The endemic flora of the Iberian Peninsula: species richness, spatial phylogenetics and ecological differentiation

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TESIS DOCTORAL

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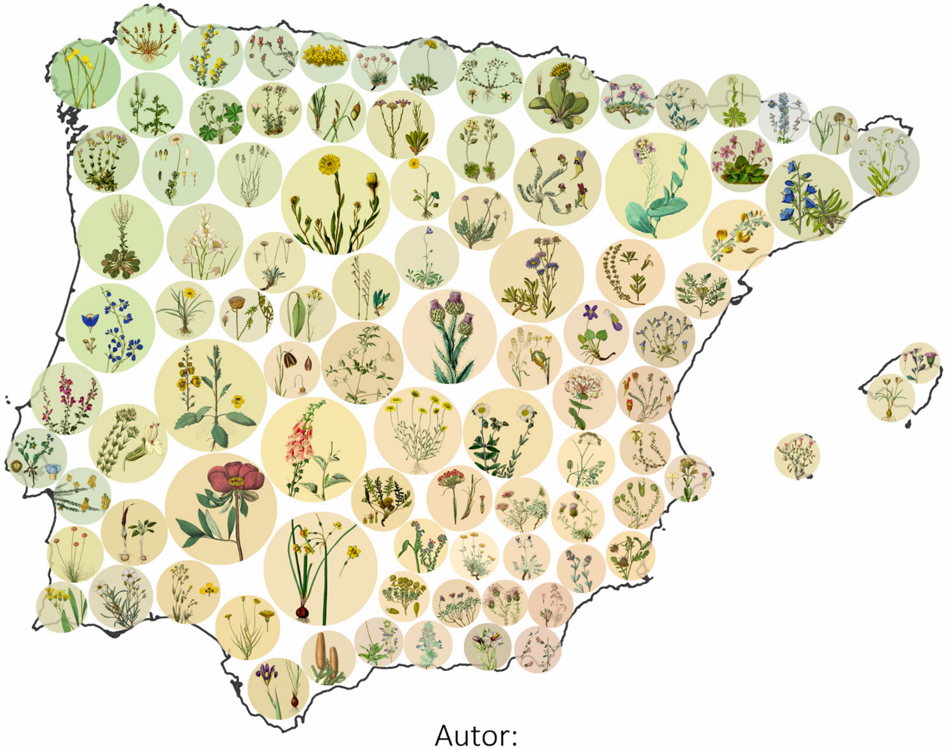

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Programa de Doctorado en Ciencias
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Resumen

Antecedentes

La Península Ibérica representa casi una cuarta parte del área del *hotspot* de biodiversidad conocido como Cuenca del Mediterráneo, que es el tercero del mundo en número de especies de plantas. La excepcional concentración de endemismos en la región se debe a una compleja interacción del clima, la geomorfología y la actividad tectónica. El elemento más característico del Mediterráneo es el clima marcadamente estacional con veranos secos que se estableció durante el Plioceno, el cual ha tenido importantes implicaciones en la evolución de las plantas. Muchas partes de la región han actuado además como refugio durante los ciclos glaciales-interglaciales del Pleistoceno. Las oscilaciones climáticas causaron que las áreas de distribución de las especies se contrajeran y luego se expandieran nuevamente a medida que el clima se temperaba. Como resultado, muchos linajes mediterráneos diversificaron en ambientes nuevos a través de diferentes procesos evolutivos. Muy probablemente, la litología también ha jugado un papel clave en la diversificación de las plantas mediterráneas, ya que es un factor que contribuye al aislamiento espacio-ecológico.

La descripción de la flora endémica ibérica ha sido muy irregular desde que se inició la nomenclatura botánica en 1753. De hecho, el conocimiento de la flora ibérica está todavía incompleto. Afortunadamente, el proyecto *Flora iberica* ha avanzado considerablemente en los últimos años y a día de hoy se puede estimar con bastante fiabilidad la riqueza de plantas y el endemismo en la Península Ibérica. Del mismo modo, el reciente y rápido aumento de las bases de datos de distribución de especies permite explorar los patrones espaciales de riqueza y endemismo a través de métricas de diversidad espacial. De forma similar, las técnicas de regionalización permiten reconocer e interpretar regiones con una historia biogeográfica común.

Sin embargo, los métodos que utilizan solo las especies como unidad de medida dan una imagen incompleta de la diversidad, ya que no incorporan las relaciones evolutivas entre especies. Gracias a la disponibilidad cada vez mayor de secuencias de ADN y a las herramientas analíticas del campo emergente conocido como *spatial phylogenetics*, es posible evaluar ahora los patrones espaciales del endemismo desde un punto de vista evolutivo e investigar los correlatos ambientales de los centros de neo y paleo-endemismo.

Por otro lado, el amplio conocimiento de la ecología de las especies de plantas se puede utilizar para explorar las características relacionadas con la rareza y evaluar la importancia potencial que tiene la diferenciación ecológica en la diversificación de los

endemismos de distribución restringida. La rareza es además el principal determinante del riesgo de extinción de una especie, si bien los criterios de la UICN también consideran otros factores como las posibles amenazas futuras y el grado de fragmentación del hábitat. En este sentido, se espera que ciertos entornos ecológicos sean más propensos a contener especies amenazadas que otros y se considera que su detección podría ser útil para encaminar la conservación hacia grupos de plantas vulnerables.

Objetivos

Los objetivos de esta tesis son explorar los patrones espaciales de riqueza florística y endemismo desde la perspectiva taxonómica y filogenética, identificar las características ecológicas relacionadas con la rareza y el estado de conservación de las especies y hacer una revisión del proceso de descripción de la flora endémica ibérica.

Creemos que todo ello es importante para comprender los mecanismos subyacentes a la generación y el mantenimiento de la diversidad de plantas a escala regional, así como para priorizar áreas de especial interés para la conservación, especialmente en el contexto actual de pérdida acelerada de biodiversidad.

Nuestros objetivos específicos, sintetizados y ordenados según la disposición de los capítulos son (i) revisar los principales determinantes sociohistóricos y macroecológicos del proceso de descubrimiento de las especies; (ii) analizar la composición taxonómica de la flora endémica ibérica en el contexto mediterráneo; (iii) explorar los patrones espaciales de riqueza utilizando distintas métricas de diversidad; (iv) definir e interpretar regiones florísticas basadas en la distribución de las plantas endémicas; (v) cuantificar la contribución de los factores ambientales (clima, suelo, topografía) a la hora de explicar la distribución espacial de los centros de diversificación reciente; (vi) evaluar el grado de diferenciación ecológica de las especies endémicas (vii) identificar variables que condicionan el estado de conservación de las especies.

Metodología

En primer lugar, se elaboró una lista actualizada de las especies y subespecies endémicas de la Península Ibérica (incluidos todos los Pirineos) y las Islas Baleares, que sirvió como base para todos los estudios. Los datos de distribución se obtuvieron principalmente de las bases de datos Anthos y Flora-On. Previo a su uso, se realizaron varios pasos de verificación para eliminar posibles errores.

En el capítulo 1 se construyeron curvas de acumulación de especies a partir de los porcentajes cumulativos de las especies descritas por año desde 1753. Se realizaron análisis de varianza y correlación para examinar la relación de ciertos factores (tamaño del área de distribución de las especies, formas de vida y riqueza espacial) con el número de especies descritas por área y con la fecha de descripción.

En el capítulo 2 se usaron y compararon varias métricas de diversidad. Todas ellas se aplicaron usando dos resoluciones espaciales distintas (cuadrículas de 10×10 km y de 50×50 km). En concreto, la riqueza de endemismos es la simple suma de todas las especies endémicas del territorio que se encuentran presentes en una cuadrícula determinada, mientras que el endemismo ponderado y el endemismo ponderado corregido tienen en cuenta el tamaño del área de distribución de las especies. Por otro lado, se exploraron las correlaciones entre el número total de registros de ocurrencia por celda y las distintas métricas de diversidad, con el fin de evaluar el efecto que tiene la intensidad de muestreo en los patrones resultantes.

Para definir regiones florísticas en el capítulo 3, se usó el método de agrupamiento particional *k-means* basándose en la presencia/ausencia de las especies endémicas en cada una de las celdas. El número de *k* grupos se determinó usando el valor de la silueta promedio. Los valores de fidelidad de las especies se usaron como medida de compacidad de los grupos.

En el capítulo 4 se construyó un árbol filogenético de la flora endémica ibérica a partir de una filogenia global que contenía todos los taxones con secuencias de ADN disponibles en GenBank. Los taxones sin datos moleculares disponibles (55%) se agregaron utilizando un método de aleatorización. El endemismo filogenético (PE) se midió en cada celda como la suma de las ramas filogenéticas ponderadas por el tamaño del área de distribución en el territorio. El endemismo filogenético relativo (RPE) se calculó como el cociente entre el PE medido en el árbol real y el PE medido en un árbol comparativo que retenía la topología del árbol real pero en el que todas las ramas tenían la misma longitud. Los patrones de RPE se calcularon de forma independiente para el conjunto de la flora endémica y para cuatro superclados (eudicotiledóneas, monocotiledóneas, superastéridas y superrósidas). Para cuantificar la contribución de los factores ambientales a la hora explicar el endemismo filogenético se utilizaron regresiones lineales múltiples y la varianza se dividió en grupos individuales de variables (clima, suelo y topografía).

La diferenciación ecológica de las especies endémicas se evaluó en el capítulo 5 comparando las frecuencias de especies nativas y endémicas para determinadas variables ecológicas (hábitat, rango altitudinal y preferencia edáfica). Además, se realizó un análisis de correspondencia para explorar las relaciones entre el tamaño del área de distribución y las características ecológicas de las especies. Finalmente, mediante regresiones logísticas se identificaron las variables que tenían un efecto significativo sobre el estado de conservación de las especies, basado en las categorías de la UICN.

Resultados

Capítulo 1

Después de revisar la historia de la descripción de la flora ibérica desde 1753 hasta el presente, se identificaron dos picos de descripción principales: el primero se asocia a los trabajos de exploración botánica realizados por Boissier en el *hotspot* regional del Sistema Bético a mediados del siglo XIX, y el segundo a las revisiones taxonómicas para *Flora iberica* a finales del siglo XX. El aplanamiento de la curva de acumulación de especies en los últimos años indicó que el descubrimiento de nuevas especies es cada vez más escaso, pero también que el inventario aún está incompleto. El número de especies descritas por área estuvo altamente correlacionado con la métrica de endemismo ponderado y, en menor medida, con la influencia humana. El tamaño del área de distribución estuvo negativamente correlacionado con la fecha de descripción. Por el contrario no se encontraron diferencias significativas en la fecha de descripción media para los distintos tipos de formas de vida.

Capítulo 2

Según nuestra última actualización, la flora ibérica consta de 1357 especies endémicas (1823 taxones), lo que representa el 24% de todas las especies nativas (26% de todos los taxones nativos). Casi la mitad de las especies endémicas tienen además un área de distribución reducida. Una gran parte de los endemismos se acumula en linajes ricos en especies, incluidos algunos géneros ampliamente representados en la mayor parte de la cuenca mediterránea, como *Centaurea*, *Silene* y *Limonium*, y otros que tienen sus principales centros de diversidad en la Península Ibérica, como *Armeria*, *Linaria* y *Teucrium.*

Los valores más altos de riqueza de endemismos ibéricos se dieron en las principales cordilleras. El Sistema Bético presentó con diferencia los valores más altos de endemismo ponderado. Las Islas Baleares y en menor medida algunas zonas costeras de la mitad sur de la Península, particularmente en el centro y sur de Portugal, también mostraron valores altos de endemismo ponderado.

El examen de los efectos de la escala espacial y la intensidad de muestreo mostró que las medidas de diversidad taxonómica se ven afectadas por el sesgo sistemático en la recogida de datos, particularmente a una resolución más fina. No obstante, los patrones resultantes a distintas resoluciones fueron considerablemente similares.

Capítulo 3

El análisis de partición basado en la distribución de especies endémicas permitió distinguir once regiones, la mayoría de las cuales tenían un significado geográfico y ecológico. Las regiones que incluían la Cordillera Cantábrica, los Pirineos, el Sistema Bético y las Islas Baleares presentaron además una gran proporción de especies fieles, cuyas distribuciones no eran completamente coincidentes pero se superponían en gran parte.

El dendrograma de distancias entre grupos reveló una primera división entre las regiones orientales predominantemente calcáreas y las regiones occidentales predominantemente silíceas. Se observaron diferencias significativas entre regiones en cuanto a la representación de los géneros ibéricos más ricos en especies. Algunos géneros típicamente mediterráneos (*Limonium*, *Thymus*, *Teucrium*, *Sideritis*, *Linaria*) se encontraron mejor representados en las regiones del este y sobre todo del sureste, mientras que algunos géneros predominantemente eurosiberianos y ártico-alpinos (*Festuca*, *Ranunculus*, *Saxifraga*) lo estuvieron en las regiones montañosas del norte y noroeste.

Capítulo 4

El efecto de la incertidumbre filogenética en el cálculo del RPE fue bajo, es decir que la inclusión de un elevado número de especies sin datos moleculares no alteró susceptiblemente los resultados. Las celdas de las montañas del norte y centro-oeste de la Península Ibérica y las Islas Baleares mostraron valores altos de RPE. Por el contrario, valores bajos de RPE prevalecieron en las celdas de las zonas orientales y surorientales. Los patrones espaciales de RPE fueron en gran medida similares para todos los superclados, excepto para las monocotiledóneas.

Las regresiones con variables ambientales mostraron que la diversificación reciente de las eudicotiledóneas (90% de todas las especies endémicas) estaba relacionada con valores altos de pH del suelo y condiciones climáticas estacionales secas. El factor edáfico fue además el que explicó mayor porcentaje de la varianza. Por el contrario, la diversificación reciente de las monocotiledóneas solo se asoció levemente con la elevación y el clima poco estacional.

Capítulo 5

En términos de hábitat, la mayor riqueza de especies endémicas se encontró en ambientes rocosos calcáreos de altitud media, y secundariamente en formaciones arbustivas mediterráneas abiertas. Los hábitats costeros, estépicos y alpinos contribuyeron al endemismo en regiones específicas y las áreas de distribución de sus especies fueron en promedio pequeñas. La mayoría de los taxones endémicos mostraron una clara preferencia por los sustratos calcáreos o silíceos, y se encontró que muchos endemismos de área de distribución reducida (20%) crecían en sustratos especiales como yesos o dolomías.

El 25% de los taxones endémicos ibéricos (455) se incluyeron en alguna categoría de amenaza. Los resultados de la regresión logística mostraron que ciertos entornos ecológicos tenían más probabilidades de contener especies amenazadas que otros, siendo los humedales de baja altitud, los hábitats costeros y los matorrales estépicos los más significativos en orden decreciente.

Conclusiones

1) Se han identificado dos picos importantes en la descripción de las plantas ibéricas: el primero se asocia a los trabajos de exploración botánica realizados por Boissier en el *hotspot* regional del Sistema Bético a mediados del siglo XIX, y el segundo a las revisiones taxonómicas para *Flora iberica* a finales del siglo XX.
2) El patrón espacial de descripción de especies mostró que muchos endemismos se han descrito en zonas con una alta diversidad de especies, pero también en áreas pobladas y accesibles; mientras que el patrón temporal mostró que las especies raras se han descrito más tarde.
3) Los cambios en el esfuerzo de descubrimiento se han regido por factores sociohistóricos y, en consecuencia, las curvas de acumulación de especies no son fiables a la hora de indicar el grado de completitud del proceso de descripción.
4) Según nuestra última actualización, la flora ibérica consta de 1357 especies endémicas (1823 taxones), que representan el 24% de todas las especies nativas (26% de todos los taxones nativos). Las especies endémicas ibéricas son en su mayoría de área de distribución reducida y están en gran parte agrupadas en linajes ricos en especies.

5) Los valores más altos de riqueza de endemismos se dan en las principales cordilleras ibéricas como resultado del aislamiento orográfico, la complejidad geomorfológica y el amortiguamiento de las fluctuaciones climáticas. Los valores altos de endemismo ponderado de las Islas Baleares y, en menor medida, de la costa central y sur de Portugal, se deben en parte a la gran diversidad de hábitats costeros y a la estabilidad climática regional.

6) La excepcional concentración de especies endémicas en el Sistema Bético puede explicarse por el amplio rango altitudinal, la orografía fragmentada, las condiciones heterogéneas de clima y suelo, y las bajas tasas de extinción durante las fluctuaciones glaciales-interglaciales.

7) A través del análisis de partición se han distinguido once regiones, la mayoría de las cuales tienen un significado geográfico y ecológico. Las regiones que incluyen la Cordillera Cantábrica, los Pirineos, el Sistema Bético y las Islas Baleares pueden considerarse áreas de endemismo a gran escala.

8) El dendrograma de distancias entre grupos reveló una primera división entre las regiones orientales predominantemente calcáreas y las regiones occidentales predominantemente silíceas, lo que subraya la importancia de la litología en la configuración de la composición de especies en la Península Ibérica.

9) La reciente diversificación de las angiospermas en su conjunto, y en particular de las eudicotiledóneas, ha sido impulsada por factores ambientales estresantes que incluyen valores altos de pH del suelo y condiciones climáticas estacionales secas. Por primera vez se revela y cuantifica el papel clave de las propiedades del suelo en la diversificación reciente de una flora endémica completa.

10) La diversificación de las monocotiledóneas no se ha asociado con las condiciones del suelo, sino con la elevación y el clima menos estacional. Los patrones contrapuestos en la diversificación de las eudicotiledóneas y monocotiledóneas resaltan la importancia de analizar patrones filogenéticos espaciales a múltiples escalas filogenéticas.

11) Se obtuvieron valores altos de endemismo filogenético relativo en áreas donde hay evidencia de la presencia de especies paleoendémicas, como en las Islas Baleares, Cazorla, centro-sur de los Pirineos y montañas del norte de Portugal y noroeste de España, estas últimas albergan además el mayor número de géneros endémicos.

12) Los endemismos de distribución reducida están predominantemente adaptados a hábitats hostiles con poca competencia y a sustratos litológicos estresantes. Todo esto refuerza la hipótesis de que las propiedades del suelo y las condiciones del hábitat pueden desempeñar un papel importante en la segregación ecológica y la especiación a escala regional.

13) Casi una cuarta parte de los endemismos ibéricos (455 taxones) se consideran amenazados. Se cree que muchas especies de área de distribución reducida son

intrínsecamente raras. Sin embargo, se han detectado algunos entornos ecológicos que son más propensos a contener especies amenazadas que otros como consecuencia de la acción humana, entre los que destacan los humedales de baja altitud, los hábitats costeros y los matorrales estépicos.

14) Paradójicamente, las áreas de ocupación de las especies que se encuentran en esos hábitats están relativamente menos protegidas. Por el contrario, una gran proporción de hábitats montanos y alpinos están protegidos y muchas de sus especies se consideran no amenazadas en la actualidad. Sin embargo, algunos centros de endemismo ubicados en alta montaña como Sierra Nevada están en riesgo debido al calentamiento global.

General introduction

This thesis is a compendium of researches in which the central theme is endemism and the subject matter is the contemporary Iberian vascular flora. It sets out to explore the spatial patterns of endemic species and understanding the mechanisms underlying the generation and maintenance of plant biodiversity in the Iberian Peninsula and, by extension, to the Mediterranean Basin. Additionally, there are some chapters or sections dedicated to illustrate the process of species discovery and analyze the taxonomic composition and the conservation status of the Iberian endemic flora.

The term *endemic* (from Greek *endēmos,* meaning "in the people") is used in biogeography, to refer taxa that are restricted to a defined geographical area. Thus, in general, the terms "endemic" or "Iberian endemic" are used here to refer to any taxon, regardless of its range size, restricted to the Iberian Peninsula and the Balearic Islands. Likewise, the term "narrow endemic" (Kruckeberg & Rabinowitz, 1985) is usually used to refer to any Iberian endemic being unique to a well-defined small area (approximately 2500 km^2 or less, but see criteria within each chapter).

The Iberian Peninsula is located in the western of the Mediterranean Basin (Fig. I1), which is the third major plant biodiversity hotspot of the world (Mittermeier et al., 2004). According to these authors, the Mediterranean Basin is home to nearly 22500 plant species and 11700 endemics, over half of which are narrow endemics (Thompson, 2005). Such exceptional concentration of narrow endemic species has not gone unnoticed by biogeographers and botanists, who have long investigated the processes that trigger and maintain plant endemism at a macroecological scale (e.g. Cowling et al., 1996; Médail & Verlaque, 1997; Quézel & Médail, 2003; Molina-Venegas et al., 2013).

It has been argued that complex interactions of climate, geomorphology and tectonic activity have shaped the Mediterranean hotspots as we know them today (Thompson, 2005; Molina-Venegas et al., 2016; Rundel et al., 2016). The geological history of the meeting between the Eurasian and the African plates has resulted in numerous islands, which are home of many endemics that are relicts of a former mainland distribution or cases of within-island diversification (Contandriopoulos & Cardona, 1984). Likewise, the intermittent connection of the African tectonic plate with the Iberian plate (Rosenbaum et al., 2002) is known to have encouraged spatial divergence and local speciation in several lineages (Lavergne et al., 2013).

Fig. I1 Delimitation of the Mediterranean Basin Hotspot (Mittermeier et al., 2004).

The most characteristic feature of the Mediterranean region is the highly seasonal climate with summer drought established since the Pliocene (Suc, 1984), which has had important implications for evolution of plants (Verdú & Pausas, 2013). On the other hand, many parts of the region have acted as a refuge during the glacial-interglacial cycles of the Pleistocene (Hungerer & Kadereit, 1998; Médail & Diadema, 2009). Climatic oscillations caused plant species ranges to contract and then expand again as the climate warmed (Thompson, 2005). As a result, many Mediterranean lineages diversified in new environments through different evolutionary processes, including hybridization, polyploidization and inbreeding (Thompson, 2005).

Most likely, lithology has also played a key role in the diversification of Mediterranean plants, as it is a factor that contributes to spatio-ecological isolation (Molina-Venegas et al., 2016). Indeed, the association between soil type and endemism ("edaphism") has long been recognized by botanists who have studied the Mediterranean flora (e.g. Willkomm, 1852; Braun-Blanquet, 1932; Rivas Goday, 1956). However, the evidence connecting plant diversification and soil properties has been mostly narrative and only few researches have attempted to empirically quantify their contribution (but see Lobo et al., 2001; Molina-Venegas et al., 2013).

The Mediterranean region is also the home of many human civilizations, which certainly have been altering natural habitats and species distributions for thousands of years. Thus, human activities have also played an important role in shaping contemporary evolutionary pressures in natural populations (Thompson, 2005).

The Iberian Peninsula and the Balearic Islands account for almost a quarter of the area of the Mediterranean Basin hotspot. Most of the Peninsula and the Balearic Islands are included within the Mediterranean region (Fig. I1), while a narrow strip in the north and northwest (less than 15% of the territory), including the Pyrenees and the Cantabrian Range, has traditionally been characterized as Eurosiberian region (Peinado & Rivas-Martínez, 1987). The Iberian Peninsula is also one of the most species-rich areas within the Mediterranean Basin, together with the Balkan and Anatolian peninsulas in the East (Médail & Quézel, 1997), and is home to over half of all European plants (Aedo et al., 2013). Thus, the Iberian Peninsula represents an ideal eco-historical setting to illustrate the species discovery process, explore spatial patterns of species richness, recognize and interpret areas of endemism and delve into eco-evolutionary drivers of plant diversification in Mediterranean ecosystems.

Methodological framework

The description of the Iberian endemic flora has been very uneven over the last 265 years, ranging from the first Iberian plants included in Linnaeus' *Species Plantarum* in the mid-18th century, through the extensive works of Boissier and Willkomm in the 19th, to the specific taxonomic revisions for *Flora iberica* (Castroviejo, 1986-2019) in the late 20th and early 21st centuries. In fact, the knowledge of the Iberian flora is still incomplete at the present time. Fortunately, the *Flora iberica* project has made considerable progress in recent years and it is almost finished (only a part of Gramineae is still unpublished). Thanks to the information provided by *Flora iberica,* plus subsequent publications describing new taxa and more recent taxonomic monographs, the overall plant richness and endemism in the Iberian Peninsula can be now assessed fairly reliably. Likewise, completeness of species description may be cautiously judged through discovery curves.

The available distributional data are also becoming huge over the past few years thanks to ongoing digitization of bibliographic sources and revised herbarium specimens. Thus, the Anthos (Spain) and Flora-On (Portugal) databases compile together more than 1.6 million occurrence records. The availability of extensive and accurate data on plant species distribution enables us to explore the spatial patterns of richness and endemism in several ways. Considering endemics as taxa restricted to a particular region of any size, the most straightforward way to determine the spatial richness is by dividing the study area into portions, usually grid cells, and summing the total endemic species occurring in a given grid cell. Metrics weighting species range restriction can be used to detect centers of endemism more accurately (Crisp et al., 2001; Linder, 2001). The areas of endemism are defined as regions which are not only rich in endemic species, but where endemics are mostly common to the whole area (Bradshaw et al., 2015; Linder, 2001; Morrone, 1994). The identification of these areas can be approached by using regionalization techniques. Regionalization provides in addition understandable and meaningful regions for spatial representation, historical and ecological interpretation (Bradshaw et al., 2015; Kreft & Jetz, 2010; Morrone, 2009).

All these methods are useful to examine the distributional pattern of plant endemism and provide insights into the causes of endemism, but give an incomplete picture of diversity since they fail to incorporate the evolutionary relationships among species. DNA-based phylogenies are increasingly available, enabling the assessment of spatial patterns of endemism from an evolutionary standpoint (e.g. Mishler et al., 2014; Thornhill et al., 2016; Thornhill et al., 2017). Phylogenetic approaches specifically allow for phylogenetic position of endemic species and thus can be used to investigate the environmental drivers that boost and maintain endemism at a macroecological scale (Schmidt-Lebuhn et al., 2015; Molina-Venegas et al., 2017).

The extensive knowledge of plant species ecology relating to habitat, edaphic preference and altitudinal ranges can be used to explore rarity-related characteristics and assess the potential significance of local ecological differentiation in plant diversification. Rarity is also the main determinant of a species' risk of extinction (Gaston & Fuller, 2009). Besides the current range and population sizes, the IUCN Red List (UICN, 2012) also considers criteria as the potential future threats and the degree of habitat fragmentation. Thus, some plants occurring on naturally sheltered habitat types are likely to be at lower risk of extinction than those growing on environments that tend to be anthropized (Silcok & Fensham, 2018). In this sense, statistical models can be applied to find combinations of sites and ecological variables associated with the occurrence of threatened plants, which may be useful to target conservation strategies at assemblages of vulnerable species.

Objectives and scenarios

Chapter 1 focuses on the history of description of the Iberian endemic flora and reviews the main socio-historical and macroecological determinants of the discovery process. In particular, our aims are to (i) draw up an overview of the described taxa from 1753 to present identifying the most important historical events and prolific authors; (ii) explore the macroecological determinants of geographical and temporal pattern of species description; and (iii) assess the degree of completeness of the Iberian flora description. We believe that reviewing spatial and temporal trends of species discovery may help to understand why some species are described first as well as to determine whether or not the process of species description is predictable.

In chapter 2 we present a checklist of the Iberian and Balearic endemic flora based primarily on *Flora iberica* and updated with new taxa published subsequently and revised on the basis of more recent taxonomic monographs. On the other hand, we explore spatial patterns of species richness and sampling intensity. Our specific aims are (i) to analyze the taxonomic composition of the Iberian endemic flora within the Mediterranean context; (ii) explore the spatial patterns of endemic richness using different diversity metrics; and (iii) examine the effects of spatial scale and sampling intensity on the resulting endemism patterns. We presume that patterns of spatial richness are broadly recognizable to different spatial resolutions, despite the possible bias in distributional data. Likewise, we expect that certain taxonomic diversity metrics may prove more useful than others for identifying areas of significantly high endemism and to point out new areas not previously recognized.

Chapter 3 seeks to recognize and interpret areas with a common biogeographic history through regionalization techniques. To that end, we draw on extensive distributional data for the entire Iberian endemic flora and partitional clustering methods to (i) define meaningful floristic regions based on the endemic plant distributions; (ii) analyze the degree of compactness of the resulting regions and (iii); compare their species richness, endemism and taxonomic composition. Our hypothesis is that the rugged geography and the contrasting soil and climate conditions of the Iberian Peninsula shape the main areas of endemism and determine their taxonomic composition in terms of large taxonomic groups.

Chapter 4 sets out to evaluate the spatial patterns of plant endemism from an evolutionary standpoint and delve into the environmental drivers of recent plant diversification. To that end, we draw on distributional and phylogenetic data for the endemic flora of the Iberian Peninsula and analytical tools from the emerging field of "spatial phylogenetics" to (i) detect centers of recent plant diversification; (ii) assess how edaphic, climatic and topographic factors contribute to explain the spatial distribution of these centers; and (iii) test whether the patterns are consistent across plant superclades (i.e. Monocots, Eudicots, Superasterids and Superrosids). We hypothesize that environmental variables contribute to explain phylogenetic endemism and that soil properties may be as relevant as climate and topographic features in determining the spatial distribution of centers of recent plant diversification.

Finally, chapter 5 focuses on the habitat characteristics related to narrow endemism and conservation status. We draw on a database including ecological traits and conservation status and correspondence analysis and logistic regression techniques to (i) evaluate ecological differences between endemic and native flora (ii) explore the habitat characteristics and plant traits associated with rarity; and (iii) identify variables other than range size related to the conservation status. We expect that narrow Iberian endemics are specialized to particular soil and habitat conditions, and that some ecological settings are more likely to contain threatened species than others.

We believe that all these aims are important to understand the mechanisms underlying the generation and maintenance of plant diversity on a regional scale, as well as to prioritize areas of special interest for conservation, especially in the current context of accelerated loss of biodiversity.

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Chapter 1

The discovery process: socio-historical and macroecological determinants

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Abstract

Since 1753 the description of vascular plants has been highly uneven. Given its high levels of plant endemism and long botanical history, the Iberian Peninsula is considered a suitable territory to study the species discovery process. Here, we identify the most important historical events and prolific authors in the description of the Iberian flora and explore how particular species traits and spatial variables, i.e. richness and human impact, have influenced on the process. Two important peaks of description were identified: the first was associated to the extensive botanical exploration of the Baetic Mountains hotspot by Boissier (mid-19th century), and the second to the taxonomic revisions for *Flora iberica* (late 20th). As found in other studies, a negative correlation existed between the range size and the description date, while no differences were found for the life-form categories. The number of described species per area was highly correlated with the weighted endemism metric and to a lesser extent with the human influence. Our results show that changes in discovery effort have been governed by socio-historical factors and consequently the discovery curves are not reliable to indicate the final approach to completeness. However, the high number of recently discovered species suggests that the inventory is still incomplete.

Introduction

It was not until Linnaeus' *Species Plantarum* in 1753 that the binomial names were consistently applied. Thus, this date was established as the starting point for the naming of plants (art. 13.1 of the ICN: Turland et al., 2018), and consequently a large share of the currently European accepted species is credited to Linnaeus (Jarvis, 1992). Because the system was established, most of the common plants in Europe were described in the 50 following years, either by Linnaeus himself or by other prolific naturalists such as Lamarck, Willdenow or Miller (Aeschimann et al., 2011).

On the whole, however, the endemic species whose geographical ranges are locally restricted have been described in later time periods. The authors who have studied the macroecological determinants of the species discovery process tend to agree that narrowly distributed and smaller size taxa are later described, both for vertebrates (Blackburn & Gaston, 1995; Diniz-Filho et al., 2005), invertebrates (Gaston et al., 1995a) and vascular plants (Bebber et al., 2007a; Cavallin et al., 2016). On the other hand, the cumulative frequency of described species has been used to estimate the number of species that remain undiscovered (Gaston et al., 1995b; Dolphin & Quicke, 2001; Ulloa et al., 2016), although methods such as interpolation from species discovery curves have high margins of error (Bebber et al., 2007b).

The protologue of a newly published name generally includes a geographical location (sometimes more) from which it was described; this is known as *locus classicus* or type locality. As single data points, the type localities provide scarce information about the plant distributions and the species richness. However, at a broad scale, a spatial correlation can be expected between the pattern of aggregation of the type localities and the observed richness of narrow endemics (e.g. Peruzzi et al., 2015). Beyond that, similarly to the biodiversity data collection, the type localities are very likely biased by several socio-economic and geographic aspects (Meyer et al., 2015). Some factors including varying accessibility of areas, heterogeneous academic activity, and focus on regions with certain appeal like endemism or species richness (Boakes et al., 2010; Meyer et al., 2015; Brundu et al., 2017) condition the type localities choice.

The Iberian flora –including the Balearic Islands– consists of more than 1800 endemic taxa (nearly 26% of all native taxa; Buira et al., 2017; see Chapter 2 for details). The description of these plants has been uneven over the last 265 years, ranging from the first Iberian plants included in Linnaeus' *Species Plantarum* in the mid-18th century, through the extensive works of Boissier or Willkomm in the 19th, to the specific taxonomic revisions for *Flora iberica* (Castroviejo, 1986-2019) in the late 20th and early 21st centuries. In fact, several Iberian narrow endemics are still being discovered and described in recent times.

Although the specific contribution of some of the most prolific authors has been documented (e.g. Devesa & Vieira, 2001; González Bueno, 2010), so far any comprehensive account in terms of described taxa over time has been done for the whole Iberian flora. Knowing the historical events that have boosted the discovery effort can help to determine whether or not the process of species description is predictable and is reaching completion. Likewise, exploring the spatial distribution of type localities enable us to understand why species are described in some places rather than others.

Given its high level of plant endemism, relative isolation and long botanical history, the Iberian Peninsula is considered a suitable territory to explore how the historical events and the macroecological and human presence variables influence the process of species discovery. Here, we make the first chronological and spatial overview of the Iberian flora description. Particularly our aims are to (i) draw up an overview of the described taxa from 1753 to present identifying the most important historical events and prolific authors; (ii) explore the macroecological determinants of geographical and temporal pattern of species description; and (iii) assess the degree of completeness of the Iberian flora description.

