Advances in geobotany and new tools in biogeographic and bioclimatic maps: Sierra de Guadarrama National Park

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Abstract

We present the biogeographic and bioclimatic maps of the Sierra de Guadarrama, as part of the geobotanic review of the National Park. The bioclimatic map has been made following the guidelines of the Worldwide bioclimatic classification system. The dominance of the orotemperate horizon (also supratemperate) in the central nucleous confers a great originality to the National Park. The biogeographic map and typology are based on both previous geobotanic studies and recent field works. In the Sierra de Guadarrama National Park, we recognize 8 homogeneous spaces (biogeographic countries), included in other larger spaces (2 districts, 2 sectors and 2 provinces). The new association *Avenello ibericae-Quercetum pyrenaicae* is described.

Resumen

Presentamos los mapas bioclimático y biogeográfico de la Sierra de Guadarrama, como parte de la revisión geobotánica del Parque Nacional. El mapa bioclimático se ha realizado siguiendo las directrices de Worldwide bioclimatic classification system. La dominancia del horizonte orotemplado (también supratemplado) en el núcleo central confiere una gran originalidad al Parque. El mapa y tipología biogeográficos están basados tanto en estudios geobotánicos previos como en trabajos de campo recientes. En el Parque Nacional de la Sierra de Guadarrama reconocemos 8 espacios homogéneos (comarcas biogeográficas), incluidos en otros espacios más amplios (2 distritos, 2 sectores y 2 provincias). Se describe la nueva asociación *Avenello ibericae-Quercetum pyrenaicae*.

Introduction

Some years ago, a group of professional geobotanists of universities and research centers in solidarity decided to improve the field work researches on vegetation dynamic and global geobotany in the Spanish National Parks in which the altitude of the main summits exceeds the timber line. The National Parks selected for the initial programme were: Sierra Nevada, Sierra de Guadarrama and Picos de Europa in the Iberian Peninsula and Teide, in Tenerife Canary Islands.

For the second programme: Ordesa-Monte Perdido and Aigues Tortes-San Maurici. The principal aims of the researches are to know better the global geobotanic models and to compare their biogeographic territories using as bioindicators: flora, vegetation communities, habitats, vegetation series and clinosequences, as well as the significance of the bioclimatic and biogeographic units. We also decided that the responsibles of any na tional park project could freely request help or cooperation to any qualified non profitable scientific or technic useful expert. And furthermore, the "solidarity group" must be able to offer a high standard and accurate information on botanical and geobotanical topics to the scientific community and to the staff members of the national parks responsable of the management and conservation.

Geobotany, term utilized in continental European botanical tradition, is an environmental and naturalistic science which deals with the relationships between plants, habitats and plant communities, and the geobiosphere. Nowadays, the main interest of the global geobotany is to correlate and to compare scientific data coming from geography, plant taxonomy, synecology, dynamic-catenal phytosociology, bioclimatology, biogeography, geomorphology, edaphology, paleohistory, etc., to establish predictive and synthetic models having ability and useful predictive, conservative and managing applications (Rivas-Martínez 2007: 115).

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Materials and methods

Notions on Bioclimatology

Bioclimatology is a geobotanical science that studies the reciprocity between the climate and the distribution of living bodies and their communities on Earth. This discipline, which has also been called Phytoclimatology, began to be structured as a result of connecting numeric climate values (much temperature and rainfall data) with the areas of plants, formations, plant communities, ecosystems and biomes, adding at a later stage information of biogeocenosis and knowledges from dynamic-catenal phytosociology (vegetation series, geoseries, permaseries and geopermaseries).

For more than two decades, we have been trying to develop worldwide bioclimatic classification; the reasons were to dispose an easily quantifiable bioclimatic typology that shows a close relationship between the vegetational components and climate values, at the same time, considering the high predictive value of the bioclimatic units, it could be used in other sciences, in studies and conservation programmes for biodiversity, as well as in agricultural, forestry resources, and climate change. Our increasingly detailed knowledge in the distribution of vegetation on Earth, as well as modifications in the appearance and composition of the natural potential vegetation and its substitution stages caused by climatic, edaphic, geographic and anthropogenic factors, is making possible and easier to recognize the bioclimatic and vegetational frontiers with greater precision and objectivity. Once the bounds of the vegetation series (sigmetum), geoseries (geosigmetum), permaseries (permasigmetum) and geopermaseries (geopermasigmetum) are known, as well as the bioindicator species, it is possible to calculate the numerical bioclimatic threshold values that distinguish them. These spaces corresponding to the bioclimatic units (bioclimates, thermotypes, ombrotypes and continentality: isobioclimates and meroisobioclimates) have been progressively delimited and adjusted. The obtained biophysical models have demostrated a high level of reciprocity in the relationship between climate-vegetation distribution, which is making it possible to create bioclimatic and biogeographic maps of the world significantly more precisely. One practical consequence is to have achieved a reciprocal predictive value in all the Earth, only knowing the climatic and bioclimatic data to infer the vegetation types and bioindicators.

The global bioclimatic classification we use is based on the axioms and logical reasoning principles of reciprocity, photoperiods, continentality, seasonality of the precipitation, mediterraneity, deserts, orobioclimates and orobiomes. Our classification recognizes on Earth: five macrobioclimates, twenty-eight bioclimates and eight bioclimatic variants. The macrobioclimate is the highest typological unit in the bioclimatic classification system; it is an eclectic biophysical model, delimited by specific climatic and vegetational values, which covers a wide territorial range and which is connected with the main types of climates, biomes and biogeographical regions today accepted in the Earth. There are five macrobioclimates: tropical, mediterranean, temperate, boreal and polar. Each of them, and each of their 28 respective subordinate units or bioclimates (mesobioclimates), are represented by a group of vegetation types, biocoenosis, ecoregions, formations and plant communities (Rivas-Martínez, Rivas-Sáenz & Penas 2011).

Continentality index

Continentality indices reflect the amplitude of the annual oscillation of temperature. The degree of continentality is directly proportional to this amplitude, and its opposite is oceanity. Unfrozen seas, lakes and oceans tend to absorb the temperature contrast, while the opposite occurs inland, farther away from the coast.

Because its simplicity, availability of data and excellent global correlation, in the bioclimatic classification of the Earth we have finally used the simple conti nentality index (Ic), whose origins lie in the first oceanity map of the Earth by Supan in nineteen century. This con-

Table 1.
Types, subtypes and levels of simple continentality index (Ic) recognised on Earth.

Types	*Subtypes*	*Levels*	*Values*
1. Hyperoceanic (0-11)	Ultrahyperoceanic	1.1a. Strong	0-2.0
		1.1b. Weak	2.0-4.0
	Euhyperoceanic	1.2a. Strong	4.0-6.0
		1.2b. Weak	6.0-8.0
	Subhyperoceanic	1.3a. Strong	8.0-10.0
		1.3b. Weak	10.0-11.0
2. Oceanic (11-21)	Semihyperoceanic	2.1a. Strong	11.0-12.0
		2.1b. Weak	12.0-14.0
	Euoceanic	2.2a. Strong	14.0-15.0
		2.2b. Weak	15.0-17.0
	Semicontinental	2.3a. Weak	17.0-19.0
		2.3b. Strong	19.0-21.0
3. Continental (21-66)	Subcontinental	3.1a. Weak	21.0-24.0
		3.1b. Strong	24.0-28.0
	Eucontinental	3.2a. Weak	28.0-37.0
		3.2b. Strong	37.0-46.0
	Hypercontinental	3.3a. Weak	46.0-56.0
		3.3b. Strong	56.0-66.0

inentality index expresses in degrees centigrade the difference between the average temperature of the hottest-month (Tmax) and that of the coldest month of the year (Tmin). Ic = Tmax – Tmin in degrees centigrade. The types, subtypes and levels of continentality that are recognised are shown in table. By averaging the value of the subtypes, we obtain strong and weak levels, which are allocated in each case depending on their greater (strong) or lesser (weak) proximity to the extreme values in the table (0 and 66) (Itinera Geobot. 17: 16, tb.2. 2007).

On occasions it is useful to use the terms from the scale of nine continentality values proposed, especially to classify certain types of vegetation and bioclimates (Itinera Geobot. 18 (2): 605, tb.3. 2011).

Table 2.
Relationship between the terms and subtypes of continentality with the values of the simple continentality index (Ic).

Expressions	*Ic values*	*Subtypes*	*Ic values*
Extreme hyperoceanic	0.0-8.0	Ultrahyperoceanic	0.0-4.0
		Euhyperoceanic	4.0-8.0
Moderate hyperoceanic	8.0-14.0	Subhyperoceanic	8.0-11.0
		Semihyperoceanic	11.0-14.0
Balanced oceanic	14.0-17.0	Euoceanic	14.0-17.0
Moderate continental	17.0-28.0	Semicontinental	17.0-21.0
		Subcontinental	21.0-28.0
Extreme continental	28.0-66.0	Eucontinental	28.0-46.0
		Hypercontinental	46.0-66.0

Submediterraneity index

A locality or territory with a temperate, boreal or polar macrobiocolimate is submediterranean, i.e. it belongs to the submediterranean bioclimatic variable [Sbm], when in at least one month of the summer quarter its average precipitation in millimetres is 2.8 tenths less the average temperature in degrees centigrade [Te, Bo, Po, 23º-90 N & S, Iosi: P < 2,8 T]. The submediterraneity value is calculated as follows: Vsbmn = 280 – (100 Iosi). Similarly, the submediterraneity index is obtained from the sum of the submediterraneity values of the monthly ombrothermic indices Ios1, Ios2, Ios3, Ios4, providing they are positive, without taking into account the submediterraneity values if they are negative. On the Earth, depending on the amount of summer drought or aridity, measured in hundredths of ombrothermic units, six levels of submediterraneity are distinguished: (Itinera Geobot. 18(2): 606, tb.5), (table).

Table 3.
Levels and threshold values for submediterraneity corresponding to the submediterranean bioclimatic variant on Earth.

