations have also a wealth of other thermomediterranean *taxa* of the *Quercetea ilicis* class: *Rhamnus oleoides* subsp. *oleoides*, *Asparagus aphyllos*, etc. Its natural edge is formed by the *Empetraceae* - *Corema album* (*Rubio longifoliae-Coremetum albae*) includable in the same vegetation class.

THE PLANT COMMUNITIES AND LANDSCAPE OF "SERRA DA ARRÁBIDA"

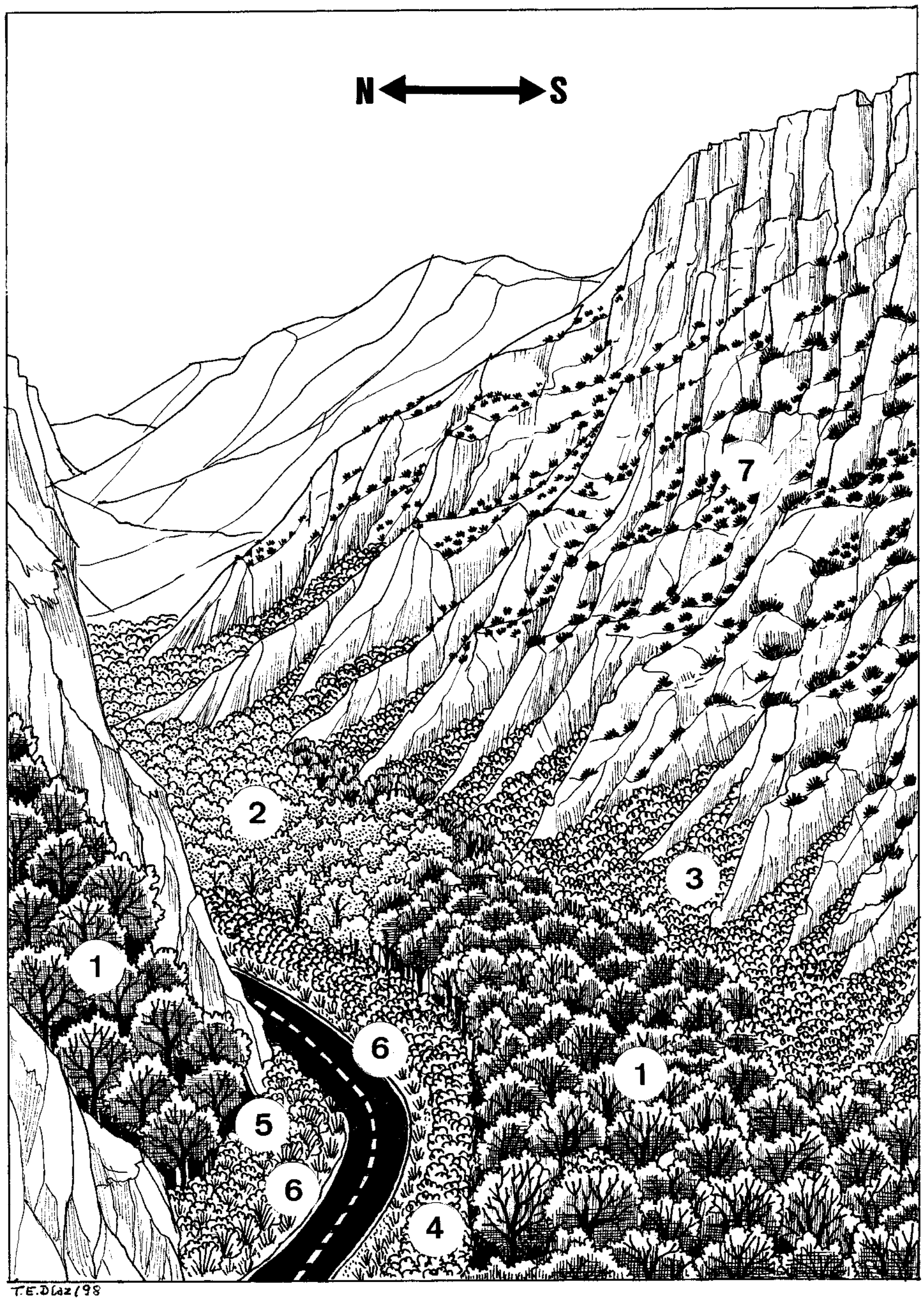
The "Serra da Arrábida" is a small limestone outcrop, mostly of Jurassic origin, where the dominant soils are derived of hard calcium carbonate rocks some with dolomitical character. It is placed on the thermomediterranean, upper sub-humid stage and biogeographically stands as a Superdistrict (Arrabidense) within the Tagano-Sadense subsector. It shares a large proportion of its flora and vegetation with the larger calcareous unit – Divisorio Portugues sector - found north of the Tagus river.

Its vegetation has a relictual character due to the wealth of paleo-tropical and paleo-mediterranean *taxa* and vegetation structures still found there. Although similar to the limestone territories of Algarve, its higher precipitations allow the development of an original combination of vegetation series. The climatophyllous woodland vegetation is composed of micro-mesoforests dominated by tree-quermes oak - *Quercus coccifera* - , which in normal conditions never reaches the height and physiognomy of a tree (here up to *ca*. 14 meters) – *Viburno tini-Quercetum cocciferae* (*Querco-Oleion*, *Quercetalia ilicis, Quercetea ilicis*). This special feature lead some authors to admit the possibility that a taxon distinct of *Quercus coccifera* L. should be considered for these tree-kermes oaks. This woodlands occupy the mid-slope in well drained deep soils in the valleys of Arrábida. The *Cheirolophus sempervirens* clearing community (*Leucanthemo sylvatici-Cheirolophetum sempervirentis, Trifolio-Geranietea*) is also a striking feature of these forest ecosystems. Its substitution stage is an *Arbutus unedo-Quercus coccifera* community which in its primary positions can be considered as *Phillyreo angustifoliae-Arbutetum unedonis viburnetosum tini* variant of *Coronilla valentina* subsp. *glauca*.

Nevertheless, some parts of the valleys are covered with a secondary forest, which can be ascribed to the later association, but on which *Quercus coccifera* is co-dominant and even some plants of *Juniperus phoenicea* subsp. *turbinata* can be found. As a second substitution stage the *Cistus albidus* dominated community *Phlomido purpureae-Cistetum albidi* is found within the scope of this series. It's a low-scrub community found in deep clay-rich soils that suffered erosion of its top horizons.

PICTURE 23

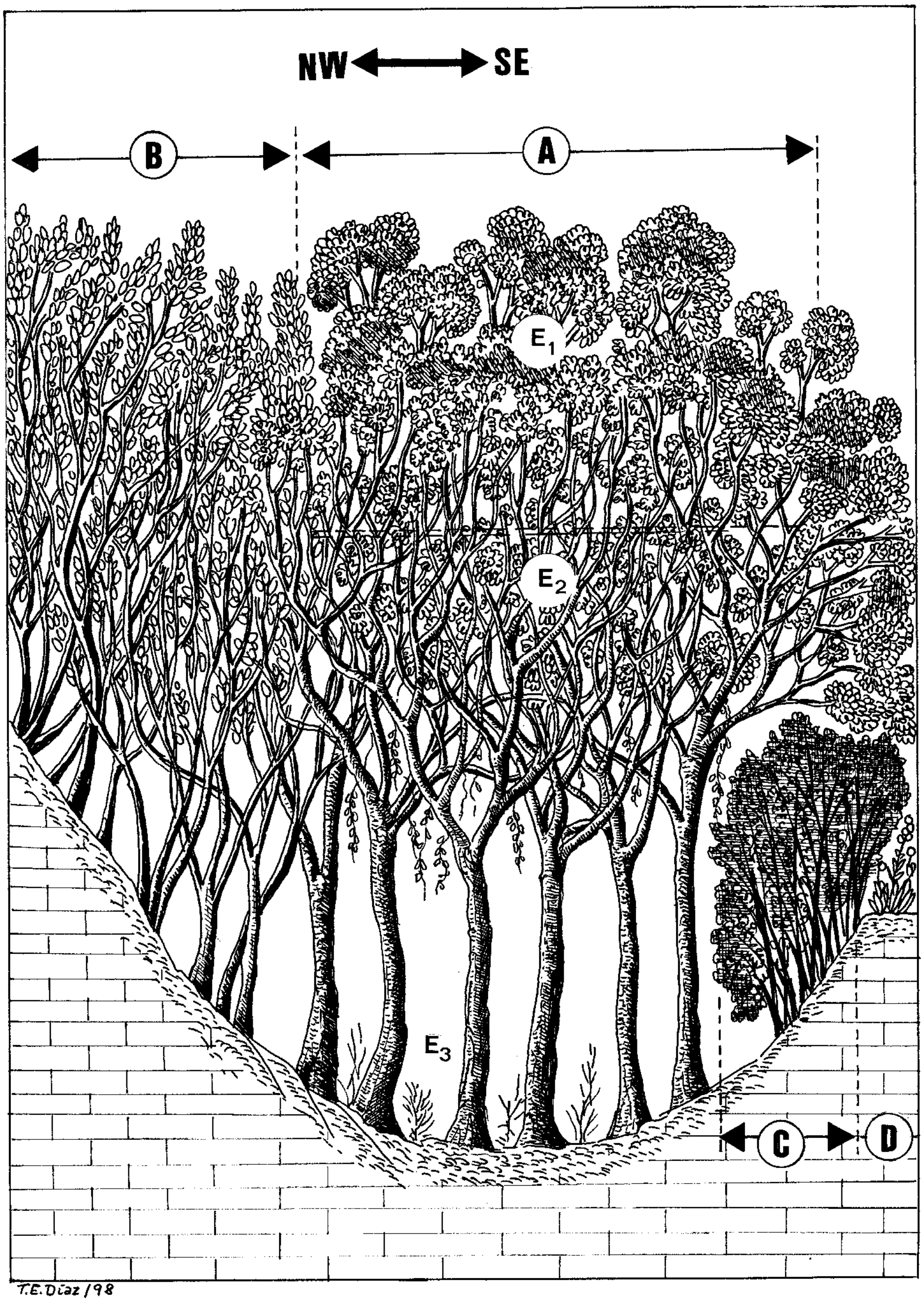
Locality: Mata do Solitario, Serra da Arrábida. Portugal.
Altitude: 180 m
Date: 17-VII-1999
Biogeography: Superdistrito Arrabidense superdistrict; Sadense sector
Bioclimatic belt: Thermomediterranean, upper subhumid to humid
Lithology: Limestone-Dolomite; soil with forestal mull (chromic luvisol).
1. Arboreal coscojar (*Viburno tini-Quercetum cocciferae*).
2. Quejigar of depressions (*Arisaro-Quercetum broteroi*).
3. Arbutus shrubland (*Phillyreo-Arbutetum*).
4. Mesophytic Arbutus shrubland with *Bupleurum fruticosum* (*Phillyreo-Arbutetum*).
5. Xerophytic Arbutus shrubland with *Coronilla glauca* (*Phillyreo-Arbutetum*).
6. Community of *Cheirolophus sempervirens*.
7. Juniper woodland (*Querco cocciferae-Juniperetum turbinatae jasminetosum fruticantis*).


N S
7
2
3
1
6
1
5
6
4
T.E.Díaz/98

PICTURE 24

Locality: Mata do Solitario, Serra da Arrábida. Portugal.
Altitude: 180 m
Date: 17-VII-1999
Biogeography: Superdistrito Arrabidense superdistrict; Sadense sector
Bioclimatic belt: Thermomediterranean, upper subhumid to humid
Lithology: Limestone-Dolomite; soil with forestal mull (chromic luvisol).

A. Arboreal coscojar (*Viburno tini-Quercetum cocciferae*).
B. Arbutus shrubland (*Phillyreo-Arbutetum*).
C. Mesophytic Arbutus shrubland with *Bupleurum fruticosum*.
D. Herbaceous community of *Cheirolophus sempervirens* (*Origanion virentis*).
E_1: *Quercus coccifera*, *Olea europaea* var. *sylvestris*, *Phillyrea latifolia* subsp. *media*, *Ceratonia siliqua*.
E_2: *Arbutus unedo*, *Pistacia lentiscus*, *Viburnum tinus*, *Myrtus communis*, *Sorbus domestica*, *Smilax aspera* var. *altissima*, *Rubia peregrina*, *Rosa sempervirens*, *Tamus communis*.
E_3: *Asplenium onopteris*, *Lonicera implexa*, *Erica arborea*, *Crataegus monogyna*, *Arisarum vulgare*, *Rhamnus oleoides*, *Coronilla glauca*.


NW SE
B
A
E1
E2
E3
C
D
T.E.Díaz/98

Synthetic table of Arrabida Communities

	A	B	C	D	E	F	G	H	I	J
Quercus coccifera (tree)	V	.	.	.	.	.	.	.	.	.
Bupleurum fruticosum	III	.	.	X	.	.	.	.	.	.
Gennaria diphylla	+	I	.	.	.	.	.	.	X	.
Osyris quadripartita	+	I	.	.	.	.	.	.	.	.
Rhamnus oleoides	+	V	.	X	.	.	III	.	.	.
Viburnum tinus	V	.	V	X	.	.	.	.	.	.
Asplenium onopteris	IV	.	IV	.	.	.	.	.	.	.
Deschampsia sricta	III	.	I	.	.	.	.	.	.	.
Erica arborea	+	.	III	X	.	.	.	.	.	.
Paeonia broteroi	+	.	II	.	.	.	.	.	.	.
Pistacia lentiscus	V	V	III	X	.	.	II	.	.	.
Smilax aspera var. *nigra*	V	III	V	X	.	.	II	.	.	.
Arisarum vulgare var. *clusii*	V	IV	V	X	X	X	.	.	X	.
Arbutus unedo	V	III	IV	X	.	.	.	.	.	.
Phillyrea latifolia	V	II	III	.	.	.	.	.	.	.
Ruscus aculeatus	V	II	V	X	.	.	.	.	.	.
Rubia peregrina var. *longifolia*	IV	III	IV	X	.	.	II	.	.	.
Phillyrea media	IV	III	III	X	.	.	.	.	.	.
Hyacinthoides hispanica	III	I	III	.	.	.	.	.	X	.
Olea europaea var. *sylvestris*	III	IV	I	.	.	.	I	.	.	.
Myrtus communis	II	II	II	X	.	.	.	.	.	.
Coronilla glauca	II	+	II	X	.	.	.	.	.	.
Lonicera implexa	I	V	II	X	.	.	I	.	.	.
Phillyrea angustifolia	I	IV	II	X	.	.	I	.	.	.
Carex distachya	I	III	IV	.	.	.	.	.	.	.
Daphne gnidium	+	II	II	X	.	X	V	.	.	.
Asparagus aphyllus	+	I	I	X	.	.	IV	X	.	.
Vinca difformis	II	I	III	.	X	.	.	.	.	.
Jasminum fruticans	+	IV	II	X	.	.	.	.	.	.
Rhamnus alaternus	+	I	I	X	.	.	.	.	.	.
Quercus coccifera	III	V	III	X	.	X	II	.	.	.
Juniperus turbinata	.	V	.	X	.	.	II	.	.	.
Ceratonia siliqua	.	III	.	.	.	.	.	.	.	.
Asparagus albus	.	II	.	.	.	.	.	.	.	.
Anemone palmata	.	II	I	X	.	X	.	.	.	.
Bupleurum rigidum ssp. *paniculatum*	.	I	II	X	.	.	IV	X	.	.
Asparagus acutifolius	.	+	I	.	.	.	.	.	.	.
Euphorbia characias	.	+	II	.	.	.	.	.	.	.
Quercus faginea ssp. *broteroi*	I	.	V	X	.	.	.	.	.	.
Lonicera etrusca	.	.	III	X	.	.	.	.	.	.
Genista tournefortii	.	.	III	.	.	.	II.	.		
Acer monspessulanum	.	.	I	.	.	.	.	.	.	.
Selaginella denticulata	.	.	III	.	.	.	.	.	.	.
Laurus nobilis	.	.	II	.	.	.	.	.	.	.
Cephalanthera longifolia	.	.	I	.	.	.	.	.	.	.

Melica arrecta	.	.	I	.	.	.	+	.	.	.
Cheirolophus sempervirens	.	.	II	.	X	.	+	.	.	.
Origanum virens	.	.	II	.	X	.	.	X	.	.
Geranium purpureum	I	I	IV	X	X	.	.	.	.	.
Teucrium scorodonia	I	.	III	X	X	.	.	.	.	.
Calamintha baetica	.	.	III	X	X	.	.	.	.	.
Brachypodium sylvaticum	.	.	III	.	X	.	.	.	.	.
Picris spinifera	.	.	.	.	X	.	.	.	.	.
Campanula rapunculus	.	.	.	.	X	.	.	X	.	.
Clinopodium vulgare ssp. *arundanum*	.	.	.	.	X	.	.	.	.	.
Stachys germanica ssp. *lusitanica*	.	.	.	.	X	.	.	.	.	.
Sedum forsteranum	.	.	.	.	X	.	.	.	.	
Silene latifolia	.	.	.	.	X	.	.	.	.	.
Agrimonia eupatoria	.	I	.	.	X	.	.	.	.	
Rubus ulmifolius	IV	.	V	X	.	.	.	.	.	.
Tamus communis	IV	.	IV	X	.	.	.	.	.	.
Aristolochia paucinervis	+	I	I	.	.	.	.	.	.	.
Lonicera periclymenum ssp. *hispanica*	+	.	II	.	.	.	.	.	.	.
Narcissus calcicola	.	I	I	.	.	.	.	.	X	X
Calendula suffruticosa ssp. *algarbiensis*	.	I	.	.	.	.	.	.	X	.
Iris foetidissima	.	.	III	.	.	.	.	.	.	.
Pulicaria odora	.	.	I	X	.	.	I	X	.	.
Erica scoparia	.	.	.	X	.	.	+	.	.	.
Luzula forsteri ssp. *baetica*	.	.	.	.	X	.	.	.	.	.
Cistus albidus	I	II	.	.	.	X	II	.	.	.
Phlomis purpurea	.	.	.	.	.	X	II	.	.	.
Cistus monspeliensis	.	III	.	X	.	X	III	.	.	.
Cistus salvifolius	I	II	III	X	.	X	IV	.	.	.
Lavandula luisieri	.	I	.	.	.	X	IV	.	.	.
Astragalus lusitanicus	.	III	.	.	.	X	II	.	X	.
Thymus mastichina	.	.	.	.	.	X	.	.	.	.
Cistus crispus	.	.	.	.	.	X	II	.	.	.
Asphodelus aestivus	.	I	.	.	.	X	.	.	X	.
Ulex densus	.	.	.	.	.	.	V	.	.	.
Thymus zygis ssp. *silvestris*	.	.	.	.	.	.	V	.	.	.
Sideritis hirsuta var. *hirtula*	.	.	.	.	.	.	IV	.	.	.
Serratula baetica ssp. *lusitanica*	.	.	.	.	.	.	III	.	.	.
Serratula estremadurensis	.	.	.	.	.	.	I	.	.	.
Anthyllis vulneraria ssp. *maura*	.	.	.	.	.	.	II	X	.	.
Staehelina dubia	.	II	.	.	.	X	IV	.	.	.
Rosmarinus officinalis	.	IV	.	.	.	X	V	.	X	.
Coridothymus capitatus	.	.	.	.	.	.	II	.	.	.
Bartsia aspera	.	.	.	.	.	.	I	.	.	.
Micromeria graeca ssp. *micrantha*	.	.	.	.	.	.	I	.	.	.
Avenula occidentalis	.	.	.	.	.	.	II	.	.	.
Carex hallerana	.	+	.	.	.	.	IV	X	.	.
Phagnalon rupestre	.	.	.	.	.	.	II	.	.	.
Fumana thymifolia	.	.	.	.	.	.	II	.	.	.

Valeriana tuberosa	.	.	.	.	.	.	I	.	.	.
Cistux x pulverulentus	.	.	.	.	.	.	I	.	.	.
Daucus crinitus	.	.	.	.	.	.	II	X	.	.
Eryngium dilatatum	.	.	.	.	.	.	IV	X	.	.
Salvia sclareoides	.	I	II	.	X	.	V	X	.	.
Brachypodium phoenicoides	I	I	I	X	.	.	V	X	.	.
Phlomis lychnitis	.	.	.	.	.	.	+	X	.	.
Asphodelus ramosus	.	I	.	.	.	.	.	X	.	.
Plantago serraria var. *hispanica*	.	.	.	.	.	.	+	X	.	.
Plantago lanceolata	.	.	.	.	.	.	.	X	.	.
Ophrys lutea ssp. *murbekii*	.	.	.	.	.	.	.	X	.	.
Lathyrus amphicarpos	.	.	.	.	.	.	.	X	.	.
Allium roseum	.	.	.	.	.	.	.	X	.	.
Dactylis glomerata ssp. *hispanica*	.	.	.	.	.	.	III	X	X	.
Stipa offneri	.	I	.	.	.	.	.	.	X	.
Iberis procumbens ssp. *microcarpa*	.	+	.	.	.	.	.	.	X	X
Sedum sediforme	.	.	.	.	.	.	.	.	X	.
Phagnalon saxatile	.	.	.	.	.	X	+	.	X	.
Brachypodium retusum	.	.	.	.	.	.	.	.	X	.
Ornithogalum concinum	.	.	.	.	.	.	.	.	X	.
Gladiolus reuteri	.	.	.	.	.	.	.	.	X	.
Stipa gigantea.	.	.	.	.	.	X	.	X	.	.
Hyparrhenia hirta	.	.	.	.	.	.	II	.	.	X
Antirrhinum linkianum+	.	.	.	.	.	.	.	X		
Silene longicilia	.	+	.	.	.	.	.	.	.	X
Biscutella lusitanica	.	.	.	.	.	.	.	.	.	X
Calendula suffruticosa ssp. *lusitanica*	.	.	.	.	.	.	.	.	.	X
Sanguisorba multicaulis	.	.	.	.	.	.	.	.	.	X
Psoralea bituminosa	.	.	.	.	X	.	+	.	.	X
Sedum album var. *micranthum*	.	.	.	.	.	.	.	.	X	.
Euphorbia portlantica	.	.	.	.	.	.	III	.	.	.
Narcissus bulbocodium ssp. *obesus*	.	.	.	.	.	.	II	X	.	.
Convolvulus althaeoides	.	.	.	.	.	.	I	X	.	.
Urginea maritima	.	+	.	.	.	.	I	X	X	.
Scabiosa artropurpurea	.	.	.	.	.	.	+	X	.	.
Cynara humilis	.	.	.	.	.	.	.	X	.	.
Cynodon dactylon	.	.	.	.	.	.	.	X	.	.
Centaurium erythraea ssp. *grandiflorum*	.	.	.	.	.	.	IV	X	.	.
Helichrysum stoechas	.	.	.	.	.	.	II	.	.	.

A ***Viburno tini-Quercetum cocciferae*** **(Rivas-Martínez et al. 1990, Capelo & Almeida, 1993);** B ***Querco cocciferae-Juniperetum turbinatae*** **(Rivas-Martínez et al. 1990);** C ***Arisaro-Quercetum broteroi*** **(Br.-Bl. et al. 1956, Pinto da Silva & Teles, 1972, Capelo &Almeida 1993);** D ***Phillyreo-Arbutetum viburnetosum tini*** **(Capelo & Almeida, 1993);** E ***Leucanthemo sylvatici-Cheirolophetum sempervirentis*** **(Capelo, 1996);** F ***Phlomido purpureo-Cistetum albidi*** **(Capelo & Almeida, 1993);** G ***Salvio sclareoidis-Ulicetum densi thymetosum silvestris*** **(Capelo et al. 1993);** H ***Phlomido lychnitidis-Brachypodietum phoenicoides*** **(Capelo & Almeida, 1993);** I ***Iberido microcarpae-Stipetum offneri*** **(Rivas-Martínez et al.1990);** J ***Sileno longiciliae-Antirrhinetum linkiani*** **(Ladero et al.1991)**

In the bottom of the valleys, where an intermitent stream is found during the winter months, deep clay-rich soils are exposed to a temporary water-table which compensates slightly the summer drought. In these partially edaphohygrophyllous biotopes another forest community is found: *Arisaro clusii-Quercetum broteroi*, where the beech oak –*Quercus faginea* subsp. *broteroi* is dominant. Normally a mesophytic *Arbutus unedo –Bupleurum fruticosum* community is found (*Phillyreo-Arbutetum unedonis* variant of *Bupleurum fruticosum*) as its substitution stage. The rocky steep cliffs of the valleys are, in most cases, deprived of well-developed soils. Moreover, the presence of karst also contributes to the shortage of water *in situ*. Although receiving the same amount of rain, these biotopes are short on water available to plant communities. Therefore, a edaphoxerophyllous permanent high-scrub juniper community is interpreted as the climax: *Querco cocciferae-Juniperetum turbinatae*. The strongly xeric character of this vegetation is testified by the co-dominance of *Olea europaea* var. *sylvestris*, *Asparagus albus* and ecologically similar taxa in some of these biotopes. Normally, primary positions of the *Querco-Juniperetum* have a perennial grass community as a substitution stage: *Iberido microcarpae-Stipetum offneri* (*Lygeo-Stipetea*).

The secondary versions of the *Querco-Juniperetum turbinatae* have a strong fire-adapted character and are, in most cases, in very eroded rocky, thinner soils, although in more or less flat topographical positions. In these cases, the soil mosaic was eroded in patches which determine a vegetation mosaic: *Querco-Juniperetum* in deeper soils; a tall-grass *Brachypodium phoenicoides* dominated community (*Phlomido lychnitidis-Brachypodietum phoenicoidis*, *Festuco-Brometea erecti*) and in the rocky eroded positions a community dominated by *Ulex densus* and *Thymus zygis* subsp. *sylvestris* (*Salvio sclareoidis-Ulicetum densi thymetosum sylvestris*). This endemic gorse can also be found as a substitution stage in the series *Arisaro-Querco broteroi* sigmetum in marle-derived soils or even in low-carbonate soils within the scope of the *Viburno-Querco cocciferae* sigmetum . In some cliffs exposed to the sea winds the *Salvio-Ulicetum densi thymetosum sylvestris* also seems to have a permanent character or as a substitution stage of the *Querco-Juniperetum turbinatae* variant of *Euphorbia pedroi* (a spurge of the grex "*dendroides*" endemic to Arrábida).

The surroundings of Serra da Arrábida belong to the cork oak vegetation series on sand *Oleo sylvestris-Quercetum suberis*.

THE PLANT COMMUNITIES AND LANDSCAPE BETWEEN SETÚBAL AND ÉVORA

From Setúbal to the surroudings of Vendas Novas, the route runs away in the termomediterranean territories, over sandy soils of the Pliocenic covered by cork oak forests of the *Oleo-Querco suberis sigmetum* .

It´s a landscape marked by the presence of the "montados" or "dehesas" of *Quercus suber* alternating with pine and eucalyptus afforestations, and accompanied by frequent dwarf oak communities (*Quercus lusitanica*), belonging to the *Quercion lusitanicae* alliance, and by psamophillous and xerophitic scrub communities of *Coremion albi*, dominated by *Cistus* and *Halimium* species, which include several endemic plants like: *Armeria rouyana, A. pinifolia, Thymus capitellatus, Halimium verticillatum, Leuzea longifolia, Euphorbia transtagana, Thymus villosus.*

Near Vendas Novas, the soils change from Pliocenic sands to hard soils derived of schists and granitic rocks. This change causes the modification of vegetation series: from the *Oleo-Querco suberis sigmetum* to the *Myrto-Querceto suberis* sigmetum, the termomediterranean, subhumid to humid, cork oak vegetation series of Southwestern part of the Iberian Peninsula on hard, non sandy, substrata.

Until Évora the cork oak forests are bordered, specially in the farm boundaries and temporary watercourses, by spiny communities of *Calicotome villosa* which forms the *Asparago aphylli-Calicotometum villosae*. Under the cork oak trees, if they are grazed, the xerophitic grasslands of *Poo bulbosae-Trifolietum subterranei* appear; this grassland association can be considered as a good bioindicator of the "montados" conservation.

ÉVORA-VILLALBA (18 July)

(The plant communities and landscape between Évora and Badajoz)

MÁRIO FERNANDES LOUSÃ , JOSÉ CARLOS COSTA, JORGE HENRIQUE CAPELO, CARLOS PINTO GOMES & CARLOS NETO SILVA

This journey begins in the mesomediterranean territories over hard *substrata* (granites and similar rocks, schists) where the cork and holly oak "montados" dominate the landscape.

The potential vegetation at Évora Monte (Serra de Ossa) is constituted by the mesomediterranean, subhumid to humid, Luso-Extremadurensian and Ribatagano cork oak forests which belong to *Sanguisorbo-Querco suberis* sigmetum vegetation series. In the surroundings of Estremoz, over hard *substrata*, it´s possible to see the mesomediterranean siliceous, holly oak forests of *Pyro-Querco rotundifoliae* sigmetum with the serial scrubs dominated by the endemic *Ulex eriocladus*.

At Estremoz, the *substrata* change through the appearance of Cambrian dolomitic limestones and marbles, together with a subhumid to humid ombroclimate, which allows the existence of some specimens of beech oak - *Quercus faginea* subsp. *broteroi*. In this area, the landscape is marked by the extraction industry of marbles (the most important of this region) and over lithosoils the olive trees and some holly oak forests are dominant.

At Borba there is a new change of *substrata*: the schists. Between Borba and Vila Boim the potential vegetation is the holly oak forests of the *Pyro-Querco rotundifoliae* sigmetum and on the farms the vineyards are dominant.

From Vila Boim till Badajoz the calcareous *substrata* predominate. The landscape is marked by corn and olive trees cultivation with fragments of natural vegetation where the scrubs of *Asparago albi-Rhamnetum oleoidis* present large patches.

(The Vegetation of Extremadura: The Badajoz-Talavera de la Reina transect)

MIGUEL LADERO ÁLVAREZ & ÁNGEL AMOR MORALES

The route of the IVAS 99 excursion through the Spanish Luso-Extremadurensian subprovince begins at the border between Spain and Portugal at the river Caia close to the city of Badajoz and ends at the sand banks of Talavera de la Reina (Toledo) (see Fig 1). The transect is 318 km long, covering the territory from west to east, and allows the visualization of some of the most representative plant ecosystems of this chorological province. Outstanding for its plant diversity is the Monfragüe National Park, with a high percentage of endemic taxa and plant communities. It is also one of the most important animal reserves in Europe.

During the journey, one traverses territory belonging to the Regions (Autonomous Communities) of Extremadura (provinces of Badajoz and Cáceres) and Castilla-La Mancha (province of Toledo).

Here we report on the most representative and best conserved biotopes with a view to offering a clear idea of the Mediterranean Luso-Extremadurensian vegetation.

As pointed out by Lautensach (1967), the territory studied here forms part of the southern Submeseta and includes as regional units the Tagus and Guadiana basins as well as the Montes de Toledo and the Sierra Morena. The surface of this biogeographic unit is some 55,000 km^2, of which about 42,000 km^2 correspond to the Extremadurensian region and the rest to areas belonging to Castilla-La Mancha and Andalusia.

The orography of the territory is not very complex, the Cordillera Oretana forming the backbone of the territory with the peniplains of the Tagus and Guadiana basins to the sides. The northern edge is defined by the Central Range up to 900 m and by the Guadalquivir valley and the Tierras de Andévalo (Huelva) to the south. The main mountainous elevations correspond to La Villuerca -at 1,601 m-, Rocigalgo -at 1,447 m-, and Cervales, at 1,442 m.

Spain is entered through the river Caia at Km 408 of highway N. V, in the Araceno-Pacense subsector of the Luso-Extremadurensian subprovince. The potential vegetation corresponds to dry-subhumid mesomediterranean holm oak forests, whose mature stage is defined by the association *Pyro bourgaeanae-Quercetum rotundifoliae* (*Paeonio broteroi-Quercenion rotundifoliae*) developed on Oligocene clays and arkosic rocks. Alluvial sediments harbour supra- and mesomediterranean riparian communities of willow stands -*Salicetum lambertiano-salvifoliae* (*Salicion salvifoliae*-, ash stands -*Ficario ranunculoidis-Fraxinetum angustifoliae-,* and elm stands of *Aro italici-Ulmetum minoris,* both associations from the *Fraxino angustifoliae-Ulmenion minoris* suballiance, developed on gleisols and fluvisols. The rooted cormophyte vegetation is found in turbid, slow and mineralized waters and is formed of nympheids, myriophyllids and batrachids from the *Myriophyllo alterniflorae-Nupharetum lutei* (*Nymphaeion albae*). This community is also found in the rivers Gévora and Rivilla, close to their convergence with the river Guadiana, near Badajoz.

We stress the presence in the riparian ecosystem of shrubby formations with *Tamarix gallica* and *T.africana* in the old beds of the rivers Gévora (N.V highway, Km 399) and Guadiana (N. V highway, Km 396), although they are very altered, belonging to the *Rubo ulmifolii-Nerietum oleandri* (*Rubo ulmifolii-Nerion oleandri*) association.

Regarding the use of the territory, this first stretch of the trajectory is used for irrigated cultivation.

At Km 361, at the limits of the municipalities of Lobón and Mérida, the Perales "*dehesa"* has basic Miocene sediments formed of clays and arkoses. The vegetation corresponds to the dry-subhumid, basophilous, Betic and Marian-Monchiquense mesomediterranean vegetation series of kermes oak, whose mature stage is defined by the *Paeonio coriaceae-Quercetum rotundifoliae* (*Paeonio broteroi-Quercenion rotundifoliae*) association that has currently been replaced by a dense kermes growth belonging to *Asparago albi-Rhamnetum oleoidis cocciferetosum* (*Asparago albi-Rhamnion oleoidis*). In the clear parts of the brush, one observes the white rock rose of *Cistus albidus* defined as *Phlomido purpureae- Cistetum albidi* (*Ulici argentei-Cistion ladaniferi*) and thyme stands of *Helianthemo hirti-Saturejetum micranthae* (*Saturejo-Corydothymenion*). These basophilous communities allow the Marianense sub-sector (Superdistrict of Tierra de Barros) to reach the River Guadiana and even to cross it in the territories of Montijo and Mérida. In this municipality, close to Los Canchales, one finds perhaps the best conserved basophilous holm oak stands of the whole territory.

At Km 349, the Sierra de San Serván offers the first view of the Serena-Pedroches superdistrict (Marianense sub-sector) on its north-western face, limited by the basic and alluvial substrates that follow the course of the river Guadiana. This is a mountainous elevation 608 m high formed of Ordovician slates and quartzites. There is considerable contrast in the vegetation, depending on the orientation. At sunny spots the climax corresponds to the *Pyro-bourgaeanae-Quercetum rotundifolia* association, currently absent owing to anthropic and animal activities. Instead, at the same sites, the hill-side alluvia are mainly covered by *aulagar-jarales* from the *Genisto hirsutae-cistetum ladaniferi Cistetosum monspeliensis* (*Ulici argentei-Cistion ladaniferi*) association. The permanent spiny shrub developed only on the deepest soils corresponds to the *Asparago-albi-Rhamnetum oleoidis* (*Asparago albi- Rhamnion oleoidis*) association. The summit zones merit comment owing to the presence of saxicolous communities of *Erodio mouretii-Rumicetum indurati* (*Rumici indurati-Dianthion lusitani*), with the presence of the Marianense endemism *Scrophularia oxyrhyncha*, which covers ledges and hollows of the quartzite cornice, and vegetation -colonizing loose rocks of the same geological material- belonging to the *Phagnalo saxatilis-Rumicetum indurati* (*Rumici indurati-Dianthion lusitani*) association.

The chasmophyte vegetation colonizing vertical quartzite outcrops belongs to the *Jasiono marianae-Dianthetum lusitani* (*Cheilanthion hispanicae*) association and in earth-filled and sciophilous cracks of the same biotopes is replaced by the *Asplenio billotii-Cheilanthetum hispanicae* (*Cheilanthion hispanicae*) association.

On the northern face, depending on altitude, there is a characteristic vegetation whose altitudinal catena is as follows: on the Piedmont the potential vegetation corresponds to dry-subhumid mesomediterranean holm-oak stands of the *Pyro bourgaeanae-Quercetum rotundifoliae* association, which have been transformed through human activity into a wooded pasture belonging to the *Trifolio subterranei-Poetum bulbosae* (*Trifolio subterranei-Periballion*) association and into the *retamares* of *Retamo sphaerocarpae-Cytisetum bourgaei* (*Retamion sphaerocarpae*). In the middle stretch, on rock slides, the mature stage corresponds to cork-oak stands of *Sanguisorbo-Quercetum suberis* (*Quercenion broteroi*; the preclimax brush forms thermophilous arbutus stands of *Phillyreo angustifoliae-Arbutetum unedonis pistacietosum lentisci* (*Ericion arboreae*) and in some clear zones heather rock-rose stands of *Erico australis-Cistetum populifolii* (*Ericion umbellatae*) are well developed. At certain favoured exposures on the same outcrop the siliceous kermes oak of the *Hyacinthoido hispanicae-Quercetum cocciferae* (*Rhamno lycioidis-Quercion cocciferae*) association appears, as happens at *Cerro Grajera*, a municipality of Mérida.

Cerro Carija lies at Km 341, at a height of 375 m. This corresponds to an outcrop of Cambrian limestones where there is a highly structured wild olive stand belonging to *Asparago albi-Rhamnetum oleoidis cocciferetosum* (*Asparago albi-Rhamnion cocciferae*), together with basophilous *majadales* of the *Poo bulbosae- Astragaletum sesamei* (*Poo bulbosae-Astragalion sesamei*) association and therophyte pastures of the *Velezio rigidae-Astericetum aquaticae* (*Trachynion distachyae*) association. In former quarries exploited since Roman times, broad fissures and earth-filled clefts harbour the chasmochomophyte community of pteridophytes of *Asplenio ceterach-Cheilanthetum acrosticae cosentinietosum velleae* (*Asplenion glandulosi*).

As from Km 342, circling Cerro Carija, until Km 333, there are red soils arising from the degradation of diorites, -basic plutonic rocks-, that are used integrally for cereal and vine cultivation. As at Cerro Carija, the vegetation series corresponds to dry-subhumid mesomediterranean holm-oak stands belonging to the *Paeonio coriaceae-Querco rotundifoliae sigmetum* (*Paeonio broteroi-Quercion rotundifoliae*) association. This series defines the *Tierra de Barros* superdistrict. The only community by which this series can be recognised is through the nitrophilous vegetation of thistles *Nothobaso syriacae-Scolymetum maculati* (*Onopordion nervosi*) which grows on rock slides and road-sides where, together with the directing species, *Cynara cardunculus* is outstanding owing to its large capitula.

As from San Pedro de Mérida (Km 324) up to the proximity of Puerto de Santa Cruz (Km 272) the terrain features cultivated lands and "*dehesa*"-like holm-oak stands. At Km 303 and at a certain distance from the road -which runs parallel to the Orellana Canal- there is a set of low hills and small sierras which never exceed a height of 535 m. Here the potential vegetation is repeated and the serial stages described above for the Sierra de San Serván are also present. Owing to its state of conservation, we feel that the vegetation of the Sierra del Saltillo is of interest; the sierra contains one of the best structured cork-oak stands in the whole of the Luso-Extremadurensian province.

Km 272 sees the beginning of the ascent to the Puerto de Santa Cruz (500 m), which limits the Marian-Monchiquense and Toledano-Tagano sectors. The step-like rise of approximately 100 m shows pronounced differences as regards the prevailing vegetation. Cambrian slates give way to the granitic batholith of Montánchez, represented here by the Sierra de Santa Cruz, with the peak of San Cristobal at 844 m. From the base up to a height of 500 m, there are wild olive stands belonging to the *Asparago albi-Rhamnetum oleoidis* (*Asparago albi-Rhamnion oleoidis*) association, accompanied by white rock-rose -*Cytisus albidus*- as a thermophilous element (*Genisto hirsutae-Cistetum ladaniferi cistetosum monspeliensis*). Above that height (500 m), the woody vegetation corresponds to holm-oak with cork-oak -*Pyro-bourgaeanae-Quercetum rotundifoliae quercetosum suberis* (*Paeonio broteroi-Quercenion rotundifoliae*), of which as remains there are some specimens of *Pistacia terebinthus*. Intense anthropic activity has allowed the climax forest to be replaced by white broom belonging to the *Cytiso multiflori-Retametum sphaerocarpae* (*Retamion sphaerocarpae*) association. The communities of wild olive and white broom are some of the phytocenoses that separate the Mariánico-Monchiquense and Toledano-Tagano sectors.

As one departs from the Sierra de Santa Cruz and the granites give way to Cambrian slates, one begins to enter the Cáceres subsector, which occupies almost the whole of the northern peniplain and which persists until one arrives at the Monfragüe National Park. There are two important phytocenoses in this part; the one developed on the "*berrocal*" (granite boulders) of Trujillo and the *"dehesa"*-like holm-oak stands that extend from Aldea de Trujillo to the Monfragüe National Park itself.

With an extension of 115 km^2, the granite bouldered area of Trujillo corresponds to a plutonic outcrop lying within a large metamorphic formation of Cambrian slates. It can be seen as from Km 257 and runs for approximately 14 Km. The potential vegetation - currently destroyed by long term extensive grazing and charcoal production in former times- corresponds to holm-oak with cork-oaks in a subhumid mesomediterranean habitat (annual precipitation at Trujillo: 670 mm), coinciding with observations on the upper stretch of the Sierra de Santa Cruz and belonging to *Pyro bourgaeanae-Quercetum rotundifoliae quercetosum suberis* (*Paeonio broteroi-Quercenion rotundifoliae*). Together with *Quercus suber* (cork-oak), which are very scanty, there are growths of *Quercus rotundifolia* (holm-oak), *Pyrus bourgaeana* (wild pear) and the elements of their floristic combination: *Asparagus acutifolius* (wild asparagus), *Crataegus monogyna* (hawthorn), *Tamus communis, Bryonia dioica,* etc.

This type of vegetation is one of those most affected by human activity in Extremadura even though owing to the rough nature of the terrain it cannot be used for agricultural purposes. However, it is not the only example since this type of wooded vegetation formerly covered the *"berrocales"* of Malpartida de Cáceres, Navalmoral de la Mata, Navas del Madroño and the sterile terrain of Alburquerque, within the same chorological sector.

The disappearance of holm-oak has given way to a widely extended growth of broom on the granites of Northern Extremadura. This is the so-called *white broom*, belonging to the *Cytiso multiflori-Retametum sphaerocarpae* (*Retamion sphaerocarpae*) association in which outstanding, owing to their abundance, are *Cytisus multiflorus* (white broom) -a native Iberian species-, *Cytisus scoparius* (black broom), *Adenocarpus complicatus, Retama sphaerocarpa* and *Ornithogalum concinnum*.

Cytiso multiflori-Retametum sphaerocarpae: Characteristics: *Cytisus multiflorus* 3, *Retama sphaerocarpa* 3, *Ornithogalum concinnum* 1. Companions: *Lavandula sampaiana* 2, *Quercus rotundifolia* 3, *Cistus ladanifer* 1, *Digitalis tapsi* 1, *Phagnalon saxatile* 1, *Carlina hispanica* 1, *Dactylis hispanica* 1, *Asphodelus aestivus* 1, *Urginea maritima* 1, *Umbilicus rupestris* 1, *Stipa gigantea* 1, *Hyparrhenia pubescens* 1. Localities: CC. Jaraicejo. Rincón de Valladolid. (Belmonte 1986: 188 rel. 3, tab. 96). CC. Casatejada (Belmonte 1986: 188 rel. 5, tab. 96). CC. Trujillo (Ruiz Téllez 1986: 523, rel. 1, tab. 66).

This is a characteristic formation of the northern Extremadurensian *"berrocales"* that serve to separate the Marianico-Monchiquense and Toledano-Tagano sectors and features good regenerative capacity since it has been subject to periodic burning to increase grazing areas. The root systems of these broom formations, especially those of *Retama sphaerocarpa*, in symbiosis with bacteria of the genus *Rhizobium*, form nodes able to fix atmospheric nitrogen in the form of NH_4^+ which is later converted into nitrites and nitrates, assimilable by higher plants. Soil nitrogen contents thus become enriched, and this is reflected in an increase in therophytes belonging to grasses and legumes. The implantation of *Retama sphaerocarpa* is favoured by human activity, creating *"retamares"*, which are monospecies formations where an increase occurs in the quantity and quality of pasture. At the same time, its seeds are of high energy value and complete the diet of the livestock grazing at this site at the end of summer.

In clear parts of the broom growth, naturally arising annual pastures belonging to the class *Helianthemetea guttati* can be found. These are poor, oligotrophic pastures with low nutritional potential. Within this type of pasture are large communities of *Crassulo-Sedetum caespitosi* (*Sedenion caespitosi*), colonizers of soils compacted by trampling, and on the sandy soils over the "*berrocal"* the community of *Sedetum caespitosi-arenarii* (*Sedion pedicellato-andegavensis*) flourishes. Sandy-silty soils with a certain depth harbour pastures of the *Trifolio cherleri-Plantaginetum bellardi* (*Helianthemenion guttati*) association, in which there is a predominance of plants of little palatability to animals such as *Cistaceae, Caryophyllaceae, Plantaginaceae* and grasses (*Vulpia, Bromus, Micropyrum*, etc), legumes being rare and always with little biomass.

On sandy soils that have arisen owing to the action of the wind and on surrounding areas there is a therophyte pasture formed by psammophilous elements such as *Brassica oxyrrhina, Ornithopus sativus* subsp. *isthmocarpus, Ononis pinnata, O. broterana, Ornithopus pinnatus, Erodium cicutarium* subsp. *bipinnatum*, etc, and some border cover such as *Trifolium arvense, T. campestre, T. sylvaticum*, included in *Malcolmietalia,* etc.

The therophyte pastures, with a poor vegetation cover, subjected to irregular grazing are readily altered. The selective grazing exerted by livestock results in an increase in plants of low palatability, such as legumes. The ordered seasonal use of the therophyte pastures that is put into practice in the neighbourhood of Trujillo with cattle has resulted over time in the establishment of a caespitose pasture that is balanced in grasses and legumes belonging to the *Trifolio subterranei-Poetum bulbosae* (*Trifolio subterranei-Periballion*) association, which represents the optimum in dry-subhumid mesomediterranean pastures on siliceous substrates.

The *"berrocal"* landscape serves as an ecological niche for a series of plant communities linked to this biotope; these are rupicolous or saxicolous and comprise the pteridophyte formations that occupy deep, narrow fissures, with *Asplenium billottii, Cheilanthes tinaei* and *Anogramma leptophylla*, encompassed with the associations *Asplenio billottii-Cheilanthetum duriensis* (*Cheilanthion hispanicae*) and *Anogrammo leptophyllae-Parietarietum lusitanicae* (*Geranio pusilli-Anthriscion caucalidis*). In broad earth-filled cracks with good exposure to the light one finds heliophyllous communities with a high percentage of endemisms from the Luso-Extremadurensian flora; species such as *Coincya transtagana, Digitalis thapsi, Dianthus lusitanus, Rumex induratus* or *Antirrhinum graniticum* find their ecological niche here and form the association *Digitali thapsi-Dianthetum lusitani* (*Rumici indurati-Dianthion lusitani*).

Close to the entrances of rabbit burrows and fox holes at the base of *granite boulders* is a nitrophilous community -*Torilido nodosae-Parietarietum mauritanicae* (*Geranio pusilli-Anthriscion caucalidis*), whose most representative elements are *Urtica membranacea* and the Luso-Extremadurensian endemism -flourishing on acid plutonic rocks- *Scrophularia schousboei.*

Within the nitrophilous communities are eunitrophilous tuffs developed over neutro-basic soils, possibly through the outcropping of alkaline granites. This has permitted the establishment of the community *Carthamo lanati-Onopordetum macracanthii* (*Onopordion nervosi*).

After Km 70 of secondary road 524 from Plasencia to Zorita, one leaves behind the *"berrocal"* of Trujillo to enter the peniplain formed by Cambrian slates with a NE orientation which extends as far as the Monfragüe National Park at Km 33. This huge area of terrain is covered by dry-subhumid mesomediterranean holm-oak stands which grow on shallow soils (distric Cambisols) and whose mature stage is represented by the typical *Pyro bourgaeanae-Quercetum rotundifoliae* association. The peniplain is crossed by the river Almonte and the Arroyo de la Vid, summer dry water courses running through the Cambrian slates with scarped banks. The permanent community here in sunny spots comprises wild olive stands of *Asparago albi-Rhamnetum oleoidis.* On the banks of these water courses can be found the Luso-Extremadurensian association *Pyro bourgaeanae-Securinegetum tinctoriae* (*Securinegion tinctoriae*), currently included in the alliance *Salicion salvifoliae.*

Two main ecological factors regulate the dry-subhumid mesomediterranean holm-oak stands: annual precipitation, which is about 500 mm, and the shallowness of the soils. The climax holm-oak stands have been modified by humans in their own interests in open terrain devoid of an arbustive canopy and with a strong development of the herbaceous stratum, comprising hemicryptophytes and therophytes, among which very palatable grasses and legumes are predominant. These are the so-called "*dehesas arboladas"*, which cover large areas of the Luso-Extremadurensian province. The "*dehesa"* is the prototype of the anthropic Mediterranean ecosystem for integral use. Ordered management affords the livestock fodder over a large part of the year- the pastures from autumn to spring and the holm-oaks, with their branches and fruit, complement the animals' diet during winter. "*Dehesas"* also harbour large numbers of wild animals -mammals, birds, etc- both throughout the year and during the winter. This has increased the profitability of the area since large extensions are rented out for hunting purposes.

The caespitose pastures representing the optimum of the *"dehesa"*-like pasture have their origin in the siliceous Mediterranean therophyte communities of the alliance *Helianthemion guttati*. Depending on the depth and texture of the soil and on humidity and phenology, pre-spring communities of *Airo praecocis-Radioletum linoidis* enter into contact with spring communities of *Paronychio cymosae-Pterocephaletum diandri* and *Trifolio cherleri-Plantaginetum bellardi*, the latter occupying the greatest area. These oligotrophic pastures evolve via an ordered seasonal use accompanied by the use of natural fertilizer to caespitose communities defined by the presence of *Poa bulbosa* and *Trifolium subterraneum* as directing taxa together with numerous species of legumes from the genera *Trifolium, Ornithopus, Onobrychis, Biserrula, Medicago, Scorpiurus* and *Coronilla,* all of which increase the trophic value of these pastures.

Currently, owing to the lack of human resources, farm practices such as sheepfolding have been abandoned; such practices are essential for the establishment and conservation of the eutrophic pastures of *Trifolio subterranei-Poetum bulbosae* (*Trifolio subterranei-Periballion*). Today, natural fertilizer has been replaced by phosphorus mineral fertilizer with highly satisfactory results as regards plant mass but negative outcomes in so far as biodiversity in the plant community is concerned.

Inappropriate explotation of these ecosystems with a grazing load below what they can meet, allows the establishment, following the natural succession, of banks of thyme, broom and brush, with the consequent loss of economic value. The most frequent seral stage is the *"aulagar-jaral"* of *Genisto hirsutae-Cistetum ladaniferi* which is usually accompanied by a regrowth of *Quercus rotundifolia* from its root buds.

In this part of the trajectory, on "*dehesas"* on slaty substrates one observes areas devoid of tree covering, coinciding with the presence of lithosoils and rocky outcrops. These have almost monospecies open formations of *Retama sphaerocarpa* belonging to the *Cytiso scoparii-Retametum sphaerocarpae* (*Retamion sphaerocarpae*) association.

[In the river basins, streams and rivers extending from Trujillo to the Monfragüe National Park there are flourishing pastures, known as *vallicares* of *Festuco amplae-Agrostietum castellanae* (*Agrostion castellanae*) where, together with *Festuca ampla* and *Agrostis castellana* some legumes of the genus *Trifolium -Trifolium strictum*, *T. repens, T, pratense, T.dubium* and *T. cernum-* can be found. This is an optimum mesomediterranean Carpetan-Leonesian community established on the Luso-Extremadurensian mesomediterranean floor with humid soil, these are humid pseudo-gley soils. The potential vegetation corresponds to ash stands of *Ficario ranunculoidis-Fraxinetum angustifoliae* (*Fraxino angustifoliae-Ulmenion minoris*) that have been transformed by grazing and sowing into low-cropped pastures or hay pastures. From a catena perspective, it contacts with rush beds of *Trifolio resupinati-Holoschoenetum* (*Molinio-Holoschoenion*) and grasses of *Trifolio-resupinati-Caricetum chaetophyllae* (*Trifolio fragiferi-Cynodontion*); on drier soils, it contacts with *vallicares* of *Gaudinio fragilis-Agrostietum castellanae* (*Agrostion castellanae*). This latter type of *vallicar* can be distinguished by the greater abundance of therophyte species and an earlier withering.

The Monfragüe National Park is left through the Puerto de la Serrana, at 390 m, between the Mingazo and Serrana sierras. This is a hilly alignment that never surpasses a height of 570 m running parallel to the Sierra de Corchuelas and that comprises Silurian slates and quartzites. The potential vegetation at sunny spots corresponds to mesomediterranean cork-oak stands of *Sanguisorbo agrimonioidis-Quercetum suberis* (*Quercenion broteroi*), transformed into a cultivation of *Eucaliptus camaldulensis* and, in shady spots, the old oak stands destroyed by fire conserve remains of an arbutus stand of *Phillyreo angustifoliae-Arbutetum unedonis viburnetosum*. The greatest part is occupied by a "*jaguarzal-brezal"* of *Erico australis-Cistetum populifolii* (*Ericion umbellatae*) and on lithosoils one even encounters *Halimio ocymoidis-Ericetum umbellatae* (*Ericion umbellatae*) and siliceous therophyte pastures of *Periballio minutae-Airopsietum tenellae* (*Helianthemenion guttati*).

From Km 18 of secondary road 524 until the flood plains of the river Tiétar, at Km 32 of secondary road 511, one traverses the Cambrian peniplain formed of slates and grauwacks with deeper or shallower soils typical of southern brown soils or distric Cambisols. The ombrotype of the territory lies within the lower subhumid type of the Salto de Torrejón (P 702 mm), the superior subhumid type of Malpartida de Plasencia (P 904 mm) and the inferior humid of Tejeda de Tiétar (P 1,072 mm). The potential vegetation corresponds to Luso-Extremadurensian subhumid mesomediterranean oak stands of *Pyro bourgaeanae-Quercetum rotundifoliae* (*Paeonio broteroi-Quercenion rotundifoliae*) which can be recognised by the abundance of *Quercus suber* and, in some low parts, even the presence of *Quercus pyrenaica*. The substituting broom belong to the association *Cytiso scopari-Retametum sphaerocarpae* (*Retamion sphaerocarpae*); the brush comprises *"aulagar-jarales"* of the *Genisto hirsutae-Cistetum ladaniferi* (*Ulici argentei-Cistion ladaniferi*) association, sometimes exhibiting the aspect of a thyme stand with *Lavanda stoechas* subsp. *sampaiana, Thymus mastichina, Urginea maritima,* etc. The therophyte pasture corresponds to the *Trifolio cherleri-Plantaginetum bellardi* (*Helianthemion guttati*) association. As is the case of the road from Trujillo to the Monfragüe National Park, the climax holm-oak stands have been transformed into "*dehesa"*-like holm-oak that covers the *majadal* of *Trifolio subterranei-Poetum bulbosae.*

The passage of the river Tiétar at La Bazagona allows one to recognize the riparian geoseries of the Luso-Extremadurensian rivers on sandy soils. The river branches into numerous arms among sand banks that are colonized by willows of *Salicetum lambertiano-salvifoliae* (*Salicion salvifoliae*). At the banks there are highly altered alder stands of *Scrophulario scorodoniae-Alnetum glutinosae* (*Osmundo-Alnenion*). Regarding the ash of *Ficario ranunculoidis-Fraxinetum angustifoliae* (*Fraxino angustifoliae-Ulmenion minoris*) that should colonize the fluvisols, these have been displaced by irrigated cultivations. The riparian communities are bordered by the spiny *Clematido campaniflorae-Rubetum ulmifolii* (*Pruno Rubenion ulmiflorii*) association.

The last stretch of the trajectory is performed on Miocene arkoses and conglomerates of the Talaverano-Placentino subsector. These soils are sandy or sandy-clayey. The potential vegetation corresponds to Luso-Extremadurensian mesomediterranean oak stands with a dry-subhumid ombroclime, corresponding to the *Pyro bourgaeanae-Quercetum rotundifoliae quercetosum suberis* association. These cork oaks disappear as one approaches Talavera de la Reina when the substrate changes and passes from a middle and superior subhumid ombroclime to a dry superior one. Although there are many similarities with the vegetation described above, there are some differences that differentiate this

Arañuelian superdistrict, such as the pioneer sabulicolous vegetation with a spring phenology that colonizes the arenosols. Outstanding in this sense is the farmland at Bazagona at Km 29; that at Espadañal (between Km 1 and 5 on secondary road 511); that at Navalmoral de la Mata and at the sheep trail at Talavera de la Reina, at the crossroads of highway N. V and secondary road 502. Characteristic features of this chorological unit are the sabulicolous therophyte pastures belonging to the *Anthyllido hamosae-Malcolmietum patulae* (*Corynephoro-Malcolmion patulae*) association. This community is present on all the Luso-Extremadurensian sandstones of the mesomediterranean floor and behaves as a continental vicariant of the thermomediterranean littoral sabulicolous therophyte pastures of the Gaditan-Onubian-Algarvian subprovince. The presence of taxa such as *Anthyllis hamosa, Brassica barrelieri* subsp. *oxyrhina, Corynephorus fasciculatus, Erodium cicutarium* subsp. *bipinnatum, Leucojum trichophyllum, Linaria viscosa, Malcolmia lacera* subsp. *patula, Ononis broterana, Ornithopus isthmocarpus* or *Vulpia membranacea* confirm this. However, it also represents the transition towards Carpetan -Leonesian supramediterranean sabulicolous pastures of the *Loeflingio hispanicae-Malcolmietum patulae* association, where taxa such as *Loeflingia hispanica, Prolongoa hispanica, Evax astericiflora,* etc. have their optimum.

The nitrification of the psammophilous pasture of *Anthyllido hamosae- Malcolmietum patulae* altered by anthropozoogenic activity has resulted in the appearance of the psammophilous and subnitrophilous spring-flowering community of *Chamaemeli mixti-Vulpietum alopecuroidis,* with a thermo- and mesomediterranean distribution.

To complete the sabulicolous communities that define the Luso-Extremadurensian arenosols of the Talaverano-Placentino subsector it is necessary to assign the "*jaguarzales"* of *Halimietum commutati* (*Ulici argentei-Cistion ladaniferi*), which are currently very altered. The presence of *Halimietum commutatum* is limited to the land of El Baldío farm at Velada (Toledo). Along the cattle routes of the Talaverano-Placentino subsector, on sandy soils, there is a "*codesal"* (flatpod) characterized by *Adenocarpus complicatus* subsp. *aureus* and *Retama sphaerocarpa,* together with taxa such as *Lavandula stoechas* subsp. *sampaiana, Halimium viscosum* and *Ononis pinnata.* This is a roadside community very close to *Lavandulo pedunculatae-Adenocarpetum aurei* (*Retamion sphaerocarpae*), although with the absence of supramediterranean elements such as *Genista cinerea* subsp. *cinerascens, Santolina rosmarinifolia,* and *Lavandula pedunculata.*

Regarding the *"berrocal"* of Navalmoral de la Mata (Km 185-176 of highway N. V), the vegetation developed there is similar to that discussed for Trujillo.

Finally, owing to their rarity the Miocene limestone outcrops between Km 173 and 150 of highway N.V, at Peraleda del la Mata and Torralba de Oropesa, respectively, are interesting. These are small enclaves of Manchegan vegetation within the Luso-Extremadurensian province. The high agricultural value of the eutric Cambisols, luvisols and vertisols only allows one to appreciate the Manchegan and Aragonian mesomediterranean basophilous series of holm-oak (*Quercus rotundifolia*) via the nitrophilous vegetation, both on cultivated land (*Roemerio hybridae-Hypecoetum pendulae*, *Roemerion hybridae*) and of the edges of paths and nitrificated zones, represented by tuffs of *Onopordetum acantho-nervosi* (*Onopordion nervosi*).

THE VEGETATION OF MONFRAGÜE

The vegetation of the Monfragüe National Park, with an extension of 17,852 Ha, is located in the heart of *Alta Extremadura* along the course of the Tagus river where it converges with the river Tiétar. The terrain is abrupt, with large differences in height, and access is difficult. Mean height does not surpass 800 m. a.s.l. and the substrate comprises Silurian quartzites and slates. The reserve is surrounded by a set of sierras forming part of the northern arm of the Villuerca massif.

The thermotype of the territory, in the Oretan subsector, is mesomediterranean and the ombrotype is dry-subhumid.

The potential natural vegetation depends on the orientation of the terrain; thus on south- and west- exposed areas one encounters mesomediterranean cork oak stands of *Sanguisorbo agrimonioidis-Quercetum suberis* (*Quercenion broteroi*) as occurs at sunny spots in the Sierra de las Corchuelas.

***Sanguisorbo agrimonioidis-Quercetum suberis*:** Characteristics: *Sanguisorba hybrida* 2, *Quercus suber* 3, *Thapsia maxima* 2, *Ruscus aculeatus* 3, *Arbutus unedo* 3, *Viburnum tinus* 2, *Paeonia broteroi* 2, *Rubia peregrina* 2, *Osyris alba* 2, *Melica arrecta* 1, *Phillyrea media* 1, *Pyrus bourgaeana* 1, *Lonicera etrusca* 1, *Moehringia pentandra* 1, *Quercus broteroi* 1, *Phillyrea angustifolia* 1, *Daphne gnidium* 1, *Pistacia terebinthus* 1, *Erica arborea* 1. Companions: *Genista triacanthos* 2, *Teucrium scorodonia* 2, *Origanum virens* 2, *Pimpinella villosa* 1, *Aristolochia paucinervis* 2, *Tamus communis* 2, *Bryonia dioica* 2, *Silene alba* 2, *Brachypodium sylvaticum* 2, *Calamintha sylvatica ascendens* 2, *Luzula forsteri* 2, *Clinopodium vulgare* 2, *Lonicera hispanica* 1, *Pteridium aquilinum* 1, *Epipactis latifolia* 1, *Hedera helix* 1, *Geum sylvaticum* 1, *Cytisus grandiflorus* 1, *Cistus psilosepalus* 1, *Bellis sylvestris* 1, *Rosa sempervirens* 1, *Arum italicum* 1, *Cistus salvifolius* 1, *Cytisus scoparius* 1, *Helichrysum stoechas* 1, *Adenocarpus complicatus* 1, *Castanea sativa* 1, *Rosa micrantha* 1, *Limodorum abortivum* 1, *Doronicum plantagineum* 1, *Acer monspessulanus* 1. Localities: CC: Grimaldo. (Rivas Goday 1964: 501. rel. 2, tab. 75). CC: Mirabel, Puerto de los Castaños (Belmonte 1986: 208, rel. 5, tab. 105). CC: Jaraicejo, Sierra del Riofrio (Belmonte 1986, rel. 12, tab. 105).

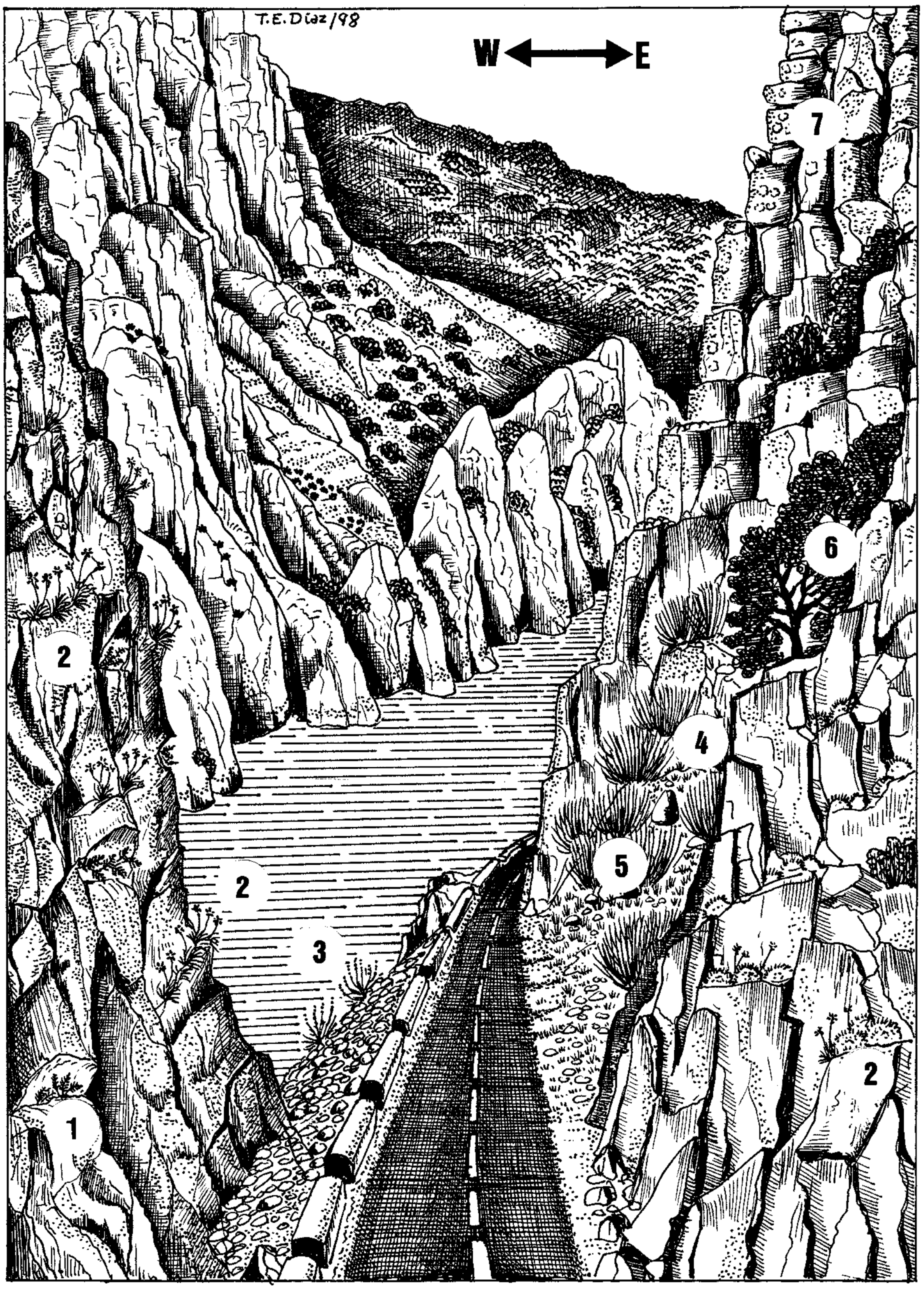
At sites with a similar degree of exposure, colonizing slides of quartzite blocks and regosols one sees thermo-Mediterranean wild olive stands of *Asparago albi-Rhamnetum oleoidis* (*Asparago albi-Rhamnion oleoidis*) as a permanent sunny community accompanied, together with the directing species, by *Celtis australis.*

Asparago albi-Rhamnetum oleoidis Characteristics: *Olea sylvestris* 2, *Asparagus albus* 2, *Quercus rotundifolia* 2, *Daphne gnidium* 1, *Rhamnus oleoides* 1, *Pistacia terebinthus* 1, *Jasminum fruticans* 1, *Phillyrea angustifolia* 1, *Quercus suber* 1. Companions: *Retama sphaerocarpa* 1, *Celtis australis* 2, *Crataegus monogyna* 2, *Bryonia dioica* 2, *Scilla hispanica* 1, *Cytisus multiflorus* 1, *Asphodelus aestivus* 1, *Ballota foetida* 1, *Mercurialis annua* 1, *Urtica membranacea* 1, *Psoralea bituminosa* 1, *Vinca difformis* 1, *Dactylis hispanica* 1. Localities: CC: Monfrague, pr. Castillo. 29SQE5212. 2. CC: Torrejón el Rubio. Salto del Gitano. (Belmonte 1986: 213, rel. 4, tab. 107).