Material and methods

Data compilation

We used a list of all Iberian and Balearic native taxa based on *Flora iberica* (Castroviejo, 1986-2019), and updated with new taxa published subsequently (see Chapter 2 for details). The endemic taxa were used for all the analyses, while the non-endemic native taxa were only used to compare the described taxa over time between both groups. The endemic taxa were defined as the species and subspecies occurring exclusively in the Iberian Peninsula and the Balearic Islands, as well as those whose distributions slightly exceed the Iberian limits into the northern side of the Pyrenees (here after referred as Iberian endemics). The highly polymorphic groups in which hybridation, apomixis or reticulation phenomena are common (i.e. *Limonium, Alchemilla, Festuca* and *Taraxacum*) and whose distribution ranges are generally poorly known, were separated for certain comparative analysis (hereafter referred as 'apomictic' groups).

We compiled for each accepted taxon all the nomenclatural information, including the basionym, the describing and combining authors, and the date and place of publication. The list of the accepted taxa includes a part of non-combined names – applied as they were originally described–, and another part of names that have been combined under alternative genera or at a different taxonomic rank of the basionym. In the case of combined names, the authors and dates of description are always referred to the basionyms or, in the few cases of replacement names, to the replaced synonyms (Art. 6.11 and 7.4 of the ICN: Turland et al., 2018).

The type localities were procured for each endemic species from the text of its protologues. The geographical accuracy of the locations varied from the great precision of the GPS points to vague references to broad regions or even just the country. The spatial units for our analysis were UTM 50 × 50 km grid cells. Accordingly, we removed all type localities whose geographical position could not be located, at the very least, to this geographic accuracy. By doing so, we included 1050 species, which account for 80% of all Iberian endemic species. Of those, 94% consisted of only one type locality (sometimes more but located in a single grid cell), while the remaining 6% included two or more grid cells.

The endemic species distributional data were obtained from Anthos (www.anthos.es) and Flora-On (www.flora-on.pt) databases, which compiled over 60,000 unique records on UTM 10 × 10 km grid cells. The range size of the species was measured by the sum of 10 km grid cells in which the species occurs (ranging from 1 to 1050). All the species were classified into five range size categories by dividing the total sample into five equal-sized groups, i.e. very narrow (VN), narrow (N), medium (M), wide (W) and very wide (VW).

The life-forms were used as indicator of the species detectability as they are related to the body size and seasonality of plants. Categories were adapted from the Raunkiaer system (1934), i.e. phanerophytes (P), chamaephytes (C), hemicryptophytes (H), therophytes (T) and geophytes (G).

Taxa described over time and authors' contribution account

The number of total non-endemic native taxa and endemic taxa described per year from 1753 to 2017 were plotted in bar graphs and cumulative frequency polygons in order to compare the historical trends between both groups. Dates of publication were also grouped in 20 year periods for different taxa groups to make interpretation easier. The contribution of the most prolific authors and their main botanical works in terms of endemic taxa were accounted and depicted in time-line graphs. Tables including the first name initials and the dates of birth and death of all botanists cited in the text as well as the main authors of both endemic taxa and non-endemic taxa are provided in Table A1.1 (Appendix).

Statistical analyses

One-way analyses of variance (ANOVA) were conducted to explore whether significant differences existed on the mean description date for the different categories of range size and life-form.

A Correlation Analysis was carried out to examine the relationship among several spatial variables, i.e. the number of species described per area, observed richness and human influence. In particular, we used the number of total endemics type localities (TETL) per grid cell and two separated subsets for narrow endemics (NETL) and widespread endemics (WETL). Two different metrics of richness were used (see Chapter 2 for details). The endemic species richness (ESR) is the total number of endemics occurring within a 50 km grid cell; and the weighted endemism (WE), which takes species range restriction into account, is calculated by the sum of the inverse range sizes (i.e. 1/number of grid cells) of the total endemic species occurring in a grid cell (Crisp et al., 2001). The Global Human Influence Index (HII; Wildlife Conservation Society, 2005) was used to calculate the average degree of human impact in each 50 km grid cell. This index incorporates population density, land use and human accessibility variables, and even though it measures the current human influence we assumed that its spatial pattern has varied proportionally over the period of study. All cells of the Iberian Peninsula (excluding the Balearic Islands) containing at least one type locality (180) were included in the analysis.

Additionally, the number of type localities (TETL) was fitted by a Generalized Lineal Model (GLM) with Poisson error distribution and log-link function using the HII and the WE variables as predictors. Finally, we tested whether the description date of the species was related with the spatial human influence and observed richness through linear regression. We conducted all analyses using the R statistical software (www.R-project.org) with the associate package 'car' (Fox & Weisberg, 2019).

Results

Number of Iberian taxa described over time

An account of the described taxa per year from 1753 to 2017 was made for the 4534 non-endemic native taxa and for the 1823 endemic taxa. Large differences can be observed between the trends of both graphs (Fig. 1.1a,b). The cumulative species number of the non-endemic native taxa follows an approximate negative exponential distribution ($R^2 = 0.94$), while that of the endemics is better fitted to a linear model ($R^2 = 0.98$). About the 40% of the non-endemic native taxa were initially described in Linnaeus' *Species Plantarum* in 1753 –considered the starting point–. Most of the non-endemic native species were, in fact, described during the first stage, from the latter half of the 18th century to the early 19th. At the end of the 19th century more than 90% of the non-endemic native taxa were already described.

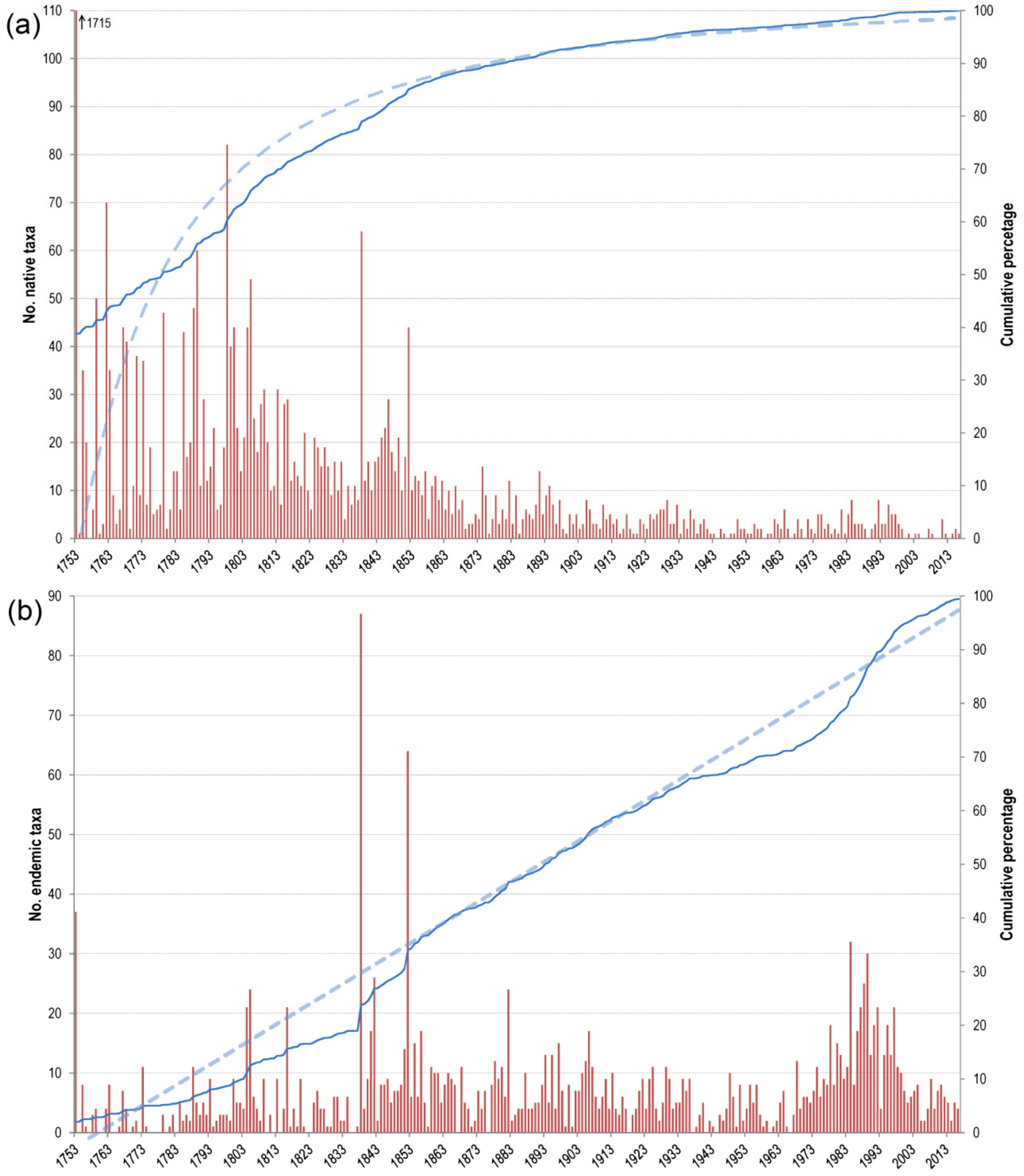

Fig. 1.1 Number of taxa described per year from 1753 to 2017 (red bars), cumulative percentage (blue line) and trend line (dashed line). (a) Iberian non-endemic native taxa (4534 taxa referred), the first column (year 1753) represents nearly 40% of the total and juts out from the graph; the best-fitting curve is a negative exponential distribution ($R^2 = 0.94$). (b) Iberian endemic taxa (1823 taxa referred); the best-fitting line is a linear model ($R^2 = 0.98$).

On the contrary, only 37 Iberian endemic taxa were included in Linnaeus' work of 1753 and very few were described in the following 50 years. It was not until the beginning of the 19th century that the Iberian endemic species description gained momentum. Two important peaks occurred in 1838 and in 1852 and more than 15% of the endemic taxa were described during this 15 year period (Fig. 1.1b). Likewise, these two dates were also meaningful in the description of the non-endemic native species. In the following years there was a relative steady increase and at the beginning of the 20th century over half of the endemics had already been described. However, the botanical activity in Iberia from 1936 to 1967 was very low and the rise of described taxa during that period was meager. In 1968 the endemics description started to increase progressively, reaching a maximum in the 1980s, but as early as the 21st century the activity descended again. In any event, the contribution was very significant in the last 35 years, in which 20% of the endemic taxa were described.

In regard to the taxonomic rank, few taxa currently accepted as subspecies were described in the early years; the ratio between taxa and species is in general greater for the periods as of 1876 (Fig. 1.2a). Similarly, the portion of described taxa belonging to 'apomictic' groups is much greater in later periods (from 1976 to 2017). They are mostly *Limonium* and *Alchemilla* species described at the end of the 20th century. The greatest number of endemic genera was also described in the period between 1816 and 1855 (Fig. 1.2b). Remarkably, four endemic genera (14% of the total) were discovered in the last period.

Main authors and botanical works

A total of 365 authors have contributed to the description of the currently accepted endemic taxa. However, the 42% have been described only by the 12 most prolific authors (Fig. 1.3a), most of whom lived in the 19th century. Whereas Linnaeus is the author of almost half (47%) of the non-endemic native species (Table A1.2 in Appendix), only 4.4% of the endemics are credited to him. The *loci classici* of the Linnean endemics were in general references to the country (*Hispania* or *Lusitania*) or at best to a broad region (e.g. *Habitat in Pyrenaeis*). In several cases they were wrongly indicated, like in most of the 11 Balearic endemics described by him. Thus, any type locality of the Linnean plants could be geolocated.

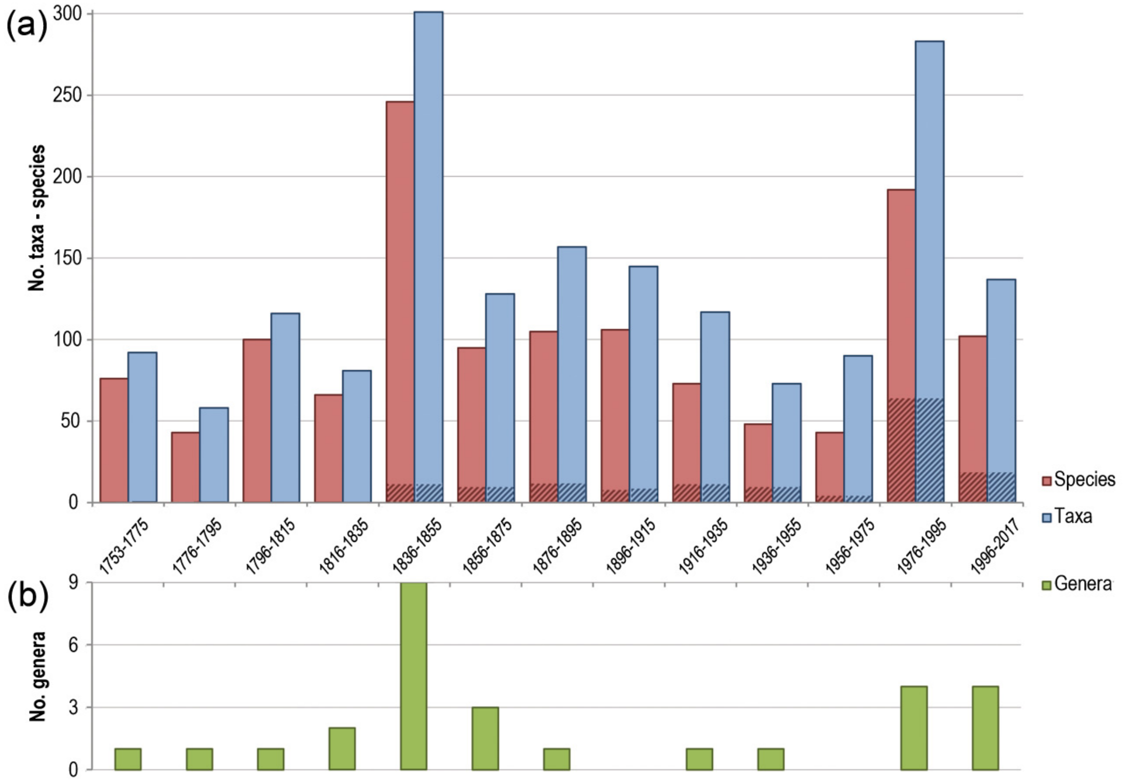

Fig. 1.2 (a) Number of endemic species and endemic taxa (1357 species and 1823 taxa in total) described for 20 year periods from 1753 to 2017; the shaded part is the portion corresponding to 'apomictic' groups. (b) Number of endemic genera (29 in total) described for 20 year periods.

During this first period Linnaeus was the only relevant contributor, but in the late 18th and early 19th century the Spanish Cavanilles and Lagasca described several new endemic species (1.6% and 2.4% of the total respectively; Table 1.1), mainly from central and eastern Spain (Fig. A1.1). In Portugal, the Portuguese Brotero published his *Flora lusitanica* (1804), while the German Hoffmannsegg and Link prepared the *Flore portugaise* (1809-1840). The endemics described by these three authors accounted for 3% of the total. By that time, the Genevan De Candolle prepared the third edition of the *Flore française* (1803-1815), which included several new Pyrenean endemics – accounted in the present work as Iberian endemics and representing c. 2%.

The 20-year period from 1836 to 1855 was the most fruitful of all times, when several prolific authors coincided in time (Fig. 1.3b). The Genevan Boissier was by far the most productive, who throughout his career described about 13% (170 species, 213 taxa) of the total Iberian endemics (Table 1.1). Reuter was co-author of 36% of these taxa. Boissier was particularly focused on the Baetic System (south of Spain; Fig. A1.1); from 1838 to 1852 he described in several works 100 Baetic endemic species (c. 40% of the total endemics of that region), 55 of which were only from Sierra Nevada. In the second half of the 19th century the Willkomm and Lange's *Prodromus* (1861-1880) had a relevant weight. In total, Willkomm described about 5% of total endemic taxa and Lange almost 3%.

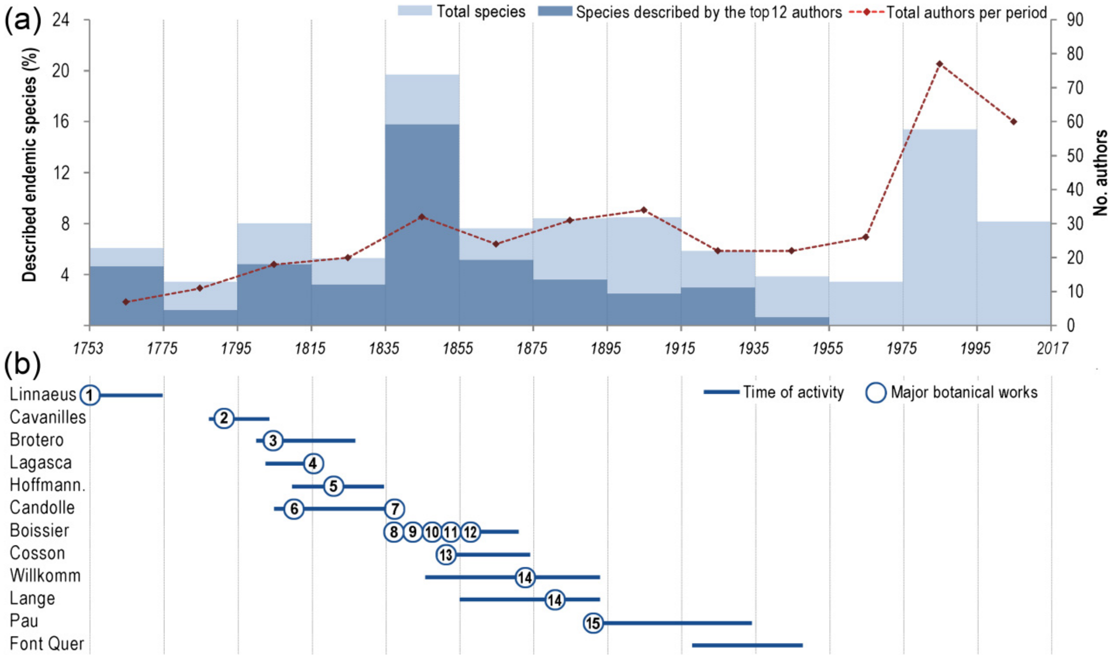

Fig. 1.3 (a) Percentage of the total endemics described per 20 year periods in pale blue bars, portion described by the 12 most prolific authors in dark blue bars (authors describing only 'apomictic' species not included), and number of total authors per period (red points). (b) Time-line showing the active period of the top 12 authors and their main works (abbreviated names in Table 1.1). The top 12 authors described 42% of all endemics.

Table 1.1 Endemic species and taxa described by the 12 most prolific authors (usual coauthors are in parentheses), portion of narrow endemics, percentage of the types self-collected and list of the main works (abbreviation follows IPNI; www.ipni.org)

Author	Species (taxa)	Narrow (%)	Types (%)	Main works
Linnaeus	58 (76)	5	0	**1.** L., Sp. Pl. (1753)
Cavanilles	20 (29)	5	75	**2.** Cav., Icon. (1791-1801)
Brotero	23 (26)	4	100	**3.** Brot., Fl. Lusit. (1804)
Lagasca	31 (35)	13	75	**4.** Lag., Elench. Pl. (1816)
Hoffmannsegg (Link)	18 (24)	16	100	**5.** Hoffmanns. & Link, Fl. Portug. (1809-1840)
De Candolle	39 (42)	19	25	**6.** Lam. & DC., Fl. Franç. ed. 3 (1805-1815) **7.** DC., Prodr. (1824-1839)
Boissier (Reuter)	170 (213)	34	70	**8.** Boiss., Elench. Pl. Nov. (1838) **9.** Boiss., Voy. Bot. Espagne (1839-1845) **10.** Boiss. & Reut., Diagn. Pl. Nov. Hisp. (1842) **11.** Boiss. & Reut., Pugill. Pl. Afr. Bor. Hispan. (1852) **12.** Boiss., Diagn. Pl. Orient. ser. 2 (1854-1859)
Cosson	18 (22)	28	0	**13.** Coss., Notes Pl. Crit. (1849-1852)
Willkomm	54 (89)	39	45	**14.** Willk. & Lange, Prodr. Fl. Hispan. (1861-1880)
Lange	40 (52)	27	46	**14.** Willk. & Lange, Prodr. Fl. Hispan. (1861-1880)
Pau	61 (87)	43	41	**15.** Pau, Not. Bot. Fl. Españ. (1887-1895)
Font Quer	23 (36)	56	60	

By the end of the century the number of authors increased slightly, the Spanish Pau being the largest contributor. During more than 40 years he published numerous species (4.6% of the total) in several papers. Font Quer also described several endemics (c. 2%) during the first third of the 20th century. After the works of these authors, it was not only towards the end of the 20th century that Iberian botany was back on track again. In the last two periods (1975 to 2017), the endemics were described by a much larger number of authors (Fig. 1.3a), generally specialized in certain groups, and published in periodical journals. Furthermore, in this last phase any single author described more than 20 endemic species, except those who worked with ‘apomictic’ groups.

About 50 percent of the types used by the top 12 authors to describe their taxa were on average collected by them. However there are great differences between authors (Table 1.1), whereas Linnaeus or Cosson did not collect any of their type species, others like Brotero allegedly collected all the plants he described.

Description date for range size and life-form categories

No statistically significant differences were found among means of description dates for the life-form categories (Fig. 1.4a). In contrast, significant differences were found between all the five range-size categories (Fig. 1.4b). Likewise, the description date was negatively correlated with the range size as continuous variable (R^2 = -0.52, p < 2e-16), indicating that recently described species are in general geographically restricted. Near 70% of all widespread species (W and VW) were described during the first century. The few endemics described in recent times within the categories W and VW generally came from the split of widely distributed species due to thorough taxonomic or phylogenetic studies or in few cases, from the assignment of new names to those badly applied. For instance, the name *Prolongoa pectinata* (L.) Boiss. was used for a widespread plant endemic to central Iberia, but López González & Jarvis (1984) demonstrated that its type material was another plant and consequently proposed a new name, *P. hispanica* G. López & C.E. Jarvis.

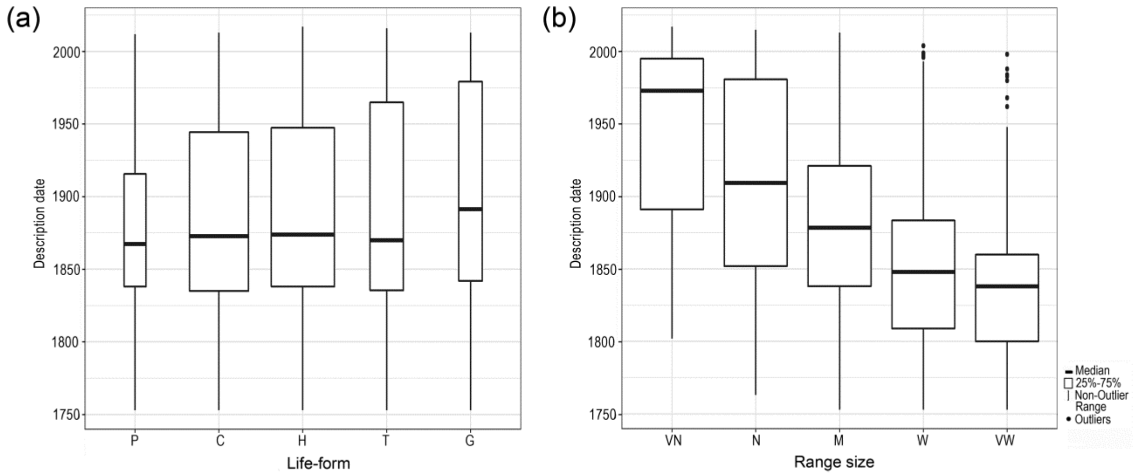

Fig. 1.4 (a) Mean description date for life-forms categories (phanerophytes, P; chamaephytes, C; hemicryptophytes, H; therophytes, T; geophytes, G); ANOVA test: $F = 0.87$, $p = 0.48$. (b) Mean description date for range size categories (very narrow, VN; narrow, N; medium, M; wide, W; very wide, VW); ANOVA test: $F = 104$, $p < 2e\text{-}16$; Tukey multiple comparisons were all significant ($p < 0.05$). The width of the box is proportional to the group size.

Spatial distribution of type localities and spatial average description date

The type localities were highly aggregated since the 50% were gathered on just 26 grid cells (10% of all grid cells). The highest number of *loci classici* was found in Sierra Nevada (Fig. 1.5, the circle exceeds the size of the cell), where nearly 90 endemic species were described, followed by western Mallorca with 33 type localities recorded. All the rest of Iberian grid cells contained less than 30 type localities.

As might be expected, both diversity metrics (ESR and WE) were correlated with the number of type localities per area (Table 1.2), however WE showed higher correlations with TETL and NETL and had no correlation with human influence (HII). Remarkably, HII was negatively correlated with the endemic species richness (ESR) but positively with the number of species described per area (TETL and particularly the subset of WETL). The proportion of deviance accounted by the model was 67% (Table 1.3). Although it had much less weight than WE, HII had a positive significant contribution to the model, indicating that many endemic species were described in species-rich areas, but also in populated and accessible localities. Results of models fitted for the subsets are not presented here, but the HII had higher influence on the description of the widespread endemics (WETL) while it had a weak but significant effect on the description of the narrow endemics (NETL).

Table 1.2 Correlation matrix of the spatial variables: human influence index (HII); weighted endemism (WE); endemic species richness (ESR); total endemics type localities (TETL); narrow endemics type localities (NETL); widespread endemics type localities (WETL). Significance in bold number; level of significance *p<.05 **p<.01 ***p<.001

	HII	WE	ESR	TETL	NETL	WETL
HII	1					
WE	-0.02	1				
ESR	**-0.24*****	**0.76*****	1			
TETL	**0.14***	**0.67*****	**0.55*****	1		
NETL	0.09	**0.66*****	**0.5*****	**0.89*****	1	
WETL	**0.23*****	**0.38*****	**0.45*****	**0.79*****	**0.48*****	1

Table 1.3 Results of the generalized lineal model (GLM) fitted to the total number of type localities (TETL). Adjusted D^2 value = 0.67. Level of significance *p<.05 **p<.01 ***p<.001

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.05772	0.09441	-0.611	0.541
Weighted endemism (WE)	0.68728	0.02566	26.783	<2e-16 ***
Human influence (HII)	0.19631	0.02724	7.207	5.71e-13***

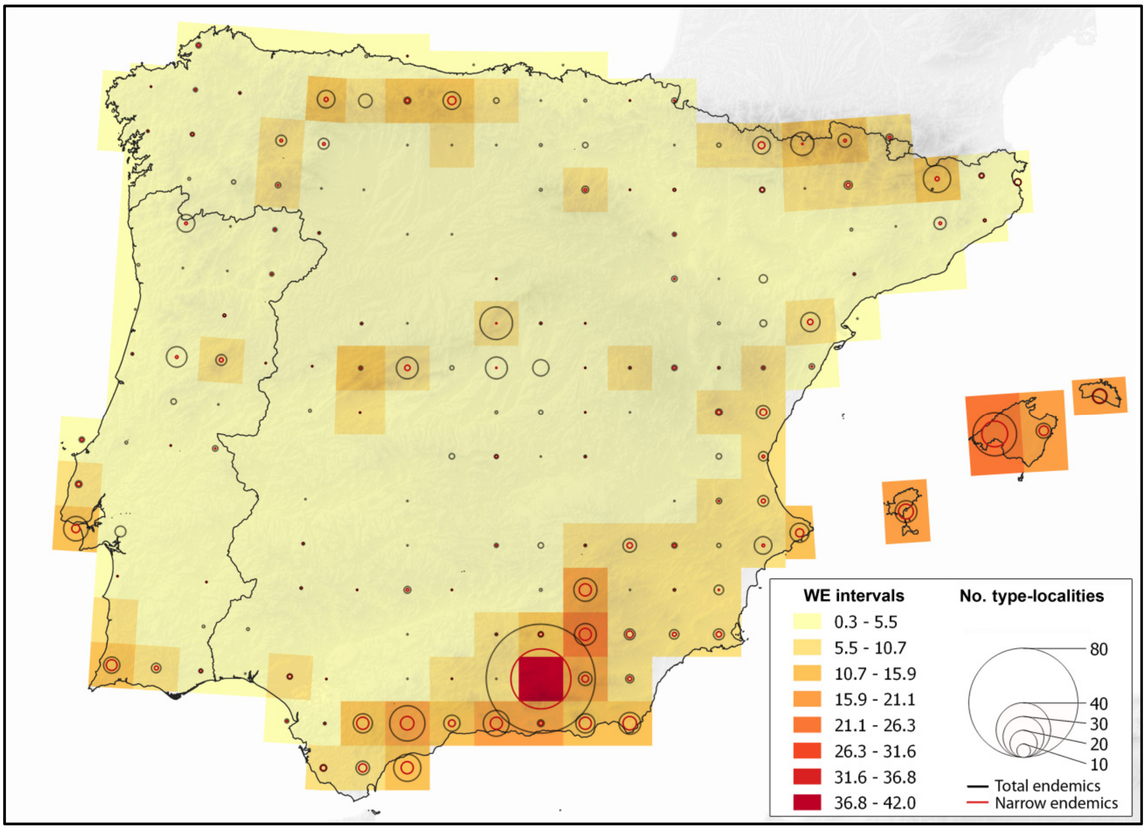

Fig. 1.5 Spatial distribution of type localities (black circles: total Iberian endemics described per grid cell; red inner circles: narrow endemics) and weighted endemism (WE; yellow-red color scale). 1130 type localities are included (80% of total endemic species). The circles exceed the size of the cell in Sierra Nevada (SE Iberia).

With regard to the spatial pattern of description date, any relation was found with the human influence (HII) and richness (ESR and WE) variables, either with the average description date per grid cell or at the single level of species description date. Only the number of species described over the last 50 years was positively correlated with WE ($R^2 = 0.63$, $p < 5e\text{-}12$), indicating that the species recently described were generally discovered in endemic-rich areas. In any event, a map showing the average description date per grid cell is presented for informative purposes (Fig. 1.6). The grid cells containing at least 9 type localities showed differences of up to 100 years on the average description date. The minor Balearic Islands and the Prebaetic Mountains had the highest average description dates, while Coimbra (Central Portugal) and Val d'Aran (Pyrenees) had the lowest ones.

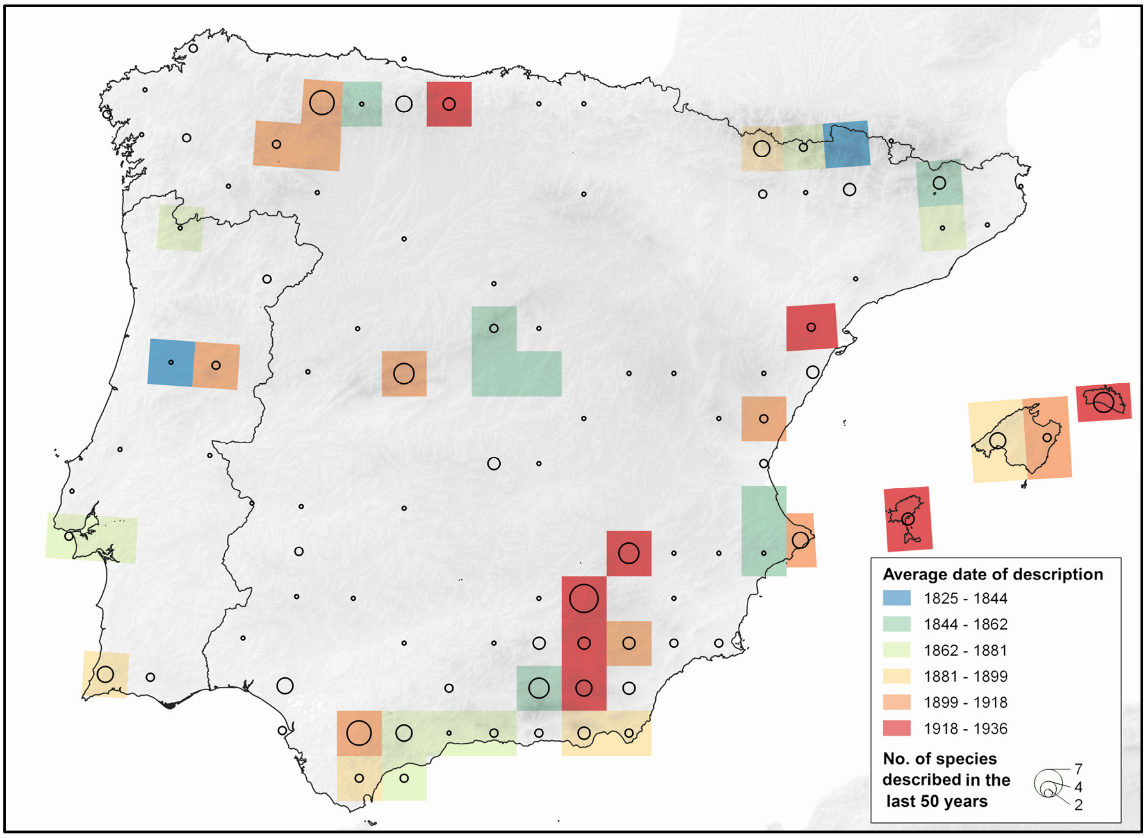

Fig. 1.6 Average description date in the grid cells containing ≥ 9 type localities (blue-red color scale) and number of endemics described in the last 50 years (circles). 'Apomictic' species are not included.

Discussion

Historical overview

Linnaeus only described 4.4% of all Iberian endemic species, and most of them are widespread plants. As noted by López González (1990), some of these were exclusively bibliographic references taken from some previous authors, particularly Clusius. In other cases, they were described based on herbarium specimens (e.g. Burser's herbarium) or cultivated plants (Botanical Gardens of Hartekamp and Uppsala) coming from material harvested during the voyages of Tournefort and Jussieu (conducted in 1687 and 1716 respectively) and labeled with the adjectives *lusitanica* or *hispanica*. Another important source of Iberian material was that provided by his botanical correspondents and the disciples who travelled to the Iberian Peninsula, Löfling being the most relevant.