Submediterraneity levels	*Isbm*
Extremely weak submediterranean	1-30
Highly weak submediterranean	30-80
Weak submediterranean	80-180
Strong submediterranean	180-320
Highly strong submediterranean	320-460
Extremely strong submediterranean	460-580

Compensable summer ombrothermic indices from mediterranean to temperate macrobioclimate

By definition, the mediterranean macrobioclimate is the extratropical type (> 23° N & S) which, coinciding with the summer (the hottest part of the year), has a drought period in which, for at least two consecutive months, the precipitation is less than or equal to twice the temperature (P = 2T). On the contrary, a territory is not mediterranean if the ombrothermic index of the hottest two months of the summer quarter Ios_2 is higher than 2 (Ios_2 > 2). If Ios_2 is less than or equal to 2.0 (Ios_2 = 2.0), the territory may be mediterranean or not, as if the availability of water in the soil can be compensated with the precipitation of the previous month, i.e. if P (June+July+August)/T (June+July+August) in the northern hemisphere, or otherwise P (December +January+February)/T (December+January+February) in the southern hemisphere is higher than 2.0 (Ios_3 >2.0) then the territories are not mediterranean. If the Ios_3 is greater than or equal to 2.0 (Ios_3 = 2.0), the territory may be mediterranean or not, as with a deficient Ios_3 compensation may occur with the precipitation from the previous month (May or November respectively), i.e. if P (May+June +July+August)/T (May+June+July+August) in the northern hemisphere, or P (November+December+ January +February)/T (November+December+January+ February) in the southern hemisphere is higher than 2.0 (Ios_4 >2.0), the territories are not bioclimatically mediterranean, and in the opposite case, they are definitely mediterranean. Ombrothermic values have a highly discriminatory value on the frontier between mediterranean-temperate territories and mediterranean-boreal territories. The compensable values of the summer ombrothermic indices are shown in table (Itinera Geobot. 18 (2): 606. 2011).

Table 4.
Compensation table. Intervals of the values of the annual ombrothermic indices (Io) which, depending on the values of the summer ombrothermic values (Ios_2, Ios_3, Ios_4), can be compensated and change from the mediterranean macrobioclimate to the temperate macrobioclimate (submediterranean variant).

Io	*Ios2*	*Ios3*	*Ios4*
2.0-2.8	≥ 1.9	≥ 2.0	≥ 2.0
2.8-3.6	≥ 1.8	≥ 1.9	≥ 2.0
3.6-4.8	≥ 1.8	≥ 1.9	≥ 2.0
4.8-6.0	≥ 1.7	≥ 1.9	≥ 2.0
6.0-7.0	≥ 1.5	≥ 1.8	≥ 2.0
7.0-8.0	≥ 1.4	≥ 1.8	≥ 2.0
8.0-9.0	≥ 1.3	≥ 1.8	≥ 2.0
9.0-10.0	≥ 1.2	≥ 1.8	≥ 2.0
10.0-11.0	≥ 1.1	≥ 1.7	≥ 2.0
11.0-12.0	≥ 1.0	≥ 1.7	≥ 2.0
> 12.0	≥ 0.9	≥ 1.7	≥ 2.0

Notions on Biogeography

Biogeography is the science that study the distribution of species, plant communities, habitats, biocoenosis, ecosystems, biomes and bioregions on the Earth, as well as the relationships between them and their conditions. It takes into account the areas of taxa and syntaxa (chorology), in addition to information from other natural sciences (geography, botany, synecology, soil science, bioclimatology, geology, etc.), and attempts to establish a hierarchical biogeographic typology of the land territories on the planet. The main systematic units in decreasing rank are: kingdom, region, province, sector, district, country, landscape cell and tesela (Rivas-Martínez & al., 2007, 2011, 2014). Terrestrial biogeography has been twinned with phytogeography due to the value of vascular plant species and communities in its definition and delimittation on Earth. Oceanic biogeography should be study and synthetize only with oceanological research science and methods.

The elementary biogeographic terrestrial unit of the lowest rank is the tesela, defined as a geographic space with a greater or lesser extension homogeneous, that means, has only a single type of potential natural vegetation (climax) and a single sequence of substitution communities.

The permatesela, conceived within the framework of dynamic-catenal phytosociology, is located in exceptional sites: polar, fluvial, lake and marine landscapes, deserts, high mountain summits, dunes, rock formations, coastal cliffs, etc., in which the permanent unistrata long lasting vascular vegetation growing in these elementary spaces lacks of other type of perennial vascular substitution communities. The tesela and permatesela are the only biogeographical units which can be repeated disjointed. The landscape cells are constituted by a group of teselas or permateselas and their corresponding complexes, assembled by networks of geosigmeta and geopermasigmeta based on the geomorphology and soils of one small or big territory.

The biogeographical country, district, sector and provinces are the most used types. The province is a vast geographic territory which, as well as possessing a large number of endemisms and differential species (its own subelement), has particular macroseries, It is also characteristic of each biogeographical province to hold geomacroseries and a particular altitudinal vegetation zonation or exclusive geoclinoseries. The region is a very extensive territory, formed by a group of biogeographical provinces which has a flora or regional floristic element with species, genera or even endemic families; in addition it has its own particular megaseries, geomegaseries and geomegapermaseries and in consequence, its own bioclimatic and vegetation belts (Rivas-Martínez, 2005). Finally, the kingdom is the supreme unit of biogeography, generally pluricontinental and multinsular, which in addition to taxonomic and ecosystematic considerations, addresses the origins of the flora and fauna, as well as the origin of the great continents, orogenies and particular macrobioclimates.

Notions on dynamic and catenal phytosociology

The vegetation series, also termed sigmetum, expresses the whole set of plant communities or stages which can be found within similar teselar spaces as a result of the succession process, and includes both the representative association of the mature stage or series head, which is used as a nomenclatural reference, and the initial or subserial associations that may replace it. Based on this concept, the vegetation serie or sigmetum (pl. sigmeta) represents the basic unit or essential model of dynamic phytosociology. Distinctions can also be made between climatophilic, edaphoxerophilic, temporihygrophilic and edaphohygrophilic series. Climatophilic or climatophilous is a zonal serie located on mature soils according to the mesoclimate, and only receive rainwater: mesophytic, submesophytic and subxerophytic; the temporihygrophilic series, included among the climatophilic, are those which have additional water contribution due to their topographical circumstances, and they thus develop on flooded or very wet soils throughout part of the year, and –at least during the summer or dry period– the soil horizons are well-drained and aerated. The edaphoxerophilous series are found in particularly dry or xerophytic soils or biotopes such as lithosols, arenosols, very windy sites, steep slopes, crests, ledges, etc.; and finally, the edaphohygrophilous series grow on particularly wet soils and biotopes such as fluvisols, halosols, histosols, etc., and are found on river beds, marsh areas, salt flats, peat bogs, etc.

The vegetation geoserie or geosigmetum (pl. geosigmeta) is the basic unit of dynamic-catenal phytosociology. It corresponds to a catena of vegetation series which is found around a given bioclimatic belt and biogeographic territory in the heart of the universal crest-slope-valley model. This topographic framework makes it possible to distinguish the three geomorphological aspects of any complete catena where the vegetation series constituting the geosigmetum are located in zones; the edaphoxerophilous series and geoseries (hyperxerophilic and xerophilic) are located in the driest sites (crests, escarpments, lithosols, etc.); the climatophilous and temporigrophilous series and geoseries are located on slopes and foothills where greater humidity is contributed by rainfall; and the edaphohygrophilous series and geoseries are found in the valleys and watercourses (fluvial, lake and watercourses), among which the river fractogeosigmetum is of great important to plant landscape science due to its extrazonality, and also, in combination with the edaphoxerophilous and climatophilous sigmeta and geosigmeta, to the definition and structuring of regional and global biogeography.

The vegetation geopermaseries, also known as geopermasigmeta, is the catenal expression of a set of neighboring permaseries or permasigmeta, delimited by changing topographic or soil situations. These are conditioned by extreme climate (high mountains and polar areas) and exceptional microtopographic and soil conditions (walls, rock formations, marine cliffs, salt flats, etc.) which give rise to a large number of neighboring ecological residences populated by diverse permanent perennial plant communities (continuous vegetation permaseries) with an absence of non-nitrophilous serial perennial communities which appear to have reached their equilibrium. The most favorable sites for the existence of geopermaseries or geopermasigmeta, as well as sites corresponding to permanent types of vegetation in extreme high-mountain and polar region bioclimates, are ledges, rock crevasses, cliffs and coastal rock formations bathed by sea waters, peat bogs, wind drifts, mobile sand dunes, lake shores, streams etc.

The basic phytosociological, syntaxonomic and taxonomic nomenclature and contents reference publication for this paper are: Rivas-Martínez & al. 2002; Rivas-Martínez & al. 2011. The first column of tables 1-8 shows the numbering of each phytosociological association that appears in these studies -syntaxonomical checklist-. The bioindicators shown are the most significant for the countries, although some of them are not exclusive since they are small areas. The combination of the series and bioindicators is what gives each territory originality. The biogeographic typology proposed to Sierra de Guadarrama National Park is based on both previous geobotanic publications (Rivas-Martínez 1964, Rivas-Martínez & Cantó 1987, Fernández-González 1991, Rivas-Martínez et al. 1999, Rivas-Martínez 2007, Cantó 2007, Rivas-Martínez et al. 2017) and field work carried out over the last eight years.

Study area

Geography and geology overview of Sierra de Guadarrama National Park

The Sierra de Guadarrama is part of the Iberian Central Range, an E-W oriented mountain alignment of ca. 500 km which divides the Iberian Meseta into two. The Sierra de Guadarrama is found at the centre of the Iberian Central Range. Somosierra and Ayllón can be found to the East, and Sierra de Gredos to the West.

The Sierra de Guadarrama National Park (Law 7/2013, from June 25th) is found in tow autonomous regions: Madrid and Castilla y León (Segovia province). It has a total extension of 96.847 ha, of which 33.960 ha are strictly National Park territory, and of which 62.887 ha are a Peripheral Area of Protection. It extends from W to E over Peña del Águila and Mujer Muerta massif, Siete Picos, Peces river valley, and the left side of the Acebeda river valley, the Maliciosa massif, La Pedriza, the Hueco de San Blas, Mount Aguirre and all the Cuerda Larga (with the exception of Valdesquí) from Valdemartín to La Najarra, including the Puerto de la Morcuera. From the Puerto de los Cotos it continues towards the North with the Peñalara massif and the Cuerda which unites the Nevero and Reventón peaks, and the summits and hillsides of the Reajos Capón and Alto. The height oscillates between 950m in the south of la Pedriza to 2428m in the Peñalara summit.

Brief geological and glacial sketch

The dominant outcropping materials in the Sierra de Guadarrama are crystalline rocks rich in acid silicates, some of which are of plutonic origin and others metamorphic.