PICTURE 25

Locality: Monfragüe Natural Park. Cáceres.
Altitude: 300 m
Date: 18-VII-1999
Biogeography: Oretana subsector, Luso-Extremadurensian subprovince
Bioclimatic belt: Lower mesomediterranean

1. Sheltered rock crevice community (*Asplenio billotii-Cheilanthetum hispanicae)*
2. Casmocomophyitic vegetation of wide fissures (*Jasiono-Dianthetum lusitanici*)
3. Debris community (*Phagnalo saxatili-Rumicetum indurati*)
4. Grassland (*Arrhenatherum, Holcus setiglumis*)
5. Broom community or piornal (Community de *Genista cinerascens*, *Cytisus multiflorus*, etc.)
6. Fragments of carrascales with cork oaks and olive trees.
7. Rock lichen community (*Acarosporetum*)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At the *Umbría de Monfragüe*, on mature soils of the southern brown soil type, the potential vegetation comprises a mixed semi-deciduous forest corresponding to the *Pistacio terebinthi-Quercetum broteroi* (*Quercenion broteroi*) association.

The first stop is programmed for the *Salto del Gitano*, at Km 30 of secondary road 511, at a height of 240 m. This is the opening formed by the sierras of Santa Catalina and Monfragüe through which the river Tajo runs. Flanking it are vertical walls with large quartzite outcrops that form the habitat for chasmophyte, chasmocomophyte and lithophyte communities.

The chasmophyte vegetation is represented by the Luso-Extremadurensian *Jasonio mariani-Dianthetum lusitani* (*Cheilanthion hispanicae*) association, which colonizes fissures on vertical walls and stepped cracks in the quartzite scarps. It is a common community in the mountain peaks of the eastern side of the Oretana and Marianic ranges.

Jasiono marianae-Dianthetum lusitani: Characteristics*: Jasione crispa ssp. mariana 3, Dianthus lusitanus 3, Sedum hirsutum 3, Umbilicus rupestris 2.* Companions*: Digitalis thapsi 2, Arrhenatherum eriantum var. montanum 3, Adenocarpus argyrophyllus 1, Rumex induratus 1, Anogramma leptophylla 1, Conopodium majus ssp. ramosum 1.* Localities: CC: Torrejón el Rubio. Monfragüe, Salto del Gitano. 29SQE5113. CC: Serradilla, Ggta. de la Trasierra (Belmonte1986: 76, tab. 28).

Regardless of orientation, at the base of quartzite peaks and in narrow earth-filled cracks this same biotope harbours the pteridophyte chasmochomophyte community of the *Asplenio billottii-Cheilanthetum hispanicae* (*Cheilanthion hispanicae*) association, a vicariant of the association *Asplenio billottii-Cheilanthetum duriensis* typical of the tight shady cracks in granitic outcrops.

Asplenio billotii-Cheilanthetum hispanicae: Characteristics: *Asplenium billotii* 2, *Cheilanthes hispanica* 3, *Umbilicus rupestris* 3. Companions: *Digitalis thapsi* 1, *Sedum caespitosum* 1, *Senecio lividus* 1, *Mercurialis ambigua* 1, *Micropyrum tenellum* var. *aristatum* 1, *Anogramma leptophylla* 1. Localities: CC: Torrejón el Rubio: Monfragüe, Salto del Gitano. 29SQE5113. CC: Torrejón el Rubio: El Picadero. 30STQ4314. CC: Torrejón el Rubio. Monfragüe, Sª de las Corchuelas (Belmonte 1986: 77, tab. 29).

The denuded surfaces of these quartzite peaks harbour the lithophyte community of *Acarosporetum*, comprising lichens that confer a greenish hue to the rock. Striking among the species found are *Ramalina polymorpha, Girophora cylindrica, Lasalia pustulata, Rhizocarpon geographicum* and *Parmelia saxatilis,* together with several species of the genus *Acarospora* (*Rhizocarpetalia geographici*).

The saxicolous community of *Phagnalo saxatili-Rumicetum indurati* (*Rumici indurati-Dianthion lusitani*) helps to consolidate the quartzite gravel; it comprises chamephytes and hemicryptophytes with a Luso-Extremadurensian mesomediterranean optimum and enjoys a certain presence on the meso- and supra-Mediterranean floors of the Carpetan-Leonesian subprovince. The following are taxa characteristic of this community: *Rumex induratus, Phagnalon saxatile, Psolarea bituminosa* and *Sedum album.*

Phagnalo saxatilis-Rumicetum indurati: Characteristics: *Rumex induratus* 3, *Phagnalon saxatile* 2, *Digitalis thapsi* 2, *Dianthus lusitanus* 2, *Hypericum linarifolium* 1, *Crambe hispanica* 1. Companions: *Arrhenatherum erianthum* var. *montanum* 3, *Umbilicus rupestris* 2, *Sedum album* 2, *Linaria saxatilis* 1, *Ceterach officinarum* 1, *Ballota foetida* 1, *Campanula erinus* 1, *Dactylis hispanica* 1. Localities: CC: Torrejón el Rubio. Monfragüe, Salto del Gitano. CC: Jaraicejo, Garganta del Cubo (Belmonte 1986: 84, rel. nº 6, tab. 34).

Contacting this community and at the base of the quartzite peaks, colonizing broad earth-filled cracks is the association *Digitali thapsi-Dianthetum lusitani* (*Rumici indurati-Dianthion lusitani*), formed by the frutescent chamephytes *Digitalis thapsi* and *Dianthus lusitanicus,* accompanied by taxa such as *Narcissus rupicola* var. *auricolor, Hyacinthoides hispanica*, etc.

At the *Salto del Gitano* and on all the quartzite cornices of the meso- and supra-Mediterranean floors of the Oretana Subsector, one find the endemic silicicolous and chasmochomophyte association *Adenocarpetum argyrophylli* (*Genistion floridae*) typical of rock falls and wide earth-filled cracks. This behaves as a permanent inhabitant of peaks and has an early spring phenology, being defined by the Luso-Extremadurensian endemism *Adenocarpus hispanicus* subsp. *argyrophyllus, cenizo*, accompanied by *Genista cinerea* subsp. *cinerascens* and *Arrhenatherum erianthum* var. *montanum* throughout the occupied area. *Cytisus striatus* subsp. *eriocarpus* and *Cytisus multiflorus* are only seen locally.

Adenocarpetum argyrophylli: Characteristics: *Adenocarpus argyrophyllus* 4, *Arrhenatherum erianthum* var. *montanum* 4, *Cytisus multiflorus* 1, *Cytisus eriocarpus* 2, *Frangula alnus* fma. *retusa* 1, *Genista cinerascens* 1. Companions: *Digitalis thapsi* 2, *Quercus rotundifolia* 4, *Dianthus lusitanus* 2, *Cistus ladanifer* 1, *Lavandula sampaiana* 1, *Juniperus oxycedrus* 1, *Conopodium majus* 2, *Digitalis purpurea* var. *toletana* 1. Localities: CC: Torrejón el Rubio: Monfragüe, Salto del Gitano. 29SQE5113. CC: Casas de Miravete, Canchal de la Peñuela. (Belmonte 1986: 191, rel. 1, tab. 98). CC: Mirabel, Sierra de los Canchos (Belmonte 1986: 191, rel. 3, tab. 98). CC: Carrascalejo, Sierra de Altamira. (Ladero 1970: 106, rel. 2).

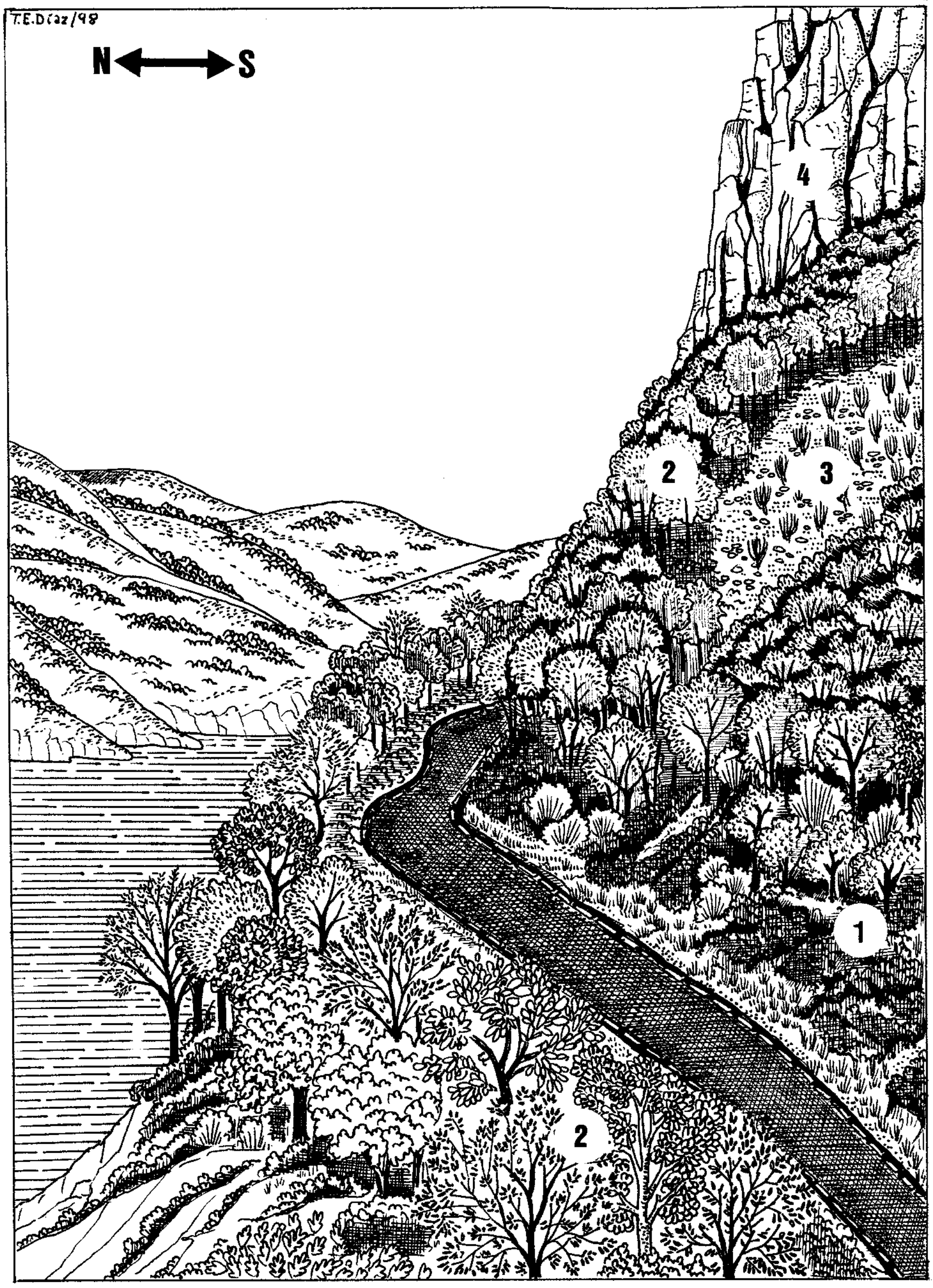
On the inferior Luso-Extremadurensian supra-Mediterranean floor this community is enriched by the presence of *Frangula alnus* (*retusa* form) and *Trisetaria hispida.*

On flat parts of the peaks and consolidated quartzite gravels, in fairly shallow soils, one finds a therophyte pasture cohabiting with the *Adenocarpetum argyrophylli* association; this is pioneer, has a grass-like aspect and has Luso-Extremadurensian distribution and features *Anthoxantho aristati-Holcetum setiglumis*, where the directing species *Holcus setiglumis* and *Anthoxanthum aristatum* accompany elements of *Helianthemetea guttati* such as *Micropyrum tenellum* var. *aristatum, Hypochoeris glabra, Andryala arenaria, Jasione montana* var. *echinata, Briza maxima, Tolpis barbata, Teesdalia nudicaulis,* etc. This community was included by Rivas Goday (1964: 354) and Belmonte (1986: 171) in the *Agrostion castellanae* alliance due to the presence in the inventories of *Agrostis castellana.* From the same biotope, Belmonte (*op. cit.:* 145) described *Anthoxantho aristati-Micropyretum patentis*. Scrutiny of both tables and their comparison with the inventories carried out for this allow us to state that it is the same association.

PICTURE 26

Locality: Monfragüe Natural Park. Cáceres.
Altitude: 300 m
Date: 18-VII-1999
Biogeography: Oretana subsector, Luso-Extremadurensian subprovince
Bioclimatic belt: Lower mesomediterranean

1. Arbutus shrubland (*Phillyreo-Arbutetum oleetosum* variante de umbría con *Viburnum*)
2. Quejigar (*Pistacio-Quercetum broteroi*)
3. Jaguarzal (*Erico-Cistetum populifolii*)
4. Chasmophytic communities (*Asplenio billotii-Cheilanthetum hispanicae*), chasmocomophytic (*Jasiono-Dianthetum lusitanici*) and rock lichen (*Acarosporetum*).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Anthoxantho aristati-Holcetum setiglumis: Characteristics: *Anthoxanthum aristatum* 3, *Holcus setiglumis* 3, *Micropyrum tenellum* var. *aristatum* 2, *Briza maxima* 2, *Tolpis barbata* 2, *Jasione montana* 2, *Teesdalia coronopifolia* 2, *Andryala arenaria* 1, *Corrigiola telephiifolia* 1, *Molineriella laevis* 1, *Tuberaria guttata* 1, *Rumex bucephalophorus* 1, *Aira caryophyllea* 1, *Logfia minima* 1. Companions: *Arrhenatherum erianthum* var. *montanum* 2, *Agrostis castellana* 1, *Linaria saxatilis* 1, *Cynosurus echinatus* 1, *Digitalis thapsi* 1, *Anthemis arvensis* 1, *Rumex angiocarpus* 1, *Anogramma leptophylla* 1, *Conopodium capillifolium* 1, *Ornithogalum pyrenaicum* 1, *Juncus capitatus* 1, *Lotus parviflorus* 1, *Agrostris pourretii* 1, *Allium sphaerocephalon* 1, *Chamaemelum mixtum* 1, *Umbilicus rupestris* 1, *Conopodium ramosum* 1. Localities: CC: Torrejón el Rubio, Monfragüe, Salto del Gitano. 29SQE5113. BA: Almorchón, Sierra de Almorchón (Rivas Goday 1964: 354, rel. 2, tab. 50). CC: Serradilla, Garganta de la Trasierra. (Belmonte 1986: 173, rel. 2, tab. 89).

In shady spots of the Silurian sierras of the Luso-Extremadurensian province between heights of 250 and 270 m, with a subhumid ombroclime and southern brown soils and siliceous red soils resting on paleozoic substrates, one encounters a semi-deciduous forest of *Pistacio terebinthi-Quercetum broteroi* (*Quercenion broteroi*) dominated by *Quercus faginea* subsp. *broteroi, Q. faginea* subsp. *broteroi* x *Q.rotundifolia* and *Quercus suber*, harbouring forest herbaceous elements typical of this community such as *Thapsia maxima, Magydaris panacifolia, Paeonia broteroi, Sanguisorba hybrida, Asplenium onopteris, Moehringia trinervia,* etc.

***Pistacio terebinthi-Quercetum broteroi*:** Characteristics: *Quercus broteroi* 3, *Pistacia terebinthus* 2, *Pistacia x raportae* 1, *Quercus rotundifolia* 2, *Arbutus unedo* 2, *Viburnum tinus* 2, *Rubia peregrina* 3, *Daphne gnidium* 2, *Phillyrea angustifolia* 3, *Osyris alba* 3, *Jasminum fruticans* 2, *Olea sylvestris* 2, *Ruscus aculeatus* 3, *Quercus suber* 3, *Asparagus acutifolius* 2, *Erica arborea* 1, *Acer monspessulanus* 1, *Asplenium onopteris* 1, *Myrtus communis* 1, *Carex muricata* 1, *Phillyrea media* 1, *Carex longiseta* 1, *Moehringia trinervia* 1, *Lonicera etrusca* 1, *Teucrium fruticans* 1, *Lonicera implexa* 1, *Carex depressa* 1, *Smilax aspera* 1, *Melica arrecta* 1, *Pyrus bourgaeana* 1, *Quercus coccifera* 1. Companions: *Cytisus scoparius* 3, *Aristolochia paucinervis* 2, *Tamus communis* 3, *Teucrium scorodonia* 2, *Origanum virens* 2, *Vincetoxicum nigrum* 2, *Rubus ulmifolius* 2, *Pteridium aquilinum* 1, *Cistus populifolius* 1, *Brachypodium sylvaticum* 1, *Vitis vinifera sylvestris* 1, *Stipa bromoides* 1, *Campanula rapunculus* 1, *Clinopodium vulgare* 1, *Lapsana communis* 1, *Luzula forsteri* 1, *Urginea maritina* 1, *Cistus psilosepalus* 1, *Lithodora diffusa* 1, *Stachys lusitanica* 1, *Calamintha ascendens* 1, *Stachys officinalis* 1, *Genista triacanthos* 1, *Genista hirsuta* 1, *Lavandula sampaiana* 1, *Pulicaria odora* 1, *Lathyrus latifolius* 1, *Silene alba* 1, *Rosa sempervirens* 1, *Cistus salvifIfolius* 1. Localities: CC: Monfragüe, Umbría Sª Corchuelas. 29SQE5212. CC: Serradilla, Sª Sta. Catalina. (Martínez Gómez-Rodulfo 1996: 75). CC: Cañaveral, El Caño. (Rivas Goday 1964: 504, rel. 2, tab. 76).

These formations, known as "*quegijares"*, represent the mature stage of the silicicolous Luso-Extremadurensian mesomediterranean series of the gall oak (*Quercus faginea*), *Pistacio terebinthi-Querco faginae sigmetum* and are well represented on shady slopes in the sierras of Monfragüe and Piatones, in the Monfragüe National Park. These mesophyte forests act as a refuge for elements of *Querco-Fagetea* such as *Acer monspessulanum, Luzula forsteri, Epipactis latifolia, Lonicera peryclimenum* subsp. *hispanica, Ligustrum vulgare,* etc, and in turn harbour thermophilous elements such as *Olea europaea* subsp. *oleaster*, *Myrtus communis, Pistacia* x *raportae*.

The dense arbustive canopy, 2-3 m high, corresponds to mesophilous arbutus stands of *Phillyrea angustifoliae-Arbutetum unedonis viburnetosum*.

***Phillyreo angustifoliae-Arbutetum unedonis viburnetosum tini*:** Characteristics: *Arbutus unedo* 2, *Phyllyrea angustifolia* 2, *Viburnum tinus* 2, *Quercus rotundifolia* 2, *Quercus broteroi* 1, *Olea sylvestris* 1, *Erica arborea* 1, *Pistacia terebinthus* 1, *Daphne gnidium* 1, *Quercus suber* 1, *Rubia peregrina* 1, *Myrtus communis* 1, *Smilax aspera* 1, *Asplenium onopteris* 1. Companions: *Erica australis* 1, *Lavandula luisieri* 1, *Pteridium aquilinum* 1, *Origanum virens* 1, *Vincetoxicum nigrum* 1, *Silene alba* ssp. *divaricata* 1, *Bellis sylvetris* 1, *Teucrium scorodonia* 1, *Cistus ladanifer* 1. Localities: CC. Torrejón el Rubio Salto del Gitano (Belmonte 1986: 216, rel. 20, tab.108). BA. Sierra de Peloche (Pérez-Chiscano 1975: 133, rel. 5).

In the clearing of these stands there are "*jaguarzal-brezales"* of *Erico australis-Cistetum populifolii* (*Ericion umbellatae*). The border vegetation in this type of community corresponds to the *Vincetoxico nigri-Origanetum virentis* (*Origanion virentis*) association. According to the floristic, chorological, dynamic, bioclimatic and biogeographic and historical characteristics, we propose that these gall oak stands are a new series that should be included in the series of the supra-mesomediterranean gall oak.

VILLALBA-BENAVENTE (19 July)

(Synopsis of the Sierra de Guadarrama vegetation)

SALVADOR RIVAS-MARTÍNEZ, PALOMA CANTÓ RAMOS, FEDERICO FERNÁNDEZ-GONZÁLEZ, JOSÉ ANTONIO MOLINA ABRIL, JOSÉ MARÍA PIZARRO DOMÍNGUEZ & DANIEL SÁNCHEZ-MATA

THE PHYSICAL ENVIRONMENT

The Sierra de Guadarrama is one of the massifs of the Iberian Central Range, an E-W oriented mountain alignment of ca. 500 Km which divides the Iberian Meseta into two halves: the North and South Submesetas. It was uplifted during the Alpine orogeny and its relief was renewed during the Wurmian ice-age due to the activity of the glaciar erosion in its summital part.

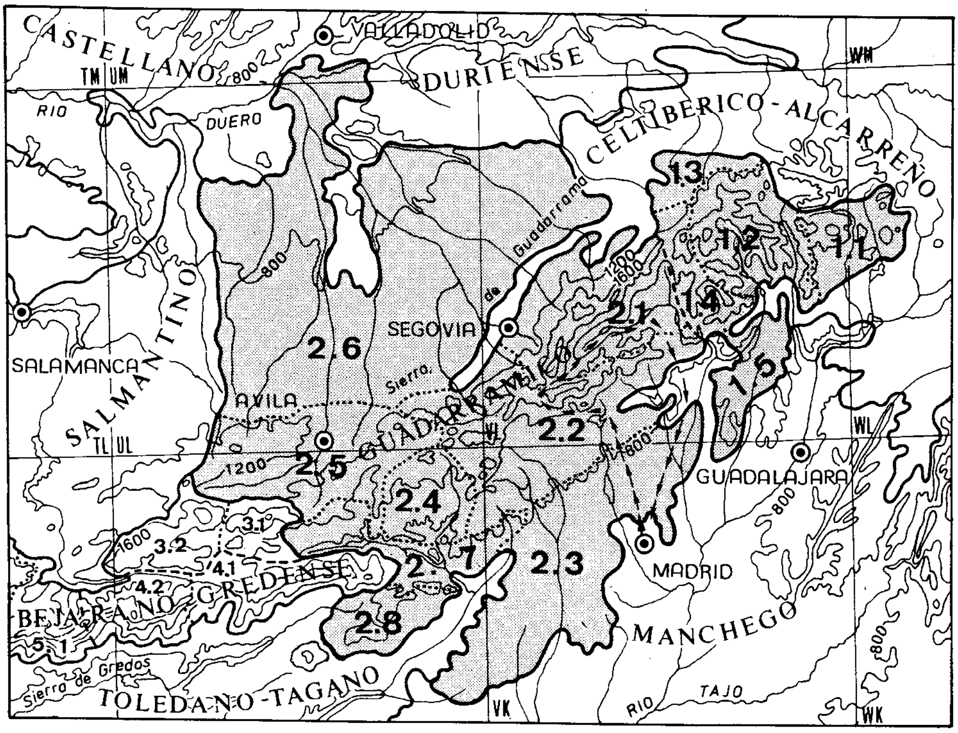
The generally accepted geographical limits of the Sierra de Guadarrama are the Somosierra pass (1,444 m) in the northeast, and the Peña de Cenicientos (1,253 m) in the southwest. This stretch corresponds to the assembley of massifs and mountains which form part of the watershed between the Duero and Tagus basins in the provinces of Madrid, Segovia and the southeastern corner of Ávila. The most relevant peaks are, in order from west to east, Siete Picos (2,138 m), La maliciosa (2,227 m), Cabezas de Hierro (2,383 m) , Peñalara (2,430 m) and El Nevero (2,209 m). The passes crossed by roads are, in the southern branch of the range forming thr southern limit of the Paular valley, Cuerda Larga-Sierra de la Cabrera, the Morcuera pass (1,782 m) and the Canencia pass (1,600 m); in the northern branch, forming the northern limit of the Paular valley and dividing the Segovia and Madrid areas, from west to east, Cotos pass (1,830 m), Navafría pass (1,773 m) and the above mentioned Somosierra pass (1,444 m). Finally, the western stretch between Siete Picos (2,138 m) and the Sierra de Malagón (1,757 m), there are the Navacerrada pass (1,860 m), Fuenfría pass (1,796 m), Guadarrama pass (1,511 m) and Lancha pass (1,480 m), the latter being in the Ávila province.

The dominant outcropping materials in the Sierra de Guadarrama are crystalline rocks rich in acid silicates, some of which are of plutonic origin (granites, adamellites and granodiorites) and others metamorphic (biotite and hornblende gneiss). In a much lower proportion, there are in some high areas, aplites and filonian porfids as well as some ultrabasic gabbros and marbles outcropping in some localized spots. In the piedmont areas of both the Segovian and Madridean sides, especially on the borders of the faults of the techtonic fosses originated during the Alpine orogeny, there have remained Mesozoic materials rich in clay and calcareous rocks (limestone, conglomerate, marl, etc) which bear vegetation series, plant communities and endemic taxa of basopilous character and of central-Iberian distribution mostly related to the Castilian-Maestracean-Manchegan biogeographical subprovince.

The Sierra de Guadarrama has traditionally been a poor mountainous area, with an economy based on husbandry and forestry (*Pinus sylvestris* and *Pinus pinaster* plantations). The socio-economic changes of the last decades have provoked the progressive replacement of the traditional land use by the modern urban tourism expansion which mainly takes place on the southern Madridean slope of the Sierra, between El Escorial and La Cabrera. Nevertheless, husbandry continues to be the main resource in areas such as El Paular and the northern Segovian slope. Rural abandonment has favourised this process but the main threat comes from pressure from the metropolitan area of Madrid. Those serious problems are trying to be corrected through the creation of Natural Parks and other protected areas in the Guadarrama and in other areas of Madrid.

BIOGEOGRAPHY

The Sierra de Guadarrama and a substantial part of its surrounding area in Madrid, Ávila and Segovia, belongs to the biogeographical Guadarrámico sector (Carpetano supersector). According to Rivas-Martínez, Fernández-González, Sánchez-Mata & Pizarro (1990), the districts and the biogeographical units of higher rank in which the territory of the Sierra de Guadarrama can be structured are (Map 1):



Map 1. Biogeographical units of the Sierra de Guadarrama

Holarctic Kingdom
+ Mediterranean Region
++ Western Mediterranean Subregion
* Mediterranean Iberoatlantic Province
** Carpetan-Leonesian Subprovince
*** Carpetan sSpersector
I. Guadarrámico Sector
1. Ayllonense Subsector
1.1. Atienzano District
1.2. Ayllonense District
1.3. Riacense District
1.4. Somoserrano District
1.5. Ucedano District
2. Subsector Guadarramense Subsector
2.1. Paularense District
2.2. Guadarramense District
2.3. Matritense District
2.4. Cofiense District
2.5. Abulense District
2.6. Arevalense District
2.7. Temblense District
2.8. Cadalsiano District
II. Bejarano-Gredense Sector
3. Paramero-Serrotense Subsector (transitional I and II)
3.1. Paramero Abulense District
3.2. Serrotense District
4. Gredense Subsector
4.1. Eastern Gredense District
4.2. Altogredense District
5. Bejarano-Tormantino Subsector
5.1. Tormantino District
5.2. Bejarano District
III. Salmantino Sector
6. Salmantino Subsector
7. Altosalmantino Subsector
IV. Estrellense Sector

The Sierra de Guadarrama is included only in the Guadarrámico sector (Guadarramense subsector). The southwestern limit of this sector is established with the Toledano-Tagano sector (Sierra de San Vicente district), the northern one is with the Castellano-Duriense sector, the northeastern with the Celtibérico-Alcarreño sector and the southeastern with the Manchego sector. The last three units are predominantly of base-rich or calcareous substrata and belong to the Castilian-Maestracean-Manchegan biogeograpical subprovince.

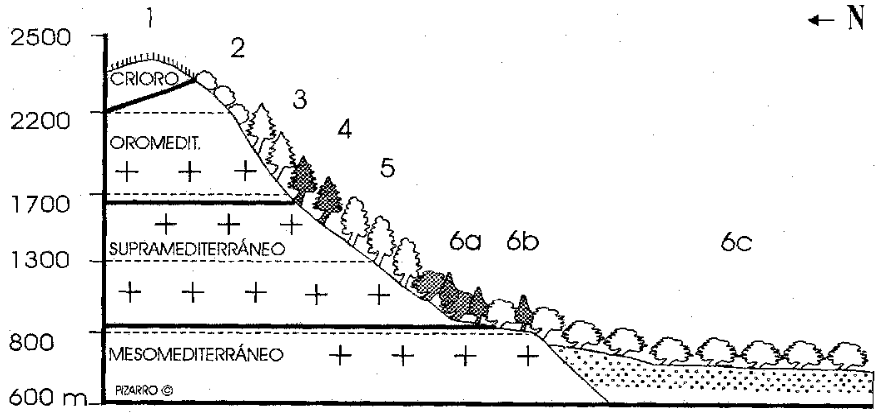


Figure 20. Scheme of the altitudinal zonation of the southern slope of the Sierra de Guadarrama: 1- *Hieracio myriadeni-Festuco curvifoliae microsigmetum;* 2- *Senecioni carpetani-Cytiso oromediterranei sigmetum*; 3- *Avenello ibericae-Pino ibericae sigmetum;* 4- *Pteridio aquilini-Pino ibericae sigmetum;* 5- *Luzulo forsteri-Querco pyrenaicae sigmetum*; 6- *Junipero oxycedri-Querco rotundifoliae sigmetum* (a: supramediterranean variant *arenarietosum montanae*, b: mesomediterranean typical variant, c: mesomediterranean sandy soils variant).

If we consider the orography of the Guadarrámico sector, it is formed primarily by the mountainous alignments of the Sierra de Guadarrama (Guadarramense subsector) as well as by the sandy-silty piedmont deposits of the Miocene to Quaternary periods on both sides of the range, in the north, Arevalense district, and in the south, Matritense district. The sierras of Ayllón and Somosierra (Ayllonense subsector) are also included in this sector with similar Plio-Pleistocenic piedmont deposits of the "*raña*" type, also on both sides of the ranges, in the north, the Riacense district, and in the south, the Ucedano district. In the Ayllonense subsector, as in the high peaks above 2,000 m of the rest of the Guadarrámico sector, there is a substantial increase in the mean annual precipitation in relation to the average of the whole Guadarramense area, especially concerning the summer and autumm rainfalls. This has relevant effects on the vegetation as in this part ombrofilous vegetation series are found. Among the ombrofilous plant communities diagnostic of this Ayllonense subsector we can mention the humid melojares (*Festuco braun-blanquetii-Quercetum pyrenaicae*), the hyperhumid beech forests (*Galio rotundifolii-Fagetum sylvaticae*), and some seral stages such as heathlands (*Halimio ocymoidis-Ericetum aragonensis*) and jarales (*Halimio ocymoidis-Cistetum laurifolii*). On the other hand the Guadarramense subsector bears at compareable altitudes subhumid melojares (*Luzulo forsteri-Quercetum pyrenaicae*), silicicolous white juniper woodlands (*Juniperetum hemisphaerico-thuriferae juniperetosum oxycedri*), climatophilous pine forests (*Avenello ibericae-Pinion ibericae*) and the supramediterranean jarales (*Rosmarino-Cistetum ladaniferi cistetosum cyprii*).

Among the endemic taxa whose optimum is in the Guadarrámico sector we can mention: *Allium schoenoprasum* subsp. *latiorifolium*, *Armeria caespitosa* (con disyunción Easterm Gredense and Serrotense disjunction), *Erodium paularense* (restricted to the limestone outcrops of the Paular valley), *Erysimum penyalarense*, *Hieracium vahlii* subsp. *myriadenum* (with Tormantine disjunctions), *Adenocarpus hispanicus* subsp. *hispanicus* (with Eastern Gredense and Paramero-Serrotense disjunctions), *Festuca curvifolia* (with Iberian-Sorian disjunctions) and *Sedum pedicellatum* subsp. *pedicellatum*. Some Carpetan endemic taxa occurring in the Guadarrámico sector can be pointed out: *Biscutella intermedia* subsp. *gredensis* (Guadarrámico and Bejarano-Gredense), *Hippocrepis carpetana* (Guadarrámico and Bejarano-Gredense), *Sempervivum vicentei* subsp. *paui* (Guadarrámico and Altogredense), *Senecio pyrenaicus* subsp. *carpetanus, Silene boryi* subsp. *penyalarensis* (Guadarrámico and Altogredense), *Thymus bracteatus* subsp. *bracteatus, Thymus praecox* subsp. *penyalarensis* (Guadarrámico and Bejarano-Gredense), *Viola langeana,* etc.

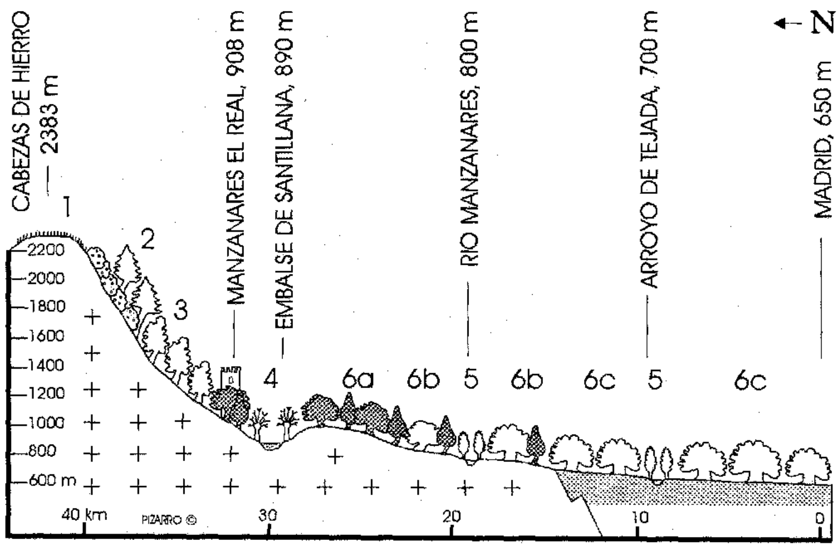


Figure 21. Transect of the southern slope of the Sierra de Guadarrama, from Madrid to the Cabezas de Hierro summit (Cuerda Larga range): 1- *Hieracio myriadeni-Festucetum curvifoliae;* 2- *Senecioni carpetani-Cytisetum oromediterranei + Avenello ibericae-Pinetum ibericae + Pteridio aquilini-Pinetum ibericae*; 3- *Luzulo forsteri-Quercetum pyrenaicae;* 4- *Querco pyrenaicae-Fraxinetum angustifoliae;* 5- *Salicetum lambertiano-salvifoliae;* 6- *Junipero oxycedri-Quercetum rotundifoliae* (a: supramediterranean variant *arenarietosum montanae*, b: mesomediterranean typical variant, c: mesomediterranean sandy soils variant).

BIOCLIMATE AND VEGETATION

In the Sierra de Guadarrama and in the Guadarrámico sector the Mediterranean and Temperate macroclimates are represented. Above 1,500 m, in high mountainous areas of Guadarrama where the rainfall is more abundant, the Temperate Submediterranean variant becomes widespread. Thermotypes in this area are meso, supra and oromediterranean (Rivas-Martínez 1996), but in the rainiest areas are found the temperate submediterranean variants: supra, oro and criorosubmediterranean, which thermically correspond to the supra and orotemperate (Tp 380-1,400).

Locality	Altitude	Years	T	P	Tp	Pp	Io	Io2	Io3	Ic	Itc	Thermotype	Ombrotype
Madrid	667	40	13.9	438	1666	438	2.63	0.52	0.76	19.3	244	U. mesom.	L. dry
Avila	1131	40	10.4	364	1253	364	2.91	0.68	1.14	17.5	154	L. supram.	U. dry
Segovia	1002	40	11.5	468	1375	468	3.40	0.88	1.24	19.3	168	L. supram.	U. dry
Colmenar V.	879	38	12.7	725	1521	725	4.77	0.52	1.05	20.3	207	L. supram.	L. shum.
Manjirón	1000	39	11.1	650	1336	650	4.87	0.82	1.40	17.9	175	L. supram.	L. shum.
Rascafría	1159	27	9.9	858	1188	858	7.22	1.13	1.63	16.1	159	L. supram.	L. hum.
S. Ildefonso	1191	18	8.8	885	1056	885	8.38	1.22	2.23	17.3	109	U. supram.	L. hum.
P. Navacerrada	1860	38	6.5	1511	798	1019	12.77	1.33	2.68	17.5	42	L. orosubm.	L. hhum.

Table 2. Bioclimatic data of the Guadarrámico biogeographical sector.

Ombrotypes	**Io**
1. Ultrahyperarid	< 0.1
2. Hyperarid	0.1-0.3
3. Arid	0.3-1.0
4. Semiarid	1.0-2.0
5. Dry	2.0-3.6
6. Subhumid	3.6-7.0
7. Humid	7.0-14.0
8. Hyperhumid	14.0-28.0
9.Ultrahyperhumid	> 28.0

Thermotypes	**Itc**	**Tp**
1. Inframediterranean	450-580	>2450
2. Thermomediterranean	350-450	2150-2450
3. Mesomediterranean	210-350	1500-2150
4. Supramediterranean	80-210	900-1500
5. Oromediterranean	-	450-900
6. Cryoromediterranean	-	1-450
7. Athermic	-	0

Table 3. Thershold values of mediterranean ombrotypes and thermotypes. Only the types enclosed by a broken line exist in the Guadarramic biogeographical sector.

Io	**Ios_2**	**Ios_3**	**Ios_4**
>2.0- <=3.6	> 1.9	> 1.9	>2.0
>3.6- <=4.8	> 1.8	> 1.9	>2.0
>4.8- <=6.0	> 1.7	> 1.8	>2.0
>6.0- <=8.0	> 1.5	> 1.8	>2.0
>8.0- <=10.0	> 1.2	> 1.6	>2.0
>10.0- <=12.0	> 0.7	> 1.4	>2.0
>12.0			>2.0

Table 4. Summer ombrothermic compensation values (Ios2, Ios3) from mediterranean to temperate macrobioclimate (submediterranean bioclimate variant). It will be temperate if Ios2 > 2.0 or Iosc3 and Iosc4 > 2.0, with Ios2 and Ios3 inside the thershold values expresed in the table.

In the Guadarramense subsector the altitudinal zonation of the climatophilous vegetation can be summarized in a few vegetation belts. The lower zone is populated by the silicicolous carrascales or encinares of *Quercus rotundifolia*, above this belt is that of the melojares of *Quercus pyrenaica* and higher that of the pine forests of *Pinus sylvestris* var. *iberica*. Between 2000-2,400 m is the belt of the dwarf juniper or *Juniperus communis* subsp. *alpina* and the top is the belt of the psychroxerophile grasslands of *Festuca curvifolia*.

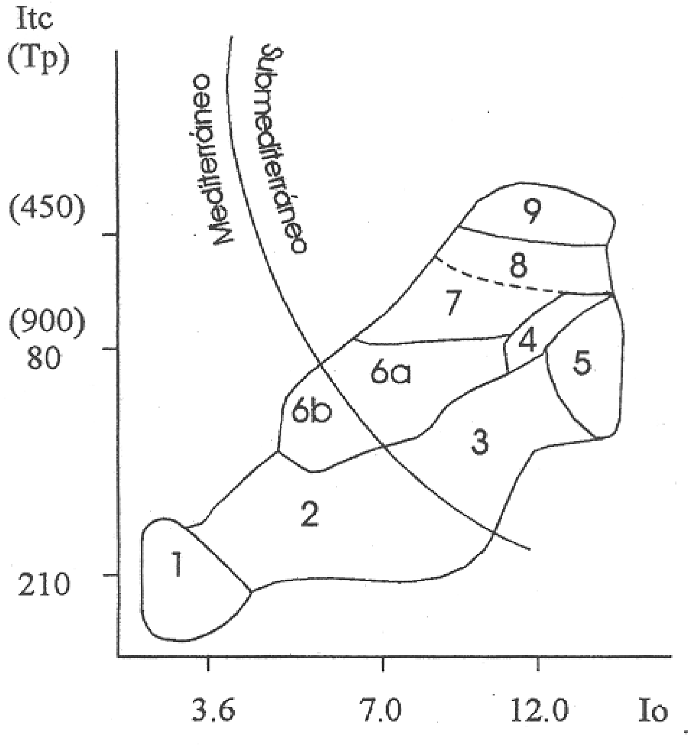


Figure 22. Diagram showing the bioclimatic amplitude of the Vegetation Series in the Centre of Spain. 1- *Junipero oxycedri-Querco rotundifoliae* sigmetum. 2. *Luzulo forsteri-Querco pyrenaicae* sigmetum. 3- *Festuco braun-blanquetii-Querco pyrenaicae* sigmetum. 4- *Melico uniflorae-Betulo celtibericae* sigmetum. 5- *Galio rotundifolii-Fago sylvaticae* sigmetum. 6- *Pteridio aquilini-Pino ibericae* sigmetum (a: *typicum,* b: *cistetosum laurifolii*). 7- *Avenello ibericae-Pino ibericae* sigmetum. 8- *Avenello ibericae-Junipero nanae* sigmetum. 9- *Hieracio myriadeni-Festuco curvifoliae* microsigmetum.

Vegetation belt of the encinares (carrascales) of *Quercus rotundifolia* (*Junipero oxycedri-Querco rotundifoliae* sigmetum)

At the southern piedmont of the Sierra de Guadarrama, around the line of 800 m altitude, is the limit between the meso and the supramediterranean thermotypes (Itc 210). This border coincides in a great part, in the stretch between the Guadarrama and Manzanares rivers, with the ombrothermic transition lower dry/upper dry (Io 3.0). Although the climatophilous forest vegetation is the same at both bioclimatic levels (*Junipero oxycedri-Quercetum rotundifoliae*) the differences become relevant in the level of seral stages such as the broom forest mantles and the grasslands. In the lower dry mesomediterranean belt live the pornales of *Genisto floridae-Cytisetum scoparii* and the grasslands (berceales) of *Arrhenathero baetici-Stipetum giganteae*.

The climatophilous and edaphoxerophilous meso-supramediterranean dry-subhumid silicicolous Guadarrámicos carrascales: *Junipero oxycedri-Quercetum rotundifoliae* (*Quercion broteroi*) have a floristic composition shown in the following table:

Junipero oxycedri-Quercetum rotundifoliae: V *Quercus rotundifolia*, IV *Carex distachya*, IV *Daphne gnidium*, IV *Dactylis hispanica*, III *Juniperus oxycedrus*, III *Doronicum plantagineum*, III *Rubus ulmifolius*, III *Crataegus monogyna*, III *Arenaria montana*, III *Agrostis castellana*, III *Lavandula pedunculata*, II *Rubia peregrina*, II *Paeonia broteroi*, II *Lonicera etrusca*, II *Asparagus acutifolius* (dif. subass.), II *Ruscus aculeatus*, II *Cardamine hirsuta*, II *Galium spurium* subsp. *aparinella*, II *Sanguisorba verrucosa*, II *Carex pairae*, I *Phillyrea angustifolia* (dif. subass.), etc. (Rivas-Martínez 1964: 395, 7 relevés.; Fernández-González 1991: 185, tab. 4, 13 relevés.)

Together with the typical mesomediterranean subassociation (*quercetosum rotundifoliae*), which can reach some warm south facing slopes in the lower levels of the supramediterranean belt and is accompanied by the silicicolous Carpetan retamar (*Cytiso scoparii-Retametum spaherocarpae*), we can distinguish the suprameditarranean subassociation: *Junipero oxycedri-Quercetum rotundifoliae arenarietosum montanae*. The latter ofren represents xerophytic permanent communities in the climactic area of the subhumid melojares of *Quercus faginea* (*Luzulo forsteri-Quercetum pyrenaicae*) which also bear as seral stages the piornales of *Genisto floridae-Cytisetum scoparii* and the tall grassland of berceo: *Arrhenathero baetici-Stipetum giganteae*.

In addition to the mesomediterranean typical subassociation (*quercetosum rotundifoliae*) -which can reach some thermic south-facing slopes in the supramediterranean belt and is permanently accompanied bythe silicicolous Carpetano retamar *(Cytiso scoparii-Retametum sphaerocarpae)*- we can distinguish the supramediterranena carrascales: *Junipero oxycedri-Quercetum rotundifoliae arenarietosum montanae*, which often represent the xerophytic permanent forest communities in the climactic territory of the subhumid melojares of *Quercus pyrenaica* (*Luzulo forsteri-Quercetum pyrenaicae*). The latter have also a broom forest mantle (piornal) of the association *Genisto floridae-Cytisetum scoparii* and the grasslands (berceal) of Stipa gigantea (berceo): *Arrhenathero baetici-Stipetum giganteae.*

The Guadarrámico supramediterranean piornal has the following floristic composition:

Genisto floridae-Cytisetum scoparii: V *Cytisus scoparius*, IV *Genista florida* subsp. *florida*, IV *Genista cinerascens*, IV *Pteridium aquilinum*, IV *Lavandula pedunculata,* IV *Quercus pyrenaica* (S2), IV *Dactylis hispanica*, IV *Santolina rosmarinifolia*, III *Adenocarpus complicatus* susbsp. *complicatus,* III *Quercus rotundifolia* (S2), III *Stipa gigantea*, III *Agrostis castellana*¸ etc. (Rivas-Martínez & Cantó 1987: 246, tab. 3, 12 relevés.; Fernández-González 1991: 232, tab. 12, 14 relevés.)

The Guadarrámico berceales have the following floristic composition:

Arrhenathero baetici-Stipetum giganteae: V *Stipa gigantea*, IV *Arrhenatherum tuberosum* subsp. *baeticum*, IV *Armeria lacaitae,* IV *Koeleria caudata* subsp. *crassipes*, IV *Dactylis hispanica*, III *Agrostis castellana*, III *Lavandula pedunculata,* II *Allium guttatum* subsp. *sardoum,* II *Allium pallens*, II *Centaurea gabrielis-blancae*, II *Centaurea alba*, II *Stipa lagascae*, II *Thapsia villosa*, II *Avenula sulcata*, II *Arrhenatherum elatius* subsp. *carpetanum*, etc. (Rivas-Martínez, Fernández-González & Sánchez-Mata 1986: 59, tab. 2, 11 relevés.; Fernández-González 1988: 469, tab. 9.2, 17 relevés)

Vegetation belt of the melojares of *Quercus pyrenaica* (*Luzulo forsteri-Querco pyrenaicae sigmetum*)

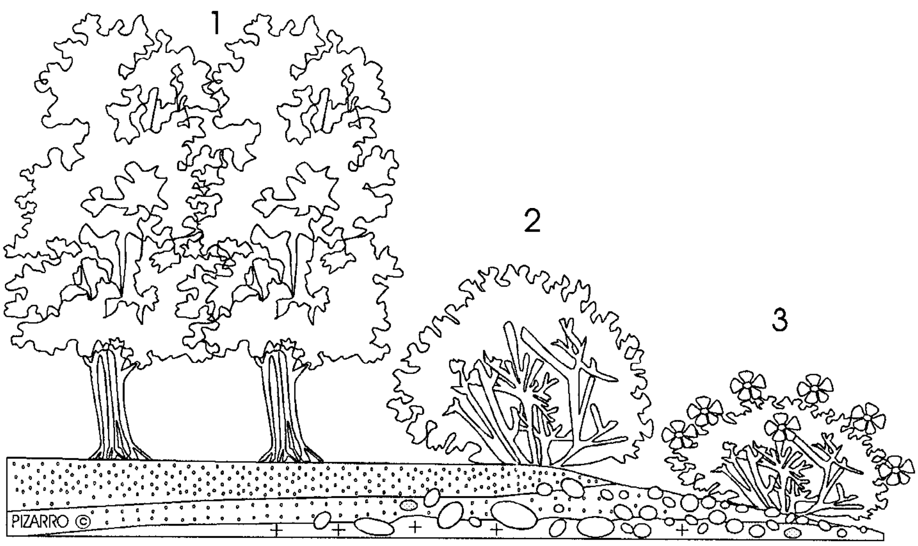


Figure 23. Scheme of the dynamism in the Guadarraman melojar (*Quercus pyrenaica* forest): 1- Forest (*Luzulo forsteri-Quercetum pyrenaicae*); 2- Broom shrubland or piornal (*Genisto floridae-Cytisetum scoparii*); 3- Cistus scrub or jaral (*Santolino-Cistetum laurifolii*)

The vegetation belt of the supramediterranean subhumid melojares of *Quercus pyrenaica* occupies in the Sierra de Guadarrama a variable altitudinal range depending on the amount of rainfall. In the Abulense district, where dry ombrotype (Io 2.0-3.6) is preponderant, the carrascales (*Junipero oxycedri-Quercetum rotundifoliae*) occupy most of the area till ca. 1,400 m; quite another situation is in the Buitrago-Lozoya area, mostly subhumid (Io 3.6-7.0), in which climatophilous melojares (*Luzulo forsteri-Quercetum pyrenaicae*) dominate above the line of 1.000 m. The upper altitudinal limit of those *Quercus pyrenaica* forests in the Guadarrámico sector is about 1,500-1,600 m. Above this level the climatophilous potential natural vegetation corresponds to pine forests of *Pinus sylvestris* var. *iberica* (*Avenello ibericae-Pinion ibericae*). Due to antropic influence (husbandry, selective tree plantations, fire, etc.) the pine forests of *Pteridio aquilini-Pinetum ibericae* can totally replace the melojares above 1,200 m and form large plagioclimacic pine forests.

The lower and warmer horizon of the melojares (*Luzulo forsteri-Quercetum pyrenaicae paeonietosum broteroi*) bear the same type of piornales and berceales as the supramediterranean carrascales: *Genisto floridae-Cytisetum scoparii* y *Arrhenathero baetici-Stipetum giganteae*. The upper horizon (upper supramediterranean) of those Guadarrámicos melojares is indicated by the subassociation *Luzulo forsteri-Quercetum pyrenaicae deschampsietosum ibericae* (diffs. *Avenella flexuosa* subsp. *iberica, Luzula lactea, Avenula sulcata, Linaria nivea*) which was described by Fernández-González (1991: 199) as well as by the sierran piornales of the forest mantle (*Cytiso oromediterranei-Genistetum cinerascentis*) and the chemephytic grasslands on lithosols (*Thymo zygidis-Plantaginetum radicatae*).

The climatophilous supramediterranean subhumid melojares have the following floristic composition:

Luzulo forsteri-Quercetum pyrenaicae: V *Quercus pyrenaica,* V *Holcus mollis*, V *Arenaria montana*, V *Poa nemoralis*, V *Satureja vulgaris* subsp. *arundana*, V *Cruciata glabra,* V *Pteridium aquilinum,* IV *Luzula forsteri*, IV *Viola riviniana,* IV *Melica uniflora*, IV *Sedum forsteranum,* IV *Lathyrus linifolius*, IV *Dactylis glomerata,* IV *Genista florida* subsp. *florida,* III *Potentilla sterilis*, III *Primula veris*, III *Brachypodium sylvaticum,* III *Hyacinthoides non-scripta*, III *Rosa canina,* III *Lonicera hispanica*, III *Viola odorata*, III *Silene nutans,* III *Lathyrus niger,* III *Vicia tenuifolia*, III *Potentilla micrantha,*III *Teucrium scorodonia,* III *Carex pairae*, III *Moehringia trinervia*, III *Vicia sepium,* III *Tanacetum corymbosum,* III *Conopodium pyrenaeum*, III *Lactuca viminea*, III *Trisetum flavescens*, etc. (Rivas-Martínez 1962: 106, 4 relevés.; Fernández-González 1991: 188, tab. 5A, 5B, 38 relevés)

Vegetation belt of the pine forests of *Pinus sylvestris* var. *iberica* (*Avenulo-Pino ibericae sigmion*)

1,700 m is the approximate altitude, with a variation ranging 70 m up or down depending on the orientation, in which the frontier between the supra and oromediterranean thermotypes in the Sierra de Guadarrama can be established. When Ios_4>2.0 and is compensated by the summer hydric deficit in Ios2 or in Ios3 (see table 4), as at such altitudes Itc varies around 80 and Tp is about 900, then we can consider the supra and orosubmediterranean thermotypes instead of the above mentioned. In the mentioned level, the Guadarramense subsector (Guadarramense and Paularense districts) bears a climatophile vegetation formed by pine forests which is accompanied by several forest mantle piornales associations. The lower humid subsupramediterranean bioclimatic belt is covered by climatophilous pine forests (*Pteridio aquilini-Pinetum ibericae* typicum, *Avenello ibericae-Pinion ibericae*) and also by substitution piornales communities (*Cytiso oromediterranei-Genistetum cinerascentis*), jarales with bearberries and dwarf juniper (*Erico arboreae-Arctostaphyletum crassifoliae juniperetosum hemisphaericae*) and thyme-grasslands (*Thymo-Plantaginetum radicatae festucetosum rivas-martinezii*).

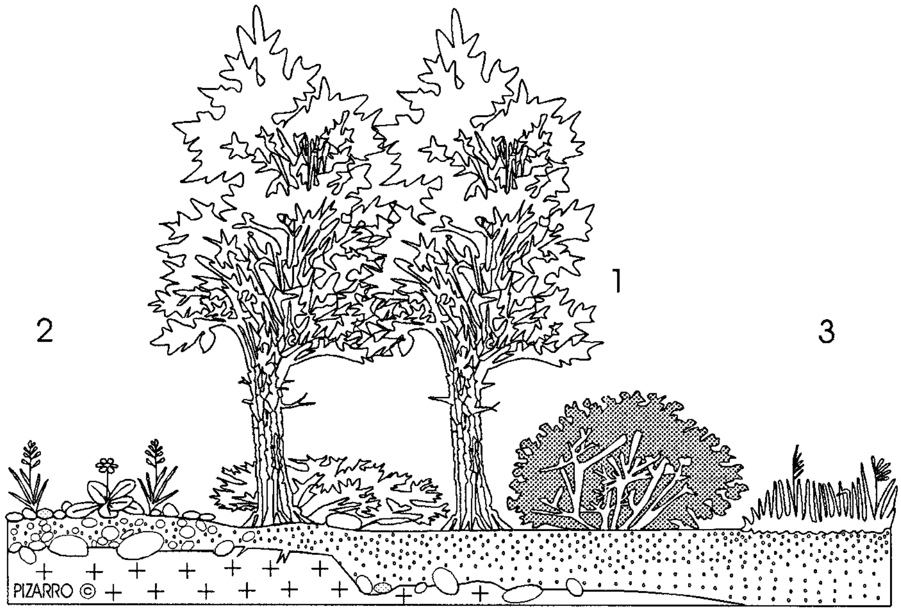


Figure 24. Scheme of the distribution of the plant communities in the Cotos pass: 1- Pine forest (*Avenello ibericae-Pinetum ibericae*); 2- Psychroxerophilous oromediterranean grasslands (*Hieracio castellani-Festucetum curvifoliae*); 3- Chionophile *Nardus* grasslands or cervunales (*Campanulo-Festucetum ibericae*)

The suprasubmediterranean and supramediterranean upper humid Guadarrámica pine forest association has the following floristic composition:

Pteridio aquilini-Pinetum ibericae: V *Pinus sylvestris* var. *iberica,* V *Avenella flexuosa* subsp. *iberica*, V *Juniperus communis* subsp. *hemisphaerica*, V *Pteridium aquilinum*, V *Conopodium pyrenaeum,* V *Galium rotundifolium*, V *Avenaria montana,* IV *Cytisus oromediterraneus*, IV *Holcus mollis,* IV *Luzula forsteri,* IV *Viola riviniana*, IV *Cruciata glabra,* III *Genista florida* subsp. *florida*, III *Satureja vulgaris*, III *Luzula lactea*, III *Veronica officinalis,* III *Dicranum scoparium*, III *Agrostis castellana*, III *Avenula sulcata*, III *Satureja alpina* subsp. *meridionalis*, II *Linaria nivea*, II *Erica arborea,* II *Rumex acetosa* subsp. *pyrenaicus,* II *Rubus castellarnaui,* II *Rosa canina*, II *Cistus laurifolius* (dif. subass.), II *Arctostaphylos uva-ursi* subsp. *crassifolia* (dif. subass.), etc. (Rivas-Martínez & J.A. Molina 1999, tab. 2, 31relevés)

The Guadarrámica and Bejarano-Gredense supramediterranean and suprasubmediterranean Sierran piornales association with *Genista cinerascens* has the following floristic composition:

Cytiso oromediterranei-Genistetum cinerascentis: V *Cytisus oromediterraneus,* V *Genista cinerascens*, IV *Pteridium aquilinum,* IV *Avenella flexuosa* subsp. *iberica*, IV *Koeleria caudata* subsp. *crassipes*, III *Genista florida* subsp. *florida*, III *Juniperus communis* subsp. *hemisphaerica*, III *Stipa gigantea*, III *Santolina rosmarinifolia*, III *Cytisus scoparius*, III *Jasione crispa* subsp. *sessiliflora,* III *Luzula lactea*, III *Arrhenatherum elatius* subsp. *carpetanum,* III *Agrostis castellana*, III *Orobanche rapumgenistae*, II *Erica arborea*, II *Festuca summilusitana*, II *Lavandula pedunculata*, II *Avenula sulcata*, II *Linaria nivea*, II *Festuca curvifolia*, II *Coryhephorus canescens*, II *Adenocarpus hispanicus* (dif. subass.), II *Festuca elegans* (dif. subass.), II *Echinospartum barnadesii* (dif. subass.), etc. (Rivas-Martínez 1970: 151, tab. 2, 26 relevés; Rivas-Martínez & Cantó 1987: 246, tab. 2, 10 relevés; Fernández-González 1991: 239, tab. 14A, 14B, 34 relevés)

The Guadarrámico orosubmediterranean humid and hyperhumid pine forests have the following floristic composition:

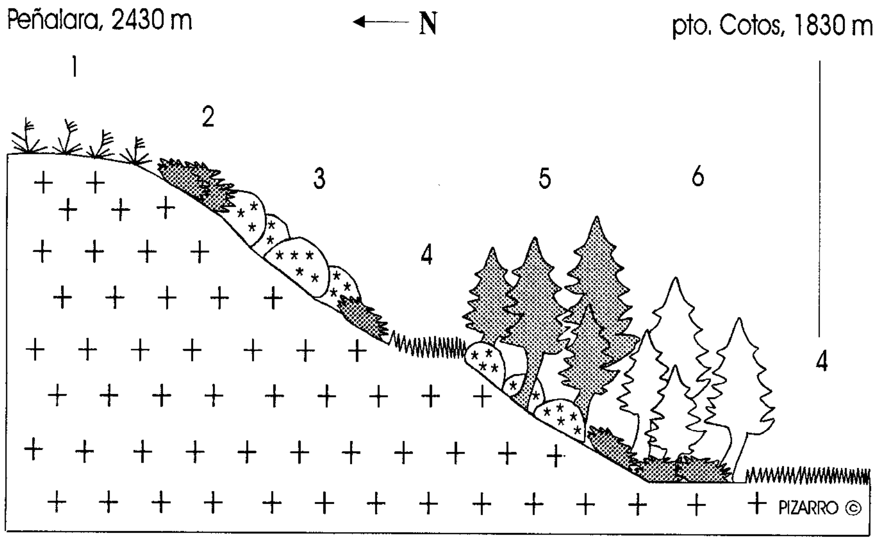


Figure 25. Zonal distribution of the vegetation between the Cotos pass and Peñalara summit: 1- Psychroxerophilous crioromediterranean grasslands (*Hieracio myriadeni-Festucetum curvifoliae*); 2- Dwarf juniper scrub (*Avenello ibericae-Junieretum alpinae*); 3- Dwarf piornales (*Senecioni carpetani-Cytisetum oromediterranei)* 4- Chionophile *Nardus* grasslands or cervunales (*Campanulo-Festucetum ibericae*); 5- Pine forest (*Avenello ibericae-Pinetum ibericae)* with *Adenocarpus hispanicus*; 6- Pine forest (*Avenello ibericae-Pinetum ibericae).*

Avenello ibericae-Pinetum ibericae: V *Pinus sylvestris* var. *iberica*, V *Avenella flexuosa* subsp. *iberica*, V *Juniperus communis* subsp. *alpina*, IV *Juniperus communis* subsp. *hemisphaerica*, IV *Jasione laevis* subsp. *carpetana,* IV *Cytisus oromediterraneus*, IV *Linaria nivea*, IV *Luzula lactea,* IV *Arenaria montana*, IV *Dicranum scoparium,* IV *Rumex acetosella* subsp. *pyrenaicus,* IV *Cerastium ramosissimum*, III *Agrostis castellana*, III *Conopodium pyrenaeum*, III *Festuca marginata* subsp. *braun-blanquetii,* III *Festuca iberica*, III *Nardus stricta*, III *Leontodon hispidus* subsp. *bourgaeanus,* II *Festuca curvifolia,* II *Avenula sulcata*, II *Erica arborea*, II *Leucanthemopsis pallida* subsp. *alpina*, etc. (Rivas-Martínez & J.A. Molina 1999: tab. 1, 25 relevés; Fernández-González 1991: 177, tab. 2B, 45-57, 12 relevés)

The seral stages favoured by fire and husbandry correspond to the submediterranean piornales of *Senecioni carpetani-Cytisetum oromediterranei* and to the psychroxerophilous grasslands of *Hieracio castellani-Festucetum curvifoliae.* Their floristic composition is shown in the following tables:

Senecioni carpetani-Cytisetum oromediterranei: V *Cytisus oromediterraneus*, V *Juniperus communis* subsp. *alpina*, V *Avenella flexuosa* subsp. *iberica*, IV *Luzula lactea,* IV *Arenaria montana,* III *Juniperus communis* subsp. *hemisphaerica*, III *Senecio pyrenaicus* subsp. *carpetanus*, III *Arrhenatherum elatius* subsp. *carpetanum*, III *Erica arborea*, III *Rumex acetosella* subsp. *pyrenaicus*, III *Festuca curvifolia*, III *Linaria nivea*, III *Agrostis castellana,* III *Lactuca viminea*, II *Adenocarpus hispanicus* subsp. *hispanicus* (dif. subass.), II *Arctostaphylos uva-ursi* subsp. *crassifolia* (dif. subass.), II *Ranunculus ollissiponensis* subsp. *alpinus,* II *Pinus sylvestris* var. *iberica* (S2), etc. (Rivas-Martínez 1963: 176, tab. 22, 9 relevés; Rivas-Martínez & Cantó 1987: 23, 12 relevés; Fernández-González 1991: 176, tab. 2A: 10-27, 17 relevés)

Hieracio castellani-Festucetum curvifoliae: V *Festuca curvifolia*, V *Hieracium castellanum*, V *Thymus bracteatus* subsp. *bracteatus*, V *Koeleria caudata* subsp. *crassipes,* IV *Jurinea humilis*, IV *Agrostis truncatula*, IV *Sedum brevifolium,* IV *Poa bulbosa,* IV *Jasione crispa* subsp. *sessiliflora*, IV *Leucanthemopsis pallida* subsp. *alpina*, III *Armeria caespitosa,* III *Avenella flexuosa* subsp. *iberica,* II *Corynephorus canescens,* III *Agrostis castellana,* II *Plantago radicata,* II *Dianthus toletanus* subsp. *cutandae*, II *Festuca rivas-martinezii*, II *Linaria elegans*, II *Avenula sulcata.* (Rivas-Martínez & Cantó 1987: 255, tab. 7, 9 relevés. Fernández-González 1988, tab. 9.4, 23 relevés.)

In the upper orosubmediteranean belt (Tp<700) and, topographically in the criorosubmedierranean, mostly in fire safe rocky habitats, the climatophylous potential vegetation can be a dwarf juniper shrubland: *Avenello ibericae-Juniperetum nanae*. This vegetation, above the orosubmediterranean climatophilous pine forest belt, form a mosaic on lithososls with the psychroxerophilous criorosubmediterranean grasslands of *Hieracio myriadeni-Festucetum curvifoliae*. The following table, whose relevés come from areas above 2,150 m, shows the floristic composition of this Guadarrámico and Bejarano-Gredense relic vegetation.

Avenello ibericae-Juniperetum alpinae: V *Juniperus communis* subsp. *alpina*, V *Avenella flexuosa* subsp. *iberica,* IV *Festuca curvifolia,* III *Senecio pyrenaicus* subsp. *carpetanus,* II *Thymus praecox subsp. penyalarensis,* II *Hieracium vahlii* subsp. *myriadenum,* II *Veronica fruticans* subsp. *cantabrica,* II *Festuca iberica,* II *Nardus stricta,* II *Saxifraga willkommiana,* etc. (Fernández-González 1991: 176 tab. 2A, rel. 1-9, sub *Senecioni carpetani-Cytisetum oromediterranei juniperetosum nanae* (Rivas-Martínez 1970) Rivas-Martínez & Fernández-González 1991)

The psychroxerophilous grasslands vegetation belt (*Hieracio myriadeni-Festuco curvifoliae* microsigmetum)

The lower subhumid criorosubmediterranean belt (Tp<550, Io 12.0-18.0) is only well represented in the Sierra de Guadarrama in summital areas above 2,150 m, under strong windy conditions, becoming general above 2,250 m. The climacic vegetation corresponds to tufty psychroxerophilous grasslands of the *Hieracio myriadeni-Festucetum curvifoliae*, which is replaced y the more mesophytic grasslands of *Campanulo herminii-Festucetum ibericae hieracietosum myriadeni* in areas with long-lasting snow cover.