The Iberian botany at Linnaeus' time was barely developed. In addition, the few Spanish botanists still followed Tournefort's system, as the creator of the Royal Botanic Garden of Madrid in 1755, Joseph Quer (Gómez Ortega, 1784; Aedo et al., 2017b). Cavanilles was the first director of such institution (from 1801) with a modern scientific training (López Piñero, 2004). He and his apprentice and successor Lagasca were the first Spanish authors to describe numerous Iberian endemic taxa (c. 4 % of the total), mainly from the outskirts of Madrid and eastern Iberia. However, their contribution was rather modest, partly because the former was more focused on describing plants from the New World and the latter was frustrated by the prevailing political situation (González Bueno & Rodríguez, 1996). By that time in Portugal, the botanical knowledge was considerably higher than in Spain since there were two precursory national floras (Brotero's and Hoffmannsegg and Link's). Similarly, the Pyrenean endemic flora was reasonably well known in the early 19th century due to the botanical activity carried out in France, particularly that of Lapeyrouse and De Candolle. This explains the earlier average description date of some of the grid cells included in this area (Fig. 1.6).

The scientific activity remained very low in Spain for much of the 19th century largely due to the social and political upheavals of the time. However, the taxonomy enjoyed a golden age in Europe (Endersby, 2010) and many European botanists were attracted by the highly diverse Iberian flora. There is no doubt that the most important was Boissier, whose explorations in the Baetic Mountains are the main cause of the first and most important peak (period from 1836 to 1855; Fig. 1.3) in the Iberian plants descriptions (20% of all endemics). Boissier travelled for the first time to southern Spain in 1837 and only one year after published most of the new plants collected there. Additionally, that same year De Candolle included in his *Prodromus* (vol. 7) several Compositae species collected by Boissier in the Baetic Mountains. As a result, 90 endemic taxa (c. 5% of the total) were published only in 1838, beating the discovered taxa per year record (Fig. 1.1b). Boissier and Reuter made two more extensive field trips to Spain and over the 25 subsequent years published numerous species from the Cantabrian Mountains, the Central System and especially the south of Iberia (Fig A1.1).

The Baetic Mountains are considered a regional hotspot within the Mediterranean Basin (Médail & Quézel, 1997) and particularly Sierra Nevada, where the highest number of Iberian endemics occurs (over 200 species). Boissier, encouraged by his mentor De Candolle (Gonzalez Bueno, 2010), wisely chose the Baetic region (including Sierra Nevada) when it broadly remained botanically unexplored. The great richness of an uncharted territory, together with the excellent botanical training of Boissier, his relations with local botanists and his frequent collaboration with Reuter, enabled the Genevan to get the most of his explorations and become the most prolific author of the Iberian endemic flora (13% of the total). Likewise, Boissier made a great contribution describing non-endemic species (c. 3% of the total; Table A1.2), mostly Ibero-African plants that only occur in southeastern Iberia within Europe.

In the second half of the 19th century Willkomm and Lange explored a large share of the territory (Fig. A1.1) and prepared the *Prodromus florae Hispanicae,* the first extensive flora of mainland Spain (incl. 5092 species) which also incorporated chorological notes for the Balearic Islands and Portugal. This was a great breakthrough that allowed the botanists at the time to detect undescribed species (Aedo et al., 2017a). After that (1880), over half of the endemic species were already known, and by that time the number of authors slightly increased, including some relevant as Rouy, Sampaio or Pau. This latter author conducted a major work in collecting and describing cryptic and rare species with the aim to fill the gaps of knowledge of the Iberian endemic flora. Font Quer followed Pau's task but regrettably his botanical projects were truncated as a result of the Spanish Civil War (Ibáñez Cortina, 2003). From 1936 to 1967 botanical activity was very low due to the economic and political situation and the rise of described taxa during that period was meager.

At the beginning of 1960s *Flora Europaea* (Tutin et al., 1964-1980) started to be published. Similar to the Willkomm and Lange's *prodromus,* this updated work allowed the easy identification of the plants but also the comparison with those that grew in neighboring countries. On the other hand the shortcomings inherent in all the syntheses showed up, which led to the publication of numerous new cryptic species. This was also a motivation to start the *Flora iberica* project in the early 1980s. Thus, in the late 20th century period (from 1975 to 1995) there was the second major peak in the Iberian endemic flora description (15% of the total). During this last stage, the endemic taxa were described by a much larger number of authors generally specialized in certain groups and derived in many cases from large taxonomic revisions.

The description process of the Iberian flora has been spatially and temporally uneven and mainly described by a few authors. About half of all endemics were described by 16 authors (less than 5% of all authors) and, in turn, almost half of the type specimens were on average self-collected by them. This agrees with the general pattern observed by Bebber et al. (2012), in which most type specimens of extensive floras were collected by a very small number of collectors.

On the contrary, a large share of the new Iberian taxa emerged from monographic studies was based on older herbarium specimens, which is also in line with the pattern observed by Bebber et al. (2010) and Cavallin et al. (2016).

Factors influencing description dates and type localities distribution

As found in previous studies (e.g. Gaston et al., 1995a; Blackburn & Gaston, 1995; Diniz-Filho et al., 2005; Cavallin et al., 2016), the description date for Iberian endemics is negatively correlated with the geographical range size. All these authors also found that smaller size taxa tend to be later described (both for animals and plants); however, we did not find any significant difference on the average year of description for the life-form categories. This result may suggest that detectability determined by the height and seasonality of the plants is not a constraining factor on plant discovery in the Mediterranean region, especially compared to tropical and subtropical ecosystems.

As in other papers (Peruzzi et al., 2015; Brundu et al., 2017) we detected a high correlation between the number of type localities and the observed richness, particularly with the weighted endemism (WE) metric, which takes into account the range restriction of the species. It is clear that the likelihood of describing a species within an area rich in narrow endemics is certainly high. Moreover, centers of endemism have been primary focuses for botanists, and many widespread endemics have also been described in local hotspots; for instance *Hypericum caprifolium* Boiss. and *Satureja intricate* Lange were described in Sierra Nevada. On the other hand, we also found a positive significant contribution of the human influence variable, indicating that many endemic species were described in populated and accessible areas. The surroundings of Madrid, Lisboa or Coimbra (location of the first Portuguese Botanical Garden) were the *loci classici* of many endemics (mostly widespread), some of them (e.g. *Cynara tournefortii* Boiss. & Reut. and *Onobrychis matritensis* Boiss. & Reut.) are currently extinct in their type localities. Likewise, the endemics restricted to a particular mountain range like the Pyrenees were generally first described from the most accessible part of it.

While type localities distribution was significantly biased by human influence, we found no positive correlation between the observed richness and the human influence (Table 1.2), suggesting that the available species distribution data for the Iberian territory has no ostensible bias at the spatial resolution used here. Therefore, caution is advised when using type localities distribution to assess the richness of a poor data region –even at large scales– or as a tool for conservation planning and resource management (e.g. Brundu et al., 2017).

Species accumulation and completion

Large differences were observed between the cumulative frequency of the non-endemic native taxa and the endemic taxa. Whereas the cumulative number of species for the first group followed a typical species discovery curve (Fisher et al., 1943) with a clear tendency to stabilize, that of the endemics was better adjusted to a lineal function. However, it is also true that the curve in the last 25 years trends to slow down (Fig. 1.1 b), suggesting that new species are becoming more and more difficult to find and the species description is reaching completion. Our study reveals that changes in discovery effort have been arbitrary and unpredictable and generally governed by historical events and botanical trends. Thus, as shown in previous works (Bebber et al., 2007b), the discovery curves are not reliable to estimate the total number of undescribed species or indicate the final approach to completeness in the case of the endemic Iberian flora.

A large share of the later described taxa consisted of cryptic taxa, i.e. distinct related taxa that were initially classified under one species name (Bickford et al., 2007). Thus, it is important to consider that the high number of discovered taxa in the late 20th century (second peak) could be partly attributable to a taxonomic inflation process (i.e. change in the species concept rather than new discoveries; Isaac et al., 2004). The implementation of analytical taxonomic treatments make the species continue to be described (Bebber et al., 2007b). The taxonomic criterion used in the present work is based mostly on *Flora iberica* (1983-2017), so many taxa described by the authors of that time are currently accepted. For instance, it is particularly remarkable the high number of *Limonium* and *Alchemilla* microspecies recognized at species level in *Flora iberica*.

Nonetheless, if asexual and taxonomically problematic species are excluded, the number of endemic species recently described is still rather high. More than 200 endemic species ('apomictic' excluded) have been described from 1975 to present and many of them were not related to any other. Remarkably, five rare species discovered in this last period could not be assigned to any known genus and were described as new endemic genera (i.e., *Gadoria* Güemes & Mota*, Rivasmartinezia* Fern. Prieto & Cires*, Pseudomisopates* Güemes and *Gyrocarium* Valdés). All this, suggests that there certainly remain several undiscovered species in the Iberian territory, as well as it highlights the importance of field work even in a well-explored territory like this. As in other studies (Schatz, 2002; Cavallin et al., (2016) we have found that the number of recently discovered species is spatially correlated with the richness of narrow endemics.

In this sense, the mountains in which numerous and later described narrow endemics occur, such as some parts of the Baetic and Cantabrian mountains, are particularly likely to harbor undescribed rare species.

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Appendix Chapter 1

Table A1.1 Dates of birth and death of all botanists and plant collectors cited in the text in alphabetical order.

Alströmer, C.	1736-1794	Lange, J.M.C.	1818-1898
Boissier, P.E.	1810-1885	Lapeyrouse, P.P.	1744-1818
Bory, J.-B.	1778-1846	Link, J.H.F.	1767-1851
Bourgeau, E.	1813 -1877	Linnaeus, C.	1707-1778
Brotero, F.A.	1744-1828	Löfling, P.	1729-1756
Burser, J.	1583-1639	Miller, P.	1691-1771
Cavanilles, A.J.	1745-1804	Pau, C.	1857-1937
Clusius, C.	1526-1609	Quer, J.	1695-1764
Cosson, E. S.-Ch.	1819-1889	Reuter, G.F.	1805-1872
De Candolle, A.P.	1778-1841	Rouy, G.	1851-1924
Font Quer, P.	1888-1964	Sampaio, G.A.	1865-1937
Hoffmannsegg, J.C.	1888-1964	Tournefort, J.P.	1656-1708
Jussieu, A.	1686-1758	Webb, P.B.	1793-1854
Lagasca, M.	1776-1839	Willdenow, C.L.	1765-1812
Lamarck, J.-B.	1744-1829	Willkomm, H.M	1821-1895

Table A1.2 Main authors of the non-endemic native Iberian taxa on the left and main authors of the endemic taxa on the right. The names in parentheses are usual coauthors. The numbers in italics are taxa that exclusively belong to ‘apomictic’ groups.

Authors (non-endemic)	Species (taxa)	Authors (endemic)	Species (taxa)
Linnaeus, C.	1962 (1971)	Boissier, P.E. (Reuter, G.F.)	170 (213)
Boissier, P.E.	114 (140)	Pau, C.	61 (87)
De Candolle, A.P.	92 (111)	Linnaeus, C.	58 (76)
Desfontaines, R.L.	81 (86)	Willkomm, H.M.	54 (89)
Lamarck, J.-B.	69 (76)	*Erben, M.*	*44 (44)*
Willdenow, C.L.	51 (59)	Lange, J.M.C.	40 (52)
Villars, D.	42 (46)	De Candolle, A.P.	39 (42)
Miller, P.	40 (42)	Lagasca, M.	31 (35)
Allioni, C.	38 (40)	*Fröhner, S.E.*	*25 (25)*
Cavanilles, A.J.	35 (40)	Font Quer, P.	23 (36)
Poiret, J.L.M.	35 (37)	Brotero, F.A.	23 (26)
Brotero, F.A.	33 (36)	Cavanilles, A.J.	20 (29)
Gouan, A.	33 (37)	Hoffmannsegg, J.C. (Link, J.H.F.)	18 (24)
Hudson, W.	30 (30)	Cosson, E.S.-Ch.	18 (22)
Gussone, G.	29 (34)	Talavera, S.	16 (22)
Pourret, P.A.	29 (29)	Sennen, Fr.	15 (26)
Jacquin, N.J.	28 (30)	Rothmaler, W.H.P.	14 (17)
Lagasca, M.	25 (29)	Lapeyrouse, P.P.	12 (13)
Cosson, E.S.-Ch.	24 (28)	Rouy, G.	11 (20)
Jordan, A.	23 (35)	Sampaio, G.A.	9 (19)
Lapeyrouse, P.P.	23 (25)	Lamarck, J.-B.	9 (14)
Smith, J.E.	22 (26)	Webb, P.B.	9 (12)
Willkomm, H.M.	21 (35)	Coincy, A.H.	9 (10)
Lange, J.M.C.	21 (24)	López González, G.	8 (11)

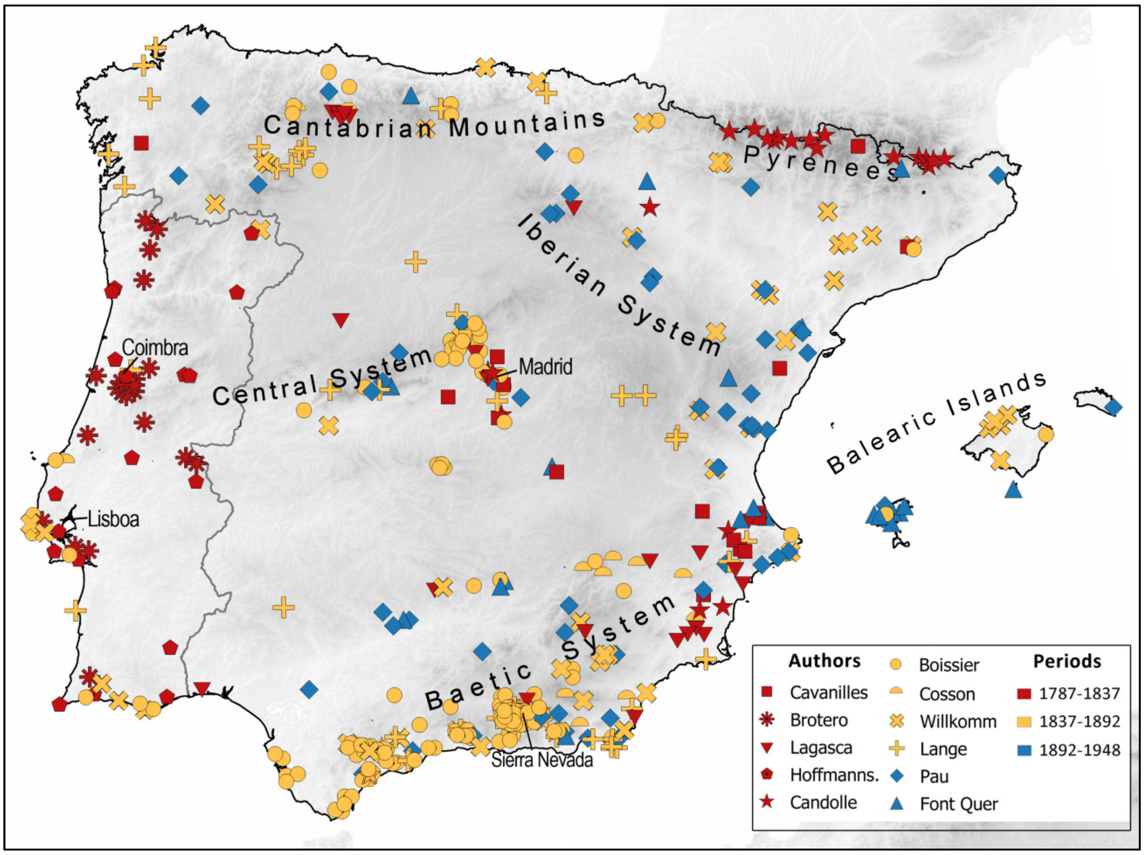

Fig. A1.1 Type localities of the endemic species described by the most prolific authors and main mountain ranges and other geographic locations cited in the text. Authors are represented by symbols and ages by colors.

Chapter 2

Taxonomic composition and geographical patterns of richness

This chapter is partly published in Buira, A., Aedo, C. & Medina, L. (2017). Spatial patterns of the Iberian and Balearic endemic vascular flora. Biodiversity and Conservation, 26, 479-508.

Abstract

The Iberian Peninsula is one the most plant species-rich regions within the Mediterranean Basin Hotspot. Here, we present an updated list of all vascular plant taxa endemic to the Iberian Peninsula and Balearic Islands, analyze its taxonomic composition and explore the spatial pattern of richness using several diversity metrics (i.e. endemic richness, weighted endemism and corrected weighted endemism) at different spatial scales. The Iberian flora consists of 1357 endemic species (1823 taxa; 24% of endemism), which are largely represented by species-rich Mediterranean genera, including *Limonium, Centaurea, Armeria, Teucrium* and *Linaria*. High endemic richness occurs in the main mountain ranges, the Baetic System being by far the richest region of the studied territory. Some coastal areas in southern Iberia and particularly in the Balearic Islands are also rich in range-restricted endemics. The high rate of narrow endemic species in the Baetic System compared to other Iberian mountain ranges can be explained by a complex interaction of environmental factors and historical causes. Measures of diversity are affected by sampling effort, particularly at finer resolution, but it does not obscure the spatial patterns of richness. Metrics weighting species range restriction appears to be useful for identifying areas of significantly high endemism that warrant special care for the conservation.

Introduction

The Iberian Peninsula, in the western Mediterranean, accounts for almost a quarter of the area of the Mediterranean Basin biodiversity hotspot (Myers et al., 2000), and it is one of the two most plant species-rich areas of the region (together with the Anatolian

Peninsula in the East; Médail & Quézel, 1997). Its geographical position, between Africa and Eurasia, as well as its relative isolation, make its flora very diverse and original. In addition, the remarkable plant biodiversity and endemism of the Iberian Peninsula are attributable to its varied climate conditions and topography and the complex historical processes (e.g. Messinian salinity crisis and Milankovitch climate oscillations) that took place in the Mediterranean Basin (Thompson, 2005).

The Quaternary glacial episodes, which were responsible for the recent floristic impoverishment in Central Europe, had less effect in the Iberian Peninsula, enabling many taxa to seek refuge there (Hewitt, 1999; Domínguez-Lozano et al., 2000). By providing suitable habitats during adverse climatic periods, the Iberian refugia areas would have limited species extinction as well as favoring the emergence of new taxa (Hungerer & Kadereit, 1998; Médail & Diadema, 2009). In particular, the Balearic Islands and the Baetic System have been recognized as regional hotspots (Médail & Quézel, 1997) due to their high levels of plant endemism. The Baetic System is characterized by a strong environmental heterogeneity (Mota et al., 2002) and, in addition, has had intermittent connection over geological time with the African tectonic plate (Rosenbaum et al., 2002), which have triggered the spatial divergence and local speciation of several plant lineages (Lavergne et al., 2013; Molina-Venegas et al., 2015).

The Iberian and Balearic endemic flora has been the subject of several chorological studies. The first complete synthesis of the dicotyledonous endemic taxa was developed by Sainz-Ollero & Hernández-Bermejo (1981), whereas Moreno-Saiz & Sainz-Ollero (1992) later compiled the monocotyledonous endemic taxa. These authors estimated that about 1500 taxa are endemic to this territory (Sainz-Ollero & Moreno-Saiz, 2002; see also Médail & Quézel, 1997). Likewise, other works focused on identifying the areas rich in range-restricted species (e.g. Domínguez-Lozano et al., 2000; Gómez-Campo et al., 1984). However, neither a complete Iberian flora nor extensive distributional data at fine spatial resolution were available when these studies were carried out.

Fortunately, the *Flora iberica* project (Castroviejo, 1986-2019) has made considerable progress in recent years and it is almost finished. Similarly, the available distributional data are becoming huge over the past few years thanks to ongoing digitization of bibliographic sources and revised herbarium specimens. Thus, the Anthos (Spain) and Flora-On (Portugal) databases compile together more than 1.6 million occurrence records. The availability of extensive and accurate data on plant species distribution enables us to explore the spatial patterns of endemism and locate the main centers of endemism (i.e. areas rich in range-restricted species; Linder, 2001), which is a basic objective for a practical conservation policy (Moreno-Saiz et al., 1998).

Considering endemics as taxa restricted to a particular region of any size, spatial endemic richness can be measured by dividing the study area into portions, usually grid cells, and summing the total endemic species occurring in a given grid cell. The weighted endemism (WE) is a more precise measurement that takes into account species range restriction (Crisp et al., 2001; Linder, 2001; Laffan & Crisp, 2003). These metrics can be affected by underestimated species ranges and by the incomplete sampling of grid cells and (Baldwin et al., 2017). Data bias is presumably more apparent at finer resolution, so it is important to know how diversity metrics vary when different spatial resolutions are used, and the extent to which they are affected by the sampling intensity.

Here we draw up a list of the Iberian and Balearic endemic flora, based primarily on *Flora iberica* and updated with new taxa published subsequently, and check distributional data of all species to (i) analyze the taxonomic composition of the Iberian endemic flora within the Mediterranean context; (ii) explore the spatial patterns of endemic richness using different diversity metrics; and (iii) examine the effects of spatial scale and sampling intensity on the resulting endemism patterns.

Materials and methods

Study area

The study area (Fig. 2.1) comprises the Iberian Peninsula (continental Spain and Portugal and Andorra), the whole Pyrenees mountain range (including the northern side, located in southern France), and the Balearic Islands, which are a continuation of the Baetic System (southeastern Iberian Peninsula). The flora of this area is hereinafter referred to as Iberian flora.

The total extent of the study area is 598,830 km^2. It is separated from northwest Africa by the Strait of Gibraltar and relatively well isolated from the rest of the European continent by the Pyrenees.

The main mountain ranges are the Pyrenees, which reach 3404 m a.s.l., the Cantabrian Mountains (2650 m), the Iberian System (2316 m), the Central System (2592 m) and the Baetic System, with the highest point of the study area located in the Sierra Nevada at 3478 m.

Fig. 2.1 Map of the Iberian Peninsula and the Balearic Islands showing the main geographic features. Color indicates the predominant lithology: soils developed on acidic, siliceous rocks (yellow-blue), and soils derived from calcareous, basic materials (orange-red). The black line indicates the limits of the study area.

Old siliceous materials of the Hercynian basement, such as plutonic (granites) and metamorphic rocks (gneiss, quartzite, slate and schist), emerge extensively in the western half of Iberia and in the core of major mountain ranges. Sedimentary materials such as limestones, marls and evaporites predominate in eastern mountain ranges and plateaus. These geological features determine a major lithological divide between western acidic and eastern basic substrates (Fig. 2.1). Two main bioclimatic regions have been distinguished.

The Eurosiberian region covers a narrow strip in the north and northwest, including the Pyrenees and the Cantabrian Range, with cool temperate and wet climate without a marked summer drought, while the rest of the Peninsula and the Balearic Islands are included within the Mediterranean region, with warm and dry summers and relatively cool and wet winters (Peinado & Rivas-Martínez, 1987).

Endemic species list and distributional data

We drew up an updated list (attached in Supplementary Material at the end of the thesis) of the species and subspecies endemic to the area of study, which was used as a basis of this work. The list was based mainly on *Flora iberica* (Castroviejo, 1986-2019), though it was updated with new taxa published subsequently and revised on the basis of more recent taxonomic monographs (the taxonomic source of each species is noted in the checklist). The list was also contrasted with the latest published floras from the neighboring countries (i.e. Fennane et al., 1999-2014 for Morocco; Tison et al., 2014 for France) to verify the species endemic status. Families follow the APG IV classification (Chase et al., 2016).

Distributional data were obtained from the Anthos (www.anthos.es) and Flora-On (www.flora-on.pt) databases, which together compiled more than 1.6 million occurrence records (including all native and alien species and duplicate records at a site) from bibliography, herbarium specimens and expert field observations. Endemic species consisted of about 60,000 unique records on UTM 10×10 km grid cells, which were used to calculate diversity metrics (see below). Additionally, data for the northern side of the Pyrenees were complemented using the Atlas of the Pyrenean Flora (www.florapyrenaea.com).

Although our list included both species and subspecies, we only used distributional data at species level because many occurrences did not specify the infraspecific level. For instance, the Iberian endemic species *Anchusa calcarea* consists of two subspecies (subsp. *calcarea* and subsp. *losadae*), but only a few records from Anthos (33%) specify the subspecies name. Thus, considering the subspecies level in our analyses would lead to the loss of many occurrence data.

Prior to analyzing, we examined the distributional accuracy of the records to identify potential outliers derived from positional errors or incorrect identification. We automatically removed all records whose geocodes were not within the Province indicated in the original source. Additionally, distributions of narrow endemic species were accurately revised on the basis of the chorological information of *Flora iberica* and the Spanish (e.g. Bañares et al., 2010) and Portuguese (www.listavermelha-flora.pt) Atlas and Red Lists of vascular endangered flora.

Diversity metrics and sampling intensity analyses

Analyses were carried out using UTM 10×10 km and 50×50 km grid cells. Only cells with at least 35% of their area not covered by seawater were considered. The shapes of some coastal 50×50 km cells were modified to avoid the loss of data. After excluding cells with no distributional data, the total extent consisted of 4440 and 255 cells at 10 and 50 km resolution, respectively.

Two diversity metrics, i.e. endemic species richness (ESR) and weighted endemism (WE) were calculated for each grid cell using both 10 km and 50 km spatial resolutions. ER is the total number of Iberian endemics occurring within a cell. WE takes range restriction into account and is calculated by the sum of the inverse range sizes (i.e. 1/number of grid cells) of the total endemic species occurring in a grid cell (Crisp et al., 2001). Additionally, corrected weighted endemism (CWE; i.e. WE/ESR) and endemic genera richness (EGR) were calculated at 50 km resolution. All metrics were plotted using equal intervals in QGIS 3.4.

Correlations between total occurrence records per grid cell and diversity metrics (ESR and WE) were explored at both spatial resolutions (10 km and 50 km) in order to assess the effect of sampling intensity.

Results

Overall taxa richness and endemism

According to our latest update (see checklist in Supplementary Material), the Iberian flora consisted of 1357 endemic species (24% of all native species) and 580 subspecies, representing 1823 endemic taxa (26% of all native taxa). They belonged to 352 genera and 67 families. Mainland Spain contained 87.3% of all Iberian endemic species. Only 65 endemic species (4.8%) were exclusive to Portugal and 103 (7.5%) to the Balearic Islands (Table 2.1). There are not endemic families, but 29 genera are endemic to the study area (Table A2.1 in Appendix; Fig. 2.2). All endemic genera are monospecific, except *Borderea* (2 species), *Endressia* (2), *Petrocoptis* (9) and *Rivasmartinezia* (2).

Table 2.1 Endemic species number of mainland Spain and Portugal, Balearic Islands and the whole territory of the Iberian flora. Percentages are calculated on the basis of the number of native species within each territory.

Territory	Native species	Iberian endemic species	Exclusive endemic species
Mainland Spain	5296	1160 (21.9%)	889 (16.8%)
Mainland Portugal	2449	336 (13.7%)	65 (2.7%)
Balearic Islands	1373	125 (9.1%)	103 (7.5%)
Iberian flora	5549	1357 (24%)	

Fig. 2.2 Species belonging to Iberian endemic genera: (a) *Boleum asperum*, (b) *Borderea chouardii*, (c) *Castrilanthemum debeauxii,* (d) *Euzomodendron bourgaeanum,* (e) *Gadoria falukei,* (f) *Gyrocaryum oppositifolium,* (g) *Hispidella hispanica,* (h) *Naufraga balearica,* (i) *Odontitella virgata,* (j) *Petrocoptis montsicciana,* (k) *Pterocephalidium diandrum,* (l) *Teesdaliopsis conferta.*

Composition by taxonomic groups

Eudicots comprised 89.7% of all endemic taxa and monocots 9.9%, while pteridophytes and gymnosperms were marginally represented (0.4%), including only seven and two endemic taxa respectively. The 10 largest families in terms of endemic species were the same as those of the total Iberian flora (they differ in the order; Fig. 2.3a) and comprised 75.1% of all endemics. The 30 most endemic species-rich genera accounted for 53% of all endemics (Fig. 2.3b). Asteraceae was the most species-rich family in the Iberian flora (15% of all endemics; Fig. 2.3a), *Centaurea* being the largest genus within the family (Fig. 2.3b). Plumbaginaceae, which in Iberia is composed almost exclusively of the genera *Armeria* and *Limonium,* was the second largest family in terms of endemic species. Two other families with high ratios of endemism were Lamiaceae and Plantaginaceae. Some genera belonging to these families, such as *Teucrium, Thymus, Sideritis, Linaria* and *Antirrhinum* consisted of many Iberian endemic species (Fig. 2.4). Some genera consisting of many Iberian native species (e.g. *Carex*: 92*, Trifolium*: 59*, Ononis*: 43 and *Vicia*: 41) barely contributed to the endemic species group. It should be noted that some large genera considered here such as *Limonium* and particularly *Alchemilla* have commonly apomictic reproduction, and consist of a large number of microspecies accepted in *Flora iberica.*

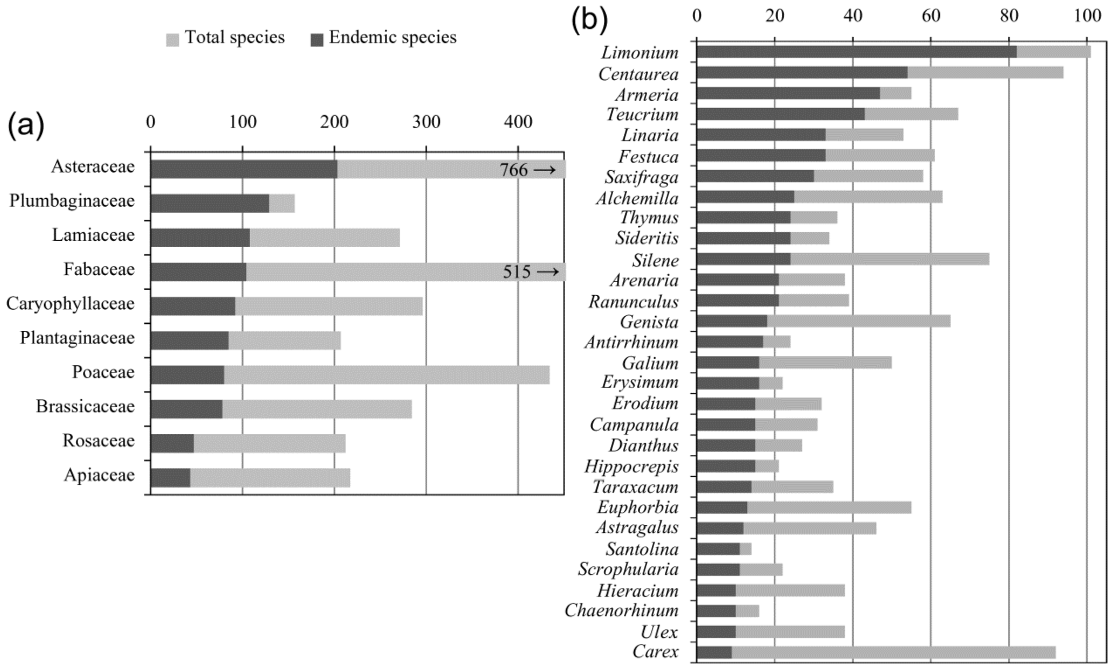

Fig. 2.3 (a) Number of native species and endemic species in the 10 largest families, accounting for 58% of all Iberian native flora and 75.1% of all Iberian endemic flora. (b) Number of native species and endemic species in the 30 largest genera of the Iberian endemic flora, accounting for 22% of all Iberian native flora and 53% of all Iberian endemic flora.