Even though the Central System was formed during the Tertiary period, it is formed of paleozoic rocks, which are much older. The National Park includes various different types of rocks. According to Velasco & Carcavilla (2015), they can be classified in 5 main groups. The oldest rocks are those that were formed before the Variscan orogeny, but during which they suffered an intense metamorphism. On the one hand, there are the sedimentary rocks formed before the Variscan range which suffered mineralogical transformations due the high pressure and elevated temperatures they were exposed to; this is how the metagneisses (1) were formed. These are also called metasedimentary, as in the Mujer Muerta, for example. On the other hand, old preexisting granite rocks formed around 475-485 million years ago, around 100 million years before the Variscan orogeny, also suffered a significant metamorphism, leading to the formation of orthogneisses (2), which are the most abundant in the Sierra de Guadarrama National Park, like in the Peñalara massif for example. The rocks formed later, between 320 and 280 million years ago, are granite rocks (3), created as a consequence of the formation of the Variscan Range. Not all granite rocks of this period were formed simultaneously, but in different phases and from different origins (Villaseca & Herreros, 2000); some of them form nowadays the southern part of the National Park, like Sitie Picos, or La Pedriza. The next type of rocks (4) was originated much later in time. The Range suffered a great erosion, resulting in a practically flat surface, covered in great part by the sea, where later on, after eight elevation and erosion episodes, calcareous sediments were accumulated. The rising of the Sistema Central took place in two stages. The first one, around 37 million years ago, in which the rocks experienced a rising of around 2 km due to tectonic action. During the second stage, they elevated 3.2 km more, even though an intense erosion happened simultaneously. The millions of tons of eroded rock ended up in the sedimentary basin over which Madrid stands today. The last unit of rocks (5) is the one formed by sediments from very recent times, during the Quaternary, when the current range had already been formed. It consists of rocks accumulated by the action of rivers, glaciers or streams.

Ice covered terrains with heights over 1850m during the Quaternary. Peñalara´s southern slope had various glaciers during this period; they weren´t extensive, but were found in the glacial cirque, in which snow was accumulated, originating small glacial lagoons. In Peña Artiñuelo, Romalo Pelao, El Chorro and Hoyo Berrocoso some other small glaciers can be found.

The glaciers from the Peñalara massif reached the peak in their development between 25 000 and 19 000 years ago, period in which they were stable. From then on, they started slowly decreasing and about around 16 000 years ago, they started doing so faster, as a consequence of a softer climate and with less precipitation events (Palacios et al. 2012). 12 000 years ago, glaciers disappeared from Sierra de Guadarrama. To this day, evidence of this glacial past can be found, like the Peñalara lagoons, Pájaros and Claveles were formed by the flooding of the basins excavated by the ice.

Results

Bioclimatology

Table 5 and Map 1

Table 5.
Thermotypic horizons. Sierra de Guadarrama National Park (park and prepark). Ic > 21 (*). (See appendix 1: Appendix: Bioclimates Guadarrama N P table).

Thermotype horizons	Abb	It, Itc	Tp, Itc<120 Ic>21 (*)	N.
Upper mesomediterranean	umme	220-285	1500-1800 (*)	1
Lower supramediterranean	lsme	150-220	1200-1500 (*)	2
Upper supramediterranean	usme	(120)-150	900-1200 (*)	3
Lower oromediterranean	lome	-	675-900	4
Lower supratemperate	lste	(120) 190	1100-1400	5
Upper supratemperate	uste	-	800-1100	6
Lower orotemperate	lote	-	590-800	7
Upper orotemperate	uote	-	380-590	8

Biogeography

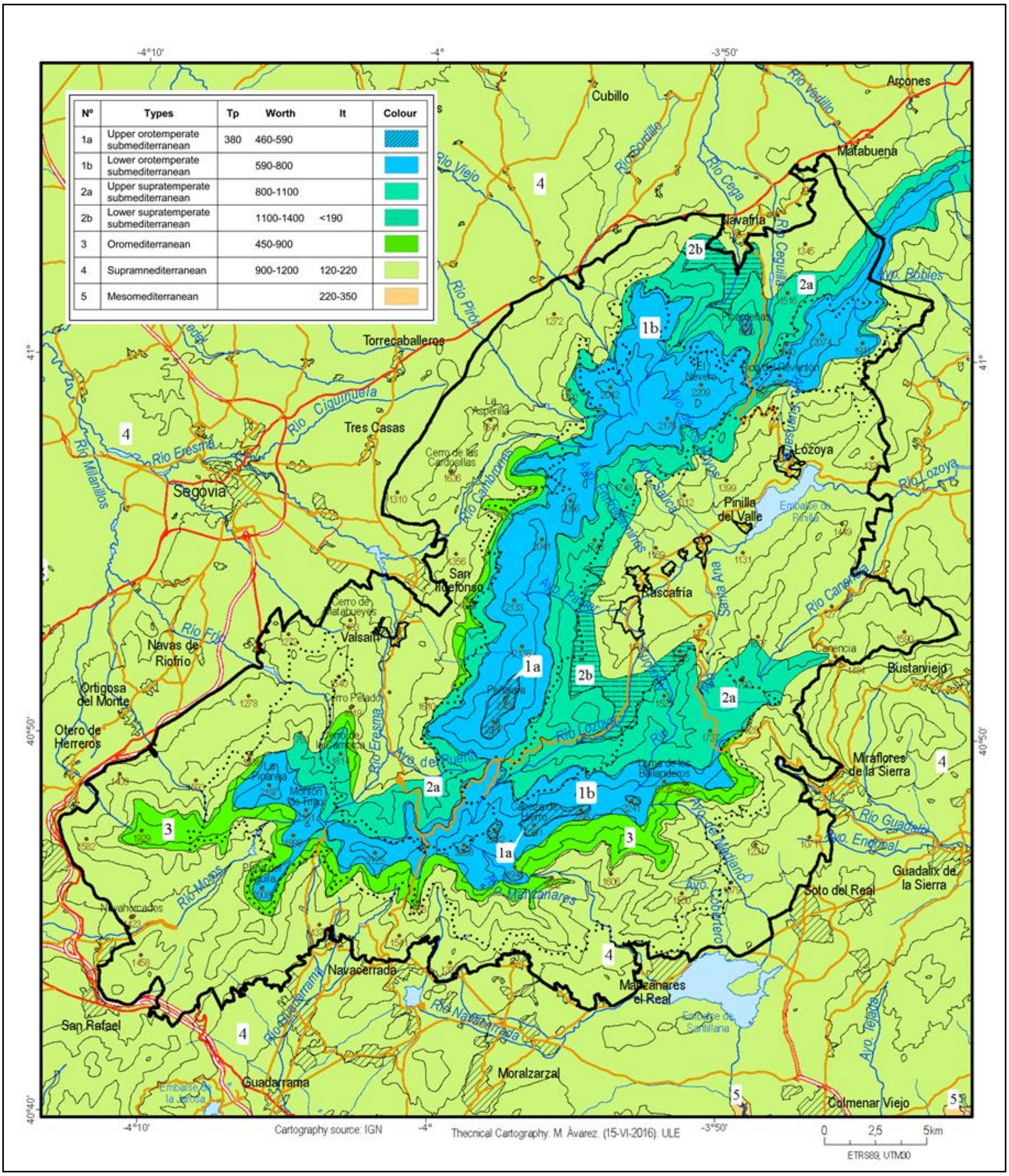
The National Park belongs to the Mediterranean Region, although from the bioclimatic point of view, the central nucleus of the National Park has a Temperate bioclimate, submediterranean variant.

The relationship between the characteristics of the natural environment (geology, orography, drainage basins and bioclimate) and the recognition of species, communities and vegetation series, geoseries and permaseries has made it possible to establish in Sierra de Guadarrama National Park and Peripheral Area of Protection a total of 8 homogeneous spaces (countries), included in other larger spaces (2 districts, 2 sectors and 2 biogeographic provinces), which shape the biogeographic typology of the territory.

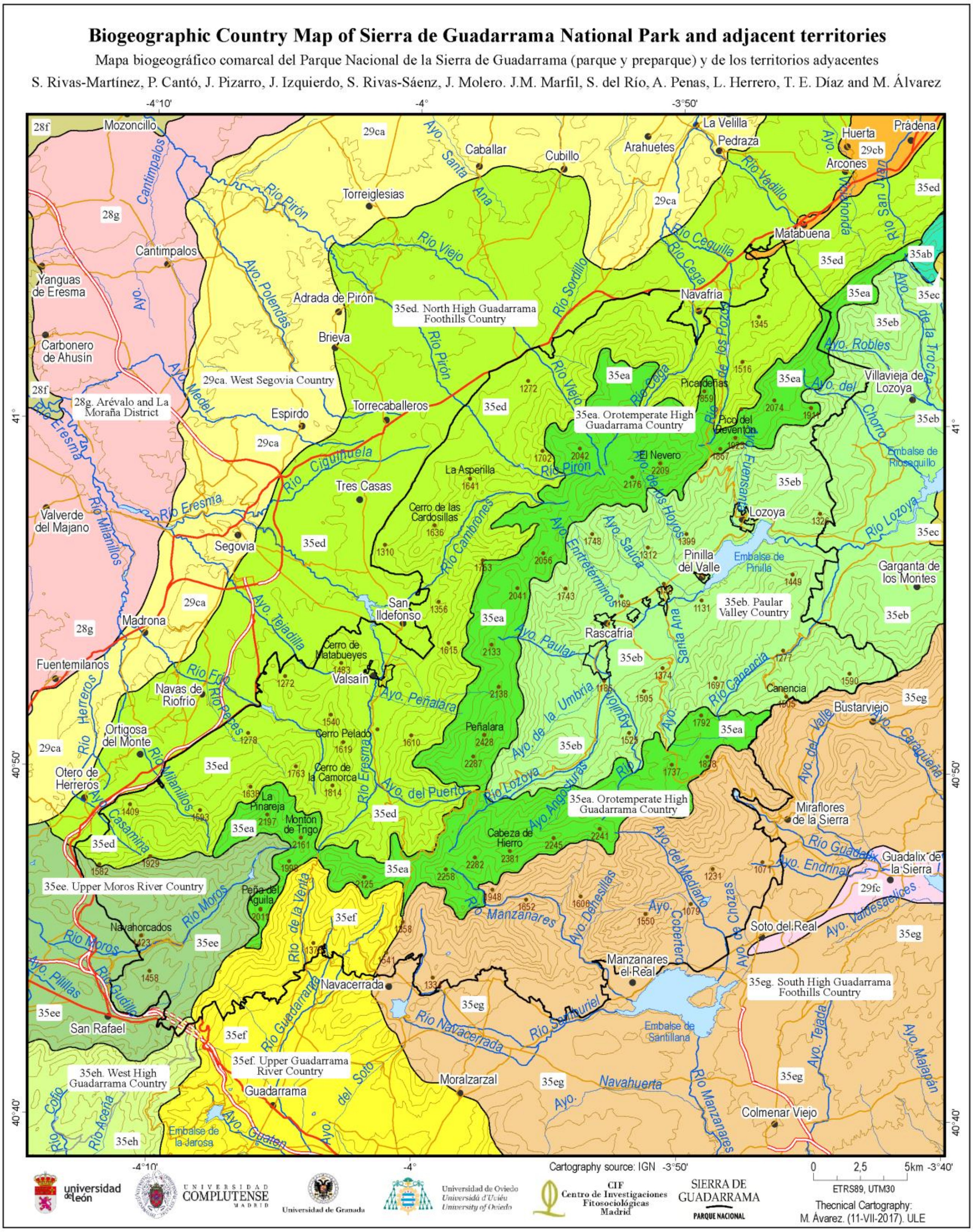
Biogeographic units of the Sierra de Guadarrama National Park (Park and Peripheral Area of Protection)