The psychroxerophilous criorosubmediterranean joragales (joraga is the local name for *Festuca curvifolia* Lag. ex Lange; syn *Festuca indigesta* and *Festuca indigesta* subsp. *aragonensis* sensu auct. cf. Fuente, Ortúñez & Ferrero in Itinera Geobotanica 10: 347 1997) represent the potential natural vegetation of the summital microsigmetum of the Sierra de Guadarrama and they are included in the association *Hieracio myriadeni-Festucetum curvifoliae* corr. hoc loco [syn. *Hieracio-Festucetum indigestae* Rivas-Martínez in Anal. Inst. Bot. Cavanilles 21: 149, tab. 21. 1963] which has the following floristic composition:

Hieracio myriadeni-Festucetum curvifoliae: V *Festuca curvifolia,* V *Hieracium vahlii* subsp. *myriadenum,* V *Jasione crispa* subsp. *centralis,* V *Silene ciliata* subsp. *elegans,* IV *Minuartia recurva var. bigerrensis,* IV *Armeria caespitosa,* IV *Thymus praecox* subsp. *penyalarensis,* IV *Jurinea humilis,* IV *Luzula hispanica,* IV *Sedum brevifolium,* IV *Agrostis truncutula,* III *Phyteuma hemisphaericum,* III *Leucanthemopsis pallida* subsp. *alpina,* III *Erysimum penyalarense,* III *Avenella flexuosa* subsp. *iberica,* II *Senecio boissieri,* II *Agrostis rupestris,* II V*eronica fruticans* subsp. *cantabrica,* II *Sedum candollei,* II *Plantago alpina* subsp. *penyalarensis* (dif. subass.), *Festuca iberica* (dif. subass.), II *Sempervivum vicentei* subsp. *paui* (dif. subass.), etc. (Rivas-Martínez 1963: 149. tab. 21, 16 relevés.; Fernández-González 1991: 170, tab. 1A, 1B, 54 relevés)

Orophile cervunales (*Nardus* grasslands) and mires (*Campanulo-Nardion*, *Caricion fuscae*)

Nardus grasslands, called cervunales in Spanish, are edaphohygrophile and chionophile pastures dominated by *Nardus stricta* and *Festuca iberica* which constitute one of the most important summer pasture resources in the Iberian high mountains. Their communities are distributed into several well characterised alliances in the Iberian Peninsula. *Nardion* (Pyrenean and eastern Cantabrian supra and orotemperate), *Violion caninae* (Atlantic, supratemperate: incl. Juncion squarrosi), *Campanulo-Nardion* (Carpetan-Iberian-Leonesian, western Orocantabrian, supra, oro and criorosubmeditarranean) and *Plantaginion nivalis* (Nevadense, oro and crioromediterranean). In the Sierra de Guadarrama there are five associations of the *Campanulo-Nardion* alliance: *Campanulo hermini-Festucetum ibericae*, *Luzulo carpetanae-Juncetum squarrosi* [syn.: *Luzula sudetica-Pedicularis sylvatica* ass.], *Campanulo herminii-Festucetum rivularis*, *Allietum latiorifolii* and *Festuco rothmaleri-Juncetum squarrosi*. The first four mentioned occur in the orosubmediterranean of the Guadarrámico subsector; *Allietum latiorifolii* is an endemic association of the Peñalara massif which lives on lithosols and crevices frequently flooded by the water from melting snow which is characterized by the Guadarrámico endemic plant *Allium schoenoprasium* subsp. *latiorifolium*. The oro-criorosubmediterranean Guadarrámica and Bejarano-Gredense chyionophilous association of stream edges *Campanulo herminii-Festucetum rivularis* is well characterized by the orophilous Iberian endemic grass *Festuca rivularis* Boiss.

The most common cervunales in Guadarrama ar the mesophytic corresponding to the association *Luzulo-Juncetum squarrosi*, which in mires is in contact with the sedge community of mires *Caricetum* (*carpetanae*) *ibericae*.

Campanulo hermini-Festucetum ibericae: V *Campanula herminii,* V *Festuca iberica,* V *Narduus stricta,* V *Jasione laevis* subsp. *carpetana,* IV *Narcissus bulbocodium* subsp. *nivalis,* III *Luzula campestris* subsp. *carpetana,* III *Ranunculus bulbosus* subsp. *cacuminalis,* III *Agrostis truncatula,* III *Hieracium pilosella,* III *Lotus glareosus,* III *Rumex acetosella* subsp. *pyrenaicus,* III *Polytrichum juniperium,* II *Euphrasia willkommii,* II *Gagea nevadensis,* II *Dianthus deltoides,* II *Galium rivulare,* II *Pedicularis sylvatica,* II *Galium saxatilis,* II *Polygala vulgaris,* II *Danthonia decumbens,* II *Potentilla erecta,* II *Pedicularis sylvatica,* II *Plantago alpina* subsp. *penyalarensis,* II *Trifolium repens* subsp. *nevadense,* I *Ranunculus abnormis,* I *Selinum pyrenaeum,* I *Hieracium pseudovahlii,* I *Juncus squarrosus,* etc. (Rivas-Martínez 1963: 127, tab. 18, 14 relevés; Fernández-González,1988, tab. 14.1, 44 relevés)

The hygrophytic sedge association of oro-criorosubmediterranena mires has the following floristic composition:

Caricetum (carpetanae) ibericae: V *Carex nigra* subsp. *iberica,* V *Carex echinata,* IV *Sphagnum sp. pl.,* IV *Viola palustris* subsp. *juressi,* III *Agrostis canina,* III *Carex demissa,* III *Drosera rotundifolia,* III *Potentilla erecta,* III *Nardus stricta,* III *Pedicularis sylvatica,* III *Parnassia palustris,* II *Eleocharis quinqueflora,* II *Carex ovalis,* II *Epilobium palustre,* II *Luzula campestris* subsp. *carpetana,* II *Aulacomnium palustre,* II *Juncus alpinoarticulatus* subsp. *alpestris,* II *Ranunculus bulbosus* subsp. *cacuminalis,* II *Epilobium palustre,* II *Calliergonella cuspidata,* II *Erica tetralix,* I *Pinguicula grandiflora,* etc. (Rivas-Martínez 1963: 91, tab. 12, 14 relevés; Fernández-González 1988: 702, tab. 33.1, 34 relevés)

Orophilous rupicolous and scree vegetation (*Saxifragion willkommianae*, *Linario-Senecionion carpetani*)

The Sierra de Guadarrama in general terms is not exceedingly abrupt but its summital areas have been carved out during the Würmian ice period and they bear an important quantity of rupicolous and scree habitats. They bear plant communities rich in Carpetan and Guadarrámicos endemic plants, specialized in living under such extreme conditions. The outstanding oro and criorosubmediterranean communities are *Saxifragetum willkommianae* (rock crevices, chyonofobous) and *Digitali carpetanae-Senecionetum carpetani* (unstable screes, chyonophilous).

The chasmophytic Guadarrámica silicicolous association with oromediterranean and oro-criorosubmediterranean distribution has the following floristic distribution:

Saxifragetum willkommianae: V *Saxifraga willkommiana,* V *Murbeckiella boryi,* V *Hieracium carpetanum,*IV *Asplenium septentrionale,* III *Alchemila saxatilis,* III *Cryptogramma crispa,* III *Sedum* *brevifolium,* III *Avenella flexuosa* subsp. *iberica,* II *Silene boryi* subsp. *penyalarensis,* II *Sedum hirsutum,* II *Alchemilla transiens,* II *Agrostis rupestris,* II *Hieracium amplexicaule,* II *Poa nemoralis* subsp. *glauca,* II *Cystopteris fragilis,* II V*eronica fruticans* subsp. *cantabrica*, etc. (Rivas-Martínez 1963: 46, tab. 1, 17 relevés; Fernández-González 1988. tab. 23.3, 30 relevés)

The chyonophilous Guadarrámica scree association, of oro-criorosubmediterranean distribution, has the following floristic composition:

Digitali carpetanae-Senecionetum carpetani: V *Senecio pyrenaicus* I *carpetanus,* I *Digitalis purpurea* I *carpetana,* I *Paronychia polygonifolia,* I *Cryptogramma crispa,* II *Linaria saxatilis,* II *Leontodon hispidus* I *bourgaeanus,* III *Biscutella intermedia* I *gredensis,* III *Solidago virgaurea* I *fallittirones,* III *Agrostis truncatula,* III *Sedum brevifolium,* III *Leucanthemopsis pallida* I *alpina,* II *Epilobium collinum,* II *Galeopsis angustifolia* I *carpetana,* II *Arrhenatherum elatius* I *carpetanum,* I *Poa fontqueri*, etc. (Rivas-Martínez 1963: 62, tab. 5, 10 relevés; Fernández-González 1988, tab. 25.2, 31 relevés)

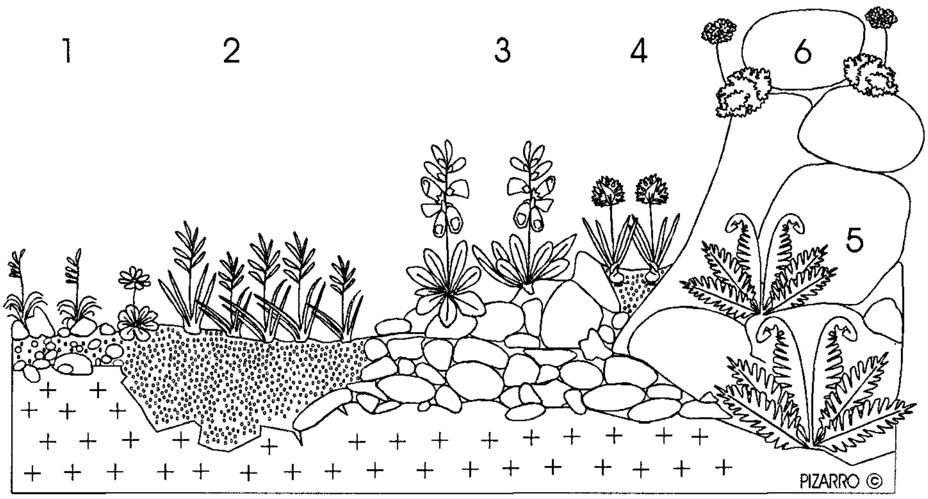


Figure 26. Scheme of the plant communities in the Peñalara summit. Psychroxerophilous crioromediterranean grasslands (*Hieracio myriadeni-Festucetum curvifoliae*); 2- Chionophile *Nardus* grasslands or cervunales (*Campanulo-Festucetum ibericae*); 3- Stabilized scree communities (*Digitali-Senecietum carpetani*); 4- Wet rupicolous communities (*Allietum latioriflori*); 5- Scree fern communities (*Cryptogrammo-Dryopteridetum oreadis*); 6- Rock crevices communities (*Saxifragetum willkommianae*)

TAXONOMIC APPENDIX

The nomenclature of the taxa cited in the text follows, in the indicated order, that of the volumes of the following basic floras: *Flora iberica* (Castroviejo & al., 1986-1998), *Med-Checklist* (Greuter & al. 1984-1989) and *Flora Europaea* (Tutin & al., 1964-1980; 1993). The following list is formed by taxa not considered in the mentioned floras, with indication of the rank and author accepted by us. Abbreviations of authors of taxa follow that proposed by Brummitt & Powell (1996) and the abbreviations of the journals in the bibliographic references, those of Flora Iberica.

Allium schoenoprasum subsp. *latiorifolium* (Pau) Rivas Mart., Fern.Gonz. & Sánchez Mata
Arctostaphylos uva-ursi subsp. *crassifolia* (Braun-Blanq.) Rivas Mart.
Armeria lacaitae (Villar) Rivas Mart.
Arrhenatherum elatius subsp. *carpetanum* Rivas Mart., Fern. Gonz. & Sánchez Mata ined.
Arrhenatherum tuberosum subsp. *baeticum* (Romero Zarco) Rivas Mart., Fern.Gonz. & Sánchez Mata
Avenella flexuosa subsp. *iberica* (Rivas Mart. in Rivas Mart., Izco & M.J.Costa) García-Suárez, Fern.-Carv. & Fern.Prieto in García-Suárez & al.
Avenula sulcata (Gay ex Boiss.) Dumort.
Biscutella intermedia subsp. *gredensis* (Guinea) Malag.
Carex nigra subsp. *iberica* Rivas Mart.
Centaurea gabrielis-blancae Fern.Casas
Conopodium pyrenaeum (Loisel.) Miègev.
Cytisus oromediterraneus Rivas Mart., T.E.Díaz, Fern.Prieto, Loidi & Penas
Dactylis hispanica Roth
Digitalis purpurea subsp. *carpetana* (Rivas Mateos) Rivas Mart., Fern.Gonz. & Sánchez Mata
Erodium paularense Fern.Gonz. & Izco
Festuca curvifolia Lag. ex Lange
Festuca marginata subsp. *braun-blanquetii* Fuente, Ortuñez & L.M.Ferrero
Festuca rivas-martinezii Fuente & Ortuñez
Festuca summilusitana Franco & Rocha Afonso
Galium spurium subsp. *aparinella* (Lange) Rivas Mart. & Castrov.
Hieracium pseudovahlii De Retz
Hieracium vahlii subsp. *myriadenum* (Boiss. & Reut.) Zahn
Juncus alpinoarticulatus subsp. *alpestris* (Hartm.) Hämet-Ahti
Koeleria caudata subsp. *crassipes* (Lange) Rivas Mart.
Lavandula pedunculata Cav.
Leontodon hispidus subsp. *bourgaeanus* (Willk.) Rivas Mart. & Sáenz de Rivas
Leucanthemopsis pallida subsp. *alpina* (Boiss. & Reut.) Rivas Mart., Fern.Gonz. & Sánchez Mata
Luzula campestris subsp. *carpetana* Rivas Mart.
Minuartia recurva var. *bigerrensis* (Pau) Font Quer
Narcissus nivalis Graells
Plantago alpina subsp. *penyalarensis* (Pau) Rivas Mart.
Plantago radicata Hoffmanns. & Link
Poa fontqueri Braun-Blanq.
Poa nemoralis subsp. *glauca* (Rouy) Gaud.
Sempervivum vicentei subsp. *paui* Fern.Casas
Senecio pyrenaicus subsp. *carpetanus* (Willk.) Rivas Mart.

Silene boryi subsp. *penyalarensis* (Pau) Rivas Mart.
Silene ciliata subsp. *elegans* (Link ex Brot.) Rivas Mart.
Solidago virgaurea subsp. *fallit-tirones* (Font Quer) Rivas Mart., Fern.Gonz. & Sánchez Mata
Thymus praecox subsp. *penyalarensis* (Pau) Rivas Mart., Fern.Gonz. & Sánchez Mata
Veronica fruticans subsp. *cantabrica* M.Laínz
Viola palustris subsp. *juressi* (Link ex K.Wein) W.Becker ex Cout.

BENAVENTE-VILLAFRANCA DEL BIERZO (20 July)

(Geobotanical excursion between Benavente and Villafranca del Bierzo)

ÁNGEL PENAS MERINO & EMILIO PUENTE GARCÍA

INTRODUCTION

The journey crosses territories belonging to the Orensano-Sanabriense phytogeographical sector (Carpetan-Leonesian subprovince, Iberoatlantic province, Mediterranen region) and to the Laciano-Ancarense sector (Orocantabrian province, Atlantic European province, Eurosiberian region).

Mediterranean and Eurosiberian regions are separated climatically due to the occurrence in the former of a summer drought of at least two months. This causes in the vegetation the dominance of evergreen sclerophylle forests in the Mediterranean region while in the Eurosiberian the summergreen deciduous forests predominate.

The Orensano-Sanabriense sector, in comparison with the Leonés sector, is geologically characterised by hard siliceous substrata such as slate, with some dolomite outcrops like that of the Peñarrubia massif in El Bierzo area. Climatically, this sector is submitted to a Mediterranean pluviseasonal oceanic bioclimate and the meso, supra and oromediterranean thermotypes and the subhumid, humid and hyperhumid ombrotypes are represented.

The flora of the Orensano-Sanabriense sector presents several endemics of this territory such as *Petrocoptis grandiflora, Petrocoptis pyrenaica* subsp. *viscosa*, *Leontodon farinosus, Campanula arbatica* subsp. *adsurgens, Genista sanabrensis* and *Rhamnus legionensis*. There are also some western Iberian elements such as *Cytisus multiflorus, Genista hystrix, Echinospartum ibericum, Hispidella hispanica* and *Lavandula sampaioana* among others, which together with all the orophile flora of the oromediterranean belt, sharply separate this sector from the Leonés.

The Laciano-Ancarense sector is the westernmost of those of the Orocantabrian subprovince and, lithologically is predominantly siliceous. Its climate shows a significant decrease of the summer rainfall in comparison to other Orocantabrian areas located in an eastern position; this causes a diminution of the area occupied by the beech, which is mostly replaced by the birch. The bioclimate is temperate oceanic and temperate ocanic submediterranean, with supratemperate (montane) and orotemperate (subalpine) thermotypes and humid and hyperhumid ombrotypes. The submediterranean climatic variant (with a marked summer drought but shorter than two months) of the temperate climatic type is present in many areas of this sector, especially in the limiting fringe with the Mediterranean region.

As endemics of this sector, only Sideritis lurida and Doronicum diazii can be pointed out, but there are other western Iberian elements which can be used as differentials with other eastern Orocantabrian units (Ubiñense subsector) such as *Cardamine raphanifolia* subsp. *gallaecica*, *Cytisus multiflorus*, *Eryngium duriaei* and *Spergularia rimarum*.

The distribution of the vegetation series in the visited phytogeographical territories of NW Spain

	A		B			
	1	**2**	**3**	**4**	**5**	**6**
Oromediterranean orensano-sanabriense silicicolous series of the dwarf juniper or *Juniperus communis* subsp. *alpina* (*Genisto sanabrensis-Junipero nanae* sigmetum)	+					
Supra-mesomediterranean Luso-Extremadurensian and Carpetan-Iberian-Leonesian edaphohygrophyle series of the alder or *Alnus glutinosa* (*Galio broterianae-Alno glutinosae* sigmetum)	+					
Supra-mesomediterranean Luso-Extremadurensian and Carpetan-Iberian-Leonesian edaphohygrophyle series of the alder or *Alnus glutinosa* (*Galio broterianae-Alno glutinosae* sigmetum)	+					
Supra-mesomediterranean western carpetana and orensano-sanabriense humid-hyperhumid silicicolous series of the melojo or *Quercus pyrenaica* (*Holco mollis-Querco pyrenaicae* sigmetum)	+					
Supra-mesomediterranean salmantina, lusitano-duriense and orensano-sanabriense silicicolous series of the carrasca or *Quercus rotundifolia* (*Genisto hystricis-Querco rotundifoliae* sigmetum)	+					
Supra-mesomediterranean salmantina and orensano-sanabriense subhumid-humid silicicolous series of the melojo or *Quercus pyrenaica* (*Genisto falcatae-Querco pyrenaicae* sigmetum)	+					
Supra-mesomediterranean guadarrámica, Iberian-Sorian, celtibérico-alcarreña ald leones silicicolous vegetation series of the carrasca or *Quercus rotundifolia* (*Junipero oxycedri-Querco rotundifoliae* sigmetum)		+				
Supramediterranean Iberian-Sorian ayllonenseald leonesa silicicolous vegetation series of the melojo or *Quercus pyrenaica* (*Festuco braun-blanquetii-Querco pyrenaicae* sigmetum)		+				
Meso and supramediterranean orensano-sanabriense, leones and castellano-duriense mesophytic vegetation series of the elm or *Ulmus minor* (*Aro maculati-Ulmo minoris* sigmetum)	+	+				
Meso and supramediterranean Iberoatlantic and Castellano-Duriense edaphohygrphyle vegetation series of the poplar or Populus nigra and the arboreal willow or *Salix neotricha* (*Populo nigrae-Saliceto neotrichae* sigmetum)	+	+				
Meso and supramediterranean Iberoatlantic and Castellano-Duriense edaphohygrphyle vegetation series of the narrow-leaved willow or Salix eleagnos subsp. angustifolia and the salvifolious willow or *Salix salvifolia* (*Saliceto angustifolio-salvifoliae* sigmetun)		+				
Montane Orocantabrian and Galaico-Asturiana acidophile vegetation series of the melojo or *Quercus pyrenaica* (*Linario triornithophorae-Querco pyrenaicae* sigmetum)			+	+		+

	A		B			
	1	**2**	**3**	**4**	**5**	**6**
Montane Orocantabrian acidophile vegetation series of *Quercus petraea* (*Linario triornithophorae-Querco petraeae* sigmetum)			+	+		+
Subalpine Orocantabrian silicicolous vegetation serires of the dwarf juniper or *Juniperus communis* subsp. *alpina* (*Junipero nanae-Vaccinio microphylli* sigmetum)			+	+		+
Montane Orocantabrian acidophile vegetation series of the Iberian birch or *Betula celtiberica* (*Luzulo henriquesii-Betuleto celtibericae* sigmetum)			+	+		+
Montane Orocantabrian acidophile vegetation series of the beech or *Fagus sylvatica* (*Blechno spicanto-Fago sylvaticae* sigmetum)			+	+	+	+
Montane Laciano-ancarense basophile vegetation series of the beech or *Fagus sylvatica* (*Omphalodo nitidae-Fago sylvaticae* sigmetum)			+			
Montane Orocantabrian and Cántabro-Euskalduna basophilous and xerophyle vegetation series of the beech or *Fagus sylvatica* (*Epipactido helleborines-Fago sylvaticae* sigmetum)				+	+	+
Montane Orocantabrian and Cántabro-Euskalduna basophilous and ombrophilous vegetation series of the beech or *Fagus sylvatica* (*Carici sylvaticae-Fago sylvaticae* sigmetum)				+	+	+
Oromediterranean Iberian-Sorian silicicolous vegetation series of the dwarf juniper or Juniperus comminis subsp. alpina in its subalpine Orocantabrian version with *Jasione crispa* subsp. *brevisepala* (*Vaccinio microphylli-Junipero nanae* sigmetum)			+	+		+
Colline-montane Orocantabrian mesophytic vegetation series of the oak-ash forests (*Mercurialidi perennis-Fraxino excelsioris* sigmetum)					+	
Montane Laciano-Ancarense mesophytic vegetation series of the ash or *Fraxinus excelsior* (*Festuco giganteae-Fraxino excelsioris* sigmetum)			+			
Colline-montane riverine eastern Cantabrian vegetation series of the alder or *Alnus glutinosa* (*Hyperico androsaemi-Alno glutinosae* sigmetum)					+	
Montane Orocantabrian edaphohygrophyle vegetation series of the Cantabrian willow or *Salix cantabrica* (*Salico cantabricae* sigmetum)			+	+	+	+
Supramediterranean Iberoatlantic and Castellano-Duriense edaphohygrophyle vegetation series of the salvifolian willow or *Salix salvifolia* (*Salico lambertiano-salvifoliae* sigmetum)	+		+			
Montane Orocantabrian edaphoxerophyle basophilous relic vegetation series of the white juniper or *Juniperus thurifera* (*Junipereto sabino-thuriferae* sigmetum)				+		+
Coline-montane Orocantabrian basophilous relic vegetation series of the carrasca or *Quercus rotundifolia* (*Cephalanthero longifoliae-Querco rotundifoliae* sigmetum)				+	+	+

	A		B			
	1	**2**	**3**	**4**	**5**	**6**
Subalpine Orocantabrian basophilous vegetation series of the dwarf juniper or *Juniperus communis* subsp *alpina* (*Daphno cantabricae-Arctostaphylo uva-ursi* sigmetum)				+	+	+
Montane Orocantabrian mesophytic vegetation series of the ash or *Fraxinus excelsior* (*Pruno padi-Fraxino excelsioris* sigmetum)				+		+
Alpine Picoeuropeana basophilous vegetation series of *Elyna myosuroides* (*Oxytropido pyrenaicae-Elyno myosuroides* sigmetum)					+	
Alpine Altocarrionesa silicicolous vegetation series of *Oreochloa blanka* (*Junco trifidi-Oreochloo blankae* sigmetum)						+

Table 5. Vegetation series of the sectors and subsectors of NW Spain crossed by the Iter Ibericum MIM (**A:** Carpetan-Leonesian subprovince**. 1:** Orensano-Sanabriense sector. **2:** Leonés sector. **B:** Orocantabrian subprovince. **3:** Laciano-Ancarense sector. **4:** Ubiñense subsector. **5:** Picoeuropeano subsector. **6:** Altocarrionés subsector

THE VEGETATION OF THE ITINERARY

The starting point is Benavente, a town located between the "vegas" or alluvial plains of the Órbigo and Esla river valleys and thus in an area where the potential natural vegetation corresponds to the typical riparian geoserie of this Orensano-Sanabriense sector. Some remains of the elm forests (*Aro maculati-Ulmetum minoris*), poplar-willow forests (*Populo nigrae-Salicetum neotrichae*), willow shrublands (*Salicetum lambertiano-salvifoliae*) and alder forests (*Galio broteriani-Alnetum glutinosae*) can be observed.

The remains of the elm forests (*Aro maculati-Ulmetum minoris*) are formed by small populations of *Populus nigra, P. alba, Fraxinus angustifolia, Ulmus minor, Salix neotricha*, *S. fragilis*, *Arum maculatum, Euphorbia amygdaloides* and *Euonymus europaeus*, which often adopt a linear arrangement along streams or limits between rural properties. The spiny hedges rich in brooms of the association *Rubo ulmifolii-Rosetum corymbiferae* are characteristic of this vegetation series, and are dominated by *Rubus ulmifolius, Rosa corymbifera, R. micrantha, R. canina, Viburnum opulus, Ligustrum vulgare, Euonymus europaeus, Prunus spinosa, Cornus sanguinea, Clematis vitalba, Sambucus nigra, Crataegus monogyna* and *Lonicera periclymenum* among others, bordering ways and paths and marking, as living fences, the divisory lines between properties. The meadows of *Festuco amplae-Cynosuretum cristati* are also characteristic of the valley bottoms, as well as the summer crops and their associated weed communities.

The willow shrublands are formd by several *Salix* species such as *S. salvifolia*, *S. purpurea* subsp. *lambertiana*, *S. triandra* subsp. *discolor* and *S. atrocinerea*, and live on the pebble river beds. They belong to the association *Salicetum lambertiano-salvifoliae*. As seral stages we can point out the hygrophylr herb communites of *Glycerio declinatae-Oneanthetum croccatae*, dominated by the huge hemlock water-dropwort *Oenanthe crocat*a, which is usually accompanied by *Glyceria declinata, Phalaris arundinacea, Galium* *palustre, Lythrum salicaria, Mentha suaveolens* and *Sparganium erectum* subsp. *neglectum*. On the pebble screes of the river bed communities of the association *Lactuco chondrilliflorae-Andryaletum ragusinae* occur, characterised by *Andryala ragusina*, *Lactuca viminea* subsp. *chondrilliflora*, *Scrophularia canina* and *Linaria supina*. In the spots where organic matter accumulates, communities of *Artemisio glutinosae-Santolinetum semidentatae andryaletosum ragusinae* appear, which are formed mostly by *Santolina rosmarinifolia* subsp. *semidentata, Artemisia campestris* subsp. *glutinosa, Plantago sempervirens, Helichrysum stoechas, Dorycnium pentaphyllum* and *Andryala ragusina.*

The mature stage of the vegetation series of the alder forests corresponds to a riverine gallery forest (*Galio broteriani-Alnetum glutinosae*) dominated by trees such as *Alnus glutinosa*, *Fraxinus angustifolia* and *Ulmus minor*, whose understorey is populated by herbs such as *Galium broterianum* and *Carex elata* subsp. *broteriana*. Inside those forests hygrophilous helophytic communities of *Glycerio declinatae-Oenanthetum crocatae* and skionitrophilous vegetation of the *Geranio robertiani-Caryolophetum sempervirentis*, with *Pentaglottis sempervirens, Urtica dioica, Alliaria petiolata, Geranium robertianum, Galium aparine, Chelidonium majus, Bromus sterilis*, *Lapsana communis*, etc.appear.

A few kilometres farther on, when leaving the valley bottom, we enter the territory of the climatophilous Orensano-Sanabriense "carrascales" vegetation series (*Genisto hystricis-Querco rotundifoliae sigmetum*). The mature stage of this series is a "carrascal" (also often called "encinar") which lives in the meso and supramediterranena areas of the Orensano-Sanabriense sector, under dry, subhumid and humid ombroclimete and preferently on base-poor soils. Those carrascales are floristically poor, bearing a few species such as *Genista hystrix*, *Paeonia broteroi*, *Cistus ladanifer* and *Daphne gnidium*. Their structure corresponds to a "carrascas" woodland with medium sized trees profusely branched from the base of the trunk. In the warmest areas of their distribution range, they are enriched with *Arbutus unedo*, *Phillyrea angustifolia* and *Ruscus aculeatus*, species which also constitute their forest mantle. The seral stage of those forests are the *Cistus* scrub ("jarales") of the association *Lavandulo pedunculatae-Genistetum hystricis*, with *Genista hystrix, Lavandula stoechas* subsp. *pedunculata, Cistus ladanifer, Cistus laurifolius, Halimium umbellatum, Thymus mastichina* and *Thymus zygis*. The forest mantle association *Genisto hystricis-Cytisetum multiflori* is widespread over normal soils of the area of this vegetation series and is constituted by *Cytisus multiflorus*, *C. scoparius*, *Genista hystrix*, *Adenocarpus complicatus* and *Erica arborea*. On shallow soils, the association *Echinospartetum lusitanici* is found, formed almost exclusively by *Echinospartum ibericum*, *Genista hystrix* and *Thymus zygis*. As mentioned above, the seral *Cistus* scrub is included in the *Lavandulo pedunculatae-Genistetum hystricis* when the ombroclimate is dry, but in rainier areas, under subhumid conditions, heathlands of *Genistello tridentatae-Ericetum aragonensis* replace the *Cistus* scrub. They are formed by *Erica australis* subsp. *aragonensis, Genistella tridentata, Erica umbellata, Cistus salvifolius, Halimium umbellatum, Halimium alyssoides, Calluna vulgaris, Polygala microphylla, Thymus mastichina* and *Erica cinerea.* The next degradation stage is hard-leaved grasslands of the association *Diantho merinoi-Plantaginetum radicatae*, with *Plantago radicata, Dianthus merinoi, Armeria caballeroi, Jasione crispa* subsp. *sessiliflora, Corynephorus canescens, Hieracium castellanum, Koeleria caudata* subsp. *crassipes* and *Festuca graniticola*.

Arriving at Rionegro del Puente, we enter the vegetation series *Genisto falcatae-Querco pyrenaicae* sigmetum. The mature stage is a "melojar" belonging to the association *Genisto falcatae-Quercetum pyrenaicae*, with *Genista falcata*, a Mediterranean Iberoatlantic endemic species, as a differential element in comparison with other "melojares" associations. This vegetation series occupies areas under subhumid or humid ombrotype and is replaced by the *Holco mollis-Querco pyrenaicae* sigmetum in still rainier areas and by *Genisto hystricis-Querco rotundifoliae* sigmetum in the drier ones. The forest mantle (and first succesional stage) is the "piornal" of *Genisto hystricis-Cytisetum multiflori* and the seral stage, with more degraded soil conditions, is the heathland of *Genistello tridentatae-Ericetum aragonensis*.

On reaching the village of Cernadilla, the rainfall increase provokes the change to the vegetation series *Holco mollis-Querco pyrenaicae* sigmetum. The potential natural vegetation is a "melojar" (*Holco mollis-Quercetum pyrenaicae*) with plants like *Anemone nemorosa, Stellaria holostea, Physospermum cornubiense, Euphorbia angulata, Oxalis acetosella, Sanicula europaea, Melica uniflora, Poa nemoralis, Holcus mollis*, *Luzula sylvatica* subsp. *henriquesii*, etc. This vegetation series occupies a higher position in altitude than the *Genisto falcata-Querco pyrenaicae* sigmetum. The forest mantle is represented by the "piornales" of *Cytiso scoparii-Genistetum polygaliphyllae* formed by species such as *Genista florida* subsp. *polygaliphylla, Cytisus scoparius, Cytisus multiflorus, Adenocarpus complicatus, Pteridium aquilinum* ans *Erica arborea*. The seral scrub consists of heathlands of the association *Genistello tridentatae-Ericetum aragonensis*, one of the most represented vegetation type in the landscape due to the antropic influence.

On the steep slopes of the road banks communities of *Phalacrocarpo oppositifolii-Festucetum elegantidis* and *Phalacrocarpo oppositifolii-Saxifragetum continentalis* are frequent. They combine, among others, species such as *Festuca elegans, Phalacrocarpum oppositifolium, Koeleria caudata* subsp. *crassipes, Anarrhinum bellidifolium, Erysimum linifolium, Sedum reflexum, Jasione laevis* subsp. *sessiliflora* and *Pimpinella villosa* in the former, and *Saxifraga continentalis, Phalacrocarpum oppositifolium, Anarrhinum bellidifolium, Erysimum linifolium, Sedum brevifolium, Sedum hirsutum* and *Umbilicus rupestris* in the latter.

This vegetation series extends all the way up to the Sierra de La Cabrera till 1,800 m high. Above this altitude the oromediterranean thermotype and the hyperhumid ombrotype extend and thus we enter the Orensano-Sanabriense dwarf scrub vegetation series (*Genisto sanabrensis-Junipero nanae* sigmetum). The vegetation of this belt is dominated by silicolous chionophobous communities of dwarf shrubs characterised by the local endemic *Genista sanabrensis*, which is accompanied by other species such as *Cytisus oromediterraneus, Calluna vulgaris, Vaccinium myrtillus* and *Juniperus communis* subsp. *alpina*. Those juniper dwarf shrublands are replaced in degraded spots and clearings by a tufted psichroxerophile grassland which adopts a particular spacial pattern forming scattered half-moon steps on the slopes submitted to solifluxion. The dominant plant in those grasslands is *Festuca indigesta* subsp. *summilusitana*, belonging the association *Teesdaliopsio confertae-Festucetum summilusitanae*, and other species are *Teesdaliopsis conferta, Luzula caespitosa, Dianthus langeanus, Deschampsia flexuosa* subsp. *iberica, Silene ciliata* subsp. *elegans* and *Leontodon pyrenaicus*, among others.

In more favourable places, i.e. where the slope is gentler and the snow accumulates, the soil is deeper and stores more humidity, *Nardus* grasslands ("cervunales") of the association *Poo legionensis-Nardetum strictae* develop, with *Nardus stricta, Poa alpina* subsp. *legionensis, Campanula herminii, Luzula campestris, Galium saxatile, Deschampsia flexuosa* subsp. *iberica, Juncus squarrosus, Potentilla erecta, Carex muricata, Carex binervis, Jasione laevis* subsp. *carpetana, Meum athamanticum, Festuca indigesta* subsp. *summilusitana* and *Festuca nigrescens* subsp. *microphylla*.

Other communities common in this oremediterranean belt of the Sierra de La Cabrera are *Agrostio durieui-Sedetum pyrenaici* (grasslads with crassifolious plants formed by *Sedum brevifolium, Sedum anglicum* subsp. *pyrenaicum, Sedum hirsutum* and *Agrostis durieui*), *Cryptogrammo crispae-Dryopteridetum abbreviatae* (rupicolous fern comunidades living between big half-stabized siliceous blocks in which dominate *Dryopteris oreades* y *Cryptogramma crispa*) and *Cryptogrammo crispae-Silenetum gayanae* (communities of siliceous small-sized screes, characterized by the northwestern Iberian endemic *Silene foetida* subsp. *gayana*, other plants are *Cryptogramma crispa* and *Rumex suffruticosus*).

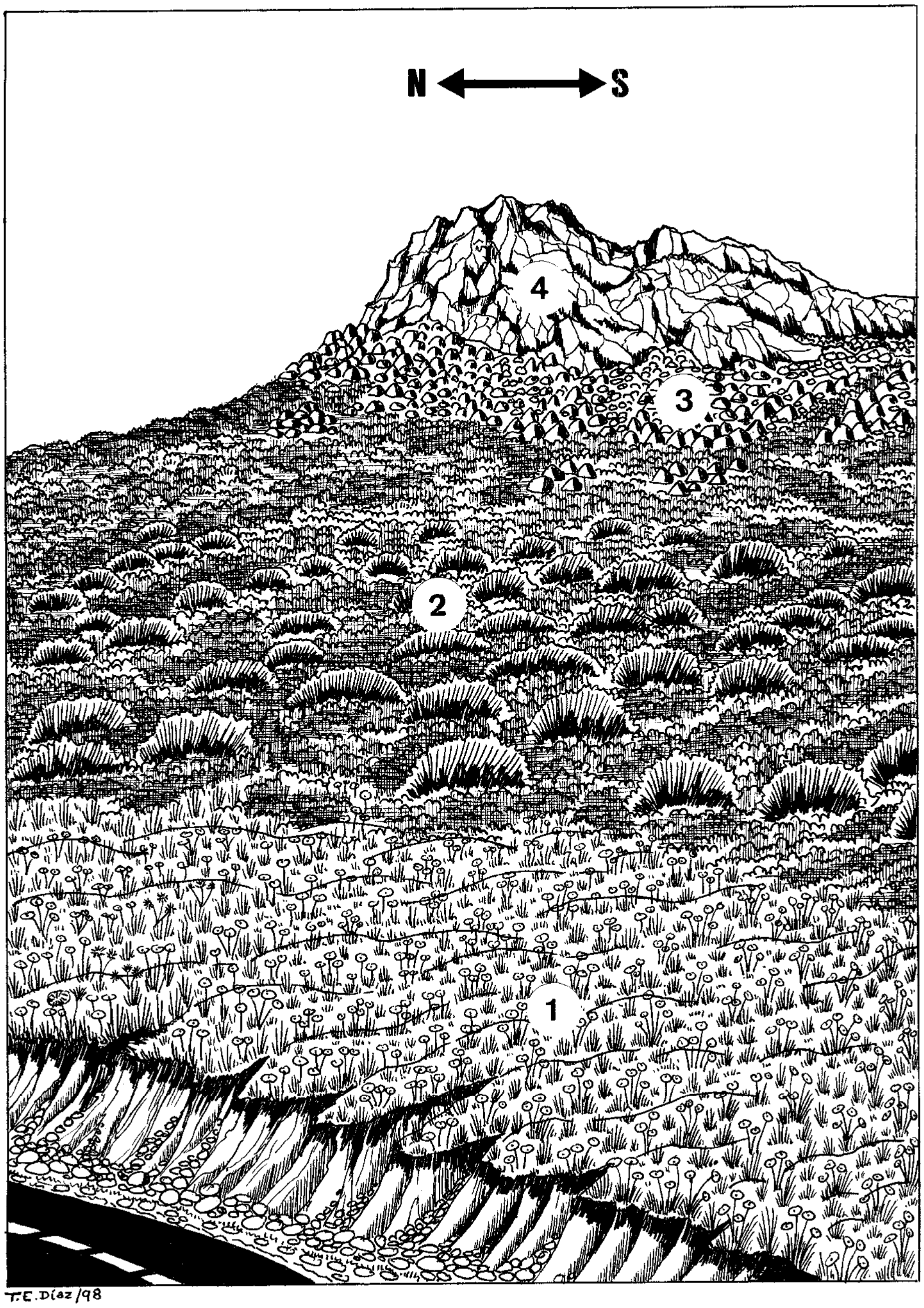
The communities of *Murbeckiello boryi-Sperguletum rimarum*, characterized by *Spergula rimarum* and *Murbeckiella boryi* live in siliceous rock crevices while the shadowed wide fissures of quartzitic rocks filled with earth are colonized by the communities of *Sedo brevifolii-Sperguletum rimarum*, defined by the dominance of *Spergula rimarum, Sedum brevifolium* and *Sedum hirsutum*.

Altough not easily visible, there is anothe important vegetation series in the surrounding area, the *Saxifrago spathularidis-Betulo celtibericae* sigmetum. In the León province the birch forests representing the mature stage of this series are mostly found in some areas at the Sierras of La Cabrera and El Teleno. They belong to the association *Saxifrago spathularidis-Betuletum celtibericae* and the most common trees are *Betula celtiberica*, *Sorbus aucuparia* and *Quercus pyrenaica*; the main herbs are *Physospermum cornubiense* and *Saxifraga spathularis*. Those birch forests mark the timberline of the forested vegetation in those mountain ranges. Their lower limit is established with the melojares of *Holco mollis-Quercetum pyrenaicae*. Due to human influence (cutting down, repeated fires and heavy husbandry), those birch forests have almost dissappeared, remaining small patches located in protected places such as ravines and moist depressions where they have survived. Their seral stages are the piornales of *Cytiso scoparii-Genistetum polygaliphyllae cytisetosum multiflori* and, on degraded soils, the heathlands of association *Erico umbellatae-Genistetum sanabrensis*.

PICTURE 27

Locality: Alto del Peñón (Sierra de Cabrera). León.
Altitude: 1,840 m m
Date: 20-VII-1999
Biogeography: Orensano-Sanabriense sector, Carpetan-Leonesian subprovince
Bioclimatic belt: Oromediterranean

1. Cervunales (*Poo legionensis-Nardetum*)
2. Dwarf juniper shrubland of *Genisto sanabriensis-Juniperetum nanae* with *Erica aragonensis* due to fire.
3. Big quartzitic block community (*Cryptogrammo-Dryopteridetum abbreviatae*).
4. Rupicolous communities of *Spergula rimarum*.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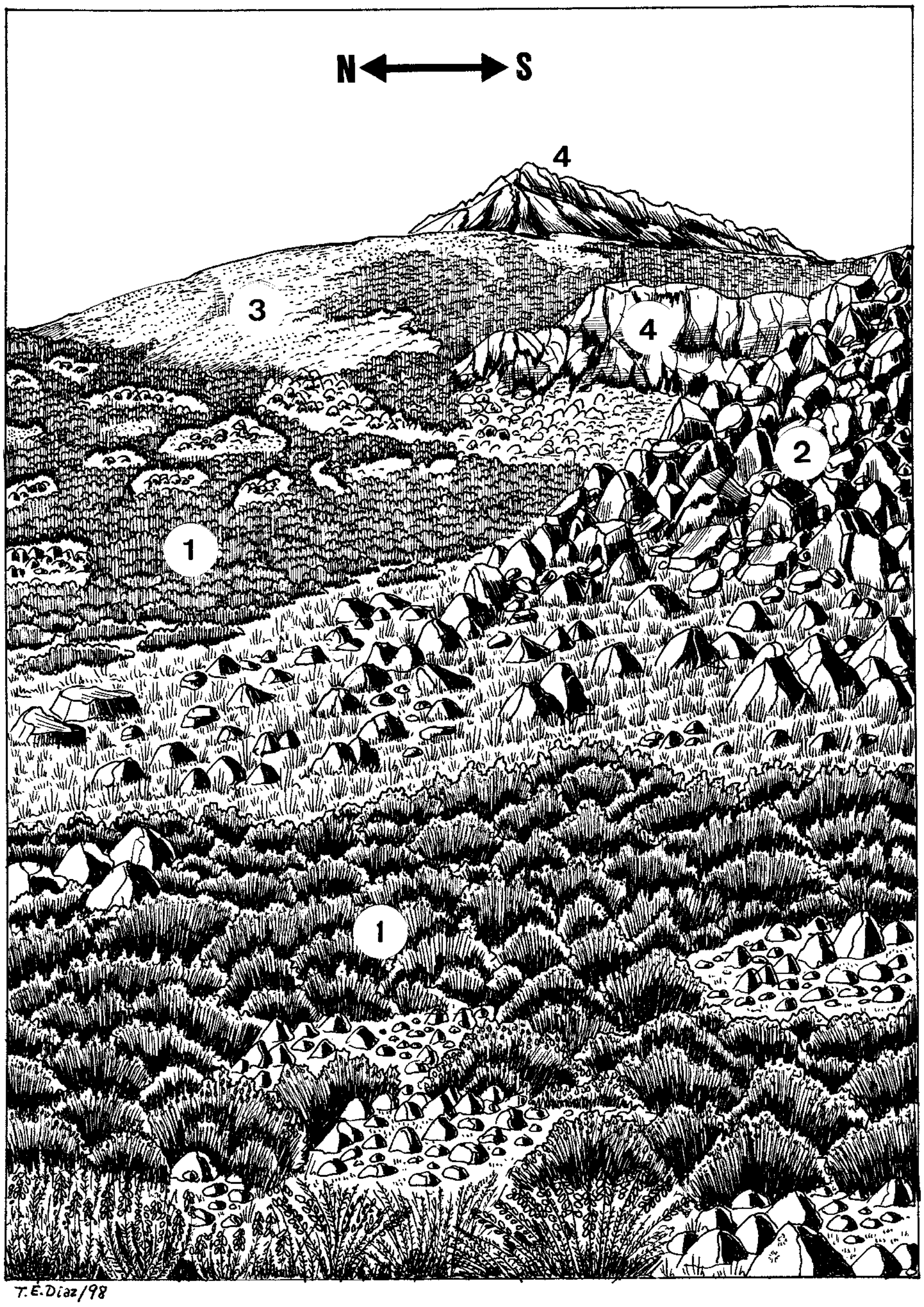
T.E. Díaz/98

PICTURE 28

Locality: Alto del Peñón (Sierra de Cabrera). León.
Altitude: 1,940 m m
Date: 20-VII-1999
Biogeography: Orensano-Sanabriense sector, Carpetan-Leonesian subprovince
Bioclimatic belt: Oromediterranean

1. Dwarf juniper shrubland *Genisto sanabriensis-Juniperetum nanae* with *Erica aragonensis* due to fire.
2. Big quartzitic block community(*Cryptogrammo-Dryopteridetum abbreviatae*).
3. Dwarf juniper shrubland *Genisto sanabriensis-Juniperetum nanae,* alternating with psychroxerophilous grasslands of *Teesdaliopsio-Festucetum sumilusitanicae*.
4. Rupicolous communities of *Spergula rimarum*.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Some examples of those birch forests can be seen on the way down towards Truchillas. The descending sequence of the vegetation series is: 1-the humid-hyperhumid vegetation series of the melojares (*Holco mollis-Querceto pyrenaicae* sigmetum), 2-the subhumid-humid vegetation series of the melojares (*Genisto falcatae-Querceto pyrenaicae* sigmetum) and 3-the vegetation series of the encinares (*Genisto hystricis-Querceto rotundifoliae* sigmetum). The riparian geoseries riparia is again formed by the series of the elm (*Aro maculati-Ulmeto minoris* sigmetum), poplar-arboreal willow (*Populo nigrae-Saliceto neotrichae* sigmetum), shrubby willows (*Saliceto lambertiano-salvifoliae* sigmetum) and alder (*Galio broteriani-Alneto glutinosae* sigmetum). This pattern is repeated in the landscape till Villafranca del Bierzo.

(The vegetation of stretch Villafranca del Bierzo-Pedrafita do Cebreiro-Liñares)

JESÚS IZCO SEVILLANO & JAVIER AMIGO VÁZQUEZ

GEOMORPHOLOGY AND GEOLOGY

In Villafranca del Bierzo, we leave the open landsapes of the Bierzo Depression, and begin the climb to the pass at Pedrafita do Cebreiro. Immediately after Villafranca the road crosses the River Burbia, then goes through a short tunnel, then crosses the River Valcarce. The watershed up to the pass drains into this river, which drains into the Burbia; the Burbia then drains into the Sil, which in turn drains into the Miño, which flows into the Atlantic at the border between Spain and Portugal. Between Villafranca (at 504 m) and the top of the pass (1099 m), the road climbs 595 m, with a mean gradient of 5.3% from Vega de Valcarce up.

Our route from Villafranca - following the Way of Saint James, the traditional pilgrim's route to Santiago - is representative of the topography of this region: the landscape is rugged, cut by deep lateral valleys, with steep slopes but peaks rounded as a result of their great age. In similar areas nearby, more than 60% of map area has class-6 slope (> 55%) (Izco, 1997).

The Pedrafita Pass marks the division between two watersheds. The River Navia has its source nearby: it runs initially towards the northwest, and eventually reaches the Cantabrian Sea close to the village of Navia (Asturias).

The town of Pedrafita do Cebreiro, just past the pass, still retains some traditional dwellings with roofs thatched with rye straw or broom (*Cytisus scoparius*). Here, our route leaves the main road (the N-VI) and continues via a local road (the C-535), westwards to the village of Liñares. A bit further is the San Roque pass (1,275 m), the highest point of this stretch of the excursion, at the boundary between the watersheds of the Navia and the Lor (a tributary of the Sil). Looking north and west from this pass, we can see a high plateau at ca. 1,350 m, which is result of old erosion levels.

GEOLOGY

The Bierzo Depression is covered by very deep tertiary sediments, readily identifiable in view of their red colour; in the lower and less abrupt part of this depression, Tertiary sediments are covered by Quaternary materials. Apart from these sediments, the northwestern part of the Iberian Peninsula (including the westernmost extreme of the Cantabrian Mountains, the *Cordillera Cantábrica*) is composed of Palaeozoic materials (Cambrian, Ordovician, in some cases Precambrian) that underwent violent folding during the Hercynian orogeny. All these materials are ordered in bands oriented SSE-NNW, forming part of the great Narcea Antiform (*Anticlinorio del Narcea*) which in turn forms part of the Asturian Arch (*Arco Asturiano*) (Anon., 1971).

The dominant materials are Cambrian and Ordovician slates, which break up easily. Intercalated with these slates are thin bands of calcareous materials (limestones and Vegadeo dolomites). Also present, though less frequent, are dykes of quartzite, which form prominent outcrops in valleys in which erosion has removed the softer materials (Anon., 1980). The limestones and dolomites are quarried for construction material, at some locations on an industrial scale. The traditional houses of the village of Liñares have limestone walls and slate roofs.

BIOCLIMATOLOGY

Between Villafranca and Liñares the climate changes drastically. The higher precipitation and lower temperatures, due to the higher altitude, are clearly apparent. Villafranca (504 m a.s.l.) has an annual mean temperature of 12.3°C and mean annual precipitation of 901 mm, while Pedrafita (1099 m a.s.l.) has an annual mean temperature of 8.0°C and mean annual precipitation of 1897 mm. The differences are even more marked if we consider the bioclimatic regimes prevailing in the two locations: Villafranca is Mediterranean, while Pedrafita is Temperate. This can be considered one of the most marked bioclimatic transition in a short space of Europe, in that Mediterranean and Temperate are the only two macrobioclimates (*sensu* Rivas-Martínez) present in the continent. The vegetation changes associated with this transition are evident during the ascent to Pedrafita.

The Bierzo Depression has a Mediterranean bioclimate with seasonal rainfall regime, and Villafranca is situated in the Upper Subhumid rainfall belt (*ombropiso*) of the Upper Mesomediterranean temperature belt (*termopiso*). Potential vegetation is evergreen *Quercus rotundifolia* woodland (*Genisto hystricis-Quercetum rotundifoliae*). At higher altitudes, the increasing rainfall leads to replacement of the evergreen *Q. rotundifolia* with the deciduous *Q. pyrenaica*, in accordance with the pattern observed throughout the northwest Iberian Peninsula (Izco et al., 1991). Note that this switch from evergreen to deciduous occurs at a lower altitude than the Mediterranean-Temperate transition. Furthermore, the severe deforestation and replacement of mature woodland with species-poor successional scrubland communities means that physiognomic interpretation of the landscape is difficult.

There are no intermediate weather stations in the Mediterranean section of the territory. However, indirect models allow us to trace the gradual transition from Mesomediterranean to Supramediterranean, and from Upper Subhumid to Hyperhumid. The lower part of the zone in which the potential vegetation is *Quercus pyrenaica* woodland (*Genisto falcate-Quercetum pyrenaicae*) is characterized by the presence of small villages, associated with intensive cultivation of chestnut and with highly productive small river terraces and gently sloping hillsides. At altitudes above 750 m, the villages are very different: river terraces are not present at these altitudes, and the villages are located on flat areas on hillsides suitable for vegetable cultivation. Their inhabitants have traditionally dedicated most of their labour to extensive livestock farming, which is currently in clear decline. From this altitude upwards, the potential vegetation is another *Quercus pyrenaica* woodland (*Holco mollis-Quercetum pyrenaica*).

As is normal, the Mediterranean-Temperate transition does not take place at the watershed transition, but in fact somewhat earlier, on the Mediterranean side of the pass, influenced by topographic factors, at about 900 m. From this level to the Pedrafita Pass, and from here to Liñares and the San Roque Pass, our route passes through the Upper Supratemperate belt, with Upper Hyperhumid to Ultrahyperhumid rainfall regime. This territory, though it forms part of one of the best-conserved natural areas in Galicia, is severely deforested and shows marked human influence. The gently sloping mountains of the Montes do Rañadoiro are without woodland on their peaks and on their southern slopes, though relict stands remain on the northern slopes, interspersed with patches of meadow and scrub that reflect the characteristic land-use patterns in this area. There are also small areas of *Pinus sylvestris* plantation, comprising rather small individuals, the product of attempts at reforestation in the 1960s.

The potential vegetation of these Supratemperate territories of O Cebreiro comprises both *Quercus pyrenaica* woodlands (*melojares*) of the association *Linario triornithophorae-Quercetum pyrenaicae* and *Quercus petraea* woodlands of the association *Linario triornithophorae-Quercetum petraeae*. In the altitudinal range between 900-1400 m beech forests (*Omphalodo nitidae-Fagetum sylvaticae)* occur as discontinuous patches in topographically favourable conditions, such as North-facing slopes.

CHOROLOGY AND MIGRATION ROUTES

The Bierzo Depression forms part of the Orensano-Sanabriense Sector of the Carpetano-Ibérico-Leonesa Subprovince of the Mediterráneo-Ibero-Atlántica Province. The temperate territories form part of the Laciano-Ancariense Sector of the Orocantábrica Subprovince of the Atlántica Province.

The district (*municipio*) of Cebreiro, the only Galician district visited during this excursion, covers the area comprising the lower-altitude peaks of the Sierras Orientales (Eastern Mountains) of Lugo Province. These mountains, which constitute the boundary between Galicia and León, constitute a prolongation of the Cantabrian Mountains at their southwest extreme, and thus biogeographically form part of the Orocantábrica Subprovince. From north to south, the Sierras Orientales comprise the Sierra de Ancares (highest peak Pico Cuiña, 1998 m), the Montes do Rañadoiro (Carballal, 1474 m) and the Sierra do Courel (Formigueiros, 1654 m).

The beechwoods of the Sierras Orientales have been considered the westernmost populations of this species. These woodlands are located in the Supratemperate belt at altitudes between 900 and 1400 m (optimum 1100 - 1250 m). By contrast with the extensive areas of beechwood located in eastern Spain, the end-of-range beechwoods of northwest Spain currently occur as small patches with a highly fragmented distribution, clearly reflecting environmental conditions and human activity; the recent history of the latter has been clearly illustrated by a study based on the analysis of various legal documents (wills, litigations, land transactions, etc.) (Guitián, 1996). In recent years, beeches have been found within Mesotemperate woodlands of the association *Blechno spicantis-Quercetum roboris*, at altitudes of 400 - 500 m upwards (Rodríguez-Guitián et al., 1996a).

It has traditionally been speculated that beech reached the westernmost extreme of the Iberian Peninsula from Pyrenean nuclei, leaving the Pyrenees about 4000 years ago and travelling along the Pyrenean-Cantabrian chain to reach Galicia about 1000 - 1500 years ago, the period of maximum expansion of this species. This latter date is accepted by Janssen (1996). However, previously published pollen datings of beech in the Cantabrian Mountains imply a migration rate of 190 - 320 m/year (Rodríguez-Guitián et al., 1996b), which is too slow to explain departure from the Pyrenees 4000 years BP and arrival in Galicia 1000 - 1500 years BP. On the basis of new analyses of pollen from 19 sites in the Cantabrian Range, these authors argue that beech was present in the northwest Iberian Peninsula at much earlier dates than those reported previously, and indeed earlier than the theoretical date for arrival in the western French Pyrenees. Specifically, they report data indicating the presence of beech in the northwest about 4000 years BP in Prado (Maldonado, 1994) and about 7500 years BP in Lagoa do Marinho (Ramil-Rego, 1993). All this leads the authors to suggest that "almost certainly, at least part of the Iberian populations of this species are autochthonous in origin, regardless of whether it is confirmed that Central European stocks arrived during the Holocene by way of the Pyrenees. Likewise, it seems likely that areas of refuge existed in various parts of the Iberian Peninsula, (...) providing bases for the recolonization of large parts of the territory previously occupied".

VEGETATION

1- From Villafranca to Pedrafita

During this ascent, we cross territories corresponding to four vegetation series, which in order of appearance are:

Genisto hystricis-Querco rotundifoliae Sigmetum: a Mesomediterranean Orensano-Sanabriense holm oak woodland series whose disturbed stages include the *Arbutus* *unedo* scrub (*madroñales* of *Erico scopariae-Arbutetum unedonis*, the *Genista* spine cushion scrub (*Genisto hystricis-Cytisetum multiflori)*, and even the *Cistus* scrub (*jarales* of *Cisto ladaniferi-Genistetum hystricis)*. In practice, these communities are present in a highly degraded state near the Villafranca, the most visible characteristic of the vegetation being *Cytisus multiflorus* formations interspersed with patches of *Cistus ladanifer* scrub, which prefers drier locations, since its optimum is in the Dry and Subhumid rainfall belts. Individuals of *Quercus rotundifolia* or *Erica scoparia* survive on spurs.

At about 600 m and in north-facing valley bottoms, we find the serial complexes *Genisto falcatae-Querco pyrenaicae Sigmetum* and *Holco mollis-Querco pyrenaicae* sigmetum. As we pass into the Supramediterranean, *Erica scoparia* and *Quercus rotundifolia* are generally no longer seen, though isolated individuals are occasionally present at lower levels on south-facing slopes or spurs. Instead of these species, we see small stands of *Quercus pyrenaica*, and chestnut stands (*soutos*, small monospecific stands of *Castanea sativa* managed for chestnuts as food and fodder); however, most of the landscape bears substitution scrubs dominated by *Cytisus multiflorus* or *C. striatus* (*piornos* in spanish and *xestas* in galician). The potential vegetation over the entire altitudinal range of the Supramediterranean belt is *Quercus pyrenaica* woodland, but only a small part of this belt, at about 600 - 700 m, bears vegetation of the *Genisto falcatae-Querco pyrenaicae Sigmetum* (possible indicators of this series being *Genista hystrix* and *Cistus ladanifer*), and even then the distribution is discontinuous. The rest of this belt is territory of Carpetano-Occidental and Orensano-Sanabriense woodland belonging to the association *Holco mollis-Quercetum pyrenaicae*, of which little remains, most having been felled or burnt and replaced by *Cytisus multiflorus* scrubs (*Lavandulo sampaioanae-Cytisetum multiflori*), *Cytisus striatus* scrubs (*Cytiso striati-Genistetum polygaliphyllae*) or heathlands (*Genistello tridentatae-Ericetum aragonensis)*.

At altitudes of 900 m upwards, coinciding with the change in macrobioclimate, we enter the territory of the *Linario triornithophorae-Querco pyrenaicae Sigmetum*, a serial complex that is clearly different from the others in view of its markedly Orocantabrian (Eurosiberian) character. As in the previous cases, little remains of the mature woodland type as we ascend to Pedrafita, though the series is apparent from the presence of *Cytiso scopariae-Genistetum polygalyphyllae* scrubs (of which a particular subassociation, *cytisetosum multiflori*, is present in this region) interspersed with heathlands with *Daboecia cantabrica* (*Daboecio-Ericetum aragionensis)*; presence of *Ulex galli* into this last association shows the oceanic character of local weather. In addition, on banks and steep slopes colonized by trees, birches (*Betula pubescens* subsp. *celtiberica*) and sycamores (*Acer pseudoplatanus*) are frequent, and indicative of new pre-forest communities that can be seen in the Supratemperate but not the Supramediterranean belt.

2- Montes do Rañadoiro

This group of mountains is located between the Sierra de Ancares and the Sierra de O Courel, both of which contain higher peaks.

The *Quercus pyrenaica* woodlands occur preferentially on south-facing slopes, though even with this orientation they rarely occur at altitudes of more than 1250 m. Their potential area is largely covered by broom scrubs of the *Cytiso scoparii-Genistetum polygaliphyllae cytisetosum multiflori*, a subassociation that reflects a degree of summer drought within the Hyperhumid rainfall regime generalized in this territory. Oak woodlands dominated by *Quercus* x *rosacea* and with *Q. pyrenaica* occasionally present (*Linario-Quercetum petreae*) are predominant on sites not facing south, and even on south-facing sites at altitudes in excess of (1250) 1300 m. Mature woodlands of *Linario-Quercetum petreae* are likewise replaced by broom scrubs similar to those already mentioned, but rather more moisture-loving, and probably assignable to *Cytiso scoparii-Genistetum polygaliphyllae ulicetosum gallii*. Occasionally, we find a distinct version of these oakwoods, artificially maintained in a pre-mature state dominated by *Betula celtiberica*. These formations are known locally as *biduedos* (from *bíduo*, birch in Galician), although syntaxonomically they can be interpreted as a variant of the typical climax community (*Linario-Quercetum petraeae* var. of *Betula celtiberica*).

The third vegetation series detectable in these mountains is clearly at an extreme of its distribution, representing the westernmost spontaneous formations of *Fagus sylvatica* in Europe. It is found only in patches on north-facing steep slopes, often in areas of hard limestone outcrops. The relict nature of this forest is apparent from the fact that felling of the mature woodland gives rise to non-beech woodland (oakwood or birchwood) subsequently develops. The head of the series, *Omphalodo nitidae-Fagetum sylvaticae*, has a recovery (pre-forest) stage dominated by *Corylus avellana*, which in numerous parts of the Sierras Orientales (Ancares, Rañadoiro, Courel) constitutes the only surviving evidence of the presence of beechwoods in the recent past.

In the Sierra de Ancares and the Sierra de O Courel, both beechwoods and *Quercus petraea* oakwoods may come into contact with mixed sycamore woodlands of the association *Luzulo henriquesii-Aceretum pseudoplatani* in moister soils, and with birchwoods of the association *Luzulo henriquesii-Betuletum celtibericae* at higher altitudes (from about 1400 m). In the Montes do Rañadoiro, however, the altitude reached is insufficient, and the areas of forest are too small, for such communities to be present.

The landscape of the Pedrafita do Cebreiro district is dominated by scrub communities. Apart from the broom scrubs already mentioned, at least two types of heath can be recognized: a taller community, dominated by *Erica australis* subsp. *aragonensis*, belonging to the association *Daboecio cantabricae-Ericetum aragonensis*, and a shorter gorse heath belonging to the association *Halimio alyssoidis-Ulicetum gallii*. The former association may form part of the *Quercus pyrenaica* series (*Linario-Querco pyrenaicae Sigmetum)*, or equally of the montane *Quercus petraea* series (*Linario-Querco petraeae Sigmetum)*. By contrast, the *Halimio-Ulicetum gallii* always occurs in the Ultrahyperhumid rainfall belt, where it replaces montane oakwoods or beechwoods.

Riparian vegetation is scarcely present along our route, since only very young and fast-flowing streams are present, and often any arboreal vegetation has been removed to make way for *Cynosurion cristati* meadows along the banks. On north-facing slopes, and especially close to beechwoods, fragments of the Supratemperate Laciano-Ancarense community *Festuco giganteae-Fraxinetum excelsioris* can be recognized. At altitudes below 800 m, when slopes become less steep in valley bottoms, alder communities of the association *Valeriano pyrenaicae-Alnetum glutinosae* begin to occur; these are particularly evident in the Mesotemperate belt, and even penetrate several kilometres into the Mediterranean Orensano-Sanabriense territory.

3- Liñares

The most interesting feature of this stop is the contrast between the acidophilous vegetation (characteristic of the region in general) and the vegetation associated with the outcropping of a band of limestone, which includes a patch of *Omphalodo nitidae-Fagetum sylvaticae* and calciphilous communities of the *Rhamno-Prunetea spinosae*, *Asplenietea trichomanis* and *Festuco-Brometea*.

Along the short track leading to the beechwood from the village of Liñares, on the banks beside the track itself, we can see more or less representative fragments of the calciphilous perennial pasture communities of the *Helianthemo cantabrici-Brometum erecti* (class *Festuco-Brometea erecti*). Various species of this association can be seen, forming small fragmented patches, notably *Anthyllis vulneraria* subsp. *alpestris*, *Acinos alpinus* subsp. *pyrinaeus*, *Brachypodium pinnatum* subsp. *rupestre*, *Briza media*, *Dianthus hyssopifolius* and *Helianthemum croceum* subsp. *cantabricum*, in addition to various orchids. In the Sierras Orientales, this communities is at an extreme of its distribution, like the beechwoods, since it represents the extinction of the communities of the alliance *Bromion erecti* (and thus of the whole class) towards the south-west of the Atlantic Province.

The structure of the outcropping limestone band and local topography gives rise to small ledges with lithosoils that favour the presence of psychroxerophilous calciphilous communities assignable to the alliance *Festucion burnatii* (class *Festuco-Ononidetea striatae*). The association *Koelerio vallesianae-Erodietum glandulosi* was described from this territory, though only a few members of this community reach Liñares, and the association cannot be considered well-formed here. On the banks alongside the track we can see *Koeleria vallesiana*, *Arenaria grandiflora* subsp. *incrassata* and *Hippocrepis conmutata*.

Where the track-side banks are steeper and stonier, we find calciphilous rupicolous communities of the association *Saxifragetum trifurcatae* (*Saxifragion trifurcato-canaliculatae*, class *Asplenietea trichomanis*), rich in endemics and well-represented in the nearby Sierra de O Courel; in Liñares, however, suitable fissured walls are lacking, and only a few of these species are present, namely *Hutchinsia alpina* subsp. *auerswaldii*, *Crepis albida* subsp. *asturica* and *Leontodon farinosus*.

The Liñares beechwood is a reasonably representative example of *Omphalodo nitidae-Fagetum sylvaticae* in the territory: it contains an acceptable number of the humus-loving geophytes characteristic of the Orocantabrian beechwoods, such as *Galium odoratum*, *Mercurialis perennis*, *Lilium martagon*, *Milium effusum*, *Paris quadrifolia* and *Sanicula europaea*, though other acidophilous species are also frequently present, particularly species whose optimum is in northwest Iberia, such as *Omphalodes nitida*, *Saxifraga spathularis* and *Luzula henriquesi*.

Along the fringes of the beechwood, we see some woody and herbaceous communities that are typical of such locations. One such community, characteristic of clay soils developed from limestone, is a mesotrophic thorny woody community. The most conspicuous phanerophytes of this formation are *Rosa villosa*, *Rosa canina*, *Crataegus monogyna* and *Ilex aquifolium*, and it is probably best considered an extreme form of *Berberidion vulgaris* (class *Rhamno-Prunetea*).

On calcareous banks at the upper limit of the beechwood, we find a characteristic herbaceous community that contains species of the woodland-fringe community *Trifolio-Geranietea* alongside others characteristic of *Festuco-Brometea* or even *Querco-Fagetea*. This community is typically dominated by the conspicuous species *Iris latifolia*, accompanied by *Lilium martagon*, *Fragaria vesca*, *Vicia sepium*, *Ranunculus tuberosus* and *Mercurialis perennis*. These species develop on soils of some depth and with marked depletion of carbonates in the surface layers, as indicated by the extensive areas often occupied by *Pteridium aquilinum*, which gives the community a rather misleading appearance. We have given this association the provisional name of *Galio rivularis-Iridetum latifoliae*.