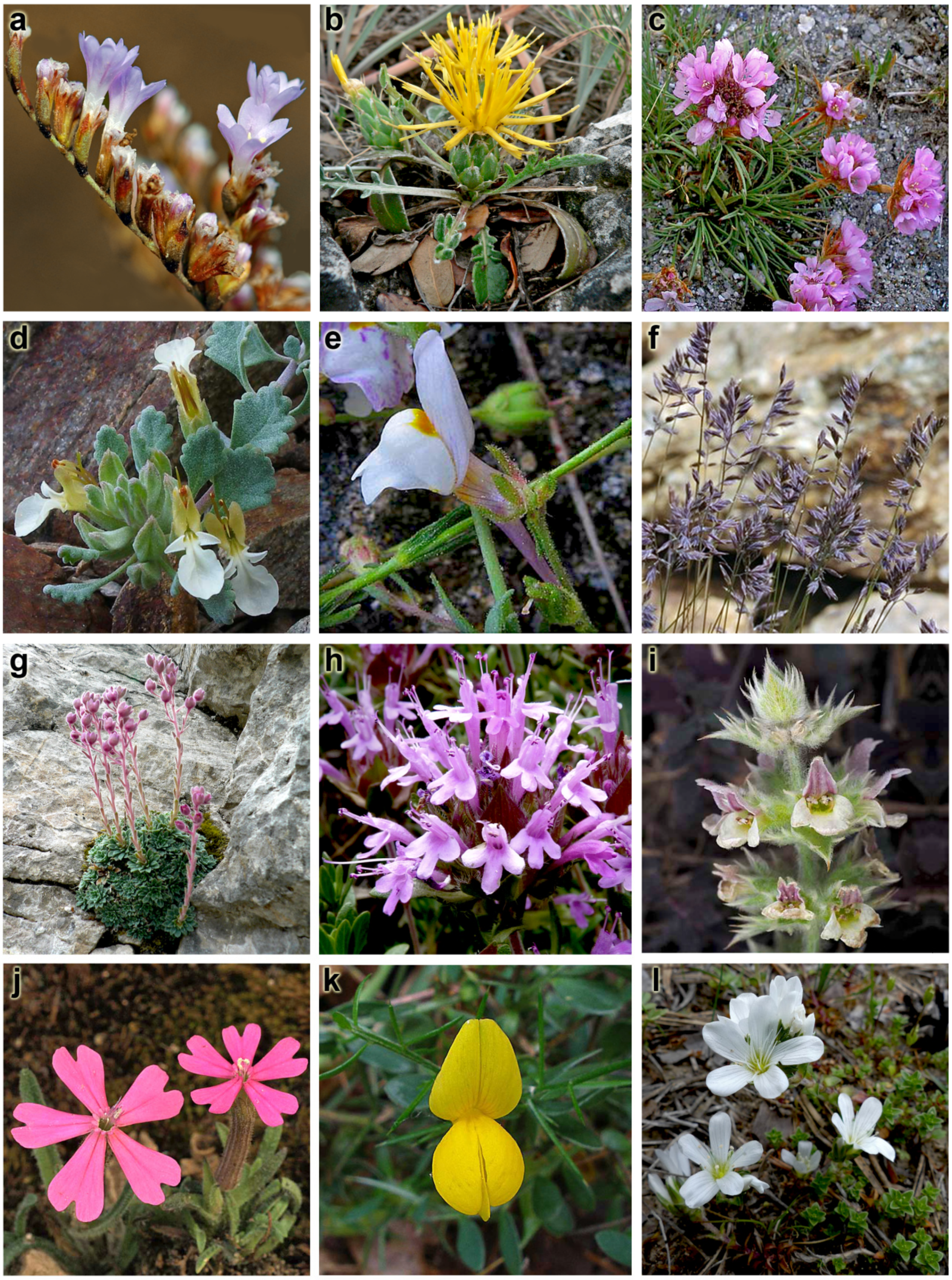

Fig. 2.4 Species belonging to the 12 largest genera of the Iberian endemic flora: (a) *Limonium angustebracteatum*, (b) *Centaurea podospermifolia*, (c) *Armeria humilis,* (d) *Teucrium freynii,* (e) *Linaria verticillata,* (f) *Festuca glacialis,* (g) *Saxifraga media,* (h) *Thymus granatensis,* (i) *Sideritis lasiantha,* (j) *Silene stockenii,* (k) *Genista falcata,* (l) *Arenaria vitoriana.*

Sampling intensity and spatial resolution

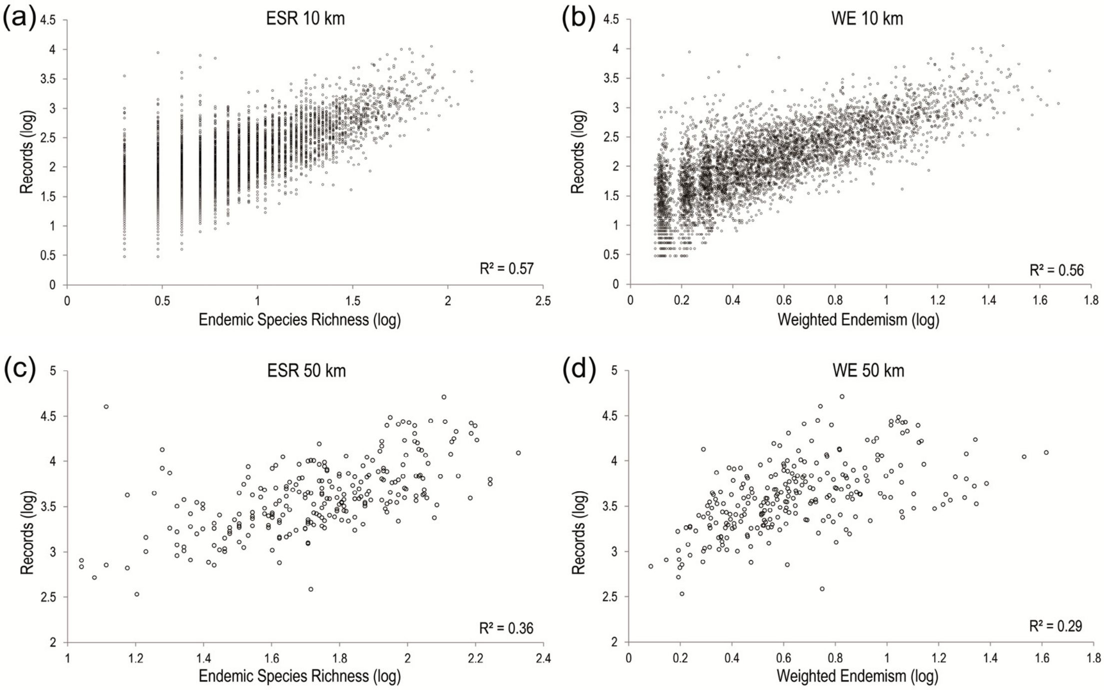

Fig. 2.5 Relationship between sampling intensity (total occurrence records per grid cell) and (a) endemic species richness at 10 km, (b) weighted endemism at 10 km, (c) endemic species richness at 50 km, (d) weighted endemism at 50 km. All values are log-transformed.

The total number of occurrence records per grid cell ranged from 1 to 11403 (median = 90) at 10 km resolution, and from 340 to 51159 (median = 3940) at 50 km resolution. Richness metrics (ESR and WE) were significantly correlated with the total occurrence records per grid cell at both spatial resolutions, indicating that the richest grid cells are also the most intensively sampled. However, correlations were much stronger at 10 km resolution (Fig. 2.5a,b) than at 50 km resolution (Fig. 2.5c,d). In particular WE at 50 km showed the lowest value ($R^2 = 0.29$; Fig. 2.5d), indicating that this is little affected by the sampling intensity.

Diversity metrics

The average range size of the Iberian endemic species was 13.2 grid cells at 50 km resolution and 41.4 grid cells at 10 km resolution. Nearly half of the endemics had a narrow range size, less than or equal to 5 grid cells at 50 km resolution (48% of all endemics) and less than or equal to 20 at 10 km resolution (52%). Conversely, a few endemics (e.g. *Thymus mastichina* or *Salix salviifolia*) occurred in more than half of the total 50 km grid cells.

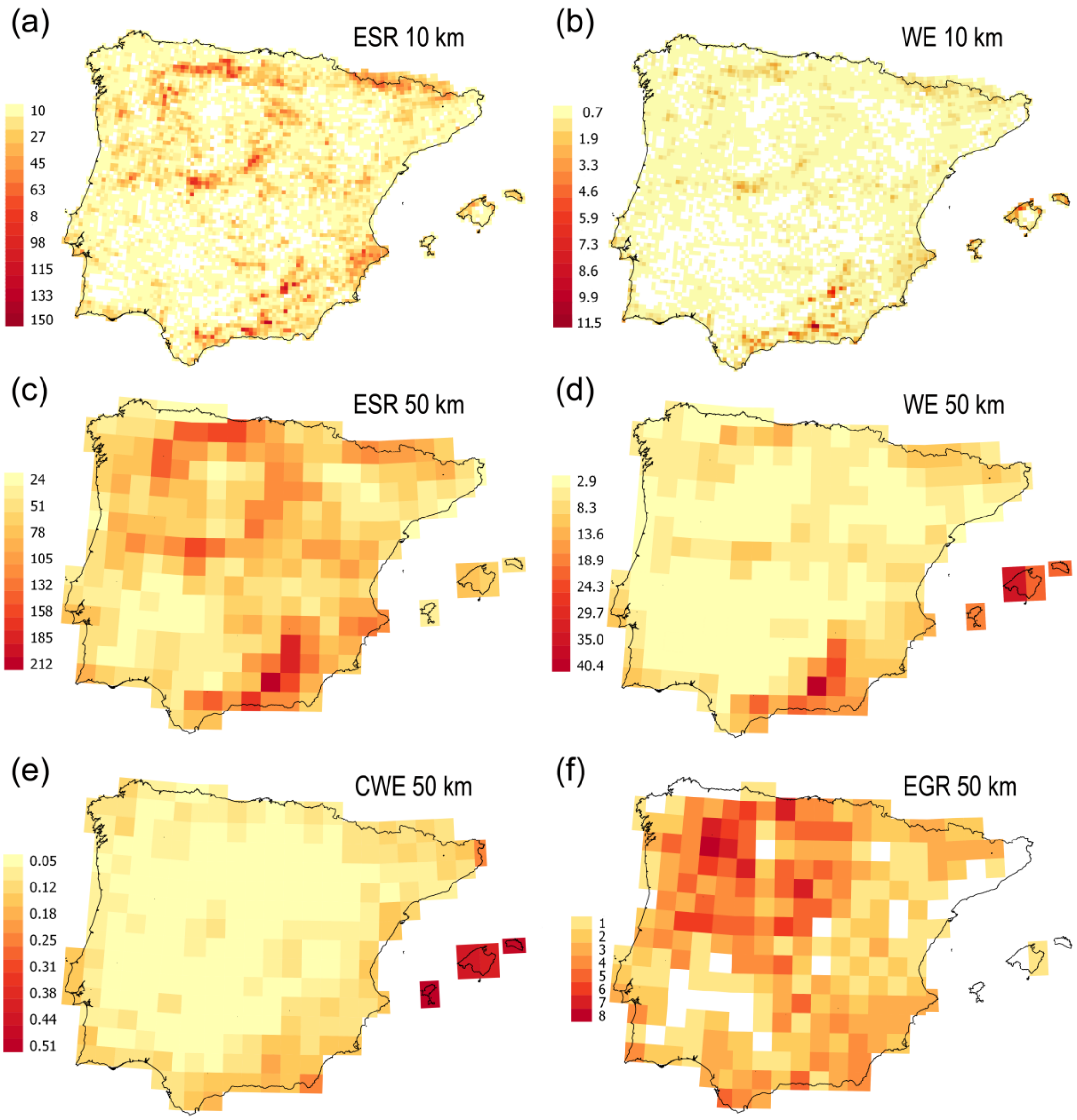

Fig. 2.6 Diversity metrics for the Iberian flora. (a) Spatial distribution of endemic species richness (ESR) at 10 km. (b) Spatial distribution of weighted endemism (WE) at 10 km. (c) Spatial distribution of endemic species richness (ESR) at 50 km. (d) Spatial distribution of weighted endemism (WE) at 50 km. (e) Spatial distribution of corrected weighted endemism (CWE) at 50 km. (f) Spatial distribution of endemic genera (EGR) at 50 km.

With regard to diversity metrics at 10 km resolution, endemic species richness (ESR) ranged from 1 to 150 (Fig. 2.6a) and weighted endemism (WE) ranged from 0.009 to 11.5 (Fig. 2.6b), while at 50 km resolution ESR ranged from 21 to 212 (Fig. 2.6c) and WE ranged from 0.22 to 40.4 (Fig. 2.6d). The maximum values were located in Sierra Nevada (southeast) in all cases.

At both spatial resolutions high ESR values occurred in the main mountain ranges, i.e. Pyrenees, Cantabrian Mountains, Central System and Baetic System (Fig. 2.6a,c). Moderately high values also occurred in some coastal areas of the southern half of Iberia. The 50 km grid cells located in Picos de Europa (Cantabrian Mountains), Gredos

(Central System) and Sierra de Almijara, Sierra Nevada and Sierra de Cazorla (Baetic System) had the greatest numbers of Iberian endemic species, with values over 155 per grid cell (Fig. 2.6c). The poorest 50 km grid cells were mainly located in extensive agricultural areas from the southwestern inner quadrant and the Ebro Depression, as well as in some northern coastal areas. Map of ESR at 10 km (Fig. 2.6a) partly reflected the heterogeneous sampling intensity across the territory; thus, in some well sampled areas (e.g. central Pyrenees and Alicante in northeastern Baetic System) values appeared to be spatially correlated, while in others (e.g. most Baetic System) values were very uneven.

Weighted endemism (WE) followed a quite different pattern (Fig. 2.6b,c), with high values occurring mostly in the Baetic System and the Balearic Islands. Nearly all endemics occurring in the Balearic Islands are exclusive to there, which significantly increased CWE (Fig. 2.6e). Conversely, CWE extremely decreased in cells where many widespread endemics occur such as in Central System and Cantabrian Mountains. Baetic Mountains showed high ESR and WE and medium CWE, indicating that large numbers of both range-restricted and widely distributed Iberian endemics occur there. WE and CWE were medium in some grid cells of the southeastern coast (e.g. Cabo de Gata) and southwestern coast (e.g. Algarve and Lisboa). The largest numbers of endemic genera (Fig. 2.6f) were not found in the most species-rich areas but were mostly gathered in the northwestern quadrant, León Mountains having the greatest number (8).

Discussion

Comparing richness and endemism in Mediterranean floras

There are several limitations when comparing total numbers and rates of endemism and weights of the major taxonomic groups among different floras. Some restrictions are shaped by the own geographic features such as the variation in size, the unlike proportion of insular territories and the lack of correspondence between the biogeographical and the political boundaries of the states (Gaston, 1996; Hobohm & Tucker, 2014). Other limitations are due to the disproportionate level of knowledge and the different taxonomic criteria applied, for instance whether or not the infraspecific taxa or the highly polymorphic groups (e.g. apomictic genera such as *Hieracium, Taraxacum, Alchemilla* and *Limonium*) are included (Médail & Quézel, 1997; Jeanmonod et al., 2015).

In any case, the high degree of originality of the Iberian flora (24% of endemism) is comparable to that of other countries in the Mediterranean Basin (Table A2.2 in Appendix). Although Greece is smaller than Iberia, it has a similar number of endemic species (1278) and rate of endemism (23.2%; Dimopoulos et al., 2013). The rates of endemism are somewhat lower in Italy (17.7%; adapted from Peruzzi et al., 2014) and Morocco (16.5%; adapted from Fennane & Ibn Tattou, 2008), while in Turkey endemism is significantly higher (30.9%; Davis et al., 1988). The rate of endemism of the Balearic Islands (7.5%) is also comparable to other Mediterranean Islands, such as Sardinia (6.9%; Bacchetta et al., 2012) and Corsica (5.5% or 8.9% considering Corsica and Sardinia together; Jeanmonod et al., 2015). The Iberian flora nevertheless has the highest number of endemic genera (29) of the five regions. As far as the flora of other Mediterranean-type biogeographic regions, California (1315 endemic species, 26.5% of endemism; Baldwin, 2012), is similar to the Iberian Peninsula; whereas southwestern Australia (3000 endemic species, 52% of endemism; Beard et al., 2000), and the Cape Floristic Region (6401 endemic species, 68% of endemism; Manning & Goldblatt, 2012), are much richer than any other region of the Mediterranean Basin.

With regard to the largest families of the five aforementioned Mediterranean endemic floras (Iberia, Morocco, Italy, Greece and Turkey), Asteraceae is the most species-rich family in all cases (Table A2.3), which is common for non-tropical regions (Goldblatt & Manning, 2002). Caryophyllaceae, Brassicaceae and Fabaceae are also among the 10 largest families in the five regions, while Lamiaceae, which includes many typically Mediterranean genera (e.g. *Teucrium* and *Thymus*), consists of many endemic species in all regions, except in Italy.

The largest genera vary greatly among the different endemic floras (Table A2.4) and only *Silene* and *Centaurea* rank in the top ten in the five regions. *Centaurea* is a paradigmatic Mediterranean genus (Hilpold et al., 2014) and is by far the largest contributor of endemics within the area (Table A2.4). Just as in Iberia, *Limonium* is the largest genus in the Italian and Greek floras (Table A2.4). Indeed, the coasts of central and western Mediterranean are one of the two main centers of diversity of *Limonium* (the other is located in the Asian steppes; Erben, 1993), though many described taxa are not truly sexual species (Lledó et al., 2005). Similarly, *Armeria* is a complex genus with extensive reticulate evolution (Fuertes-Aguilar & Nieto-Feliner, 2003) and has its major center of differentiation in Iberia, where over half of the total described *Armeria* species are found (Domina, 2011). Likewise, *Linaria* is much more diversified in the Iberian Peninsula, where the genus is known to have its main center of diversity (Thompson, 2005). The high similarity between Iberia and Morocco in terms of endemic species-rich genera (e.g. *Thymus, Teucrium, Sideritis, Linaria,* and *Centaurea*) reflects the floristic links between southern Iberia and northwest Africa due to past species migration across the Strait of Gibraltar (Valdés, 1991; Molina-Venegas et al., 2015).

Sampling bias and spatial resolution

We observed that both diversity metrics (SRE and WE) increased with sampling intensity, but, as might be expected, correlation was much stronger at finer spatial resolution (10 km). A significant proportion of 10 km grid cells of the study area are undersampled, since more than half of the total cells have less than 100 occurrence records. Even if large grid cells (50 km) have many more occurrence records and better represent the real richness values, broad patterns of endemic richness and weighted endemism across the territory are the same using both spatial resolutions (10 and 50 km). In any event, our results for diversity metrics are presented for all grid cells, but we only emphasize areas of high richness.

As stated by Baldwin et al. (2017), plant data collection is not random sampling but it is biased in several ways, including geographic focus on regions of high diversity and endemism and systematic effort in favor of collecting rare as opposed to common species (see also Boakes et al., 2010). It is true that poor sampled cells in the Iberian Peninsula usually contain only occurrence records of range-restricted taxa. Likewise, distributions of Iberian narrow endemics are tentatively well depicted at fine spatial resolutions due to efforts made for Atlas and Red Lists of vascular endangered flora (e.g. Bañares et al., 2010; www.listavermelha-flora.pt). Thus, although cells with low richness might be undersampled, they are unlikely to be unknown centers of endemism.

In any event, the systematic bias in plant data collections enhances the utility of distributional data for mapping endemic richness. In particular, weighted endemism metric (WE), which emphasizes range-restricted taxa and is buffered against poor sampling of any particular grid cell by considering species occurrences across all grid cells (Baldwin et al., 2017), appear to be suitable for identifying areas of remarkable high endemism. In contrast, corrected weighted endemism (CWE) can obscure richness patterns. High values can result in poor sampled cells in which only rare species have been recorded or in cells containing a few range-restricted endemics but very few widespread Iberian endemics (e.g. Cap de Creus in the northeastern tip; Fig. 2.6e). Conversely, very low CWE can result in rich cells containing many widespread endemics (e.g. Gredos in Central System).

Spatial patterns of richness across the study area

The Iberian endemic flora is characterized by a high proportion of range-restricted species (nearly half have narrow range size) and its richness is unevenly distributed across the territory. This is consistent with the pattern of plant richness in the Mediterranean Basin, which is distinguished by the high species turnover rate along sharp environmental gradients and the great richness in narrow endemic species (Thompson, 2005; Molina-Venegas et al., 2013). Our results also show that the highest endemic richness occur in the main mountain ranges, which is also in line with the premise that mountain areas are major centers of plant diversity and endemism in the mainland Mediterranean Basin (Médail & Quézel, 1997; Lobo et al., 2001).

On the one hand, allopatric speciation is boosted in mountain ranges due to orographic isolation (Favarger, 1972). On the other hand, geomorphological complexity provides a great diversity of environments (Jetz et al., 2004) that allows for the coexistence of species with disparate ecological requirements within a small area (Molina-Venegas et al., 2013). In particular, the harsh habitats with reduced aboveground competition (e.g. steep rock faces) are decisive for the local persistence of narrow-ranged endemic plants (Thompson et al., 2005; Lavergne et al., 2004). Perhaps more importantly, mountains have high levels of plant endemism because topography contributes to buffer the effects of climatic fluctuations by enabling species to survive through short-distance dispersal along altitudinal gradients or into more advantageous topographic positions (Ohlemüller et al., 2008; Dobrowski, 2011).

The highest values of weighted endemism are located in the Balearic Islands, which is logical given their isolated nature, and the Baetic System. The exceptional richness of narrow endemic species in the Baetic System compared to other Iberian mountain ranges can be explained by a complex interaction of environmental factors and historical causes (Molina-Venegas et al., 2013). The Baetic range is a discontinuous chain of mountains of recent origin (the uplift started around 8 Ma; Braga et al., 2003), whose massifs are distant and isolated by younger Miocene-Pliocene substrates (Domínguez-Lozano et al., 2000). It has a fragmented orography caused by the erosion of limestones and dolomites and contrasting soil conditions (including serpentines, dolomites, and gypsum) derived from outcrops of differing lithology (Mota et al., 2002; Cueto et al., 2014).

The diversification processes that lead to the current richness of endemic species in the Baetic Mountains were probably driven by geographical isolation and specialization to contrasting lithologies (Molina-Venegas et al., 2016; this issue is further developed in Chapter 4). On the other hand, extinction rates in the Baetic Mountains during the Pleistocene ice ages were almost certainly lower than in other Iberian mountain ranges given the lower latitude and the influence of the Atlantic Ocean and the Mediterranean Sea (Carrión et al., 2003; Médail & Diadema, 2009), combined with a wide altitudinal range (0 to >3000 m a.s.l.) enabling climate-driven range shifts. This amelioration of climatic oscillations was probably essential for the persistence of old lineages but especially for diversification of new ones (Harrison & Noss, 2017). In particular, the Sierra Nevada has the greatest level of endemism in the Iberian Peninsula, being home to over 200 Iberian endemics. This massif exhibits a wide variety of ecological conditions; it has the highest peak in Iberia (3482 m), contains five of the six bioclimatic belts identified for the Mediterranean (Blanca et al., 1998), and siliceous and calcareous-dolomitic rocks alternate (Mota et al., 2002). Moreover, the isolated high mountains of Sierra Nevada enabled the persistence and postglacial diversification of arctic-alpine lineages migrated from northern territories (Blanca et al., 1998; Kropf et al., 2006).

The mountains of the northwestern quadrant have also a rugged topography, including peaks over 2500 m, and contain a high number of endemic species, but narrow endemics are relatively scarce. This could be partially explained by the continuous and uniform siliceous lithology which has not promoted the differentiation by local edaphic specialization. On the other hand, Vargas & García (2003) have postulated that a high ratio of extinction/survival after Quaternary glacial episodes may have been, in part, responsible for a limited number of endemics and genetic differentiation in the Central System, in contrast with Baetic mountain ranges. Similarly, the Iberian System might have been severely affected by the glaciations due to its strong continental climate. In addition, its central location provides an incomplete isolation which could have facilitated the recurrent population contacts more than in other Iberian peripheral mountains.

The Pyrenees are moderately poorer in Iberian endemic species than other large mountain ranges. This can be partly explained due to its location on the border, which implies a higher level of connectivity with the mountains of southern France. Thus, although we have taken into account the endemics whose distributions reach the northern side of the Pyrenees, there are some Pyrenean range-restricted species that also occur in other mountains of southern France (e.g. Massif Central; Finnie et al., 2007), which are not considered in this study. However values of weighted endemism (Fig. 2.6b,d) are similar to those of the Cantabrian Mountains and Central System since many endemics occurring in the Pyrenees are exclusive to this mountain range.

Some coastal areas also have remarkable levels of endemism, especially in the Balearic Islands, but also in the southern Iberian coast. Indeed, the main centers of endemism in Portugal are found in the central and southern coastal regions, particularly the peninsulas of Sintra and Setúbal and the Algarve region gather large numbers of narrow endemics (Fig. 2.6d). The richness of these areas can be explained by their isolated climatic features, like those found in the wet and warm coastal mountains of Sintra and Monchique, the great diversity of habitats including extended coastal cliffs and sand plains, and the contrasting soil types derived from the calcareous outcrops of Setúbal and Algarve (Pereira et al., 2016). In the same vein, the regional climatic stability generated by the maritime influence has likely contributed to maintain and foster endemism in the Balearic Islands (Harrison & Noss, 2017).

Contrary to what would be expected, the largest numbers of endemic genera are not found in the Baetic System but in the northwestern mountains (up to 8 genera in the grid cell located in León Mountains; Fig. 2.6f). The systematically isolated taxa, such as paucispecific endemic genera, are potential candidates to be paleondemics, i.e. taxa of ancient origin whose current range is not necessarily the original one, but rather a relic area of a larger territory (Favarger & Contandriopoulos, 1961; Stebbins & Major, 1965). The presence of several endemic genera in the northwestern mountains suggests that this area could have served as refugium, enabling distinct lineages to persist through Tertiary and Quaternary climate fluctuations (Médail & Diadema (2009). However, phylogenetic studies are needed to demonstrate the veritable paleoendemic status of all these genera (but see Vargas et al., 2020).

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Appendix Chapter 2

Table A2.1 Endemic genera of the Iberian flora in alphabetical order. Abbreviations of range size are very narrow (VN), narrow (N), wide (W) and very wide (VW).

Genera	Family	Species (taxa)	Distribution	Range size
Avellara	Asteraceae	1	SW Peninsula	VN
Boleum	Brassicaceae	1	Ebro valley	N
Borderea	Dioscoriaceae	2	Pyrenees	N
Castrilanthemum	Asteraceae	1	N Baetic System	VN
Dethawia	Apiaceae	1(2)	Pyrenees and Cantabrian Range	VW
Distichoselinum	Apiaceae	1	S Peninsula	VW
Endressia	Apiaceae	2	N Peninsula	VW
Euzomodendron	Brassicaceae	1	SE Peninsula	N
Gadoria	Plantaginaceae	1	SE Baetic System	VN
Guillonea	Apiaceae	1(2)	E-SE Peninsula	VW
Guiraoa	Brassicaceae	1	SE Peninsula	W
Gyrocaryum	Boraginaceae	1	W Peninsula	VN
Hispidella	Asteraceae	1	NW Peninsula	VW
Hymenostemma	Asteraceae	1	S Peninsula	N
Lepidophorum	Asteraceae	1	W Peninsula	VW
Lycocarpus	Brassicaceae	1	SE Peninsula	W
**Naufraga*	Apiaceae	1	Mallorca	VN
Odontitella	Orobanchaceae	1	C-W Peninsula	VW
Ortegia	Caryophyllaceae	1	NW Peninsula	VW
Periballia	Poaceae	1	C-W Peninsula	VW
Petrocoptis	Caryophyllaceae	9(11)	Pyrenees and Cantabrian Range	VW
Phalacrocarpum	Asteraceae	1(3)	NW Peninsula	VW
Pseudomisopates	Plantaginaceae	1	Central System (Gredos)	VN
Prolongoa	Asteraceae	1	C-E Peninsula	VW
Pterocephalidium	Dipsacaceae	1	C-W Peninsula	VW
Rivasmartinezia	Apiaceae	2	W Cantabrian Range and N Baetic System	VN
Rothmaleria	Asteraceae	1	S Baetic System	N
Teesdaliopsis	Brassicaceae	1	NW Peninsula	W
Xatardia	Apiaceae	1	Pyrenees	N

*It was reported in Corsica in 1981, but became extinct shortly after (Fridlender, 2001)

Table A2.2 Comparison of species richness and endemism in the floras of the Iberian Peninsula, Morocco, Italy, Greece and Turkey. Sources: Morocco: Fennane & Ibn Tattou (2008); Italy: Conti et al. (2005), Peruzzi et al. (2014); Greece: Dimopoulos et al. (2013); Turkey: Davis et al. (1988).

	Iberia	Italy	Greece	Turkey	Morocco
Area (km^2)	588,824	301,338	131,957	783,562	446,550
Endemic genera	27	7	8	15	14
Total native species	5537	5935	5502	8575	3913
Endemic species	1328 (24%)	1050 (17.7%)	1278 (23.2%)	2651 (30.9%)	640 (16.4%)
No. of families	63	152	53	63	54
No. of genera	321	260	239	371	255
Species/genus	4.1	4	5.3	7.1	2.5

Table A2.3 Number of species for the 10 largest families of the endemic floras of the Iberian Peninsula, Italy, Turkey, Greece and Morocco. The 10 largest families of each flora are grey-shaded cells. Sources: Morocco: Fennane & Ibn Tattou (2008); Italy: Peruzzi et al. (2014); Greece: Dimopoulos et al. (2013); Turkey: Davis et al. (1988).

	Iberia	Morocco	Italy	Greece	Turkey
Asteraceae	203	131	221	204	430
Plumbaginaceae	129	15	100	86	21
Lamiaceae	108	80	20	68	240
Fabaceae	104	78	53	35	375
Caryophyllaceae	92	35	72	96	187
Plantaginaceae	108	22	23	10	34
Poaceae	80	35	40	19	50
Brassicaceae	78	42	47	68	194
Rosaceae	47	8	34	9	46
Apiaceae	43	30	24	52	117
Ranunculaceae	25	6	45	29	43
Boraginaceae	22	12	21	35	108
Rubiaceae	19	3	23	57	74
Campanulaceae	19	9	19	50	66
Amaryllidaceae	16	13	22	48	52
Orchidaceae	3	0	53	9	4
Scrophulariaceae	19	12	8	26	207

Table A2.4 Number of species for the 10 largest genera of the endemic flora of the Iberian Peninsula, Italy, Turkey, Greece and Morocco. The 10 largest genera of each flora are grey-shaded cells. Sources: Morocco: Fennane & Ibn Tattou (2005; 2009); Italy: Peruzzi et al. (2014); Greece: Dimopoulos et al. (2013); Turkey: Davis et al. (1988).

	Iberia	Morocco	Italy	Greece	Turkey
Limonium	82	11	89	79	7
Centaurea	58	16	49	59	109
Armeria	48	2	12	3	2
Teucrium	43	26	0	6	8
Linaria	34	10	6	0	4
Festuca	33	7	15	6	17
Saxifraga	30	8	10	1	1
Alchemilla	25	4	13	1	18
Thymus	24	9	2	8	20
Silene	24	22	22	42	52
Sideritis	24	10	0	4	31
Genista	19	3	24	4	4
Ranunculus	18	3	30	7	13
Galium	17	3	12	28	49
Campanula	15	9	16	50	53
Taraxacum	14	7	22	49	13
Astragalus	12	11	13	14	233
Hieracium	10	2	62	35	66
Verbascum	8	7	6	24	185
Allium	8	2	18	47	50
Ononis	4	15	2	1	3
Alyssum	2	4	2	17	53

Chapter 3

Exploring distributional patterns through regionalization

This chapter is partly published in Buira, A., Aedo, C. & Medina, L. (2017). Spatial patterns of the Iberian and Balearic endemic vascular flora. Biodiversity and Conservation, 26, 479-508.

Abstract

The vascular flora of the Iberian Peninsula is very rich in endemic species, but the contrasting soil and climate conditions together with historical causes make their distributions very uneven. Here, we use distributional data for the entire Iberian endemic flora and partitional clustering methods to define and characterize floristic regions and provide a more complete insight on the distributional pattern of plant endemism. We delineated a total of eleven regions, most of which were geographically and ecologically meaningful. The clusters including the Cantabrian Mountains, the Pyrenees, the Baetic System and the Balearic Islands had a high degree of compactness and a high ratio of diagnostic species and may thus be considered areas of endemism at large scale. We found varying patterns in the distribution of large taxonomic groups, the typically Mediterranean genera being more represented in the eastern calcareous regions. As previous regionalization, our classification reflects a primary longitudinal division between a basic eastern and an acidic western region, highlighting the importance of lithology in shaping the species composition in the Iberian Peninsula. Our regionalization also partly supports the traditional climatic division between Eurosiberian and Mediterranean regions.

Introduction

Exploring patterns of biodiversity has long been a primary objective of biogeographers and conservation planners. Biodiversity databases are becoming huge over the past few years, and the available species occurrence data enable us to examine the distributional pattern of plant endemism in several ways. A comprehensive analysis can be approached using regionalization techniques. Regionalization simplifies numerous and complex distribution data providing understandable and meaningful regions for spatial representation, historical and ecological interpretation and conservation planning (Bradshaw et al., 2015; Kreft & Jetz, 2010; Morrone, 2009).

An advantage of defining biogeographic areas using endemic taxa is that local endemics are more likely to be indicative of local contemporary and historical conditions and processes, as opposed to widespread, easily dispersed or adaptive taxa (Bradshaw et al., 2015). The areas of endemism are defined as regions which are not only rich in endemic species, but where endemics are mostly common to the whole area (Bradshaw et al., 2015; Linder, 2001; Morrone, 1994). Therefore, assuming a loose consensus (Aagesen et al., 2013), the biogeographic regions where the defining endemic species are not completely congruent but their distributions overlap in a large proportion may be recognized as areas of endemism.

Multiple proposals of phytogeographical regionalization have been done for the Iberian Peninsula using different techniques (i.e. clustering, parsimony analysis and expert knowledge), geographical grain and quality of data. They have been based on the distribution of different groups of plants: endemic dicotyledons (Sainz-Ollero & Hernández-Bermejo, 1985), endemic monocotyledons (Moreno-Saiz et al., 1998), a subset of the whole Iberian flora (Moreno-Saiz et al., 2013), pteridophytes (Moreno-Saiz & Lobo, 2008) and plant communities (Rivas-Martínez et al., 2002). However, so far any regionalization has used the entire Iberian and Balearic endemic flora with extensive distributional data.

The Iberian Peninsula and the Balearic Islands consist of 1357 endemic species, of which nearly half are narrow endemics. The territory has contrasting soil and climate conditions, with a major lithological divide between western acidic and eastern basic substrates and a major bioclimatic division between Eurosiberian region and Mediterranean region (Peinado & Rivas-Martínez, 1987). Thus, the Iberian Peninsula represents an ideal eco-historical setting to study the distributional pattern of plant endemism. Here, we draw on distributional data for the entire Iberian endemic flora, together with partitional clustering methods to (i) define floristic regions based on the endemic plant distributions; (ii) analyze the degree of compactness of the resulting regions and (iii); compare their species richness, endemism and taxonomic composition.

Materials and methods

Study area

The study area comprises the Iberian Peninsula (continental Spain and Portugal and Andorra), the whole Pyrenees mountain range (including the northern side, located in southern France), and the Balearic Islands (Fig. 2.1). See *Study area* in Chapter 2 for further detail about geology and climate.

Endemic species list and distributional data

We used as a basis of this study an updated list (attached in Supplementary Material) that includes all vascular plant species endemic to the study area (see Fig. 2.1). This list was based primarily on *Flora iberica* (Castroviejo, 1986-2019), and it was updated with new taxa published subsequently and revised on the basis of more recent taxonomic monographs.

Distributional data were obtained from the Anthos (www.anthos.es), Flora-On (www.flora-on.pt) and Atlas of the Pyrenean Flora (www.florapyrenaea.com) databases, which compiled over 60,000 unique records on UTM 10×10 km grid cells for the target species. Several steps of data quality checking were conducted to remove potential errors (see Chapter 2 for details).