II Mediterranean Region (Región Mediterránea)
- IIb. Central Iberian Mediterranean Province (Provincia Mediterránea Ibérica Central)
  - IIbc. Castilian Subrovince (Subprovincia Castellana)
    - 28. Castilian Duero Sector ● (Sector Castellano Duriense)
      - 28f. Tierra de Pinares District ● (Distrito Terrapinarense)
      - 28g. Arévalo and La Moraña District ● (Distrito Arevalense-Morañés)
    - 29. Celtiberia and Alcarria Sector (Sector Celtibérico-Alcarreño)
      - 29c. Segovia District (Distrito Segoviano)
        - 29ca. West Segovia Country ● (Comarca Segoviana Occidental)
        - 29cb. East Segovia Country (Comarca Segoviana Oriental)
      - 29f. High Alcarria District (Distrito Alcarreño)
        - 29fc. Calcareous Torrelaguna Country ● (Comarca Torrelagunense calcárea)
- IIc. West Iberian Mediterranean Province (Provincia Mediterránea Ibérica Occidental)
  - IIca. Carpetanian and León Subprovince (Subprovincia Carpetana Leonesa)
    - 35. Guadarrama Sierran Sector (Sector Guadarrámico)
      - 35a. Ayllón Sierran District ● (Distrito Serrano Ayllonense)
        - 35ab. Somosierra Country ● (Comarca Somoserrana)
      - 35e. High Guadarrama Sierran District (Distrito Serrano Altoguadarrámico)
        - 35ea. Orotemperate High Guadarrama Country (Comarca Altoguadarrámica Orotemplada)
        - 35eb. Paular Valley Country (Comarca Paularense)
        - 35ec. Buitrago Country ● (Comarca Buitragueña)
        - 35ed. North High Guadarrama Foothills Country (Comarca Altoguadarrámica Pedemontana Septentrional)
        - 35ee. Upper Moros River Country (Comarca Alto Río Moros)
        - 35ef. Upper Guadarrama River Country (Comarca Alto Río Guadarrama)
        - 35eg. South High Guadarrama Foothills Country (Comarca Altoguadarrámica Pedemontana Meridional)
        - 35eh. West High Guadarrama Country (Comarca Altoguadarrámica Occidental)

● Out of bounds of Sierra de Guadarrama National Park and Prepark (Peripheral Area of Protection



Map 1. Bioclimatic Map of Sierra de Guadarrama National Park.



Map 2. Biogeographic Country Map of Sierra de Guadarrama National Park and adjacent territories.

Biogeographic Country Map of Sierra de Guadarrama National Park and adjacent territories

Mapa biogeográfico comarcal del Parque Nacional de la Sierra de Guadarrama (parque y preparque) y de los territorios adyacentes

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A. Penas, L. Herrero, T. E. Díaz & M. Álvarez

Typological summary (*)

II. Mediterranean Region (Región Mediterránea)

IIb. Central Iberian Mediterranean Province (Provincia Mediterránea Ibérica Central)

IIbc. Castilian Subprovince (Subprovincia Castellana)

28. Castilian Duero Sector (•) (Sector Castellano Duriense)

28f. Tierra de Pinares District (•) (Distrito Terrapinariego) [13km^2][a]

28g. Arévalo and La Moraña District (•) (Distrito Arevalense-Morañés) [234km^2][a]

29. Celtiberia and Alcarria Sector (Sector Celtibérico-Alcarreño)

29c. Segovia District (Distrito Segoviano)

29ca. West Segovia Country (•) (Comarca Segoviana Occidental) [319km^2][a]

29cb. East Segovia Country (Comarca Segoviana Oriental) [17km^2][a], [0,6km^2][b], [0,1][c]

29f. High Alcarria District (•) (Distrito Altoalcarreño)

29fc. Calcareous Torrelaguna Country (•) (Comarca Torrelagunense Calcárea) [18km^2][a]

IIc. West Iberian Mediterranean Province (Provincia Mediterránea Ibérica Occidental)

IIca. Carpetanian and León Subprovince (Subprovincia Carpetana Leonesa)

35. Guadarrama Sierran Sector (Sector Guadarrámico)

35a. Ayllón Sierran District (•) (Distrito Serrano Ayllonense)

35ab. Somosierra Country (•) (Comarca Somoserrana) [4km^2][a]

35e. High Guadarrama Sierran District (Distrito Serrano Altoguadarrámico)

35ea. Orotemperate High Guadarrama Country (Comarca Altoguadarrámica Orotemplada) [211km^2][a], [201,4km^2][b], [20,8%][c]

35eb. Paular Valley Country (Comarca Paularense) [351km^2][a], [230,4km^2][b], [23,8%][c]

35ec. Buitrago Country (•) (Comarca Buitragueña) [3km^2][a]

35ed. North High Guadarrama Foothills Country (Comarca Altoguadarrámica Pedemontana Septentrional) [671km^2][a], [287,1km^2][b], [29,7%][c]

35ee. Upper Moros River Country (Comarca Alto Río Moros) [114km^2][a], [59,5km^2][b], [6,2%][c]

35ef. Upper Guadarrama River Country (Comarca Alto Río Guadarrama) [162km^2][a], [41,5km^2][b], [4,3%][c]

35eg. South High Guadarrama Foothills Country (Comarca Altoguadarrámica Pedemontana Meridional) [540km^2][a], [145,5km^2][b], [15%][c]

35eh. West High Guadarrama Country (Comarca Altoguadarrámica Occidental) [47km^2][a], [0,5km^2][b], [0,1%][c]

(*) S. Rivas-Martínez, A. Penas, T.E. Díaz, S. del Río, P. Cantó, L. Herrero, C. Pinto Gomes & J. C. Costa in J. Geobot. Res. 4 (1): 1-64. 2015.
(•) Out of bounds of Sierra de Guadarrama National Park (park and prepark).

[a] Total area in the map; [b] total area in the National Park; [c] % of total National Park (park and prepark).

Spain Alpine National Parks. Global Geobotanical Project: ULE, UGR, UCM, UO, CIF, PNSG [2014-2017]
[Version: 11-VII-2017]

Map 2. Leyend.

Map 3. Drainage basins of Sierra de Guadarrama National Park and their adjacent territories.

Phytosociological plant communities of the biogeographic units

East Segovia Country

This occupies a very small area in the extreme Northeast of the peripheral area of protection (0.6 km^2), which represents 0.1% of the total. It belongs to the Central Iberian Mediterranean Province, Castilian Subprovince, Celtiberia and Alcarria Sector, Segovia District. The substrates are predominantly base rich and its flora and the vegetation differs from that of the rest of the park. The thermotype predominant is lower supramediterranean.

Some of the bioindicators in this country are listed in table 6.

Table 6.
29cb. East Segovia Country bioindicators. (Segovia District, Celtiberia and Alcarria Sector). S: sigmetum. Ms: minorisigmetum. Ps: permasigmetum. Synvar: synvariant.

	29cb. East Segovia Country	Thermotypic horizons					
		lsme	usme	lome	lste	uste	lote
	Series and synvariants						
74.2.1	Junipero hemisphaerico-thuriferae S	●					
75.1.13	Junipero thuriferae-Querco rotundifoliae S	●					
76.7.10	Luzulo-Querco pyrenaicae S J. thurifera synvar	●					
76.10.1	Cephalanthero rubrae-Querco fagineae S	●					
71.2.11	Aro cylindracei-Ulmo minoris S	●					
71.2.13	Querco pyrenaicae-Fraxino angustifoliae S	●					
71.8.2	Salico lambertiano-salviifoliae Ms	●					
12.2.12	Glycerio declinatae-Oenantetum crocatae Ps	●					
	Other bioindicators						
66.2.12	Rubo ulmifolii-Rosetum corymbiferae	●					
64.5.3	Lino differentis-Salvietum lavandulifoliae	●					
57.1.3	Festuco amplae-Agrostietum castellanae	●					
54.3.1	Astragalo sesamei-Poetum bulbosae	●					
51.3.4	Festuco andresmolinae-Brachypodietum phoenicoidis	●					
49.5.14	Thymo zygidis-Plantaginetum radicatae	●					
37.7.2	Artemisio glutinosae-Santolinetum rosmarinifoliae	●					

Orotemperate High Guadarrama Country

It is the culminating zone of Sierra de Guadarrama National Park, with 201.4 km2, 20.8 %. It spreads out all over the park and punctually reaches the peripheral protection area. Mostly over crystalline rocks rich in acid silicates, some of which are plutonic origin (granites, adamellites and granodiorites) and others metamorphic (biotite and gneiss). From a bioclimatic point of view, is the only temperate submediterranean country in its whole, with two thermotypic horizons: lower orotemperate and upper orotemperate. The upper orotemperate horizon begins at 2100 m asl (2150 m asl south). The *Avenello ibericae-Pinetum ibericae* is the climax forest in the lower zone. These pine forests in some especially humid environments have plants like *Vaccinium myrtillus* and *Luzula pediformis*. In the lower orotemperate horizon and, topographically in the upper orotemperate, mostly in fire safe rocky habitats, the climatophylous potential vegetation can be a dwarf juniper shrubland: *Avenello ibericae-Junipero alpinae minorisigmetum.* In the upper orotemperate a mosaic of permaseries occupy the different habitats of the high mountain. *Hieracio myriadeni-Festuco carpetanae geopermasigmetum* is the altioreine quionofobous geopermaseries of *Festuca carpetana* and *Minuartia bigerrensis* with *Hieracium myriadenum* and *Jasione centralis*. Other interesting plants that grow in the orotemperate High Guadarrama Country habitats are for example: *Armeria caespitosa*, *Senecio boissieri*, *Erysimum humile* subsp. *penyalarense*, *Plantago alpina* subsp. *penyalarensis*, *Sempervivum vicentei* subsp. *paui*, *Allium schoenoprasum* subsp. *latiorifolium*, *Silene boryi* subsp. *penyalarensis*, *Thymus praecox* subsp. *penyalarensis*, *Androsace vitaliana* subsp. *assoana*, *Ranunculus abnormis*, *Veronica fruticans* subsp. *cantabrica*, *Cirsium odontolepis*, *Gentiana lutea* and *Astragalus muticus*, some of them with a very restricted area.