Finally, when the beechwood occurs on an acid substrate (schists, phyllites), different substitution communities occur. The shrub fringe is replaced by a community of *Cytisus scoparius* and *Erica arborea*, while the herbaceous fringe loses its eutrophic species (for example, *Fragaria vesca*), and gains species such as *Saxifraga spathularis*, *Melampyrum pratense* and *Digitalis purpurea*, forming a community assignable to *Linarion triornithophorae* (class *Trifolio-Geranietea sanguinei*).

Above the beechwood, we climb gradually to the coll at San Roque, the boundary between the two watersheds. Here the substrate is siliceous, and the scrub that covers these peaks is patently acidophilous: we see patches of the broom scrub *Cytiso scoparii-Genistetum polygaliphyllae*, but the predominant scrub community is a dense gorse heath, dominated by *Ulex galli* and various low Ericaceae; this community can be assigned to the Supratemperate Ultrahyperhumid association *Halymio alyssoidis-Ulicetum gallii* (*Daboecion cantabricae*, class *Calluno-Ulicetea*). Also present in these mountains, in drier locations (i.e. at lower altitudes or on south-facing slopes), are heaths of the association *Daboecio-Ericetum aragonensis* (likewise a member of *Daboecion cantabricae*), which includes *Erica australis* subsp. *aragonensis* and *Genistella tridentata* and lacks *Ulex galli*.

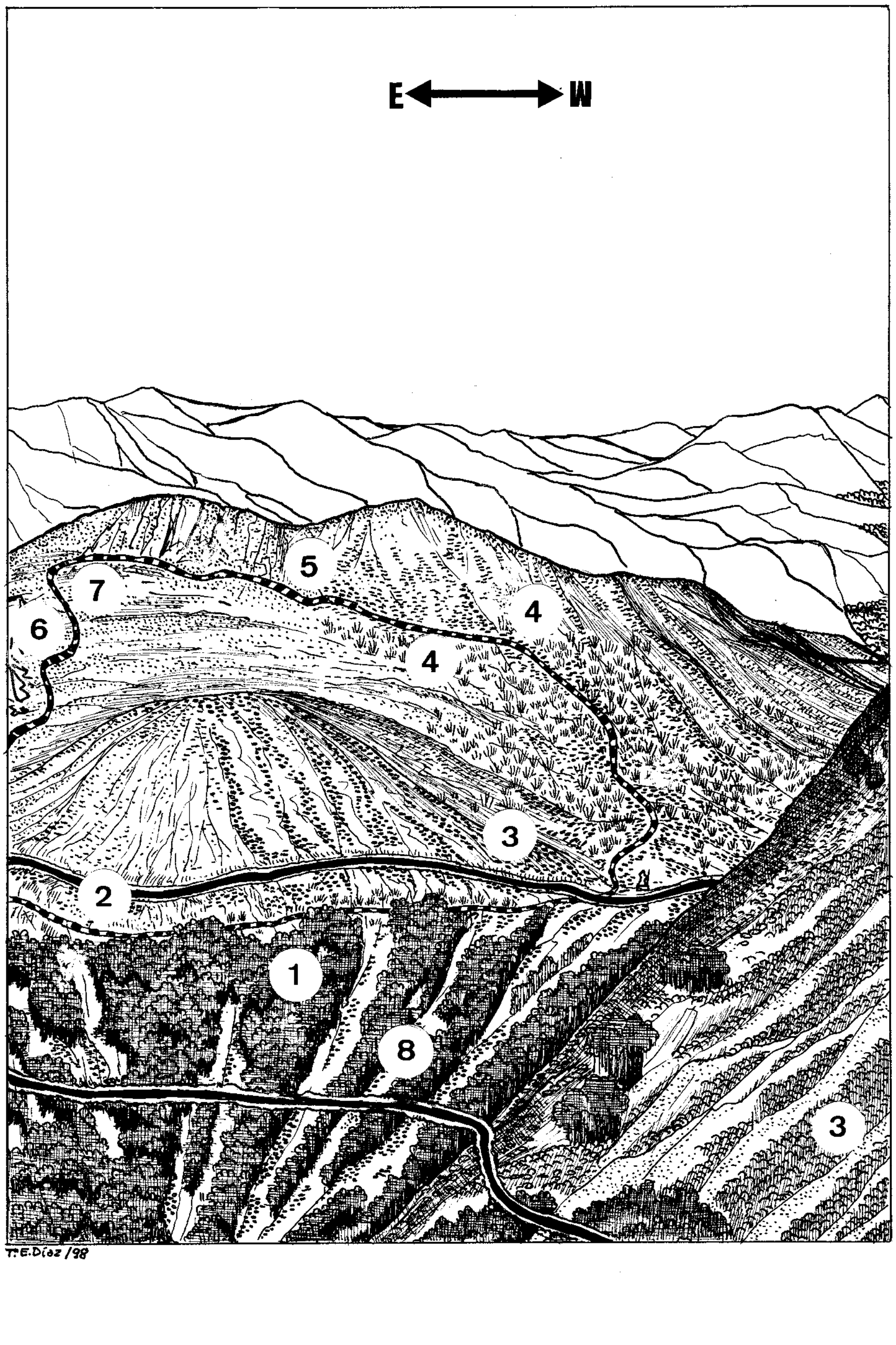
At the end of our walk we cross a calcareous dyke, quarried for stone, in which we again see the basophilous substitution and permanent communities observed by the beechwood.

Of the remaining vegetation types present around Liñares, only meadows make an important contribution to the landscape. The most frequent such communities are meadows subjected to a mixed mowing and grazing regime. Soil nutrient levels and pH are both rather low, except where the meadow is located below a limestone hillside. In valley bottoms in the Sierra do Courel, meadows assignable to *Arrhenatherion elatioris* have been described; however, the more usual meadow communities in these mountains are of the alliance *Cynosurion cristati*, within which the association that best defines floristic composition is *Merendero pyrenaicae-Cynosuretum cristatae*. Also sometimes present in this territory are Supratemperate grazed mat-grass (*Nardus stricta*) pastures of the alliance *Violion caninae*, falling within the association *Serratulo seoanei-Nardetum strictae*; according to the degree of variability in grazing regime, transitions between this association and *Merendero-Cynosuretum cristati* may be observed.

PICTURE 29

Locality: Linares (Cebreiro). Lugo, Galicia.
Altitude: 1,300 m
Date: 20-VII-1999
Biogeography: Subsector Ancarense subsector (Laciano-Ancarense sector, Orocantabrian subprovince)
Bioclimatic belt: Supratemperate (montane), hyperhumid.
Lithology: Mixtured, calcareous and siliceous.

1. Ancarense beech forests (*Omphalodo nitidae-Fagetum sylvaticae*).
2. Spiny mantle of beech forest alternating with grasslands (*Bromion*) and rupicolous communities.
3. Heathlands with gorses (brezal-tojal) (*Halimio-Ulicetum gallii*)
4. Piornal (*Cytiso scoparii-Genistetum polygaliphyllae)*
5. Abandoned crop-fields.
6. Limestone quarry.
7. Basophilous grasslands of *Helianthemo cantabrici-Brometum erecti* (*Bromion*) and megaphorbic community of *Iris latifolia*.
8. Megaphorbic higrophilous community of *Chaerophyllo hirsuti-Valerianetum pyrenaicae.*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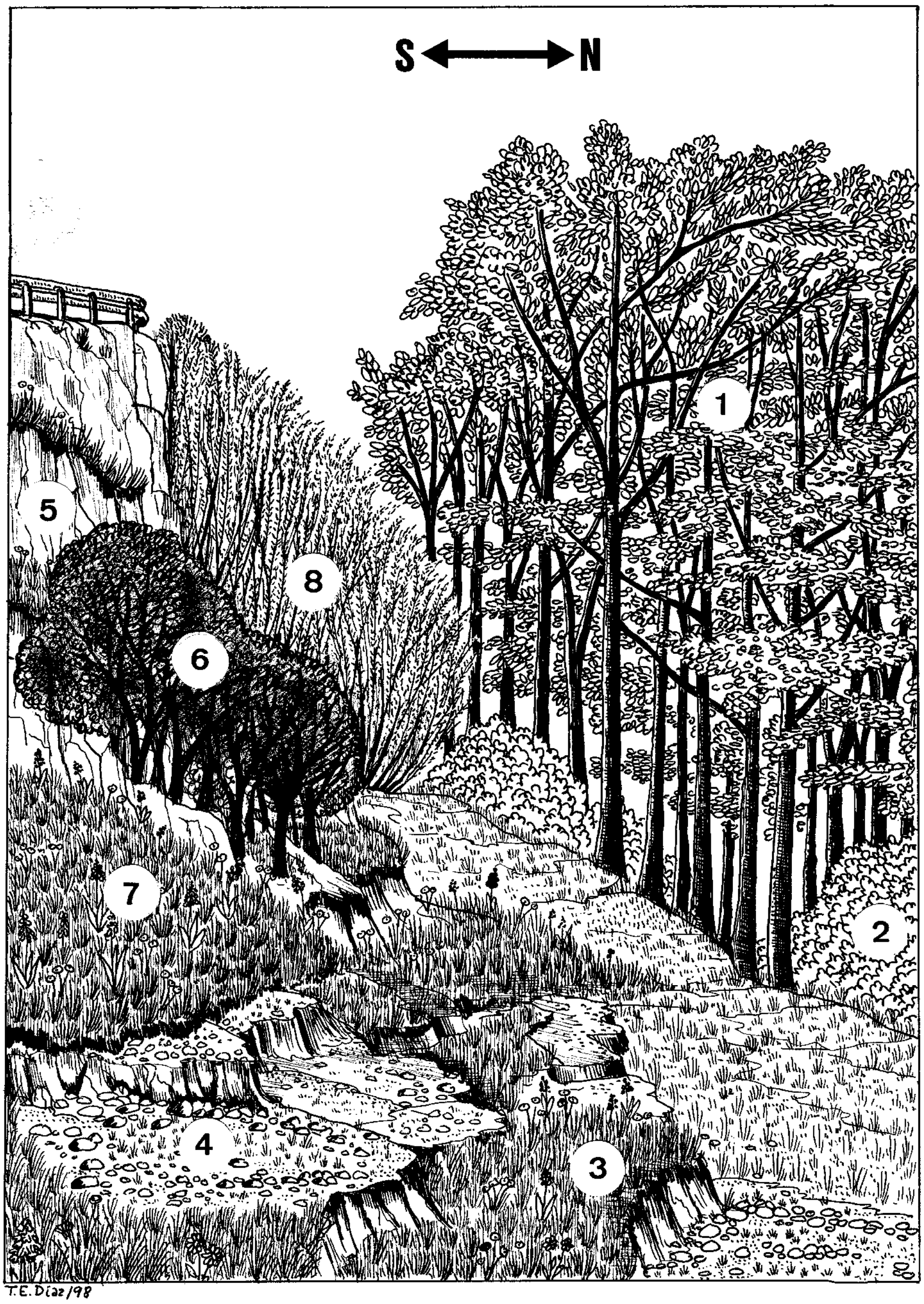
T. E. Díaz /98

PICTURE 30

Locality: Linares (Cebreiro). Lugo, Galicia.
Altitude: 1,250 m
Date: 20-VII-1999
Biogeography: Subsector Ancarense subsector (Laciano-Ancarense sector, Orocantabrian subprovince)
Bioclimatic belt: Supratemperate (montane), hyperhumid.
Lithology: Mixtured, calcareous and siliceous.

1. Beech forest (*Omphalodo nitidae-Fagetum sylvaticae*).
2. Spiny mantle of the beech forest.
3. Basophilous grasslands of the *Helianthemo cantabrici-Brometum erecti* (*Bromion*).
4. Grasslands of *Festuco-Poetalia*
5. Rupicolous communities of limestone rocks with *Crepis asturica*.
6. *Corylus avellana* community.
7. Megaphorbic community of *Iris latifolia*.
8. Piornales on suliceous substrata (*Cytiso scoparii-Genistetum polygaliphyllae).*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LAND USE

The entire Sierras Orientales area is classified as a "high-mountain agriculture" zone. One of the most notable features of such areas has been the marked population decline over the last half-century, which has of course had profound effects on land use and consequently on landscape.

The traditional rural settlement pattern in this region is based on small groups of houses, with labour mostly devoted to livestock rearing and relatively little cultivation of crops, these being destined mainly for own consumption. The land-use activities can be viewed as forming a series of concentric bands, at increasing distances from the nucleus constituted by the village itself:

1) The first band, adjacent to the houses themselves, contains small (often very small), vegetable plots, or *leiras*, for cultivation of cabbages and potatoes, and broad beans and onions if the climate permits (i.e. at lower altitudes in the Lower Supratemperate belt).

2) The second band, still very close to the village, contains the chestnut grove (*souto*), with a highly degraded understorey as a result of frequent transit. The chestnut has traditionally constituted a important part of the diet, but nowadays *soutos* are often abandoned as a result of both changing dietary habits and the ageing of the population.

3) The third band, which may extend a considerable distance from the village, contains the meadows and pastures. These typically extend in ribbon-like fashion along the banks of rivers and streams, facilitating irrigation with the water that feeds into the watercourse. This band can also be considered as that containing the *searas*, plots for the cultivation of cereal (generally rye); unlike the meadows, these are generally located on dry and preferably sunny slopes.

4) The fourth band contains the *devesa*, the area of woodland used as a source of timber and firewood, and to some extent for hunting. Depending on its size, rights to the *devesa* might be shared by several villages in a parish (i.e. the administrative unit between village and *municipio*). Within this fourth band we should also include treeless moor, mostly gorse heath, generally held communally and periodically burnt to improve grazing for sheep or goats.

Around settlements in the Upper Supratemperate belt, this pattern is somewhat modified: there is no *souto*, and the village is typically closer to its *devesa* (as in the case of Liñares).

Historically and currently, there has been little industrial activity in this area. However, iron smelting (*ferrerías*, in galician) was an important activity in the whole region between the 17th and 19th centuries, and the consequent demand for wood as fuel led to very considerable deafforestation; indeed, over-exploitation of forest for fuel was perhaps the chief reason for the decline of this industry.

Mining has also been historically important in this region, dating back to the gold-mining activity of the Romans. Quarrying for marble and limestone has left its mark on a number of outcrops, but in recent decades slate quarries, including several large operations, have had much more devastating effects on landscape.

VILLAFRANCA DEL BIERZO-LEÓN (21 July)

(Geobotanical excursion between Villfranca del Bierzo and León)

ÁNGEL PENAS MERINO & EMILIO PUENTE GARCÍA

INTRODUCTION

This journey goes through territories belonging to the phytogeographic Laciano-Narceense subsector (Laciano-Ancarense sector, Orocantabrian subprovince, Atlantic European province, Eurosiberian region); in the Ubiñense subsector (Ubiñense-Picoeuropean sector, Orocantabrian subprovince, Atlantic European province, Eurosiberian region); the Orensano-Sanabriense sector and the Leonés sector (Carpetan-Leonesian subprovince, Iberoatlantic province, Mediterranean region).

The Ubiñense subsector, located in the central zone of the Cantabrian Range, is geologicaly characterized by a prevalence of Devonic and Carboniferous limestones with clear alternances of slates, sandstones, and siliceous conglomerates.

From the bioclimatic point of view it includes, in the province of León, territories of temperate oceanic and temperate oceanic, submediterranean bioclimate with supratemperate (montane), suprasubmediterranean, orotemperate (subalpine) and orosubmediterranean thermotypes, and humid and hyperhumid ombrotypes. It is worth noting the submediterranean climatic character which is present in many territories of this subsector, mainly in those near the Mediterranean area, or in places strongly influenced by it (there is a somewhat summer aridity, although never reaching two months).

Floristically, *Armeria bigerrensis* subsp. *legionensis, Centaurea janeri* subsp. *babiana, Centaurium somedanum, Fritillaria legionensis* and *Saxifraga babiana* can be considered endemic taxa of the Ubiñense subsector.

Vegetation during the journey

In Ponferrada we take the road towards Villablino. The road goes along the course of the Sil river and thus along this stretch the various communities associated to the riverine vegetation series, above commented, can be appreciated. Outside the riparian environment only some seral stages of the “carrascales” (*Genisto hystricis-Querco rotundifoliae* sigmetum) and “melojares” (*Genisto falcatae-Querco pyrenaicae* sigmetum) vegetation series can be observed. At Susañe del Sil the last example of *Genisto histricis-Querco rotundifoliae* sigmetum can be seen on a south-facing slope on lithsols, completely surrounded by communities of the *Holco mollis-Querco pyrenaicae* sigmetum.

After passing the Ondinas dam, the valley narrows markedly and heathlands of the associations Daboecio cantabricae-Ericetum aragonensis and *Genistello tridentatae-Ericetum aragonensis* appear. This indicates that we are entering the Orocantabrian vegetation series of the “melojares” (*Linario triornithophorae-Querco pyrenaicae* sigmetum) and crossing again the Mediterranean-Eurosiberian border.

The entrance into the Eurosiberian region is also marked by the plants and communities living in the bottom of the valley, *Fraxinus angustifolia* is replaced *by F. excelsior* indicating the entrance into the Laciano-Ancarense vegetation series of the ash (*Festuco giganteae-Fraxino excelsioris* sigmetum). The willow shrublands of *Salix cantabrica* and its hybrids with the other common species of the genus *Salix*, correspond to the association *Salicetum cantabricae* and replace those of the *Salicetum lambertiano-salvifoliae*. The plant communities embraced in the vegetation series of *Quercus pyrenaica*, *Fraxinus excelsior* and *Salix cantabrica* will dominate the landscape till Villablino; on moist well drained soils of some colluvial piedmonts small populations of maples belonging to the *Luzulo henriquesii-Aceretum pseudoplatani* association can be seen.

From Villablino and until we pass Villaseca de Laciana, we go through territories whose geoseries is the typical Laciano-Narceense one, that, in the province (administrative) of León is composed of the subalpine dwarf juniper, of the Orocantabrian birch forests, of the Orocantabrian oak forests, of the Orocantabrian and Galaico-Asturiana melojares, of the Laciano-Ancarense ash forests and of the Cantabrian willow shrubland vegetation series.

The subalpine acidophilous series of the dwarf juniper (*Junipero nanae-Vaccinieto microphylli* sigmetum) appears in those mountains above 1.800 m.s.n.m. (Cueto de Arbás, Cornón, Muxavén) and is represented by its mature stage, the dwarf juniper shrubland of the *Junipero nanae-Vaccinietum microphylli*, in which the blueberries *Vaccinium myrtillus* and *Vaccinium uliginosum* subsp. *microphyllum* participate, as well as the dwarf juniper *Juniperus communis* subsp. *alpine* and the common heather *Calluna vulgaris*. The psychroxerophilous grasslands of the *Teesdaliopsio confertae-Festucetum eskiae* also belong to this vegetation series, with its typical half moon shaped step structure, due to the action of the wind and the snow, where *Festuca eskia*, *Teesdaliopsis conferta*, *Luzula caespitosa*, *Dianthus langeanus*, *Deschampsia flexuosa* subsp. *iberica*, *Silene ciliata* subsp. *elegans* and *Leontodon pyrenaicus*, among others, live together.

In the orotemperate submediterranean levels in the juniper formations *Vaccinium uliginosum* subsp. *microphyllum* is lacking, but we can appreciate the *Vaccinio myrtilli-Juniperetum nanae* subassociation *jasionetosum brevisepalae* and in the grasslands *Festuca eskia* is replaced by *Festuca indigesta* subsp. *summilusitana*; this changes the association into the *Teesdaliopsio confertae-Festucetum summilusitanae*. In those territories the *Vaccinio myrtilli-Junipereto nanae* sigmetum series is recognized in its subalpine continental Orocantabrian faciation with *Jasione crispa* subsp. *brevisepala*.

Near these communities are easily seen and conspicuous the associations *Agrostio durieui-Sedetum pyrenaici* (crassifolious communities with *Sedum brevifolium*, *Sedum anglicum* subsp. *pyrenaicum*, *Sedum hirsutum* and *Agrostis durieui*), *Cryptogrammo crispae-Dryopteridetum abbreviatae* (fern communities living between almost stable great siliceous blocks, dominated by *Dryopteris oreades*, *Cryptogramma crispa* and *Valeriana mountana*) and *Cryptogrammo crispae-Silenetum gayanae* (scree-communities on small-sized siliceous stones, with dominace of the northwestern Iberian endemism *Silene foetida* subsp. *gayana*, together with *Cryptogramma crispa* and *Rumex suffruticosus*).

The series of the Orocantabrian birch forests, *Luzulo henriquesii-Betuleto celtibericae sigmetum*, placed on the altimontane leve, achieves a great development replacing the acidofilous beech forest vegetation series; the latter has practically disappeared on the southern slope of the Cantabrian Range in the district of Laciana, due to the marked decrease in summer rains. The mature stage of the series belongs to the Orocantabrian birch forests of the association *Luzulo henriquesii-Betuletum celtibericae*, acidofilous forest constituted by *Betula celtiberica*, *Sorbus aucuparia*, *Ilex aquifolium*, *Erica arborea*, *Luzula sylvatica* subsp. *henriquesii*, *Vaccinium myrtillus*, *Poa nemoralis*, *Viola riviniana*, *Saxifraga spathularis*, *Anemone nemorosa*, *Crepis lampsanoides*, *Oxalis acetosella*, *Dryopteris affinis*, *Dryopteris dilatata*, *Dryopteris filix-mas*, *Blechnum spicant*, *Stellaria holostea* and *Melampyrum pratense*, among others. The forest mantle and first succesional stage of these birch forests belongs to the piornal of *Genistetum polygaliphyllo-obtusirameae*, with *Genista obtusiramea*, *Genista florida* subsp. *polygaliphylla*, *Cytisus scoparius*, *Erica arborea*, *Gentiana lutea* subsp. *aurantiaca* and *Orobanche rapum-genistae*. In the clearings of the piornal or close to it, and favored by human influence, the meadows of the association *Merendero pyrenaicae-Cynosuretum cristati* develop. they are characterized by the constant presence of *Merendera pyrenaica, Cynosurus cristatus, Lolium perenne, Phleum bertolonii, Plantago media* and *Trifolium repens*, together with elements of *Nardetalia* such as *Nardus stricta* or *Danthonia decumbens*. The most degraded succesional stage belongs to the heathlands of the *Daboecio cantabricae-Ericetum aragonensis* that is characterized by the presence of *Daboecia cantabrica*, *Erica australis* subsp. *aragonensis*, *Halimium alyssoides*, *Genistella tridentata*, *Vaccinium myrtillus*, *Hypericum richeri* subsp. *burseri* and *Carex asturica*. Sometimes, these heathlands are enriched with gorses (*Ulex cantabricus*), mainly when the soil retains a lot of moisture, being found the *Daboecio cantabricae-Ericetum aragonensis* subassociation *ulicetosum cantabrici*. In other cases, mainly in ridges and rams on the zones of higher altitude, near the subalpine environment, they are enriched with the dwarf juniper (*Juniperus communis* subsp. *alpina*), giving way to the *Daboecio cantabricae-Ericetum aragonensis* subassociation *juniperetosum nanae*.

Between 1,400 1,600 m.s.n.m., and in territories with strong continentality, the vegetation series of the sessile oak *Linario triornithophorae-Querceto petraeae* sigmetum is found. The mature stage of this series is a forest with *Quercus petraea*, *Quercus x rosacea* and to a lesser extent *Quercus x trabutii*, which is accompanied by other species of trees such as *Betula celtiberica*, *Corylus avellana*, *Ilex aquifolium* and *Sorbus aucuparia*; a group of herbaceous plants such as *Linaria triornithophora*, *Luzula sylvatica* subsp. *henriquesii* or *Saxifraga spathularis*, etc. also participate.

The first seral stage is a piornal, that varies among different associations depending mainly on the ombroclimate, under high moisture conditions appears the *Genistetum polygaliphyllo-obtusirameae*, when moisture decreases occurs the *Cytiso scoparii-Genistetum polygaliphyllae*, characterized by *Genista florida* subsp. *polygaliphylla*, *Cytisus scoparius*, *Erica arborea*, *Adenocarpus complicatus*, *Orobanche rapum-genistae* and *Pteridium aquilinum*.

The perennial pastures which develop in the potential area of these forests, belong to the association *Merendero-Cynosuretum cristati*, while the most regressive stages, the heathlands, are included in the *Daboecio* association *cantabricae-Ericetum aragonensis* or in the *Genistello tridentatae-Ericetum aragonensis* subassociation *hypericetosum burseri*, with a floristic combination formed by *Erica australis* subsp. *aragonensis*, *E. umbellata*, *E. cinerea*, *Genistella tridentata*, *Calluna vulgaris*, *Hypericum richeri* subsp. *burseri* and *Agrostis curtisii*.

The climatophilous series occupying the lowest altitude areas is that of the melojares or *Linario triornithophorae-Querceto pyrenaicae* sigmetum. The head of this series is a forest of marked Mediterranean-Iberoatlantic influence, dominated by *Quercus pyrenaica* with a high density and medium height; in fresh habitats other taxa of the genus *Quercus* can also appear, mainly hybrids, such as *Quercus x rosacea* or *Quercus x trabutii*. Within its floristic composition we point out some herbaceous plants such as *Linaria triornithophora*, *Omphalodes nitida* and *Physospermum cornubiense*, very characteristic of the association *Linario triornithophorae-Quercetum pyrenaicae*.

As the first substitution stage it has piornales of the association *Cytiso scoparii-Genistetum polygaliphyllae* and perennial meadows belonging to the *Merendero-Cynosuretum cristati* can also be added; the herbaceous fringes of the forest borders belong to *Omphalodo nitidae-Linarietum triornithophorae*. Those fringes are formed by species like *Linaria triornithophora*, *Omphalodes nitida*, *Teucrium scorodonia*, *Clinopodium vulgare*, *Campanula rapunculus*, *Lathyrus niger*, *Laserpitium latifolium*, *Aquilegia vulgaris*, *Silene nutans*, *Vicia sepium*, *Silene alba*, *Melittis melissophyllum*, *Astragalus glycyphyllos* and *Agrimonia eupatoria*, among others. The most regressive stage is formed by the heathlands of the *Daboecio cantabricae-Ericetum aragonensis* or the *Genistello tridentatae-Ericetum aragonensis hypericetosum burseri*.

In the bottom of the valleys, on deep and moist soils the vegetation series of the Laciano-Ancarense ash forest develops: *Festuco giganteae-Fraxineto excelsioris* sigmetum. The remains of mixed forest that have been preserved in good condition allow us to recognize the association head of this vegetation series. Sometimes the vestiges are so scarce that they need to be studied starting from the rows of the edges of water courses, road sides or boundaries between properties. In any case, it is possible to recognize the association *Festuco giganteae-Fraxinetum excelsioris*, due to the occurrence of *Fraxinus excelsior*, *Acer pseudoplatanus*, *Corylus avellana*, glabrous *Ulmus*, *Rhamnus frangula*, *Prunus avium*, *Festuca gigantea*, *Athyrium filix-femina*, *Silene dioica*, *Polystichum setiferum*, *Dryopteris filix-mas*, *D. dilatata*, *D. affinis, Oxalis acetosella*, *Campanula latifolia*, *Stellaria nemorum*, *Mercurialis perennis*, *Melica uniflora*, *Milium effusum*, etc. among others

On fresh and well drained soils, mainly on coluvia of the lower stretches of the hillsides, little fragments of the association *Luzulo henriquesii-Aceretum pseudoplatani* are found. They are mixed forest similar to the fomer but with many demanding plants in their understorey, many of them characteristic of *Quercetalia roboris*, such as *Omphalodes nitida*, *Physospermum cornubiense*, *Hypericum pulchrum*, *Linaria triornithophora*, *Holcus* *mollis*, *Vaccinium myrtillus*, *Luzula sylvatica* subsp. *henriquesii* and *Saxifraga spathularis*, among others, with the absence of the typical Carpinion taxa.

In both cases, the best way to recognize the riparian series is through the hedges or bramble formations which still survive in the properties and roads sides, and constitute the protection fringe and first substitution stage of the mixed forests formerly mentioned. Those bramble formations (zarzales) probably belong the to *Rubo ulmifolii-Tametum communis* subassociation *rosetosum villosae* and are constituted by *Rubus ulmifolius*, *Rosa corymbifera*, *R. canina*, *R. villosa*, *R. tomentosa*, *Sambucus nigra*, *Crataegus monogyna*, *Prunus spinosa*, *Clematis vitalba*, *Tamus communis* and *Lonicera periclymenum* subsp. *hispanica*, among others.

The richness and moisture of the soils where these riparian vegetation series are settled, brings the consequence that man has put his hay meadows and horticultural cultivations on them. Because of it, a great part of the land belonging to this series is occupied nowadays by hay meadows of *Malvo moschatae-Arrhenatheretum bulbosi* and *Bromo commutati-Polygonetum bistortae*, rich in grasses and legumes, many of them considered as good forage, such as *Trisetum flavescens*, *Arrhenatherum bulbosum*, *Festuca pratensis*, *Poa pratensis*, *Dactylis glomerata*, *Holcus lanatus*, *Lolium perenne*, *Cynosurus cristatus*, *Phleum pratense*, *Alopecurus pratensis*, *Briza media*, *Lathyrus pratensis*, *Trifolium pratense*, *Trifolium repens*, *Medicago lupulina*, *Vicia cracca*, *Lotus corniculatus* and *Lotus pedunculatus*. The difference between both associations is related to the hidromorphy of the soils: the former lives on drier places and bears plants such as *Arrhenatherum bulbosum*, *Carum carvi*, *Tragopogon pratensis*, *Lathyrus pratensis*, *Trisetum flavescens* and *Ornithogalum umbellatum*, and the latter association has *Polygonum bistorta*, *Sanguisorba officinalis*, *Bromus commutatus*, *Crepis paludosa*, *Geum rivale*, *Succisa pratensis*, *Pedicularis verticillata* and *Narcissus leonensis*, among others.

In the district of Laciana, on the banks of the Sil river, still a young stream whose waters have a high lime content, the vegetation series is that of the Cantabrian willow shrubland or *Salico cantabricae* sigmetum. This series occupies the edge nearest to the water channel of the rivers and streams. Its mature stage is a willow formation (*Salicetum cantabricae*) dominated by *Salix cantabrica*, *S. x legionensis*, *S. x expectata*, *S. atrocinerea*, *S. triandra* subsp. *discolor*, *S. purpurea* subsp. *lambertiana* and *S. elaeagnos* subsp. *angustifolia*, among others. The hygrophilous grasslands of the *Erucastro nasturtifolii-Calamagrostietum pseudophragmitis*, dominated mainly by the two species giving the name to the association, also belong to this series.

After ascending to the Piedrafita de Babia pass, we arrive at the Puente de las Palomas, crossing the Sil river over a great canyon with a spectacular fall of 82 m. carved in limestone rock. At this point we enter the Ubiñense subsector; we are also changing districts, leaving Laciana and entering Babia.

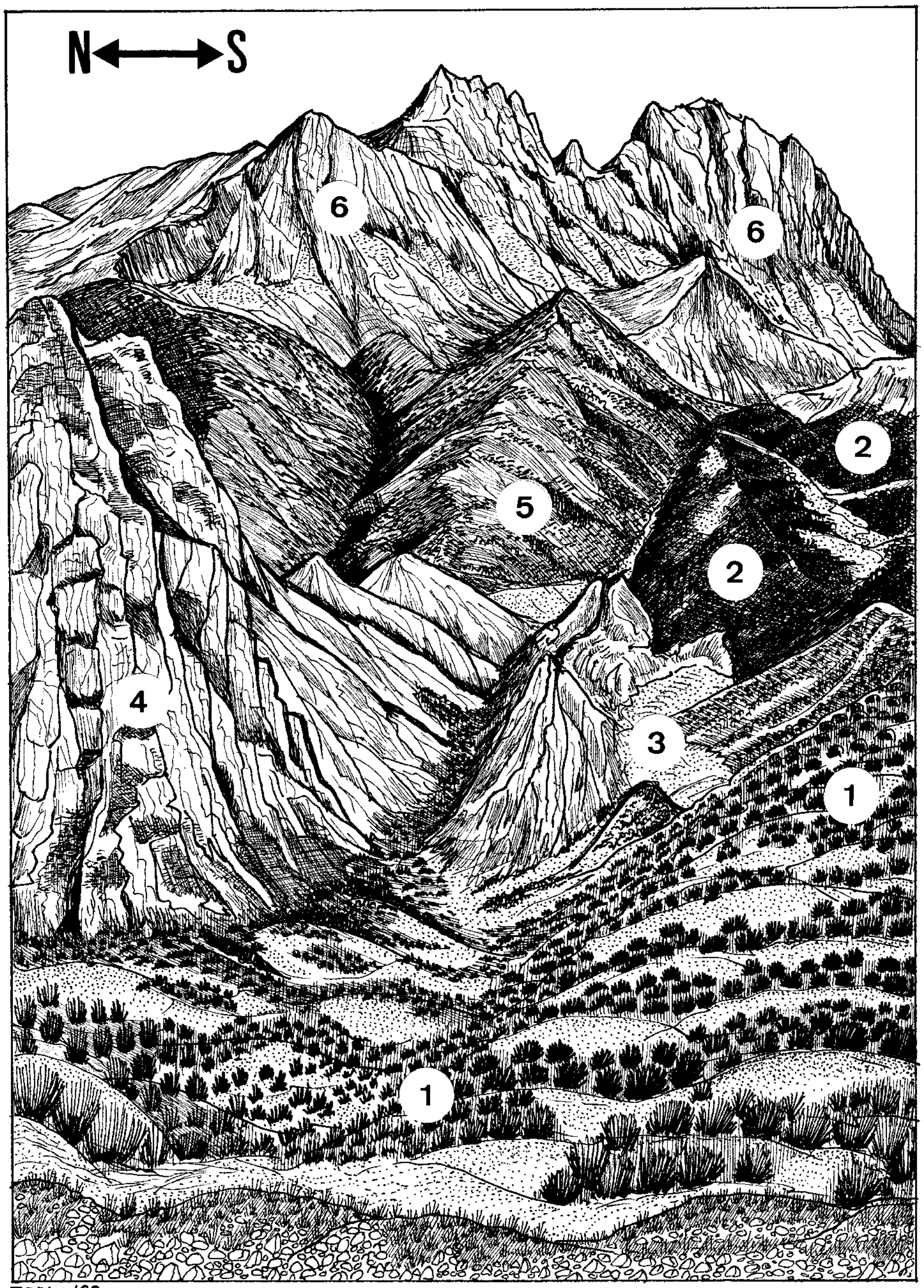
The Ubiñense subsector is clearly characterized by the basophilous species and communities that we had not found till now. So, the *Lithodoro diffusae-Genistetum occi-*

dentalis appears, presided by *Genista occidentalis* and *Lithodora diffusa* and accompanied by species that are also participating in basofilous pastures such as *Helianthemum nummularium*, *H. canum*, *H. croceum* subsp. *cantabricum*, *Pimpinella tragium* subsp. *lithophila*, *Brachypodium pinnatum* subsp. *rupestre*, *Teucrium pyrenaicum* and *Teucrium chamaedrys*. Spiny formations with barberries, *Pruno spinosae-Berberidetum cantabricae*, with *Berberis vulgaris* subsp. *cantabrica, Prunus spinosa*, several rose species, *Ribes uva-crispa*, *Viburnum lantana* and *Rhamnus alpina*, etc., also appearing here, as well as the basofilous grasslands of the associations *Arenario cantabricae-Festucetum hystricis* and *Helianthemo cantabrici-Brometum erecti*, which bear species such as *Festuca hystrix*, *Bromus erectus*, *Arenaria cantabrica*, *Arenaria grandiflora*, *Helianthemum canum*, *H. croceum* subsp. *cantabricum*, *Brachypodium pinnatum* subsp. *rupestre*, *Centaurea janeri* subsp. *babiana*, *Seseli montanum*, *Pimpinella tragium* subsp. *lithophila*, *Koeleria vallesiana*, *Poa ligulata*, *Teucrium pyrenaicum*, *Teucrium chamaedrys*, etc.

PICTURE 31

Locality: Ubiña massif from the Ventana Pass. León – Asturias.
Altitude: 1,650 m - 2,417 m.
Date: 21-VII-1999
Biogeography: Ubiñense subsector (Ubiñense-Picoeuropeano sector, Orocantabrian subprovince
Bioclimatic belt: Upper supratemperate (highmontane)-orotemperate (subalpine), hyperhumid.
Lithology: Limestone, sandstone and slate.

1. Highmontane orocantabrian piornales (brooms communities) of *Cytiso cantabrici-Genistetum obtusirameae*.
2. Mesophytic neutral-basophilous and ombrophilous beech forest of *Carici sylvaticae-Fagetum*, alternating with siliceous beech forest on depressions with deep and rich soils of the *Blechno spicanti-Fagetum scilletosum lilio-hyacinthi*.
3. Highmontane and subalpine orocantabrian grasslands of *Bromo erecti-Caricetum brevicollis*.
4. Orocantabrian furze scrub (aulagar) of *Lithodoro diffusae-Genistetum occidentalis,* Orocantabrian psychroxerophilous pastures of the *Saxifrago coniferae-Festucetum hystricis* and calcicolous chasmophytic communities of the Orocantabrian association *Anemono pavonianae-Saxifragetum canaliculatae*.
5. Heathland with gorses (brezal-tojal) of *Vaccinio myrtilli-Ulicetum cantabricae*.
6. Basophilous Orocantabrian dwarf juniper scrub of *Daphno cantabricae-Arctostaphylletum uva-ursi,* calcicolous chasmophytic communities of the *Saxifragion trifurcato-canaliculatae* alliance and vegetation of the calcareous screes of *Linarion filicaulis*.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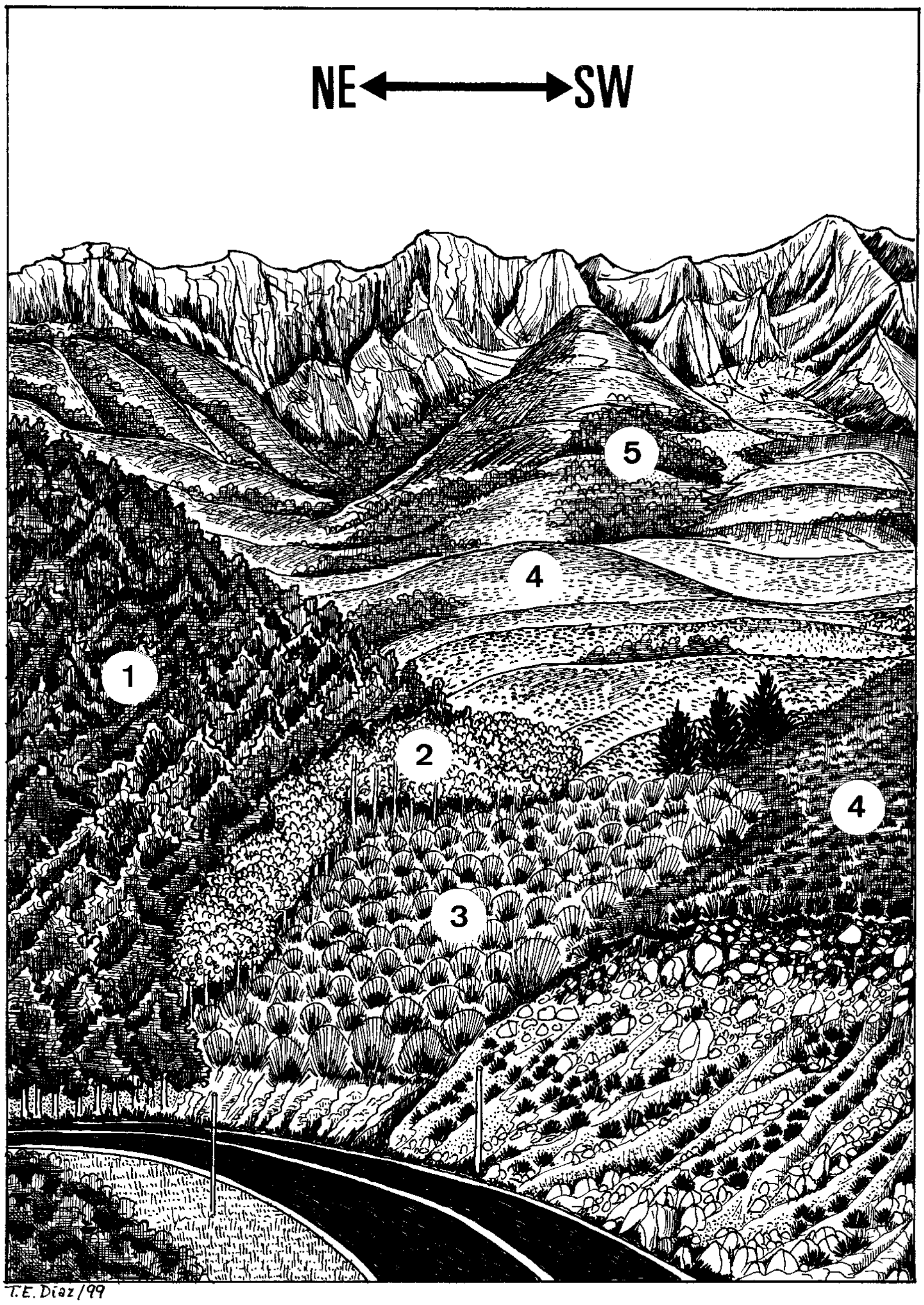
In the fissures and crevices of the limestone rocks chasmophitic communities of the *Centrantho-Saxifragetum canaliculatae saxifragetosum babianae* develop, where, beside *Saxifraga canaliculata*, lives the Ubiñense endemism *Saxifraga babiana*, together with species such as *Ceterach officinarum* or *Centranthus lecoqii*. In limestone screes of medium and small-sized blocks develop communities of the associations *Linario odoratissimae-Rumicetum scutati*, characterized by the abundant presence of *Rumex scutatus*, *Linaria propinqua* var. *odoratissima*, *Centranthus lecoqii* and *Vincetoxicum hirundinaria* subsp. *lusitanicum*. If the stone pieces are bigger (blocks), *Cystopterido pseudoregiae-Dryopteridetum submontanae* appears, characterized by the dominance of ferns such as *Dryopteris submontana*, *Cystopteris fragilis* subsp. *pseudoregia*, *Polystichum lonchitis*, *Polystichum aculeatum* and even, sometimes, several species of the genus *Asplenium* such as *A. trichomanes* or *A. viride*.

These communities belong to the vegetation series of the white juniper (*Junipereto sabino-thuriferae* sigmetum), which occupies the sunniest hillsides, generally south exposed, and also to the vegetation series of the basophilous and xerophilous beech forests (*Epipactido helleborines-Fageto sylvaticae* sigmetum), in shady places, and north exposed hillsides. The mature stages of these series are scarcely represented (savin woods in Pobladura de Luna and Mirantes de Luna and beech forests in Caldas de Luna) because of the traditional exploitation of the territory, mainly cattle grazing, in these districts of Babia and Luna. In the landscape, the communities that allow us to recognize both vegetation series are the aulagares, which in the juniper series belong to the *Lithodoro diffusae-Genistetum scorpii*, often with *Juniperus sabina* (*Lithodoro diffusae-Genistetum occidentalis juniperetosum sabinae*), while in the beech series is the typical *Lithodoro diffusae-Genistetum occidentalis*. They also differ because the beech forests series bears a wood of hazels *(Laserpitio eliasii-Coryletum avellanae*) which is lacking in the juniper series.

PICTURE 32

Locality: On the way up to the Ventana pass, near Páramo. Teverga, Asturias.
Altitude: 1,390 m.
Date: 21-VII-1999
Biogeography: Ubiñense subsector, Ubiñense-Picoeuropeano sector, Orocantabrian subprovince.
Bioclimatic belt: Supratemperate (montane), hyperhumid.
Lithology: Limestone, sandstone and slate.

1. Mesophytic neutral-basophilous and ombrophilous beech forest of *Carici sylvaticae-Fagetum*, alternating with siliceous beech forests on depressions with deep and rich soils of *Blechno spicanti-Fagetum scilletosum lilio-hyacinthi*.
2. Secondary birch forest (*Betula celtiberica*)
3. Montane orocantabrian broom communities (piornales) of *Cytiso cantabrici-Genistetum polygaliphyllae*.
4. Heathlands of *Erica aragonensis* (*Daboecio-Ericetum aragonensis*) on slope colluvia.
5. Highmontane birch forests of *Luzulo-Betuletum celtibericae*.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On siliceous substrata the vegetation series are similar to those reported in the Laciano-Ancarense sector, but step by step is produced the incorporation of the acidophilous beech series which develops in spots with a more humid climate, mainly because of the frequent presence of summer fog (beech forest of Torrebario going up to the Ventana pass in Peña Ubiña slopes).

In the bottom of the valleys appear remains of the ash woods of the *Pruno padi-Fraxinetum excelsioris* (few trees, sparse or in arrays, of *Fraxinus excelsior*, *Acer pseudoplatanus*, *Corylus avellana*, *Populus nigra*, *Prunus avium* and *Prunus padus*); spiny hedges of the *Rhamno catharticae-Ribesetum alpini* (dominated by *Prunus spinosa*, *Prunus padus*, *Rhamnus cathartica*, *Rubus ulmifolius*, *Crataegus monogyna*, *Rosa canina*, *Rosa corymbifera*, *Sambucus nigra*, *Ribes alpinum* and *Ribes petraeum*, among others); hay meadows (*Malvo moschatae-Arrhenatheretum bulbosi* and *Bromo commutati-Polygonetum bistortae*) and shrubby willow formations of the *Salicetum cantabricae*, presided by the Cantabrian willow (*Salix cantabrica*) and its hybrids with the other common species of the genus *Salix*.

In the Ventana pass, we can observe a good example of the Ubiñense upper supratemperate (altimontanous) and orotemperate (subalpine) vegetation. The series of the acidophilous beech forests (*Blechno spicanti-Fageto sylvaticae* sigmetum), and of the mesophitic neutro-basphilous and ombrophilous beech forests (*Carici sylvaticae-Fageto sylvaticae* sigmetum) are observed here.

The acidophilous beech forests, *Blechno spicanti-Fagetum sylvaticae*, bear under the canopy of Fagus sylvatica, many acidophilous species like *Saxifraga spathularis*, *Vaccinium myrtillus*, *Blechnum spicant* and *Luzula sylvatica* subsp. *henriquesii*, together with other nemoral ones such as *Anemone nemorosa* or *Milium effusum*. Besides this, the series is very well indicated by the presence of piornales with *Cytisus cantabricus* (*Cytiso cantabrici-Genistetum polygaliphyllae* and *Cytiso cantabrici-Genistetum obtusirameae*), heathlands (*Daboecio cantabricae-Ericetum aragonensis*) and heath-gorse formations (*Daboecio cantabricae-Ericetum aragonensis ulicetosum cantabrici* and *Daboecio cantabricae-Ulicetum cantabrici*, this last association differs from the former by the absence of *Erica australis* subsp. *aragonensis* and the presence of *Erica vagans*).

The mesophytic, neutro-basophilous and ombrophilous beech forests, *Carici sylvaticae-Fagetum sylvaticae*, are characterized by the presence as companions of *Fagus sylvatica*, such as *Carex sylvatica*, *Saxifraga hirsuta*, *Scilla lilio-hyacinthus*, *Galium odoratum*, *Melica uniflora*, *Paris quadrifolia* and *Phyteuma spicatum* subsp. *pyrenaicum*. Its vegetation series is also recognized by the presence of aulagares of the association *Lithodoro diffusae-Genistetum occidentalis*.

The forest altitudinal limit (timberline), in the Ventana pass, is marked by the birch forests of the *Luzulo henriquesii-Betuletum celtibericae*. The pastures of *Merendero pyrenaicae-Cynosuretum cristati* are very frequent in this area. In places of ploughed, very oxygenated soils, influenced by cattle excrements, the thistle association *Carduo nutantis-*

Cirsietum chodati is found; it is characterized by *Carduus nutans* var. *nutans*, *Carduus nutans* var. *phyllolepis* and *Cirsium eriophorum* subsp. *chodati*.

In the Peñon de Ventana and towards the Peña Ubiña calcareous massif, there is vegetation of the basophilous subalpine series *Daphno cantabricae-Arctostaphyleto uva-ursi* sigmetum. The climax belongs to a dwarf juniper formation of the association *Daphno cantabricae-Arctostaphyletum uva-ursi*, with *Arctostaphylos uva-ursi*, *Daphne laureola* var. *cantabrica*, *Juniperus communis* subsp. *alpina* and sometimes *Cotoneaster integerrimus*. By degradation of the juniper formations, psicroxerophilous pastures of the *Saxifrago coniferae-Festucetum burnatii* appear. They are formed mainly by *Festuca burnatii*, *Saxifraga conifera*, *Helianthemum croceum* subsp. *cantabricum*, *Oxytropis foucaudii*, *Teucrium pyrenaicum*, *Astragalus danicus*, *Koeleria vallesiana*, *Festuca hystrix*, *Poa ligulata*, *Helianthemum canum* subsp. *piloselloides*, *Arenaria aggregata* subsp. *racemosa* var. *cantabrica* and *Arenaria grandiflora*, among others.

At those altitudes snow accumulates quite a lot and thus appear the altimontanous and subalpine, basophilous and chionophilous pastures of the *Pediculari comosae-Caricetum sempervirentis*. These pastures are characterised by *Pedicularis comosa* subsp. *comosa*, *Carex sempervirens*, *Sesleria albicans*, *Anemone pavoniana*, *Armeria cantabrica*, *Pedicularis pyrenaica*, *Luzula nutans* and *Arenaria purpurascens*, among others. On deep and well drained soils, develop the pastures of *Bromo erecti-Caricetum brevicollis*, characterized by *Carex brevicollis*, *Eryngium bourgatii*, *Thymus praecox* subsp. *britannicus*, *Plantago media*, *Bromus erectus*, *Helianthemum nummularium*, *Dianthus hyssopifolius*, *Phyteuma orbiculare* subsp. *ibericum*, *Carex humilis* and *Brachypodium pinnatum* subsp. *rupestre*, among other.

At lower altitudes, on the slopes of Peña Ubiña the montane pastures of the *Pulsatillo hispanicae-Genistelletum sagittalis* (Villargusan is their locus classicus) develop, they are similar to the former but here they are dominated by *Pulsatilla rubra* subsp. *hispanica* and *Genistella sagittalis*.

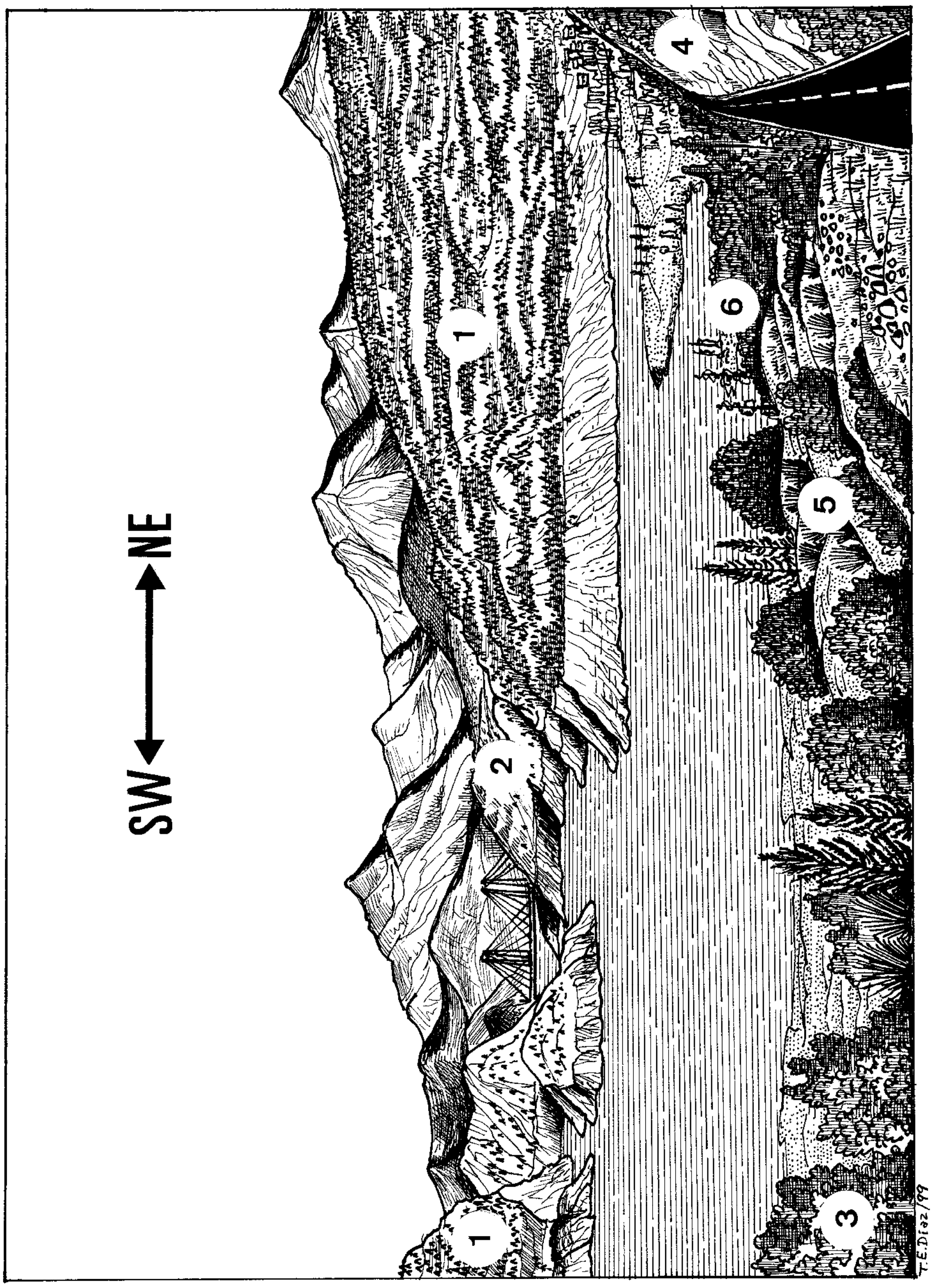
However, in the Peña Ubiña massif, due to the abundance of rocky habitats, the chasmophitic and scree communities achive a great development, bearing also have a high diversity in function of several factors such as the degree of moisture or snow cover, the size of the blocks, etc. In fissures of altimontanous and subalpine limestone rocks the *Anemono pavonianae-Saxifragetum canaliculatae* subassociation *saxifragetosum septentrionalis* develops, characterized by *Saxifraga canaliculata*, *Anemone pavoniana*, *Campanula arbatica* and the Ubiñense endemism *Saxifraga babiana* var. *septentrionalis*. In subalpine fissures the combination dominated by *Potentilla nivalis* subsp. *asturica*, *Valeriana apula* and *Globularia repens*, defines the association *Potentillo asturicae-Valerianetum apulae*. Finally, if the fissures have moisture, the chasmophitic communities are presided by *Saxifraga hirsuta* susbp. *paucicrenata*, giving way to the association *Campanulo arbaticae-Saxifragetum paucicrenatae*. As far the scree communities and besides the above commented associations *Linario odoratissimae-Rumicetum scutati*, on middle and small sized blocks and *Cystopterido pseudoregiae-Dryopteridetum submontanae*, on blocks of greater size, other associations can be mentioned. *Epilobio anagallidifolii-Doronicetum braun-blanquetii* lives on big blocks with long snow cover, originating very humid soils all through the year and characterized by the presence of *Doronicum grandiflorum* subsp. *braun-blanquetii*, *Epilobium anagallidifolium*, *Cystopteris fragilis* subsp. *pseudoregia*, *Arabis alpina* var. *cantabrica* and *Linaria filicaulis*. *Ranunculo leroyi-Saxifragetum praetermissae* lives on tiny stone screes and is also a chionophilous and hygrophylous community, defined by the Ubiñense-Picoeuropeano endemism *Ranunculus alpestris* subsp. *leroyi*, which lives together with *Saxifraga praetermissa* and *Arabis alpina* var. *cantabrica*.

Between Puente Orugo and Villafeliz de Babia on the calcareous north exposed hillsides can be observed a good example of hazelnut wood of the association *Laserpitio eliasii-Coryletum avellanae*, preforest of a basophilous and xerophilous beech forest of the *Epipactido helleborines-Fagetum sylvaticae* association. In that hazelnut wood are common *Corylus avellana*, *Sorbus aria*, *Crataegus monogyna*, *Ribes alpinum*, *Berberis vulgaris* subsp. *cantabrica*, *Rosa canina*, *Rhamnus alpina*, *Amelanchier ovalis*, *Genista occidentalis*, *Viburnum lantana*, *Laserpitium nestleri* subsp. *eliasii*, *Crepis lampsanoides*, *Primula veris* subsp. *columnae*, *Helleborus viridis* subsp. *occidentalis*, *Tanacetum corymbosum*, *Hepatica nobilis*, *Mercurialis perennis*, *Melica uniflora*, *Milium effusum*, *Bormus ramosus*, *Sanicula europaea*, *Lithodora diffusa* and *Stellaria holostea*, among others.

PICTURE 32

Locality: Barrios de Luna dam. León.
Altitude: 1,350 m.
Date: 21-VII-1999
Biogeography: Ubiñense subsector, Ubiñense-Picoeuropeano sector, Orocantabrian sub-province.
Bioclimatic belt: Upper supratemperate (highmontane), lower humid.
Lithology: Limestone, quartzite and sandstone.

1. Patches of junipers (*Juniperus thurifera* and *Juniperus sabina*) and dwarf junipers (*Juniperus communis* subsp. *alpina*) belonging to the montane Orocantabrian basophilous relic association *Juniperetum sabino-thuriferae*.
2. Furze scrub (aulagar) (*Lithodoro diffusae-Genistetum scorpii*), Orocantabrian hawthorn with barberry shrublands (*Pruno spinosae-Berberidetum cantabricae*) and Orocantabrian psychroxerophilous grasslands of *Arenario cantabricae-Festucetum hystricis*.
3. Melojares (*Quercus pyreanica* forests) of *Linario triornithophorae-Quercetum pyrenaicae*.
4. Dry heathlands of *Erica aragonensis* (*Genistello tridentatae-Ericetum aragonensis*).
5. Piornales (broom communities) of *Cytiso scoparii-Genistetum polygaliphyllae*.
6. Willow shrublands of *Salicetum cantabricae*.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In this zone, it is frequent to find practically monospecific populations of *Petrocoptis pyrenaica* subsp. *glaucifolia*, living in almost momoespecific populations which colonize the limestone overhanging cliffs, giving way to the association *Petrocoptidetum glaucifoliae*. Curiously, it in the Church of Pruneda it is possible to see an example of living together with the communities of the *Sedo micranthi-Saxifragetum babianae*, an Ubiñense association of natural and urban walls, presided by *Saxifraga babiana*, *Sedum micranthum*, *Umbilicus rupestris* and *Ceterach officinarum*.

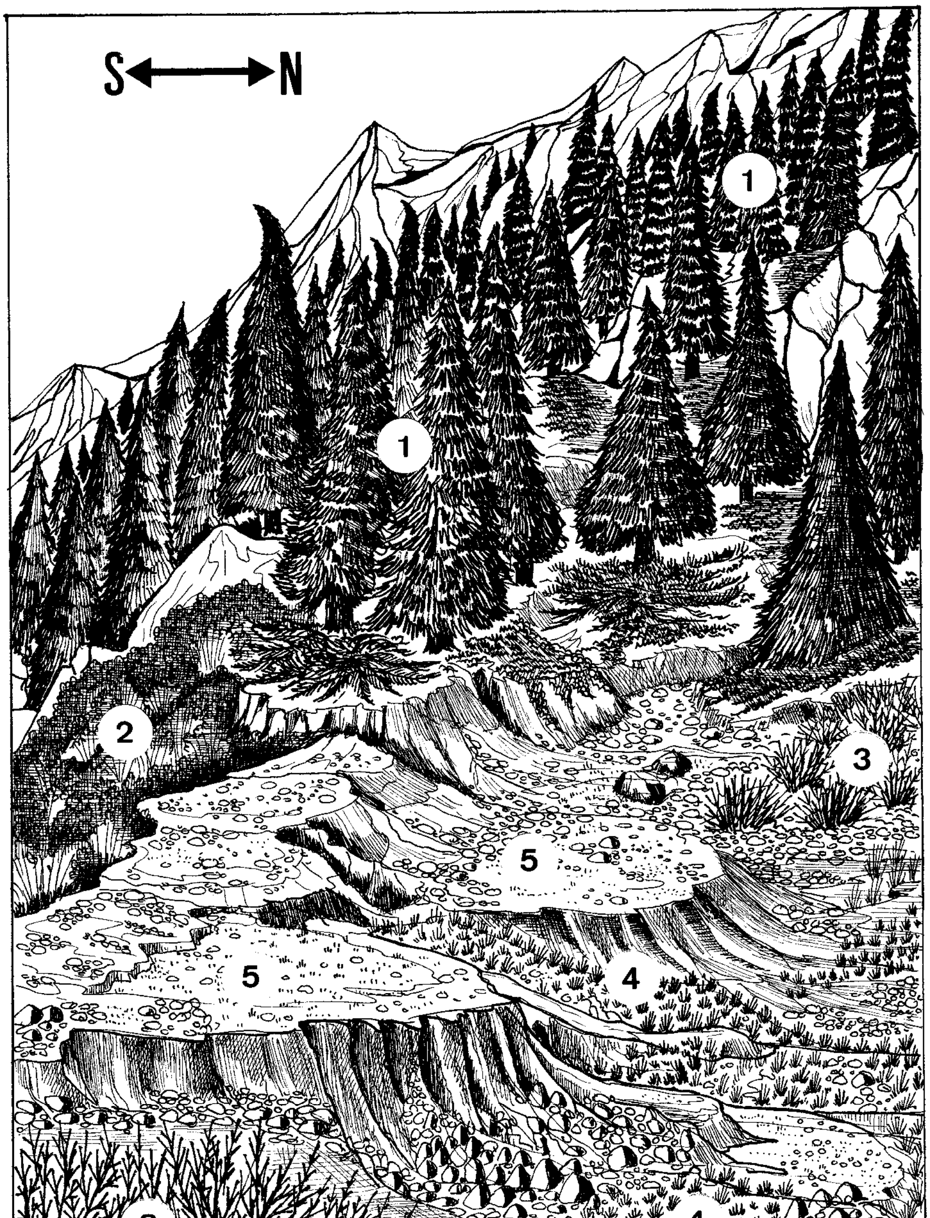
It is also frequent to find the nitrophilous communities of *Urtico dioicae-Sambucetum ebuli* (in which develop, among other, *Sambucus ebulus*, *Urtica dioica*, *Arctium minus* and *Galium aparine*), as well as the humid forb communities of *Senecio laderoi-Filipenduletum ulmariae* (characterized by *Filipendula ulmaria*, *Senecio laderoi*, *Epilobium hirsutum*, Mentha longifolia and *Phalaris arundinacea*), and the thistle communities of *Cirsio chodati-Carduetum carpetani* (defined by *Carduus carpetanus* and *Cirsium eriophorum* subsp. *chodati*).

In Mirantes de Luna can be appreciated, on limestone substratum, every stage of the relic vegetation series of the white juniper woodland (*Junipereto sabino-thuriferae* sigmetum). Their structure is an open woodland of white juniper (*Juniperus thurifera*) growing over the dwarf savin (*Juniperus sabina*) and dwarf juniper (*Juniperus communis* subsp. *alpina*) carpet, constituting the association *Juniperetum sabino-thuriferae*. In depressions and areas retaining high moisturein the soil, the quejigo (*Quercus faginea*) is incorporated giving way to *the Juniperetum sabino-thuriferae* subassociation *quercetosum fagineae*. The spiny hedges with barberries, *Pruno spinosae-Berberidetum cantabricae*; the

PICTURE 34

Locality: Barrios de Luna dam. León.
Altitude: 1,350 m.
Date: 21-VII-1999
Biogeography: Ubiñense subsector, Ubiñense-Picoeuropeano sector, Orocantabrian subprovince.
Bioclimatic belt: Upper supratemperate (highmontane), lower humid.
Lithology: Limestone.

1. Patches of junipers (*Juniperus thurifera* and *Juniperus sabina*) and dwarf junipers (*Juniperus communis* subsp. *alpina*) belonging to the montane Orocantabrian basophilous relic association *Juniperetum sabino-thuriferae*.
2. Orocantabrian hawthorn with barberry (*Berberis vulgaris* subsp. *cantabrica*) shrublands of the association *Pruno spinosae-Berberidetum cantabricae*].
3. Furze scrub (aulagar) of *Lithodoro diffusae-Genistetum scorpii*.
4. Orocantabrian psychroxerophilous grasslands of *Arenario cantabricae-Festucetum hystricis*.
5. Fragmentary communities of therophitic grasslands on bare soil patches of *Minuartio hybridae-Saxifragetum tridactylitae*.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basophilous pastures of the associations *Arenario cantabricae-Festucetum hystricis* and *Helianthemo cantabrici-Brometum erecti* and the aulagares of the *Lithodoro diffusae-Genistetum scorpii*, dominated by *Genista scorpius* and *Lithodora diffusa*, and of *Lithodoro diffusae-Genistetum occidentalis*, dominated by *Genista occidentalis* and *Lithodora diffusa*, complete the list of plant communities of this vegetation series. There can also be appreciated some rupicolous communities of the associations *Centrantho-Saxifragetum canaliculatae* and *Linario odoratissimae-Rumicetum scutati*.

On every hillside on siliceous substratum the vegetation series of the melojares or *Linario triornithophorae-Querceto pyrenaicae* sigmetum develops. One can see remains of the melojo forests of the *Linario triornithophorae-Quercetum pyrenaicae*, piornales of the *Cytiso scoparii-Genistetum polygaliphyllae* and heathlands of the *Daboecio cantabricae-Ericetum aragonensis* or the *Genistello tridentatae-Ericetum aragonensis hypericetosum burseri*.

In the bottom of the valley appear remains of the ash forests *of Pruno padi-Fraxinetum excelsioris*, spiny hedges of *Rhamno catharticae-Ribesetum alpini*, hay meadows (*Malvo moschatae-Arrhenatheretum bulbosi* and *Bromo commutati-Polygonetum bistortae*) and shrub willow formations of *Salicetum cantabricae*.