All analyses were carried out using UTM 50×50 km grid cells. The shapes of a few coastal cells were slightly modified to avoid the loss of data. The total extent consisted of 255 cells.

Clustering analysis and diagnostic species

There are several clustering methods to define biogeographic areas. In particular, the *k*-means clustering has been widely used in biogeographical regionalization (e.g. Foukal & Thomas, 2014; Rueda et al., 2010; Heikinheimo et al., 2007; Valdés et al., 2006). This clustering method aims to provide a classification of objects (grid cells) into *k* clusters in which each object belongs to the cluster with the nearest centroid, serving as a prototype of the cluster. This partitioning technique has the advantage of avoiding the use of subjective phenon lines (Sneath & Sokal, 1973), but it requires the user to specify the number of *k* clusters. We conducted a *k*-means partitioning analysis based on the presence/absence data of the endemic species and the number of *k* clusters was determined using the average silhouette of the data. Silhouette analysis (Rousseeuw, 1987) is a non-parametric method of interpretation and validation of consistency within clusters. For each object, it compares the distance to the centroid of the cluster where it belongs with the distance to the nearest centroid, among all others. A silhouette close to 1 implies the datum is in an appropriate cluster, while a silhouette close to -1 implies the datum is in the wrong cluster.

To perform *k*-means analysis we used the R package *vegclust* (De Cáceres, 2010) that allows working with distance matrices. The distance matrix was previously built using the coefficient of dissimilarity derived from Sørensen's measure. This coefficient weights matches in species composition between the two samples more heavily than mismatches. This weighting is desirable when some species have been omitted in the sample because of the lack of sampling (Krebs, 1999).

The fidelity statistics, which measure whether the distributions of the species are restricted to the regions, can additionally be used as a measure of compactness of clusters (e.g. Valdés et al., 2006). We determined the diagnostic species of each cluster using the statistical phi-fidelity (Sokal & Rohlf, 1995), which is not affected by the size of the data set (Chytrý et al., 2002). The phi-coefficients were calculated with the R package *indicspecies* (v1.7.6; De Cáceres & Legendre, 2009). The coefficients range from -1 to 1, where 1 indicates the presence of a species in all grid cells of a cluster (region) and the absence in all others, and -1 indicates presence in all the cells except in the analyzed cluster. We considered as diagnostic species of a given cluster all those species with phi-values ≥ 0.3 and calculated their percentage in relation to the total Iberian endemics occurring within each cluster. All species with a negative phi-value in a given cluster were considered as occasional. The species occurring in just one grid cell always had positive phi-values. The degree of fidelity of each Iberian endemic taxon to the regions is included in the Supplementary Material.

Richness and taxonomic composition of the regions

We calculated the total number of native species and Iberian endemics occurring within each region, as well as the ratio of narrow endemics. The threshold to establish the status of narrow endemic was set at five grid cells, as from that point, the distribution data showed a natural rupture (see Fig. A3.1 in Appendix). A total of 649 species (48% of all Iberian endemics) were considered as narrow endemics. Additionally, we calculated the average range size in grid cells of the species occurring within each region.

On the other hand, we calculated the number of endemic species belonging to the 12 most species-rich genera of the Iberian endemic flora (see Chapter 1) that occurred within each region. These genera account for the 34% of all Iberian endemics.

Results

Clustering analysis

The overall mean silhouette coefficient had similar values from $k = 9$ to $k = 20$, but the maximum values were obtained for $k = 11$ and $k = 18$ (see Fig. A3.2 in Appendix). Considering that the minimum group silhouette for $k = 18$ was very small, we chose $k = 11$ to set the partition.

The 11 regions that resulted from the clustering analysis were generally well defined by natural geographic features (Table 3.1; Fig. 3.1a). Most of the main Iberian mountain ranges were included within different clusters, with only few exceptions. The northern part of the Iberian System was clustered with the Cantabrian Mountains, shaping the CM region. On the other hand, IS included most of the remaining Iberian System plus some adjacent areas of the Northern Plateau and the Southern Plateau, and made up one of the biggest clusters obtained in the analysis (41 grid cells). The northwestern mountains (NWM) and the southwestern quadrant (SWQ) were also very large and almost covered all the western half of Iberia.

The dendrogram of the inter-cluster distances (Fig. 3.2b) revealed two main groups, one formed by the western units (SWQ, SWC, NWM and NWC), and the other by the eastern ones (IS, CRE, SEC and BS). The two northern clusters PYR and CM were relatively close to each other but also linked with their contiguous clusters, especially CM was very close to IS (Table 3.2). IS had the lowest average inter-cluster distance, whereas BI was well separated from all the groups (Table 3.2).

Table 3.1 Geographical description of the 11 regions resulted from the clustering analysis

Region	Description
BI	Balearic Islands
BS	Baetic System
CM	Cantabrian Mountains and northern Iberian System (Sierras de Demanda, Urbión and Cebollera)
CRE	Catalan Coastal Range and Ebro Depression
IS	Iberian System (excluding the north) and partial areas of Southern Plateau and Northern Plateau
NWC	Northwestern Atlantic coast and Galician Massif
NWM	Northwestern mountains, incl. Central System, León Mountains and Northern Portuguese mountains
PYR	Pyrenees
SEC	Southeastern Mediterranean coast and north-eastern Prebaetic System
SWC	Southwestern Atlantic coast and lowland inland areas (mainly Alentejo Region)
SWQ	South-western inner quadrant, incl. Montes de Toledo, Sierra Morena, Guadiana and Guadalquivir basins

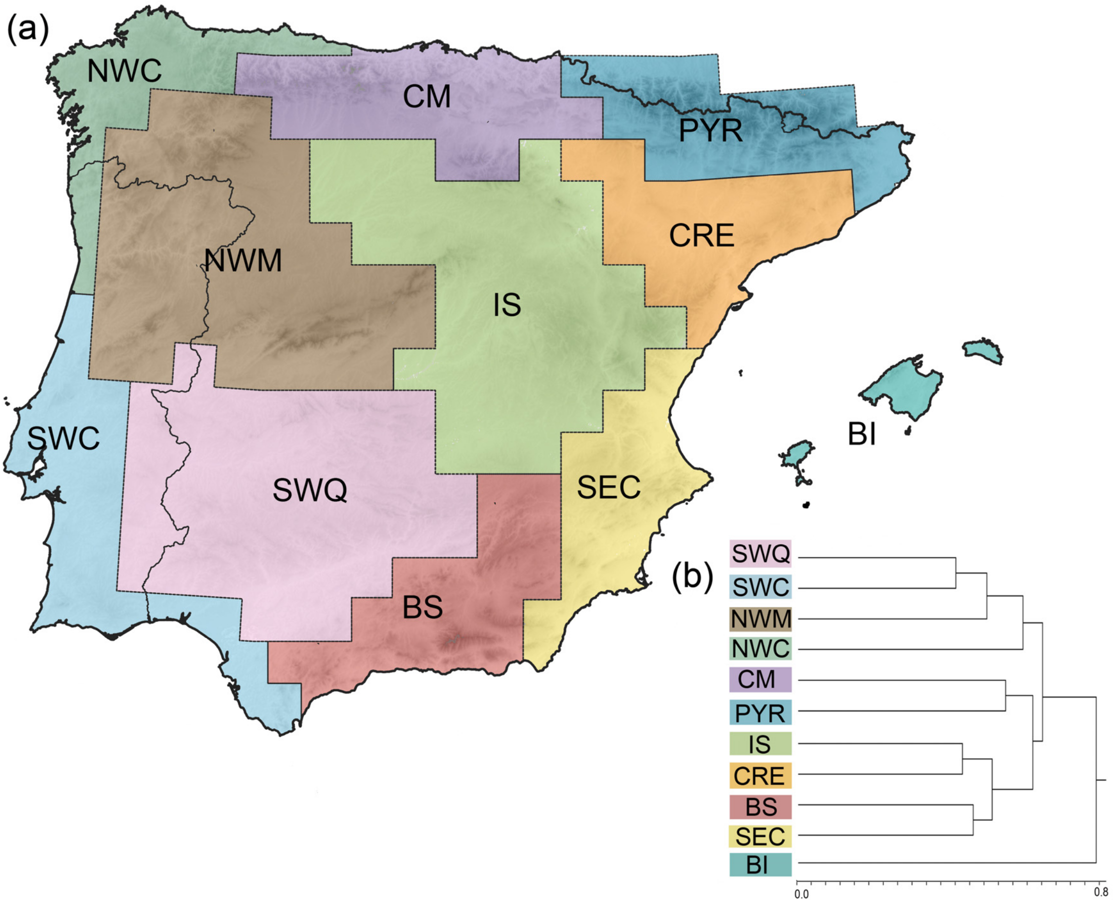

Fig. 3.1 (a) Regionalization based on the Iberian endemic species distributions resulted from the *k*-means clustering analysis. (b) Dendrogram of the inter-cluster distances calculated with the UPGMA method.

Table 3.2 Inter-cluster distances resulted from the *k*-means clustering analysis

	SWQ	SWC	IS	CRE	BI	PYR	BS	CM	SEC	NWC	NWM
SWQ	0.00										
SWC	0.44	0.00									
IS	0.56	0.65	0.00								
CRE	0.65	0.71	0.46	0.00							
BI	0.81	0.81	0.81	0.81	0.00						
PYR	0.72	0.76	0.65	0.57	0.85	0.00					
BS	0.61	0.65	0.52	0.62	0.84	0.74	0.00				
CM	0.69	0.71	0.50	0.66	0.86	0.58	0.68	0.00			
SEC	0.68	0.71	0.51	0.51	0.82	0.72	0.49	0.72	0.00		
NWC	0.68	0.66	0.70	0.75	0.85	0.75	0.77	0.62	0.78	0.00	
NWM	0.48	0.58	0.56	0.72	0.85	0.75	0.69	0.54	0.75	0.55	0.00

Degree of compactness and diagnostic species

Clusters showed significant differences in the degree of compactness. As expected, BI showed the maximum silhouette value; all other groups showed values under 0.25 (Table 3.3). PYR and BS showed the highest silhouette values in the peninsula while CRE, SWQ and especially IS had the lowest ones. The regions with high silhouette values had also high means of species phi-value and large percentages of diagnostic species (CM, SEC and particularly BI, BS PYR). Despite the NWM being one of the two largest regions, it showed a reasonable high percentage of diagnostic species (30%), which supported the compactness of the cluster.

The 68% of all endemics occurred exclusively in one single region when the occasional species (phi-value < 0 in a given region) were not included. Similarly, the 65% of the endemics were diagnostic of one or more regions (some species had phi-value ≥ 0.3 for two different regions). However, the distribution of very few diagnostic species entirely overlapped with the corresponding region. The highest phi-values were found in BI (see Table A3.1), even though only seven Balearic endemics occurred in all the grid cells of the islands (phi-value = 1). Many diagnostic species were only endemic to the eastern islands (Mallorca and Menorca), but a few were shared with the western islands (included in one single cell).

BS and PYR had a large proportion of endemics exclusive to their respective regions, but most of them only covered a small portion. Only a few species with phi-values close to 1 (e.g. *Ptilostemon hispanicus* or *Galeopsis pyrenaica*, see Table A3.1) entirely draw the shape of these regions. Phi-values were, on average, significantly lower in IS, CRE and SWQ (Table 3.3). Moreover, any species occurring in IS showed a phi-value particularly high, since all the endemics distributed throughout the region are also found in other regions (e.g. *Silene legionensis* and *Thymus leptophyllus*). Similarly, any phi-value was over 0.7 in CRE, since any endemic occurring there fit the area of the region accurately.

Table 3.3 Estimators of compactness of clusters: mean silhouette, mean species phi-value and percentage of diagnostic species (phi-value ≥ 0.3); and measures of richness, endemism and average species range size per region.

	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ
Size (grid cells)	4	19	18	19	41	17	41	17	17	23	39
Mean Silhouette	0.56	0.23	0.21	0.13	0.09	0.19	0.18	0.22	0.19	0.16	0.11
Mean phi-value	0.59	0.28	0.28	0.14	0.15	0.18	0.20	0.33	0.25	0.23	0.11
Diagnostic species	100	240	120	30	69	38	112	116	121	71	28
Diagnostic (%)	80	48.5	37.5	15.8	18.6	24.1	29.9	50	39	28.5	12.2
Native species	1508	3325	3143	2885	3160	2097	3093	3207	2616	2423	2511
Iberian endemics (IE)	125	495	320	190	370	158	375	232	310	249	230
Contribution to the total (%)	9.2	35	28.5	17.3	31	14.5	32.5	18.4	25.5	21.7	21.2
Narrow endemics (NE)	108	194	47	39	39	19	59	66	86	66	21
Ratio NE/IE	0.86	0.39	0.15	0.21	0.11	0.12	0.16	0.28	0.28	0.27	0.09
Average range IE (grid cells)	4.5	16.2	26.5	23.1	30	25.4	27.5	17.9	18.4	20.9	33.2

Richness, endemism, and taxonomic composition of the regions

Native species richness was greater in the regions including the highest mountain ranges (over 3000 species in BS, IS, CM and PYR; Fig. 3.2 and Table 3.3). With regard to endemic species, BS was by far the richest region, accounting for 35% of all Iberian endemics. Indeed, the entire Baetic System, including the Prebaetic Mountains clustered in the SEC region, accounted for 43% of all endemics. BS was also far above regarding the richness of narrow endemics, consisting of 194 species (39% of all endemics occurring in the region). BI had the highest ratio of narrow endemics (86%), since almost all the endemics occurring there are exclusive to the islands. IS, CM and NWM were very rich in absolute terms, each including more than 30% of the total Iberian endemics. However, the average species range size and the ratios of narrow endemics (Table 3.3) indicated that most of the endemics occurring in these regions are widespread species. PYR was poorer in terms of Iberian endemic species, but showed a significant proportion of narrow endemics. SEC and SWC also had high ratios of narrow endemics and relatively low values of average range size. SWQ, NWC and CRE were poorer in terms of Iberian endemics and their ratios of narrow endemics were also low.

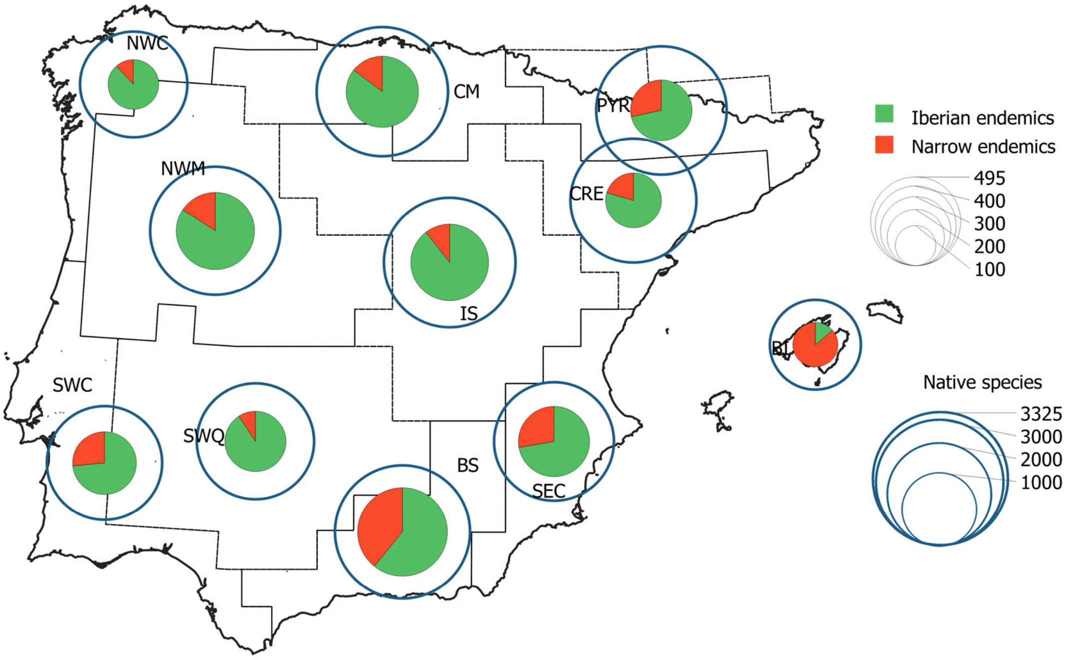

Fig. 3.2 Diagrams showing native and Iberian endemic species richness in each region; the portion in red is the fraction of narrow endemics. Numbers are indicated in Table 3.3

Remarkable differences were observed among regions with regards to the richness of the largest genera of the Iberian endemic flora (Fig. 3.3). The flora of SEC was found to be highly represented by the largest Iberian genera, which accounted for 39% of all endemics of the region, whereas in all other regions the percentage was less than 31%.

The genera *Silene, Linaria* and *Centaurea* were more or less well represented in all the regions, except in BI (only *Silene* have 3 endemic species). The species of the apomictic genus *Alchemilla* were basically restricted to the northern mountains regions (CM and PYR). Similarly, *Saxifraga* and *Festuca* consisted of many endemics in PYR and CM, but also in NWM and BS. *Teucrium* and *Sideritis* were dominant in the southeastern regions (SEC and BS). *Thymus* also consisted of many endemics in the eastern and southeastern regions (IS, SEC and BS) but also in the southwestern coast (SWC). The number of *Ranunculus* endemic species was particularly high in the northwestern mountains (NWM and CM). *Limonium* species mostly occurred in the regions including the Mediterranean coast (CRE, SEC and particularly BI), but several endemics were also recorded in the inland IS region. *Armeria* was found to be more diversified in the western mountains and Atlantic coast (NWM, CM, NWC and SWC). All genera except *Alchemilla* were well represented in the Baetic System.

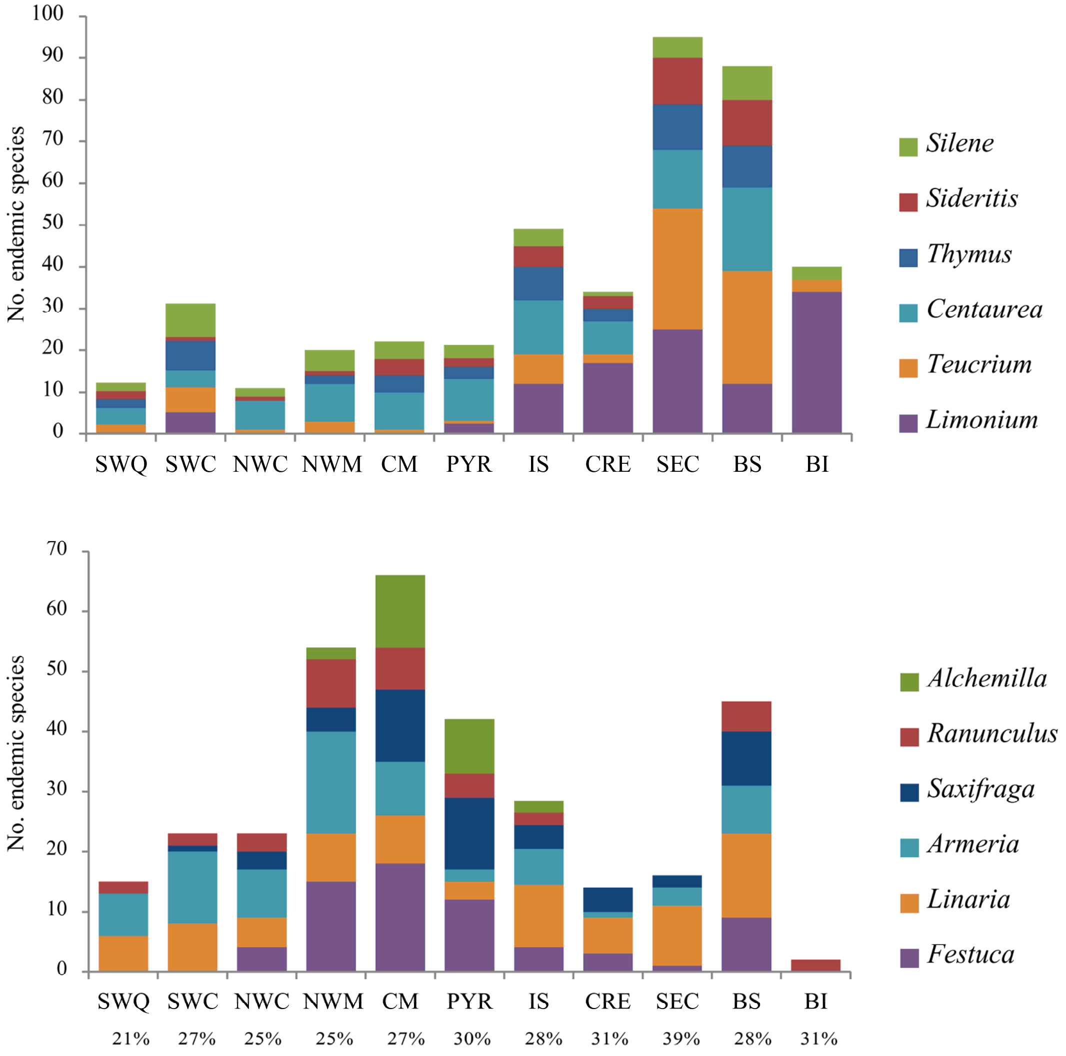

Fig. 3.3 Number of species in the 12 largest genera of the Iberian endemic flora within each region. Occasional species (phi-value < 0) are not included. The total percentage of endemics accounted by these genera within each region is indicated at the bottom.

Discussion

Regionalization based on the endemic flora and potential areas of endemism

The partitioning analysis based on the endemic species distribution resulted in eleven regions, most of which appear to be geographically and ecologically meaningful. The dendrogram of the inter-cluster distances (Fig. 3.2b) revealed a primary division between the four predominantly calcareous eastern regions and the four predominantly siliceous western regions (see Fig. 2.1), leaving aside the two northern regions of the Pyrenean-Cantabrian belt and the Balearic Islands. Thus, our classification point out the key role of the substrates in shaping the plant community structure both at regional and at large scale, as had already been stated by other authors (Liu et al., 2020; Moreno-Saiz et al., 2013).

Among the delimited regions, those including the Balearic Islands, the Pyrenees and the Baetic System showed the highest degree of compactness. The Baetic System is in addition the richest region in endemic species of the studied area (the whole system accounts for nearly 40% of all Iberian endemics). As stated in Chapter 2, its exceptional richness can be explained by a complex interaction of environmental factors and historical causes (see also Molina-Venegas et al., 2013). Although the Baetic region is characterized by the high species turnover rate and the great richness of range-restricted endemics, we have identified several endemics that are distributed largely or entirely along the region.

The presence of an assemblage of species that is mostly common to the whole Baetic System suggests that this region has had a common biogeographic history, though obviously linked to that of the northern Africa (Valdés, 1991; Médail & Quézel, 1997; Molina-Venegas et al., 2013) and the rest of the peninsula. Similarly, many endemics are restricted to the Pyrenees, even if this mountain range is considerably poorer in endemic species. To a lesser extent, the regions classified here as CM, NWM, SEC and SWC have also many defining species whose distributions are not completely congruent but overlap in a large portion. Thus, in a broad approach (e.g. Linder, 2001; Aagesen et al., 2013) all these regions could be regarded as areas of endemism at large scale.

Compared to the Pyrenees, the Cantabrian Mountains are relatively less isolated, since they are contiguous to the Pyrenees, the Montes de León and the Iberian System. This would explain why in our analysis they were clustered together with the northern part of the Iberian System (CM region), as well as the lower proportion of diagnostic species of this region compared to the Pyrenees and the Baetic System. The resulting large IS region, which included a large share of the Iberian System together with a portion of the Southern Plateau, did not form a consistent group. The IS region further showed the lowest average inter-cluster distance, indicating that many endemics occurring there are widespread and also occur in other regions. Indeed, the Iberian System is a discontinuous mountain range that runs from northwest to southeast and has played an important role as a longitudinal corridor between northern and southern territories (Martín-Cano & Gurrea, 2003).

The other two largest regions (NWM and SWQ) covered almost all the western half of Iberia, largely corresponding to the ancient Hercynian massif. Despite its size, the region including the northwestern mountains (NWM) showed a reasonable high percentage of diagnostic species, which supports its delineation as a floristic region. The northwestern mountains, which mostly consist of acidic rocks and are edaphically uniform, have relatively few narrow endemics but there are certainly many Iberian endemics widely distributed along the region. The region including the southwestern inner quadrant has also a siliceous uniform lithology but its topography is much smoother, and it appears to be the poorest in native and endemic species relative to its size. Due to the general lack of endemic species in the region, the level of compactness of the cluster was very low.

In the Balearic Islands a high proportion of endemics were classified as diagnostic, but in fact only a few species occur in all the grid cells of the archipelago. The Balearic endemic taxa tend to be either endemic to the eastern islands (Mallorca and Menorca) or to the western islands (Ibiza and Formentera). It has been argued that the flora of the eastern islands is more linked to Corsica and Sardinia, while that of the western islands is more related with eastern Iberia (Cardona, 1979; Contandriopoulos & Cardona, 1984). Nevertheless, the number of endemic species shared between both groups of islands seems to be large enough to cluster them into one single region.

Comparison with previous regionalization

Multiple proposals of phytogeographical regionalization have been made for the Iberian Peninsula (e.g. Moreno-Saiz & Lobo, 2008; Rivas-Martínez et al., 1990, 2002; Moreno-Saiz et al., 1998; Sainz-Ollero & Hernández, 1985), based on different groups and made using different techniques. Moreno-Saiz et al. (2013) recently analyzed the distributional pattern of the Iberian flora using hierarchical clustering and parsimony methods with a large dataset of 3041 taxa of vascular plants (> 40% of total taxa). The results obtained by these authors from the clustering analysis are significantly similar to ours, even though we have exclusively focused on the endemic species and used different methods of classification. Nine groups were identified in their clustering analysis, seven of which overlap to a large extent with ours. Basically the main differences of their classification is that the Pyrenees and the Cantabrian Range are clustered together, the northwestern and southeastern coastal areas do not form independent clusters, and the Iberian System and the inner plateaus are separated into two different clusters.

Another significant common feature between the regionalization of Moreno-Saiz et al. (2013) and ours is that both identify a primary longitudinal division of Iberia between the basic eastern and the acidic western region. By contrast, the regionalization proposed by Rivas-Martínez et al. (2002), based on physiography, distribution of indicator plants, and potential natural vegetation, but without an explicit methodology, divides Iberia into primarily Eurosiberian and Mediterranean regions. Although the substrates appear to be more significant in our classification based on endemic species, the partial coincidence of our three northernmost regions with the Eurosiberian region (Rivas-Martínez et al., 1990; 2002) also supports such climatic division.

Varying patterns in the distribution of large taxonomic groups

We have observed remarkable differences through the representation of the largest genera along the Iberian territory, which suggests that different mechanisms of diversification have occurred (this issue is further analyzed in Chapter 4). *Limonium* is the major contributor to endemism in the eastern part of Iberia and especially in the Balearic Islands (nearly 25% of all endemics), mainly occurring in coastal areas but also in inland salt marshes and gypsum outcrops of the Ebro Depression and Southern Plateau. *Armeria* has an opposite distributional pattern and is more diversified in the western Iberia, growing from granitic rock fissures at high altitude to sandy soils near the sea (Fuertes-Aguilar & Nieto-Feliner, 2003).

Several Mediterranean genera (e.g. *Thymus, Teucrium, Sideritis* and to a lesser extent *Linaria*) consist of many endemics in eastern and particularly southeastern Iberia. The high diversification of these genera has probably been stimulated by the onset of summer drought (see Blanco-Pastor & Vargas, 2013; Fernández-Mazuecos & Vargas, 2015; Salmaki et al., 2016). On the other hand, the high diversification of some predominantly Eurosiberian and arctic-alpine genera (*Festuca, Ranunculus, Alchemilla* and *Saxifraga*) in the highest mountains of the northern and northwestern regions may have been boosted by orographic isolation (Comes & Kadereit, 2003; Hughes & Atchison, 2015).

All these non-typical Mediterranean genera (except *Alchemilla*) are also well represented in the Baetic Mountains and more specifically in the isolated high mountains of Sierra Nevada. It has been documented that several arctic-alpine lineages migrated from northern territories persisted and diversified after the glacial period of the Pleistocene in Sierra Nevada (Blanca et al., 1998; Kropf et al., 2006). The higher altitudinal gradient of this massif provides microclimatic conditions that allow the current occurrence of certain lineages which do not occur in the rest of the Baetic Mountains.

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Appendix Chapter 3

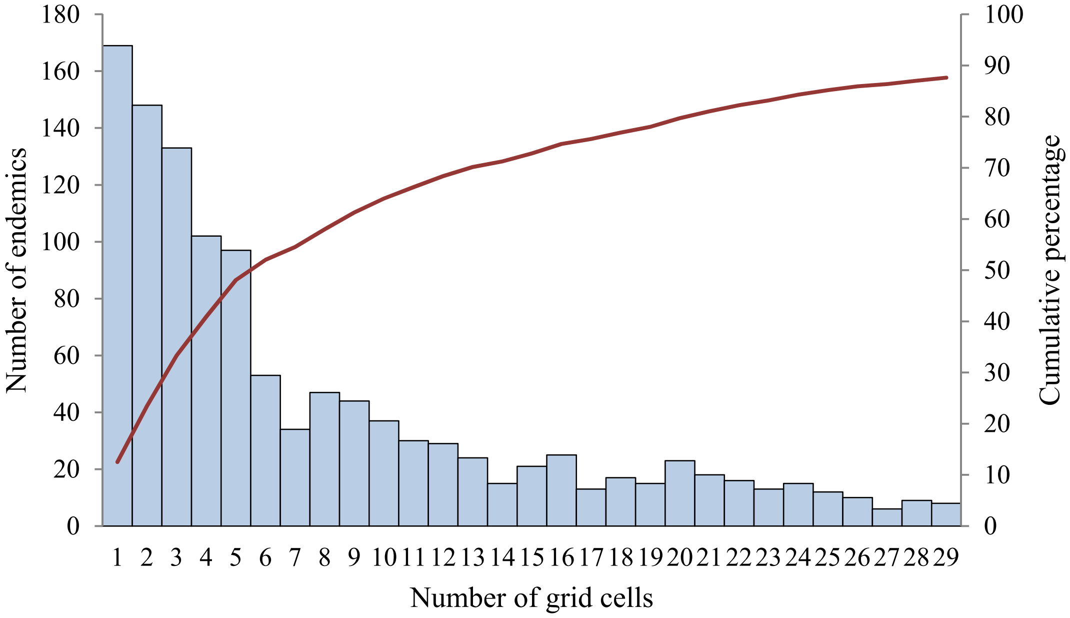

Fig. A3.1 Distribution of the number of endemic species per grid cell (bars) and cumulative percentage (red line). Values from 29 to 172 are not represented.

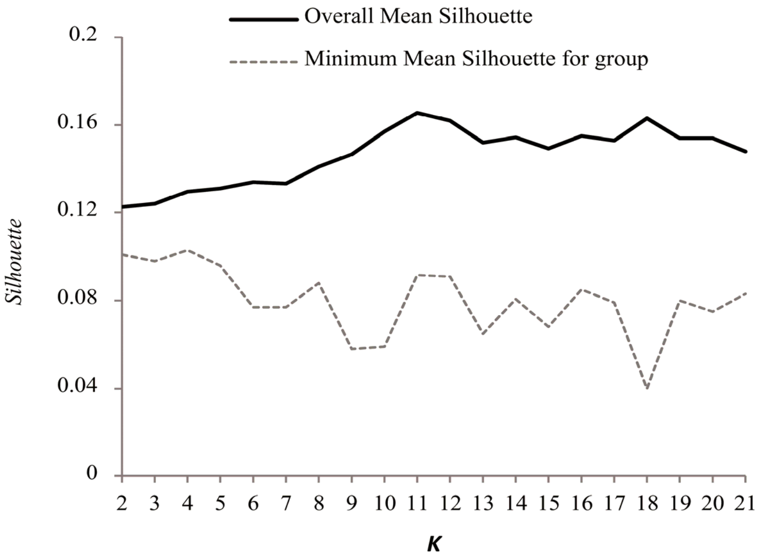

Fig. A3.2 Overall mean silhouette and minimum mean silhouette group for different *k* values.