It is worth noting the turbophile, mesohigropphytic and acuatic habitats which in some locations harbor plants of special interest such as *Eleocharis quinqueflora*, *Lycopodiella inundata*, *Utricularia minor*, *Juncus alpinoarticulatus* subsp. *alpestris*, *Juncus bulbosus*, o *Pingüicola grandiflora* and rupestrian habitats with taxa such as *Doronicum carpetanum*, *Digitalis carpetana*, *Senecio pyrenaicus* subsp. *carpetanus*, *Saxifraga willkommiana* and *Rumex suffruticosus*.

Some bioindicators of this biogeographic country are included in table 7.

Paular Valley Country

This is a large area of 230.4 km2 (23.8%) that occupies the Lozoya River micro-drainage basin, where the main watercourses are: Lozoya River and the following streams: Santa Ana, Agullón, Angostura, Umbría, Paular, Entretérminos, Sauca, Hoyos, Fuensanta, Chorro, Roble and Trochas. Lozoya River microdrainage basin is part of Jarama river meso-drainage basin and Tagus River macro-drainage basin.

Paular Valley has a great lithological diversity in which both the most important rocks of the central section of the Sierra de Guadarrama and Cretaceous sedimentary rocks

Table 7.
35ea. Orotemperate High Guadarrama Country bioindicators. (High Guadarrama Sierran District, Guadarrama Sierran Sector). S: sigmetum. Gp: geopermasigmetum. Gs: geosigmetum. Ms: minorisigmetum. Fps: permasigmetum of springs. Lps: permasigmetum of lakes. Tps: permasigmetum turbophile. Rps: rupicolous permasigmetum. Sps: stony crevice permasigmetum. Synvar: synvariant.

	35ea. Orotemperate High Guadarrama Country	Thermotypic horizons					
		usme	lome	lste	uste	lote	uote
	Series, geopermaseries minoriseries and synvariants						
49.2.4a	Hieracio myriadeni-Festuco carpetanae Gp low orotemperate synvar					●	●●
49.2.4b	upper orotemperate with Plantago penyalarensis synvar					-	●
74.5.1b	Avenello ibericae-Junipero alpinae Ms Festuca carpetana synvar					●●	●
74.4.1a	Avenello ibericae-Pino ibericae S high Guadarrama synvar					●●	-
74.4.1b	high Guadarrama synvar with Vaccinium myrtillus					○	-
74.4.1c	anthropogenic synvar					●	-
	Acuatics and turbophile habitats						
	Amphibian annual habitats						
9.2.3	Juncetum perpusilli					●	-
	Fontinal habitats						
11.4.1	Myosotido stoloniferae Fps					●	-
	Riverine and lacustrine habitats						
12.2.7	Glycerio declinatae-Alopecuro aequalis Lps					●	-
	Turbophile and mesohigrophytic habitats						
14.2.2	Carici echinato-nigrae Tps					●●	○
60.4.2	Allietum latiorifolii					○	○
60.4.4	Campanulo herminii-Festucetum ibericae					●●	●
60.4.5	Campanulo herminii-Festucetum rivularis					●	-
	Rupestrian habitats						
	Rupicolous chasmophytic habitats						
27.9.7	Saxifrago willkommianae Rps					●	●
	Loose shifting screes and pebbles habitats						
33.8.5	Digitali carpetanae-Senecio carpetani Sps					●	●
33.8.9	Rumiceto suffruticosi Sps					●	-
33.11.2	Cryptogrammo crispae-Dryopterido oreadis Sps					●	-
	Other bioindicators						
35.3.1	Linarietum niveae					●	-
52.7.19	Festuco carpetanae-Astragaletum mutici					○	-
54.1.5	Ranunculo alpine-Poetum bulbosae					●	○
60.4.8	Festuco rothmaleri-Juncetum squarrosi					●	-
74.5.7	Senecioni carpetani-Cytisetum oromediterranei					●	-

coexist. The thermotypes are mainly supratemperate and supramediterranean with humid ombroclimate. As a result of the geological and edaphic variability of this territory, we can find very different types of potential natural vegetation. The highest areas are occupied by pine forest (*Petridio aquilini-Pinetum ibericae*), which in the most humid places harbour not a few specimens of yew (*Taxus baccata*) and which in some coldest zones can come into contact with the orotemperate pine forest (*Avenello ibericae-Pinetum ibericae*). In some places facing north of the upper supratemperate horizon, there are birch forests (*Melico uniflorae-Betuletum celtibericae*) that may incorporate some ombrophilous trees like *Ilex aquifolium*, *Fraxinus excelsior*, *Quercus petraea* or *Populus tremula*. The most common climatofilous vegetation in Paular Valley Country is the Pyrenaic oak forests: *Luzulo forsteri-Quercetum pyrenaicae* (supramediterranean) and *Avenello ibericae-Quercetum pyrenaicae* (supratemperate). Ash forest (*Querco pyrenaicae-Fraxinetum angustifoliae*) occupies the bottom of the valley and on the limestone sedimentary places, potential natural vegetation is *Quercus faginea* forest.

Some interesting taxa as bioindicators or from the point of view of plant conservation, in addition to those already mentioned are, for example: *Centaurea nigra* subsp. *carpetana*, *Erodium paularense*, *Epipactis palustris*, *Filipendua ulmaria*, *Filipendula vulgaris*, *Sedum nevadense*, *Aster linosyris*, *Klasea nudicaulis*, *Lysimachia nemorum*, *Lysimachia vulgaris*, *Narcissus triandrus* subsp. *pallidulus*, *Viburnum opulus*, *Corylus avellana*, *Eriophorum latifolium*, *Stachys alpina*, *Helosciadium repens*, *Lilium martagon*, *Melica uniflora*, *Menyanthes trifoliata*, *Myosotis sicula*, *Potamogeton polygonifolius*, *Juncus compressus*, *Polygonum lapathifolium* subsp. *pallidum* and *Serratula tinctoria.*

Some bioindicators of this biogeographic country are included in table 8.

North High Guadarrama Foothills Country

This is a large area of 287.1 Km^2 (29.7%) that occupies the siliceous substrates of the high slopes of the northern Sierra de Guadarrama, located in the Cega, Pirón and Eresma drainage basins of the Douro River macro-drainage basin. The thermotypes are basically supramediterranean and supratemperate and although the potential forest vegetation corresponds mainly to *Quercus pyrenaica* forests, these are replaced by anthropogenic pine forests (*Avenello ibericae-Quercetum pyrenaicae* anthropogenic synvariant of Pinus iberica). Both in these environments and in higher elevations, in the natural pine forests (*Pteridio aquilini-Pinetum ibericae*) can be found refugees on certain slopes with heavy snow, sessile oaks (*Quercus petraea*), aspen trees (*Populus tremula*), yew trees (*Taxus baccata*), holly trees

Table 8.
35eb. Paular Valley Country bioindicators. (High Guadarrama Sierran District, Guadarrama Sierran Sector). S: sigmetum. Gps: geopermasigmetum. Mis: minorisigmetum. Fps: permasigmetum of springs (fountain). Gs: geosigmetum. Lps: permasigmetum of lakes. Tps: permasigmetum turbophile. Rps: rupicolous permasigmetum. Sps: stony crevice permasigmetum. Rsp: Rocky slopes permasigmetum. Frp: Fractured rocks permasigmetum. Anh: amphibian habitats. Synvar: synvariant.

	35eb. Paular Valley Country	Thermotypic horizons					
		lsme	usme	lome	lste	uste	lote
	Series and synvariants						
76.14.6	Melico uniflorae-Betulo celtibericae S					●	○
74.4.5	Pteridio aquilini-Pino ibericae S		●			●	
	Taxus baccata synvar.					●	
	Festuca carpetana synvar.					●	
74.4.1	Avenello ibericae-Pino ibericae S						○
74.2.1	Junipero hemisphaerico-thuriferae S	●	●				
	Juniperus lagunae synvar.	●	●				
75.2.12	Junipero lagunae-Querco rotundifoliae S	●	○		●		
	Juniperus thurifera synvar.	●	●		●		
76.10.1	Cephalanthero rubrae-Querco fagineae S	●	●				
	Fraxinus angustifolia synvar.	●	●		●		
76.7.10	Luzulo forsteri-Querco pyrenaicae S		●		●		
	Juniperus thurifera synvar.		●				
	Pinus iberica synvar.		●				
76.7.21	Avenello ibericae-Querco pyrenaicae S					●	
	Pinus iberica anthropogenic synvar.					●	
	Ilex aquifolium supratemperate synvar.					●	
71.2.13	Querco pyrenaicae-Fraxino angustifoliae Gs	●					
71.3.7	Rubo lainzii-Salicetum atrocinereae S		●	○	●		
71.8.2	Salicetum lambertiano-salviifoliae Mis	●					
	Other bioindicators						
8.1.2	Bidenti tripartitae-Polygonetum lapathifolii Anh	●	●		●		
9.2.3	Juncetum perpusilli Anh	●			●		
9.2.5	Junco pygmaei-Isoetetum velati Anh	●			●		
9.4.9	Sedetum lagascae Anh	●	●		●		
9.6.10	Verbeno supinae-Gnaphalietum uliginosi Anh	●			●		
12.2.12	Glycerio declinatae-Oenanthetum crocatae Lps	●	●		●		
12.5.3	Galio broterianae-Caricetum reuterianae Lps	●	●		●		
12.5.5	Holco reuteri-Caricetum acutiformis Lps	●	●		●		
27.8.2	Asplenio billotii-Cheillanthetum tinaei Rps	○					
32.3.7	Digitali thapsi-Dianthetum lusitani Rsp	●	●		●		
32.4.2	Sedo hirsuti-Saxifragetum continentalis Frp		●	○	●	●	
49.5.7	Hieracio castellani-Festucetum carpetanae		●	○	●	●	
49.5.14	Thymo zygidis-Plantaginetum radicatae	●					
54.1.1	Festuco amplae-Poetum bulbosae		●		●	●	
51.3.4	Festuco andresmolinae-Brachypodietum phoenicoidis	●					
57.1.3	Festuco amplae-Agrostietum castellanae	●			●		
59.6.7	Festuco amplae-Cynosuretum cristati	●			●		
64.5.3	Lino differentis-Salvietum lavandulifoliae	●	●				
65.1.4	Genisto floridae-Adenocarpetum hispanici		●		●	●	
66.2.12	Rubo ulmifolii-Rosetum corymbiferae	●	●				

(*Ilex aquifolium*) and very rarely some beeches (*Fagus sylvatica*). In river valleys there are ash and willow forests, in which singular trees such as hazelnuts (*Corylus avellana*) can grow. It is worth highlihting the presence in some locations in the Cega and Eresma Rivers (e.g., Los Asientos de Valsaín) of some alders (*Alnus glutinosa*) forming part of the *Salix atrocinerea* and *Rubus lainzii* woodlands. Other taxa of interest as bioindicators or for their value from a conservation point of view are, for example: *Aconitum napellus* subsp. *lusitanicum*, *Adenocarpus hispanicus*, *Carduus carpetanus*, *Corydalis intermedia*, *Corylus avellana*, *Laserpitium eliasii*, *Melittis melissophyllum*, *Myosotis decumbens*, *Narcissus pseudonarcissus* subsp. *confusus*, *Paris quadrifolia*, *Pyrola minor*, *Ranunculus nigrescens*, *Ranunculus peltatus*, *Ranunculus pseudofluitans*, *Serratula tinctoria*, *Sorbus aria*, *Taxus baccata*, *Ulmus glabra*, *Veratrum album* and *Viscum album*.