When we go by Los Barrios de Luna dam, and after observing, on limestone, the last aulagar of the *Lithodoro diffusae-Genistetum occidentalis* and the last fissure communities of *Centrantho-Saxifragetum canaliculatae*, we change biogeografic region again, leaving behind the Eurosiberian egion and entering the Mediterranean Region. We come into territories of the Orensano-Sanabriense sector, which is recognizable because the Eurosiberian elements and communities, such as *Daboecia cantabrica*, *Genista occidentalis*, *Salix cantabrica*, *Fagus sylvatica*, *Fraxinus excelsior*, *Daboecio cantabricae-Ericetum aragonensis*, *Daboecio cantabricae-Ulicetum cantabrici*, *Lithodoro diffusae-Genistetum occidentalis*, *Pruno padi-Fraxinetum excelsioris*, *Salicetum cantabricae*, *Blechno spicanti-Fagetum sylvaticae*, *Epipactido helleborines-Fagetum sylvaticae*, *Linario triornithophorae-Quercetum pyrenaicae*, etc. completely disappear, while, on the other hand, Mediterranean Iberoatlantic communities such as *Genisto falcatae-Quercetum pyrenaicae*, *Genisto hystricis-Quercetum rotundifoliae*, *Phalacrocarpo oppositifolii-Festucetum elegantidis* or *Phalarocarpo oppositifolii-Saxifragetum continentalis*, appear. They bear plants like *Gensta hystrix*, *Saxifraga continentalis*, *Anarrhinum bellidifolium*, *Festuca elegans*, *Pimpinella villosa* and *Erysimum linifolium*, which are differentials of this territory in comparison with the nearby Leonés sector. In the bottom of the valleys some remains of elm forests (*Aro maculati-Ulmetum minoris*), poplar-willow formations (*Populo nigrae-Salicetum neotrichae*) and shrub willow formations (*Salicetum lambertiano-salvifoliae*) can be appreciated.

Finally, towards the city of León, after passing La Magdalena and the crossroad toward Benllera, we enter territories of the Leonés sector which is highlighted in the landscape by the remains, in the valley bottoms, of the vegetation series of the elm forests (*Aro maculati-Ulmeto minoris* sigmetum), poplar-arboreal willow forests (*Populo nigrae-Saliceto neotrichae* sigmetum) and shrub willow formations (shrub willow formations *Saliceto* *angustifolio-salvifoliae* sigmetum); on the planes and hillsides, the series of the melojares is found (*Festuco braun-blanquetii-Querceto pyrenaicae* sigmetum) with their particular piornales communities bearing pedunculate lavender (*Cytiso scoparii-Genistetum polygaliphyllae lavanduletosum pedunculatae*), the heathlands with laurel leafed rockrose and bearberry (*Genistello tridentatae-Ericetum aragonensis cistetosum laurifolii*) and the grasslands dominated by *Agrostis castellana* of the association *Festuco amplae-Agostietum castellanae*. In ridges and some steep south facing hillsides, small fragments of the carrascales of the *Junipero oxycedri-Quercetum rotundifoliae* are appreciated.

LEÓN-FUENTE DÉ (22 July)

(Geobotanical excursion between León and Fuente Dé)

ÁNGEL PENAS MERINO & EMILIO PUENTE GARCÍA

INTRODUCTION

Starting from the city of León, today's journey crosses territories included in the Leonés sector (Carpetan-Leonesian subprovince, Iberoatlantic province, Mediterranean region) which has some small Castellano-Duriense enclaves (Castilian-Maestracean-Manchegan subprovince, Iberolevantine province, Mediterranean region), in the Ubiñense subsector (Ubiñense-Picoeuropeano sector, Orocantabrian subprovince, European Atlantic province, Eurosiberian region) and in the Altocarrionés subsector (Campurriano-Carrionés sector, Orocantabrian subprovince, European Atlantic province, Eurosiberian region).

In the Leonés sector Tertiary geologic materials predominate: clay and sandstone which form the so called "raña", originating poor soils with low pH.

The bioclimate is quite homogeneous in this sector and corresponds to the Pluviseasonal Oceanic Mediterranean, with supramediterranean thermotype and ombroptypes ranging from the upper dry to the upper subhumid.

The flora of this area presents few exclusive taxa, only *Sideritis borgiae* and *Quercus pauciradiata* can be considered as such. Nevertheless, other species common in the Leones sector can be used to differentiate it from other limiting units in which they do not occur. That is the case of *Arctostaphylos uva-ursi*, *Erica vagans* and *Cistus laurifolius*, completely absent in the Orensano-Sanabriense sector, or some acidophilous species such as *Genistella tridentata*, *Erica cinerea* and *E. umbellata*, absent in the marly Castellano-Duriense sector, an area of base-rich soils in which *Genista scorpius* is abundant.

In the Altocarrionés subsector the siliceous base-poor substrata predominate. Bioclimatically can be found the Temperate Oceanic and the Submediterranean Temperate Oceanic bioclimates, with supratemperate (montane), orotemperate (subalpine) and criotemperate (alpine) thermotypes; in many of those areas the submediterranean climatic conditions permit us to speak of suprasubmediterranean and orosubmediterranean thermotypes. Ombrotypes are humid and hyperhumid. Continentality is also a relevant feature of the climate of this territory.

Floristically, the Altocarrionés sector bears the following endemic taxa: *Echium italicum* subsp. *cantabricum, Primula pedemontana* subsp. *iberica, Ranunculus montserrati, Saxifraga willkommiana* and *Sempervivum giuseppi*. Some Pyrenean species, whose Cantabrian populations are restricted to this sector, can also be pointed out: *Carex atrata, Thalictrum alpinum, Artemisia umbelliformis, Silene rupestris, Sedum alpestre, Androsace cantabrica* and *Poa laxa*.

THE VEGETATION OF THE ITINERARY

The city of León is located on the "vegas" (bottom of the valleys) of the Bernesga and Totío rivers, thus the vegetation series corrsponds to that of the typical riparian of the Leonés sector. Just leaving the city, at Villanueva del Árbol, crossing the Torío river, some examples of those vegetation series: that of the elm forests (*Aro maculati-Ulmo minoris sigmetum*), of the poplar-arboreal willow forests (*Populo nigrae-Salicetum neotrichae*) and of the willow shrublands (*Salico angustifolio-salvifoliae sigmetum*) can be observed.

The elm forests *(Aro maculati-Ulmetum minoris*) and the poplar-arboreal willow forests (*Populo nigrae-Saliceto neotrichae*) are represented by small remains formed by *Populus nigra, Fraxinus angustifolia, Ulmus minor, Salix neotricha* and *S. fragilis*, which are often set in lines or rows along the river banks, ways or the limits between rural properties. The broom hedges of the association *Rubo ulmifolii-Rosetum corymbiferae*, formed by spiny shrubs such as *Rubus ulmifolius, Rosa corymbifera, R. micrantha, R. canina, Viburnum opulus, Ligustrum vulgare, Euonymus europaeus, Prunus spinosa, Cornus sanguinea, Clematis vitalba, Sambucus nigra, Crataegus monogyna* and *Lonicera periclymenum*, among others, also form rows bordering the ways and the properties. The hay meadows of *Festuco amplae-Cynosuretum cristati* and the summer crop fields (with their particular weed communities) are also linked to those vegetation series. The willow shrublands are formed by numerous species of the *Salix* genus such as *S. salvifolia, S. elaeagnos* subsp. *angustifolia, S. triandra* subsp. *discolor*, *S. atrocinerea,* etc., ehich live on the pebble river beds and belong to the association *Salicetum angustifolio-salvifoliae*.

Going up to Castrillino, there are some Castellano-Duriense enclaves which bear the *Junipero thuriferae-Querco rotundifoliae sigmetum* vegetation series on Miocenic marl. The mature stage is reduced to some small groups of *Quercus rotundifolia* individuals remaining in the most inaccessible places safe from the historical human action which leads to the transformation of all the possible area into arable land. The present day rural abandonment and the decrease of the ploughed surface, causes the appearance of the initial phases of secondary succession on abandoned land such as rose-hedges of the *Rosetum micrantho-agrestis* association, aulagar-jarales of *Genisto scorpii-Cistetum laurifolii* and tomillares of *Veronico jabalambrensis-Thymetum mastigophori*.

In the Sobarriba area is found the melojares vegetation series or *Festuco braun-blanquetii-Querco pyrenaicae* sigmetum. The melojo forests can only be seen forming small groups indicating their recovery, however, the piornales with pedunculated lavender (*Cytiso scoparii-Genistetum polygaliphyllae lavanduletosum pedunculatae*) are conspicuous; they are dominated, among others, by *Genista florida* subsp. *polygaliphylla, Cytisus scoparius, Erica arborea, Adenocarpus complicatus* and *Lavandula stoechas* subsp. *pedunculata*. The heathlands with lauroid jara and bearberry (*Genistello tridentatae-Ericetum aragonensis cistetosum laurifolii*) form a scrub in which *Erica australis* subsp. *aragonensis, E. umbellata, E. cinerea, Genistella tridentata, Calluna vulgaris, Polygala microphylla, Arctostaphylos uva-ursi, Cistus laurifolius, Thymus mastichina* and *Lavandula stoechas* subsp. *pedunculata* are the main species. The grasslands dominated by *Agrostis castellana* are included in the *Festuco amplae-Agostietum castellanae* association.

This pattern in the vegetation of this area, with dominance of the melojares vegetation series or *Festuco braun-blanquetii-Querco pyrenaicae sigmetum* and the elm forest, poplar-arboreal willow forest and willow shrublands vegetation series (*Aro maculati-Ulmo minoris sigmetum, Populo nigrae-Salico neotrichae* sigmetum, S*alico angustifolio-salvifoliae sigmetum sigmetum*) in the bottom of the valleys, is repeated along several kilometres and is only altered in some spots (Lugán, Candanedo de Boñar, Vegaquemada) when conglomerates of the Candanedo formation outcrop. On south-facing slopes of those outcrops, on base-rich soils, the upper subhumid Quercus rotundifolia vegetation series develops *(Junipero oxycedri-Querco rotundifoliae* sigmetum*)* in a faciation with *Brachypodium pinnatum* subsp. *rupestre* In it, some small open-structured forested areas with *Quercus rotundifolia* stand out bearing some plants as *Carex hallerana, Asplenium onopteris, Piptatherum paradoxum, Saponaria ocymoides, Brachypodium pinnatum* subsp. *rupestre, Helleborus foetidus, Thymus mastichina* and *Thymus zygis;* the jarales of *Halimio umbellati-Cistetum laurifolii* formed essentially by *Cistus laurifolius, Halimium umbellatum, Lavandula stoechas* subsp. *pedunculata, Santolina rosmarinifolia* subsp. *semidentata, Thymus mastichina, Thymus zygis, Cytisus scoparius* and *Helichrysum stoechas* also occur in those spots.

The edges of the road, where the soil has been turned over and is well oxygenated and rich in nitrogenate compounds, tobales of the association *Carduo carpetani-Onopordetum acanthii*, dominated by *Onopordum acathium, Carduus carpetanus* y *Cirsium odontolepis* can be observed.

Near Boñar, the valley narrows and the first limestone outcrops appear bearing species such as *Genista occidentalis* (which form aulagares of *Lithodoro diffusae-Genistetum occidentalis*) and *Saxifraga canaliculata* (the characteristic species of the chasmophytic asociation *Centrantho-Saxifragetum canaliculatae*). At this point the Eurosiberian-Mediterranean border is crossed again and we enter the former. Thistle communities also change and they now belong to *Cirsio chodati-Carduetum carpetani*.

This change is also revealed on siliceous substratum, where good Atlantic indicators such as *Daboecia cantabrica* or *Hypericum richeri* subsp. *burseri* appear; they are characteristic of the heathland communities *Daboecio cantabricae-Ericetum aragonensis* and *Genistello tridentatae-Ericetum aragonensis hypericetosum burseri* respectively. Those heathlands are seral stages in the Orocantabrian melojares vegetation series (*Linario triornithophorae-Querco pyrenaicae sigmetum*).

On all the slopes on siliceous substratum the Orocantabrian melojares vegetation series or *Linario triornithophorae-Querco pyrenaicae sigmetum* develops. Some remains of the melojares can be seen scattered in the landscape but the piornales of *Cytiso scoparii-Genistetum polygaliphyllae* the heathlands of *Daboecio cantabricae-Ericetum aragonensis* and *Genistello tridentatae-Ericetum aragonensis hypericetosum burseri* are more abundant.

In the bottom of the valleys appear remains of the ash forests of the association *Pruno padi-Fraxinetum excelsioris* (few trees, scattered or in rows, belonging to the species *Fraxinus excelsior, Acer pseudoplatanus, Corylus avellana, Populus nigra, Prunus avium* and *Prunus padus*); spiny hedges of *Rhamno catharticae-Ribesetum alpini* (dominated by *Prunus spinosa, Prunus padus, Rhamnus cathartica, Rubus ulmifolius, Crataegus monogyna, Rosa canina, Rosa corymbifera, Sambucus nigra, Ribes alpinum* and *Ribes petraeum,* among others); hay meadows (*Malvo moschatae-Arrhenatheretum bulbosi* y *Bromo commutati-Polygonetum bistortae*) and willow shrublands of *Salicetum cantabricae*, dominated by the Cantabrian willow (*Salix cantabrica*) and its hybrids with the most frequent species of the genus *Salix*.

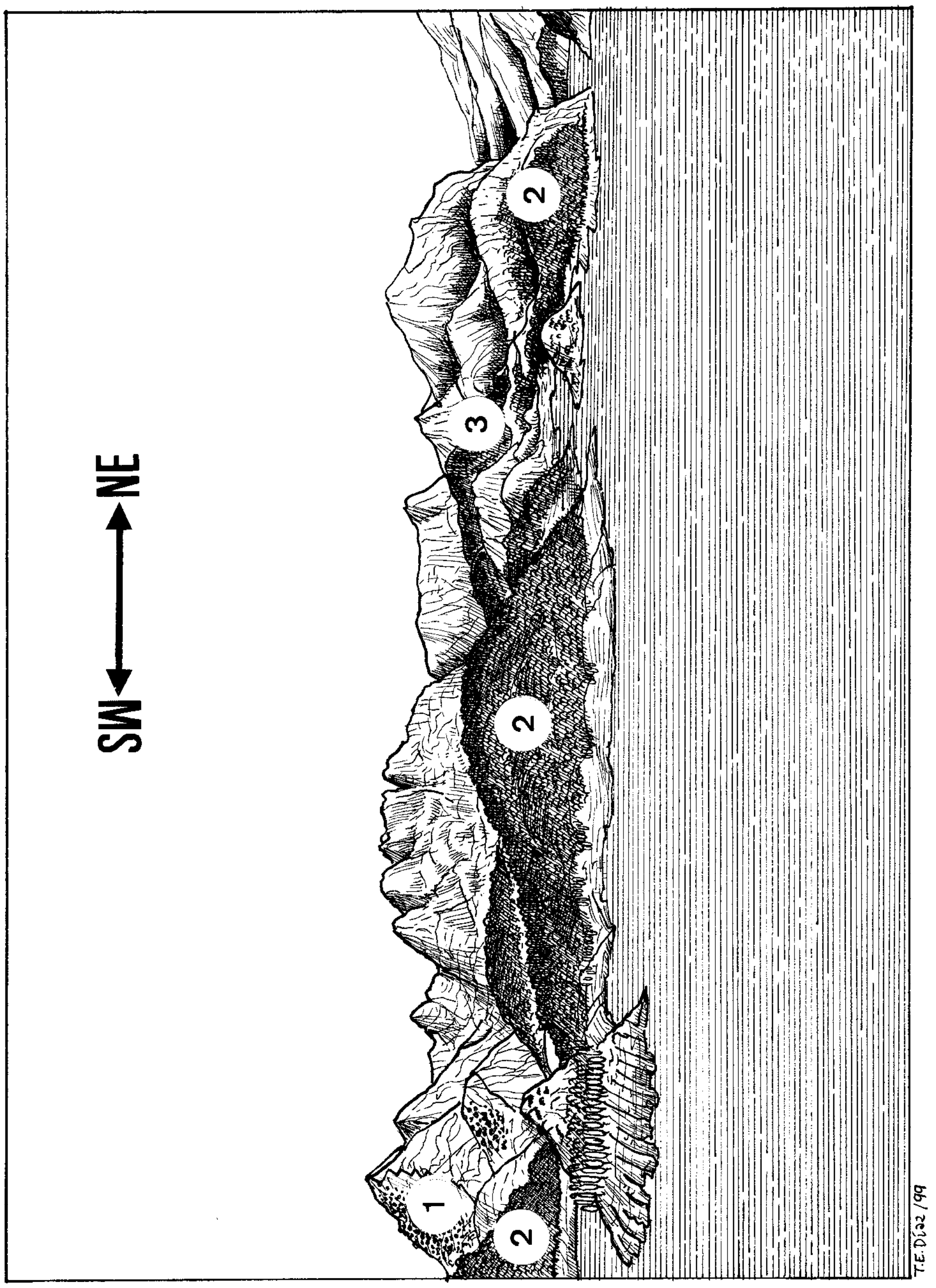
At the Porma dam we can appreciate, on calcareous base-rich soils, a geoseries formed by the basophilous and xerophylous beech forest vegetation series, or *Epipactido helleborines-Fago sylvaticae sigmetum*, on north-facing slopes, the continental montane faciation of the relic carrascales vegetation series, or *Cephalanthero longifoliae-Querco rotundifoliae sigmetum*, on south-facing slopes and the ash vegetation series, or *Pruno padi-Fraxino excelsioris sigmetum*, in the valley depressions and the Cantabrian willow vegetation series, *Salico cantabricae sigmetum*, in contact with the river waters

The basophilous and xerophilous beech forests and the relic carrascal vegetation series differentiate clearly in their mature stages: the beech forest belongs to the *Epipactido helleborines-Fagetum sylvaticae* association (in which, together with *Fagus sylvatica*, there are other differential species such as *Epipactis helleborine, Epipactis atrorubens, Cephalanthera longifolia, Lathyrus niger, Monotropa hypopitys, Ribes alpinum, Laserpitium nestleri* subsp. *eliasii* and *Tanacetum corumbosum*) and the carrascal, open-structured and

PICTURE 35

Locality: Panoramic view of the Porma dam, from the Mirador (viewpoint) de Vegamián. León.
Altitude: 1,120 m.
Date: 22-VII-1999
Biogeography: Ubiñense subsector, Ubiñense-Picoeuropeano sector, Orocantabrian subprovince.
Bioclimatic belt: Upper supratemperate (highmontane), lower humid.
Lithology: Limestone, quartzite and sandstone.

1. Colline and montane Orocantabrian carrascales (Quercus rotundifolia forests) on spurs of *Cephalanthero longifoliae-Quercetum rotundifoliae*].
2. Melojares of *Linario triornithophorae-Quercetum pyrenaicae*.
3. Mesophytic neutral-basophilous and ombrophilous beech forest of *Carici sylvaticae-Fagetum*, alternating with siliceous beech forest of *Blechno spicanti-Fagetum*.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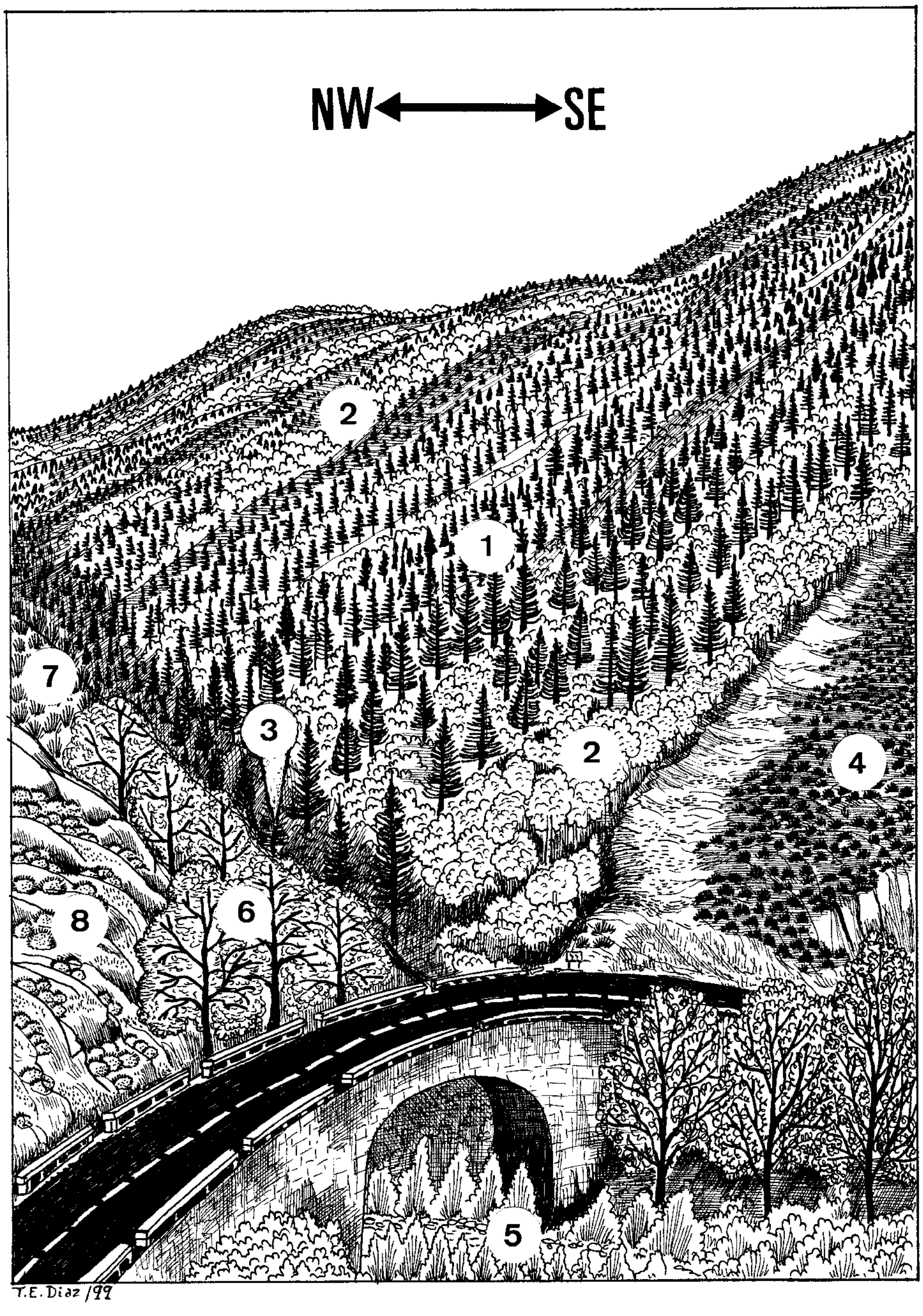
with few plants of *Quercetea ilicis,* which belongs to the association *Cephalanthero longifoliae-Quercetum rotundifoliae* (in it *Quercus rotundifolia* coexists with *Daphne gnidium, Rubia peregrina, Teucrium chamaedrys* subsp. *pinnatifidum, Carex hallerana, Lithodora diffusa, Helleborus foetidus, Saponaria ocymoides, Paeonia broteroi* and *Cephalanthera rubra*). In both cases, the seral stages are the blackthorn-Cantabrian barberry hedges (*Pruno spinosae-Berberidetum cantabricae*), the basophilous grasslands (*Arenario cantabricae-Festucetum hystricis* y *Helianthemo cantabrici-Brometum erecti*) and the aulagares (*Lithodoro diffusae-Genistetum occidentalis*). In calcareous rock crevices live chasmophytic communities of *Centrantho-Saxifragetum canaliculatae* in which, together with *Saxifraga canaliculata*, coexist species such as *Centranthus lecoqii* or *Ceterach officinarum*, among others. In the calcareous screes live the communities of *Linario odoratissimae-Rumicetum scutati*, on medium and small-sized stones, and *Cystopterido pseudoregiae-Dryopteridetum submontanae*, among big-sized blocks.

The general pattern of this siliceous territory is expressed by the geosigmetum formed by the melojares vegetation series (*Linario triornithophorae-Querco pyrenaicae sigmetum*) on the slopes and the ash forests vegetation series (*Pruno padi-Fraxino excelsioris sigmetum*) and the Cantabrian willow shrubland vegetation series (*Salico cantabricae sigmetum*) in the bottom of the valleys. It is constantly repeated during some kilometres.

PICTURE 36

Locality: Pinar de Lillo León.
Altitude: 1,280 m.
Date: 22-VII-1999
Biogeography: Ubiñense subsector, Ubiñense-Picoeuropeano sector, Orocantabrian subprovince.
Bioclimatic belt]: Upper supratemperate (highmontane), hyperhumid.
Lithology: Limestone, quartzite and sandstone.

1. *Pinus sylvestris* populations inside the beech forest (*Blechno spicanti-Fagetum sylvaticae*) and the birch forest (*Luzulo henriquesii-Betuletum celtibericae*)
2. Highmontane birch forest of *Luzulo-Betuletum celtibericae*
3. Mire formed by peat bog highmontane Orocantabrian communities (*Calluno-Sphagnetum capillifolii eriophoretosum vaginatii*), sedge fen communities with a slight drainage of water (*Narthecio ossifragi-Sphagnetum tenelli*) and communities of the border of peaty ponds (*Cariceto carpetanae-Sphagnetum recurvi*).
4. Heathlands with gorses of *Vaccinio myrtilli-Ulicetum cantabricae*.
5. Willow shrublands of *Salicetum cantabricae*.
6. Silicicolous beech forest of *Blechno spicanti-Fagetum*.
7. Highmontane Orocantabrian piornales (brooms formations) of *Cytiso cantabrici-Genistetum polygaliphyllae*.
8. Furze scrub (aulagar) of *Lithodoro diffusae-Genistetum occidentalis*.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In the Puebla de Lillo area the geosigmetum is formed by the beech forests vegetation series (acidopylous *Blechno spicanti-Fago sylvaticae* sigmetum, and basophylos *Epipactido helleborines- Fago sylvaticae* sigmetum) on the north-facing slopes, and the melojares vegetation series (*Linario triornithophorae-Querco pyrenaicae* sigmetum)in the rest of the area till an altitude of 1,400 m. Above this level, due to the increase in continentality, the oak forests vegetation series (*Linario triornithophorae-Querceto petraeae* sigmetum) replaces the melojares. In the bottom of the valleys they continue the ash forests and the Cantabrian willow shrubland vegetation series.

At the stop of Puebla de Lillo we can appreciate all the stages of the acidophilous beech forests vegetation series: the forest itself (*Blechno spicanti-Fagetum sylvaticae)*, the piornal (*Cytiso cantabrici-Genistetum obtusirameae)*, the grassland (*Merendero pyrenaicae-Cynosuretum cristati)* and the heathland (*Daboecio cantabricae-Ericetum aragonensis)*. On limestone the aulagares of *Lithodoro diffusae-Genistetum occidentalis* and the grasslands of *Helianthemo cantabrici-Brometum erecti* are found.

The relic pine forest of Puebla de Lillo has been interpreted formerly as a beech forest with pines (*Blechno spicanti-Fagetum sylvaticae pinetosum sylvestris)*, in which *Fagus sylvatica*, *Betula celtiberica*, *Pinus sylvestris*, *Sorbus aucuparia*, *Ilex aquifolium, Luzula sylvatica* subsp. *henriquesii*, *Erica arborea*, *Saxifraga spathularis*, *Anemone nemorosa*, *Blechnum spicant*, *Vaccinium myrtillus*, *Deschampsia flexuosa*, *Melampyrum pratense* and *Oxalis acetosella*, among others, live together. But in the spots where *Pinus sylvestris* var. *iberica* is dominant or exclusive in the canopy, the understorey bears *Vaccinium myrtillus*, *Avenella flexuosa*, *Erica arborea*, *Saxifraga spathularis*, *Anemone nemorosa*, *Galium saxatile, Doronicum pubescens, Sorbus aria, Sorbus aucuparia, Festuca braunblanquetii, Hypericum richeri* subsp. *burseri, Homogyne alpina, Festuca paniculata* subsp. *fontqueri, Melampyrum pratense, Potentilla erecta, Meum athamanticum, Jasione laevis, Polygala vulgaris*, *Solidago virgaurea*, etc., and thus it could be considered as a true pine forest which still has not been included in any of the already described associations.

Inside the pine forest and in its surroundigs there are mires bearing the plant communities typical of them. The swamps are covered by the association *Cariceto carpetanae-Sphagnetum recurvi*, characterized by *Sphagnum recurvum, Carex nigra* subsp. *carpetana, Carex echinata, Polytrichum commune, Eriophorum vaginatum* and *Narthecium ossifragum.* In the reddish-Spahgnum bogs develop *Calluno vulgaris-Sphagnetum capillifolii eriophoretosum vaginati*, in which coexist *Sphagnum capillifolium, Erica tetralix, Calluna vulgaris, Scirpus caespitosus, Sphagnum magellanicum, Eriophorum vaginatum, Vaccinium myrtillus, Juncus squarrosus, Potentilla erecta, Sphagnum recurvum* and *Narthecium ossifragum*. In those habitats *Equisetum sylvaticum* also lives.

In contact with those mires, there are hygrophylic *Nardus* grasslands dominated by *Nardus stricta*, *Luzula campestris* subsp. *carpetana* and *Juncus squarrosus*, other species are *Potentilla erecta, Galium saxatile, Pedicularis sylvatica, Festuca nigrescens* subsp. *microphylla* and *Festuca rothmaleri*; they constitute the association *Luzulo carpetanae-Pedicularietum sylvaticae.* In the biotopes which become dry in summer due to the efficient drainage and where peat is scarcely developing, occur the communities of *Erico tetralicis-Trichophoretum germanici,* in which species such as *Scirpus caespitosus* subsp. *germanicus, Erica tetralix, Narthecium ossifragum, Carex echinata, Parnassia palustris* and *Juncus squarrosus* predominate.

Severely degraded areas near the pine forest are covered by heathlands of *Daboecio cantabricae-Ericetum aragonensis ulicetosum cantabrici*, among which a clear recovery of the birch woodlands (*Luzulo henriquesii-Betuletum celtibericae)* is observed. This pattern is repeated all the way up to the Señales pass and even in the siliceous part of the Tarna pass. In these upper supratemperate areas under hyperhumid ombrotype the heathlands of *Daboecio cantabricae-Ulicetum cantabrici* or of *Daboecio cantabricae-Ericetum aragonensis ulicetosum cantabrici*, the piornales of *Cytiso cantabrici-Genistetum obtusirameae*, the grasslands of *Merendero pyrenaicae-Cynosuretum cristati* and the Nardus grasslands of *Polygalo edmundii-Nardetum strictae* y la *Luzulo carpetanae-Pedicularietum sylvaticae* are abundant. All those associations are participants of the acidophilous beech forests vegetation series (*Blechno spicanti-Fago sylvaticae sigmetum*) or of the birch forests vegetation series (*Luzulo henriquesii-Betulo celtibericae sigmetum*) at higher altitudes or in more abrupt situations. It is also frequent to find tall herb communities of *Chaerophyllo hirsuti-Valerianetum pyrenaicae*, characterized by the exuberance of *Valeriana pyrenaica, Chaerophyllum hirsutum, Adenostyles alliariae* subsp. *pyrenaica, Cicerbita plumieri* and *Crepis paludosa*.

On calcareous substrata the basophilous beech forest vegetation series are found (*Epipactido helleborines-Fago sylvaticae* sigmetum and *Carici sylvaticae-Fago sylvaticae* sigmetum) which can be differentianted not only in their respective forestal floristic composition but also in their seral stages. The former vegetation series bears hedges of *Pruno spinosae-Berberidetum cantabricae*, aulagares of *Lithodoro diffusae-Genistetum occidentalis* and grasslands of *Helianthemo cantabrici-Brometum erecti* and of *Arenario cantabricae-Festucetum hystricis*. In this area chasmopytic communities of *Anemono pavonianae-Saxifragetum canaliculatae* and scree communities of *Cystopterido pseudoregiae-Dryopteridetum submontanae* or of *Linario odoratissimae-Rumicetum scutati* can be observed.

Nitrophylos thistle communities frequent on the edges of the roads belong to *Carduo nutantis-Cirsietum chodati*.

The geosigmetum is dominated by the beech forests vegetation series (acidophilous and basophilous) and is constant along the Riosol river valley till the villege of Riaño. Together with the beech forests vegetation series there is also the oak forests vegetation series (*Linario triornithophorae-Querco petraeae sigmetum*) in which the potential *Quercus petraea* forest (*Linario triornithophorae-Quercetum petraeae*) is accompanied by the piornales where *Cytisus oromediterraneus* is always present, resulting in the subassociation *Cytiso cantabrici-Genistetum obtusirameae cytisetosum oromediterranei,* indicating an increase in continentality. This climatic feature is also indicated by the heathlands of *Genis-*

tello tridentatae-Ericetum aragonensis hypericetosum burseri. Only those heathlands close to beech stands can be included in *Daboecio cantabricae-Ericetum aragonensis*.

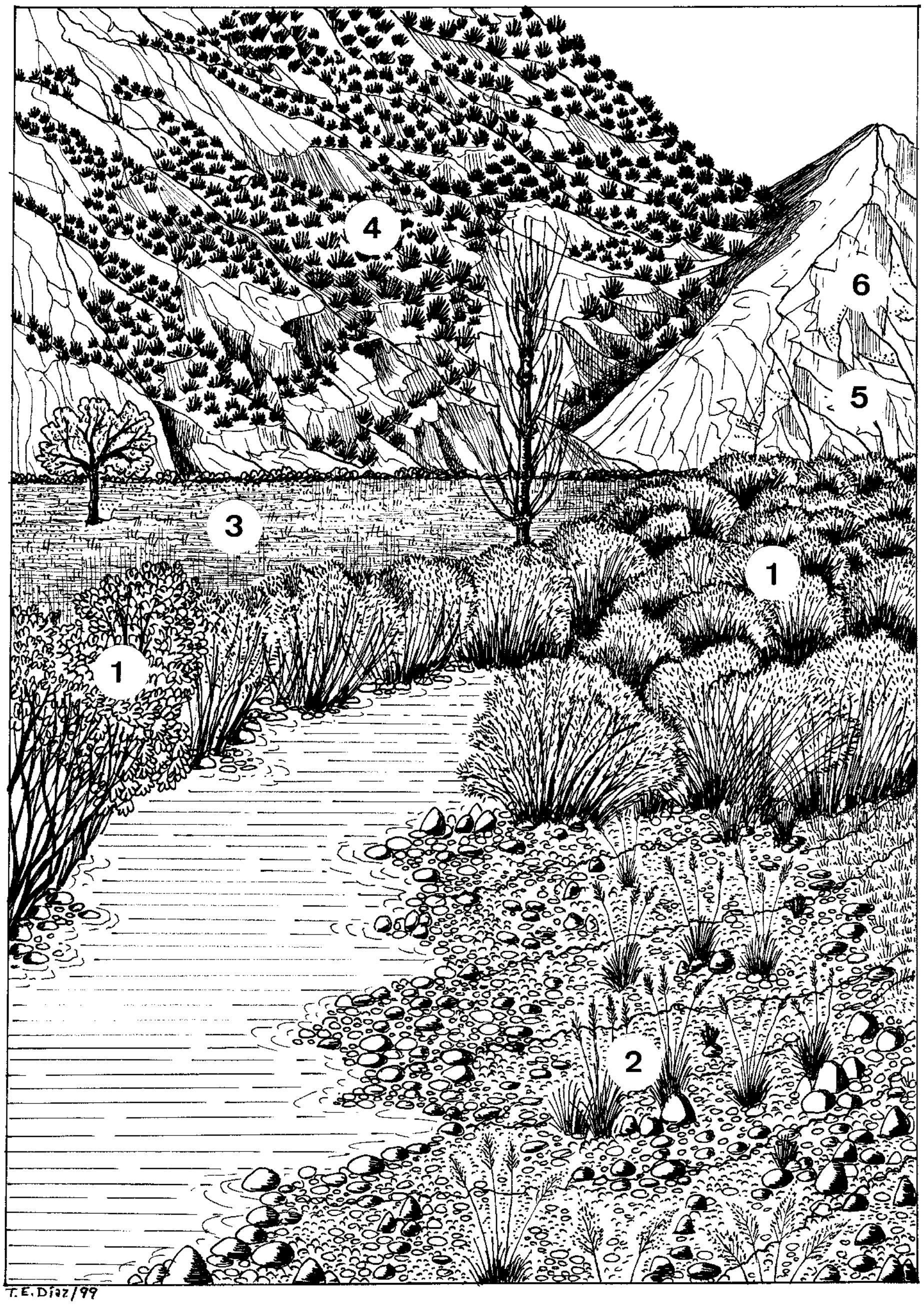
However, most of the area of those vegetation series is covered by grasslands due to human influence, trying to improve the food supply for the important livestock of this region. So, we find a huge extent of *Merendero pyrenaicae-Cynosuretum cristati* as well as hay meadows of *Malvo moschatae-Arrhenatheretum bulbosi*. This tendency increases in the bottom of the valleys where the edaphohygrophilous vegetation series (that of the ash forests or *Pruno padi-Fraxineto excelsioris sigmetum* and of the Cantabrian willow shrubland or *Saliceto cantabricae sigmetum*) are totally transformed into hay meadows (*Malvo moschatae-Arrhenatheretum bulbosi* and *Bromo commutati-Polygonetum bistortae*). Some woods of ashes, poplars and willows, together with hedges, remain in the places near the streams and in rows along the paths. The reasonably good state of conservation of this area is indicated by the lack of aulagares and heathlands and by the dominance of meadows and beech forests.

Leaving Riaño in the direction of the San Glorio pass, we leave the Ubiñense subsector and enter a new biogeographical unit, the Altocarrionés subsector. This territory is predominantly siliceous and its climate is markedly continentalized and submediterranean. That is why the dominant vegetation series are those of the melojares (*Linario triornithophorae-Querco pyrenaicae sigmetum*) and of the oak forests (*Linario triornithophorae-Querco petraeae sigmetum*), with the acidophilous beech forests vegetation series (*Blechno spicanti-Fago sylvaticae sigmetum*) searching for better moisture conditions restricted to the north-facing slopes where fog condensates. In the bottom of the valleys the ash forests (*Pruno padi-Fraxino excelsioris sigmetum*) and the Cantabrian willow shrubland (*Salico cantabricae sigmetum*) vegetation series develop.

PICTURE 37

Locality: Portilla de la Reina (León). Valle del río Esla.
Altitude: 1,320 m
Date: 22-VII-1999
Biogeography: Altocarriones subseector
Bioclimatic belt: Supratemperate
Lithology: Curavacas conglomerate

1. River side willow formations of the *Salicetum cantabricae*
2. Herbal formations on stone deposits beside the water flows (*Erucastro nasturtifolii-Calamagrostietum pseudophragmitis*).
3. Meadows and prairies (*Malvo moschatae-Arrhenatheretum*)
4. Continental altimontane and orocantabric broom formations of the *Cytisetum scopario-oromediterranei*
5. Orocantabric chasmophytic formations of the *Murbeckiello-Saxifragetum willkommianae*
6. Pioneer communites on siliceous lithosoils (*Agrostio durieui-Sedetum pyrenaici*)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Hence, the vegetal landscape of this territory is dominated by the melojares of *Linario triornithophorae-Quercetum pyrenaicae*, the oak forests of *Linario triornithophorae-Quercetum petraeae*, some beech forests of *Blechno spicanti-Fagetum sylvaticae* and, mainly, by piornales of *Cytisetum scopario-oromediterranei*, formed by *Cytisus oromediterraneus, Cytisus scoparius* and *Erica arborea*, piornales of *Cytiso scoparii-Genistetum polygaliphyllae*, heathlands of *Genistello tridentatae-Ericetum aragonensis hypericetosum burseri* and grasslands of *Merendero pyrenaicae-Cynosuretum cristati* and of *Scleranthо perennis-Plantaginetum radicatae*.

Siliceous rock crevices harbour exclusive communties of *Murbeckiello boryi-Saxifragetum willkommianae*, characterized and dominated by *Saxifraga willkommiana.*

However, the personality of the vegetation of this Altocarrionés area is found in its high-mountain vegetation (Murcia peak, Las Lomas peak, Tres Provincias, Peña Prieta, Curavacas). In the orotemperate (=subalpine) and criorotemperate (=alpine) belts of those mountains, under hyperhumid ombrotype, some exclusive plant communities of this territory occur. The alpine grasslands dominated by *Oreochloa blanka* are included in the association *Junco trifidi-Oreochloetum blankae*, which is the climax at this criorotemperate hyperhumid level. They, together with *Oreochloa blanka*, bear *Juncus trifidus, Jasione crispa, Festuca eskia, Minuartia recurva, Saxifraga moschata, Anthemis carpatica, Leontodon pyrenaeus, Luzula hispanica, Agrostis rupestris* and *Bellardiochloa violacea*, among others.

In the hyperhumid orotemperate belt the climax corresponds to dwarf juniper-bilberry shrublands of *Junipero nanae-Vaccinietum microphylli*, quite well developed and conserved in several spots in this area. The seral grasslands belong to *Teesdaliopsio confertae-Festucetum eskiae*. Scree communities achieve a high development and importance. Together with the above commented associations *Crypogrammo crispae-Dryopteridetum abbreviatae* and *Cryptogrammo crispae-Silenetum gayanae*, in those territories the endemic association *Linario filicaulis-Sperguletum viscosae* is found, in which coexist *Spergula viscosa, Linaria filicaulis, Cryptogramma crispa, Poa cenisia, Agrostis rupestris, Senecio pyrenaicus, Ranunculus parnassifolius* subsp. *cabrerensis* and *Linaria saxatilis*, among others.

In biotopes where snow accumulates, develop the chionoophylous herb communities of the association *Pediculari fallaci-Armerietum cantabricae*, quite frequent in this area and dominated by *Armeria cantabrica*, which is accompanied by *Alchemilla plicatula, Draba dedeana, Euphrasia salisburgensis, Gentiana verna, Helictotrichon sedenense, Myosotis alpestris, Arenaria purpurascens, Androsace villosa, Poa molinerii, Sedum atratum, Silene acaulis, Anthyllis vulneraria* subsp. *pyrenaica, Carex atrata* and *Carex parviflora*, etc.

At the San Glorio pass, in the upper supratemperate (highmontane) thermotype and the hyperhumid omrotype, without submediterranean influence, appear piornales of *Cytiso cantabrici-Genistetum obtusirameae*, heathlands of *Daboecio cantabricae-Ericetum* *aragonensis*, heathlands with gorses of *Daboecio cantabricae-Ericetum aragonensis ulicetosum cantabrici* and of *Daboecio cantabricae-Ulicetum cantabrici* and grasslands of *Merendero pyrenaicae-Cynosuretum cristati*. They constitute, together with some examples of beech forests of *Blechno spicanti-Fagetum sylvaticae*, the vegetation series of the acidophilous beech forests or *Blechno spicanti-Fago sylvaticae sigmetum*, which will be the dominant one until the end of today's journey. Near the village of Potes we enter the Picoeuropeano subsector and the vegetation series of this territory appear in the landscape. Among them we point out that of the carrascales or *Cephalanthero longifoliae-Querco rotundifoliae sigmetum*, those of the basophilous beech forests or *Carici sylvaticae-Fago sylvaticae sigmetum* and *Epipactido helleborines-Fago sylvaticae sigmetum* and that of the ash forests or *Polysticho setiferi-Fraxino excelsioris sigmetum*.

FUENTE DÉ-CERVERA DE PISUERGA (23 July)

(The vegetal landscape of the Picos de Europa)

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INTRODUCTION

The area we turn our attention to, partially included in the Picos de Europa National Park, embraces, from the political-administrative point of view, the southwestern part of the Principality of Asturias, the western extreme of the Community of Cantabria and the northeastern part of the Province of León (Castilla-León Community). It presents an extreme orographical, biogeograpical, bioclimatical and geological complexity, resulting in the extraordinary diversity of its flora and vegetation. The Picos de Europa form a montainous unit perfectly defined and limited, located between the main alignment of the Cantabrian Range and the sea, with an average altitude of 1,220 m ranging from 90 m in the lower course of the Cares river and the 2,649 m of the highest peak, Torre de Cerredo. This group of mountains can be divided into three massifs: a) the Western Massif or "El Cornión", limited by the Dobra (tributary of the Sella river) and the Cares rivers, b) the Central Massif or "Los Urrieles", between the Cares and Duje rivers,and c) the Eastern Massif or "Andara", limited by the Duje and Deva rivers.

Regarding the geology, most of the rocks are calcareous, corresponding to the unit given the same name (Picos de Europa), while the siliceous materials (belonging to the Pisuerga-Carrión unit) are concealed in the southern part of the area, below 1,800 - 1,900 m. The territory biogeographically belongs to the Picoeuropeano subsector (Ubiñense-Picoeuropeano sector, Orocantabrian subprovince, European Atlantic province, Eurosiberian region). A particular feature of its climate is the strong oceanic influence, more marked than in the other Orocantabrian massifs, although it is slightly lower than the coastal strip (belonging to the Ovetense subsector) located north of the Picos. This is due to their proximity to the seashore and emphasizes the originality of those mountains from the rest of the Cantabrian Range, more continental in their climate. The climatic diversity of this territory is very high, especially that referring to the thermotypes; the lower areas of the northern slope are mesotemperate (colline), the supratemperate (Montane) occupies a vast extent in a broad altitudinal range as well as the orotemperate (subalpine). The criorotemperate (alpine) is well represented in the summital areas of the highest mountains, although it occupies a much more reduced area. Asfor the ombrotypes, diversity is lower, ranging from humid, on the south-facing slopes of the mountains, to ultrhyperhumid; nevertheless, most of the area can be included in the hyperhumid ombrotype.

In the following text, we will briefly describe the vegetal landscape of the Picos de Europa framed in the different vegetation belts and most important vegetation series. Plant communities are illustrated with synthetic tables set up with relevés exclusively original from the Picos de Europa or surrounding areas.

THE COLLINE AND MONTANE VEGETATION

The areas of the colline (mesotemperate) and montane (supratemperate) bear vegetation series whose potential natural vegetation corresponds to several forest types which, as in other territories of the European Atlantic province, are mostly formed by summergreen broad-leaved deciduous trees. The vegetation series of those calcareous Picoeuropeanos territories correspond to those of the oak forests with ash, carrascales, alder forests and beech forests.

Oak and ash forests vegetation series (*Mercurialidi perennis-Fraxino excelsioris* sigmetum)

The richest colline soils of the Orocantabrian subprovince, usually linked to calcareous substrata, have as potential natural vegetation a forest type which is represented by the *Mercurialidi perennis-Fraxinetum excelsioris* association. Those forests are quite similar to the homologus oak-ash forests existing in the limiting areas belonging to the Cantabrian-Atlantic subprovince; they can be differentiated by the oak species: *Quercus petraea* is common in the former and *Q. robur* replaces it in the latter, as it is a very rare tree in the Orocantabrian area. In those forests, the tree canopy has a very varied composition with *Quercus petraea* is not always being the domiant tree, even in its mature stage because in the rainiest areas the dominance can be held by the beech. The young stages are usually dominated by fast-growing trees such as ashes (*Fraxinus excelsior*) and maples (*Acer pseudoplatanus*); limes (*Tilia platyphyllos* and *T. cordata*) are abundant in the rupicolous habitas of the calcareous areas. According to the described variability, we can distinguish the following variants for *Mercurialidi perennis-Fraxinetum excelsioris*: a) typical variant with *Tilia cordata* on karstic substrata; b) *Fagus sylvatica* variant of hyperhumid areas; c) *Quercus pyrenaica* variant of drier and sunnier habitat; and d) *Quercus petraea* variant, the most common.

Mercurialidi perennis-Fraxinetum excelsioris (10 rels.): Charcateristics and differentials of association and upper units: V *Fraxinus excelsior*, IV *Quercus petraea*, III *Acer pseudoplatanus*, III *Tilia platyphyllos*, V *Hedera helix,* V *Crataegus monogyna*, V *Corylus avellana*, V *Mercurialis perennis*, V *Polystichum setiferum*, IV *Stellaria holostea*, IV *Tamus communis*, V *Primula vulgaris*, V *Carex sylvatica*, IV *Helleborus occidentalis*, III *Melica uniflora*, IV *Brachypodium sylvaticum*, II *Cornus sanguinea*, IV *Rubus ulmifolius* p.m.p., III *Rosa arvensis*, III *Lonicera periclymenum*, II *Fragaria vesca*, II, *Crepis lampsanoides*, III *Viola* gr. *sylvestris*, IV *Euphorbia dulcis*, II *Phyllitis scolopendrium*, III *Euphorbia amygdaloides*, II *Bromus ramosus*, II *Lilium martagon*, II *Helleborus foetidus*, I *Melittis melissophyllum*, I *Asplenium onopteris*, III *Saxifraga hirsuta*, III *Sanicula europea*, II *Buglossoides purpurocaerulea*, II *Carex caudata*, III *Ulmus glabra*, II *Ilex aquifolium*, I *Castanea sativa*, I *Ruscus aculeatus*, I *Stachys officinalis*, I *Euonymus europaeus*, I *Prunus avium*, I *Sorbus aria*, II *Hepatica nobilis*, I *Stachys alpina*, II *Polypodium vulgare*, I *Primula veris*, I *Prunus spinosa*, I *Teucrium scorodonia*, I *Rhamnus alaternus*, I *Rubia peregrina*, I *Ranunculus nemorosus*, I *Aquilegia vulgaris*, I *Lathyrus niger*, I *Solidago virgaurea*, I *Hyacinthoides non-scripta*. Differentials of the variants: III *Quercus pyrenaica*, III *Fagus sylvatica*, II *Tilia cordata*. Companions: III *Laserpitium latifolium*, III *Geranium robertianum*, III *Astrantia major, etc*. (Fernández Prieto & Vázquez, *1987*: 378-379, Tab. 5, rels. 4-8 and 10; Díaz González & Fernández Prieto, *1994a*: Tab. 3, rels. 1, 7, 11 and 12,) The area occupied by this vegetation series (*Mercurialidi perennis-Fraxino excelsiori* sigmetum) is intensively exploited by man as it is covered by the most fertile soils and the climate is relatively mild. This conditions that the potential forest are reduced to small patches often in early succesional stage where pioneer trees such as ash and maple dominate. Only in the abrupt areas, where the lime variant is common, can well preserved examples be found.

Their forest mantles are rich in woody species with many wild roses (*Rosa* sp. pl.), brambles (mostly *Rubus ulmifolius*), hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*), dogwood (*Cornus sanguinea*), wild privet (*Ligustrum vulgare*), St. Lucie cherry (*Prunus mahaleb*), etc. Those spiny mantles are near to the assocation *Rubo ulmifolii-Tametum communis* although they present some remarkable differences to it, at least with the mantles of the Ovetense subsector. In abrupt calcareous reliefs appear communities of *Pruno spinosae-Berberidetum cantabricae* whre, together with the above mentioned shrubs, the bearberry (*Berberis vulgaris* subsp.*cantabrica*), juneberry (*Amelanchier ovalis*) and Alpine buckthorn (*Rhamnus alpina*) live.

On eroded soils appear, as seral stage, the aulagares of *Lithodoro diffusae-Genistetum legionensis*. Those scrub communities are rich in pulvinate chamaephytes and tuft hemicriptophytes, being the endemic *Genista legionensis* the most outstanding species. Those aulagares occupy preferably rupicolous habitats in the Picos de Europa area, in the colline and montane belts.

Lithodoro diffusae-Genistetum legionensis ericetosum vagantis *et* ***fumanetosum ericoidis*** (9 rels): Charcateristics and differentials of association and upper units: V *Genista legionensis*, IV *Genista occidentalis*, V *Lithodora diffusa*, IV *Helianthemum urrielense*, IV *Teucrium pyrenaicum*, IV *Koeleria vallesiana*, IV *Helianthemum oelandicum subsp. incanum*, III *Euphorbia flavicoma* subsp. *occidentalis*, III *Globularia nudicaulis*, III *Carduncellus mitissimus*, II Sideritis *hyssopifolia*, I *Linum salsoloides*, II *Thymelaea ruizii*. Differentials of subassociations: IV *Erica vagans*, I *Fumana ericoides*. Companions: III *Brachypodium rupestre*, III *Carex brevicollis*, III *Bromus erectus* (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas *1984*: Tab. 20, rels. 19-25; Díaz González, Penas, López Pacheco, Puente & J. Andrés *1988*: tab. 1, rels. 2; Díaz González & Fernández Prieto *1992:* 74)

The best soils of this vegetation series have been traditionally devoted to different types of meadows: *Lino biennis-Cynosuretum cristati* and *Malvo moschatae-Arrhenatheretum elatioris*; crop fields have also been common.

Riverine vegetation series (*Hyperico androsaemi-Alno glutinosae* sigmetum and *Salico cantabricae* sigmetum)

Along the banks of the rivers there is a level at which the soils are permanently humid due to the oscillating water table (umbric fluvisols) and there one finds the potential area of the adler forests of the *Hyperico androsaemi-Alnetum glutinosae* (*Hyperico androsaemi-Alno glutinosae* sigmetum). They present a canopy dominated by adler (*Alnus glutinosa*) which coexists with other trees such as ash (*Fraxinus excelsior*), maple (*Acer *pseudoplatanus*), elm (*Ulmus glabra*) and lime (*Tilia platyphyllos*). The poplar (*Populus nigra*) also appears together with *Populus* x *canadensis*, often cultivated in these river banks. The shrub layer is very rich in species with willows (*Salix atrocinerea*, *Salix caprea*, *Salix alba*, *Salix fragilis*), spindle (*Euonymus europaeus*), dogwood (*Cornus sanguinea*), hazel (*Corylus avellana*), hawthorn (*Crataegus monogyna*), etc. This floristic richness is also shown by the herbaceous layer where many fern species (*Dryopteris affinis*, *Dryopteris dilatata*, *Athyrium filix-femina*, *Polystichum setiferum*, *Phyllitis scolopendrium*, etc) as well as many soil moisture demanding plants such as *Carex remota*, *Carex pendula*, *Silene dioica*, *Circaea lutetiana*, *Festuca gigantea*, *Lamiastrum galeobdolon*, *Lathraea clandestina*, etc. occur. When the rivers cross quartzite or limestone areas, *Osmunda regalis*, absent in the base rich territories, appears.

Hyperico androsaemi-Alnetum glutinosae (5 rels.): Charcateristics and differentials of association and upper units: V *Alnus glutinosa*, V *Fraxinus excelsior*, V *Corylus avellana*, III *Salix atrocinerea*, II *Crataegus monogyna*, V *Hypericum androsaemum*, V *Polystichum setiferum*, V *Carex pendula*, I *Dryopteris aemula*, I *Dryopteris dilatat*a, II *Equisetum telmateia*, III *Athyrium filix-femina*, I *Blechnum spican*t, IV *Brachypodium sylvaticum*, V *Hedera helix*, I *Saxifraga hirsuta*, I *Crepis lampsanoides*, I *Festuca gigantea*, II *Dryopteris affinis*, I *Phyllitis scolopendrium*, II *Viola riviniana*, I *Cornus sanguinea*, I *Carex sylvatica*, II *Tamus communis*, I *Carex remota,* II *Euphorbia dulcis*, I *Primula vulgaris*, I *Circaea lutetiana,* I *Lamiastrum galeobdolon*, III *Bromus ramosus*, I *Lonicera peryclimenum*, I *Prunus spinosa*, II *Euphorbia amygdaloides*, I *Pulmonaria longifolia*, II *Poa nemoralis,* I *Veronica montana*, I *Frangula alnus*. Companions: III *Angelica sylvestris*, III *Pimpinella major* (Amigo, J Guitián & Fernández Prieto 1987, Tab. 2, rels. 11, 12, 13 and 17,. 74; Pérez Carro. 1990, Tab. 11, rel. 5)

The mantle of the alder forest varies depending on the soil degree of moisture; on the less humid soils (usually located in the band closer to the slope not influenced by the water table and more separated from the stream), the mantle corresponds to the *Rubo ulmifolii-Tametum communis* in a version with a lot of *Salix atrocinerea*, *Cornus sanguinea*, *Crataegus monogyna*, etc., while in the most humid band the mantle is a willow shrubland with *Salix atrocinerea, Salix caprea*, *Frangula alnu*s and a herbaceous layer formed by hygrophile plants. In the Ovetense territories those alder forests contact with the willow formations of *Salix eleagnos* subsp. *angustifolia* and *Salix alba* belonging to *Salicetum angustifolio-albae*. Those willow shrublands occupy fine-textured soils on the river banks and beds, flooded by calm waters only during the big spates. Closer to the permanet stream channel, there is another willow community formed almost entirely by *Salix eleagnos* subsp. *angustifolia* on pebble beds and exposed to violent stream.

In the bottom of the valleys, a large part of the area corresponding to those riverine forests have been transformed into hay meadows as the grass grows also in summer, when the production diminishes in the meadows laying in the slopes. Those humid meadows have a particular floristic composition with several reeds (*Juncus conglomeratus*, *Juncus effusus* and *Juncus acutiflorus*) and other plants of similar hydric requirements such as *Lychnis flos-cuculi*, *Bromus racemosus* or *Lotus pedunculatus*.

In the upper stretches of the Orocantabrian river courses and streams, the willow shrubland is formed bu *Salix cantabrica* (*Salicetum cantabricae*) which is often accompanied by other willow species; the richness in those willow species and hybrids is maximal in the transition with the Mediterranean region.

Salicetum cantabricae (10 rels.): Characteristics and differentials of association and upper units: V *Salix cantabrica*, II *Salix elaeagnos* subsp. *angustifolia*, *Salix purpurea* subsp. *lambertiana*, II *Salix triandra* subsp. *discolor*, II *Salix alba*, + *Salix x expectata* (*S. atrocinerea* x *S. cantabrica*), + *Salix x rijosa* (*S. cantabrica* x *S. triandra* subsp. *discolor*). Companions: IV *Mentha longifolia*, III *Salix atrocinerea*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984, Tab. 50, rels. 1-8; Díaz González & Penas, 1987, Tab. 2, rels. 1-2)

Vegetation series of the carrascales (*Cephalanthero longifoliae-Querco rotundifoliae* sigmetum)

The carrascales (*Quercus rotundifolia* forests) occupy a relatively modest extent in the area but they have a high landscape value and a deep palaeoclimatic significance as they are a remain of the northward migrations of Mediterranean flora and vegetation in the past. This vegetation series occupies sunny south-facing slopes in the colline (mesotemperate) level of the northern slope of the Cantabrian Range (Ubiñense-Picoeuropeano sector). The soils are base-rich and dry, usually of the *terra rossa* or *terra fusca* types on limestone substrate. The mature forest (*Cephalanthero longifoliae-Quercetum rotundifoliae*) is scarce nowadays; in rupicolous habitats remain open woodlands with low trees living on abrupt calcareous canyons, karstic areas or well drained colluvia. There are not many evergreen shrubs, the most frequent being *Rhamnus alaternus*, *Smilax aspera* and *Rubia peregrina* and the forest mantle bears, among other shrubs; *Rhamnus alaternus*, *Rosa sp. pl*., *Berberis vulgaris* subsp. *cantabrica, Prunus mahaleb, Amelanchier ovalis, Rhamnus alpina* and *Prunus spinosa*, many of them of marked calcicolous character and winter frost resistant. In the transition area towards the Ovetense subsector, some lauroid winter cold sensitive elements appear such as Laurus nobilis and Rosa sempervirens; this permits us to consider a particular geographical race in this belt (*rosetosum sempervirentis* subassociation).

Cephalanthero longifoliae-Quercetum rotundifoliae (5 rels.): Characteristics and differentials of association and upper units: V *Quercus rotundifolia*, V *Quercus x gracilis* (*Q. rotundifolia* x *Q. ilex*), IV *Phillyrea latifolia*, IV *Rhamnus alaternus*, III *Pistacia terebinthus*, III *Arbutus unedo*, III *Juniperus oxycedrus*, *Phillyrea media*, II *Jasminum fruticans*, I *Quercus faginea*, V *Rubia peregrina*, V *Helleborus foetidus*, IV *Smilax aspera*, III *Origanum virens*, II *Cephalanthera longifolia*, I *Teucrium pinnatifidum*, I *Ruscus aculeatus*, I *Osyris alba*, I *Epipactis microphylla*, I *Epipactis helleborine*, I *Piptatherum paradoxum*. Differentials of subassociations: I *Rosa sempervirens*, *Saxifraga continentalis*, I *Erica arborea*. Companions: IV *Brachypodium rupestre*, IV *Genista occidentalis*, IV *Crataegus monogyna*, III *Cistus salvifolius*, III *Tamus communis*, III *Genista legionensis*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984, Tab. 10, rels. 1-5)

As first seral stage those carrascales present a spiny community rich in bearberry (*Pruno spinosae-Berberidetum cantabricae*) in the most continental areas or calcicolous evergreen shrublands formed by *Phillyrea latifolia*, *Arbutus unedo* and *Rhamnus alaternus* (*Phillyreo latifoliae-Arbutetum unedonis)* when oceaneity increases.

Phillyreo latifoliae-Arbutetum unedonis (8 rels.): Characteristics and differentials of association and upper units: V *Phillyrea latifolia*, III *Arbutus unedo*, III *Rhamnus alaternus*, III *Quercus rotundifolia*, II *Quercus x gracilis*, I *Pistacia terebinthus*, I *Osyris alba*, V *Smilax aspera*, III *Rubia peregrina*, II *Ruscus aculeatus*, I *Asplenium onopteris*. Companions: IV *Erica vagans*, III *Genista legionensis*, III *Genista occidentalis*, III *Lithodora diffusa*, III *Helictotrichon cantabricum*, III *Crataegus monogyna*, III *Brachypodium rupestre*, III *Melica ciliata*, III *Euphorbia flavicoma* subsp. *occidentalis*, III *Teucrium pyrenaicum*, III *Globularia nudicaulis*, III *Helianthemum nummularium*, III *Rosa sempervirens*. (Mayor & Álvarez, 1978: 3, rels. 1-6; García Rodríguez 1995, Tab. 5 (gr. 16), rels. 263-264).

In the gaps of those shrublands perennial *Brachypodium pinnatum* subsp. *rupestre* grasslads are frequent, but on lithosols and shallow soils, the aulagares of *Lithodoro diffusae-Genistetum legionensis fumanetosum ericoidis* replace them.

In the siliceous areas of La Liébana valley, there are some carracales of the aforementioned association which are much poorer floristically and whose understorey bears some clearly acidophilous plants such as *Arbutus unedo*, *Erica arborea* and *Juniperus oxycedrus*. Those silicicolous carrascales constitute a race particular of La Liébana district, inside the *Cephalanthero longifoliae-Quercetum rotundifoliae*. *Quercus suber* (alcornoque) appears in some of the woods mixed with *Quercus rotundifolia* and sometimes even form quite pure stands (alcornocales); they are often accompanied by a piornal of *Genista florida* subsp. *polygaliphylla*, which is replaced by a dry heathland when the upper layers of the soils are eroded.

The quejigares (*Quercus faginea* forests) are not frequent in the area, they appear in areas quite similar to La Liébana, as is Valdeón, where this tree mixes with carrasca or with the beech.

Beech forests (hayedos) vegetation series (*Carici sylvaticae-Fago sylvaticae* sigmetum, *Blechno spicanti-Fago sylvaticae sigmetum* and *Epipactido helleborines-Fago sylvaticae sigmetum*)

Perhaps the most representative potential forest type of the montane Orocantabrian area under hyperhumid and ultrhyperhumid omric conditions, are the beech forests. Depending on substratum and ombrotype we can distinguish three vegetation series where the beech forest is the mature stage: *Carici sylvaticae-Fago sigmetum*, *Blechno spicanti-Fago sigmetum* and *Epipactido helleborines-Fago sigmetum*.

In the calcareous ares of the Orocantabrian subprovince (essentially in the Ubiñense-Picoeuropeano sector) the montane (supratemperate) ombrophile beech forests vegetation series (*Carici sylvaticae-Fago sigmetum*) is predominant. The potential forest: *Carici sylvaticae-Fagetum sylvaticae*, develops on humic-calcic cambisols or calcic luvisols and in its understorey little trees and shrubs such as *Sorbus aria*, *Ilex aquifolium* and *Corylus avellana* appear. The herbaceous layer is species rich and has many nutrient-demanding species such as *Galium odoratum*, *Carex sylvatica*, *Mercurialis perennis*, *Daphne laureola*, *Helleborus viridis* subsp. *occidentalis*, *Melica uniflora*, *Corydalis bulbosa*, *Scilla lilio-hyacinthus*, *Veronica montana*, *Polystichum aculeatum*, *Hepatica nobilis*, *Hordelymus* *europaeus*, *Brachypodium sylvaticum*, etc. On karstic soils, shallower and drier, occurring on steep slopes of massive limestone massifs, there is a faciation (seslerietosum albicantis subassociation) in where the ground is rocky and litter accumulates in a higher proportion; *Rhamnus alpina*, *Ribes alpinum*, *Sesleria albicans*, *Carex caudata* and *Helictotrichon cantabricum* are the indicator species for this variant.

Carici sylvaticae-Fagetum sylvaticae (11 rels.): Characteristics and differentials of association and upper units: V *Fagus sylvatica*, V *Galium odoratum*, V *Carex sylvatica*, IV *Melica uniflora*, IV *Scilla lilio-hyacinthus*, III *Paris quadrifolia*, III *Mercurialis perennis*, III *Daphne laureola*, IV *Helleborus viridis* subsp. *occidentalis*, IV *Viola reichenbachiana*, II *Cardamine impatiens*, IV *Oxalis acetosella*, IV *Polystichum aculeatum*, IV *Anemone nemorosa*, III *Hepatica nobilis*, III *Polygonatum multiflorum*, III *Euphorbia amygdaloides*, III *Crepis lampsanoides*, III *Poa nemoralis*, III *Sanicula europea*, II *Corylus avellana*, II *Ranunculus nemorosus*, II *Stellaria holostea*, I *Ilex aquifolium*, I *Laserpitium nestleri*, I *Fragaria vesca*, I *Dryopteris filix-mas*, I *Dryopteris dilatata*, I *Euphorbia hyberna*, I *Saxifraga hirsuta*, I *Lilium pyrenaicum*, I *Hordelymus europaeus*, I *Milium effusum*, I *Neottia nidus-avis*, I *Veronica montana*, I *Epilobium montanum*, I *Lysimachia nemorum*, I *Geranium sylvaticum*, I *Quercus petraea*, I *Crataegus monogyna*, I *Fraxinus excelsior*, I *Primula veris*, I *Aquilegia vulgaris*, I *Cephalanthera rubra*, I *Monotropa hypopitys*, I *Lathyrus niger*, I *Physospermum cornubiense*, I *Dryopteris affinis*, I *Polystichum x bicknellii*, I *Athyrium filix-femina*, I *Dryopteris carthusiana*, I *Lilium martagon*, I *Polygonatum verticillatum*, I *Polystichum lonchitis*, I *Gymnocarpium robertianum*, I *Euphorbia dulcis*, I *Brachypodium sylvaticum*, I *Carex brevicollis*, I *Actaea spicata*, I *Mycelis muralis*, I *Blechnum spicant*, *Lathyrus occidentalis* subsp. *hispanicus*, I *Pimpinella siifolia*. Differentials of subassociations: I *Sesleria albicans*, I *Carex caudata*, I *Helictotrichon cantabricum*. Companions: III *Gymnocarpium dryopteris*, III *Pteridium aquilinum*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 5, rels. 1-7; Pérez Carro & Díaz González 1987: Tab. 1, rels. 1-2; Tab. 2, rel. 2; Díaz González & Fernández Prieto 1994a: 274)

The spiny forest mantle of this beech forest type bears several species of Rosa, *Prunus spinosa*, *Crataegus monogyna* and *Corylus avellana*. On shallow dry soils on massive limestone, the forest mantle belongs to the association *Pruno spinosae-Berberidetum cantabricae*, with *Berberis vulgaris* subsp. *cantabrica* several roses (*Rosa* sp. pl.), *Rhamnus alpina*, *Amelanchier ovalis* and *Prunus mahaleb*.