Table A3.1 The 10 diagnostic species with the highest phi-values for each unit

BI	phi	BS	phi	CM	phi	CRE	phi	IS	phi	NWC	phi
Carex rorulenta	1	*Ptilostemon hispanicus*	0.9	*Oreochloa confusa*	0.87	*Sideritis ilicifolia*	0.68	*Genista pumila*	0.61	*Angelica pachycarpa*	0.73
Hypericum balearicum	1	*Echinospartum boissieri*	0.86	*Linaria propinqua*	0.75	*Centaurea linifolia*	0.67	*Silene legionensis*	0.48	*Carex durieui*	0.72
Limonium biflorum	1	*Lavandula lanata*	0.86	*Anemone pavoniana*	0.73	*Limonium hibericum*	0.59	*Antirrhinum pulverulentum*	0.46	*Genista berberidea*	0.68
Limonium pseudebusitanum	1	*Linaria verticillata*	0.85	*Draba dedeana*	0.73	*Limonium catalaunicum*	0.52	*Aster willkommii*	0.45	*Armeria pubigera*	0.67
Micromeria filiformis	1	*Chaenorhinum macropodum*	0.82	*Endressia castellana*	0.7	*Knautia rupicola*	0.48	*Thymus leptophyllus*	0.44	*Leucanthemum pluriflorum*	0.63
Santolina magonica	1	*Saxifraga camposii*	0.8	*Laserpitium eliasii*	0.69	*Valerianella multidentata*	0.48	*Arenaria obtusiflora*	0.43	*Narcissus cyclamineus*	0.6
Sibthorpia africana	1	*Centaurea granatensis*	0.8	*Onobrychis reuteri*	0.66	*Salix tarraconensis*	0.44	*Thymus lacaitae*	0.42	*Centaurea corcubionensis*	0.58
Crocus cambessedesii	0.86	*Erodium cheilanthifolium*	0.8	*Thymus mastigophorus*	0.66	*Galium brockmannii*	0.45	*Artemisia assoana*	0.42	*Leucanthemum merinoi*	0.55
Digitalis minor	0.86	*Hormathophylla longicaulis*	0.79	*Digitalis parviflora*	0.65	*Boleum asperum*	0.42	*Lepidium cardamines*	0.42	*Adenocarpus lainzii*	0.54
Chaenorhinum formenterae	0.86	*Armeria villosa*	0.79	*Centaurea lagascana*	0.64	*Ferula loscosii*	0.4	*Sideritis pungens*	0.41	*Sagina merinoi*	0.54

NWM	phi	PYR	phi	SEC	phi	SWC	phi	SWQ	phi
Hispidella hispanica	0.82	*Galeopsis pyrenaica*	0.87	*Guiraoa arvensis*	0.8	*Euphorbia transtagana*	0.74	*Digitalis mariana*	0.75
Crocus carpetanus	0.77	*Salix pyrenaica*	0.87	*Teucrium carolipaui*	0.76	*Allium pruinatum*	0.69	*Flueggea tinctoria*	0.69
Genista falcata	0.69	*Ranunculus ruscinonensis*	0.82	*Teucrium thymifolium*	0.74	*Stauracanthus genistoides*	0.68	*Centaurea cordubensis*	0.64
Echinospartum ibericum	0.67	*Saxifraga pubescens*	0.82	*Limonium caesium*	0.72	*Fritillaria stenophylla*	0.64	*Genista polyanthos*	0.57
Cytisus multiflorus	0.66	*Narcissus moschatus*	0.79	*Teucrium libanitis*	0.72	*Cistus libanotis*	0.64	*Ulex eriocladus*	0.55
Ornithogalum concinnum	0.66	*Campanula jaubertiana*	0.73	*Scrophularia tanacetifolia*	0.72	*Armeria pinifolia*	0.64	*Dianthus crassipes*	0.53
Armeria transmontana	0.65	*Festuca liviensis*	0.72	*Genista valentina*	0.69	*Ulex australis*	0.63	*Narcissus jonquilla*	0.51
Ortegia hispanica	0.62	*Reseda glauca*	0.72	*Linaria depauperata*	0.68	*Salvia sclareoides*	0.63	*Sideritis paulii*	0.51
Arenaria querioides	0.62	*Odontites pyrenaeus*	0.71	*Thymus moroderi*	0.67	*Pycnocomon intermedium*	0.62	*Biarum mendax*	0.49
Paradisea lusitanica	0.62	*Achillea chamaemelifolia*	0.71	*Sideritis leucantha*	0.66	*Euphorbia boetica*	0.62	*Armeria genesiana*	0.45

Chapter 4

Environmental correlates of spatial phylogenetic endemism

This chapter is published in Buira, A., Fernández-Mazuecos, M., Aedo, C., Molina-Venegas, R. The contribution of the edaphic factor as a driver of recent plant diversification in a Mediterranean biodiversity hotspot. Journal of Ecology, 00, 1-13.

Abstract

The high diversification rates of plant lineages in the Mediterranean Basin hotspot have been linked to a complex interaction of climatic stressors, geographic isolation and soil type, but the question remains as to which of these factors has been the most significant environmental driver of recent speciation. Here, we draw on distributional data for the entire endemic flora of the Iberian Peninsula, together with DNA-based phylogenies and spatial phylogenetic methods, to detect centers of recent diversification at different spatial resolutions and phylogenetic scales (superclades) and assess how environmental factors contribute to explain the geographic distribution of these centers. We found that recent diversification of angiosperms as a whole, and particularly of Eudicots, has been boosted by environmental stressors including high values of soil pH and dry-seasonal climatic conditions, while diversification of Monocots has not been associated with soil conditions but with high elevation and less seasonal climate. These results provide robust insights into the environmental factors driving recent plant diversification in the Mediterranean Basin, including a role of soil properties that had not been quantified before. The contrasting environmental drivers of diversification in Eudicots and Monocots highlight the importance of analyzing spatial phylogenetic patterns at multiple phylogenetic scales to get a better understanding of the processes that shape biodiversity.

Introduction

With nearly 22500 plant species and 11700 endemics, the Mediterranean Basin is the third major plant biodiversity hotspot of the world (Mittermeier et al., 2004). More than half of all plant species occurring only in the Mediterranean region are narrow endemics (Thompson, 2005), which are largely clustered in species-rich lineages of recent origin (Verlaque et al., 1997; Lavergne et al., 2004; Buira et al., 2020). Such exceptional concentration of narrow endemics has not gone unnoticed by biogeographers and evolutionary biologists, who have long emphasized the value of Mediterranean biomes for understanding the mechanisms underlying the generation and maintenance of plant biodiversity (e.g. Cowling et al., 1996; Médail & Verlaque, 1997; Quézel & Médail, 2003; Molina-Venegas et al., 2013).

It has been argued that high diversification rates in the Mediterranean are linked to a complex interaction of climatic stressors, geographic isolation and soil type (Molina-Venegas et al., 2013; Rundel et al., 2016). In particular, it is well known that intensification of summer drought since the Pliocene (Suc, 1984) has been a crucial stimulus for recent diversification of some lineages (Verdú & Pausas, 2013). Likewise, the rugged topography of the territory has led to geographic isolation and provided high heterogeneity of environmental niches and climatic refugia, fostering local speciation (Comes & Kadereit, 2003; Smyčka et al., 2017) and enabling lineages to survive periods of climatic oscillation such as the glacial-interglacial cycles of the Pleistocene (Ohlemüller et al., 2008; Médail & Diadema, 2009).

The association between soil type and endemism (“edaphism”) was recognized by early Mediterranean botanists (e.g. Willkomm, 1852; Braun-Blanquet, 1932, Rivas Goday, 1969, Escudero et al., 2015; Mota et al., 2017) who pointed that numerous endemic species are narrowly linked to specific substrates. However, the evidence connecting plant diversification and soil properties has hitherto been mostly narrative (but see Lobo et al., 2001; Molina-Venegas et al., 2013). The question remains as to whether climate, topography or soil has been the most significant environmental driver of recent speciation in the Mediterranean (Rundel et al., 2016).

In recent years, a family of methods collectively referred to as “spatial phylogenetics” has emerged as a promising tool to evaluate spatial patterns of biodiversity from an evolutionary standpoint (e.g. Thornhill et al., 2016; Scherson et al., 2017; Thornhill et al., 2017). Specifically, Mishler et al. (2014) developed the concept of relative phylogenetic endemism to enable identification of significant centers of recent diversification by analyzing the flora of a given geographic area using distributional data and DNA-based phylogenies. While this novel approach has been used in combination with climatic and topographical data to evaluate potential environmental drivers of recent diversification in some Mediterranean-type floras (Molina-Venegas et al., 2017; Thornhill et al., 2017), the role of edaphic conditions remains unexplored.

The Iberian Peninsula, in the western Mediterranean, is one of the most species-rich areas of the Basin (together with the Balkan and Anatolian peninsulas in the East; Médail & Quézel, 1997). It accounts for almost a quarter of the area of the Mediterranean Basin biodiversity hotspot and is home to nearly half of all European plants (Aedo et al., 2017). Thus, the Iberian Peninsula represents an ideal eco-historical setting to delve into the drivers of plant diversification in Mediterranean ecosystems. Here, we draw on distributional data for the entire endemic flora of the Iberian Peninsula, together with DNA-based phylogenies and spatial phylogenetic methods to (i) detect centers of recent diversification; (ii) assess how edaphic, climatic and topographic factors contribute to explain the spatial distribution of these centers; and (iii) test whether the patterns are consistent across plant superclades (i.e. Monocots, Eudicots, Superasterids and Superrosids). We hypothesize that soil properties may be as relevant as, or even more relevant than, climate and topographic features in determining the spatial distribution of centers of recent plant diversification in the Iberian Peninsula.

Materials and methods

Study area

The study area (Fig. 2.1) comprises the Iberian Peninsula (continental Spain and Portugal and Andorra), the whole Pyrenees mountain range (including the northern side, located in southern France), and the Balearic Islands, which are a continuation of the Baetic System (southeastern Iberian Peninsula). See *Study area* in Chapter 2 for further detail about geology and climate.

Endemic species list and distributional data

We used an updated list (attached in Supplementary Material) that includes all angiosperm plant species endemic to the study area (see Fig. 2.1). This list was based primarily on *Flora iberica* (Castroviejo, 1986-2019), and it was updated with new taxa published subsequently and revised on the basis of more recent taxonomic monographs. Gymnosperms and pteridophytes were not included in the study because endemics of these groups are comparatively rare in the study area (less than 0.5% of all endemic species), and the much older ancestor of all vascular plants compared to that of the angiosperms can obscure phylogenetic patterns among the latter (Letcher, 2010; Qian et al., 2017). After removing taxa of dubious taxonomic validity or with deficient distributional data (10%), a total of 1252 angiosperm species were included in this study. Of these, 1207 are strictly endemic to the study area. The remaining 45 are non-endemic polytypic species such that all subspecies present in the study area are endemic.

Distributional data were obtained from the Anthos (www.anthos.es) and Flora-On (www.flora-on.pt) and Atlas of the Pyrenean Flora (www.florapyrenaea.com) databases, which compiled about 60,000 unique records on UTM 10×10 km grid cells for the target species. Several steps of data quality checking were conducted to remove potential errors (see Chapter 2 for details). Despite the large amount of distributional data available, ranges of many endemics might still be substantially incomplete at 10 km resolution, which may have an effect on the analyses (Thornhill et al., 2017). Thus, in addition to 10×10 km grid cells, all analyses were carried out using 50×50 km grid cells to avoid potential biases caused by incomplete sampling. After excluding cells with no distributional data, the total extent consisted of 4440 and 255 cells at 10 and 50 km resolution, respectively.

Phylogenetic tree

We used the species-level time-calibrated global phylogeny published by Smith & Brown (2018), which included all taxa with DNA sequences available in GenBank up to that date and was constrained using the backbone topology provided by Magallón et al. (2015). Instances of synonymy between species names in the global phylogeny and those in our list were detected following the taxonomic criteria in *The Plant List* website (www.theplantlist.org). After pruning the global phylogeny to include only the species that were in our list, 55% of Iberian endemics were still missing from the phylogeny. To include these taxa in the tree and account for uncertainty in their phylogenetic placement, we used a randomization approach (Rangel et al., 2015). Most missing species were added at random to the crown group of their corresponding genera using the *add.random* function in the phytools R package (Revell, 2012). In the few cases in which the genus was missing from the global phylogeny (only 14 monospecific genera), we used published phylogenetic evidence to constrain the randomization scheme. For example, molecular studies supported that *Prolongoa*, *Hymenostemma* and *Castrilanthemum* (missing in the global phylogeny) are affiliated to the monophyletic Asteraceae subtribe Leucanthemopsidinae (Oberprieler et al., 2007), and thus their species were added randomly to the crown group of this clade in the phylogeny. This randomization procedure was repeated iteratively to obtain n = 1000 alternative topologies, which were used to compute averaged values for phylogenetic metrics (see below).

Taxonomic and phylogenetic endemism metrics

Although in this chapter we aimed to explore phylogenetic endemism, we also used two taxonomic metrics (see Chapter 2) to compare the environmental correlates of both taxonomic and phylogenetic endemism. While endemic richness (ER) is simply the number of Iberian endemic species in a given grid cell, weighted endemism (WE) is the sum of the inverse range sizes (i.e. 1/number of grid cells) of the endemic species occurring in a grid cell (Crisp et al., 2001; Linder, 2001).

In analogy with WE, phylogenetic endemism (PE) is the sum of the range-weighted phylogenetic branches present in a given grid cell (Rosauer et al., 2009), which in turn is used to compute relative phylogenetic endemism (RPE, Mishler et al., 2014). RPE is the ratio between PE measured on the actual tree and PE measured on a comparison tree that retains the actual tree topology but makes all branches of equal length (Mishler et al., 2014). Thus, while high RPE values indicate over-representation of long range-restricted branches (suggesting the presence of paleoendemic lineages, sensu Stebbins & Major, 1965), low RPE values indicate over-representation of short-rare branches, which can be interpreted as evidence of recent local diversification (i.e. neoendemism, Mishler et al., 2014).

Previous studies have used RPE to detect centers of paleo and neoendemism in a certain region of interest using either the species of a target group that are endemic to the region (e.g. Mishler et al., 2014; Molina-Venegas et al., 2017) or entire floras regardless of the endemic status of the species (Thornhill et al., 2017; Scherson et al., 2017). Both approaches have advantages and limitations. On the one hand, using entire floras rather than endemic species may obscure or even confound patterns of recent *in situ* diversification, especially when many species that are widely distributed outside of the study area occur in just a few localities within the study area (e.g. the Pyrenees mountains represent the southernmost distribution limit for many widespread European temperate species). On the other hand, using only endemics may result in overly long terminal phylogenetic branches if the closest relatives of certain endemic species are excluded from the analyses due to their non-endemic status (i.e. the most recent common ancestor of the endemic species and its closest relative might seem older in the phylogeny than it really is). The latter problem is also present, although to a lesser extent, when analyzing entire floras, because the closest relatives of some non-endemic species may also be absent from the study area. Therefore, caution must be exercised when interpreting centers of paleoendemism. In this study, we aimed at identifying areas of recent *in situ* diversification (neoendemism) in the Iberian Peninsula, and therefore we focused on the species that are restricted to the region (Thornhill et al., 2017). Note that, unlike previous studies that also explored RPE patterns, we did not aim at categorizing cells into discrete classes on the basis of observed *p*-values (see the CANAPE framework in Mishler et al., 2014). Instead, we simply ranked cells based on a continuum of RPE values, which enabled the calculation of correlations with environmental variables (see below).

In order to get a better insight into RPE patterns, all analyses were conducted at multiple phylogenetic scales (Graham et al., 2018), including all angiosperm species (RPE-ANG) and four nested monophyletic superclades: (i) Monocots (RPE-MON; 9.5% of all angiosperm species), (ii) Eudicots (RPE-EUD; 90.5%), (iii) Superasterids (RPE-SAS; 61.5%) and (iv) Superrosids (RPE-SRO; 26.3%).

Environmental data

Variables were grouped into three categories: climatic, topographic and edaphic. For each cell, we calculated: means of annual temperature, annual precipitation, temperature seasonality and precipitation seasonality (coefficient of variation) from WorldClim 2.0 layers at 1 km spatial resolution (www.worldclim.org; Fick & Hijmans, 2017); means and standard deviations of elevation, slope, roughness and aspect variables (calculated from a digital elevation model (DEM) using terrain analysis tools of QGIS 3.4); and mean and standard deviation of soil pH_{CaCl2} derived from the map of soil pH in Europe at 5 km resolution (Reuter et al., 2008). In the Iberian Peninsula, low (acidic) pH values typically correspond to soils developed on siliceous rocks while high (basic) values correspond to soils developed on carbonate or evaporite sedimentary rocks (see Fig. 2.1).

Individual correlations between response variables (i.e. ER, WE and RPE) and environmental variables were explored. Only variables showing a significant correlation with at least one response variables were selected in the first step. In a second step, highly correlated variables ($|r| > 0.7$) were excluded to avoid collinearity issues by testing correlations for each possible pair of explanatory variables within each group. The explanatory variables that remained after the selection process and were used in the analyses are shown in Table 4.1.

Table 4.1 Environmental variables and their abbreviations used in this study grouped by category. The Maximum and minimum values correspond to those calculated in 10×10 km grid cells. Variables marked with an asterisk (*) were only significant in the analyses at 50 km resolution.

Category	**Variable**	**Abbrev.**	**Unit**	**Min. value**	**Max. value**
Climatic	Annual precipitation mean	*Precip*	mm	223	1608
	Precipitation seasonality mean	*P_Seas*	%	12	77
	Temperature seasonality mean	*T_Seas*	%	27	70
Topographic	Elevation mean	*Elevat*	m a.s.l.	0	2597
	Slope angle mean	*Slope*	º	0	18.5
	*Aspect (compass direction) mean	*Aspect*	º	0	301.4
	*Aspect standard deviation	*Asp_SD*	_	0	167
Edaphic	Soil pH_{CaCl2} mean	*Soil_pH*	_	3.5	7.8
	*Soil pH_{CaCl2} standard deviation	*Soil_SD*	_	0.5	7.5

Multiple linear regressions and variation partitioning

Multiple linear regressions were used to model the relationship between environmental variables and taxonomic and phylogenetic endemism. As taxonomic metrics (ER and WE) were derived from overdispersed count data, they were log-transformed to meet parametric test assumptions. In order to mitigate the problem of under-sampled cells in the analyses at 10 km resolution, we fixed a threshold of at least 190 recorded species per grid cell (including endemic and non-endemic species), which is the mean of the total dataset (ranging from 2 to 1500). As a result, the total number of observations for the regressions of taxonomic metrics at 10 km was 1440 (32% of all grid cells).

RPE values (RPE-ANG, RPE-EUD, RPE-MON, RPE-SRO and RPE-SAS) followed log-normal distributions, and they were also log-transformed before applying multiple linear regressions. In this case, we included all the observations and the total numbers of endemics per grid cell across each superclade were used as weights in order to give greater importance to grid cells with larger amounts of data, as poor cells may not represent centers of diversification despite low RPE values. All regressions were checked to ensure that model assumptions were met.

Variation partitioning (Borcard et al., 1992) was applied to assess the overall contribution of edaphic, climatic and topographic variables to explaining taxonomic diversity and relative phylogenetic endemism patterns. Input data for variation partitioning (*modEvA* R package; Barbosa et al., 2016) are the coefficients of determination (adjusted R^2) of the response variable on all the explanatory variables in the full model, on the explanatory variables in each particular group, and on the explanatory variables in each pair of groups. The outputs are the amount of variation attributable purely to each given group of variables –climatic, topographic and edaphic– and the amounts of shared variation attributable to two or three groups. Fractions of variation can sometimes take negative values because two groups of variables explain the response variable better than the sum of the individual effects of those two groups of variables (Legendre & Legendre, 2012). These negative values should be interpreted as zero (Legendre, 2008).

Additionally, the relative importance of each explanatory variable was estimated for each model following Johnson & LeBreton's (2004) criterion. That is, by measuring the proportionate contribution of each predictor to R^2, considering both its direct effect on the dependent variable and its effect when combined with the other variables in the linear regression. In particular, the *lmg* metric (*relaimpo* R package) was used, which is the R^2 contribution averaged over orderings among regressors. This approach provides a decomposition of the variance explained by the model into non-negative contributions (Grömping, 2006).

Results

Taxonomic diversity metrics

As reported in Chapter 2, the higher ER values occurred mostly in the main mountain ranges (Fig. 4.1a). Moderately high values also occurred in some coastal areas of the southern half. Weighted endemism (WE) followed a quite different pattern, with high values occurring almost exclusively in the Baetic Mountains and the Balearic Islands (Fig. 4.1b). The overall explanatory power of linear regressions was near 50% for both ER and WE at 10 km resolution (Fig. 4.1c,d). Variation partitioning and relative importance of variables revealed that topographic variables –elevation and slope– are by far the most important in explaining ER (Fig. 4.1c). They were also very significant in WE models, but climatic (particularly precipitation seasonality) and edaphic factors gained importance in explaining this metric (Fig. 4.1d). Thus, results suggest that rugged mountains with seasonal rainfall and calcium-rich substrates are more likely to harbor narrow endemics. Results using a spatial resolution of 50 km were similar (see Fig. A4.1 in Appendix); however, values of R^2 were slightly higher (particularly for WE), climatic variables had a lower relative importance and additional topographic (aspect) and edaphic (standard deviation of soil pH) variables contributed to explain both diversity metrics. In particular, the contribution of the latter variable suggests that heterogeneity of substrates increase endemic richness; nevertheless, its relative importance was rather low.

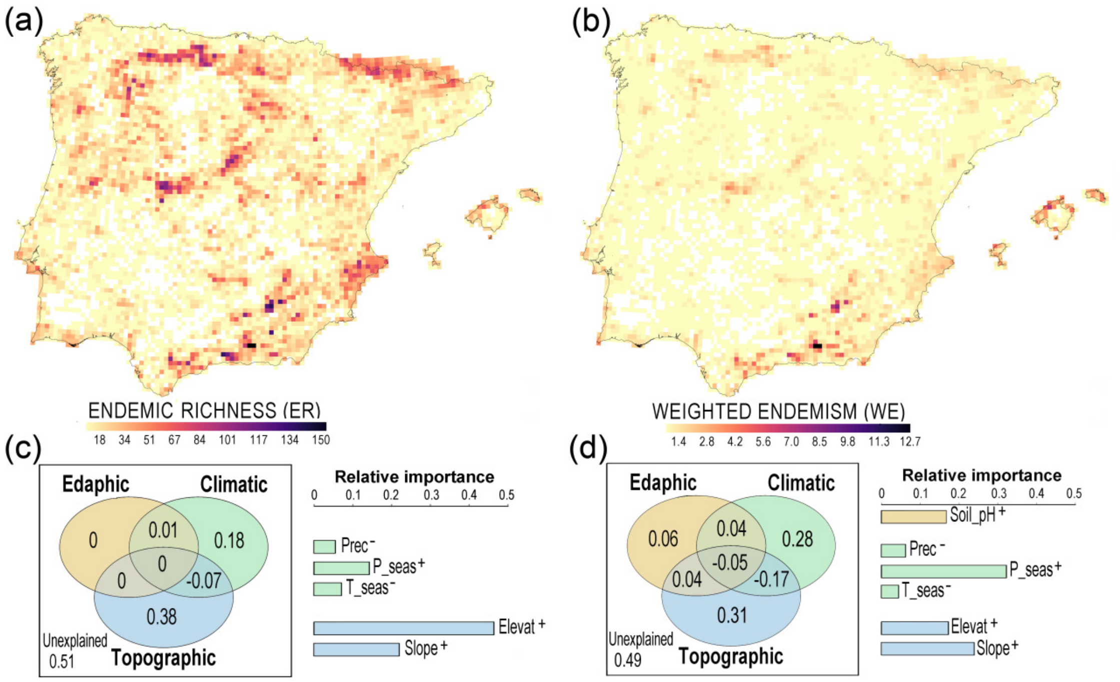

Fig. 4.1 Taxonomic diversity metrics for the Iberian flora at 10 km resolution. (a) Spatial distribution of endemic richness (ER). (b) Spatial distribution of weighted endemism (WE). (c, d) Variation partitioning assessing the contribution of edaphic, climatic and topographic variables and relative importance of individual environmental variables (symbols + or - indicate the sign of correlation) in explaining (c) endemic richness (ER) and (d) weighted endemism (WE) at 10 km spatial resolution. Individual explanatory variables with a contribution < 0.03 are not represented.

Spatial RPE patterns

The impact of phylogenetic uncertainty on RPE was rather low. At 10 km resolution the mean of the coefficient of variation of the 1000 topologies for all angiosperms (RPE-ANG) was 16.5% and 75% of grid cells had a coefficient of variation below 20.2% (see Table A4.1). The variation was similar but slightly lower for the rest of groups at 10 km, while it was significantly lower for the metrics calculated at 50 km (e.g. the mean of variation of RPE-ANG was 8.2%).

Spatial patterns of RPE for all Angiosperms (Fig. 4.2e) show that mountain ranges of the northern Iberian Peninsula (Pyrenees, northern Iberian System, Cantabrian Range and northern Portuguese mountains) and central-western mountains (part of Central System) have, on average, higher values of RPE. On the contrary, low RPE values prevail in the eastern and southeastern mountains (e.g. Iberian System and Baetic System), although some cells of the northern (Cazorla) and the western tips of the Baetic Mountains display high RPE. RPE is also high in the two eastern Balearic Islands, while it varies considerably across the southwestern coast.

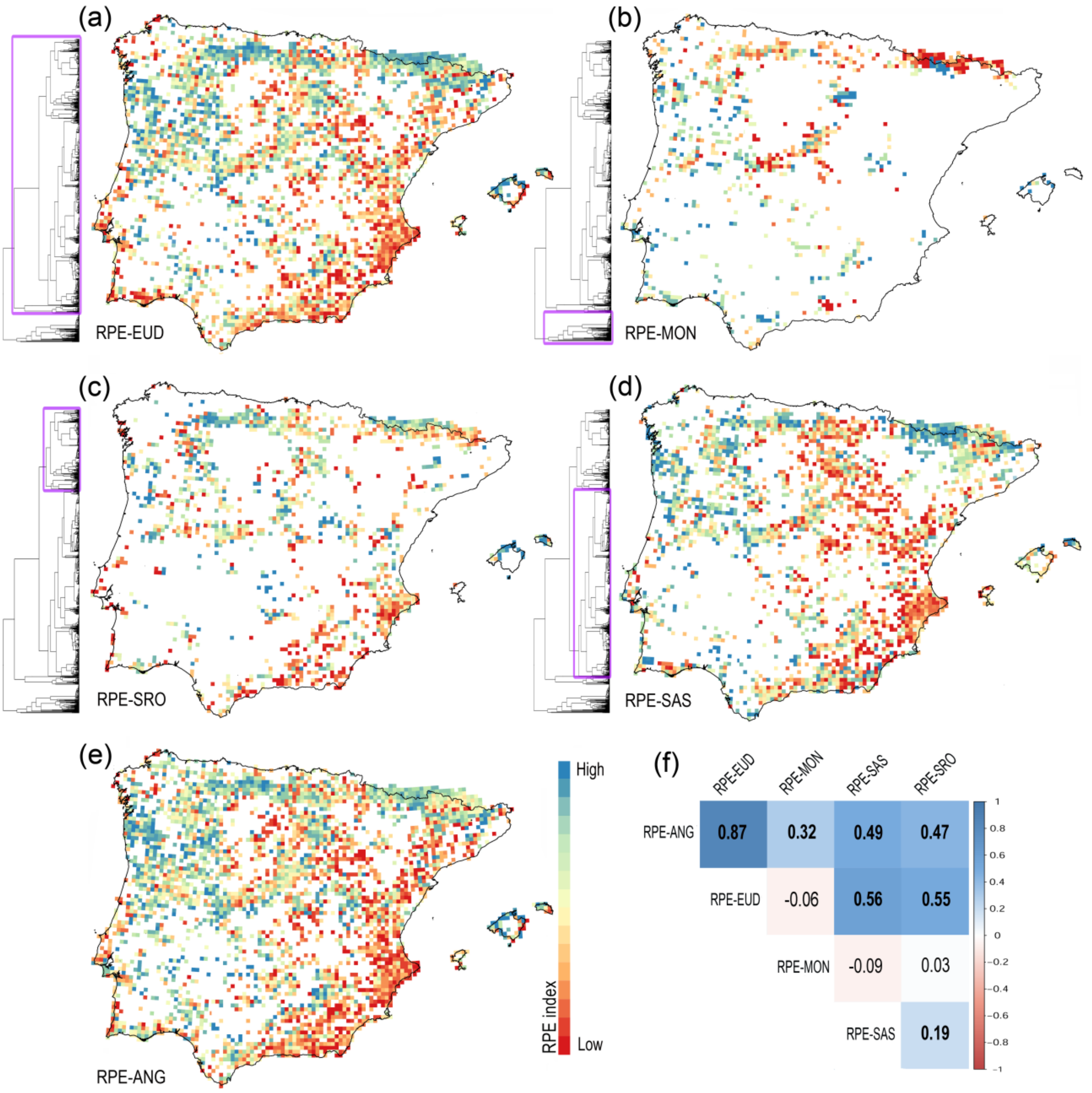

Fig. 4.2 Spatial distribution of relative phylogenetic endemism (RPE) of the Iberian flora at 10 km resolution. (a) Eudicots (RPE-EUD). (b) Monocots (RPE-MON). (c) Superrosids (RPE-SRO). (d) Superasterids (RPE-SAS). (e) all Angiosperms (RPE-ANG). Diagrams on the left of figures a-d show the size and position of each superclade within the phylogenetic tree of the Iberian endemic flora. (f) Correlation matrix among RPE values for all groups; values in bold are statistically significant. Classes of RPE values are visualized by quantiles to make comparisons among groups easier; only cells containing at least 3 endemics within each clade are represented.

Spatial patterns of RPE were largely similar for all superclades except the Monocots (Fig. 4.2a,b,c,d). For the latter, low RPE values are mostly located in northern high mountains, while cells with high values are scattered mostly in the western half of the Iberian Peninsula and the island of Mallorca (Fig. 4.2b). Indeed, all pairs of superclades, except those including the Monocots (RPE-MON), displayed positive and significant spatial correlation of RPE values between them (Fig. 4.2f).

Superrosids and Superasterids displayed the lowest significant correlation (0.19) but, unlike the other clade pairs showing significant correlations, they are independent (non-nested) clades. RPE-MON was only significantly correlated (0.32) with RPE-ANG, indicating that Monocots had a weighty effect on the estimated RPE for all angiosperms. It is important to note that endemic Monocots are very scarce in areas of low RPE-EUD, which partly explains the total lack of correlation between RPE-MON and RPE of the other superclades (RPE-EUD, RPE-SAS and RPE-SRO).

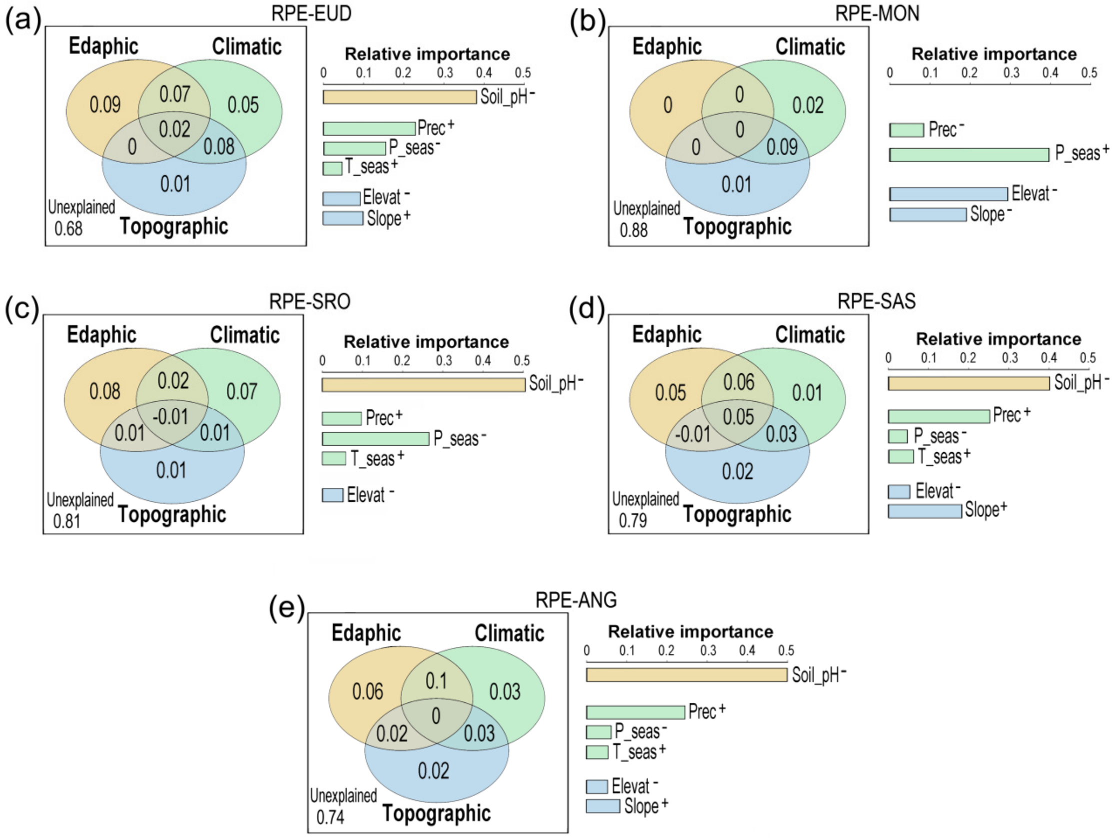

Fig. 4.3 Variation partitioning assessing the contribution of edaphic, climatic and topographic variables and relative importance of individual environmental variables in explaining relative phylogenetic endemism (RPE) at 10 km spatial resolution. (a) Eudicots (RPE-EUD). (b) Monocots (RPE-MON). (c) Superrosids (RPE-SRO). (d) Superasterids (RPE-SAS). (e) all Angiosperms (RPE-ANG). Symbols + and - indicate the sign of correlations. Individual explanatory variables with a contribution < 0.03 are not represented.

In regressions with environmental variables, models at 50 km resolution had significantly greater explanatory power than those at 10 km (Fig. 4.3, Fig. A4.3, Table A4.2). At both resolutions, models of RPE-EUD had the highest overall explained variation ($R^2 = 0.61$ at 50 km and $R^2 = 0.34$ at 10 km), followed in order by RPE-ANG, RPE-SAS, RPE-SRO and RPE-MON. The relative variation partitioning and the relative importance of variables were also very similar at both spatial resolutions.

With regard to differences among superclades, all angiosperms (RPE-ANG) and Eudicot groups (RPE-EUD, RPE-SAS and RPE-SRO) presented similarities in the contribution by groups of variables and in the relative importance of variables. Considering individual fractions, the edaphic predictor explained the greatest variation of RPE for all these groups (Fig. 4.3a,c,d; Fig. A4.3a,c,d) and had a negative effect in all cases. As for climatic variables, annual precipitation had a positive effect on RPE and it was the climatic variable showing the highest relative importance (except in RPE-SRO; Fig. 4.3c), while precipitation seasonality had a negative effect. Topographic variables had low weight; slope was in general the most significant and had a positive effect. Thus, for endemic Eudicots of the study area, high values of soil pH and dry and seasonal climatic conditions are linked to high neoendemism levels (low RPE), while wet mountain areas are potentially linked to paleoendemism (high RPE). In contrast, RPE of Monocots was only positively correlated with precipitation seasonality and negatively with elevation, but both correlations were very weak.