Some bioindicators of this biogeographic country are included in table 9.

Upper Moros River Country

Upper Moros River Country is the western country of the High Guadarrama Sierran District, with 59.5 km^2 (6.2%) in the Moros river micro-drainage basin. Thermotype is mainly upper supramediterranean. The boundary between supramediterranean and supratemperate is located at 1500-1550 m asl.

The most widespread vegetation series in this biogeographic country is the climatofilous guadarramean silicicolous supratemperate and supramediterranean euoceanic

Table 9.
35ed. North High Guadarrama Foothills Country bioindicators. (High Guadarrama Sierran District, Guadarrama Sierran Sector). Bio: bioindicators. S: sigmetum. Gs: geosigmetum. Gps: geopermasigmetum. Mis: minorisigmetum. Fps: permasigmetum of springs (fountain). Lps: permasigmetum of lakes. Tps: permasigmetum turbophile. Rps: rupicolous permasigmetum. Sps: stony crevice permasigmetum. Aah: annual aquatic habitat. Synvar: synvariant.

	35ed. North High Guadarrama Foothills Country	Thermotypic horizons					
		lsme	usme	lome	lste	uste	lote
74.4.1	Avenello ibericae-Pino ibericae S						○
	Festuca iberica synvar.						○
	Luzula pediformis et Vaccinium myrtillus synvar.						○
	Pinus uncinata synvar.						○
74.4.5	Pteridio aquilini-Pino ibericae S		●			●	
	Festuca carpetana synvar.		●		●	●	
	Taxus baccata et Quercus petraea synvar.				●	●	
76.7.21	Avenello ibericae-Querco pyrenaicae S				●	●	
76.7.10	Luzulo forsteri-Quercetum pyrenaicae	●	●				
75.2.12	Junipero lagunae-Querco rotundifoliae S	●					
	Avenella iberica sinvar.		●			○	
71.2.13	Querco pyrenaicae-Fraxino angustifoliae Gs	●					
71.3.7	Rubo lainzii-Salico atrocinereae S		●	●	●		
	Alnus glutinosa synvar.		○				
71.8.2	Salici lambertiano-salviifoliae Mis				●	●	
3.3.3	Callitricho brutiae-Ranunculetum peltati Aah				●	●	
11.4.1	Myosotido stoloniferae Fps						○
32.4.2	Sedo hirsuti-Saxifragetum fragosoi Rps		●		●	●	
	Other bioindicators						
34.9.1.	Carduo-Onopordetum acanthii carduetosum carpetani		●	●	●	●	○
40.4.3	Galio aparines-Conietum maculati		●				
49.5.7.	Hieracio castellani-Festucetum carpetanae		●	●	●	●	○
54.1.1.	Festuco amplae-Poetum bulbosae		●		●	●	
59.6.7.	Festuco amplae-Cynosuretum cristati	●			●		
59.8.8.	Sanguisorbo lateriflorae-Deschampsietum hispanicae	●	●		●		
60.4.8.	Festuco rothmaleri-Juncetum squarrosi		●			●	
62.2.13	Santolino rosmarinifoliae-Cistetum laurifoliae		●				
65.1.6.	Pteridio aquilini-Cytisetum oromediterranei		●		●	●	
65.1.3.	Cytiso oromediterranei-Genistetum cinerascentis		●				
65.1.4.	Genisto floridae-Adenocarpetum hispanici		●		●	●	

and semicontinental subhumid-hiperhumid of *Pinus sylvestris* var. *iberica* and *Pteridium aquilinum* forests series with *Avenella iberica* and *Genista florida* (*Pteridio aquilini-Pino ibericae sigmetum*). The supramediterranean series of *Quercus pyrenaica* and *Luzula forsteri* is also well represented in the territory, especially in its anthropogenic variant of *Pinus sylvestris* var. *iberica*. Some representative taxa, although not exclusive, of the vegetal landscape of this country are, for example *Adenocarpus hispanicus*, *Agrostis castellana*, *Carduus carpetanus*, *Cytisus oromediterraneus*, *Erica arborea*, *Frangula alnus*, *Genista cinerascens*, *Genista florida*, *Neottia nidus-avis*, *Pentaglotis sempervirens*, *Pinus sylvestris* var. *iberica*, *Rubus castellarnaui*, and *Santolina rosmarinifolia*.

Some bioindicators of this biogeographic country are included in table 10.

Upper Guadarrama River-Country

Upper Guadarrama River Country with 41.5 km^2 (4.3%) corresponds to the upper section of the Guadarrama river meso-drainage basin from its source south of Siete Picos. Both the supramediterranean and supratemperate thermotypes are found here. The natural potential vegetation is mainly *Quercus pyrenaica* forest, although in part of the area it is transformed into an anthropogenic pine forest of *Pinus sylvestris* var. *iberica*. The natural pine forests in the upper reaches are also well represented. In both types of forest, the anthropogenic fringe, megaphorbic vegetation and perennial mesohigrophytic grasslands are common. Riparian vegetation dominant is a willow woodland (*Rubo lainzii-Salicetum atrocinereae*) or a *Fraxinus angustifolia* woodland (*Querco pyrenaicae-Fraxinetum angustifoliae*).

Some bioindicators of this biogeographic country are included in table 11.

South High Guadarrama Foothhills Country

The southern country, with 145.5 km^2 (15%) spans the Manzanares River micro-drainage basin (Jarama River meso-drainage basin) from the south of Cuerda Larga, where it meets Orotemperate High Guadarrama Country, to the southern border of La Pedriza. Thermotypes go from lower supramediterranean to the lower orotemperate. Both *Quercus pyrenaica* oak forest series and *Quercus rotundifolia* oak woodland series are well represented, although the latter in some locations presents reforestation trees such as *Pinus salzmanii*, *Cupressus arizonica*, *Cedrus atlantica*, *Pinus pinaster* and even some *Pinus halepensis* in the lowest and sunniest areas. In some very humid ravines, in the *Quercus pyrenaica* forest habitats, some specimens of *Taxus baccata* grow. From 1600 m asl the natural pine forest (*Pteridio aquilini-Pino ibericae sigmetum*) begins, in which some reforestation specimens of black pine (*Pinus uncina*

Table 10.
35ee. Upper Moros River Country bioindicators. (High Guadarrama Sierran District, Guadarrama Sierran Sector). Bio: bioindicators. S: sigmetum. Gs: geosigmetum. Gps: geopermasigmetum. Mis: minorisigmetum. Fps: permasigmetum of springs (fountain). Lps: permasigmetum of lakes. Tps: permasigmetum turbophile. Rps: rupicolous permasigmetum. Sps: stony crevice permasigmetum. Aah: annual aquatic habitat. Synvar: synvariant.

	35ee. Upper Moros River Country Country	Thermotypic horizons					
		lsme	usme	lome	lste	uste	lote
74.4.1	Avenello ibericae-Pino ibericae S			○			○
74.4.5	Pteridio aquilini-Pino ibericae S		●			●	
	Festuca carpetana synvar.		●			●	
76.7.10	Luzulo forsteri-Querco pyrenaicae S		●				
	Pinus iberica anthropogenic synvar.		●			●	
71.2.13	Querco pyrenaicae-Fraxino angustifoliae Gs	●	●		○		
71.8.2	Salici lambertiano-salviifoliae Mis		●		○		
71.3.7	Rubo lainzii-Salicetum atrocinereae Gs		●	●	○	●	
9.4.9	Sedetum lagascae Aah	●	●				
3.3.3	Callitricho brutiae-Ranunculetum peltati Aah		●			●	
11.4.1	Myosotido stoloniferae Fps			○			○
27.9.7	Saxifragetum willkommianae Rps						○
	Other bioindicators						
34.9.1	Carduo-Onopordetum acanthii carduetosum carpetani		●	●		●	○
37.7.2	Artemisio glutinosae-Santolinetum rosmarinifoliae		●	●			
40.2.8	Pentaglottido sempervirentis-Scrophularietum reuteri					●	
57.3.1	Arrhenathero baetici-Stipetum giganteae	●	●				
60.4.8	Festuco rothmaleri-Juncetum squarrosi		●			●	
65.1.3	Cytiso oromediterranei-Genistetum cinerascentis		●				
65.1.4	Genisto floridae-Adenocarpetum hispanici		●			●	
66.212	Rubo ulmifolii-Rosetum corymbiferae	●	●				

Table 11.
35ef. Upper Guadarrama River Country bioindicators. (High Guadarrama Sierran District, Guadarrama Sierran Sector). Bio: bioindicators. S: sigmetum. Gps: geopermasigmetum. Mis: minorisigmetum. Fps: permasigmetum of springs (fountain). Lps: permasigmetum of lakes. Tps: permasigmetum turbophile. Rps: rupicolous permasigmetum. Sps: stony crevice permasigmetum. Aah: annual aquatic habitat. Synvar: synvariant.