Pruno spinosae-Berberidetum cantabricae (7 rels.): Characteristics and differentials of association and upper units: IV *Berberis vulgaris* subsp. *cantabrica*, IV *Rosa pendulina*, I *Ribes alpinum*, II *Daphne laureola*, II *Mercurialis perennis*, I *Pimpinella siifolia*. Companions: III *Helictotrichon cantabricum*, III *Juniperus communis* subsp. *alpina*, III *Festuca burnatii*, III *Asperula hirta*. (Nava Fernández 19881988: Tab. 26, rels. 1-7).

When the upper horizons of the soil are eroded, the above commented vegetation types of this vegetation series disappear and are replaced by a basophilous scrub rich in aulagas (*Genista legionensis* and *Genista occidentalis*) as well as *Lithodora diffusa* and *Erica vagans* (*Litodoro diffusae-Genistetum legionensis ericetosum vagantis*). If soils are deeper and become leached, with an evident decarbonatation, soil moisture increases and a certain hydromorphy occurs, then the scrub is a heathland with gorses of the association *Vaccinio myrtilli-Ulicetum gallii* where *Ulex cantabricus* (*Ulex gallii* 2n=96), *Daboecia cantabrica* and several *Erica* species are frequent.

Vaccinio myrtilli-Ulicetum gallii (3 rels.): Characteristics and differentials of association and upper units: V *Ulex cantabricus*, V *Erica vagans*, II *Daboecia cantabrica*, II *Calluna vulgaris*, I *Carex asturica*. Companions: III *Brachypodium rupestre*, III *Potentilla erecta*, III *Lotus corniculatus*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984*:* Tab. 24, rel. 1; Nava Fernández 19881988: Tab. 29, rels. 1-2).

The territory is basically exploited for husbandry and thus hay meadows (*Malvo moschatae-Arrhenatheretum bulbosi*)and grazing meadows (*Merendero montanae-Cynosuretum cristati)* were intensively exploited in old times; nowadays this activity is clearly declining due to the present socio-economical conditions.

Malvo moschatae-Arrhenatheretum bulbosi (7 rels.): Characteristics and differentials of association and upper units: IV *Arrhenatherum elatius* subsp. *bulbosum*, V *Trisetum flavescens*, III *Malva moschata*, V *Cynosurus cristatus*, V *Festuca rubra* s.l., V *Trifolium repens*, V *Holcus lanatus*, V *Trifolium pratense*, V *Sanguisorba minor*, II *Gaudinia fragilis*, II *Knautia arvensis*, III *Pimpinella major*, IV *Poa pratensis*, IV *Centaurea nigra*, III *Rhinanthus minor*, IV *Anthoxanthum odoratum*, IV *Agrostis tenuis*, II *Bromus commutatus*, II *Leontodon autumnalis*, IV *Plantago lanceolata*, V *Dactylis glomerata*, II *Rumex acetosa*, III *Prunella grandiflora* subsp. *pyrenaica*, III *Crepis capillaris*, III *Achillea millefolium*, I *Cirsium pannonicum*, I *Tragopogon pratensis*, I *Heracleum sphondylium* s.l., I *Galium erectum*, IV *Anthyllis vulneraria* subsp. *pyrenaica*, III *Leucanthemum vulgare* s.l., II *Trifolium campestre*, II *Linum bienne*, II *Veronica chamaedrys*, III *Daucus carota*, II *Primula veris*, II *Bellis perennis*, IV *Trifolium dubium*, III *Rhinanthus asturicus*, II *Poa trivialis*, IV *Hypochoeris radicata*, IV *Lotus corniculatus*, I *Briza media*. Companions: V *Medicago lupulina*, IV *Plantago media*, III *Geranium pyrenaicum*, III *Scabiosa columbaria*. III *Brachypodium rupestre*. (Tüxen & Oberdorfer 1958: Tab. 38, rels. 110, 108, 150, 144, 148, 109; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 28, rel. 1).

Merendero montanae-Cynosuretum cristati (7 rels.): Characteristics and differentials of association and upper units: V *Cynosurus cristatus*, IV *Nardus stricta*, IV *Merendera montana*, V *Festuca rubra* s.l., V *Trifolium repens*, III *Phleum bertolonii*, III *Danthonia decumbens*, V *Hypochoeris radicata*, V *Plantago media*, IV *Carex caryophyllea*, I *Ranunculus bulbosus*, III *Eryngium bourgatii*, II *Euphrasia hirtella*, III *Agrostis tenuis*, V *Bellis perennis*, III *Taraxacum officinale*, I *Veronica chamaedrys*, IV *Trifolium pratense*, II *Leontodon hispidus*, I *Poa trivialis*, I *Rumex acetosa*, IV *Prunella vulgaris*, *Plantago lanceolata*, III *Lotus corniculatus*, I *Carum verticillatum*. Companions: III *Hieracium pilosella*, *Thymus pulegioides*, III *Medicago lupulina III Senecio jacobaea.* (Tüxen & Oberdorfer 1958: Tab. 36, rels. 116, 93, 94, 97. 1958; Díaz González & Fernández Prieto 1992: 70).

Under similar climatic conditions, on base poor substrata (slate and sandstone) the acidophilous montane Orocantabrian beech forest vegetation series is found: *Blechno spicanti-Fago sylvaticae sigmetum*. Although the acidophilous forest are scanty in the Picos de Europa (they are frequent only in its southern strip: La Liébana, Valdeón, Sajambre), the alternance between neutro-basophilous and acidophilous beech forests is repeated in almost all the Orocantabrian territory. This phenomenon is pointed out by the change in the floristic composition of the beech forests as well as by the seral stages. The silicicolous beech forest of *Blechno spicanti-Fagetum sylvaticae* live on distric cambisols or humic cambisols; the Cantabrian birch,(*Betula celtiberica*) is a frequent tree in those beech forests. The shrub layer is formed by *Vaccinium myrtillus, Sorbus aucuparia* and *Erica arborea;* in the herbaceous layer, predominate *Luzula sylvatica* subsp. *henriquesii*, *Saxifraga spathularis*, *Ave-*

nella flexuosa, *Blechnum spicant* and *Galium rotundifolium*, among other, forming a floristic combination quite similar to that of the acidophilous oak-birch forests.

Blechno spicanti-Fagetum sylvaticae (13 rels.): Characteristics and differentials of association and upper units: V *Fagus sylvatica*, V *Vaccinium myrtillus*, V *Deschampsia flexuosa*, IV *Blechnum spicant*, IV *Luzula sylvatica* subsp. *henriquesii*, V *Anemone nemorosa*, V *Oxalis acetosella*, IV *Ilex aquifolium*, IV *Stellaria holostea*, IV *Athyrium filix-femina*, III *Holcus mollis*, III *Gymnocarpium dryopteris*, III *Polypodium vulgare*, III *Euphorbia dulcis*, III *Dryopteris dilatata*, III *Dryopteris affinis*, III *Hieracium murorum*, II *Saxifraga spathularis*, II *Polygonatum verticillatum*, II *Hypericum pulchrum*, II *Viola riviniana*, II *Melampyrum pratense*, II *Veronica officinalis*, II *Polytrichum attenuatum*, II *Lonicera periclymenum*, II *Crepis lampsanoides*, II *Dryopteris expansa*, II *Poa nemoralis*, II *Quercus petraea*, II *Saxifraga hirsuta*, III *Sorbus aucuparia*, I *Luzula forsteri*, I *Hyacinthoides non-scripta*, I *Pyrola minor*, I *Corydalis claviculata*, I *Galium rotundifolium*, I *Homogyne alpina* var. *cantabrica*, I *Linaria triornithophora*, I *Physospermum cornubiensis*, I *Moerhingia trinervia*, I *Euphorbia amygdaloides*, I *Lysimachia nemorum*, I *Sorbus mougeotii*, *Helleborus viridis* subsp. *occidentalis*, I *Monotropa hypopitys*, I *Dryopteris filix-mas*, I *Mycelis muralis*, I *Polystichum setiferum*, I *Lilium martagon*, I *Quercus pyrenaica*, I *Polystichum aculeatum*, I *Euphorbia hyberna*, I *Festuca altissima*, I *Sanicula europaea*, I *Hepatica nobilis*, I *Melica uniflora*, I *Symphytum tuberosum*, I *Sambucus nigra*, I *Crataegus monogyna*. Differentials of subassociations: II *Scilla lilio-hyacinthus*, I *Galium odoratum*, I *Milium effusum* , I *Corylus avellana*, I *Fraxinus excelsior*. Companions: IV *Pteridium aquilinum*, III *Genista florida* subsp. *polygaliphylla*, III *Asphodelus albus*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 7, rels. 1-13).

The shrubby forest mantle of those acidophilous beech forests bear *Corylus avellana*, *Crataegus monogyna*, *Salix atrocinerea*, *Salix caprea*, *Frangula alnus* and *Erica arborea*. In the sunny biotopes the forest mantle is a piornal of the association *Cytiso cantabrici-Genistetum polygaliphyllae*. The degradation phase of those piornales or its initial stage is represented by simpler communities of *Cytisus cantabricus*.

Cytiso cantabrici-Genistetum polygaliphyllae (13 rels.): Characteristics and differentials of association and upper units: V *Cytisus cantabricus*, V *Genista florida* subsp. *polygaliphylla*, IV *Pteridium aquilinum*, II *Erica arborea*, I *Adenocarpus complicatus* subsp. *lainzii*. Companions: IV *Teucrium scorodonia*, III *Erica cinerea*, III *Daboecia cantabrica*, III *Avenula sulcata*, III *Deschampsia flexuosa*, III *Dactylis glomerata*, III *Digitalis purpurea*, III *Quercus pyrenaica* (pl.). (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 7, rels. 1-13).

Degraded soils are colonized by heathlands with gorses of *Vaccinio myrtilli-Ulicetum gallii* in which *Ulex cantabricus* (*Ulex gallii* 2n=96) is dominant, together with *Erica vagans* and *Daboecia cantabrica*, among others. The area is traditionally devoted to husbandry with plots of hay meadows (*Arrhenatherion*) and grazing meadows (*Cynosurion cristati*); this activity is decaying, as commented above.

In the less rainy areas of the Orocantabrian subprovince (humid ombrotype), i.e. in the southern massifs of the Cantabrian Range, an on calcareous substrata the basophile and xerophile beech forest vegetation series (*Epipactido helleborines-Fago sylvaticae sigmetum*) is found. Its mature stage is a beech forest of the association *Epipactido helleborines-Fagetum sylvaticae,* which has a particular Orocantabrian race (subassociation *laserpitietosum (nestleri) eliasii*). In the Picos de Europa this type of basophile and xerophile beech forests are better represented in the southern part of the territory, where they occupy steep slopes on the edaphic seres of "brown rendzina-calcareous brown soil" or "lithosol-proto-rendzina-brown rendzina", always on calcareous bedrock. Floristically, they are characterized by several orchids occurring in their understorey (*Epipactis helleborine*, *Neottia nidus-avis*, *Cephalanthera rubra*, *Cephalanthera longifolia*, etc.) as well as other plants such as *Laserpitium nestleri* subsp. *eliasii*, *Tanacetum corymbosum*, *Laserpitium latifolium*, *Pimpinella siifolia*, *Primula veris* subsp. *columnae* and *Lonicera xylosteum*, among others.

Epipactido helleborines-Fagetum sylvaticae (5 rels.): Characteristics and differentials of association and upper units: V *Fagus sylvatica*, III *Epipactis helleborine*, II *Laserpitium nestleri* subsp. *eliasii*, I *Neottia nidus-avis*, I *Carex caudata*, II *Helleborus foetidus*, I *Cephalanthera damasonium*, II *Hepatica nobilis*, IV *Viola reichenbachiana*, II *Crepis lampsanoides*, III *Mercurialis perennis*, II *Helleborus viridis* subsp. *occidentalis*, II *Sorbus aria*, I *Monotropa hypopitys*, I *Tanacetum corymbosum*, I *Melittis melissophyllum*, III *Daphne laureola*, III *Polystichum setiferum*, I *Sanicula europea*, I *Symphytum tuberosum*, III *Poa nemoralis*, II *Stellaria holostea*, I *Brachypodium sylvaticum*, I *Sorbus mougeotii*. I *Aquilegia vulgaris*. Companions: IV *Pimpinella siifolia*, III *Fragaria vesca*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 6, rel. 1; Pérez Carro & Díaz González 1987*:* Tab. 3, rels. 12-15).

The forest mantle of those xerophile beech forests is a spiny shrubland quite similar to that of the ombrophile beech forests mentioned above (*Pruno spinosae-Berberidetum cantabricae*) in which *Berberis vulgaris* subsp. *cantabrica*, *Rhamnus alpina*, *Rhamnus cathartica* and *Ribes alpinum* are abundant. The seral scrub are aulagares of *Lithodoro diffusae-Genistetum legionensis*. The lower rainfall and the shallow soils of this vegetation series hinder the development of meadows; instead we find mesoxerophile grasslands of *Brachypodium pinnatum* subsp. *rupestre*.

Rupicolous vegetation

In the colline (mesotemperate) canyons of the Picos de Europa, well developed azonal rocky plant communites are found. The rock crevices on the calcareous cliffs are colonized by communities of *Crepido asturicae-Campanuletum legionensis*, an association well characterized by *Campanula rotundifolia* subsp. *legionensis* in which other rupicolous taxa occur such as *Crepis albida* subsp. *asturica* o *Anthirrhinum braun-blanquetii*. In the montane (supratemperate) hyperhumid belt this association is replaced by *Saxifragetum paniculato-trifurcatae* in which *Saxifraga trifurcata*, *Asplenium viride* and *Saxifraga paniculata* are abundant.

Crepido asturicae-Campanuletum legionensis (23 rels.): Characteristics and differentials of association and upper units: V *Campanula rotundifolia* subsp. *legionensis*, V *Crepis albida* subsp. *asturica*, IV *Asplenium trichomanes* s.l., V *Globularia nudicaulis*, IV *Euphorbia flavicoma* subsp. *occidentalis*, V *Erinus alpinus*, IV *Centranthus lecoqii*, III *Pimpinella tragium* subsp. *lithophila*, II *Anthirrhinum braun-blanquetii*, III *Asplenium ruta-muraria*, II *Asperula aristata*, II *Asplenium ceterach*, III Phagnalon saxatile, II Petrocoptis pyrenaica subsp. wiedmannii, I Campanula arbatica subsp. arbatica, II *Agrostis schleicheri*, II *Chaenorhinum origanifolium*, II *Hypericum nummularium*, I *Sedum micranthum*, I *Reseda glauca*, I *Saxifraga paniculata*, I *Saxifraga trifurcata*, I *Hieracium bombycinum*. Companions: III *Helictotrichon cantabricum*. (Fernández Areces, Penas & Díaz González 1983: Tab.

6, rels. 1-9; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 38, rels. 1-2, 1984; F ernández. Areces 1989, Tab. 7, rels. 1-4, 6-8, 10 and 20; Tab. 8, rels. 1-3).

Saxifragetum paniculato-trifurcatae (3 rels.): Characteristics and differentials of association and upper units: 3 *Saxifraga trifurcata*, 2 *Saxifraga paniculata*, 1 *Saxifraga canaliculata*, 1 *Saxifraga x faucicola*, 2 *Asperula hirta*, 3 *Erinus alpinus*, 2 *Asplenium viride*, 3 *Asplenium ruta-muraria*, 3 *Asplenium trichomanes* s.l., 1 *Pimpinella tragium* subsp. *lithophila*, 3 *Campanula arbatica* subsp. *arbatica*, 1 *Agrostis schleicheri*, 1 *Chaenorhinum origanifolium*, 1 *Globularia nudicaulis*, 1 *Euphorbia flavicoma* subsp. *occidentalis*, 1 *Campanula rotundifolia* subsp. *legionensis*, 1 *Globularia repens*. (Fernández. Areces 1989, Tab. 7, rels. 1-4, 6-8, 10 and 20; Tab. 8, rels. 1-3; Díaz González & Fernández Prieto 1992: 70).

The crevices of the overhanging cliffs, the ceilings of the small caves and the cliffs shelterd by protuberances in the Picoeuropan colline (mesotemperate) belt, are inhabited by specialized species poor communities of the *Petrocoptidetum wiedmannii* association, characterized by the almost exclusive populations of *Petrocoptis pyrenaica* subsp. *wiedmannii*. In the transitional situations towards the chasmonitrophilous communities of *Parietarietalia*, the subassociation *cymbalarietosum muralis* is found.

Petrocoptidetum wiedmannii (20 rels.): Characteristics and differentials of association and upper units: V *Petrocoptis pyrenaica* subsp. *wiedmannii*, II *Erinus alpinus*, II *Asplenium trichomanes* subsp. *quadrivalens*, I *Asplenium trichomanes* subsp. *pachyrachis*, + *Antirrhinum braun-blanquetii*, i *Hypericum nummularium*, + *Campanula rotundifolia* subsp. *legionensis*, + *Phagnalon saxatile*, I *Campanula arbatica* subsp. *arbatica*, + *Globularia nudicaulis*. Differentials of subassociations: I *Cymbalaria muralis* (Fernández Areces, Penas & Díaz González 1983: Tab. 4, rels. 2, 4 y 5, 1983; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 39, rel. 12; Ladero, Díaz González, Penas, Rivas-Martínez & Valle 1987: 70; Fernández. Areces 1989: Tab. 12, rels. 1, 4, 12, 16-26, 29 and 33).

In the narrow canyons (called *hoces*) of the colline (mesotemoperate) belt of the Picos de Europa, travertines are frequent being formed by oozing rocky cliffs. Those habitats are populated by bryophyte and fern rich communities of the association *Hyperico nummularii-Pinguiculetum coenocantabricae*, characterized by *Pinguicula coenocantabrica*, *Adiantum capillus-veneris* and *Eucladium verticillatum*.

Hyperico nummularii-Pinguiculetum coenocantabricae (16 rels.): Characteristics and differentials of association and upper units: V *Pinguicula coenocantabrica*, V *Hypericum nummularium*, V *Adiantum capillus-veneris*, III *Pellia fabbroniana*, III *Eucladium varticillatum*, III *Cratoneurion commutatum*, I *Hymenostylium recurvirostrre*, I *Nostoc* sp. Companions: III *Schoenus nigricans*, III Campanula rotundifolia subsp. *legionensis*. (Díaz González, Guerra & Nieto 1982: Tab. 2, rels. 1-7; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 40, rels. 1-6, 1984; Pérez Carro 1990: Tab. 7, rels. 1-3).

The chasmophytic vegetation of nitrified walls is relevant mostly in areas under noteworthy human and animal influence. In the dry walls of the colline Piceuropan area the association *Parietarietum judaicae* is found, while in the shady and moister walls this association is replaced by *Cymbalarietum muralis*.

Parietarietum judaicae (1 rel.): Characteristics and differentials of association and upper units: 1 *Parietaria judaica*, 1 *Asplenium ceterach*, 1 *Umbilicus rupestris*, 1 *Sedum dasyphyllum*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: 154).

Cymbalarietum muralis (1 rel.): Characteristics and differentials of association and upper units: 1 *Cymbalaria muralis*, 1 *Asplenium trichomanes* s.l., 1 *Asplenium ruta-muraria*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: 155).

On unstable calcareous screes placed in the foothill of big cliffs, live specialized communities of low cover and a high proportion of geophytes and chamaephytes, of the association *Rumici scutati-Iberidetum apertae*. Those communities are typical of the Picoeuropean colline limestone screes characterized by *Iberis ciliata* (*I. aperta*), *Rumex scutatus* and *Centranthus lecoqii*, among others.

Rumici scutati-Iberidetum apertae (6 rels.): Characteristics and differentials of association and upper units: V *Rumex scutatus*, IV *Iberis ciliata* (*I. aperta*), IV *Linaria filicaulis* subsp. *faucicola*, IV *Vincetoxicum hirundinaria* subsp. *lusitanicum*, IV *Centranthus lecoqii*, II *Melica ciliata* subsp. *magnolii*, III *Geranium purpureum*, I *Erysimum cantabricum*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 42, rels. 1-2; Penas, Puente, García González & Herrero 1991: Tab. 3, rels. 1-4).

THE VEGETATION OF THE PICOEUROPEAN HIGH MOUNTAIN (SUBALPINE AND ALPINE TERRITORIES)

In the Cantabrian Range, the high mountain vegetation is restricted to areas above 1,700-1,800 m. and, from a bioclimatic point of view, it comprises the subalpine (orotemperate) and alpine (criorotemperate) belts. The lower limit of the subalpine level is determined by the position of the treeline; the montane forests are replaced by shrubby and herbaceous vegetation due to the worsening of environmental conditions with altitude. The climatic potential natural vegetation of the subalpine belt is formed by dwarf juniper shrublands whose structure and floristic composition vary depending on the soil type. The exploitation of the high mountain territories by man is not very intensive: in summer grazing activity (mainly by sheep and goats) becomes relevant, and in winter snow sports occurs in some areas.

The alpine belt occupies the small areas above 2.300 m both in the Central Massif and the Western Massif of Picos de Europa. It also occurs both at the highest peaks of the Eastern Massif and the highest siliceous summits of Peña Prieta and Curavacas. Herbaceous, sedge-rich, communities, whose floristic composition changes in relation to soil type, compose the potential natural vegetation of those alpine territories. The extreme temperatures, the abrasive effect of ice particles and snow, and the abrupt relief do not allow shrubby vegetation to develop in this high mountainous belt. Human activities are practically absent here, so the cover of the vegetation has not been damaged.

The vegetal landscape of the subalpine territories of Picos de Europa

Climatic vegetation: vegetation series of the subalpine dwarf juniper scrub.

The climactic potential vegetation of the calcareous subalpine belt of Picos de Europa and the other Orocantabrian territories is composed of dense formations of prostrate junipers with bearberry: *Daphno cantabrici-Arctostaphyletum uva-ursi*. These communities grow over rocky crests, spurs and other places not covered by a deep snow layer during most of the year. For this reason, they cover a relatively small area when compared with that occupied by other herbaceous communities. They are basically composed of the prostrate juniper (*Juniperus communis* subsp. *alpina*), bearberry (*Arctostaphylos uva-ursi*), spurge laurel (*Daphne laureola* var. *cantabrica*) and, occasionally, of *Rosa pendulina* and *Cotoneaster integerrimus*. In the more continental parts of Picos de Europa, *Juniperus sabina* also forms these communities, leading to the *juniperetosum sabinae* association.

Daphno cantabrici-Arctostaphyletum uva-ursi (14 rels.): Characteristics and differentials of association and upper units: V *Juniperus communis* subsp. *alpina*, V *Arctostaphylos uva-ursi*, III *Daphne laureola* var. *cantabrica*, II *Rosa pendulina*, I *Cotoneaster integerrimus*. Distinctive species of subassociations: II *Juniperus sabina*. Companions: IV *Genista legionensis*, IV *Helianthemum oelandicum* subsp. *incanum*, III *Dethawia tenuifolia* subsp. *cantabrica*, III *Sesleria albicans*, III *Festuca burnatii*, III *Carex sempervirens*, III *Saxifraga canaliculata*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 3, rels. 1-8; Nava Fernández 1988: Tab. 27, rels. 1-6,).

The serial phase that replaces the juniper formations mentioned above is composed of chionophobous grasslands dominated by *Festuca burnatii*, *Festuca hystrix* and *Koeleria vallesiana.* These communities grow over chryoturbated soils and lithosols, and they can spread downwards in the montane belt if environmental conditions are favourable. They belong to the endemic Orocantabrian alliance *Festucetum burnatii*, which is composed of several vicariant associations. The *Festucetum burnatii*, is the one that can be found in both Picos de Europa and the western part of the Ubiña Massif. This association is defined by the occurrence of *Oreochloa confusa*, *Draba cantabricae* subsp. *cantabriae* and *Helianthemum urrielense*, among others.

Festucetum burnatii (23 rels.): Characteristics and differentials of association and upper units: V *Festuca burnatii*, III *Oreochloa confusa*, *Helianthemum oelandicum* subsp. *incanum*, IV *Festuca vallesiana* subsp. *abbreviata*, III *Arenaria grandiflora*, II *Helianthemum urrielense*, III *Festuca hystrix*, III *Festuca indigesta* s.l., II *Draba dedeana*, I *Saxifraga conifera*, I *Carex humilis* , I *Draba cantabriae*. Companions: III *Globularia repens*, III *Saxifraga paniculata*, III *Galium pyrenaicum*. (Mayor, J. Andrés, G. Martínez, F. Navarro & Díaz González 1973: Tab. 3, rels. 1-3; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 32, rels. 1-7; Nava Fernández 1988: Tab. 2, rels. 11-15; Tab. 3, rels. 12-18; Tab. 12, rel. 15).

The mature stage of the subalpine Orocantabrian silicicolous climatic series is the *Junipero nanae-Vaccinietum uliginosi*. Siliceous substrates are scarce in Picos de Europa, which is why this association is only represented by low-diverse fragments of prostrate junipers with bog bilberry.

Junipero nanae-Vaccinietum uliginosi (6 rels.): Characteristics and differentials of association and upper units: V *Juniperus communis* subsp. *alpina*, IV *Vaccinium mycrophyllum*, V *Calluna vulgaris*, IV *Erica vagans*, III *Hypericum richeri* subsp. *burseri*, II *Nardus stricta*, I *Diphasiastrum alpinum*. (Nava Fernández 1988: Tab. 27, rels. 7-9, Tab. 28, rels. 2 and 3, 1988, Pérez Carro 1990: Tab. 1, rel. 5)

Chionophilous swards and fens

The *Armerion cantabricae* swards grow during the summer season in those places characterised by a deep and long-lasting snow cover. They also require deep soils, somewhat decalcified at the surface layer. This alliance, which is endemic of the Orocantabrian territory, is divided in various associations. The one we find at Picos de Europa and the eastern part of the Ubiña Massif belongs to the *Pediculari fallacis-Armerietum cantabricae*, and it occasionally spreads over both the altimontane and alpine belts. These pastures are very diverse, so we can find the *festucetosum burnatii* subassociation, where soil and snow cover are not so deep, always related to the *Festucetum burnatii* grasslands. At heavily snowed areas and therefore, with a delayed phenology, develops the *festucetosum glacialis* subassociation, which is characterised by the presence of *Festuca glacialis* and *Poa minor*. In stony areas and near rocky crests the *festucetosum gautieri* subassociation can be found, defined by the occurrence of *Festuca scoparia* and *Festuca picoeuropeana*. Finally, the *anemonetosum pavonianae* subassociation, has its optimal position at the bases of ledges, where snow cover persists during long periods leading to humiferous moist soils. This community is defined by the occurrence of *Anemone pavoniana*, *Ranunculus thora* and *Ranunculus alpestris* subsp. *leroyi*.

Pediculari fallacis-Armerietum cantabricae (17 rels.): Characteristics and differentials of association and upper units: V *Armeria cantabrica*, IV *Pedicularis pyrenaica* subsp. *fallax*, IV *Arenaria purpurascens*, IV *Carex sempervirens*, IV *Poa alpina*, IV *Alchemilla plicatula*, IV *Minuartia verna*, IV *Helictotrichon sedenense*, II *Jasione cavanillesii*, III *Sesleria albicans*, III *Agrostis schleicheri*, II *Sedum atratum*, II *Silene acaulis*, II *Polygonum viviparum*, II *Dethawia tenuifolia* subsp. *cantabrica*, II *Gentiana verna*, I *Androsace lactea*, I *Aquilegia pyrenaica* subsp. *discolor*, I *Pimpinella siifolia*, I *Gentiana occidentalis*, II *Androsace villosa*, I *Carex ornithopodioides*. Distinctive species of subassociations: I *Festuca burnatii*, II *Festuca glacialis*, II *Poa minor*, II *Festuca picoeuropeana*, II *Festuca gautieri*, I *Anemone pavoniana*, I *Ranunculus alpestris* subsp. *leroyi*, I *Ranunculus thora*. Companions: IV *Thymus praecox* subsp. *britannicus*, III *Luzula nutans*, III *Pritzelago alpina* subsp. *auerswaldii*, III *Anthyllis vulneraria* subsp. *pyrenaica*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 34, rels. 1-14; Gutiérrez Villarías. & Homet 1985: Tab. 3, rels. 1-8; Nava Fernández 1988: Tab. 12, rels. 11 and 16; Díaz González & Fernández Prieto 1994a: 338).

Soils have a very high moisture level, both on flat leeward areas and at the bottom of dolines where the snow layer persists longer. It is right here where mat-grass formations that belong to the *Nardion* alliance are developed. In the western part of the Orocantabrian territories the *Polygalo edmundii-Nardetum* communities are particularly important. These pastures grow over deep calcareous soils with low levels of carbonates and are characterised by the presence of *Polygala edmundii*, *Trifolium thalii* and *Carex macrostylon*, among others.

Polygalo edmundii-Nardetum (36 rels.): Characteristics and differentials of association and upper units: V *Nardus stricta*, V *Festuca rubra* subsp. *microphylla*, V *Plantago alpina*, II *Trifolium thalii*, III *Phleum alpinum*, III *Carex macrostylon*, III *Jasione laevis*, II *Sagina nevadensis*, I *Polygala edmundii*, I *Euphrasia minima*, I *Conopodium pyrenaeum*, I *Botrychium lunaria*, I *Galium saxatile*, I *Lychnis alpina*, I *Trifolium alpinum*, I *Meum athamanticum*. Companions: II *Lotus corniculatus*, III

Hieracium pilosella, III *Trifolium pratense*, III *Poa alpina*, III *Agrostis tenuis*, III *Carex caryophyllea*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 53, rels. 1-12, 1984; Nava Fernández 1988: Tab. 17, rels. 1-13; Tab. 18, rels. 1-11).

In contact with the *Nardus* grasslands, usually close to water-courses, are found nutrient rich fens that belong to the *Caricion davallianae*. This alliance is represented in the Ubiñense-Picoeuropean territories by the association *Pinguiculo grandiflorae-Caricetum lepidocarpae*, which is characterised by the presence of *Carex lepidocarpa*, *Pinguicula grandiflora* and *Parnassia palustris*. The *caricetosum rostratae* subassociation is found in permanently waterlogged meso-oligotrophous soils.

Pinguiculo grandiflorae-Caricetum lepidocarpae (21 rels.); Characteristics and differentials of association and upper units: V *Carex lepidocarpa*, IV *Carex nigra*, III *Pinguicula grandiflora*, II *Parnassia palustris*, I *Juncus alpinoarticulatus* subsp. *alpestris*, I *Carex echinata*, I *Carex demissa*, II *Eleocharis quinqueflora*, I *Pedicularis mixta*, I *Leontodon duboissi*, I *Sanguisorba officinalis*, I *Potentilla palustris*, I *Juncus cantabricus*. Distinctive species of subassociations: I *Carex rostrata*. Companions: III *Juncus articulatus*, III *Nardus stricta*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 54, rels. 1-4; Nava Fernández 1988: Tab. 22, rels. 1-13; Rivas-Martínez & Pizarro 1988: Tab. 3, rels. 1-4).

The less base-rich borders of the above mentioned fens and places heavily trampled and nitrified by cattle are occupied by the *Glycerio declinatae-Catabrosetum aquaticae alopecuretosum aequalis*. In the same way, on the edges of shallow ponds with a long low-water season there can be found low-diverse fragments of the helophytic communities of the *Glycerio declinatae-Antinorietum agrostideae* (=*Glycerio declinatae-Eleocharidetum palustris* Rivas-Martínez & Costa in Rivas-Martínez, Costa, Castroviejo & Valdés 1980). This association is characterised by the dominance of *Eleocharis palustris*.

Glycerio declinatae-Catabrosetum aquaticae alopecuretosum aequalis, (3 rels.): Characteristics and differentials of association and upper units: 3 *Catabrosa aquatica*, 3 *Nasturtium officinalis*, 3 *Veronica beccabunga*, 2 *Glyceria declinata*. Distinctive species of subassociations: 2 *Alopecurus aequalis*. Companion species: 3 *Caltha palustris*, 1 *Ranunculus bulbosus*, 2 *Senecio aquaticus*, 1 *Carex flacca, 1 Poa trivialis,* 1 *Juncus bufonius*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 59, rel. 1; Rivas-Martínez & Pizarro 1988: Tab. 2, rels. 1-2).

Glycerio declinatae-Antinorietum agrostideae, (3 rels.): Characteristics and differentials of association and upper units: 3 *Eleocharis palustris*, 1 *Veronica beccabunga*. Companion species: 2 *Epilobium alsinifolium*, 2 *Poa annua*, 1 *Veronica alpina*, 1 *Veronica serpyllifolia*. (Nava Fernández 1988: Tab. 21, rels. 5-7).

In the pools and gravel beds of streams with no sticking mud, there are both sunk and floating communities of batrachydes and amphibious helophytes dominated by *Sparganium angustifolium*. *Callitriche palustres* forms these communities if the water dries up during the summer season, whereas in the pools where it persists during the entire year there can be found *Ranunculus trichophyllus* subsp. *eradicatus* and *Potamogeton pusillus*.

Sparganium angustifolium community (6 rels.): Characteristics and differentials of association and upper units: V *Sparganium angustifolium*. Companion species: III *Ranunculus trichophyllus* subsp.

eradicatus, II *Potamogeton natans*, I *Callitriche palustris*, I *Potamogeton pusillus*, I *Menyanthes trifoliata*, I *Caltha palustris*, I *Eleocharis palustris* (Nava Fernández 1988: Tab. 21, rels. 1-4; Rivas-Martínez & Pizarro 1988: Tab. 4, rels. 1-2).

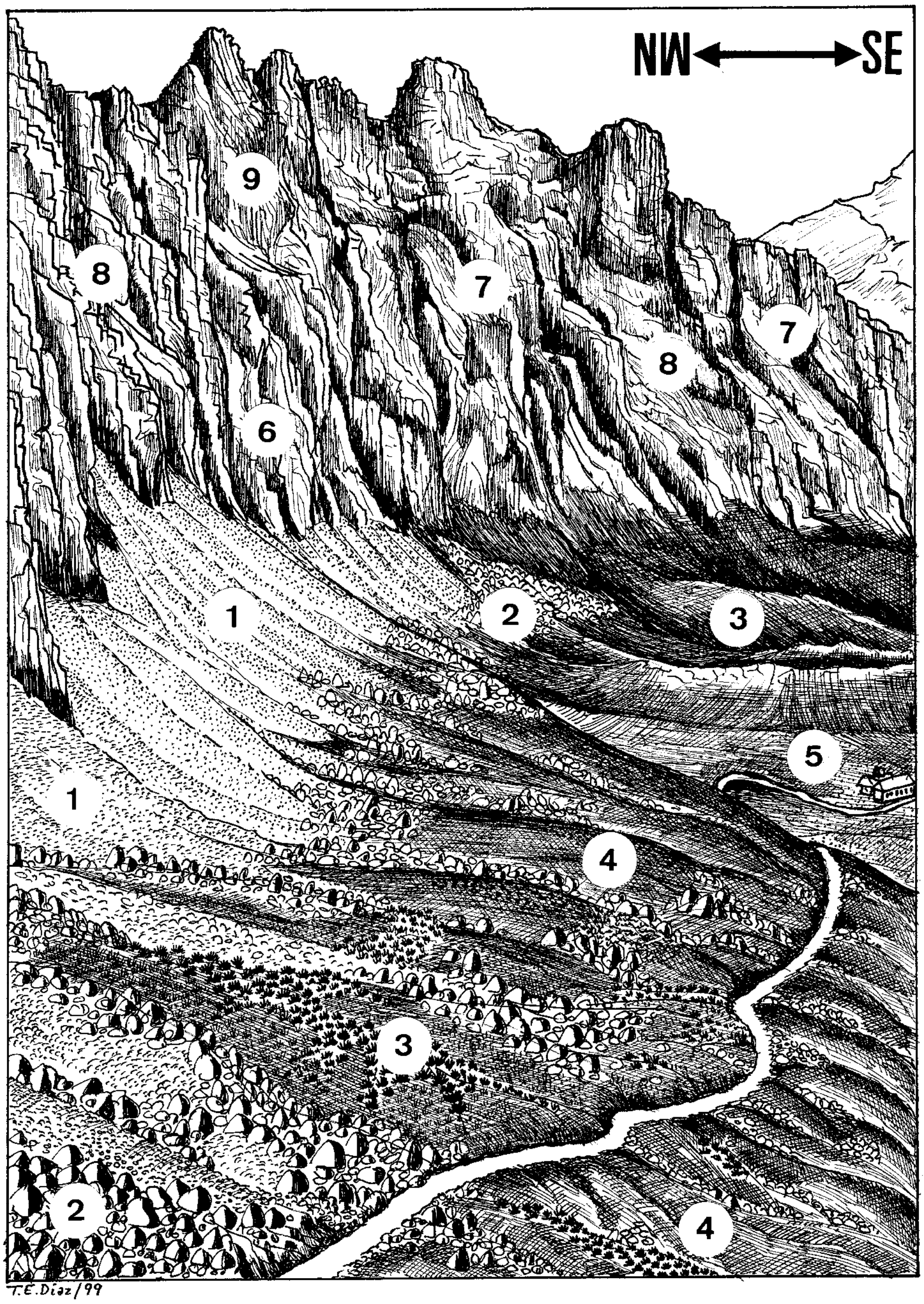
Vegetation of rock crevices, boulder fields and screes

Taking into account that the rocky slopes, ciffs and screes occupy vast areas in the subalpine territories, the vegetation linked to those environments not only expands over large areas but is also very diverse. The fissures of calcareous cliffs are colonised by chasmophytic communities of the *Saxifragion trifurcato-canaliculatae*, which enclose a great number of Cantabrian endemic taxa. In Picos de Europa, the most representative association of those communities is the *Saxifrago aretioidis-Dethawietum tenuifoliae*, which is floristically defined by the presence of *Saxifraga aretioides*, *Dethawia tenuifolia* and *Potentilla nivalis* subsp. *asturica*.

PICTURE 38

Locality: Peña Vieja piedmont and Áliva meadows. Central Massif of the National Park of Picos de Europa.
Altitude: 1,650 – 2,600 m
Date: 23-VII-1999
Biogeography: Picoeuropeano subsector, Ubiñense-Picoeuropeano sector, Orocantabrian subprovince.
Bioclimatic belt: Orotemperat (subalpine) and criorotemperate (alpine), hyperhumid.
Lithology: Limestone.

1. Orocantabrian subalpine communities of alcareous screes of *Linario filicaulis-Crepidetum pygmeae*.
2. Fern communities of the calcareous block deposits of *Cystopterido pseudoregiae-Dryopteridetum submontanae*.
3. Picoeuropean furze formations (aulagares) of *Lithodoro diffusae-Genistetum legionensis*.
4. Basophilous and chyonophilous herb communities developed on deep soils (*Pediculari fallacis-Armerietum cantabricae*).
5. *Nardus* grasslands (cervunales) of *Polygalo edmundii-Nardetum*.
6. Perennial basophilous and psychroxerophilous Picoeuropean grasslands of lithosols and ridges (*Festucetum burnatii*).
7. Basophilous Orocantabrian dwarf juniper scrub of *Daphno cantabricae-Arctostaphylletum uva-ursi*.
8. Chasmophytic communities of the calcareous subalpine-alpine Picoeuropean rock crevices of *Saxifrago aretioidis-Dethawietum tenuifoliae*.
9. Calcareous rock crevices communities of overhanging cliffs and fissures sheltered by protuberances in the rocky wall belonging to the Orocantabrian association *Petrocoptidetum glaucifoliae*].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Saxifrago aretioidis-Dethawietum tenuifoliae (22 rels.): Characteristics and differentials of association and upper units: V *Saxifraga aretioides*, V *Dethawia tenuifolia*, III *Potentilla nivalis* subsp. *asturica*, III *Globularia repens*, III *Asperula hirta*, II *Saxifraga canaliculata*, II *Reseda glauca*, I *Asplenium ruta-muraria*, I *Saxifraga paniculata*, I *Agrostis schleicheri*, I *Campanula arbatica*, I *Erinus alpinus*, I *Hypericum nummularium*, I *Petrocoptis pyrenaica* subsp. *glaucifolia*, I *Euphorbia chamaebuxus*. Companions: IV *Festuca burnatii.* (Fernández Prieto 1983: Tab. 3, rels. 1-6; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 36, rels. 1-7; Nava Fernández 1988: Tab. 1, rels. 1-7; Fernández Areces, Díaz González & Pérez Carro 1990: Tab. 5, rels. 4 and 5).

The altimontane and, in some cases, the subalpine calcareous rocky slopes located in shadowy positions are colonised by chasmophytic communities characterised by the presence of *Saxifraga canaliculata*, *Anemone pavoniana*, *Asperula hirta*, *Hypericum nummularium* and *Reseda glauca*. They belong to the race *asperuletosum hirtae*, which is part of the wide Orocantabrian association *Anemono pavonianae-Saxifragetum canaliculatae*.

Anemono pavonianae-Saxifragetum canaliculatae asperuletosum hirtae (10 rels.): Characteristics and differentials of association and upper units: V *Saxifraga canaliculata*, IV *Anemone pavoniana*, IV *Asperula hirta*, III *Hypericum nummularium*, II *Reseda glauca*, II *Saxifraga paniculata*, II *Hieracium bombycinum*, III *Asplenium trichomanes* s.l., III *Globularia repens*, V *Campanula arbatica*, II *Asplenium ruta-muraria*, IV *Agrostis schleicheri*, III *Erinus alpinus*, I *Cystopteris fragilis*, *Gypsophila repens*, I *Asplenium viride*, I *Dethawia tenuifolia*, I *Crepis albida* subsp. *asturica*, I *Chaenorhinum origanifolium*. (Nava Fernández 1988: Tab. 3, rels. 1-3, 5 and 7; Fernández Areces, Díaz González & Pérez Carro 1990: Tab. 2, rels. 9-13).

The fissures of the overhanging calcareous cliffs are colonised by species-poor open communities dominated by *Petrocoptis pyrenaica* subsp. *glaucifolia* (which can be accompanied by *Asplenium trichomanes* subsp. *pachyrachis*). These communities belong to the *Petrocoptidetum glaucifoliae*, and occur from the montane to the alpine belt of the Ubiñense-Picoeuropean territories.

Petrocoptidetum glaucifoliae (16 rels.): Characteristics and differentials of association and upper units:, *Saxifragion trifurcato-canaliculatae*, *Potentilletalia caulescentis*, *Asplenietea trichomanis*): V *Petrocoptis pyrenaica* subsp. *glaucifolia*, II *Asplenium trichomanes* subsp. *pachyrachis*, III *Erinus alpinus*, II *Asplenium ruta-muraria*, I *Campanula arbatica*, I *Hypericum nummularium*, I *Asperula hirta*, I *Saxifraga aretioides*, I *Saxifraga canaliculata*, I *Potentilla nivalis* subsp. *asturica*, I *Globularia repens*, I *Reseda glauca*, I *Hieracium lainzii*, I *Agrostis schleicheri*, I *Rhamnus pumila*. (Fernández Areces, Penas & Díaz González 1983: Tab. 4, rels. 1 and 3; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 39, rels. 1-9; Nava Fernández 1988: Tab. 1, rel. 8; Fernández Areces, Díaz González & Pérez Carro 1990: Tab. 6, rels. 2, 24, 27 and 28).

The *Linario filicaulis-Crepidetum pygmeae* communities are found over unstabilized calcareous screes made of medium-sized stones, and stand out against the other scree altimontane and subalpine communities of the Ubiñense-Picoeuropean territories. This open vegetation is characterised by the presence of *Linaria filicaulis*, *Crepis pygmaea* and *Iberis carnosa*, being diversified at the most snowy sites with *Festuca glacialis* and *Cystopteris fragilis* subsp. *pseudoregia* (*festucetosum glacialis* subassociation).

Linario filicaulis-Crepidetum pygmeae (39 rels.): Characteristics and differentials of association and upper units: V *Linaria filicaulis*, V *Crepis pygmaea*, IV *Arabis alpina* var. *cantabrica*, III *Iberis carnosa*, III *Silene vulgaris* subsp. *prostrata*, III *Rumex scutatus*, II *Carduus carlinoides*, I *Ranunculus parnassifolius* subsp. *favargeri*, I *Poa minor*, II *Euphorbia chamaebuxus*, I *Pritzelago alpina* subsp. *alpina*, I *Scutellaria alpina*, I *Epilobium alsinifolium*, I *Reseda glauca*, I *Galium pyrenaicum*, I *Saxifraga oppositifolia*. Distinctive species of the subassociations: II *Festuca glacialis*, I *Cystopteris fragilis* subsp. *pseudoregia*. Companions: IV *Erinus alpinus*, IV *Arenaria grandiflora*, III *Vicia pyrenaica*. (Fernández Prieto 1983: Tab. 6, rels. 1-8; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 43, rels. 1-9; Nava Fernández 1988: Tab. 5, rels. 1-18; Pérez Carro 1990: Tab. 19, rel. 27; Penas, Puente, García González & Herrero 1991: Tab. 1, rels. 4-6).

The calcareous fine screes submitted to prolonged snow cover and waterlogging are colonised by open vegetation communities essentially formed by geophyts. They belong to the *Ranunculo leroyi-Saxifragetum praetermissae*, which is an exclusive association of the Orocantabrian territories characterised by the presence of *Ranunculus alpestris* subsp. *leroyi* and *Saxifraga praetermissa*.

Ranunculo leroyi-Saxifragetum praetermissae (26 rels.): Characteristics and differentials of association and upper units: V *Saxifraga praetermissa*, V *Ranunculus alpestris* subsp. *leroyi*, IV *Arabis alpina* var. *cantabrica*, IV *Epilobium anagallidifolium*, III *Cystopteris fragilis* subsp. *pseudoregia*, II *Poa minor*, II *Pritzelago alpina* subsp. *alpina*, II *Saxifraga hirsuta* subsp. *paucicrenata*, II *Doronicum grandiflorum* subsp. *braunblanquetii*, I *Polystichum lonchitis*, I *Festuca glacialis*, I *Saxifraga oppositifolia*, I *Linaria filicaulis*, I *Salix breviserrata*, I *Veronica alpina*, I *Saxifraga aizoides*, I *Selaginella selaginoides* Companions: III *Poa alpina*, III *Festuca rivularis*. (Díaz González & Fernández Prieto 1983: Tab. 3, rels. 1-3; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 46, rels. 1-10; Nava Fernández 1988: Tab. 7, rels. 1-3, 5-8, 11, 13 and 15; Pérez Carro 1990: Tab. 19, rels. 23 and 24; Penas, Puente, García González & Herrero 1991: Tab. 6, rels. 1).

The floristic composition of calcareous big rock-block fields varies in relation with humidity. Acording to this, dry bocks and lapiaz vertical fissures (grikes) are colonised by fern-dominated communities, which belong to the altimontane and subalpine Orocantabrian association *Cystopterido pseudoregiae-Dryopteridetum submontanae*.

Cystopterido pseudoregiae-Dryopteridetum submontanae (13 rels.): Characteristics and differentials of association and upper units: V *Dryopteris submontana*, IV *Cystopteris fragilis* subsp. *pseudoregia*, V *Polystichum lonchitis*, II *Gymnocarpium robertianum*, I *Cystopteris alpina*, I *Epilobium anagallidifolium*, I *Arabis alpina* var. *cantabrica*, I *Senecio pyrenaicus* subsp. *pyrenaicus*, I *Euphorbia chamaebuxus*, I *Reseda glauca*. Companions: IV *Asplenium trichomanes* subsp. *quadrivalens*, IV *Asplenium viride*, III *Polystichum aculeatum*, *Polystichum x illyricum*, III *Malva moschata* var. *geranifolia*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 48, rels. 1-5; Nava Fernández 1988: Tab. 10, rels. 1-2; Pérez Carro 1990: Tab. 19, rels. 5, 8-10, 13; Penas, Puente, García González & Herrero 1991: Tab. 3, rel. 2).

The pioneer communities of the *Epilobio anagallidifolii-Doronicetum braunblanquetii* grow over somewhat stabilized calcareous screes containing bigger sized stones than those mentioned above. This chionophilous association is endemic of the subalpine and alpine Ubiñense-Picoeuropean territories, being floristically characterised by the dominance of *Campanula arbatica*, *Doronicum grandiflorum* subsp. *braun-blanquetii* and *Epilobium anagallidifolium*.

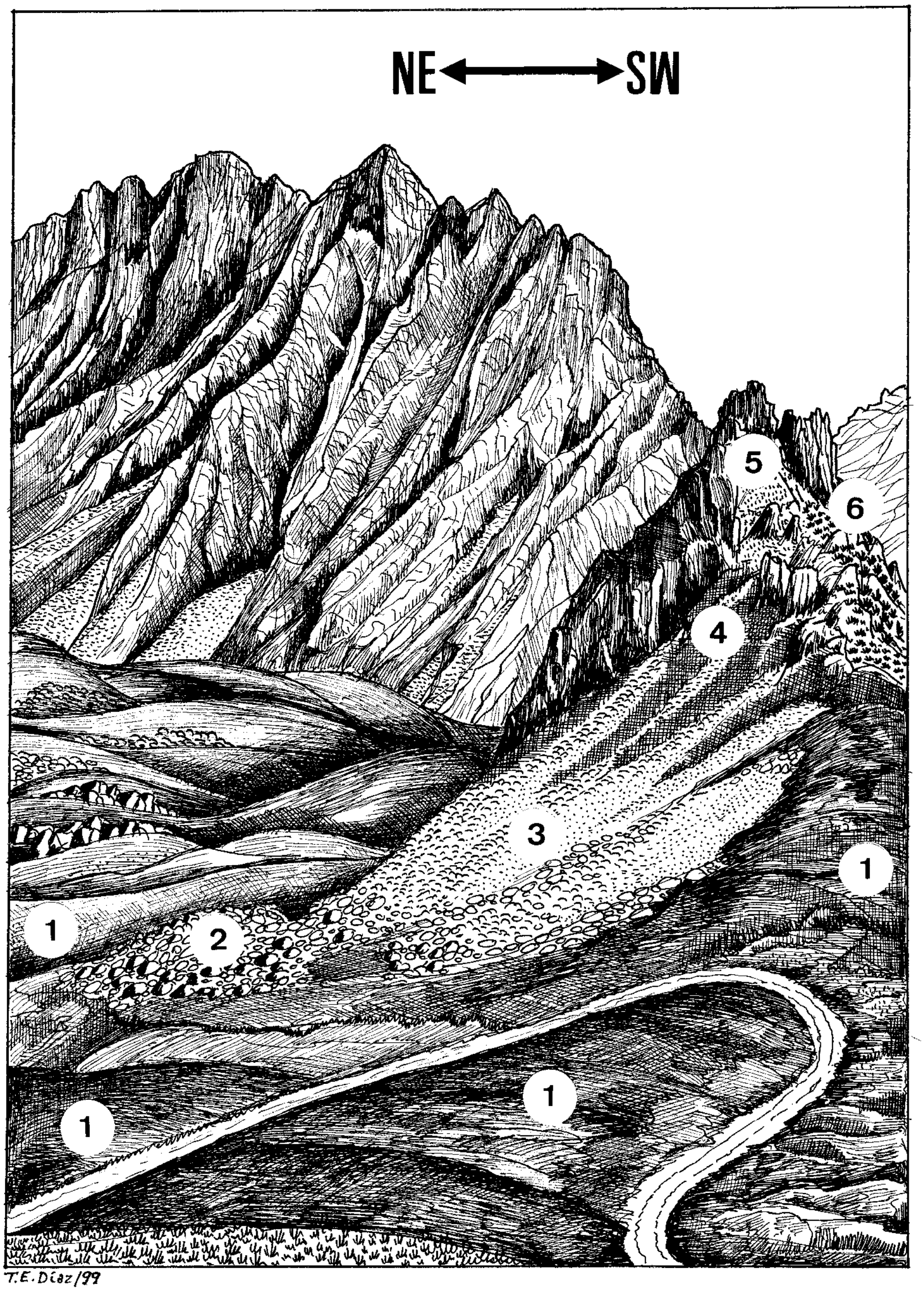
Epilobio anagallidifolii-Doronicetum braun-blanquetii (12 rels.): Characteristics and differentials of association and upper units: V *Doronicum grandiflorum* subsp. *braunblanquetii*, III *Campanula arbatica*, III *Arabis alpina* var. *cantabrica*, III *Pritzelago alpina* subsp. *alpina*, III *Epilobium anagallidifolium*, *III Linaria filicaulis*, II *Cystopteris fragilis* subsp. *pseudoregia*, II *Festuca glacialis*, II *Iberis carnosa*, II *Crepis pygmaea*, I *Polystichum lonchitis*, I *Rumex scutatus*, I *Saxifraga oppositifolia*, I *Carduus carlinoides*, I *Silene vulgaris* subsp. *prostrata* (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 47, rels. 1-4; Nava Fernández 1988: Tab. 7, rels. 10, 12, 14, 16 and 17; Tab. 5, rels. 17 and 18; Penas, Puente, García González & Herrero 1991: Tab. 2, rel. 1).

Fissures in shady places and at the bases of ledges are occupied by communities dominated by *Saxifraga hirsuta* subsp. *paucicrenata*, *Viola biflora* and *Campanula arbatica*, which are always developed over soils covered by snow during most of the year and that remain fresh during the summer. These communities belong to the altimontane, subalpine and alpine Ubiñense-Picoeuropean association *Campanulo arbaticae-Saxifragetum paucicrenatae*, where the subassociation *adenostyletosum pyrenaicae* has been described. This subassociation represents the transition stage to the meso-hygrophile tall herb (megaphorbic) communities of the *Aconito neapolitani-Myrrhetum odorati*, which are developed

PICTURE 39

Locality: Cuetos de Áliva, Central Massif of the Picos de Europa National Park. At the bottom of the Eastern Massif.
Altitude: 1,700 – 2,440 m
Date: 23-VII-1999
Biogeography: Picoeuropeano subsector, Ubiñense-Picoeuropeano sector, Orocantabrian subprovince.
Bioclimatic belt: Orotemperate (subalpine) and criorotemperate (alpine), hyperhumid.
Lithology: Limestone.

1. *Nardus* grasslands (cervunales) developed on deep soils of depressions, flat or moderately steep areas with a longer-lasting snow cover of the association *Polygalo edmundii-Nardetum*.
2. Fern communities of the calcareous block deposits of *Cystopterido pseudoregiae-Dryopteridetum submontanae.*
3. Orocantabrian subalpine communities of alcareous screes of *Linario filicaulis-Crepidetum pygmeae*.
4. Basophilous and chyonophilous herb communities developed on deep soils (*Pediculari fallacis-Armerietum cantabricae*).
5. Perennial basophilous and psychroxerophilous Picoeuropean grasslands of lithosols and ridges (*Festucetum burnatii*).
6. Picoeuropean furze formations (aulagares) of *Lithodoro diffusae-Genistetum legionensis*.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on the bases of northfacing cliffs once the snow has melt. Such communities are found in the altimontane and subalpine Ubiñense-Picoeuropean territories, with a particular floristic composition which includes *Myrrhis odorata*, *Aconitum vulparia* subsp. *neapolitanum* and *Adenostyles alliariae* subsp. *pyrenaica*.

Campanulo arbaticae-Saxifragetum paucicrenatae (17 rels.): Characteristics and differentials of association and upper units: V *Saxifraga hirsuta* subsp. *paucicrenata*, V *Cystopteris fragilis* subsp. *pseudoregia*, III *Viola biflora*, III *Campanula arbatica*, II *Arabis alpina* var. *cantabrica*, II *Epilobium anagallidifolium*, II *Cystopteris alpina*, III *Asplenium viride*, I *Hypericum nummularium*. Distinctive species of the subassociations: II *Adenostyles alliariae* subsp. *pyrenaica*. Companions: IV *Polystichum lonchitis*, II *Pimpinella siifolia*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 41, rels. 1-5; Nava Fernández 1988: Tab. 9, rels. 2, 5, 6, 8 and 20; Pérez Carro 1990: Tab. 19, rels. 17-20 and 22; Penas, Puente, García González & Herrero 1991: Tab. 7, rels. 2-3).

Aconito neapolitani-Myrrhetum odorati.(13 rels.): Characteristics and differentials of association and upper units: IV *Myrrhis odorata*, III *Aconitum vulparia* subsp. *neapolitanum*, III *Adenostyles alliariae* subsp. *pyrenaica*, II *Veratrum album*, I *Scrophularia alpestris*, II *Chaerophyllum hirsutum*. Companions: III *Myosotis alpestris*, III *Festuca rubra* s.l. (Nava Fernández 1988: Tab. 9, rels. 1, 3, 4, 7, 9-14, 17-19).

Basophilous scrub and related grasslands

Along the subalpine territories of Picos de Europa may occur basophilous heaths (aulagares) physiognomically dominated by small, hemispherical *Genista legionensis*. They cover vast areas over earthy soils, stabilized screes and sunny rock slopes, and belong to the *Lithodoro diffusae-Genistetum legionensis*. This association has a wide climatic amplitude, ranging from the colline to the subalpine level, and it is represented in the altimontane and the subalpine belts by both the *genistetosum legionensis* (typical) and the *helictotrichetosum cantabrici* subassociations. The last one is of a xerophyllous, thermopyllous nature and it can be distinguished by the presence of *Helictotrichon cantabricum* and *Oreochloa confusa*.

Lithodoro diffusae-Genistetum legionensis genistetosum legionensis and helictotrichetosum cantabrici (50 rels.): Characteristics and differentials of association and upper units: V *Genista legionensis*, IV *Lithodora diffusa*, IV *Helianthemum urrielense*, IV *Teucrium pyrenaicum*, IV *Koeleria vallesiana*, IV *Helianthemum oelandicum* subsp. *incanum*, II *Genista occidentalis*, II *Euphorbia flavicoma* subsp. *occidentalis*, II *Globularia nudicaulis*, II Sideritis *hyssopifolia*, + *Carduncellus mitissimus*, + *Thymelaea ruizii*, + *Pimpinella tragium* subsp. *lithophylla*, + *Helianthemum croceum* subsp. *cantabricum*. Distinctive species of the subassociations: IV *Helictotrichon cantabricum*, II *Oreochloa confusa*. Companions: III *Thymus praecox* subsp. *britannicus*, III *Arenaria grandiflora*, III *Anthyllis vulneraria* subsp. *pyrenaica*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 20, rels. 1-18; Gutiérrez Villarías & Homet 1985: Tab. 3, rel. 10; Díaz González, Penas, López Pacheco, Puente & J. Andrés 1988: Tab. 1, rels. 3-5; Nava Fernández1988: Tab. 24, rels. 3-7, Tab. 25, rels. 1-23).

In contact with the above mentioned heaths, there are perennial basophilous grasslands. They are dominated by *Carex brevicollis* and *Bromus erectus*, and belong to the *Bromo erecti-Caricetum brevicollis*, and they usually occupy deep, well-drained soils. That is the reason why they are also in contact with the *Polygalo edmundii-Nardetum* communities, which are developed over hydromorphous, acidificated, deeper soils.

Bromo erecti-Caricetum brevicollis (13 rels.): Characteristics and differentials of association and upper units: V *Carex brevicollis*, V *Bromus erectus*, IV *Thymus praecox* subsp. *britannicus*, III *Eryngium bourgatii*, II *Plantago media*, II *Potentilla tabernaemontanii*, II *Sanguisorba minor*, II *Carduncellus mitissimus*, II *Seseli libanotis*, II *Pimpinella siifolia*, II *Teucrium pyrenaicum*, II *Jurinea humilis*, I *Phyteuma orbiculare* subsp. *ibericum*, I *Carex humilis*, I *Dianthus hyssopifolius*, I *Brachypodium pinnatum* subsp. *rupestre*, I *Acinos alpinus* subsp. *pyrenaeus*. Companions: IV *Festuca rubra* subsp. *microphylla*, III *Agrostis tenuis*, III *Lotus corniculatus*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 26, rels. 1-6; Nava Fernández 1988: Tab. 15, rel. 6; Tab. 16, rels. 1-6).

Nitrophilous vegetation (forb, thistle and roadside communities)

The nitrophilous herbaceous communities composed of perennial species that belong to the *Chenopodio boni-henrici-Senecietum durieui* grow over the deep, fresh soils that surround cattle settlements. This association can only be found in the high mountains of the Northern half of the Iberian Peninsula, being floristically defined by the dominance of *Chenopodium bonus-henricus*, *Urtica dioica* and *Geranium pyrenaicum*.

Chenopodio boni-henrici-Senecietum durieui (10 rels.): Characteristics and differentials of association and upper units: V *Chenopodium bonus-henricus*, IV *Urtica dioica*, III *Geranium pyrenaicum*, II *Lamium maculatum*, I *Arctium minus*, I *Cynoglossum officinale*, I *Pentaglottis* Companions: III *Rumex crispus*, III *Sisymbrium austriacum*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 60, rels. 1, 3-5; Nava Fernández 1988: Tab. 23, rels. 2-4, 7, 9 and 11).

In contact with the afore-mentioned communities, there are found the altimontane thistle communities that belong to the *Cirsio chodati-Carduetum cantabrici*, which eventually can reach the subalpine belt. This type of vegetation, which has its best development in both soils that have been turned over and path slopes, is characterised by the dominance of *Carduus cantabricus*, *Cirsium eriophorum* subsp. *chodati* and *Carduus nutans* var. *phyllolepis*.

Cirsio chodati-Carduetum cantabrici (8 rels.): Characteristics and differentials of association and upper units: V *Carduus cantabricus*, IV *Cirsium eriophorum* subsp. *chodati*, II *Carduus nutans* var. *phyllolepis*, I *Verbascum thapsus*. Companion species (only those with index values higher than III have been included): V *Urtica dioica*, V *Geranium pyrenaicum*, III *Taraxacum* gr. *officinale*, III *Poa annua*, III *Trifolium repens*, III *Capsella bursa-pastoris*, III *Bellis perennis*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 61, rels. 1-5; Nava Fernández 1988: Tab. 23, rels. 1, 5 and 10).

From the montane to the subalpine belt, open pastures of the *Plantagini majoris-Poetum supinae* cover well-moistened tracks and paths. This Alpine-Pyrenean-Cantabrian association is dominated by the perennial diploid *Poa supina*.

Plantagini majoris-Poetum supinae (4 rels.): Characteristics and differentials of association and upper units: V *Poa supina*, V *Taraxacum* gr. *officinale* IV *Bellis perennis*, II *Plantago major*, I *Ranunculus* *repens*. Companions: III *Poa annua*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 68, rels. 1, 3-5).

The vegetal landscape of the alpine territories of Picos de Europa

Climatic vegetation: wind edge naked-rush swards

In Picos de Europa, where calcareous substrates prevail, the climactic potential vegetation of the alpine belt is composed of the Picoeuropean endemic naked-rush swards that belong to the *Oxytropido pyrenaicae-Elynetum myosuroides*, which is the mature stage of the *Oxytropido pyrenaicae-Elyno myosuroides sigmetum*. This community is developed on deep, fine soils of protruding ridges and edges exposed to strong winds, and it is floristically characterised by the presence of *Elyna myosuroides*, *Oxytropis pyrenaica*, *Carex capillaris*, *Carex parviflora* etc. Over stony chryoturbated soils, these swards incorporate *Salix breviserrata*, and belong to the *salicetosum breviserratae*. This subassociation represents the contact with those communities that colonise *lapiaz*.

Oxytropido pyrenaicae-Elynetum myosuroides (21 rels.): Characteristics and differentials of association and upper units: V *Elyna myosuroides*, III *Oxytropis pyrenaica*, IV *Arenaria purpurascens*, III *Carex capillaris*, III *Carex parviflora*, III *Carex sempervirens*, III *Silene acaulis*, IV *Helictotrichon sedenense*, III *Minuartia verna*, III *Androsace villosa*, III *Dethawia tenuifolia* subsp. *cantabrica*, II *Poa molinieri*, I *Carex capillaris*, I *Armeria cantabrica*, I *Erigeron uniflorus*, II *Alchemilla plicatula*, II *Jasione cavanillesii*, II *Gentiana verna*, II *Draba dedeana*, I *Agrostis schleicheri*, I *Carex ornithopoda*, I *Pedicularis pyrenaica* subsp. *fallax*, I *Polygonum viviparum*, I *Sesleria albicans*, I *Ranunculus carinthiacus*, I *Sedum atratum*, I *Gentianella campestris*. Distinctive species of the subassociations: I *Salix breviserrata*. Companions: V *Anthyllis vulneraria* subsp. *pyrenaica*, IV *Helianthemum oelandicum* subsp. *incanum*, IV *Thymus praecox* subsp. *britannicus*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 1, rels. 1-7; Gutiérrez Villarías & Homet 1985: 34, Tab. 3, rel. 9; Nava Fernández 1988: Tab. 14, rels. 1-5 and 7-12, pag. 187 rel. 2).

Vegetation of cliffs, boulder fields and screes.

Areas with mature soils are very scarce at the alpine level of Picos de Europa due to the abrupt relief and the geomorphologic processes that took place in the past. That is why rupicolous vegetation dominates the landscape. The alpine Picoeuropean endemic communities of the *Galio pyrenaici-Salicetum breviserratae* have their best position here, colonising *lapiaz* surfaces covered by small and medium sized stones. They are characterised by the presence of *Salix breviserrata* and *Galium pyrenaicum*.

Galio pyrenaici-Salicetum breviserratae (3 rels.): Characteristics and differentials of association and upper units: 3 *Salix breviserrata*, 2 *Galium pyrenaicum*, 1 *Pritzelago alpina* subsp. *alpina*, 1 *Iberis carnosa*, 1 *Saxifraga oppositifolia*, I *Festuca glacialis*. Companions: 2 *Arenaria grandiflora*, 2 *Polygonum viviparum*, 2 *Carex sempervirens*, 2 *Euphrasia salisburgensis*. (Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 45, rel. 1; Nava Fernández 1988: Tab. 11, rel. 11, Tab. 14, rel. 6).