Discussion

Our results provide, for the first time, spatial phylogenetic evidence for a significant role of soil properties in recent plant diversification. Non-phylogenetic geographical patterns of endemism richness in the Iberian Peninsula (Fig. 4.1a,b) agree with the premise that mountain areas are major centers of species richness and endemism in the Mediterranean Basin (Médail & Quézel, 1997; Lobo et al., 2001; Thompson, 2005) as a result of orographic isolation, geomorphological complexity and buffering of climatic fluctuations (Favarger, 1972; Jetz et al., 2004; Ohlemüller et al., 2008; Dobrowski, 2011; see Chapter 2 for details). Indeed, topographic variables (elevation and slope) are those that best explain endemic species richness and range-weighted endemism (WE) for the Iberian flora, followed by climatic variables (particularly precipitation seasonality) (Fig. 4.1c,d). The exceptional proportion of rare endemic species in the Baetic System compared to other Iberian mountain ranges can be explained by those topographic and climatic factors, in combination with historical causes (see Chapter 2 for details). The latter include ameliorated climatic conditions during the glacial-interglacial fluctuations of the Pleistocene as a result of the lower latitude, maritime influence and wide altitudinal range (from 0 to >3000 m a.s.l.), which led to low extinction rates and increased diversification (Carrión et al., 2003; Médail & Diadema, 2009; Molina-Venegas et al., 2013; Harrison & Noss, 2017; see also Chapter 2). In any case, soil pH remained a comparatively poor predictor of non-phylogenetic metrics of Iberian plant endemism (Fig. 4.1c,d).

Calcium-rich substrates fostered recent diversification of Iberian plants

Variation partitioning and relative importance of variables revealed that the edaphic factor is the most important predictor of relative phylogenetic endemism of angiosperms (Fig. 4.3e), which links recent diversification in the Iberian Peninsula to soils developed on carbonate and evaporite rocks (high soil pH). It has been argued that soil type may be more important than climate in determining species composition at a regional scale (Liu et al., 2020). Indeed, biogeographic regionalization of the Iberian Peninsula based on the endemic flora reflects a primary division between the predominantly basic eastern region and the predominantly acidic western region (Moreno Saiz et al., 2013; Buira et al., 2017; see also Chapter 3), and territories with calcareous (basic) soils or with a mixture of both basic and acidic soils are usually richer in plant species (Lobo et al., 2001). In addition, calcareous substrates have been shown to sustain, on average, a larger proportion of range-restricted species than siliceous ones (e.g. Médail & Verlaque, 1997; Smyčka et al., 2017; see also Chapter 5). While the importance of lithology in shaping community structure in the Mediterranean Basin has been pointed out before, quantitative evidence showing its role as a key driver of recent diversification has been lacking until now.

Compared to soil, topography appears to be relatively useless as a predictor of RPE (Fig. 4.3), perhaps because both rapid recent speciation and long-term persistence of endemics can occur together in mountainous areas. In contrast, climatic variables do provide additional insight into RPE. In particular, low annual precipitation and high precipitation seasonality are linked to low RPE values in the Iberian Peninsula. This is in line with the pattern observed in the Baetic-Rifan complex (Molina-Venegas et al., 2017) and in the Mediterranean-type region of California (Thornhill et al., 2017), where neoendemism prevails under drier climatic conditions. It is clear that novel climate regimes of summer drought and aridity established since the Pliocene in the Mediterranean Basin (Suc, 1984) have influenced the rates of speciation and extinction and shaped the patterns of endemism (Hopper & Gioia, 2004; Rundel et al., 2016). In particular, these climatic conditions have been a decisive stimulus for the recent and rapid diversification of several lineages in the Mediterranean Basin (Verdú & Pausas, 2013; Vargas et al., 2018).

Therefore, centers of recent plant diversification in the Iberian Peninsula (Fig. 4.2) are defined by a combination of stressful environmental (edaphic and climatic) conditions. Endemics occurring on calcium-rich substrates are faced with nutritional imbalances, and may be additionally influenced by physical constraints and particular biotic interactions (Mota et al., 2017). Physical and chemical limitations imposed by stressful soils have the strongest impact on plant development under drought conditions

(Escudero, 1996; Kruckeberg, 2004). Thus, intensification of summer drought may have boosted diversification of plant lineages through repeated specialization in contrasting and stressful soils (Molina-Venegas et al., 2015). This has likely occurred to a larger extent in eastern Iberia, which consists mainly of substrates derived from Cenozoic sedimentary deposits (including limestones, marls, dolostones and gypsum), in some places alternating with outcrops of siliceous materials. In Mediterranean-climate regions of western Iberia (mostly consisting of acidic rocks and edaphically more uniform), centers of recent diversification are rare, and they are primarily located in the siliceous Gredos Mountains (the highest mountain range in central Iberia) and the calcareous outcrops of central and southern Portugal (Algarve region) (Fig. 4.2). Limestones and dolostones are also found in the Pyrenees and the Cantabrian Mountains (both within the Eurosiberian bioclimatic region) but high RPE values prevail there, suggesting that, in the absence of summer drought, calcareous substrates have not acted as a driving force of recent diversification.

Many of the most species-rich Mediterranean plant lineages are highly diversified in eastern Iberia (e.g. *Limonium*, Centaureinae, Antirrhineae, *Teucrium*, *Thymus*, *Sideritis* and *Helianthemum* represent nearly 40% of the endemics of the area). The rapid evolutionary radiation of these lineages may be linked to phylogenetically conserved traits adapted to particular environmental conditions (i.e. marked summer drought and stressful substrates). Thus, closely related endemic species frequently co-occur at a regional scale, suggesting that speciation of neoendemics may have taken place in sympatry, parapatry or local allopatry. The speciation mechanism known as ‘budding’, in which a new range-restricted species originates within or at the margin of a surviving ancestral species (Crawford, 2010), seems to be common in the Mediterranean-type region of California (Anacker & Strauss, 2014) and it is probably usual also in the Mediterranean Basin (Papuga et al., 2018; Otero et al., 2019). In this connection, the fine-scale environmental heterogeneity due to soil properties and microclimatic conditions may play an important role in ecological segregation and diversification at a regional scale (Rundle & Nosil, 2005; Anacker & Strauss, 2013; Molina-Venegas et al., 2016).

Contrasting patterns of recent diversification in eudicots and monocots

The analyses based on the largest clades (all Angiosperms and Eudicots) support that RPE patterns have been shaped by environmental conditions as described above (Fig. 4.3a,e). However, the correlations become blurred in the analyses of smaller clades, particularly at 10 km resolution. This is partly because the estimation of RPE in a given cell is more affected by the occurrence of outliers (i.e. range-restricted species derived from extremely long or short branches) when reducing the phylogenetic extent. Moreover, mechanisms other than abiotic environmental factors, such as dispersal limitation and competition, may be more important determinants of RPE patterns of smaller clades (Cavender-Bares et al., 2009; Graham et al., 2018).

As in all Angiosperms and Eudicots, recent diversification (low RPE) in both independent Eudicot clades (Superasterids and Superrosids) is related to high soil pH and dry seasonal climatic conditions (Fig. 4.3c,d). Most large Iberian plant lineages that have radiated under such environmental settings belong to the Superasterid superclade, and there is increasing evidence that these lineages underwent bursts of diversification during the Plio-Pleistocene (e.g. *Limonium*, Lledó et al., 2005; *Centaurea,* Hilpold et al., 2014; *Antirrhinum,* Vargas et al., 2009; *Linaria,* Blanco-Pastor & Vargas, 2013, Fernández-Mazuecos & Vargas, 2015; *Teucrium*, Salmaki et al., 2016). Although the RPE pattern of Superrosids is more diffuse and values are less spatially correlated, the main Iberian centers of recent diversification are still in the south-east (Fig. 4.2c). Superrosids include some clades with well-documented recent radiations consisting of many neoendemics in eastern and particularly south-eastern Iberia (e.g. *Helianthemum*, Martín-Hernanz et al., 2019; *Erodium,* Fiz Palacios et al., 2010), as well as lineages that are highly diversified in other Iberian regions (e.g. Genisteae in the west; *Saxifraga* in northern mountains). Although high-elevation environments are well-known centers of recent diversification (Hughes & Atchison, 2015; Smyčka et al., 2017), our analyses only recovered a mild effect of elevation on RPE for Eudicots. Nonetheless, some Eudicot genera (e.g. *Saxifraga*, *Androsace*, *Ranunculus*) include multiple endemics occurring on the mountain tops of the Pyrenean-Cantabrian range, Sierra Nevada and other mountain ranges, and probably diversified rapidly in these habitats (Vargas 2001; Dixon et al., 2007; Cires et al., 2012).

Contrary to Eudicot clades, recent diversification of Monocots is not associated with soil conditions, and only weakly with low precipitation seasonality and high elevation (Fig. 4.3b). Large numbers of endemic Monocots occur in northern and central-western mountain ranges and in Sierra Nevada, but they are rare in eastern Iberia. Indeed, richness of endemic Monocots is higher in areas of high Eudicot RPE (correlation between endemic Monocot richness and Eudicot RPE is 0.43), and it is low or nil in areas of recent Eudicot diversification. These results indicate divergent patterns of speciation in Monocots and Eudicots. Likewise, the lower ratio of endemism in Monocots compared to Eudicots in the Iberian Peninsula (14% vs. 28%) and in other Mediterranean floras (e.g. Davis et al., 1988; Fennane & Ibn Tattou, 2008) also suggests that environmental conditions boosting recent diversification in certain Eudicot lineages have not driven Monocot diversification to the same degree. Iberian endemic Monocots derived from short branches comprise species of Gramineae (mostly *Festuca*) and *Carex*. More than one third (40%) of these species occur in alpine or subalpine habitats, which explains the low RPE values of some cells in the Pyrenees, Central System and Sierra Nevada (Fig. 4.2b). The recent speciation of these Monocot lineages (e.g. Marques et al., 2016; Jiménez-Mejías et al., 2017) has probably been fostered by orographic isolation, as documented for several plant clades characteristic of high-mountain environments (Comes & Kadereit, 2003; Boucher et al., 2016).

Concluding remarks

The approach used here was successful at identifying centers of recent *in situ* diversification (neoendemism, low RPE) of Iberian plant species and their environmental correlates. Centers of paleoendemism (high RPE), however, should be interpreted with caution. In most cases, high RPE values are the result of endemism being represented by distant relatives rather than by relicts from past climate changes. In fact, impoverished lineages of pre-Mediterranean origin compose only a small fraction of the modern Mediterranean flora (Rundel et al., 2016), and Iberian narrow endemics representing ancient lineages are very rare (Vargas et al., 2020). Nevertheless, high RPE values were generally obtained in areas where there is available evidence for the presence of paleoendemic species, such as the eastern Balearic Islands (Mallorca and Menorca), the central-southern Pyrenees, the mountains of northern Portugal and northwestern Spain, and the Cazorla Mountains in the Baetic region (Fig. 4.2; see Notes A4.1 in Appendix for details). Further investigation, possibly using phylogenies of endemic and non-endemic species, will shed more light on the distribution of paleoendemic Mediterranean lineages.

Patterns of endemic richness and RPE, as well as variation partitioning and relative importance of variables were largely robust to different spatial resolutions. However, phylogenetic uncertainty had a stronger effect at the finer spatial resolution (10 km), and the explanatory power of regressions was significantly lower at this resolution. All metrics used in this work depend on range sizes and on the pool of species recorded in each cell. As a result, metrics are affected by underestimated species ranges and by the incomplete sampling of grid cells (Thornhill et al., 2017; see also Chapter 2). Problems associated with biased distributional data are alleviated by the use of larger grid cells, although this strategy results in coarser patterns that are more difficult to interpret.

Our results provide robust insights into the environmental factors driving recent plant diversification in the Mediterranean Basin, including a role of soil properties that had not been quantified before. Additionally, we show evidence of contrasting environmental drivers of diversification in Eudicots and Monocots, which highlights the importance of analyzing spatial phylogenetic patterns at multiple phylogenetic scales to get a better understanding of the processes that shape biodiversity.

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Appendix Chapter 4

Fig. A4.1 Taxonomic diversity metrics for the Iberian flora at 50 km resolution. (a) Spatial distribution of endemic species richness (ER). (b) Spatial distribution of weighted endemism (WE). (c, d) Variation partitioning assessing the contribution of edaphic, climatic and topographic variables and relative importance of individual environmental variables (symbols + or - indicate the sign of correlation) in explaining (c) endemic species richness (ER) and (d) weighted endemism (WE) at 10 km spatial resolution. Individual explanatory variables with a contribution < 0.03 are not represented.

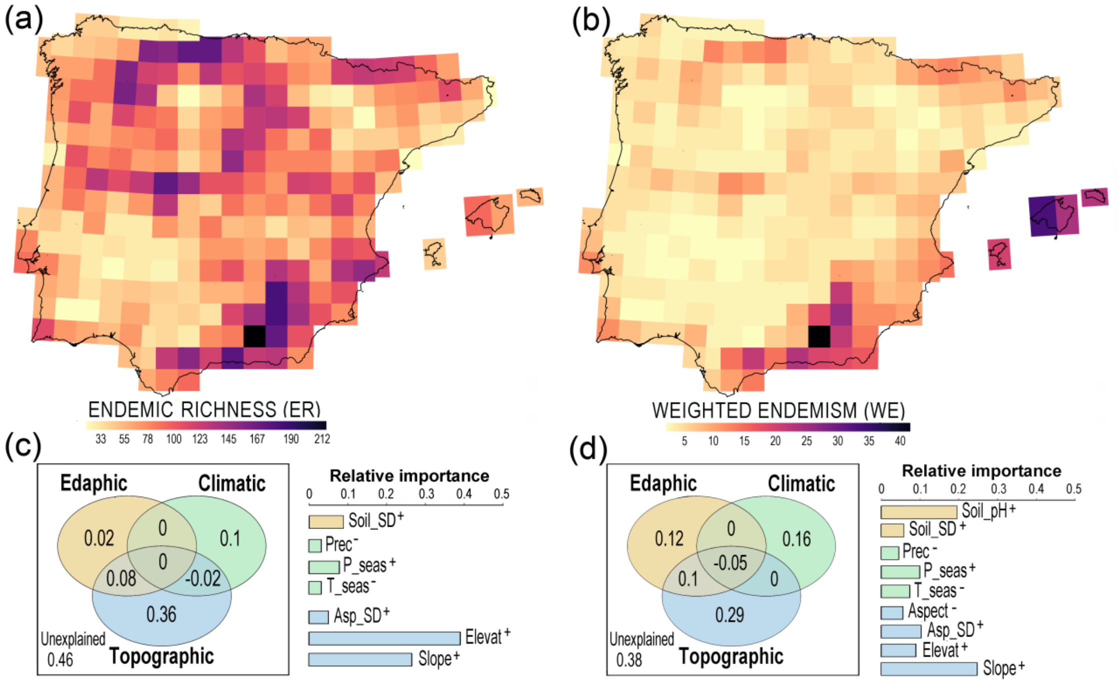
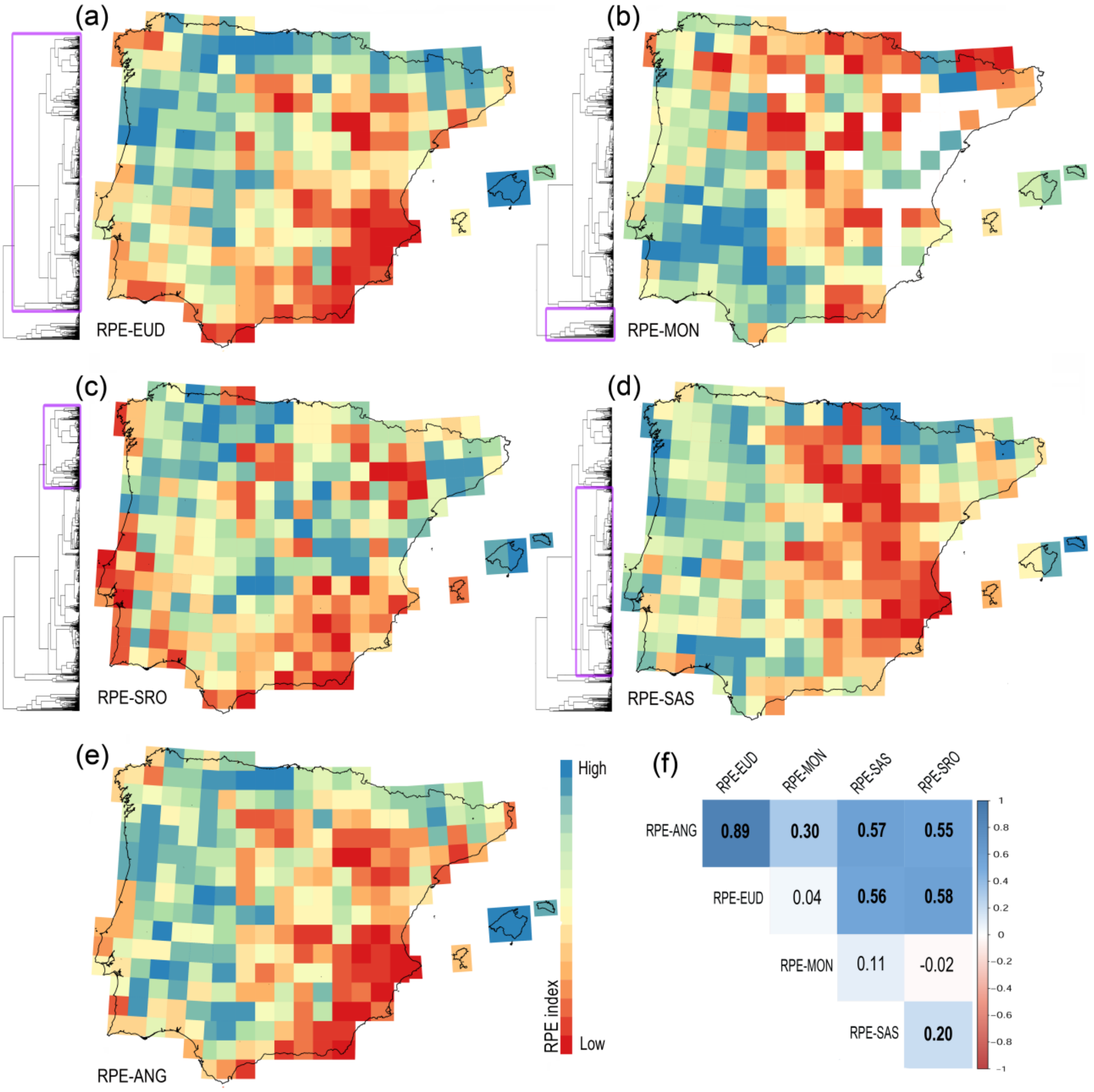


Fig. A4.2 Spatial distribution of relative phylogenetic endemism (RPE) of the Iberian flora at 50 km resolution. (a) Eudicots (RPE-EUD). (b) Monocots (RPE-MON). (c) Superrosids (RPE-SRO). (d) Superasterids (RPE-SAS). (e) all Angiosperms (RPE-ANG). Diagrams on the left of figures a-d show the size and position of each superclade within the phylogenetic tree of the Iberian endemic flora. (f) Correlation matrix among RPE values for all groups; values in bold are statistically significant. Classes of RPE values are visualized by quantiles to make comparisons among groups easier.



	RPE-EUD	RPE-MON	RPE-SAS	RPE-SRO
RPE-ANG	**0.89**	**0.30**	**0.57**	**0.55**
RPE-EUD		0.04	**0.56**	**0.58**
RPE-MON			0.11	-0.02
RPE-SAS				**0.20**

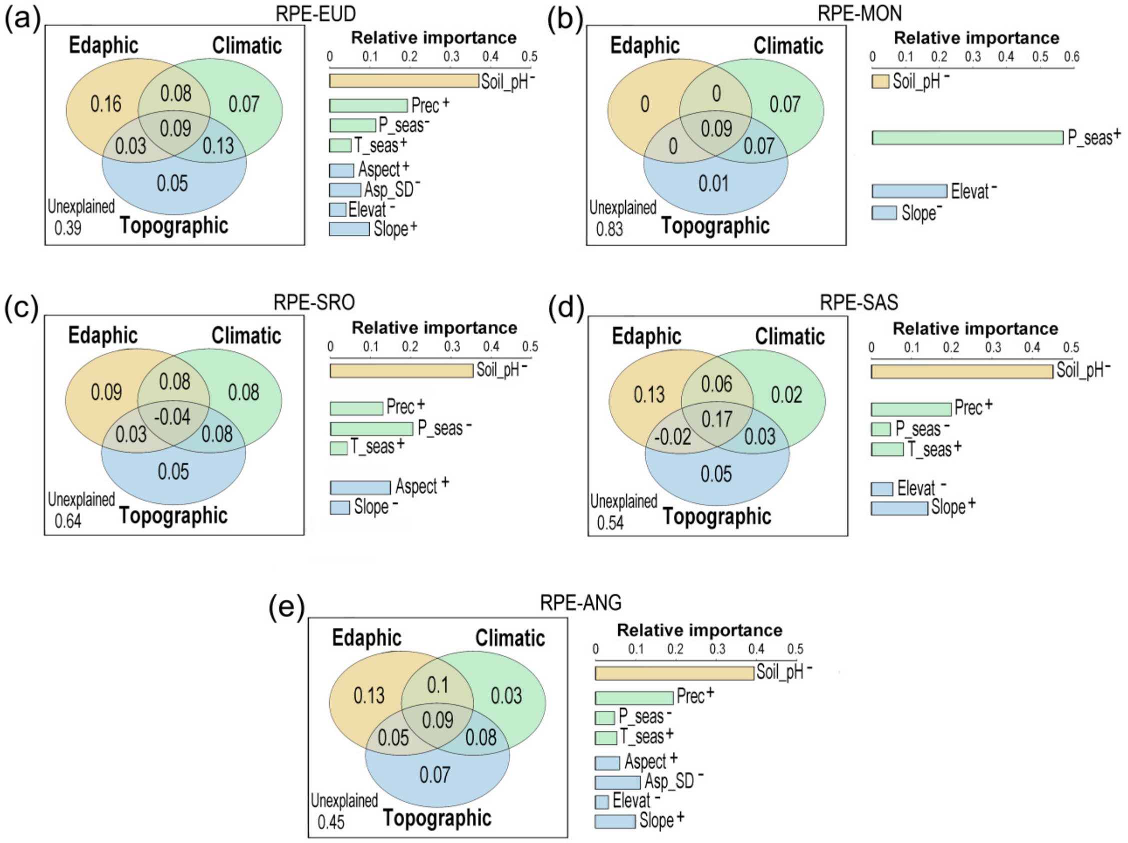


Fig. A4.3 Variation partitioning assessing the contribution of edaphic, climatic and topographic variables and relative importance of individual environmental variables in explaining relative phylogenetic endemism (RPE) at 50 km spatial resolution. (a) Eudicots (RPE-EUD). (b) Monocots (RPE-MON). (c) Superrosids (RPE-SRO). (d) Superasterids (RPE-SAS). (e) all Angiosperms (RPE-ANG). Symbols + or - indicate the sign of correlation. Individual explanatory variables with a contribution < 0.03 are not represented.

Table A4.1 Coefficients of variation expressed as percentage of the relative phylogenetic endemism (RPE) values calculated for the 1000 phylogenetic topologies. Mean and quartiles (*Q1-Q3*) of all grid cells for each group and spatial resolution are presented.

Group	50 km				10 km			
	mean	Q_1	Q_2	Q_3	mean	Q_1	Q_2	Q_3
RPE-ANG	8.2	9.6	7.1	5.5	16.5	20.2	13.3	9
RPE-EUD	7.5	8.9	6.5	5	16.3	20.3	13.2	8.7
RPE-MON	9.2	10.9	7.4	5.6	11.9	15.3	10.4	6.5
RPE-SRO	7.6	9.4	6.5	4.8	12.9	16.5	10.9	7
RPE-SAS	8.7	10.6	7.3	5.1	14.4	18	11.4	7.2

Table A4.2 Total explained variation (R2) and relative importance of individual environmental variable (% of R2) in explaining relative phylogenetic endemism of all Angiosperms (RPE-ANG), Eudicots (RPE-EUD), Monocots (RPE-MON), Superrosids (RPE-SRO) and Superasterids (RPE-SAS) at 10 km and 50 km spatial resolutions. The relative contribution of individual variables is R2 partitioned by averaging over orders.

RPE-ANG			RPE-EUD			RPE-MON			RPE-SRO			RPE-SAS		
	10 km R^2 = 0.28	50 km R^2 = 0.55		10 km R^2 = 0.34	50 km R^2 = 0.61		10 km R^2 = 0.11	50 km R^2 = 0.17		10 km R^2 = 0.20	50 km R^2 = 0.36		10 km R^2 = 0.22	50 km R^2 = 0.46
Var. (sign)	% R^2	% R^2	Var. (sign)	% R^2	% R^2	Var. (sign)	% R^2	% R^2	Var. (sign)	% R^2	% R^2	Var. (sign)	% R^2	% R^2
***Soil_pH* (-)**	**51**	**41**	***Soil_pH* (-)**	**38**	**38**	*Soil_pH* (-)	2	4	***Soil_pH* (-)**	**52**	**35**	***Soil_pH* (-)**	**40**	**46**
***Precip* (+)**	**24**	**20**	***Precip* (+)**	**23**	**19**	*Precip* (-)	9	3	*Precip* (+)	10	14	***Precip* (+)**	**30**	**21**
P_Seas (-)	6	4	*P_Seas* (-)	16	11	***P_Seas* (+)**	**40**	**62**	***P_Seas* (-)**	**27**	**22**	*P_Seas* (-)	_	4
T_Seas (+)	5	5	*T_Seas* (+)	4	4	*T_Seas* (+)	_	2	*T_Seas* (+)	4	4	*T_Seas* (+)	6	8
Elevat (-)	6	3	*Elevat* (-)	10	4	***Elevat* (-)**	**30**	**22**	*Elevat* (-)	4	3	*Elevat* (-)	5	5
Slope (+)	8	10	*Slope* (+)	9	10	*Slope* (-)	19	7	*Slope* (+)	2	4	*Slope* (+)	18	14
Aspect (+)		6	*Aspect* (+)	_	6				*Aspect* (+)	_	15	*Aspect* (+)		2
Asp_SD (-)		11	*Asp_SD* (-)	_	8				*Asp_SD* (-)	_	3			

Explanatory variables are ordered by categories (edaphic, climatic and topographic). Sign of correlation (+) or (-) is indicated next to the variable name. Variables with the highest contribution (> 20 %) within each group are highlighted in bold. Abbreviations of variables are given in Table 1.

Notes A4.1 Supplementary discussion.

Potential refugial areas containing paleoendemic relict lineages

As argued in Materials and Methods, the approach used here was specifically aimed at identifying centers of recent *in situ* diversification (neoendemism) and thus centers of paleoendemism should be interpreted with caution. In most cases, high RPE values are the result of endemism being represented by distant relatives rather than by relicts from past climate changes. In fact, impoverished lineages of pre-Mediterranean origin compose only a small fraction of the modern Mediterranean flora (Rundel at al., 2016), and Iberian narrow endemics representing ancient lineages are very rare (Vargas et al., 2020). Nevertheless, high RPE values were generally obtained in areas where there is available evidence for the presence of paleoendemic species.

One of the clearest examples is the eastern Balearic Islands (Mallorca and Menorca), which show high RPE for all clades, even though the environmental conditions are similar to those that have fostered recent diversification in the Iberian Peninsula. It has been argued that many Balearic endemics are relicts of a former mainland distribution rather than cases of within-island diversification (Contandriopoulos & Cardona, 1984). Phylogenetic studies have proved the validity of such assumption for several lineages, such as the subendemic Araceae (*Helicodiceros muscivorus* and *Arum pictum*; Mansion et al., 2008) and the monospecific genus *Naufraga*, endemic to Mallorca (Fernández-Mazuecos et al., 2014). The climatic stability generated by mild maritime currents is considered one of the main causes for the survival of old lineages on islands (Kier et al., 2009).

Areas of paleoendemism are fuzzy in the Peninsula since strict paleoendemics tend to be highly localized and rarely grouped in spatially correlated cells but, in any event, some cases are commented here. With regard to the Pyrenees, the central-southern region likely acted as a refugium during the last ice ages more than other regions did. Some indirect evidence is the occurrence of putative relict species belonging to tropical families (i.e. *Borderea chouardii*, *Borderea pyrenaica* and *Ramonda myconii*), as well as the higher genetic diversity of their populations (Segarra-Moragues et al., 2007; Dubreuil et al., 2008) and the overall higher level of plant endemism. This region has numerous deep canyons, depressions and cavities created by karst, which provide climatic microrefugia and may have enabled these and other species to survive periods of climatic oscillation (Dobrowski, 2011; Bátori et al., 2017).

The western and southern Atlantic coasts of the Iberian Peninsula with wet and mild climate have served as refugia for several angiosperm relict lineages of the Cenozoic paleoflora (Rodríguez-Sánchez et al., 2010), including some evergreen trees and shrubs (e.g. *Rhododendron ponticum* subsp. *baeticum*, *Prunus lusitanica*) and herbs (e.g. *Drosophyllum lusitanicum*). However, most of these taxa have not been included in our analyses because they do not occur exclusively in the Iberian Peninsula. Nonetheless, some of these areas, such as the mountains of the northern Portuguese coast, still show high RPE values, whereas others typically regarded as refugia, such as the surroundings of the Strait of Gibraltar (Rodríguez-Sánchez et al., 2008), do not show a predominance of high RPE values (but see Molina-Venegas et al., 2017).

While most of the Baetic Mountains were classified as centers of recent diversification according to our analyses, the Cazorla Mountains showed high RPE values. This is one of the most endemic-rich territories of the study area and the environmental conditions prevailing there are apparently those linked to recent diversification (cells including these mountains show the largest residual in regressions). The endemic flora of these mountains certainly consists of many neoendemics, but the presence of some range-restricted species belonging to isolated lineages (e.g. *Solenathus reverchonii*, *Viola cazorlensis*; see Herrera, 1990) and endemic genera (i.e. *Rivasmartinezia cazorlana* and *Castrilanthemum debeauxii*, the latter documented as an ancient lineage, see Vargas et al., 2020), suggests that the area has also served as a refugium for paleoendemics. Similarly, the northwestern Iberian mountains (León Mountains) have the highest concentration of species belonging to Iberian endemic genera (up to 8 genera in a single 50 × 50 km grid cell, see Chapter 2) and also showed high RPE values in our analyses. However, the paleoendemic status of these genera is disputable in most cases and only two of them (*Phalacrocarpum*, see Tomasello et al., 2015, and *Gyrocarium*, see Vargas et al., 2020) have been documented as veritable ancient lineages.

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Chapter 5

Habitat characteristics related to plant endemism, rarity and conservation status

This chapter is published in Buira, A., Cabezas, F. & Aedo, C. (2020). Disentangling ecological traits related to plant endemism, rarity and conservation status in the Iberian Peninsula. Biodiversity and Conservation, 29, 1937-1958.

Abstract

The flora of the Iberian Peninsula is very rich in endemic taxa (1823 taxa), nearly the 50% are regarded as narrow endemics, and the 25% are considered to be at risk. Here, we evaluate the ecological dissimilarity between endemic and native plant species and explore the habitat characteristics related to rarity and conservation status using correspondence analysis and logistic regression. Similarly to other Mediterranean regions, restricted-range plant species were found to be prevalently adapted to stressful habitats in which aboveground competition is relatively low. The greatest richness of narrow endemics occurred in mid-altitude calcareous rocky environments, and secondarily in open Mediterranean shrubby formations. Coastal, steppic and alpine habitats contributed to endemism in specific regions and the species in them tended to have smaller ranges. Most endemics showed either a strong preference for calcareous or siliceous substrates, and many narrow endemics (nearly 20%) were found to grow on special substrates such as gypsum or dolomites. All this reinforces the hypothesis that soil properties and habitat conditions may play an important role in ecological segregation and speciation at a regional scale. On the other hand, certain ecological settings were more likely to contain threatened species than others, wet lowlands, coastal habitats and steppic scrub being the most significant in decreasing order. On the contrary, a large proportion of endemics occurring in montane and alpine habitats are regarded as non-threatened at present. Nevertheless, some centers of endemism located at high elevations are at risk due to global warming.

Introduction

Following Reveal's definition (Reveal, 1981), rarity is merely the current status of an extant organism which, by any combination of biological or physical factors, is restricted either in numbers or area to a level that is demonstrably less than the majority of organisms of comparable taxonomic entities. Thus, in simple terms, rare species are those having low abundance and/or small range (Gaston, 1994). Although both traits do not necessarily concur (Rabinowitz, 1981), several studies further show that rare species tend to have simultaneously low abundances and small range sizes (e.g. Gaston, 1994; Gaston & Blackburn, 2000; Yin & He, 2014).

At large scale, endemism and rarity are closely related concepts, since endemic species occur within a defined geographic area and nowhere else (Gaston, 1994). The Mediterranean region is distinguished by the great richness of narrow endemic species (i.e. being unique to a well-defined small area; Kruckeberg & Rabinowitz, 1985), which account for more than half of all species restricted to the region (Thompson, 2005). Mediterranean narrow endemics are largely clustered in species-rich lineages (Lavergne et al., 2004; Buira et al., 2017), most of which are thought to be of recent origin (Verlaque et al., 1997; Rundel et al., 2016). In comparison with widespread species, Mediterranean rare endemics are more adapted to harsh habitats with low competition (e.g. rocky, sloping and open habitats) and tend to show altitudinal zonation and preference for particular soil types (Médail & Verlaque, 1997; Lavergne et al., 2004; Thompson et al., 2005).

Rarity is also the main determinant of a species' risk of extinction (Gaston & Fuller, 2009). Besides the current range and population sizes, the IUCN Red List (UICN, 2012) also considers criteria as the rate of decline, the degree of habitat fragmentation, and the potential future threats. Many endemic plant species of recent origin are inherently rare and at risk of extinction (Davies et al., 2011); however, it is clear that rarity of several species at present is due to human activity (Hodgson, 1991; Di Marco & Santini, 2015; Le Roux et al., 2019). Thus, regardless of their degree of rarity, plants occurring on naturally sheltered habitat types are likely to be at lower risk of extinction than those growing on environments that tend to be anthropized (Silcok & Fensham, 2018). In this sense, identifying the ecological and biological characteristics related to both rarity and conservation status may shed light on the question of whether threatened endemics are intrinsically rare or as a result of anthropogenic disturbances. Likewise, finding habitat characteristics correlated with the occurrence of threatened plants may be useful to target conservation strategies at assemblages of vulnerable species.