	35ef. Upper Guadarrama River Country	Thermotypic horizons					
		lsme	usme	lome	lste	uste	lote
74.4.5	Pteridio aquilinae-Pino ibericae S		●			●	
	Festuca carpetana synvar.		●				
74.5.1b	Avenello-Junipero alpinae Ms F. carpetana synvar						○
76.7.10	Luzulo forsteri-Querco pyrenaicae S		●				
	Pinus iberica anthropogenic synvar.		●				
71.8.2	Salici lambertiano-salviifoliae Mis		●				
75.2.12	Junipero lagunae-Querco rotundifoliae S		●				
	Arenaria montana synvar.	●					
11.5.1	Montio amporitanae-Ranunculetum hederacei Fps	●	●				
32.3.7	Digitali thapsi-Dianthetum lusitani Rps	●	●				
71.2.13	Querco pyrenaicae-Fraxino angustifoliae Gs		●		●		
71.3.7	Rubo lainzii-Salicetum atrocinereae Gs		●	○	●		
3.4.1	Callitricho brutiae-Ranunculetum pseudofluitantis Aah	●					
12.2.12	Glycerio declinatae-Oenantetum crocatae Lps	●	●		●		
	Other bioindicators						
65.1.3	Cytiso oromediterranei-Genistetum cinerascentis		●				
65.1.6	Pteridio aquilini-Cytisetum oromediterranei		●			●	
65.1.4	Genisto floridae-Adenocarpetum hispanici		●		●		
65.1.5	Genisto floridae-Cytisetum scopaii	●					
66.2.12	Rubo ulmifolii-Rosetum corymbiferae	●	●				
54.1.1	Festuco amplae-Poetum bulbosae		●		●	●	
57.1.3	Festuco amplae-Agrostietum castellanae		●		●	●	
59.6.7	Festuco amplae-Cynosuretum cristati		●		●		
40.4.3	Galio aparines-Conietum maculati	●					
57.3.1	Arrhenathero baetici-Stipetum giganteae	●					
49.5.14	Thymo zygidis-Plantaginetum radicatae	●					
34.9.1	Carduo carpetani-Onopordetum acanthii		●	●			
37.7.2	Artemisio glutinosae-Santolinetum rosmarinifoliae		●	●			
62.2.13	Santolino rosmarinifoliae-Cistetum laurifolii		●				

ta) grow. From 1735 m asl *Juniperus alpina* scrublands and orotemperate pine forest (*Avenello ibericae-Pino ibericae sigmetum*) begin to be dominant, already on the boundary of the South High Guadarrama Foothills country.

Some taxa that are worth highlighting for their high presence or for their importance in plant conservation are: *Arbutus unedo, Arctostaphylos uva-ursi* subsp. *crassifolia*, *Cistus laurifolius*, *Cytisus oromediterraneus*, *Erica arborea*, *Erica tetralix*, *Frangula alnus*, *Genista florida*, *Juniperus alpina*, *Juniperus hemisphaerica*, *Juniperus oxycedrus* subsp. *lagunae*, *Quercus rotundifolia*, *Quercus suber*, *Pinus sylvestris* var. *iberica*, and *Sorbus aucuparia*.

Some of the bioindicators in this country are listed in table 12.

Table 12.

35eg. South High Guadarrama Foothills Country bioindicators. (High Guadarrama Sierran District, Guadarrama Sierran Sector). Bio: bioindicators. S: sigmetum. Gps: geopermasigmetum. Mis: minorisigmetum. Fps: permasigmetum of springs (fountain). Lps: permasigmetum of lakes. Tps: permasigmetum turbophile. Rps: rupicolous permasigmetum. Sps: stony crevice permasigmetum. Aah: annual aquatic habitat. Anh: amphibian habitat.

	35eg. South High Guadarrama Foothills Country	Thermotypic horizons					
		lsme	usme	lome	lste	uste	lote
74.4.5	Pteridio aquilinae-Pino ibericae S		●				
	Taxus baccata synvar.		●			●	
74.4.1	Avenello ibericae-Pino ibericae S			○			●
	Juniperus hemisphaerica synvar.			○			○
74.5.1b	Avenello-Junipero alpinae Ms F. carpetana synvar						○
76.7.10	Luzulo forsteri-Querco pyrenaicae S		●				
	Pinus iberica anthropogenic synvar.		●				
	Taxus baccata synvar.		●				
76.7.21	Avenello ibericae-Querco pyrenaicae S					○	
75.2.12	Junipero lagunae-Querco rotundifoliae S		●				
	Arenaria montana synvar.	●	●				
	Juniperus hemisphaerica synvar.		●				
	Quercus suber synvar.	●	●				
	Pinus salzmanii anthropogenic synvar.	●					
71.2.13	Querco pyrenaicae-Fraxino angustifoliae Gs	●					
71.8.2	Salici lambertiano-salviifoliae Mis		●		●		
71.3.7	Rubo lainzii-Salicetum atrocinereae Gs		●		●		
	Frangula alnus synvar.		●				
32.3.7	Digitali thapsi-Diantetum lusitani Rps		●				
	Linaria nivea synvar.		●				
14.2.2	Caricetum echinato-nigrae ericetosum tetralicis Tps			○			
	Other bioindicators						
65.1.3	Cytiso oromediterranei-Genistetum cinerascentis		●				
65.1.5	Genisto floridae-Cytisetum scopaii	●	●				
65.1.6	Pteridio aquilini-Cytisetum oromediterranei		●		●	●	
65.2.2	Erico arboreae-Arctostaphyletum crassifoliae	○	●				
74.5.7	Senecioni carpetani-Cytisetum oromediterranei						○
57.3.1	Arrhenathero baetici-Stipetum giganteae		●				
49.5.7.	Hieracio castellani-Festucetum carpetanae		●	●	●	●	○
49.5.14	Thymo zygidis-Plantaginetum radicatae	●	○				
57.1.3	Festuco amplae-Agrostietum castellanae	●					
54.1.1	Festuco amplae-Poetum bulbosae	●					
54.1.5	Ranunculo alpine-Poetum bulbosae						●
37.7.2	Artemisio glutinosae-Santolinetum rosmarinifoliae			●			
62.2.12	Rosmarino-Cistetum ladaniferi	●					
62.2.13	Santolino rosmarinifoliae-Cistetum laurifolii		●	●			
59.3.4	Deschampsio hispanicae-Juncetum effusi		●	●			

West High Guadarrama Country

This occupies a very small area 0.5 km^2 (0.1%) in the extreme Southwest of the Upper Moros River Country. The thermotype predominant is supramediterranean.

Some of the bioindicators in this country are listed in table 13.

New Syntaxon

The new association *Avenello ibericae-Quercetum pyrenaicae* corresponds to supratemperate humid euoceanic submediterranean natural potential vegetation *Quercus pyrenaica* forests, growing on deep siliceous soils in Sierra de Guadarrama National Park, between 1430-1790 m. At lower altitudes or in supramediterranean subhumid it can be replaced by *Luzulo forsteri-Quercetum pyrenaicae* forests and at higher altitudes, the potential natural vegetation is *Pinus sylvestris* var. *iberica* micro-mesoforests.

These *Quercus pyrenaica* oak forests are characterized by the high presence of: *Avenella iberica*, *Arenaria montana*, *Arrhenatherum carpetanum*, *Cytisus oromedi-*

terraneus, *Galium rotundifolium*, *Holcus mollis*, *Juniperus hemisphaerica* and *Poa nemoralis*. The main seral communities of this vegetation series are: *Hieracio castellani-Festucetum carpetanae*, *Pteridio aquilini-Cytisetum oromediterranei*, *Festuco amplae-Poetum bulbosae*, *Artemisio glutinosae-Santolinetum rosmarinifoliae*, *Carduo carpetani-Onopordetum acanthii*, and *Bromo scoparii-Hordeetum leporini* (Table 14).

Table 13.
35eh. West High Guadarrama Country bioindicators. (High Guadarrama Sierran District, Guadarrama Sierran Sector). Bio: bioindicators. S: sigmetum. Gps: geopermasigmetum. Ms: minorisigmetum. Fps: permasigmetum of springs (fountain). Lps: permasigmetum of lakes. Tps: permasigmetum turbophile. Rps: rupicolous permasigmetum. Sps: stony crevice permasigmetum. Aah: annual aquatic habitat.

	35eh. West High Guadarrama Country	Thermotypic horizons					
		lsme	usme	lome	lste	uste	lote
74.4.5	Pteridio aquilinae-Pino ibericae S		●				
	Festuca carpetana sinvar.		●				
74.5.1	Avenello ibericae-Junipero alpinae Ms			○			
76.7.10	Luzulo forsteri-Querco pyrenaicae S		●				
	Pinus iberica anthropogenic sinvar.						
71.8.2	Salici lambertiano-salviifoliae Mis		●				
75.2.12	Junipero lagunae-Querco rotundifoliae S		●				
	Arenaria montana sinvar.	●					
11.5.1	Montio amporitanae-Ranunculetum hederacei Fps	●					
3.4.1	Callitricho brutiae-Ranunculetum pseudofluitantis Aah	●					
32.3.7	Digitali thapsi-Dianthetum lusitani Rps	●	●				
	Other bioindicators						
66.2.12	Rubo ulmifolii-Rosetum corymbiferae	●	●				
65.1.3	Cytiso oromediterranei-Genistetum cinerascentis		●				
65.1.5	Genisto floridae-Cytisetum scoparii	●	●				
62.2.13	Santolino rosmarinifoliae-Cistetum laurifolii	●					
57.3.1	Arrhenathero baetici-Stipetum giganteae	●	●				
57.1.3	Festuco amplae-Agrostietum castellanae	●	●				
49.5.14	Thymo zygidis-Plantaginetum radicatae	●					
49.5.7.	Hieracio castellani-Festucetum carpetanae		●	○			
38.2.2	Matricario-Polygonetum arenastri		●				
50.4.6	Polytricho piliferi-sedetum pedicellati			○			

Table 14.
Syntaxonomic table of the **Avenello ibericae-Quercetum pyrenaicae** (Fdez.-Glez 1991) ass. nova hoc loco.