Grikes of the subalpine and alpine Ubiñense-Picoeuropean (and eventually Altocarrionense) belts are colonised by basophiolous chasmophytic communities that belong to the *Potentillo asturicae-Valerianetum apulae*. They are characterised by the dominance of *Potentilla nivalis* subsp. *asturica*, *Valeriana apula*, *Globularia repens*, together with some glerycolous plants such as *Galium pyrenaicum* and some other species of high-mountain pastures.

Potentillo asturicae-Valerianetum apulae (15 rels.): Characteristics and differentials of association and upper units: V *Potentilla nivalis* subsp. *asturica*, V *Valeriana apula*, IV *Globularia repens*, II *Dethawia tenuifolia* subsp. *cantabrica*, I *Asperula hirta*, I *Agrostis schleicheri*, I *Asplenium viride*. Companions: III *Galium pyrenaicum*. (Fernández Areces, Penas & Díaz González, 1983: Tab. 3, rels. 1 and 2; Rivas-Martínez, Díaz González, Fernández Prieto, Loidi & Penas 1984: Tab. 37, rels. 1-6; Nava Fernández 1988: Tab. 2, rels. 4, 7, 8, 10 y 20; Fernández Areces, Díaz González & Pérez Carro 1990: Tab. 4, rels. 1-2).

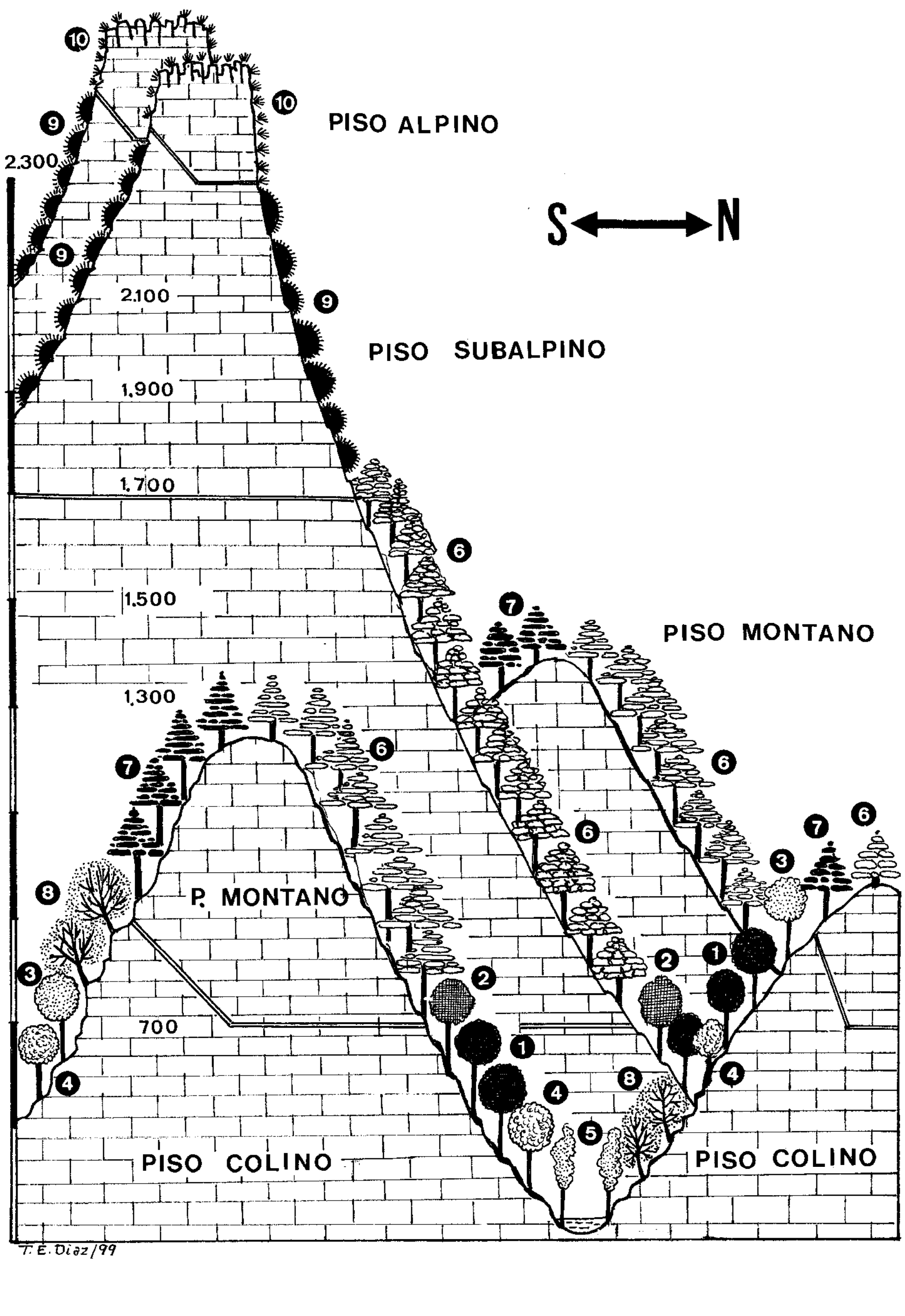
Snowdrift plant communities that belong to the *Ranunculo leroyi-Gnaphalietum hoppeani* are composed of hemicryptophytes, prostrate chamaephytes and briophytes, and have their best development in carbonate-rich soils of the subalpine and alpine levels. This chionophilous Picoeuropean endemic association is characterised by the presence of *Ranunculus alpestris* subsp. *leroyi*, *Omalotheca hoppeana*, and *Carex parviflora*, among others.

Ranunculo leroyi-Gnaphalietum hoppeani (11 rels.): Characteristics and differentials of association and upper units: V *Omalotheca hoppeana*, IV *Ranunculus alpestris* subsp. *leroyi*, IV *Carex parviflora*, IV *Veronica aphylla*, II *Carex macrostylon*, II *Potentilla brauniana*, II *Veronica alpina*, II *Sagina nevadensis*, + *Soldanella alpina*, II *Epilobium anagallidifolium*, + *Carex ornithopodioides* Companions: V *Poa alpina*, IV *Plantago alpina*, IV *Alchemilla plicatula*, III *Arenaria purpurascens*, III *Armeria cantabrica*, III *Ranunculus carinthiacus*, III *Thymus praecox* subsp. *britannicus*. (Díaz González & Nava Fernández 1991: Tab. 1, rels. 1-11).

PICTURE 40

Locality: Vegetal landscape of the Picos de Europa. Potential Natural Vegetation.
Altitude: 90 – 2.648 m
Date: 23-VII-1999
Biogeography: Picoeuropeano subsector, Ubiñense-Picoeuropeano sector, Orocantabrian subprovince.
Bioclimatic belt: Mesotemperate (colline), supratemperate (montane), orotemperate (subalpine) and criorotemperate (alpine).
Lithology: Limestone.

1. Mixed ash-sessile oak forests (*Mercurialidi perennis-Fraxinetum excelsioris* var. with *Quercus petraea*).
2. Mixed ash-sessile oak forests with beeches *(Mercurialidi perennis-Fraxinetum excelsioris* var. with *Fagus sylvatica*).
3. Mixed ash-sessile oak forests with melojo or *Quercus pyrenaica (Mercurialidi perennis-Fraxinetum excelsioris* var. with *Quercus pyrenaica*).
4. Mixed ash-sessile oak forests with limes *(Mercurialidi perennis-Fraxinetum excelsioris* var. with *Tilia cordata*).
5. Riverine alder forests (*Hyperico androsaemi-Alnetum*).
6. Eutrophic montane beech forests (*Carici sylvaticae-Fagetum*).
7. Eutrophic montane xerocalcicolous beech forests *(Carici sylvaticae-Fagetum seslerietosum albicantis*).
8. Shrubby sclerophyllous vegetation (*Quercion ilicis, Pistacio-Rhamnetalia alaterni*) .
9. Subalpine vegetation complexes.
10. Alpine vegetation complexes.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CERVERA DE PISUERGA-BILBAO (24 July)

(The vegetation of northern Burgos)

JAVIER LOIDI ARREGUI, ITZIAR GARCÍA-MIJANGOS & MERCEDES HERRERA GALLASTEGUI

On the last day, our route crosses the northern part of the province of Burgos. From Cervera de Pisuerga we cross over the Páramo (highland**)** de Masa and then we go down to the Bureba depression. After passing through the Obarenes Mountains in the Portillo de Busto pass, we reach the Ebro river banks and we follow its course along the Sobrón canyon**.** Then we continue directly to Bilbao where the excursion ends.

The territories we will visit during this day's journey constitute the southern foothills of the Basque-Santanderian Mountains and they are geomorphologically linked with the Castilian Meseta. This area presents an abrupt relief although the gap between the highest and lowest points is not very big; the altitude ranges between 500 and 1,400 m. Geologically, calcareous rocks dominate this region, mainly from the Upper Cretaceous period, with some patches of siliceous substrata. The presence of Tertiary sediments appearing in valleys and depressions is also significant. Biogeographically, this area belongs to the Mediterranean region, Iberolevantine province, Aragonese subprovince and Castellano-Cantábrico sector. The bioclimatic conditions are quite homogeneous all over the territory: almost all the area is included in the subhumid ombrotype and in the supramediterranean thermotype. It is relevant, however, that the Mediterranean climatic conditions are profoundly attenuated by significant summer rainfalls and therefore a transitional character between the Temperate and the Mediterranean macrobioclimes is reflected in the vegetation of this area.

This sector is characterised by two vegetation series. The first one, *Spiraeo obovatae-Querco fagineae* sigmetum, occupies marl substrata, whereas the other, *Spiraeo obovatae-Querco rotundifoliae* sigmetum, develops on hard limestone (Loidi & Fernández Prieto 1986). Moreover, on the siliceous patches of these territories appears the *Quercus pyrenaica* series: *Festuco heterophyllae-Querco pyrenaicae* sigmetum. In the highest areas of the northern slope of the mountains, the beech series, *Epipactido helleborines-Fageto* sigmetum, is present due to the persistent fogs. Another peculiarity of this sector is the alder forest, which belongs to the *Humulo lupuli-Alnetum glutinosae* association.

The highlands of the northern part of the province of Burgos, called "páramos", represent the geomorphological transition between the Basque-Santanderien mountains and the Castilian Meseta. They are formed by a succession of anticlines and synclines that now present a flat relief due to the erosion of the anticlines and the filling of the synclines. Occasionally, the latter remain as protuberances (hanging synclines) named here "loras". The filling of the synclines took place during the Upper Cretaceous period and are formed by a very thick complex group of calcareous sediments, that have been submitted to an intense karstification process

The high altitudes of these platforms or “loras”, ca. 1,100 m, combined with their location on the southern side of the Basque-Santanderien mountains, a barrier separating them from the oceanic influence, give mediterranean climate of these territories a continental tendency. The thermic conditions are extreme, with great falls of temperature taking place in the frequent frosts during the winter period. The summer drought is attenuated by the storms occuring in July and August and, mainly, by the cryptoprecipitations**,** because dewy days are frequent especially in August due to the intense night irradiation.

Despite the climatic conditions**,** the edaphic dryness of these highlands is due to the low water retention capability of the calcareous substrata, permitting the development of the Castilian-Cantabrian *Q. rotundifolia* vegetation series*, Spiraeo-Querco rotundifoliae* Sigmetum.

This area has suffered an intense deforestation due to wood extracting for fuel and charcoal, fire to open the land for husbandry, etc. In spite of that, there are remains of the climatic forest, *Spiraeo-Quercetum rotundifoliae*, although they are not very well structured and nowadays are in a regeneration stage. This territory has been traditionally used as pasture for sheep. Thus the dominant vegetation is now thyme grassland belonging to the *Festuco-Poetalia* order (*Festuco-Ononidetea* class), and especially to *Veronico jabalambrensis-Thymetum mastigophori plantaginetosum discoloris*.

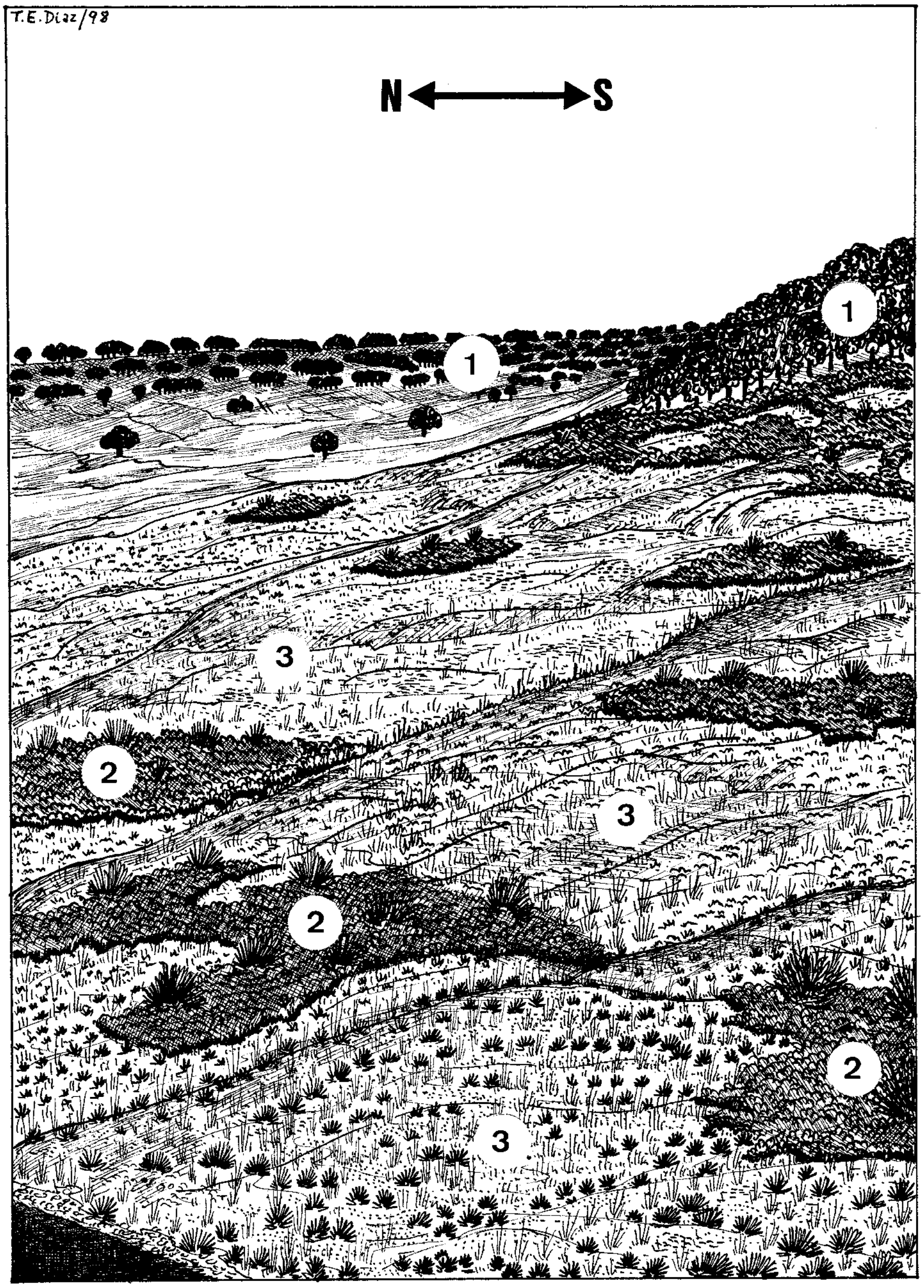
Veronico jabalambrensis-Thymetum mastigophori plantaginetosum discoloris: *Veronica jabalambrensis* V, *Carduncellus monspelliensium* V, *Helianthemum oelandicum* subsp. *incanum* V, *Koeleria vallesiana* V, *Teucrium expansum* V, *Carex humilis* V, *Linum milleti* V, *Coronilla minima* V, *Helianthemum apenninum* V, *Festuca hystrix* IV, *Plantago discolor* IV, *Thymus leptophyllus* III, *Thymus mastigophorus* III, *Inula montana* II, *Fumana procumbens* IV, *Dianthus pungens* subsp. *brachyanthus* I, *Aphyllanthes monspelliensis* III. (Izco, Molina & Fernández-González 1983: tab. 1, rels.14-20).

The hard temperature conditions of this area cause cryoturbation disturbances over the areas without vegetation and therophytic communities, belonging to *Bupleuro-Arenarietum ciliaris*, grow in them, whose optimum flowering period is in June.

PICTURE 41

Locality: Páramo de Masa, between Masa and Poza de la Sal. Burgos.
Altitude: 1,000 m
Date: 24-VII-1999
Biogeography: Castellano-Cantábrico sector, Aragonian subprovince.
Bioclimatic belt: Supramediterranean, subhumid.
Lithology: Limestone, marl.

1. Carrascal of *Spiraeo-Quercetum rotundifoliae*.
2. Scattered patches of furze scrub (aulagar) (*Arctostaphylo crassifoliae-Genistetum occidentalis*)
3. Cryoturbated thyme scrub of *Veronico javalambrensis-Festucetum hystricis*.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The intense rural emigration produced in the last few decades has led to a decay of the husbandry. Therefore the thyme grasslands have been invaded by suffruticose species characteristic of a more developed stage, such as *Arctostaphylos uva ursi* subsp. *crassifolia* and *Genista occidentalis*, leading to the formation of a scrub that belongs to the *Genistion occidentalis* alliance (*Arctostaphylo crassifoliae-Genistetum occidentalis* association).

Arctostaphylo crassifoliae-Genistetum occidentalis: *Genista occidentalis* V, *Arctostaphylos uva-ursi* subsp. *crassifolia* V, *Erica vagans* V, *Lavandula latifolia* IV, *Dorycnium pentaphyllum* IV, *Brachypodium pinnatum* subsp. *rupestre* IV, *Genista scorpius* III, *Helianthemum nummularium* III, *Aphyllanthes monspeliensis* II, *Helictotrichon cantabricum* II, *Avenula mirandana* II, *Santolina chamaecyparissus* I, *Helichrysum stoechas* I, *Thymelaea ruizii* I, *Globularia nudicaulis* I, *Onobrichys reuteri* I, *Linum milleti* I, *Euphorbia flavicoma* subsp. *occidentalis* I, *Lithodora diffusa* +, *Carduncellus mitissimus* +. (Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984: tab. 22, rels. 1-10)

The karstification processes have caused big sinkholes and decalcification depressions covered with "terra rossa" permitting cereal crops. These deeper soils are now used for agriculture and correspond to the castilian-cantabrian *Q. faginea* series *Spiraeo obovatae-Querco fagineae* sigmetum.

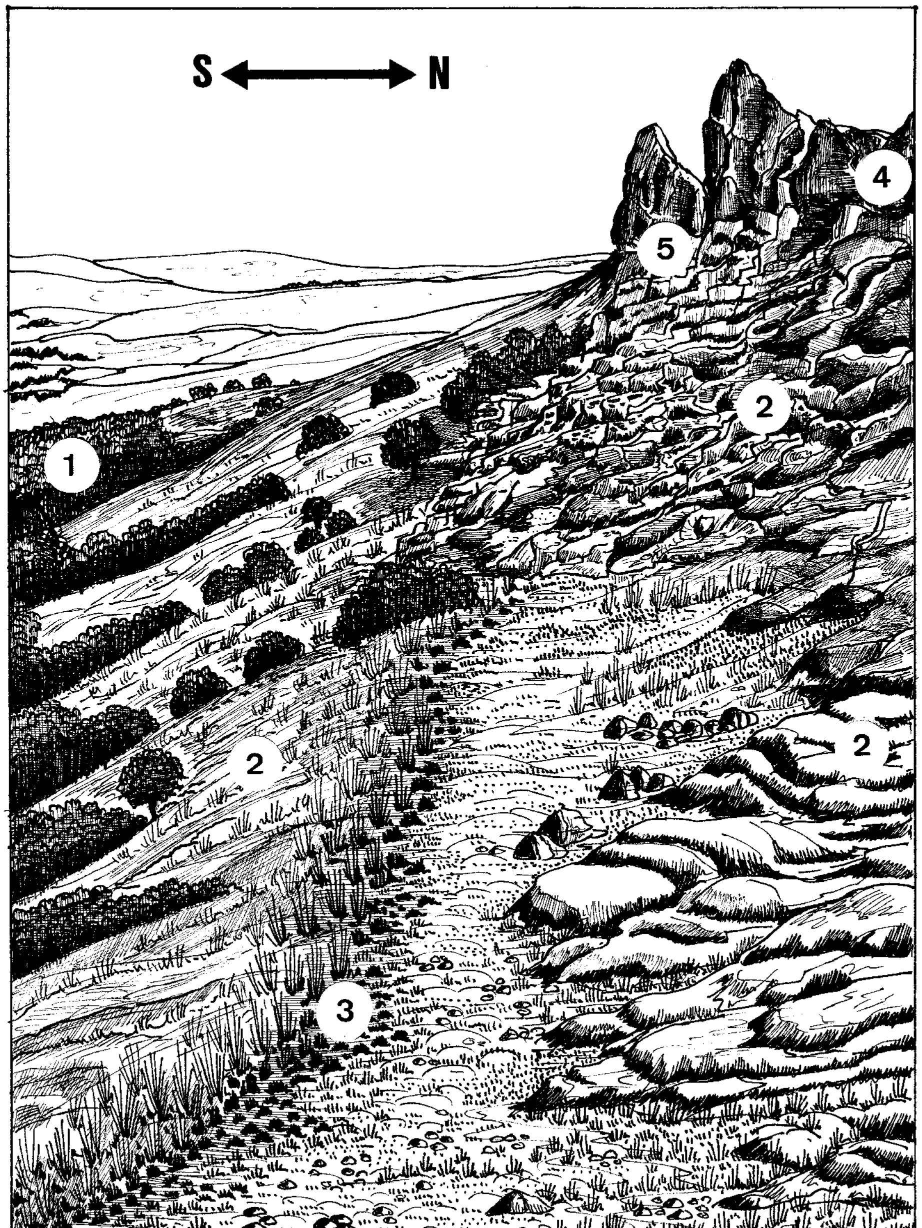
From Páramo de Masa to Portillo de Busto

The way from the highlands to the tectonic depression of the Bureba passes through steep sloped territories where marly substrata outcrop. On these soils the "quejigo" series, *Spiraeo-Querco fagineae* sigmetum, develops although there are very few remains of the climatic forest. Most of the area is occupied by the scrub of *Arctostaphylo crassifoliae-Genistetum occidentalis* or by *Brachypodium* pastures for sheep. During the descent we cross the village of Poza de la Sal, whose main activity for many years was the exploitation of a saline diapir which is in its neighbourhood and that was used for salt extraction. Nowadays this activity is completely finished.

PICTURE 42

Locality: Portillo de Busto (Montes Obarenes). Burgos.
Altitude: 1,000 m
Date: 24-VII-1999
Biogeography: Castellano-Cantábrico sector, Aragonian subprovince.
Bioclimatic belt: Supramediterranean, subhumid.
Lithology: Limestone, marl.

1. Carrascal of *Spiraeo-Quercetum rotundifoliae*.
2. Thyme scrub of *Koelerio-Thymetum mastigophori*.
3. Nitrophilous community of the roadsides with *Artemisia alba*.
4. Furze scrub (aulagar) of *Arctostaphylo crassifoliae-Genistetum occidentalis*.
5. Overhanging calcareous cliff fissures community with *Asplenium celtibericum*.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The Bureba area is situated between 700 and 800 m of altitude and presents an intense agricultural activity; wheat and barley are the main crops. We cross the northern part of this area, close to the Obarenes Mountains. The Tertiary sediments of this territory are sometimes covered with glacis of Quaternary sediments. These more recent lands formed by conglomerates are more xeric edaphically due to their texture and are occupied by evergreen oak forests of *Spiraeo obovatae-Quercetum rotundifoliae*. We can observe some patches of remarkable size of these forests that traditionally have been used for wood extraction. The best arable land, over Tertiary sediments, is totally devoted to intensive agriculture and is occupied by the "quejigo" series *Spiraeo-Querco fagineae* Sigmetum.

We pass through the Obarenes Mountains by the Portillo de Busto pass where a stop is scheduled.

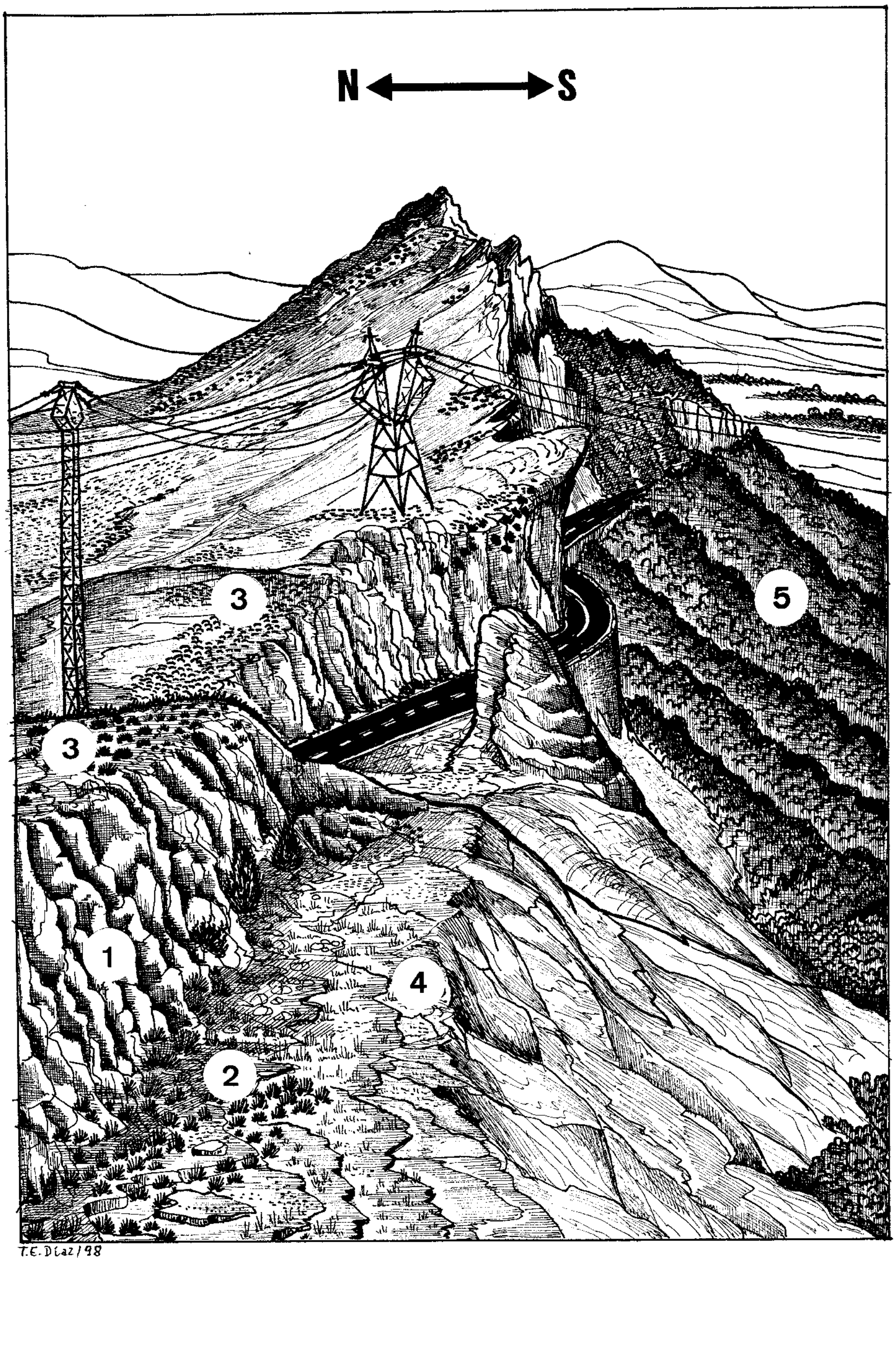
The Portillo de Busto is a pass at 1000 m which crosses the top ridge of the Obarenes mountains, an E-W oriented range. In this place we can observe the great contrast between the northern and southern slopes.

On the southern slope the rain shadow effect and the intense sunshine are noteworthy and therefore the potential natural vegetation corresponds to the *Spiraeo-Quercetum rotundifoliae* of which some quite big patches remain. In the piedmonts of the slope the land use has led to transform it into cereal crops or thyme grasslands belonging to *Koelerio vallesianae-Thymetum mastigophori brachypodietosum retusi* (in the upper part of the slope the thyme grasslands correspond to the typical subassociation *thymetosum mastigophori*). The presence of *Erodium glandulosum* in this locality is remarkable. On bare and cryoturbated soils therophytic communities of *Bupleuro-Arenarietum ciliaris* develop. Nitrophilous communities dominated by *Artemisia alba* grow at the foot of the calcareous cliffs. Communities of the *Asplenio celtiberici-Saxifragion cuneatae* alliance (*Campanulo hispanicae-Saxifragetum cuneatae* association) colonize the limestone rock crevices; the sin

PICTURE 43

Locality: Portillo de Busto (Montes Obarenes). Burgos.
Altitude: 1.000 m
Date: 24-VII-1999
Biogeography: Castellano-Cantábrico sector, Aragonian subprovince.
Bioclimatic belt: Supramediterranean, subhumid.
Lithology: Limestone, marl.

1. Calcareous rock crevices community of *Campanulo hispanicae-Saxifragetum cuneatae*.
2. Nitrophilous community of the edges of the ways with *Artemisia alba*.
3. Furze scrub (aulagar) of *Arctostaphylo crassifoliae-Genistetum occidentalis juniperetosum alpinae*.
4. Thyme scrub of *Koelerio-Thymetum mastigophori*.
5. Carrascal of *Spiraeo-Quercetum rotundifoliae*.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gular fern *Asplenium celtibericum* participates in those chasmophytic communities. The summital part of this limestone ridge is occupied by the scrub of *Arctostaphylo-Genistetum occidentalis* in its subassociation *juniperetosum alpinae* typical of the high windy biotopes. The floristic composition of those associations is shown in the following tables:

Spiraeo obovatae-Quercetum rotundifoliae: *Quercus rotundifolia* V, *Rubia peregrina* V, *Teucrium chamaedrys* V, *Juniperus communis* V, *Buxus sempervirens* IV, *Amelanchier ovalis* IV, *Genista scorpius* IV, *Genista occidentalis* IV, *Spiraea hypericifolia* subsp. *obovata* III, *Juniperus phoenicea* III, *Rhamnus alaternus* III, *Quercus faginea* III, *Arbutus unedo* II, *Carex hallerana* II, *Juniperus oxycedrus* II, *Ruscus aculeatus* II, *Ligustrum vulgare* II, *Crataegus monogyna* II, *Hedera helix* II, *Geum sylvaticum* II, *Buplerum rigidum* I. (García-Mijangos 1997: tab. 12a, rels. 1-29)

Arctostaphylo crassifoliae-Genistetum occidentalis juniperetosum alpinae: *Arctostaphylos uva-ursi* subsp. *crassifolia* V, *Genista occidentalis* V, *Erica vagans* V, *Helianthemum oelandicum* subsp. *incanum* IV, *Teucrium pyrenaicum* III, *Helictotrichon cantabricum* III, *Coronilla minima* III, *Helianthemum nummularium* III, *Filipendula vulgaris* III, *Thymus praecox* subsp. *britannicus* II, *Thymelaea ruizii* II, *Aphyllanthes monspeliensis* II, *Carex humilis* II, *Serratula nudicauilis* II, *Arenaria grandiflora* II, *Carduncellus mitissimus* II, *Koeleria vallesiana* II, *Linum milleti* II. Diferenciales de subasociación: *Juniperus alpina* V, *Sideritis hyssopifolia* subsp. *castellana* III, *Crepis albida* II, *Gentiana occidentalis* II. (García-Mijangos 1997: tab. 16b, rels. 1-31)

Koelerio vallesianae-Thymetum mastigophori* subas. *thymetosum* / subas. *brachypodietosum retusi: *Koeleria vallesiana* V/V, *Festuca hystrix* V/II, *Helainthemum oelandicum* subsp. *incanum* V/III, *Carex humilis* V/II, *Teucrium expansum* IV/IV, *Coronilla minima* IV/III, *Arenaria grandiflora* IV/III, *Thymus praecox* subsp. *britannicus* IV/II, *Helianthemum violaceum* IV/II, *Ononis striata* III/+, *Seseli montanum* III/II, *Linum milleti* II/III, *Helichysum stoechas* II/V, *Lavandula latifolia* II/IV, *Globularia vulgaris* II/III, *Serratula nudicaulis* II/+, *Helianthemum apenninum* II/II, *Thymus mastigophorus* II/+, *Coris monspeliensis* II/III, *Thesium divaricatum* II/II, *Aphyllanthes monspeliensis* I/III, *Silene legionensis* I/II, *Argyrolobium zannonii* I/IV, *Fumana ericifolia* I/III, *Genista scorpius* I/IV. Differentials of the subassociations: *Jurinea humilis* III/·, *Sideritis hyssopifolia* subsp. *castellana* III/·, *Plantago discolor* II/·, *Arenaria erinacea* II/·, *Paronychia kapela* II/·, *Fumana procumbens* I/·, *Brachypodium retusum* ·/V, *Thymus vulgaris* ·/V, *Phlomis lychnitis* ·/II, *Santolina chamaecyparissus* subsp. *squarrosa* ·/II, *Inula montana* ·/II, *Fumana thymifolia* /II. (García-Mijangos 1997: tab. 19a, rels. 1-44 / tab. 19b, rels. 1-24)

Bupleuro baldensis-Arenarietum ciliaris: *Arenaria obtusiflora* subsp. *ciliaris* V, *Cerastium pumilum* IV, *Bombycilaena erecta* IV, *Hornungia petraea* IV, *Erophila verna* II, *Euphorbia exigua* II, *Bupleurum baldense* II, *Minuartia hybrida* II, *Xeranthemum inapertum* II. (García-Mijangos 1997: tab. 25, rels. 1-13)

Campanulo hispanicae-Saxifragetum cuneatae: *Asplenium ruta-muraria* IV, *Asplenium trichomanes* III, *Campanula hispanica* III, *Jasonia glutinosa* III, *Ceterach officinarum* III, *Erinus alpinus* III, *Saxifraga cuneata* III, *Sedum dasiphyllum* III, *Chaenorhinum origanifolium* II, *Phagnalon sordidum* II, *Sarcocapnos enneaphylla* I, *Asplenium celtibericum* +. (García-Mijangos 1997: tab. 50, rels. 1-17)

On the other hand, the northern slope of this mountain range presents quite another vegetation as a result of the different climatic conditions. The rainfall increase and especially the higher frequency of fog permits the development of the *Fagus* series, *Epipactido* *helleborines-Fago* sigmetum, in the higher stretches. Nevertheless, most of the beech forests have disappeared and the seral scrub of *Arctostaphylo-Genistetum* is well represented.

Epipactido helleborines-Fagetum sylvaticae: *Fagus sylvatica* V, *Hepatica nobilis* V, *Helleborus occidentalis* V, *Hedera helix* IV, *Primula veris* subsp. *columnae* III, *Melittis melissophyllum* III, *Helleborus foetidus* III, *Poa nemoralis* III, *Ranunculus tuberosus* III, *Brachypodium sylvaticum* III, *Carex sylvatica* III, *Melica uniflora* III, *Cephalanthera damasonium* III, *Mercurialis perennis* III, *Ilex aquifolium* III, *Buxus sempervirens* II, *Lonicera xylosteum* II, *Carex flacca* II, *Polystichum aculeatum* II, *Daphne laureola* II, *Vicia sepium* II, *Aquilegia vulgaris* II, *Stellaria holostea* II, *Fragaria vesca* II, *Viola reichenbachiana* II, *Sanicula europaea* II, *Epipactis helleborine* I, *Euphorbia amygdaloides* I. (García-Mijangos 1997: tab. 1, rels. 1-23)

From Portillo de Busto to Tobera

Going down from the Portillo de Busto pass we get into the *Q. faginea* series as we lose altitude, rainfall decreases and temperatures increase. The change takes place at approximately 800 m altitude.The landscape is dominated by the substitution scrub of *Arctostaphylo-Genistetum occidentalis*, which is shared by both vegetation series *Spiraeo-Querco fagineae* sigmetum and *Epipactido-Fago* sigmetum.

The territory we pass through is formed by a succession of small mountain ranges and valleys where the height gap is not very important. The route follows a little stream called Molinar which flows over Tertiary sediments. The bottom of the valley totally used for cereal and potatoes crops, corresponds to the *Q. faginea* series. On the riverbank a community dominated by *Salix atrocinerea* and its hybrid with *S. cantabrica*, *S. x expectata* develops.

On the slopes of the hills surrounding this valley, the distribution of the different vegetation series is brought about by the substrata. In marl areas the potential vegetation correspond to the *Q. faginea* forest but most of its area is now covered by the substitution communities. The grasslands belonging to the *Avenulo mirandanae-Brachypodietum phoenicoidis* association (*Festuco-Brometea*) are invaded by species of the scrub of *Arctostaphylo-Genistetum* when they are abandoned and grazing pressure disappears.

Avenulo mirandanae-Brachypodietum phoenicoidis: *Brachypodium phoenicoides* V, *Eryngium campestre* V, *Lotus corniculatus* V, *Plantago lanceolata* V, *Sanguisorba minor* IV, *Dactylis glomerata* subsp. *hispanica* IV, *Phleum pratense* subsp. *bertolonii* IV, *Bromus erectus* IV, *Daucus carota* IV, *Trifolium pratense* IV, *Galium verum* III, *Briza media* III, *Avenula mirandana* III, *Scabiosa columbaria* II, *Leucanthemum pallens* II, *Carex flacca* II, *Ononis spinosa* II, *Medicago lupulina* II, *Carlina vulgaris* II, *Onobrychis reuteri* II, *Phleum phleoides* II, *Anacamptis pyramidalis* I, *Ophrys sphegodes* I, *Trifolium ochroleuchon* I, *Pimpinella saxifraga* I, *Hypochoeris radicata* I. (García-Mijangos 1997: tab. 22, rels. 1-22)

Some spots of sandy soils are occupied by the *Q. pyrenaica* series, *Festuco heterophyllae-Querco pyrenaicae* sigmetum. The seral communities belonging to the *Arctostaphylo crassifoliae-Daboecietum cantabricae* association appear on the degraded soils (Loidi et al. 1997)

Festuco heterophyllae-Quercetum pyrenaicae: *Quercus pyrenaica* V, *Lonicera periclymenum* V, *Pulmonaria longifolia* V, *Melampyrum pratense* V, *Rosa arvensis* V, *Serratula tinctoria* V, *Erica vagans* V, *Crataegus monogyna* V, *Corylus avellana* IV, *Lathyrus linifolius* IV, *Hypericum pulchrum* IV, *Agrostis capillaris* IV, *Brachypodium pinnatum* subsp. *rupestre* IV, *Stachys officinalis* IV, *Juniperus communis* IV, *Ligustrum vulgare* IV, *Hedera helix* IV, *Stellaria holostea* III, *Physospermum cornubiense* III, *Cruciata glabra* III, *Prunus spinosa* III, *Holcus mollis* II, *Acer campestre* II, *Melica uniflora* II, *Luzula forsteri* II, *Melittis melissophyllum* II. (García-Mijangos 1997: tab. 4, rels. 1-8)

Arctostaphylo crassifoliae-Daboecietum cantabricae: *Calluna vulgaris* V, *Erica vagans* V, *Erica cinerea* V, *Potentilla montana* V, *Daboecia cantabrica* V, *Cistus salvifolius* IV, *Genista occidentalis* IV, *Arctostaphylos uva-ursi* subsp. *crassifolia* IV, *Avenula sulcata* IV, *Thymelaea ruizii* III, *Genista sagittalis* III, *Simethis mattiazzii* III, *Agrostis curtisii* III, *Lithodora diffusa* II, *Hypericum pulchrum* II, *Xolantha tuberaria* II, *Arenaria montana* II, *Physospermum cornubiense* II, *Halimium umbellatum* I. (García-Mijangos 1997: tab. 35, rels. 1-27)

The hard calcareous substrata bear the *Q. rotundifolia* series. The potential vegetation corresponds to the *Spiraeo-Quercetum rotundifoliae* and its seral stage, the thyme grassland of *Koelerio-Thymetum mastigophori brachypodietosum retusi* represents the most abundant vegetation type. Permanent communities dominated by *Buxus sempervirens* and *Juniperus phoenicea* (*Buxo-Juniperetum phoeniceae, Pistacio-Rhamnetalia*, *Quercetea ilicis*) occupy the rocky ridges of these small mountain ranges.

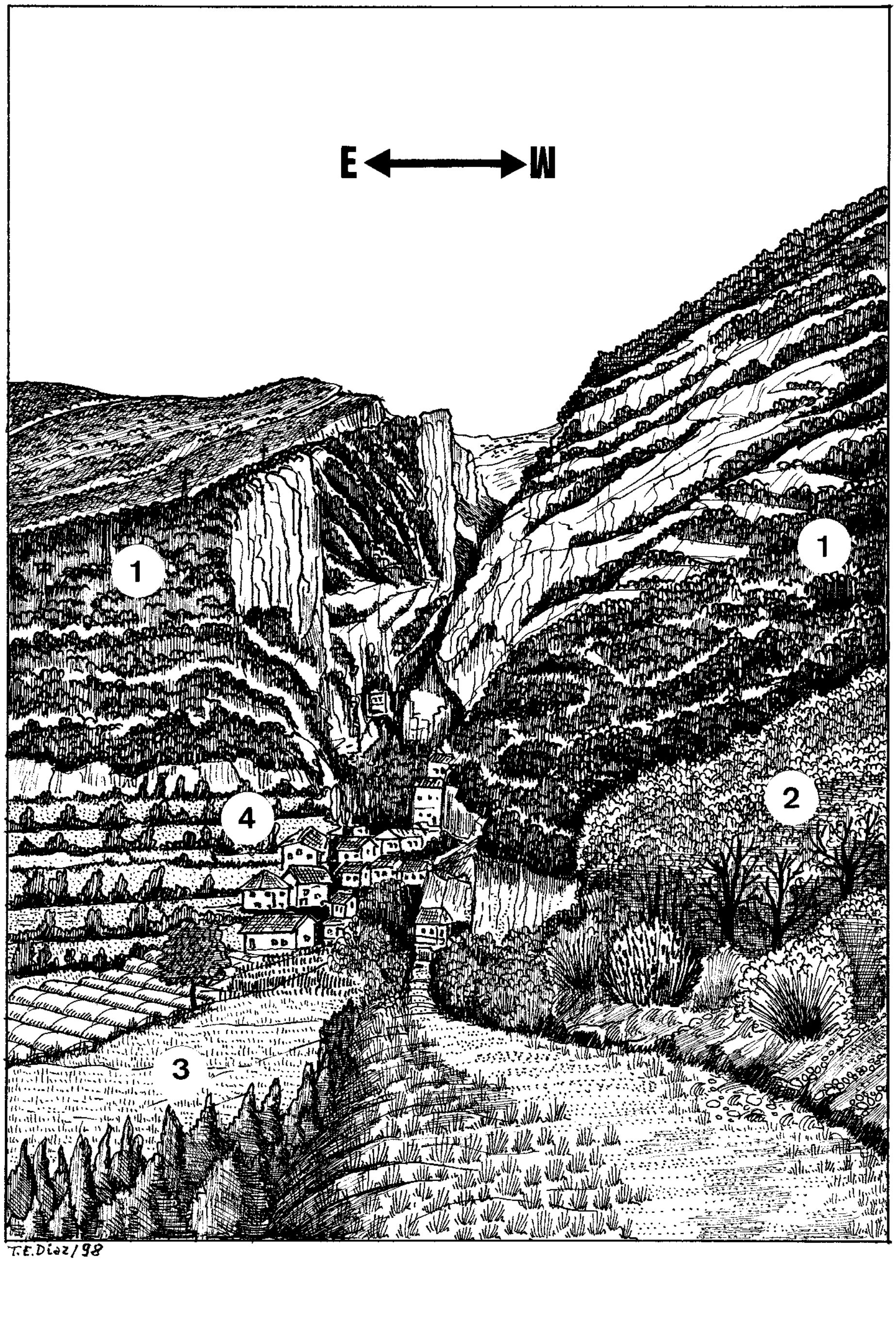
Buxo-Juniperetum phoeniceae: *Juniperus phoenicea* V, *Buxus sempervirens* V, *Amelanchier ovalis* V, *Fumana ericifolia* V, *Quercus rotundifolia* IV, *Helichrysum stoechas* IV, *Sedum sediforme* IV, *Helianthemum oelandicum* subsp. *incanum* IV, *Lavandula latifolia* IV, *Arenaria grandiflora* IV, *Galium fruticescens* IV, *Teucrium chamaedrys* III, *Juniperus oxycedrus* III, *Rhamnus alaternus* III, *Genista scorpius* III, *Thymus vulgaris* III, *Jasonia glutinosa* III, *Arctostaphylos uva-ursi* subsp. *crassifolia* III, *Spiraea hypericifolia* subsp. *obovata* II, *Bupleurum rigidum* II, *Pistacia terebinthus* I. (García-Mijangos 1997: tab. 14, rels. 1-24)

We arrive at Tobera, a small village at about 600 m of altitude, whose name is due to the Quaternary travertine (“toba”) deposits hollowed out by the Molinar river.

PICTURE 44

Locality: Santa Lucía (between Tobera and Frías). Burgos.
Altitude: 600 m
Date: 24-VII-1999
Biogeography: Castellano-Cantábrico sector, Aragonian subprovince.
Bioclimatic belt: Supramediterranean, subhumid.
Lithology]: Limestone, marl.

1. Carrascal of *Spiraeo-Quercetum rotundifoliae*.
2. Quejigar of *Spiraeo-Quercetum fagineae*
3. Crops
4. Remains of quejigar (*Spiraeo-Quercetum fagineae*)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We will walk along the path between the localities of Tobera and Frías. The way goes along the southern slope of a small defile formed by the Molinar River. This situation favours good thermic conditions permitting the growth of thermophilic species, such as *Quercus coccifera*, *Pistacia terebinthus* and *Phillyrea angustifolia*. Thus, the potencial vegetation corresponds to the *Spiraeo-Quercetum rotundifoliae arbutetosum unedonis* and its first substitution stage is a shrubland of *Quercus coccifera* maquis belonging to the *Spiraeo-Quercetum cocciferae* association.

Spiraeo obovatae-Quercetum cocciferae: *Quercus coccifera* V, *Quercus rotundifolia* V, *Rubia peregrina* V, *Buxus sempervirens* V, *Juniperus oxycedrus* V, *Genista scorpius* V, *Lavandula latifolia* V, *Dorycnium pentaphyllum* V, *Juniperus phoenicea* IV, *Rhamnus alaternus* IV, *Brachypodium retusum* IV, *Thymus vulgaris* IV, *Erica vagans* IV, *Arbutus unedo* III, *Teucrium chamaedrys* III, *Spiraea hypericifolia* subsp. *obovata* III, *Aphyllanthes monspeliensis* III, *Juniperus communis* III, *Amelanchier ovalis* III, *Cistus salvifolius* III, *Arctostaphylos uva-ursi* subsp. *crassifolia* III, *Osyris alba* I. (García-Mijangos 1997: tab. 13, rels. 1-12)

The seral thyme grassland of *Koelerio-Thymetum mastigophori brachypodietosum retusi* presents here a facies dominated by *Lavandula latifolia*.

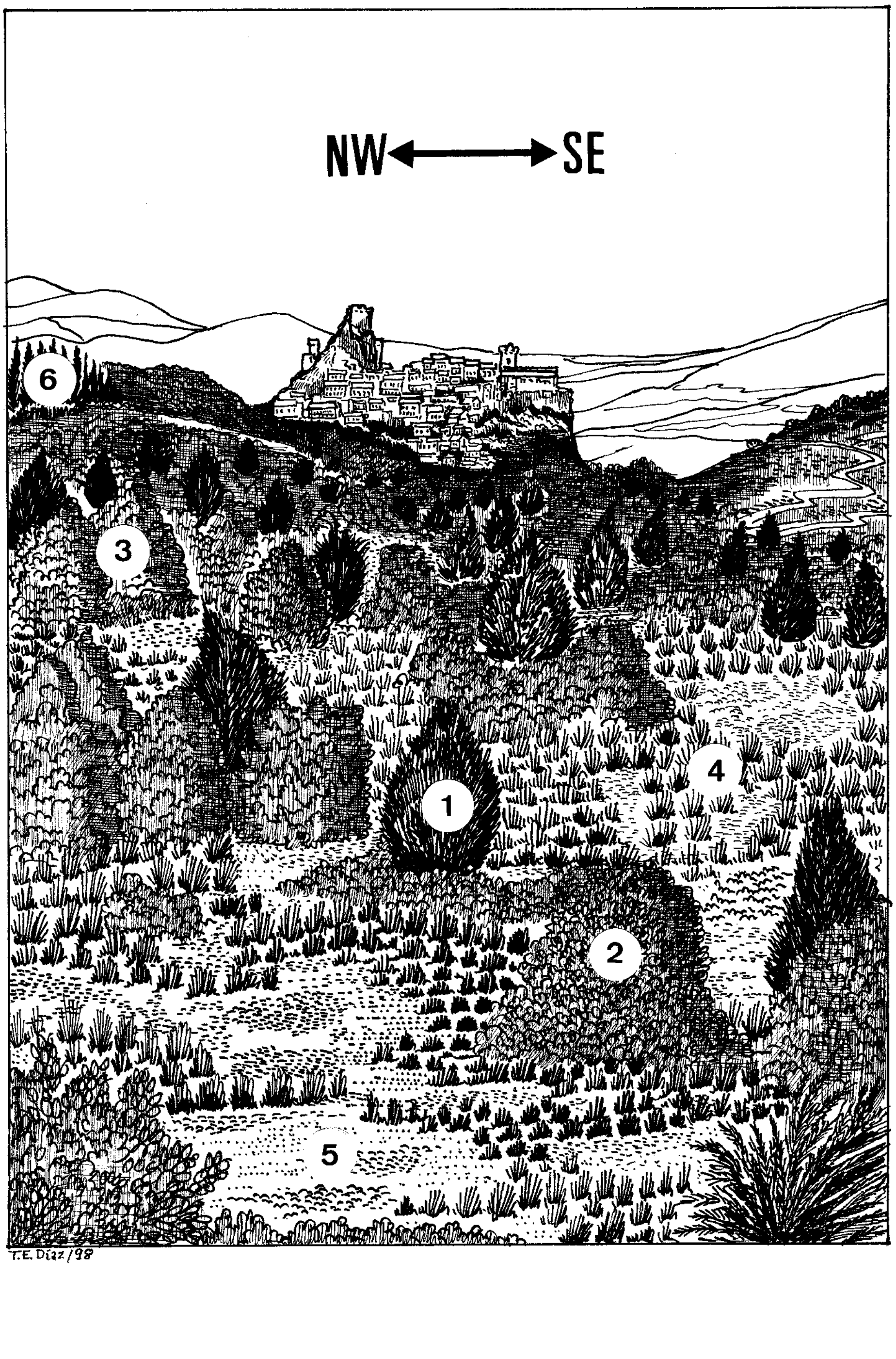
We arrive at the old city of Frías whose castle is built with travertine stone and is colonised by communities of *Asplenio-Saxifragion cuneatae* alliance; plants such as *Sarcocapnos enneaphylla*, *Chaenorhinum origanifolium*, *Asplenium trichomanes* subsp. *pachyrachys* and *Saxifraga cuneata* (*Asplenio pachyrachydo-Sarcocapnetum enneaphyllae*) are characteristic.

The road from Frías to Montejo de Cebas goes along the Ebro riverbank, crossing a small defile which cuts the Cretaceous deposits of the Humión massif. First we can observe the riparian communities of these territories: the alder forests corresponding to the

PICTURE 45

Locality: Frías. Burgos.
Altitude: 595 m
Date: 24-VII-1999
Biogeography: Castellano-Cantábrico sector, Aragonian subprovince.
Bioclimatic belt: Supramediterranean, subhumid.
Lithology: Limestone, marl.

1. Secondary coscojar of *Spiraeo-Quercetum cocciferae*, covering old crop fields with abundant juniper (*Juniperus*).
2. Coscoja (*Quercus coccifera*)
3. Boj (*Buxus sempervirens*)
4. *Lavandula latifolia*
5. Lichen communities with *Cladonia* in the gaps of the coscojar.
6. Pine plantations.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Humulo lupuli-Alnetum glutinosae association (*Populion albae*), with several Mediterranean riparian elements such as *Fraxinus angustifolia*. These alder forest represent a transitional aspect between the Eurosiberian alder forest and the riverine *Populus alba* forest of the large Mediterranean rivers. On the riverbed grow willow communities of *Salicion triandro-neotrichae* (*Salicetea purpureae*). In this locality the alder forest was cut a few years ago and is now in a regeneration stage.

Humulo lupuli-Alnetum glutinosae: *Alnus glutinosa* V, *Humulus lupulus* V, *Salix purpurea* subsp. *lambertiana* V, *Cornus sanguinea* V, *Fraxinus angustifolia* IV, *Salix neotricha* IV, *Clematis vitalba* IV, *Hedera helix* IV, *Brachypodium sylvaticum* IV, *Salix alba* III, *Salix atrocinerea* III, *Ligustrum vulgare* III, *Frangula alnus* III, *Crataegus monogyna* III, *Elymus caninus* III, *Rubus caesius* III, *Salix eleagnos* subsp. *angustifolia* II, *Salix x expectata* II, *Geranium robertianum* II, *Corylus avellana* II, *Euphorbia amygdaloides* II, *Carex pendula* II, *Arum italicum* II, *Populus nigra* II, *Ulmus minor* II, *Solanum dulcamara* II, *Rosa canina* II, *Poa nemoralis* II, *Iris foetidissima* II, *Lonicera xylosteum* II, *Viburnum lantana* II, *Bryonia dioica* II. (Biurrun, García-Mijangos & Loidi 1994: tab. 2, rels. 1-14)

The potential vegetation of this canyon corresponds to the *Quercus rotundifolia* forest (“carrascal”) and particularly to the thermophilic subassociation with *Arbutus unedo*, due to the favourable thermic conditions (lower frequency and intensity of frosts). The scrub of *Quercus coccifera* constitutes its substitution stage. We can observe the permanent communities of *Buxo-Juniperetum phoeniceae* on the limestone ridges and communities of *Asplenio celtibericae-Saxifragion cuneatae* in the rock crevices.

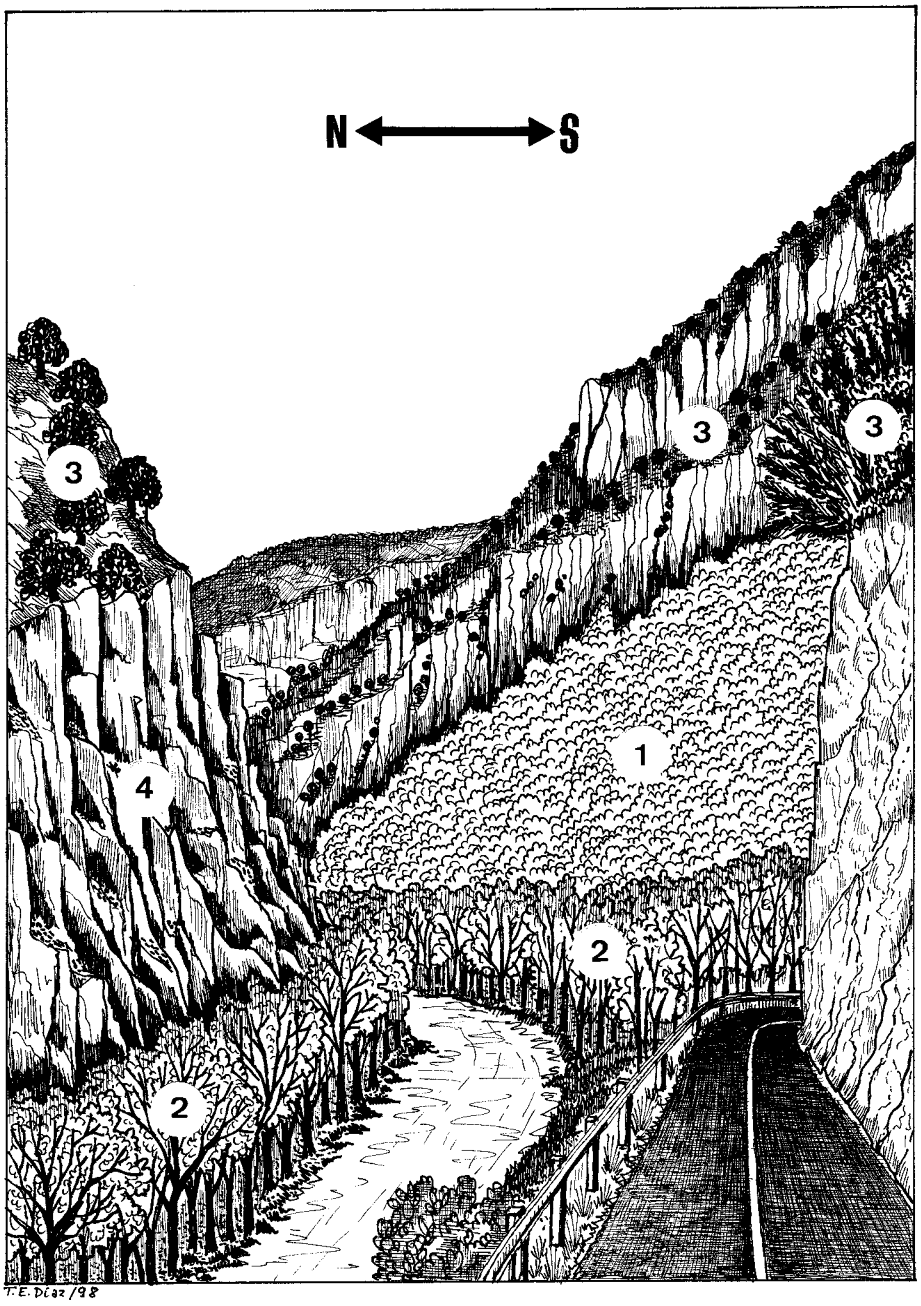
From Montejo de Cebas to the Sobrón canyon

After leaving the short defile of Montejo de Cebas, we arrive at the Villarcayo depression covered by Tertiary sediments. The land use is predominantly agricultural with cereal crops. The potential natural vegetation corresponding to *Spiraeo-Quercetum faginea* forest (“quejigar”) only remains as hedges on the crop boundaries and as small wooded patches on small hills.

PICTURE 46

Locality: Valley of the Ebro river between Frías and Montejo. Burgos.
Altitude: 540 m
Date: 24-VII-1999
Biogeography: Castellano-Cantábrico sector, Aragonian subprovince.
Bioclimatic belt: Supramediterranean, subhumid.
Lithology: Limestone, marl.

1. Carrascal of *Spiraeo-Quercetum rotundifoliae.*
2. Riverine alder forest of *Humulo lupulo-Alnetum glutinosae*
3. *Buxo-Juniperetum phoeniceae*
4. Rupicolous communities of *Campanulo-Saxifragetum cuneatae*.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From the village of Santa María de Garoña the road goes along the Sobrón dam. The border of the dam is colonized by the alder forest of *Humulo-Alnetum glutinosae*. We can also obseve *Phragmition* communities in the shallow waters of the dam.

Before arriving at the village of Sobrón, the Ebro River hollows out the Sierra de Arcena forming a spectacular canyon.

In this beautiful defile the primitive (primeval) vegetation still exists due to the inaccessibility of some of the slopes half way down the cliffs, especially on the right side, bearing *Quercus faginea* and *Q. rotundifolia* forests. The former grow on marly substrata and the latter on hard limestone. The thermic conditions permit the development of thermophilic species such as *Viburnum tinus*, *Phillyrea angustifolia* and *Pistacia terebinthus*, characterising the *arbutetosum unedonis* subassociation. Besides, at the foot of the calcareous cliff species as *Tilia platyphyllos* and *Acer monspessulanus* are abundant. In the highest part some beech appear and even beech forests of *Epipactido-Fagetum* develop.

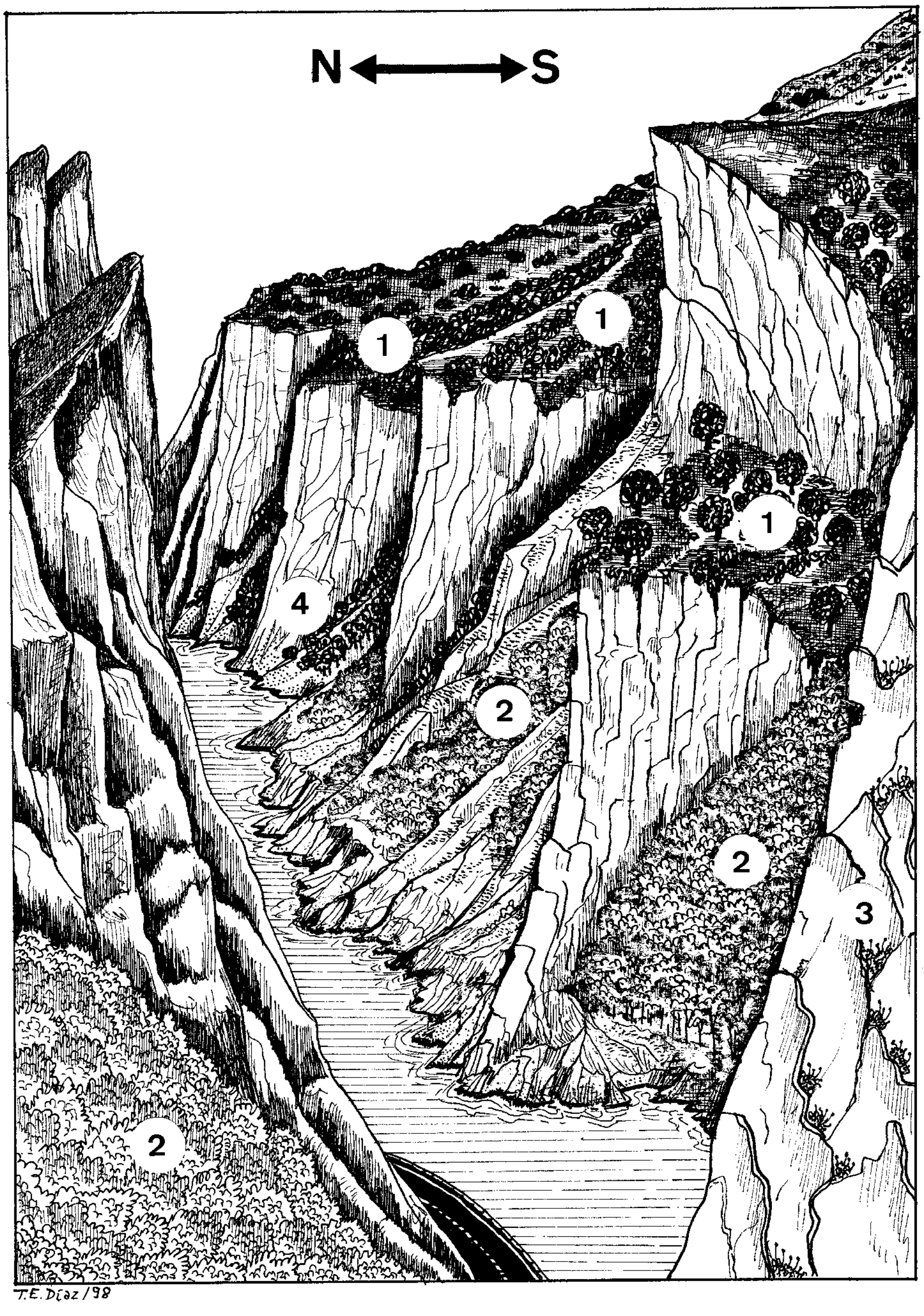
Spiraeo-Quercetum fagineae: *Quercus faginea* V, *Viburnum lantana* IV, *Hedera helix* IV, *Crataegus monogyna* IV, *Hepatica nobilis* IV, *Corylus avellana* IV, *Stachys officinalis* IV, *Erica vagans* IV, *Rubia peregrina* IV, *Genista occidentalis* IV, *Carex flacca* IV, *Rosa pimpinellifolia* IV, *Pulmonaria longifolia* IV, *Primula veris* subsp. *columnae* III, *Prunus spinosa* III, *Ligustrum vulgare* III, *Amelanchier ovalis* III, *Juniperus communis* III, *Rosa arvensis* III, *Quercus rotundifolia* III, *Spiraea hypericifolia* subsp. *obovata* II, *Lonicera xylosteum* II, *Sorbus aria* II, *Lonicera periclymenum* II, *Stellaria holostea* II, *Acer monspessulanum* II, *Buxus sempervirens* II, *Acer campestre* II, *Melittis melissophyllum* II, *Brachypodium sylvaticum* II, *Helleborus viridis* subsp. *occidentalis* II, *Sorbus torminalis* I, *Lathyrus niger* I. (García-Mijangos 1997: tab. 5, rels. 1-23)

Spiraeo-Quercetum rotundifoliae arbutetosum unedonis: *Quercus rotundifolia* V, *Rubia peregrina* V, *Amelanchier ovalis* V, *Buxus sempervirens* V, *Teucrium chamaedrys* IV, *Juniperus phoenicea* IV, *Rhamnus alaternus* IV, *Carex hallerana* IV, *Ruscus aculeatus* IV, *Genista occidentalis* III, *Genista scorpius* III, *Stachys officinalis* III, *Hedera helix* III, *Sorbus aria* III, *Spiraea hypericifolia* subsp. *obovata* II, *Juniperus oxycedrus* II, *Lonicera implexa* II, *Piptatherum paradoxum* II, *Bupleurum rigidum* II, *Osyris alba* II, *Phillyrea latifolia* II, *Acer monspessulanum* II, *Tilia platyphyllos* II. Differentials of subassociation: *Arbutus unedo* V, *Viburnum tinus* IV, *Pistacia terebinthus* IV, *Phillyrea angustifolia* IV. (García-Mijangos 1997: tab. 12b, rels. 1-25)

PICTURE 47

Locality: Embalse del Ebro (Ebro dam) in Sobrón Canyon. Álava.
Altitude: 520 m
Date: 24-VII-1999
Biogeography: Castellano-Cantábrico sector, Aragonian subprovince.
Bioclimatic belt: Lower supramediterranean, subhumid.
Lithology: Limestone, marl.

1. Carrascales of *Spiraeo-Quercetum rotundifoliae*, with *Arbutus unedo*
2. Quejigares of *Spiraeo-Quercetum fagineae* on colluvia.
3. Rupicolous communities of *Campanulo-Saxifragetum cuneatae.*
4. *Buxo-Juniperetum*.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SYNTAXONOMICAL SCHEME

The numeration of the sintaxonomic units, as well as the authorship of the ranks classis, order, aliance and suballiance are those shown in Rivas-Martínez & al. 1999.