Avenello ibericae-Quercetum pyrenaicae (Fdez.-Glez 1991) ass. nova hoc loco											
(Quercenion pyrenaicae, Quercion pyrenaicae, Quercetalia roboris, Querco-Fagetea sylvaticae)											
Altitud (1=10 m)	160	165	143	152	157	151	179	166	160	171	167
Área (1=10 m^2)	12	10	10	12	10	10	15	10	10	10	10
Exposición	S	W	W	SE	E	SE	E	SE	W	SE	SE
Pendiente (grados)	5	20	20	25	20	20	20	10	25	20	20
Nº de taxones	20	18	23	30	25	16	18	18	27	24	24
Nº de orden	1*	2	3	4	5	6	7	8	9	10	11
Characteristic species and territorials											
Quercus pyrenaica	5	5	5	5	5	4	4	5	2	4	4
Avenella iberica (terr.)	3	2	2	1	1	2	3	1	2	1	2
Poa nemoralis	1	2	2	1	2	1	2	2	1	1	1
Arenaria montana	2	2	+	2	2	2	1	2	1	2	2
Holcus mollis	1	1	1	1	2	1	1	1	1	.	.
Arrhenatherum carpetanum (terr.)	1	1	.	.	.	.	1	+	1	+	1
Cytisus oromediterraneus (terr.)	1	+	+	.	.	.	+	+	.	1	1
Clinopodium arundanum (T-G)	.	.	+	1	1	+	.	1	.	.	1
Juniperus hemisphaerica (terr.)	+	.	+	.	.	.	1	.	+	1	+
Linaria nivea	1	.	.	1	.	1	+	1	.	.	.

Galium rotundifolium	.	.	.	+	2	.	.	.	2	1	1
Acinos meridionalis (T-G)	.	1	.	+	.	.	.	.	.	+	+
Veronica officinalis	.	.	.	1	1	.	.	.	1	1	+
Carex pairaei (T-G)	1	.	1	.	.	.	.	.	.	+	1
Conopodium pyrenaeum	.	.	+	1	1	.	.	.	1	.	.
Teucrium scorodonia	.	.	1	1	.	.	.	.	.	2	1
Sedum forsterianum	.	.	+	.	1	.	.	.	1	.	.
Cruciata glabra (T-G)	.	.	.	1	+	.	.	.	1	.	.
Silene nutans (T-G)	1	1	.	.	.	.	.	+	.	.	.
Melica uniflora	.	.	.	2	1	.	.	.	.	.	.
Lonicera hispanica	.	.	.	+	1	.	.	.	.	.	.
Luzula forsteri	.	.	.	.	+	.	.	.	+	.	.
Clinopodium vulgare (T-G)	.	.	.	.	+	.	.	.	+	.	.
Pentaglottis sempervirens (T-G)	.	.	.	.	.	.	+	+	.	.	.
Sorbus aucuparia	.	.	.	.	.	.	.	.	+	+	.
Differential species of the anthropogenic synvariant											
Pinus iberica	.	.	.	.	+	2	2	1	4	3	2
Companion species											
Pteridium aquilinum	2	1	.	2	1	2	2	1	2	1	2
Luzula lactea	1	.	2	.	+	1	1	1	1	1	1
Lactuca viminea	.	1	.	1	.	+	+	1	+	+	+
Avenula sulcata	1	1	1	1	.	1	1	.	.	.	.
Festuca gr. rubra	2	2	.	+	.	1	.	.	.	+	1
Genista florida (Cyt)	.	.	.	1	+	.	.	.	2	.	1
Koeleria crassipes	1	+	.	.	.	1	.	+	.	.	.
Erica arborea (Cyt)	.	.	+	1	+	.	.	.	.	1	+
Genista cinerascens	.	.	1	.	.	1	.	1	.	.	.
Poa pratensis	.	.	.	.	+	.	+	1	.	.	.
Rubus gr. hystrix	.	.	.	.	+	.	.	.	.	2	1
Dactylis glomerata	.	.	1	+	.	.	.	.	.	.	.
Galeopsis carpetana	.	.	.	+	.	.	.	.	.	+	.
Festuca rothmaleri	.	.	.	.	1	.	.	.	2	.	.
Festuca iberica	.	.	.	.	+	.	.	.	+	.	.
Omalotheca sylvatica	.	.	.	.	.	.	.	.	.	1	1
Agrostis castellana	.	.	.	.	.	.	.	.	.	1	1

Other species: **Characteristic species**: Silene vulgaris + in 1; Euphorbia angulata and Crataegus monogyna (R-P) 1 and Rosa micrantha (R-P) + in 3; Rosa canina (R-P) + in 4; Sanicula europaea 1 and Vicia pyrenaica (T-G) + in 9. **Companion species**: Silene latifolia and Poa compressa 1 and Milium montianum + in 1; Lapsana communis and Silene legionensis 1 and Galium aparine and Asphodelus albus + in 2; Asplenium adiantum-nigrum 1 and Acer monspessulanum and Stipa gigantea + in 3; Agrostis capillaris 1 and Galium rivulare, Adenocarpus hispanicus (Cyt), Carlina vulgaris and Leontodon bourgaeanus + in 4; Asphodelus aestivus + in 6; Amelanchier ovalis in + 7; Epilobium lanceolatum + in 9; Rubus idaeus + in 10; Cytisus scoparius (Cyt) + in 11

Localities: 1. Miraflores-Morcuera, km 7 (Holotypus), 2. Miraflores-Morcuera, 3.Morcuera-Rascafría, arroyo de Santa Ana 4. El Paular, laderas de la Matosa, 5 y 9. Cabeza Mediana, 6. Cotos-Rascafría, km 36, 7. Puerto de Navafría to Somosierra, 8. Puerto de Navafría, 10 y 11. Laderas meridionales de los Pájaros. Invs. 1-11 in Fernández-González, F., Lazaroa 12: 199, tb. 5B. 1991

Acronym: terr.= territorial, T-G: Trifolio-Genarietea, R-P: Rhamno-Prunetea, Cyt= Cytisetea scopario-striati.

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Localities	Latd. & longt.	Alt. (m)	Ty	Py	T	P	Itc	Ic	Io	Ios2	Ios3	Vas	Vaa	P<2T	Tp	Ts	Years	Seasonal rhythms	Bioclimatic classification
Puerto Navacerrada	40º46'N-4º0'W	1890	59	59	6..3	1314	46	17.1	11.5	1.66	2.88	69	69	2	773	441	1941-1999	W>F>P>S	Lower orotemperate upperhumid submediterranean
Puerto Navacerrada	40º47'N-4º0'W	1860	36	36	6..5	1170	42	175	10.5	1.65	2.71	74	74	2	798	446	1935-1970	W>F>P>S	Lower orotemperate upper humid submediterranean
Rascafría-El Paular	40º53'N-3º53'W	1159	40	40	9..9	996	154	15.9	8.4	1.25	1..98	150	150	2	1190	521	1960-1999	W>F>P>S	Upper supramediterranean lower humid
Rascafría-El Paular	40º53'N-3º53'W	1159	11	11	10.1	895	159	16.0	7.4	1.22	2..53	156	156	2	1213	527	1960-1970	W>F>P>S	Lower supramediterranean lower humid
Embalse Navalmedio	40º44'N-4º2'W	1280	28	29	9.7	1015	140	17.6	8.7	1.04	1.78	192	192	2	1167	545	1971-1999	W>F>P>S	Upper supramediterranean lower humid
Embalse de Navacerrada	40º42'N-4º0'W	1140	19	19	11.0	820	165	19.0	6.2	0.89	1.43	223	223	2	1315	603	1972-1990	W>F>P>S	Lower supramediterranean lower humid
Embalse de la Jarosa	40º39'N-4º6'W	1060	25	25	10.8	913	165	18.4	7.0	0.84	1.42	232	232	2	1301	591	1972-1996	W>F>P>S	Lower supramediterranean lower humid
Manzanares el Real	40º43'N-3º51'W	908	25	30	12.0	748	205	18.9	5.2	0.78	1..34	244	244	2	1439	617	1961-1990	W>F>P>S	Lower supramediterranean upper subhumid
Presa Manzanares	40º42'N-3º48'W	908	25	40	13.4	711	229	19.1	4.4	0.68	1.16	265	265	2	1613	673	1951-1990	W>F>P>S	Upper mesomediterranean lower subhumid
Presa de Pinilla	40º55'N-3º49'W	1093	21	21	10.9	642	179	16.7	4.9	0.89	1.41	221	221	2	1306	564	1970-1990	W>F>P>S	Lower supramediterranean upper subhumid
Presa de Pts. Viejas	40º49'N-3º34'W	960	40	40	11.3	622	185	17.3	4.6	0.93	1.45	215	215	2	1360	584	1951-1990	W>F>P>S	Lower supramediterranean lower subhumid
Alameda del Valle	40º55'N-3º50'W	1105	8	24	10.8	764	168	16.0	5.9	1.25	1.77	150	150	2	1297	537	1951-1974	W>F>P>S	Lower supramediterranean upper subhumid
Manjirón	40º59'N-3º34'W	1000	39	39	11.1	650	175	17.9	4.9	0.81	1.40	237	237	2	1336	592	1931-1969	W>F>P>S	Lower supramediterranean upper subhumid
Boalo-Cerceda	40º41'N-3º55'W	950	11	40	11.9	726	181	19.7	5.1	0.78	1.20	246	246	2	1428	631	1951-1990	W>F>P>S	Lower supramediterranean upper subhumid
Lozoyuela	40º55'N-3º37'W	1028	37	18	11.5	697	189	17.2	5.1	0.97	1.40	223	223	2	1379	591	1954-1990	W>F>P>S	Lower supramediterranean upper subhumid
Presa del Atazar	40º54'N-3º27'W	960	33	32	13.0	579	222	18.8	3.7	0.57	0.96	286	286	2	1556	658	1967-1999	W>F>P>S	Upper mesomediterranean upper dry
Monasterio del Escorial	40º35'N-4º8'W	1028	25	47	13.8	870	252	17.7	5.3	0.81	1.24	237	237	2	1652	667	1951-1997	F>W>P>S	Upper mesomediterranean upper subhumid
Soto del Real	40º45'N-3º47'W	921	19	37	11.7	702	208	16.2	5.0	0.71	1.31	257	257	2	1409	583	1954-1990	W>F>P>S	Lower supramediterranean upper subhumid
La Granja S. Ildefonso Sg	40º54'N-4º0'W	1191	40	44	10.0	706	157	16.0	5.9	1.20	1.89	160	160	2	1195	523	1960-1999	P>W>F>S	Upper supramediterranean upper subhumid
San Rafael Sg	40º42'N-4º11'W	1260	34	34	9.8	735	141	17.5	6.3	0.92	1.58	216	216	2	1170	544	1966-1999	W>F>P>S	Upper supramediterranean lower humid
La Pinilla Sg	41º12'N-3º28'W	1500	21	28	8.7	1298	117	16.8	12.4	2.08	3.06	9	9	1	1046	494	1971-1998	W>P>F>S	Upper supratemperate low hyperhumid
Santo Tomé del Puerto Sg	41º11'N-3º34'W	1120	22	25	10.7	849	162	17.7	6.6	1.24	1.96	153	153	2	1287	574	1973-1994	W>P>F>S	Lower supramediterranean lower humid