3. POTAMETEA
3a. Potametalia
3.2. Nymphaeion albae
¬ *Myriophyllo alterniflori-Nupharetum lutei* Koch 1926
3.3. Ranunculion aquatilis
¬ *Ranunculetum hederacei* (Tüxen & Diemont 1936) Libbert 1940

4. HALODULO WRIGHTII-THALASSIETEA TESTUDINUM
4a. Thalassio-Syringodietalia filiformis
4.1. Syringodio-Thalassion testudinum
¬ *Cymodoceetum nodosae* Br.-Bl. 1952

7. ZOSTERETEA MARINAE
7a. Zosteretalia
7.1. Zosterion Christiansen 1934
¬ *Zosteretum noltii* Harmsen 1936

9. ISOETO-NANOJUNCETEA
9b. Nanocyperetalia
9.6. Heleochloion
¬ *Damasonio alismatis-Crypsietum aculeatae* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés 1980

11. MONTIO-CARDAMINETEA
11a. Montio-Cardaminetalia
11.4. Myosotidion stoloniferae
¬ *Sedo melanantheri-Saxifragetum alpigenae* Martínez-Parras, Peinado & Alcaraz 1987

12. OXYCOCCO-SPHAGNETEA
12a. Erico tetralicis-Sphagnetalia papillosi
12.1. Ericion tetralicis
12.1a. Ericenion tetralicis
¬ *Calluno vulgaris-Sphagnetum capillifolii* F. Prieto, F. Ordóñez & Collado 1987
12.1b. Trichophorenion germanici
¬ *Erico tetralicis-Trichophoretum germanici* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

13. PHRAGMITO-MAGNOCARICETEA
13b. Nasturtio-Glycerietalia
13.2. Glycerio-Sparganion
***13.2b. Glycerienion fluitantis* (**
¬ *Glycerio declinatae-Antinorietum agrostideae* Rivas Goday 1964 *corr.* J.A. Molina 1996
¬ *Glycerio declinatae-Eleocharitetum palustris* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980
13.2c. Phalaridenion arundinaceae
¬ *Glycerio declinatae-Oenanthetum crocatae* Rivas-Martínez, Belmonte, Fernández-González & Sánchez Mata *in* Sánchez Mata 1989
13.3. Nasturtion officinalis
¬ *Glycerio declinatae-Apietum nodiflori* J.A. Molina 1996
¬ *Glycerio declinatae-Catabrosetum aquaticae* T.E. Díaz & Penas 1984
13c. Magnocaricetalia

13.4. Magnocaricion elatae
¬ *Caricetum paniculatae* Wanguerin 1916
13.5. Caricion broterianae
¬ *Caricetum mauritanicae* Díez Garretas, Cuenca & Asensi 1986

14. SCHEUCHZERIO-CARICETEA FUSCAE
14b. Caricetalia fuscae
14.3. Caricion fuscae
¬ *Caricetum carpetanae* Rivas-Martínez 1963
¬ *Carici carpetanae-Sphagnetum recurvi* (Rivas Goday & Rivas-Martínez 1959) F. Prieto, Ordóñez & Collado 1987
¬ *Festuco rivularis-Veronicetum nevadensis* Quézel 1953
14.4. Anagallido-Juncion bulbosi
¬ *Hyperico elodis-Rhynchosporetum rugosae* Neto, Capelo, J.C. Costa & Lousa *in* Neto 1997
¬ *Utriculario gibbae-Sphagnetum auriculati* Neto, Capelo, J.C. Costa & Lousa *in* Ferreira de Almeida & Capelo 1996
14c. Caricetalia davallianae
14.5. Caricion davallianae
¬ *Pinguiculo grandiflorae-Caricetum lepidocarpae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

16. AMMOPHILETEA
16a. Ammophiletalia
16.1. Ammophilion australis
16.1a. Ammophilenion australis
¬ *Loto cretici-Ammophiletum australis* (Rivas Goday & Rivas-Martínez 1958) Rivas-Martínez 1964 *corr.*
16.2. Agropyro-Minuartion peploidis
16.2a. Agropyro-Minuartienion peploidis
¬ *Euphorbio paraliae-Agropyretum junceiformis* Tüxen *in* Br.-Bl. & Tüxen 1952 *corr.* Darimont, Duvigneaud & Lambinon 1962
16.2b. Agropyrenion farcti
16b. Crucianelletalia maritimae
16.4. Helichrysion picardii
¬ *Artemisio crithmifoliae-Armerietum pungentis* Rivas Goday & Rivas-Martínez 1958

17. CAKILETEA MARITIMAE
17a. Cakiletalia integrifoliae
17.2. Euphorbion peplis
¬ *Salsolo kali-Cakiletum maritimae* Costa & Mansanet 1981]

19. CRITHMO-STATICETEA
19a. Crithmo-Staticetalia
19.1. Crithmo-Staticion
19.1a. Crithmo-Staticenion
¬ *Limonio cymuliferi-Lycietum intricati* Esteve 1973

22. SAGINETEA MARITIMAE
22b. Frankenietalia pulverulentae
22.2. Frankenion pulverulentae
¬ *Parapholido incurvae-Frankenietum pulverulentae* Rivas-Martínez *ex* Castroviejo & Porta 1976

23. SALICORNIETEA FRUTICOSAE
23a. Salicornietalia fruticosae
23.1. Salicornion fruticosae
23.1a. Salicornienion fruticosae
¬ *Cistancho phelypaeae-Arthrocnemetum fruticosae* Géhu & Géhu-Franck 1977
23.1b. Arthrocnemenion perennis

¬ *Sarcocornio perennis-Puccinellietum convolutae* J.C. Costa *in* J.C. Costa, Lousa & Espirito-Santo 1997

23.2. Arthrocnemion glauci

23.2a. Arthrocnemenion glauci

¬ *Arthrocnemo glauci-Juncetum subulati* Brullo & Furnari 1976

¬ *Inulo crithmoidis-Arthrocnemetum glauci* (Fontes 1954) Géhu & Géhu-Franck 1977

¬ *Inulo crithmoidis-Limonietum ferulacei* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980

23.2b. Sarcocornienion alpini

¬ *Halimiono portulacoidis-Sarcocornietum alpini* Rivas-Martínez & Costa 1984

23.3. Suaedion verae

¬ *Cistancho phelypaeae-Suadetum verae* Géhu & Géhu-Franck 1977

23b. Limonietalia

23.6. Limoniastrion monopetali

¬ *Polygono equisetiformis-Limoniastretum monopetali* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980

24. SPARTINETEA MARITIMAE

24a. Spartinetalia maritimae

24.1. Spartinion maritimae

¬ *Spartinetum maritimae* Corillion 1953

25. THERO-SUAEDETEA

25b. Thero-Salicornietalia

25.2. Salicornion dolichostachyo-fragilis

¬ *Salicornietum fragilis* Géhu & Géhu-Franck 1984

25.4. Salicornion patulae

¬ *Suaedo splendentis-Salicornietum patulae* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980 *corr.* Rivas-Martínez 1990

26. ADIANTETEA

26a. Adiantetalia capilli-veneris

26.2. Pinguiculion longifoliae ¬ *Hyperico nummularii-Pinguiculetum coenocantabricae* T.E. Díaz, Guerra & Nieto 1982 *corr.* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

27. ASPLENIETEA TRICHOMANIS

27a. Potentilletalia caulescentis

27.2. Jasionion foliosae

¬ *Jasionetum foliosae* Font Quer 1935

27.3. Violo biflorae-Cystopteridion alpinae

¬ *Campanulo arbaticae-Saxifragetum paucicrenatae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

27.4. Saxifragion trifurcato-canaliculatae

27.4a. Saxifragenion trifurcato-canaliculatae

¬ *Anemono pavonianae-Saxifragetum canaliculatae* F. Prieto 1983

¬ *Centrantho-Saxifragetum canaliculatae* Rivas-Martínez, Izco & Costa 1971

¬ *Petrocoptidetum glaucifoliae* Rivas-Martínez *ex* Fernández Areces, Penas & T.E. Díaz 1983

¬ *Potentillo asturicae-Valerianetum apulae* Rivas-Martínez *in* Fernández Areces, Penas & T.E. Díaz 1983

¬ *Saxifrago aretioidis-Dethawietum tenuifoliae* F. Prieto 1983

27.4c. Drabo dedeanae-Saxifragenion trifurcatae

¬ *Crepido asturicae-Campanuletum legionensis* T.E. Díaz & F. Prieto *in* Fdez. Areces, Penas & T.E. Díaz 1983

¬ *Saxifragetum paniculato-trifurcatae* Fdez. Areces, Penas & T.E. Díaz 1983

¬ *Saxifragetum trifurcatae* Rothmaler 1941

¬ *Petrocoptideum wiedmanii* Ladero, T.E. Díaz, Penas,Rivas-martínez & C. Valle 1987

27.5. Asplenio celtiberici-Saxifragion cuneatae

¬ *Campanulo hispanicae-Saxifragetum cuneatae* Loidi & F. Prieto 1986

27.6 Saxifragion camposii

¬ *Kernero boissierii-Teucrietum rotundifolii* Quézel 1953

27b. Androsacetalia vandellii

27.9. Cheilanthion hispanicae

¬ *Asplenio billotii-Cheilanthetum duriensis* Rivas-Martínez & Costa 1973 *in* Sáenz & Rivas-Martínez 1979

¬ *Asplenio billotii-Cheilanthetum hispanicae* Rivas-Goday *in* Sáenz & Rivas-Martínez 1979

27.10. Saxifragion willkommianae

27.10a. Saxifragenion willkommianae

¬ *Murbeckiello boryi-Saxifragetum willkommianae* F. Prieto 1983 *corr.* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

¬ *Murbeckiello boryi-Sperguletum rimarum* F. Prieto 1983 *corr.* Izco & Ortiz 1989 *corr.* E. Puente, M.J. López Pacheco, Llamas & Penas 1995

¬ *Saxifragetum willkommianae* Rivas-Martínez 1963

27.11. Saxifragion nevadensis

¬ *Centrantho nevadensis-Sedetum brevifolii* Quézel 1953

¬ *Saxifragetum nevadensis* Litardière *ex* Quézel 1953

27c. Asplenietalia glandulosi

27.12. Asplenion glandulosi

¬ *Asplenio ceterach-Cheilanthetum acrosticae* M. T. Santos 1987

¬ *Jasonio glutinosae-Teucrietum rotundifolii* Pérez Raya & Molero Mesa 1988

¬ *Rhamno borgiae-Teucrietum freynii* Rivas Goday, Esteve & Rigaul 1962 *corr.* Alcaraz, T.E. Díaz, Rivas-Martínez & Sánchez Gómez 1989

27.15. Cosentinio bivalentis-Lafuenteion rotundifoliae

¬ *Cosentinio bivalentis-Teucrietum freynii* Rivas Goday, Esteve & Rigual 1962 *corr.* Alcaraz, T.E. Díaz, Rivas-Martínez & Sánchez Gómez 1989

28. Parietarietea

28a. Parietarietalia

28.1. Parietario-Galion muralis

¬ *Cymbalarietum muralis* Görs 1966

¬ *Parietarietum judaicae* K. Buchwald 1952

28.2. Cymbalario-Asplenion

¬ *Sedo micranthi-Saxifragetum babianae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas *in* E. Puente 1988

28.3. Sarcocapnion enneaphyllae

¬ *Sarcocapnetum crassifoliae* Cuatrecasas *ex* Esteve & Fernández Casas 1971

29. Anomodonto-Polypodietea

29a. Anomodonto-Polypodietalia

29.1. Bartramio-Polypodion serrati

¬ *Davallio canariensis-Sedetum baetici* Deil 1995

29.2. Polypodion serrati

¬ *Saxifragetum cossonianae* O. Bolòs 1967

31. Phagnalo-Rumicetea indurati

31a. Phagnalo saxatilis-Rumicetalia indurati

31.1. Rumici indurati-Dianthion lusitani

¬ *Crepido oporinoidis-Rumicetum indurati* Rivas Martínez, Fernández-González & Sánchez Mata 1986

¬ *Diantho lusitani-Antirrhinetum rupestris* Molero Mesa, Marín Calderón & López Guadalupe 1985

¬ *Digitali thapsi-Dianthetum lusitani* Rivas-Martínez *ex* V. Fuente 1986

¬ *Erodio mouretii-Rumicetum indurati* Ladero, Pérez Chiscano & Valdés Bermejo 1980

¬ *Jasiono marianae-Dianthetum lusitani* Rivas Goday (1955) 1964

¬ *Phagnalo saxatilis-Rumicetum indurati* Rivas-Martínez *ex* F. Navarro & C.J. Valle 1984

31.2. Saxifragion continentalis

¬ *Phalacrocarpo oppositifolii-Saxifragetum continentalis* Ortiz & Izco *ex* Pérez Carro, T.E. Díaz, Fernández Areces & Salvo 1989

31.4. Melico-Phagnalion intermedii
¬ *Antirrhino hispanici-Putorietum calabricae* Pérez Raya 1987
¬ *Campanulo velutinae-Phagnaletum intermedii* Rivas Goday & Esteve 1972

32. THLASPIETEA ROTUNDIFOLII

32a.Thlaspietalia rotundifolii

32.2. Saxifragion praetermissae
¬ *Ranunculo leroyi-Saxifragetum praetermissae* T.E. Díaz & F. Prieto 1983

32.3. Linarion filicaulis
¬ *Epilobio anagallidifolii-Doronicetum braun-blanquetii* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Galio pyrenaici-Salicetum breviserratae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Linario filicaulis-Crepidetum pygmaeae* F. Prieto 1983
¬ *Linario filicaulis-Sperguletum viscosae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

32.4. Iberido-Linarion propinquae
¬ *Linario odoratissimae-Rumicetum scutati* Puente 1988 *corr.* Penas, Puente, M.E. García & Herrero 1992
¬ *Rumici scutati-Iberidetum apertae* Rivas-Martínez, T.E. Díaz, Fernández Prieto, Loidi & Penas 1984

32b. Androsacetalia alpinae

32.9. Linario saxatilis-Senecionion carpetani
¬ *Cryptogrammo crispae-Silenetum gayanae* F. Prieto 1983 *corr.* Penas, Puente, M.E. García & Herrero 1992
¬ *Digitali carpetanae-Senecionetum carpetani* Rivas-Martínez 1963

32.10. Holcion caespitosi
¬ *Senecioni granatensis-Digitaletum nevadensis* Quézel 1953
¬ *Violo nevadensis-Linarietum glacialis* Quézel 1953

32d. Andryaletalia ragusinae

32.12. Glaucion flavi
¬ *Lactuco chondrilliflorae-Andryaletum ragusinae* Penas, T.E. Díaz, López Pacheco & M.E. García 1987

32e. Polystichetalia lonchitidis

32.15. Dryopteridion abbreviatae
¬ *Campanulo willkommii-Polystichetum lonchitidis* (Esteve & Fernández Casas 1971) Molero Mesa 1985
¬ *Cryptogrammo crispae-Dryopteridetum oreadis* Rivas-Martínez *in* Rivas-Martínez & Costa 1970

32.16. Arabidion alpinae
¬ *Cystopterido pseudoregiae-Dryopteridetum submontanae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

32f. Epilobietalia fleischeri

32.17. Calamagrostion pseudophragmitis
¬ *Erucastro nasturtiifolii-Calamagrostietum pseudophragmitis* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

33. ARTEMISIETEA VULGARIS

33A. *ARTEMISIENEA VULGARIS*

33a. Artemisietalia vulgaris

33.2. Rumicion pseudalpini
¬ *Chenopodio boni-henrici-Senecietum durieui* Rivas-Martínez 1963

33B. *ONOPORDENEA ACANTHII*

33c. Onopordetalia acanthii

33.7. Cirsion richterano-chodati
¬ *Carduo nutantis-Cirsietum chodati* Rivas-Martínez & F. Prieto *in* Penas, T.E. Díaz, García González, López Pacheco, Puente & Herrero 1988
¬ *Cirsio chodati-Carduetum cantabrici* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Cirsio chodati-Carduetum carpetani* Rivas-Martínez, T. E. Díaz, F. Prieto, Loidi & Penas 1984

33.9. Carduo carpetani-Cirsion odontolepidis
¬ *Carduo carpetani-Onopordetum acanthii* Rivas-Martínez, Penas & T.E. Díaz 1986

33d. Carthametalia lanati

33.10. Onopordion nervosi

¬ *Carthamo lanati-Onopordetum macracanthii* Ladero, Santos, Pérez Chiscano & Amor *in* Santos, Ladero & Amor 1988

¬ *Nothobaso syriacae-Scolymetum maculati* (Rivas Goday 1964) Ladero, Socorro, Molero Mesa, López Guadalupe, Zafra, Marín, Hurtado & Pérez Raya 1981

¬ *Onopordetum acantho-nervosi* Rivas-Martínez 1987

36. PEGANO-SALSOLETEA

36a. Salsolo vermiculatae-Peganetalia harmalae

36.3. Haloxylo tamariscifoliae-Atriplicion glaucae

¬ *Atriplici glaucae-Salsoletum genistoidis* O. Bolòs (1957) 1973

¬ *Thymelaeo hirsutae-Artemisietum barrelieri* Alcaraz, Sánchez-Gómez, de la Torre, S. Ríos & Álvarez Rogel 1991

36b. Helichryso stoechadis-Santolinetalia squarrosae

36.5. Artemisio glutinosae-Santolinion rosmarinifoliae

¬ *Artemisio glutinosae-Santolinetum semidentatae* Rivas-Martínez, Penas & T.E. Díaz 1986

36.6. Santolinion pectinato-canescentis

¬ *Artemisio glutinosae-Santolinetum canescentis* Peinado & Martínez-Parras 1984

¬ *Santolinetum impressae* Rivas-Martínez *in* JC. Costa, Capelo, Aguiar, Neto, Lousa & Espirito Santo *ined.*

38. STELLARIETEA MEDIAE

38A. *STELLARIENEA MEDIAE*

38a. Centaureetalia cyani

38.2. Roemerion hybridae

¬ *Roemerio hybridae-Hypecoetum penduli* Br.-Bl. & O. Bolòs 1954

38B. *CHENOPODIO-STELLARIENEA*

38f. Brometalia rubenti-tectorum

38.12. Hordeion leporini

¬ *Asphodelo fistulosi-Hordeetum leporini* A. & O. Bolòs *in* O. Bolòs 1956

38.18. Linario viscosae-Vulpion alopecuroris

¬ *Chamaemelo mixti-Vulpietum alopecuroris* Rivas-Martínez, Costa, Castroviejo & Valdés 1980 prov

39. FILIPENDULO ULMARIAE-CALYSTEGIETEA SEPIUM

39b. Filipenduletalia ulmariae

39.2. Filipendulo-Petasition

¬ *Senecioni laderoi-Filipenduletum ulmariae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984 corr.T.E. Díaz & F. Prieto 1994

40. GALIO-URTICETEA

40A. *GALIO APARINES-URTICENEA DIOICAE*

40a. Glechometalia hederaceae

40.2. Alliarion petiolatae

40.2a. Alliarienion petiolatae

¬ *Geranio robertiani-Caryolophetum sempervirentis* Izco, Guitián & Amigo 1986

40.4. Sambucion ebuli

¬ *Urtico dioicae-Sambucetum ebuli* (Br.-Bl. *in* Br.-Bl., Gajewski, Wraber & Walas 1936) Br.-Bl. *in* Br.-Bl., Roussine & Nègre 1952

40B. *GERANIO PURPUREI-CARDAMINENEA HIRSUTAE*

40b. Geranio purpurei-Cardaminetalia hirsutae

40.5. Geranio pusilli-Anthriscion caucalidis

¬ *Anogrammo leptophyllae-Parietarietum lusitanicae* Rivas-Martínez & Ladero *in* Rivas-Martínez 1978

¬ *Geranio rotundifolii-Theligonetum cynocrambis* Rivas-Martínez & Malato-Beliz *in* Rivas-Martínez 1978 corr.

¬ *Torilido nodosae-Parietarietum mauritanicae* Rivas-Martínez 1978

41. MULGEDIO-ACONITETEA
41a. Adenostyletalia
41.1. Adenostylion alliariae
41.1a. Adenostylenion pyrenaicae
¬ *Aconito neapolitani-Myrrhetum odoratae* F. Prieto & Nava *in* T.E. Díaz & F. Prieto 1994
41.2. Cirsion flavispinae
¬ *Senecio elodis-Aconitetum nevadensis* Quézel 1953

42. TRIFOLIO-GERANIETEA
42b. Melampyro-Holcetalia
42.4. Linarion triornithophorae
¬ *Omphalodo nitidae-Linarietum triornithophorae* Rivas-Martínez *in* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
42.5. Origanion virentis
42.5a. Origanenion virentis
¬ *Clinopodio arundani-Digitaletum bocquetii* Galán 1993
¬ *Leucanthemo sylvatici-Cheirolophetum sempervirentis* J.C. Costa, Ladero, T.E. Díaz, Lousã, Espirito Santo, Vaconcelos, Monteiro & Amor 1993
¬ *Vincetoxico nigri-Origanetum virentis* Ladero, F. Navarro, C.J. Valle, Pérez Chiscano, M.T. Santos, T. Ruiz, Fernández Arias, A. Valdés & F.J González 1985
¬ *Vicio onobrychyoidis-Hypericetum callithyrsi prov.*

43. CARICI RUPESTRIS-KOBRESIETEA BELLARDII
43a. Oxytropido-Elynetalia myosuroidis
43.1. Oxytropido-Elynion
¬ *Oxytropido pyrenaicae-Elynetum myosuroidis* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

44. ELYNO-SESLERIETEA
44a. Seslerietalia coeruleae
44.2. Armerion cantabricae
¬ *Pediculari comosae-Caricetum sempervirentis* T.E. Díaz & F. Prieto 1994
¬ *Pediculari fallacis-Armerietum cantabricae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

47. SALICETEA HERBACEAE
47a. Salicetalia herbaceae
47.2. Mucizonion sedoidis
¬ *Omalotheco pusillae-Lepidietum stylati* Martínez-Parras, Peinado & Alcaraz 1987
47.3. Arabidion caeruleae
¬ *Ranunculo leroyi-Gnaphalietum hoppeani* T.E. Díaz & Nava 1991

48. FESTUCETEA INDIGESTAE
48a. Festucetalia indigestae
48.1. Ptilotrichion purpurei
48.1a. Ptilotrichenion purpurei
¬ *Erigeronto frigidi-Festucetum clementei* Quézel 1953
¬ *Festucetum moleroi-pseudoeskiae* Quézel 1953 corr.
48.1b. Thymenion serpylloidis
¬ *Arenario granatensis-Festucetum indigestae* Rivas-Martínez 1964
¬ *Sideritido glacialis-Arenarietum pungentis* Quézel 1953
48.2. Minuartio-Festucion curvifoliae
¬ *Hieracio myriadeni-Festucetum curvifoliae* Rivas-Martínez 1963 corr.
48.3. Teesdaliopsio-Luzulion caespitosae
¬ *Junco trifidi-Oreochloetum blankae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Teesdaliopsio confertae-Festucetum eskiae* F. Prieto 1983
¬ *Teesdaliopsio confertae-Festucetum summilusitanae* F. Prieto 1983 *corr.* Rivas-Martínez 1987
48b. Jasiono sessiliflorae-Koelerietalia crassipedis

48.4. Hieracio castellani-Plantaginion radicatae
¬ *Diantho merinoi-Plantaginetum radicatae* Penas & T.E. Díaz 1985
¬ *Hieracio castellani-Festucetum curvifoliae* Rivas-Martínez & Cantó 1987 corr.
¬ *Scleranto perennis-Plantaginetum radicatae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Thymo zygidis-Plantaginetum radicatae* Rivas-Martínez & Cantó 1987 *corr.* Rivas-Martínez, Fernández-González, Sánchez Mata & Pizarro 1990

49. HELIANTHEMETEA
49a. Helianthemetalia guttati
49.1. Helianthemion guttati
49.1a. Helianthemenion guttati
¬ *Airo praecocis-Radioletum linoidis* Rivas Goday 1958
¬ *Anthoxantho aristati-Holcetum setiglumis* Rivas Goday 1958 *nom. inv.*
¬ *Paronychio cymosae-Pterocephaletum diandri* Rivas Goday 1958 *corr.* Rivas-Martínez 1978
¬ *Periballio minutae-Airopsietum tenellae* Rivas Goday 1958
¬ *Trifolio cherleri-Plantaginetum bellardi* Rivas Goday 1958
49.1b. Sedenion caespitosi
¬ *Crassulo tillaeae-Sedetum caespitosi* Rivas Goday 1958 *nom. inv. & mut. propos.*]
49.4. Sedion pedicellato-andegavensis
¬ *Sedetum caespitoso-arenarii* Rivas-Martínez *ex* V. Fuente 1986
49b. Malcolmietalia
49.6. Anthyllido hamosae-Malcolmion lacerae
¬ *Anochorto-Arenarietum algarbiensis* P. Silva *in* P. Silva & Teles 1972
¬ *Anthyllido hamosae- Malcolmietum patulae* Rivas Goday 1958
¬ *Tolpido barbatae-Tuberarietum bupleurifoliae* J.C. Costa, Lousa & Espirito-Santo 1991
49.7. Linarion pedunculatae
¬ *Herniario algarbicae-Linarietum ficalhoanae* Díez Garretas 1984
¬ *Ononido variegatae-Linarietum pedunculatae* Díez Garretas *ex* Izco & P. & J. Guitián 1988
49c. Trachynietalia distachyae
49.11. Omphalodion commutatae
¬ *Violo demetriae-Jonopsidietum prolongoi* Asensi, Díez Garretas & Esteve 1978
49.12. Trachynion distachyae
¬ *Bupleuro baldensis-Arenarietum ciliaris* Izco, Molina & Fernández-González 1986
¬ *Saxifrago tridactylitae-Hornungietum petraeae* Izco 1974
¬ *Velezio rigidae-Asteriscetum aquaticae* Rivas Goday 1964

50. FESTUCO-BROMETEA
50a. Brometalia erecti
50.1. Bromion erecti
50.1a. Bromenion erecti
¬ *Bromo erecti-Caricetum brevicollis* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Helianthemo cantabrici-Brometum erecti* Guitián, Izco & Amigo 1988
50.1b. Chamaespartio-Agrostienion
¬ *Pulsatillo hispanicae-Genistelletum sagittalis* Mayor, Andrés & Martínez 1970
50b. Brachypodietalia phoenicoidis
50.2. Brachypodion phoenicoidis
¬ *Avenulo mirandanae-Brachypodietum phoenicoidis* G. Mateo 1983
¬ *Lathyro tremolsiani-Brachypodietum phoenicoidis* Costa, Peris & Stübing 1985
¬ *Phlomido lychnitidis-Brachypodietum phoenicoidis* Br.-Bl., P. Silva & Rozeira 1956

51. FESTUCO HYSTRICIS-ONONIDETEA STRIATAE
51a. Ononidetalia striatae
51.5. Genistion occidentalis
¬ *Arctostaphylo crassifoliae-Genistetum occidentalis* Rivas-Martínez, Díaz, Fernández Prieto, Loidi & Penas 1984

¬ *Lithodoro diffusae-Genistetum legionensis* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Lithodoro diffusae-Genistetum occidentalis* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

51b. Festuco hystricis-Poetalia ligulatae

51.7. Minuartio-Poion ligulatae

¬ *Astragalo austriaci-Ononidetum cenisiae* Rivas Goday & Borja 1961
¬ *Coronillo minimae-Astragaletum nummularioidis* Pérez Raya 1987
¬ *Festucetum hystricis* Font Quer 1954
¬ *Paronychio-Artemisietum pedemontanae* (Rivas Goday & Borja 1961) Rivas Goday & Rivas-Martínez 1963
¬ *Seseli granatensis-Festucetum hystricis* Martínez-Parras, Peinado & Alcaraz 1987

51.8. Festucion burnatii

¬ *Arenario cantabricae-Festucetum hystricis* Martínez, Mayor, Navarro & T. E. Díaz 1974 *corr.* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Festucetum burnatii* Mayor, Andrés, Martínez, Navarro & T.E. Díaz 1973
¬ *Koelerio vallesianae-Erodietum glandulosi* Amigo, Giménez & Izco 1993
¬ *Saxifrago coniferae-Festucetum burnatii* F. Prieto 1983

51.9. Plantagini discoloris-Thymion mastigophori

¬ *Plantagini discoloris-Thymetum mastigophori* (Izco, Molina & Fernández-González 1983) Molina & Izco 1989
¬ *Veronico javalambrensis-Thymetum mastigophori* Izco, Molina & Fernández-González 1983 *em.* Molina & Izco 1989

53. POETEA BULBOSAE

53a. Poetalia bulbosae

53.1. Trifolio subterranei-Periballion

¬ *Trifolio subterranei-Poetum bulbosae* Rivas Goday 1964

53.2. Poo bulbosae-Astragalion sesamei

¬ *Poo bulbosae-Astragaletum sesamei* Rivas Goday & Ladero 1970

54. SEDO-SCLERANTHETEA

54a. Sedo-Scleranthetalia

54.2. Sedion pyrenaici

¬ *Agrostio durieui-Sedetum pyrenaici* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Sedo brevifolii-Sperguletum rimarum* E. Puente, M.J. López Pacheco, Llamas & Penas 1995

55. THERO-BRACHYPODIETEA

55a. Thero-Brachypodietalia ramosi

55.2. Stipion tenacissimae

¬ *Lapiedro martinezii-Stipetum tenacissimae* Rivas-Martínez & Alcaraz *in* Alcaraz 1984
¬ *Thymo gracilis-Stipetum tenacissimae* Pérez Raya 1987

55.3. Thero-Brachypodion ramosi

¬ *Iberido macrocarpae-Stipetum offneri* Rivas-Martínez, Lousa, T.E. Díaz, F. Fernández González & J.C. Costa 1990
¬ *Teucrio pseudochamaepitys-Brachypodietum ramosi* O. Bolòs 1957

55.4. Festucion scariosae

¬ *Festuco scariosae-Helictotrichetum arundani* Asensi, Díez Garretas & Martín Osorio 1993
¬ *Helictotricho filifolii-Festucetum scariosae* Martínez-Parras, Peinado & Alcaraz 1984

55b. Hyparrhenietalia hirtae

55.6. Hyparrhenion hirtae

¬ *Andropogonetum hirto-pubescentis* A. & O. Bolòs & Br.-Bl. *in* A. & O. Bolòs 1950

56. STIPO GIGANTEAE-AGROSTIETEA CASTELLANAE

56a. Agrostietalia castellanae

56.1. Agrostion castellanae

¬ *Festuco amplae-Agrostietum castellanae* Rivas-Martínez & Belmonte 1986
¬ *Gaudinio fragilis-Agrostietum castellanae* Rivas-Martínez & Belmonte 1986

56.2. Festucion elegantis

¬ *Deschampsio strictae-Agrostietum curtisii* Galán, Deil, Haug & Orellana 1997

¬ *Phalacrocarpo oppositifolii-Festucetum elegantis* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas *in* E. Puente 1988

56.3. Agrostio castellanae-Stipion giganteae

¬ *Arrhenathero baetici-Stipetum giganteae* Rivas-Martínez, Fernández-González & Sánchez Mata 1986

¬ *Centaureo ornatae-Stipetum lagascae* Rivas-Goday *ex* Rivas-Martínez & Fernández-González 1991

58. MOLINIO-ARRHENATHERETEA

58a. Molinietalia caeruleae

58.1. Calthion palustris

¬ *Bromo commutati-Polygonetum bistortae* Rivas-Martínez *ex* Mayor *in* Mayor, T.E. Díaz, F. Navarro, Martínez & Andrés 1975

58.3. Juncion acutiflori

¬ *Juncetum rugoso-effusi* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980

58b. Arrhenatheretalia

58.4. Arrhenatherion

¬ *Malvo moschatae-Arrhenatheretum bulbosi* Tüxen & Oberdorfer 1958 *corr.* T.E. Díaz & F. Prieto 1994

58.6. Cynosurion cristati

58.6a. Cynosurenion cristati

¬ *Festuco amplae-Cynosuretum cristati* Rivas-Martínez *ex* V. Fuente 1986

¬ *Merendero pyrenaicae-Cynosuretum cristati* Tüxen & Oberdorfer 1958

58c. Holoschoenetalia

58.7. Molinio-Holoschoenion

¬ *Galio palustris-Juncetum maritimi* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980

¬ *Holoschoeno-Juncetum acuti* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980

¬ *Trifolio resupinati-Holoschoenetum* Rivas Goday 1964

58d. Plantaginetalia majoris

58.11. Poion supinae

¬ *Plantagini majoris-Poetum supinae* Rivas-Martínez & Géhu 1978

58.12. Trifolio fragiferi-Cynodontion

¬ *Trifolio resupinati-Caricetum chaetophyllae* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980

59. NARDETEA

59a. Nardetalia strictae

59.1. Nardion strictae

59.1a. Carici macrostyli-Nardenion

¬ *Polygalo edmundii-Nardetum* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

59.2. Violion caninae

¬ *Serratulo seoanei-Nardetum strictae* Tüxen *in* Tüxen & Oberdorfer 1958

59.3. Campanulo herminii-Nardion strictae

¬ *Allietum latiorifolii* Rivas-Martínez, Fernández-González, Sánchez Mata & Pizarro 1990

¬ *Campanulo herminii-Festucetum ibericae* Rivas-Martínez 1963

¬ *Campanulo herminii-Festucetum rivularis* Rivas-Martínez, Fernández-González & Sánchez Mata 1998

¬ *Festuco rothmaleri-Juncetum squarrosi* Rivas-Martínez, Fernández-González, Sánchez Mata & Pizarro 1990

¬ *Luzulo carpetanae-Pedicularietum sylvaticae* Tüxen & Oberdorfer 1958 *corr.* Izco & Ortiz 1989

¬ *Poo legionensis-Nardetum strictae* Rivas-Martínez 1963 *corr.* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

59.4. Plantaginion thalackeri

¬ *Armerio splendentis-Agrostietum nevadensis* Quézel 1953

¬ *Nardo strictae-Festucetum ibericae* Quézel 1953
¬ *Plantagini granatensis-Festucetum ibericae* Gómez Mercado, F. Valle & Mota 1995
¬ *Ranunculo acetosellifolii-Vaccinietum uliginosi* Quézel 1953

60. CALLUNO-ULICETEA

60a. Ulicetalia minoris

60.1. Daboecion cantabricae

¬ *Arctostaphylo crassifoliae-Daboecietum cantabricae* Loidi, García-Mijangos, Herrera, Berasategi & Darquistade 1997
¬ *Daboecio cantabricae-Ericetum aragonensis* Rivas-Martínez *in* F. Prieto & Loidi 1984
¬ *Halimio alyssoidis-Ulicetum gallii* (Rivas-Martínez 1979) Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Daboecio-Ulicetum gallii* (Br.-Bl. 1969) Rivas-Martínez 1979
¬ *Vaccinio myrtilli-Ulicetum gallii* Loidi, García-Mijangos, Herrera, Berastegi & Darquistade 1997

60.3. Ericion umbellatae

¬ *Erico umbellatae-Genistetum sanabrensis* Rivas-Martínez 1979
¬ *Erico umbellatae-Ulicetum weelwistchiani* Capelo, Neto, J.C. Costa & Lousa *in* J.C. Costa, Capelo, Neto, Espirito-Santo & Lousa 1997
¬ *Genistello tridentatae-Ericetum aragonensis* Rothmaler 1954 *em.* Rivas-Martínez 1979
¬ *Erico umbellatae-Cistetum populifoli* Rivas Goday 1964
¬ *Halimio ocymoidis-Ericetum aragonensis* Rivas-Martínez 1979
¬ *Halimio ocymoidis-Ericetum umbellatae* Rivas Goday 1964

60.4. Stauracanthion boivinii

¬ *Genisto tridentis-Satauracanthetum boivinii* Rivas-Martínez 1979
¬ *Querco lusitanicae-Stauracanthetum boivinii* Rothmaler 1954 *corr.* Rivas-Martínez, Lousa, T.E. Díaz, Fernández-González & J.C. Costa 1990
¬ *Stauracantho boivinii-Drosophylletum lusitanicae* Quézel, Barbero, Benabid, Loisel & Rivas-Martínez 1988
¬ *Tuberario majoris-Stauracanthetum boivinii* Br.-Bl., P. Silva & Rozeira *ex* Rivas-Martínez 1979

60.5. Genistion micrantho-anglicae

¬ *Cirsio welwitschii-Ericetum ciliaris* Neto, Capelo, J.C. Costa, E. Santo *in* Neto & al. 1996
¬ *Genisto anglicae-Ericetum ciliaris* Quézel, Barbero, Benabid, Loisel & Rivas-Martínez 1978

62. CISTO-LAVANDULETEA

62a. Lavanduletalia stoechadis

62.1. Cistion ladaniferi

¬ *Cisto-Pinetum pinastri* O. Bolòs 1967

62.2. Cistion laurifolii

¬ *Cisto ladaniferi-Genistetum hystricis* P. Silva (1965) 1970
¬ *Erico arboreae-Arctostaphyletum crassifoliae* Rivas-Martínez 1968
¬ *Halimio ocymoidis-Cistetum laurifolii* Rivas-Martínez 1968
¬ *Halimio viscosi-Cistetum laurifolii* Martínez-Parras & Molero-Mesa 1983
¬ *Halimio umbellati-Cistetum laurifolii* Penas inéd.
¬ *Lavandulo pedunculatae-Genistetum hystricis* Rivas-Martínez 1968
¬ *Rosmarino-Cistetum ladaniferi* Rivas-Martínez 1968

62.3. Ulici argentei-Cistion ladaniferi

¬ *Calicotomo villosae-Genistetum hirsutae* Martínez Parras, Peinado & De la Cruz 1987
¬ *Cisto ladaniferi-Ulicetum argentei* Br.-Bl., Silva & Rozeira 1964
¬ *Genisto hirsutae-Cistetum ladaniferi* Rivas Goday 1956
¬ *Halimietum commutati* Rivas-Martínez 1970
¬ *Phlomido purpureae-Cistetum albidi* Rivas-Martínez, Lousa, T.E. Díaz, Fernández-González & J.C. Costa 1990

62.4. Staehelino-Ulicion baetici

¬ *Halimio atriplicifolii-Digitaletum laciniatae* Rivas Goday & Rivas-Martínez 1969

62b. Stauracantho genistoidis-Halimietalia commutati

62.5. Coremion albi

¬ *Cistetum bourgaeani (libanotidis)* Rothmaler 1954

¬ *Halimio halimifolii-Stauracanthetum genistoidis* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980

¬ *Thymo camphorati-Stauracanthetum spectabilis* (Rothmaler 1943) Rivas-Martínez, T.E. Díaz & Fernández-González 1990

¬ *Thymo capitellati-Stauracanthetum genistoidis* (Rothmaler 1954) Rivas-Martínez, T.E. Díaz & Fernández-González 1990

64. ROSMARINETEA OFFICINALIS

64a. Rosmarinetalia officinalis

64.1. Rosmarinion officinalis

64.1b. Teucrio latifolii-Thymenion piperellae

¬ *Thymo piperellae-Helianthemetum marifolii* Rivas Goday 1958 *corr.* Díez Garretas, Fernández-González & Asensi 1998

64.4. Eryngio-Ulicion erinacei

64.4b. Saturejo-Coridothymenion

¬ *Asperulo hirsutae-Ulicetum scabri* Rivas-Martínez *in* Díez Garretas & Asensi 1994

¬ *Helianthemo hirti-Saturejetum micranthae* Rivas Goday 1964

64.4c. Serratulo estremadurensis-Thymenion sylvestris

¬ *Salvio sclareoidis-Ulicetum densi* Rivas-Martínez, Lousa, T.E. Díaz, Fernández-González & J.C. Costa *ex* Capelo, J.C. Costa, Lousa & Neto 1992

64.5. Lavandulo lanatae-Genistion boissieri

¬ *Convolvulo lanuginosi-Lavanduletum lanatae* Rivas Goday & Rivas-Martínez 1969

¬ *Santolino canescentis-Salvietum oxyodontis* Rivas Goday & Rivas-Martínez 1969

¬ *Thymo gracilis-Lavanduletum lanatae* Pérez Raya & Molero Mesa 1988

¬ *Ulici baetici-Lavanduletum lanatae* Martínez-Parras, Peinado & De la Cruz 1987

64.6. Sideritido incanae-Salvion lavandulifoliae (

64.6a. Xero-Aphyllanthenion

¬ *Lithodoro diffusae-Genistetum scorpii* Ladero, T.E. Díaz, Penas, Rivas-Martínez & C.J. Valle 1987

64.6b. Saturejo gracilis-Erinaceenion anthyllidis

¬ *Armerio alliaceae-Salvietum mariolensis* (O. Bolòs & Rigual 1967) Solanas & Crespo 1998

¬ *Erodio-Erinaceetum anthyllidis* (Rivas Goday & Borja 1961) O. Bolòs & Vigo 1968

¬ *Genisto hispanicae-Erinaceetum anthyllidis* Rivas Goday & Borja 1961

¬ *Saturejo gracilis-Erinaceetum anthyllidis* Rivas Goday & Borja 1961 *corr.* Izco & Molina 1989

64b. Erinaceetalia anthyllidis

64.8. Xeroacantho-Erinaceion

¬ *Astragalo boissieri-Festucetum hystricis* Quézel 1953

¬ *Erinaceo-Genistetum longipedis* O. Bolòs & Rigual *in* O. Bolòs 1967

¬ *Astragalo andresmolinae-Ernaceetum anthyllidis* Díez Garretas & Asensi 1998

¬ *Saturejo prostratae-Velletum spinosae* Rivas Goday 1968

64c. Gypsophiletalia

64.9. Lepidion subulati

64.9a. Lepidienion subulati

¬ *Gypsophilo struthium-Ononidetum edentulae* Costa, Peris & Figuerola *in* Costa & Peris 1985

64d. Anthyllidetalia terniflorae

64.11. Thymo moroderi-Sideritidion leucanthae

64.11a. Thymo moroderi-Sideritidenion leucanthae

¬ *Saturejo canescentis-Cistetum albidi* Rivas Goday 1954 *corr.* Alcaraz, T.E. Díaz, Rivas-Martínez & Sánchez-Gómez 1989

64.12. Anthyllido terniflorae-Salsolion papillosae

¬ *Paronychio suffruticosae-Sideritidetum murgetanae* Esteve 1973 *corr.* Alcaraz & Delgado 1998

¬ *Salsolo papillosae-Limonietum carthaginensis* (Alcaraz, T.E. Díaz, Rivas-Martínez, Sánchez-Gómez 1989) Peinado, Alcaraz & Martínez-Parras 1992

64.13. Helianthemo almeriensis-Sideritidion pusillae
¬ *Sideritido marminorensis-Thymetum hyemalidis* Alcaraz & Delgado 1998
64e. Convolvuletalia boissieri
64.14. Andryalion agardhii
¬ *Convolvulo nitidi-Andryaletum agardhii* Quézel 1953
¬ *Galio baetici-Thymetum granatensis* Mota & F. Valle 1992

65. CYTISETEA SCOPARIO-STRIATI
65a. Cytisetalia scopario-striati
65.1. Genistion floridae
¬ *Adenocarpetum argyrophylli prov.*
¬ *Cytiso oromediterranei-Genistetum cinerascentis* Rivas-Martínez 1970 *corr.* Rivas-Martínez & Cantó 1987
¬ *Genisto floridae-Cytisetum scoparii* Rivas-Martínez & Cantó 1987
65.2. Adenocarpion decorticantis
¬ *Cytiso scoparii-Adenocarpetum decorticantis* F. Valle 1981
65.3. Genistion polygaliphyllae
¬ *Cytisetum scopario-oromediterranei* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984 *corr.* Rivas-Martínez & Belmonte 1987
¬ *Cytiso cantabrici-Genistetum obtusirameae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Cytiso cantabrici-Genistetum polygaliphyllae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Cytiso scoparii-Genistetum polygaliphyllae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Cytiso striati-Genistetum polygaliphyllae* Rivas-Martínez 1981
¬ *Echinospartetum lusitanici* Rivas-Martínez 1974
¬ *Genistetum polygaliphyllo-obtusirameae* Bellot 1968
¬ *Genisto hystricis-Cytisetum multiflori* Rivas-Martínez, T. E. Díaz, F. Prieto, Loidi & Penas 1984
65.4. Ulici europaei-Cytision striati
¬ *Lavandulo sampaioanae-Cytisetum multiflori* Br.-Bl., P. Silva & Rozeira 1964
65.6. Retamion sphaerocarpae
¬ *Cytiso multiflori-Retametum sphaerocarpae* Rivas-Martínez, F. Navarro & al. 1987
¬ *Cytiso scoparii-Retametum sphaerocarpae* Rivas-Martínez *ex* V. Fuente 1986
¬ *Lavandulo pedunculatae-Adenocarpetum aurei* Rivas-Martínez 1968
¬ *Pycnomo rutifolii-Retametum monospermae* Pérez Chiscano 1983
¬ *Retamo sphaerocarpae-Cytisetum bourgaei* Rivas-Martínez & Belmonte *in* Capelo 1996
64.7. Genistion linifoliae
¬ *Cytiso baetici-Genistetum monspessulanae* Martín Osorio, Galán & Vicente Orellana *ined.*

66. RHAMNO-PRUNETEA
66a. Prunetalia spinosae
66.1. Berberidion vulgaris
66.1a. Berberidenion vulgaris
¬ *Pruno spinosae-Berberidetum cantabricae* Rivas-Martínez, Izco & Costa 1971 *corr.* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
66.2. Pruno-Rubion ulmifolii O. Bolòs 1954
66.2a. Lonicerenion periclymeni
¬ *Rubo ulmifolii-Tametum communis* Tüxen *in* Tüxen & Oberdorfer 1958
66.2b. Pruno-Rubenion ulmifolii
¬ *Clematido campaniflorae-Rubetum ulmifolii* Peinado & Velasco *in* Peinado, G.Moreno & Velasco 1983
¬ *Rubo ulmifolii-Coriarietum myrtifoliae* O. Bolòs 1954
66.2c. Rosenion carioti-pouzinii
¬ *Lonicero hispanicae-Rubetum ulmifolii* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980
¬ *Rhamno catharticae-Ribesetum alpini* L. Herrero, M. E. García & Penas *in* L. Herrero 1989
¬ *Rubo ulmifolii-Rosetum corymbiferae* Rivas-Martínez & Arnáiz *in* Arnáiz 1979
66.4. Lonicero-Berberidion hispanicae
¬ *Pruno mahalebo-Berberidetum hispanicae* Asensi & Rivas-Martínez 1979

67. ALNETEA GLUTINOSAE
67a. Alnetalia glutinosae
67.1. Alnion glutinosae
¬ *Carici lusitanicae-Alnetum glutinosae* T.E. Díaz & F. Prieto 1994

69. NERIO-TAMARICETEA
69a. Tamaricetalia africanae
69.1. Tamaricion africanae
¬ *Polygono equisetiformis-Tamaricetum africanae* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980
69.3. Rubo ulmifolii-Nerion oleandri
¬ *Rubo ulmifolii-Nerietum oleandri* O. Bolòs 1956
69.4. Imperato cylindricae-Erianthion ravennae
¬ *Equiseto ramosissimae-Erianthetum ravennae* Br.-Bl. & O. Bolòs 1958
¬ *Eriantho ravennae-Holoschoenetum australis* O. Bolòs 1962

70. SALICETEA PURPUREAE
70a. Salicetalia purpureae
70.2. Salicion salviifoliae
¬ *Salicetum angustifolio-salvifoliae* T.E. Díaz & Penas 1987
¬ *Salicetum lambertiano-salvifoliae* Rivas-Martínez 1964 *corr.* Rivas-Martínez, Fernández-González & Sánchez Mata 1986
70.3. Securinegion tinctoriae
¬ *Pyro bourgeanae-Securinegetum tinctoriae* Rivas Goday 1964
70.4. Salicion triandro-neotrichae
¬ *Salicetum cantabricae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984

72. PINO-JUNIPERETEA
72a. Pino-Juniperetalia
72.1. Pino ibericae- Juniperion sabinae
¬ *Berberido hispanicae-Juniperetum sabinae prov.*
¬ *Daphno hispanicae-Pinetum ibericae* Rivas-Martínez 1964 *corr.* Rivas-Martínez & J.A. Molina 1998
¬ *Junipero sabinae-Pinetum ibericae* Rivas Goday & Borja 1961 *corr.* Rivas-Martínez & J.A. Molina 1998
¬ *Rhamno infectoriae-Juniperetum sabinae* Díez Garretas & Asensi 1998
72.2. Juniperion thuriferae
¬ *Juniperetum hemisphaerico-thuriferae* Rivas-Martínez 1969
¬ *Juniperetum sabino-thuriferae* Rivas-Martínez, Izco & Costa 1971
72.3. Avenello ibericae-Pinion ibericae
¬ *Avenello ibericae-Pinetum ibericae* Rivas-Martínez & J.A. Molina 1998
¬ *Pteridio aquilini-Pinetum ibericae* Rivas-Martínez & J.A. Molina *ined.*
72b. Juniperetalia hemisphaericae
72.5. Genisto versicoloris-Juniperion hemisphaericae
¬ *Genisto baeticae-Juniperetum nanae* Quézel 1953
72.6. Cytision oromediterranei
¬ *Avenello ibericae-Juniperetum alpinae* Rivas-Martínez, Fernández-González & Sánchez Mata 1998
¬ *Genisto sanabrensis-Juniperetum nanae* F. Prieto 1983
¬ *Senecioni carpetani-Cytisetum oromediterranei* Tüxen & Oberdorfer 1958 *corr.* Rivas-Martínez 1987

73. QUERCETEA ILICIS
73a. Quercetalia ilicis
73.1. Quercion ilicis
73.1b. Quercenion rotundifoliae
¬ *Asplenio onopteridis-Quercetum suberis* Costa, Peris & Figuerola 1986
¬ *Cephalanthero longifoliae-Quercetum rotundifoliae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Hedero helicis-Quercetum rotundifoliae* Costa, Peris & Stübing 1987

¬ *Junipero thuriferae-Quercetum rotundifoliae* (Rivas Goday 1959) Rivas-Martínez 1987
¬ *Quercetum rotundifoliae* Br.-Bl. & O. Bolòs 1958
¬ *Spiraeo obovatae-Quercetum rotundifoliae* Rivas Goday *ex* Loidi & F. Prieto 1986

73.2. Quercion broteroi

73.2a. Quercenion broteroi

¬ *Arisaro clusii-Quercetum broteroi* Br.-Bl., P. Silva & Rozeira 1956 *corr.* Rivas-Martínez 1975
¬ *Sanguisorbo agrimonioidis-Quercetum suberis* Rivas Goday 1959
¬ *Pistacio terebinthi-Quercetum broteroi* Rivas Goday 1964

73.2b. Paeonio broteroi-Quercenion rotundifoliae

¬ *Berberido hispanicae-Quercetum rotundifoliae* Rivas-Martínez 1987
¬ *Genisto hystricis-Quercetum rotundifoliae* P. Silva 1970
¬ *Junipero oxycedri-Quercetum rotundifoliae* Rivas-Martínez 1964
¬ *Paeonio coriaceae-Quercetum rotundifoliae* Rivas-Martínez 1964
¬ *Pyro bourgeanae-Quercetum rotundifoliae* Rivas-Martínez 1987

73.3. Querco rotundifoliae-Oleion sylvestris

¬ *Clematido cirrhosae-Ceratonietum siliquae* Barbero, Quézel & Rivas-Martínez 1981
¬ *Myrto communis-Quercetum rotundifoliae* (Rivas Goday 1959) Rivas-Martínez 1987
¬ *Myrto communis-Quercetum suberis* Barbero, Benabid, Quézel & Rivas-Martínez 1981
¬ *Oleo sylvestris-Quercetum suberis* Rivas Goday, F. Galiano & Rivas-Martínez *in* Rivas-Martínez 1987
¬ *Rubio longifoliae-Quercetum rotundifoliae* Costa, Peris & Figuerola 1983
¬ *Rusco hypophylli-Quercetum canariensis* Rivas-Martínez 1975
¬ *Tamo communis-Oleetum sylvestris* Benabid 1984
¬ *Teucrio baetici-Quercetum suberis* Rivas-Martínez *ex* Díez Garretas, Cuenca & Asensi 1988
¬ *Viburno tini-Quercetum cocciferae* Rivas-Martínez, Lousa, T.E. Díaz, Fernández-González & J.C. Costa 1990

73b. Pistacio lentisci-Rhamnetalia alaterni

73.4. Asparago albi-Rhamnion oleoidis

¬ *Asparago albi-Rhamnetum oleoidis* Rivas Goday 1959
¬ *Asparago aphylli-Calicotometum villosae* Rivas-Martínez 1975
¬ *Asparago aphylli-Myrtetum communis* Rivas-Martínez, Cantó, Fernández-González & Sánchez Mata *ex* J.C. Costa, Lousa & Espirito-Santo 1997
¬ *Bupleuro gibraltarici-Pistacietum lentisci* Martínez-Parras, Peinado & Alcaraz 1986
¬ *Chamaeropo humilis-Juniperetum phoeniceae* Rivas-Martínez *in* Alcaraz, T.E. Díaz, Rivas-Martínez & Sánchez-Gómez 1989
¬ *Chamaeropo humilis-Rhamnetum lycioidis* O. Bolòs 1957
¬ *Chamaeropo humilis-Myrtetum communis* (O. Bolòs 1962) Rivas-Martínez *ined.*
¬ *Pino acutisquamae-Quercetum cocciferae* Cabezudo, Nieto Caldera & Pérez Latorre 1989
¬ *Querco cocciferae-Juniperetum turbinatae* (Rivas-Martínez 1975) Rivas-Martínez, Lousa, T.E. Díaz, Fernández-González & J.C. Costa 1990
¬ *Querco cocciferae-Lentiscetum* Br.-Bl. & al. 1935

73.6. Rhamno lycioidis-Quercion cocciferae

¬ *Buxo sempervirentis-Juniperetum phoeniceae* Rivas-Martínez 1969
¬ *Crataego monogynae-Quercetum cocciferae* Martínez-Parras, Peinado & Alcaraz 1985
¬ *Hedero helicis-Genistetum patentis* Mateo 1983 *corr.* R. Roselló 1994
¬ *Hyacinthoido hispanicae-Quercetum cocciferae* (Rivas Goday 1959) Peinado & Martínez-Parras 1985
¬ *Quercetum cocciferae* Br.-Bl. 1924
¬ *Rhamno lycioidis-Juniperetum phoeniceae* Rivas-Martínez & G. López *in* G. López 1976
¬ *Spiraeo obovatae-Quercetum cocciferae* Loidi & F. Prieto 1986

73.7. Periplocion angustifoliae

¬ *Arisaro simorrhini-Tetraclinidetum articulatae* Rivas Goday & Rivas-Martínez *in* Rivas-Martínez 1975
¬ *Mayteno europaei-Periplocetum angustifoliae* Rivas Goday & Esteve *in* Rivas Goday 1959 *corr.* Rivas-Martínez 1975

73.8. Genisto spartioidis-Phlomidion almeriensis

¬ *Rhamno lycioidis-Genistetum murcicae* Peinado, Alcaraz & Martínez-Parras 1992

73.9. Juniperion turbinatae
¬ *Osyrio quadripartitae-Juniperetum turbinatae* (Rivas-Martínez 1975) Rivas-Martínez, Lousa, T.E. Díaz, Fernández-González & J.C. Costa 1990
73.10. Rubio longifoliae-Coremion albi
¬ *Rubio longifoliae-Coremetum albi* Rivas-Martínez *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980
73.11. Quercion fruticosae
¬ *Phillyreo angustifoliae-Quercetum fruticosae* Barbero, Quézel & Rivas-Martínez 1981
73.12. Ericion arboreae
¬ *Cytiso villosi-Ericetum arboreae* Costa, Peris, Figuerola & Stübing 1985
¬ *Erico scopariae-Arbutetum unedonis* Ortiz, Amigo & Izco 1991
¬ *Phillyreo angustifoliae-Arbutetum unedonis* Rivas Goday & F. Galiano *in* Rivas Goday & al. 1959
73.13. Arbuto unedonis-Laurion nobilis
¬ *Phillyreo latifoliae-Arbutetum unedonis* Loidi, Herrera, Olano & Silván 1994

74. QUERCO-FAGETEA
74a. Fagetalia sylvaticae
74.1. Carpinion
74.1a. Polysticho-Corylenion
¬ *Festuco giganteae-Fraxinetum excelsioris* F. Prieto & Bueno *in* T.E. Díaz & F. Prieto 1994
¬ *Mercurialidi perennis-Fraxinetum excelsioris* F. Prieto & V. Vázquez 1987
¬ *Polysticho setiferi-Fraxinetum excelsioris* (Tüxen & Oberdorfer 1958) Rivas-Martínez *ex* C. Navarro 1982
74.3. Fagion sylvaticae
74.3a. Fagenion sylvaticae
¬ *Carici sylvaticae-Fagetum sylvaticae* (Rivas-Martínez 1965) C. Navarro 1982
74.3b. Epipactido helleborines-Fagenion sylvaticae
¬ *Epipactido helleborines-Fagetum sylvaticae* (Rivas-Martínez 1962) Rivas-Martínez 1983
¬ *Laserpitio eliasii-Coryletum avellanae* Puente, López Pacheco & Penas *ined.*
74b. Quercetalia pubescentis Klika 1933
74.6. Aceri granatensis-Quercion fagineae
74.6a. Aceri granatensis-Quercenion fagineae
¬ *Daphno latifoliae-Aceretum granatensis* Rivas-Martínez 1964
¬ *Fraxino orni-Quercetum fagineae* Rivas Goday & Rigual *in* Rivas Goday & al. 1960 *corr.* Rivas-Martínez 1972
¬ *Spiraeo obovatae-Quercetum fagineae* O. Bolòs & P. Montserrat 1984
¬ *Violo willkommii-Quercetum fagineae* Br.-Bl. & O. Bolòs 1950 *corr.* Rivas-Martínez, Báscones, T.E. Díaz, Fernández-González & Loidi 1991
74.6b. Paeonio-Abietenion pinsapo
¬ *Paeonio broteroi-Abietetum pinsapo* Asensi & Rivas-Martínez 1976
74c. Quercetalia roboris
74.8. Quercion robori-pyrenaicae
74.8a. Quercenion robori-pyrenaicae
¬ *Blechno spicant-Quercetum roboris* Tüxen & Oberdorfer 1958
¬ *Linario triornithophorae-Quercetum petraeae* (Rivas-Martínez, Izco & Costa *ex* F. Navarro 1974) F. Prieto & Vázquez 1987
¬ *Linario triornithophorae-Quercetum pyrenaicae* Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 1984
¬ *Luzulo henriquesii-Betuletum celtibericae* Rivas-Martínez 1964
¬ *Saxifrago spathularidis-Betuletum celtibericae* Rivas-Martínez 1981
74.8b. Quercenion pyrenaicae
¬ *Adenocarpo decorticantis-Quercetum pyrenaicae* Martínez-Parras & Molero Mesa 1982
¬ *Cytiso triflori-Quercetum pyrenaicae* Barbero, Quézel & Rivas-Martínez 1981
¬ *Festuco heterophyllae-Quercetum pyrenaicae* Br.-Bl. 1967
¬ *Genisto falcatae-Quercetum pyrenaicae* Rivas-Martínez *in* Penas & T.E. Díaz 1985
¬ *Holco mollis-Quercetum pyrenaicae* Br.-Bl., P. Silva & Rozeira 1956

¬ *Luzulo forsteri-Quercetum pyrenaicae* Rivas-Martínez 1962

74.10. Ilici-Fagion

¬ *Blecho spicanti-Fagetum sylvaticae* Tüxen & Oberdorfer 1962

¬ *Galio rotundifolii-Fagetum sylvaticae* Rivas-Martínez 1962

¬ *Luzulo henriquesii-Aceretum pseudoplatani* F. Prieto & A. Bueno *in* T. E. Díaz & F. Prieto 1994

¬ *Omphalodo nitidae-Fagetum sylvaticae* (Izco, Amigo & J. Guitián 1986) Rivas-Martínez, Báscones, T.E. Díaz, Fernández-Gonzélez & Loidi 1991

74e. Populetalia albae

74.12. Populion albae

74.12a. Populenion albae

¬ *Humulo lupuli-Alnetum glutinosae* Biurrun, García-Mijangos & Loidi 1994

¬ *Populo nigrae-Salicetum neotrichae* Rivas-Martínez & Cantó ined.

¬ *Vinco-Populetum albae* (O. Bolòs & Molinier 1958) O. Bolòs 1962

74.12b. Fraxino angustifoliae-Ulmenion minoris

¬ *Aro italici-Ulmetum minoris* Rivas-Martínez *ex* V. Fuente 1986

¬ *Aro maculati-Ulmetum minoris* T.E. Díaz, J. Andrés, Llamas, Herrero & D. Fernández 1987

¬ *Ficario ranunculoidis-Fraxinetum angustifoliae* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980

74.13. Osmundo-Alnion

74.13a. Osmundo-Alnenion

¬ *Salicetum atrocinereo-australis* J.C. Costa & Lousã *in* J.C. Costa, Lousã & Paes 1997

¬ *Scrophulario scorodoniae-Alnetum glutinosae* Br.-Bl., P. Silva & Rozeira 1956

¬ *Viti viniferae-Salicetum atrocinereae* Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & Valdés Bermejo 1980

74.13b. Rhododendro baetici-Alnenion glutinosae

¬ *Frangulo baeticae-Rhododendretum baetici* Rivas Goday & Rivas-Martínez *in* Rivas-Martínez 1964

74.14. Alnion incanae

¬ *Hyperico androsaemi-Alnetum glutinosae* (Br.-Bl. 1967) Rivas-Martínez *in* Loidi 1983

¬ *Pruno padi-Fraxinetum excelsioris* L. Herrero, M.E. García & Penas *in* L. Herrero 1989

¬ *Valeriano pyrenaicae-Alnetum glutinosae* Amigo, Guitián & F. Prieto 1987

74.15. Salicion albae

¬ *Salicetum angustifolio-albae* T.E. Díaz & F. Prieto 1994

75. VACCINIO-PICEETEA

75b. Vaccinio microphylli-Juniperetalia nanae

75.2. Juniperion nanae

¬ *Daphno cantabricae-Arctostaphyletum uvae-ursi* Rivas-Martínez, Izco & Costa 1971

¬ *Junipero nanae-Vaccinietum microphylli* Rivas Goday & Rivas-Martínez *ex* F. Prieto 1983 *corr.* Loidi & Biurrun 1996

GLOSSARY OF GEOBOTANICAL SPANISH TERMS

Adelfar. *Nerium oleander* (adelfa) shrubland.

Alameda. see *Chopera*.

Alcornocal. Cork-oak forest; derived from *alcornoque* (*Quercus suber*)

Aliseda. Alder forest; derived from *aliso* (*Alnus glutinosa*)

Aulagar. Scrub dominated by spiny legumes (*aulagas*), usually of the genera *Genista, Echinospartum, Ulex*, etc.

Berceal. Tall grassland on siliceous substrata common in the western part of the Iberian Peninsula, derived from *berceo* (*Stipa gigantea*)

Borreguil. Summergreen grassland occurring in humid depressions, usually of glaciar origin, at the upper levels of Sierra Nevada (oro and crioromediterranean thermotypes). There is a zonation in the borreguiles following a soil moisture gradient: the drier borreguiles are *Nardus* grasslands (cervunales) and the most humid borreguil is a sedge mire which occupies the bottom of the depression. The term is derived from *borrego* (sheep) because they were used as summer pastures for livestock.

Brezal. Heathland or scrub formed by heaths: derived from *brezo* (species of *Erica, Calluna, Daboecia*)

Carrascal. Evergreen oak woodland; derived from *carrasca* (*Quercus rotundifolia)*, named also *encinar*

Cervunal. see *Borreguil*

Chopera. (*Alameda*) Poplar forest, derived from *chopo (álamo)* (*Populus* sp. pl.)

Cornical. *Periploca angustifolia* (*cornical*) shrubland.

Coscojar. Evergreen oak shrubland and woodland dominated by *coscoja* (*Quercus coccifera*)

Dehesa. Fenced property devoted to husbandry. It derives from *defesa* (= defence) because the area is defended by a fence. When scattered trees of the natural forest remain, then its structure is of a wooded pasture, which corresponds to the most extended concept of this term.

Encinar. *Quercus ilex* and *Q. rotundifolia* evergreen oak woodlands,derived of *encina (Quercus rotundifolia*).

Espartal. Mediterranean dry perennial grasslands of *Stipa tenacissima* (esparto); and sometimes used to formations of other hard leaved grasses like *Lygeum spartum* (albardín, esparto basto).

Fresneda. Ash forest; derived from *fresno* (*Fraxinus excelsior or F. angustifolia*)

Hayedo. Beech forest; derived from *haya* (*Fagus sylvatica*)

Jaguarzal. Scrub dominated by *Halimium* species (*jaguarzos*), mostly *H. halimifolium*.

Jaral. Scrub dominated by nanophanerophytes or chamaephytes of the genera *Cistus* called *jaras*.

Juncal. Rush community; derived from *junco* (*Juncus* sp. pl., *Scirpus holoschoenus*)

Lentiscar. Evergreen shrubland dominated by *lentisco* (*Pistacia lentiscus*)

Madroñal. Evergreen shrubland dominated by the strawberry tree or *madroño* (*Arbutus unedo*)

Matorral. Scrub

Majadal. Short and dense summer-dry winter-green perennial west mediterranean grasslands dominated by *Poa bulbosa*.

Melojar. Oak forest; derived from *melojo* (*Quercus pyrenaica*)

Olmeda. Elm forest. Derived from *olmo* (*Ulmus* sp. pl.)

Pinar. Pine forest.

Pinsapar. *Abies pinsapo* forest; derived from *pinsapo*.

Piornal. Broom shrubland. Derived from *piorno* which is any shrubby legume, aphyllous and with chlorophyllic stems, of the genera *Cytisus, Retama* and *Genista*.

Quejigar. Late deciduous oak forest; derived from *quejigo (Quercus faginea)*.

Retamar. Stand of broom-like legumes of the genus *Retama*.

Robledal. Early deciduous oak forest; derived from *roble* (mostly *Quercus robur* but also Q. *petraea* or *Q. humilis*)

Romeral. Rosemary dominated scrub; derived from *romero* (*Rosmarinus officinalis*)

Sabinar. Juniper woodland of *sabinas*, tree or shrubby species of the genus *Juniperus*, sect. *Sabina*, with scale-like and imbricate leaves.

Sauceda. Willow riparian forest or shrubland; derived from *sauce* (*Salix* sp. pl.)

Tobal. Thistle community formed by *tobas* or species of the genus *Onopordon*.

Tomillar. Thyme scrub; derived from *tomillo* (*Thymus* sp. pl.).

Vallicar. *Agrostis castellana* silicicolous perennial Iberian Peninsule grasslands.

Zarzal. Bramble community; derived from *zarza* (*Rubus* sp. pl.)

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