The flora of the Iberian Peninsula is very rich in endemic taxa (1823 taxa), nearly half are regarded as narrow endemics, and many of which are in turn considered to be at risk. Whereas the spatial pattern of plant rarity has broadly been explored in the Iberian Peninsula (e.g. Domínguez-Lozano et al., 1996; Domínguez-Lozano et al., 2000; Buira et al., 2017), so far, any study has focused on examining habitat characteristics related to endemism, rarity and conservation status. Here we draw on a large database including habitat characteristics, plant traits and conservation status for all Iberian and Balearic endemic taxa to (i) evaluate ecological differences between endemic and native flora (ii) explore the habitat characteristics and plant traits associated with rarity; and (iii) identify variables other than range size related to the conservation status. We hypothesize that narrow endemics are specialized to particular soil and habitat conditions and that some ecological settings are more likely to contain threatened species than others.

Materials and methods

Study area

The study area comprises the Iberian Peninsula (continental Spain and Portugal and Andorra), the whole Pyrenees mountain range (including the northern side, located in southern France), and the Balearic Islands (Fig. 2.1). See *Study area* in Chapter 2 for further detail about geology and climate.

Endemic taxa and range size measure

We used as a basis of this study an updated list (see Chapter 2 for details) that includes all species and subspecies endemic to the study area (see Fig. 2.1). This list was based primarily on *Flora iberica* (Castroviejo, 1986-2019), and it was updated with new taxa published subsequently and revised on the basis of more recent taxonomic monographs.

Distributional data were obtained from the Anthos (www.anthos.es), Flora-On (www.flora-on.pt) and Atlas of the Pyrenean Flora (www.florapyrenaea.com) databases, which compiled about 70,000 unique records on UTM 10×10 km grid cells for the target taxa. Several steps of data quality checking were conducted to remove potential errors (see Chapter 2 for details). The species range size was measured by the Area of Occupancy (AOO), i.e. the area within the extent of occurrence which is occupied by a taxon (Gaston, 1991). It was estimated by the total number of 10×10 km cells in which the species occurred. All taxa were classified into 4 range size levels (very narrow, narrow, wide and very wide) by dividing the total sample into 4 equal-sized groups.

IUCN categories

The IUCN categories were based on the last updated Red List of Spain (Moreno, 2011) and the recent Red List of mainland Portugal (www.listavermelha-flora.pt). We adapted both lists to the taxonomic criteria used in our list. For example, *Narcissus nevadensis* is considered to have a very narrow range in the Spanish Red List, whereas in *Flora iberica* is deemed to be widely distributed because different taxonomic circumscriptions are used. We also adapted the categories to the whole study area (i.e. considering the species' global populations). Thus, 40 taxa occurring in both countries (Spain and Portugal) and catalogued in either or both Red Lists were assigned to the lowest category of threat. A total of 22 endemic taxa described after the publication of the Spanish Red List were firstly assessed here using information from the original source of publication or personal communications of authors or experts. Taxa whose distribution data were deficient or inconsistent were classified as Data Deficient (DD) and excluded from all analyses.

Additionally, the number of threatened taxa occurring in 50×50 km cells was counted and mapped in pie charts together with the weighted endemism (WE) metric (Crisp et al., 2001).

Habitat characteristics, life-forms and lineages

All taxa were classified into habitat types, soils (edaphic preference), altitudinal ranges and life-forms (see Supplementary Material). The 15 most species-rich lineages (accounting for 45% of all endemics) were also used to test if certain taxonomic groups were more likely to be narrowly distributed and threatened than expected by chance (see below). The specific categories are defined below; the words in italics are the names of the categories used in results, tables and graphs.

- Habitats: 11 categories (Fig. 5.1) adapted from the hierarchical levels 1 and 2 of the EUNIS habitat classification (Davies et al., 2004). These include perennial and annual grasslands (*Grassland*); Mediterranean dwarf scrub formations (*Med. scrub*); gypsicolous and halo-nitrophilous steppic scrub (*Steppic*); heaths and other mesic silicicolous scrub (*Heath*); alpine vegetation (*Alpine*); rocky environments (*Rocky*); deciduous, conifer and mixed forests (*Forest*); live oaks and secondary sclerophyllous formations (*Sclerophyll*), bogs, fens, springs, waterbodies shores and temporary ponds (*Wetland*); coastal marshes, sands and sea-cliffs (*Coast*); disturbed places and crops (*Ruderal*).

- Soils: *Indifferent,* calcareous (*Ca*), siliceous (*Si*) and *Special,* including gypsum (*Gyp*), serpentines (*Serp*), dolomites (*Dol*) and haline soils (*Hal*). The information was obtained from *Flora iberica* and checklists of Iberian gypsophytes (Mota et al., 2009) and Baetic Dolomite flora (Mota et al., 2008).
- Altitudinal ranges: 0-400 (*400 m*), 401-800 (*800 m*), 801-1200 (*1200 m*), 1201-1800 (*1800 m*) and 1801-3400 (*3400 m*) meters. Ranges were established by calculating the elevation mean of each taxa and dividing the total sample into five subequal-sized groups.
- Life-forms: phanerophyte (*Ph*), chamaephyte (*Ch*), hemicryptophyte (*He*), therophyte (*Th*) and geophyte (*Ge*) (adapted from Raunkiaer, 1934).
- Lineages: 4 at genus level, i.e. *Limonium, Armeria*, *Teucrium* and *Saxifraga*; and 11 at subtribe or tribe level, i.e. *Centaureinae*, *Antirrhineae*, *Poeae*, *Sileneae*, *Alsineae*, *Loteae*, *Mentheae*, *Genisteae*, *Rubieae*, *Stachydeae* and *Geranieae*. All these tribes and genera constitute true lineages supported by molecular data (see diagram in Fig. A5.1 in Appendix).

Endemism-related characteristics and analysis of rarity

Chi-square tests were used to determine whether endemic taxa and total native taxa were distributed in the same frequency with regard to categories of habitat, soil and life-form. The ratio between the frequency of endemic taxa and the frequency of total native taxa for a given category was used to estimate its degree of association with endemism. The values >1 indicate positive association and values <1 indicate negative association. The statistical significance of association to endemism for a given category was assessed by building Bonferroni confidence intervals (Byers & Steinhorst, 1984). Additionally, we explored the representativeness of the different types of habitat in each phytogeographical region defined in Chapter 3. To that end, a graphical matrix was plotted using the percentages of endemic taxa and total native taxa for habitat categories (rows) within each region (columns).

A correspondence analysis (CA) was carried out to explore which habitat characteristics, plant traits and lineages were more related to rarity. We used the four categories of range size as columns and the habitat characteristics (altitudinal range, soil and habitat type), life-forms, and lineages as rows. The dependency between rows and columns was evaluated using the chi-square statistic. The eigenvalues retained by each dimension (axis) were extracted and the two first dimensions were used to draw a symmetric biplot, in which both rows and columns were represented in the same space using the principal coordinates. *FactoMineR* R package (Lê et al., 2008) was used to compute the CA and *factoextra* (Kassambara & Mundt, 2017) was used to extract and visualize the results. Due to the enforced differences on range size in the island territories, the species of the Balearic Islands were not included in this analysis.

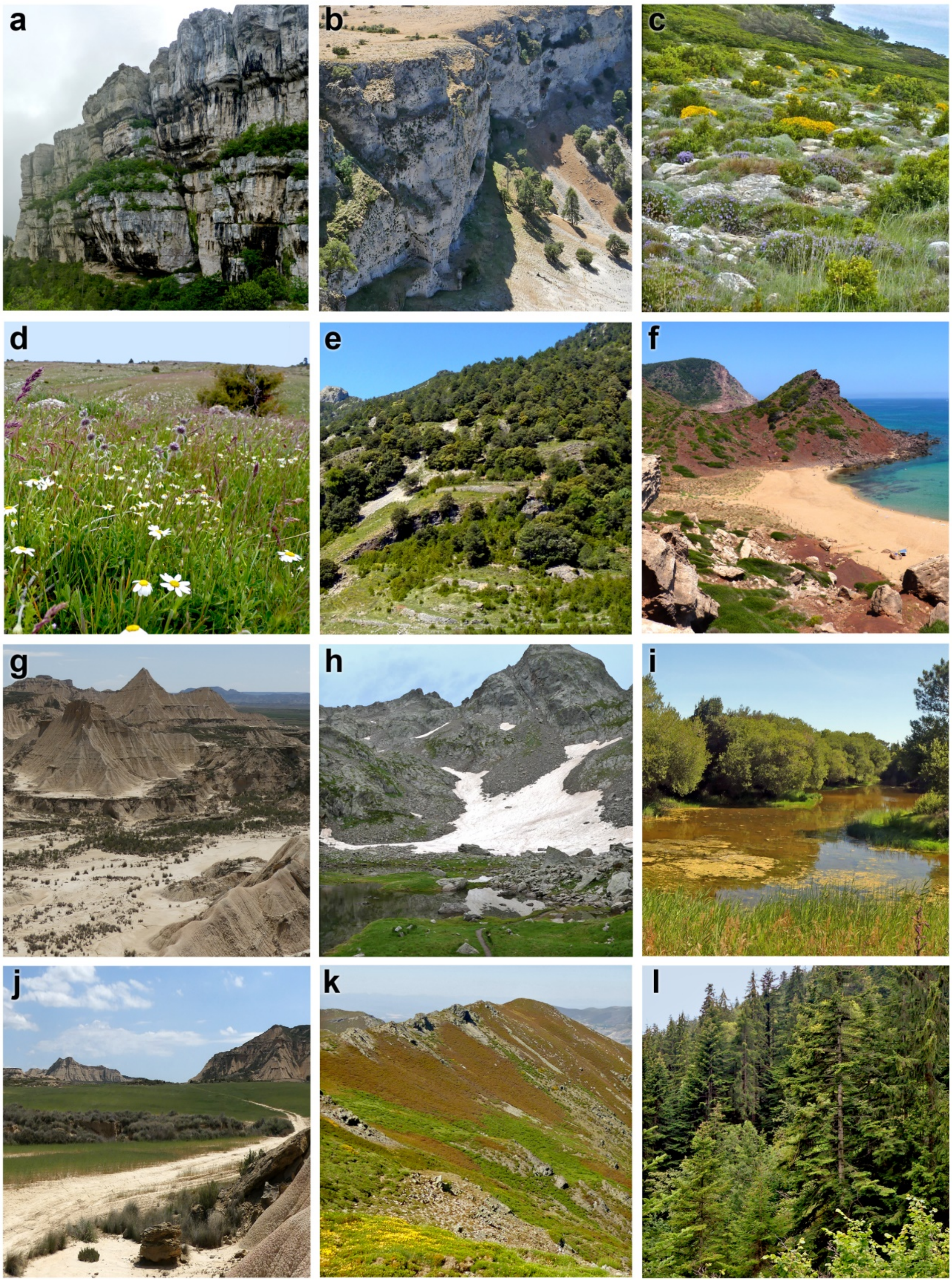

Fig. 5.1 Examples of the 11 habitat categories in the Iberian Peninsula: (a, b) Rocky, (c) Mediterranean scrub, (d) Grassland, (e) Sclerophyll, (f) Coast, (g) Steppic, (h) Alpine, (i) Wetland, (j) Ruderal, (k) Heath, (l) Forest.

Variables associated with risk categories and logistic regression

In order to explore which variables other than range size had significant effect on the species conservation status, we carried out chi-square tests and logistic regression. For these analyses we used a subset (770 taxa) including all endemics within the categories “very narrow” and “narrow” (AOO <20 cells of 10 km), which covered the 95% of all threatened taxa. The subset was divided into 3 similar-sized groups according to the IUCN categories of the taxa, i.e., low risk (LC+NT: 332 taxa), high risk (VU: 238 taxa) and very high risk (EN+CR: 200 taxa). We firstly tested separately whether habitats, altitudinal ranges, regions and lineages were significantly associated with the risk categories and also tested the differences between means of AOO at every level of the risk categories.

A total of four logistic models were built, two of them using a binary response variable (non-threatened: LC + NT; threatened: VU+ EN+CR), and the other two using an ordered response variable with 3 risk categories (low risk: LC+NT; high risk: VU; very high risk: EN+CR). In turn, two models (one binary and one 3-ordinal) were calculated using only the AOO as independent variable and the other two using the AOO plus several variables, i.e. taxonomic rank (species or subspecies), elevation mean, habitat, life-form, region, and human influence variables. A Likelihood Ratio Test was performed on the models to get a sequential analysis of deviance and see the drop in residual deviance when adding each variable one at a time. We finally assessed the predictive ability on each model running a 10-fold cross validation. *MASS* R package (function *polr*, Venables & Ripley, 2002) was used to fit the ordered logistic models and *caret* R package (Kuhn, 2008) to validate the models.

Regions were reduced to six by grouping them on the basis of their closest intercluster distance (see Fig. 3.1 in Chapter 3). Human influence variable was based on the mean values of the Global Human Influence Index (Wildlife Conservation Society, 2005) in the cells where species occurred. Lineage category was not used in the regressions, as it has too many levels. Similarly to CA analysis, taxa of the Balearic Islands were not included in regressions.

Results

Habitat characteristics and life-forms related to endemism

With regard to the representativeness of the habitats, several differences were observed among regions (Fig. 5.2). *Rocky* habitat accounted for the greatest number of endemics in many regions (*BI*, *BS*, *CM* and *PYR*), as well as it was the largest one for the whole territory (Fig. 5.2, 5.3a). This habitat was also highly associated with endemism, since the relative portion of total native taxa growing on it was much lower in all situations. *Med. scrub* habitat was also positively related to endemism; it accounted for 15% of all endemics (Fig. 5.3a), and it was particularly well represented in all eastern regions (*BI*, *BS*, *CRE*, *IS* and *SEC*).

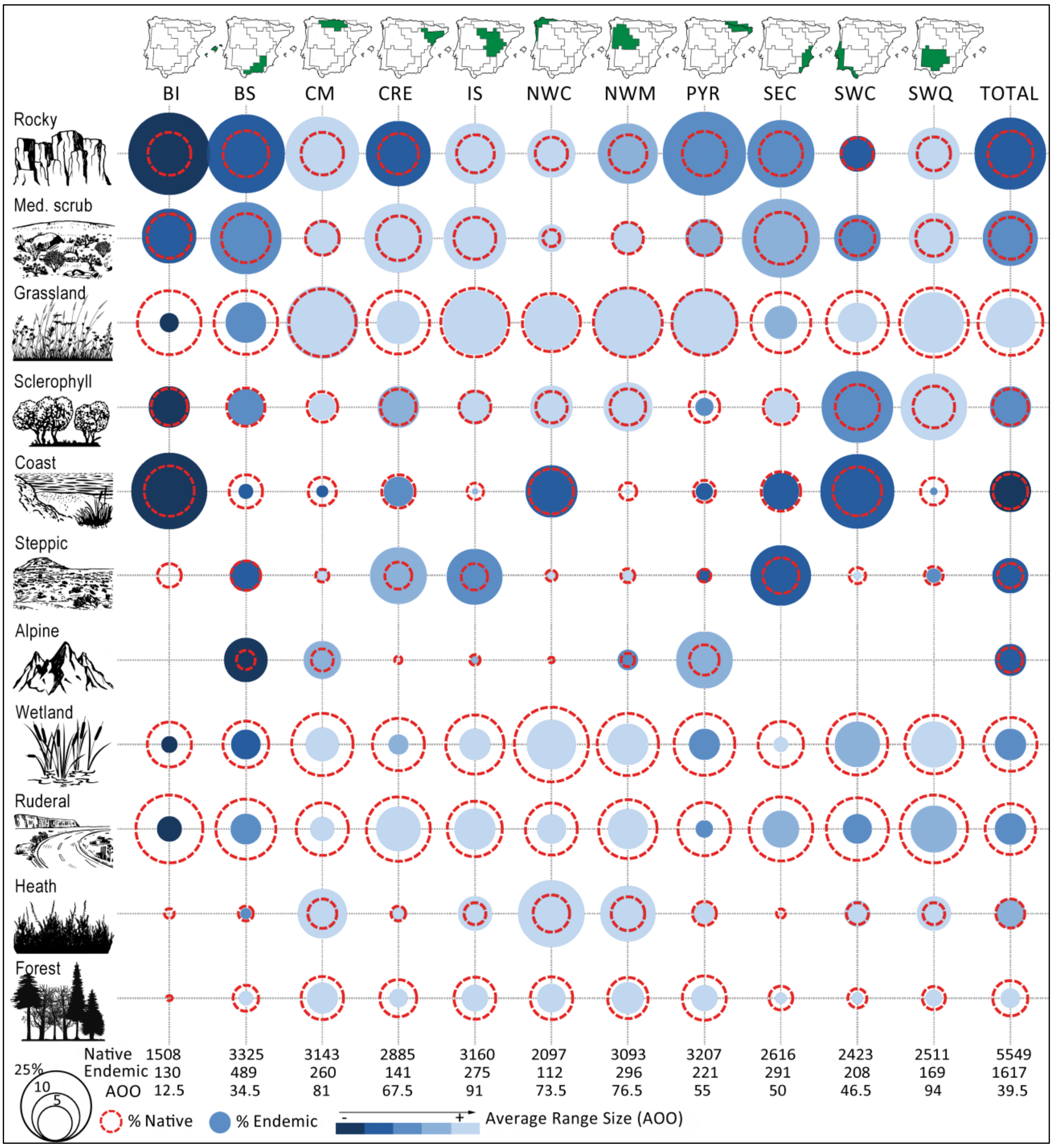

Fig. 5.2 Ballonplot showing the percentage of Iberian endemic taxa (filled blue circles) and total native taxa (red empty circles) for habitat categories (rows) within each region (columns). Habitats are ordered from top to bottom by the total number of endemics. Blue scale shows the average range size of the endemics for each situation. The number of native taxa, endemic taxa and range size mean (AOO in 10×10 km cells) per region are indicated at the bottom of the chart. Occasional taxa for a given region are not included.

Grassland also included a large portion of endemics in most regions but it was negatively associated with endemism, since the relative frequency of total native species was much higher, just like in *Wetland*, *Ruderal* and *Forest* habitats. *Coast* habitat consisted of many endemics in the Balearic Islands (*BI*) and in the western Atlantic coast (*NWC* and particularly *SWC*) but it was of little importance in other regions (even if they had coastal land). *Steppic* was only well represented in some regions, particularly in the semiarid areas of the Ebro depression (*CRE*), southern plateau (*IS*) and southeastern Iberia (*SEC*). Similarly, alpine endemics only occurred in the high mountain regions, basically Pyrenees (*PYR*), Cantabrian Mountains (*CM*) and Sierra Nevada (within *BS*).

With regard to soils, both siliceous (*Si*) and calcareous (*Ca*) were positively associated with endemism, although *Ca* represented a much larger proportion (41%) of endemics than *Si* (24%; see Fig. 5.3b). The relative percentage of native plants for both substrates was instead pretty similar. *Indifferent* was negatively associated with endemism, while *Special* showed a strong positive association. Almost 70% of Iberian taxa growing preferably on gypsum soils were endemic; the proportion was even higher for dolomite and serpentine specialized plants (nearly 85%). In contrast, haline soils included a large number of non-endemic species, and most of the endemics were species of *Limonium.* Endemics growing on special substrates comprised the 12% of all Iberian endemics (20% of all narrow endemics).

No major differences were observed between the altitudinal distribution of the total native taxa and the endemics (Fig. 5.3c), but a greater percentage of endemic taxa was found in the highlands (above 1500 m). As for the life-forms, endemics were mostly represented by chamaephytes (*Ch*) and hemicriptophytes (*He*), although *Ch* showed a stronger association with endemism (Fig. 5.3d). Phanerophytes (*Ph*), geophytes (*Ge*) and therophytes (*Th*) forms were less frequent in the endemic group. *Th* showed indeed a strong negative association with endemism.

Correspondence analysis of rarity

The chi-square test (chi-square: 464.98, p-value = 6.25e-42) showed that range size categories (rows) and plant characteristics (columns) were significantly associated. The first two axes of the correspondence analysis (Fig. 5.4) explained 94.2% of the total variation, particularly the dimension 1 explained the most variance in the solution (85.6%). The attributes *very wide* and *very narrow* were highly discriminating, while *narrow* and *wide* were closer to the origin and thereby less differentiated based on the data. The row items *400 m*, *Special*, *Alpine*, *Coast*, *Grassland*, *1200 m*, *Limonium*, *Indifferent*, *Genisteae*, and *3400* m were the most important in decreasing order on the definition of the first dimension. As regard for columns, only *very narrow* and *very wide* were well displayed on the first dimension (40% and 50% of contribution respectively).

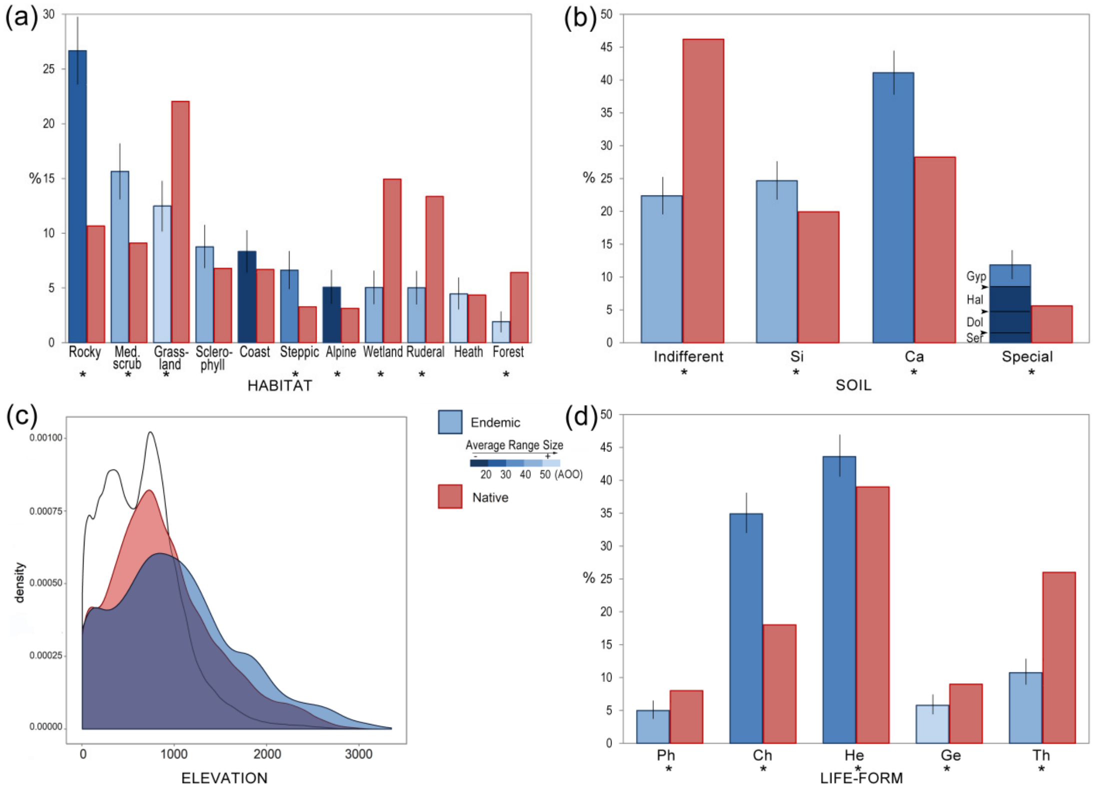

Fig. 5.3 (a,b,d) Percentage of total endemic taxa (blue) with confidence intervals and total native taxa (red) for different categories of (a) habitat, (b) soil and (d) life-form. Categories significantly associated (positively or negatively) with endemism are indicated with an asterisk (*); chi-square tests of homogeneity are showed in Table A5.1.Blue scale shows the average range size (AOO in 10×10 km cells) of the endemic taxa for each category. (c) Proportion of total surface area (empty), percentage of total endemic taxa (blue) and percentage of total native taxa (red) along the altitudinal gradient.

The altitudinal ranges *3400 m* and particularly *400 m* had an important contribution to the positive pole of the first dimension, indicating that endemics of the most extreme altitudinal belts are more frequently narrowly distributed. By contrast, *1200 m* contributed to the negative pole indicating that it is more related to wide distributions. All other altitudinal ranges were little differentiated. As regard to the habitat types, *Alpine* and *Coast* had the strongest relationship with *very narrow* and *narrow* attributes, while *Heath*, *Forest* and *Grassland* were highly associated with wide range sizes. *Coast* endemics had also the lowest range size mean (Fig. 5.2). It should be noted that certain habitats had significant differences in average range size among regions. For instance, alpine endemics from Sierra Nevada (*BS*) showed narrower distributions than those from Pyrenees (*PYR*) and Cantabrian Mountains (*CM*) (Fig. 5.2). In fact, range sizes of the endemics of Balearics (*BI*) and Baetic System (*BS*) were smaller for almost all habitats.

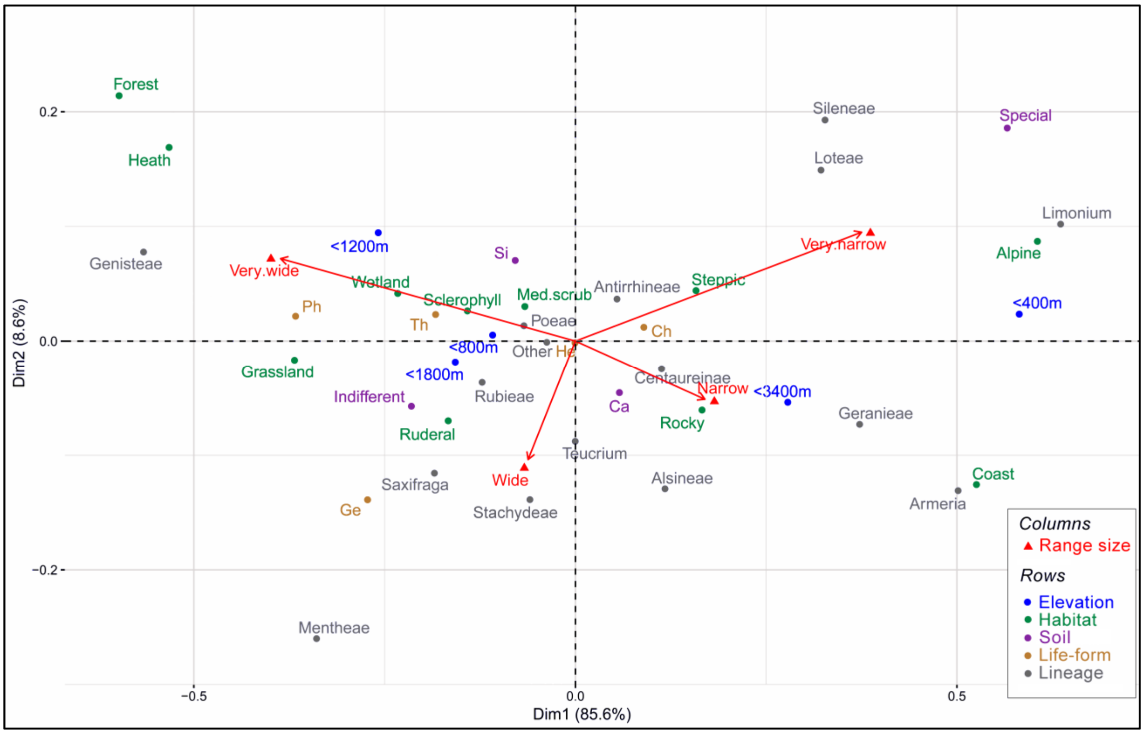

Fig. 5.4 Symmetric biplot from a correspondence analysis (CA) in which both columns (red triangles) and rows (dots) are represented in the same space using the principal coordinates. Column items are ordinal levels of range size and row items are habitat characteristics and plant traits colored by group: altitudinal range (blue), habitat type (green), soil (violet), life-form (orange) and lineage (grey).

Ca and *Si* soils were both close to the origin, although both the symmetric biplot (Fig. 5.4) and the average range size (Fig. 5.3b) show that *Ca* is somewhat more related to rarity than *Si*. *Special* category contributed the most to the positive pole, so it is highly associated with the rarity attribute, although gypsum (*Gyp*) subset had larger average range size (Fig. 5.3b). There was not any strong association between life-forms and categories of range size, only *Ge* and particularly *Ph* were moderately associated with the wide distribution. In terms of large plant lineages, *Sileneae*, *Loteae* and particularly *Limonium* were highly associated with *very narrow* attribute and *Armeria* and *Geraniae* with *narrow*. On the opposite, *Mentheae* and *Genisteae* had a strong relationship with the categories *wide* and *very wide* respectively.

IUCN categories and threatened taxa distribution

A total of 455 taxa (25% of the total endemics) were classified as threatened (CR: 101, EN: 106 and VU: 248), 1159 as non-threatened (NT: 119 and LC: 1040) and 3 as extinct (EX or EW). A total of 206 taxa (11%) taxa were classified as DD, mostly represented by *Alchemilla* (17%), *Limonium* (13%), *Taraxacum* (8%) and *Armeria* (7%) genera (See Supplementary Material). Threatened taxa were largely clustered in species-rich. The 49% of the threatened taxa were clustered in the 15 most species-rich lineages. Note that this percentage is even greater than that of all endemics (45%).

The number of threatened taxa per cell (Fig. 5.5) was highly correlated with the weighted endemism variable (Pearson's correlation = 0.81). The greatest concentrations of threatened taxa were found in the endemic-rich cells of the Baetic Mountains, Mallorca and southwestern coast.

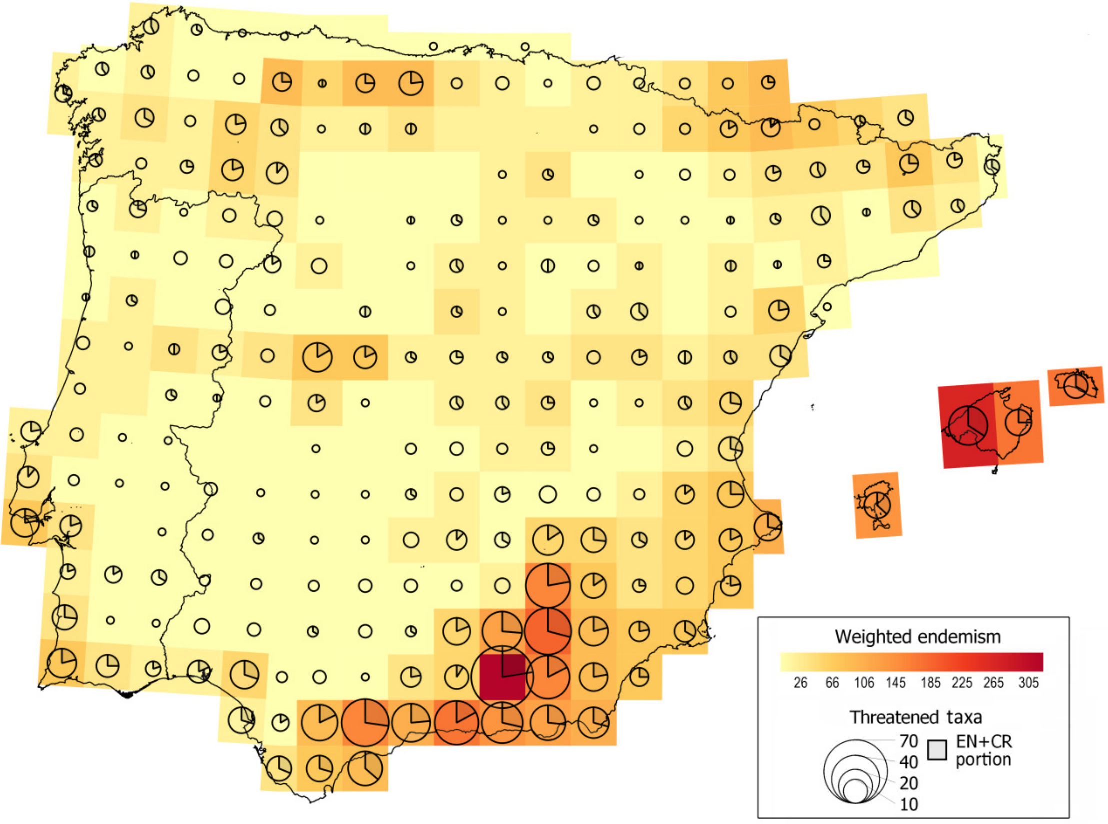

Fig. 5.5 Threatened taxa occurring in 50×50 km cells represented by scaled circles (small shaded portion is EN+CR percent) and weighted endemism (WE) represented by yellow-orange-red color scale. WE is calculated by the sum of the inverse range sizes of the total endemic species occurring within each grid cell.

Variables associated with risk categories and logistic regression

Chi-square tests showed significant differences among regions regarding the relative frequency of narrow endemic taxa per risk category (see mosaic plots and results of tests in Fig. A5.2 in Appendix). *BI* had a larger portion of non-threatened taxa (LC+NT) than expected by chance. In addition, the averages AOO for VU and EN+CR categories were significantly lower compared with those of the other regions. *CM+PYR* and *CRE+IS* had also a larger portion of non-threatened taxa (LC+NT) than expected. Habitats were also significantly associated with the risk categories (see Fig. A5.3). *Wetland, Coast*, and *Steppic* (in decreasing order of magnitude) had larger proportions of threatened taxa than expected, while *Sclerophyll* and *Alpine* were the opposite. In addition, *Wetland* had the highest average AOO for VU category, while *Alpine* had the lowest one (Fig. A5.3). With regard to the elevation, the lowest altitudinal range (*400 m*) gathered almost a third (30%) of the total threatened taxa, while the other ranges (*800*, *1200*, *1800* and *3400 m*) had lower and roughly equal percentages of threatened taxa (between 17 and 19%). Lineages and risk categories were also significantly associated (see Fig. A5.4). *Limonium*, *Antirrhineae*, *Sileneae* and *Armeria* included a larger proportion of threatened taxa than expected by chance, while *Teucrium, Mentheae* and *Stachydeae* (all included in the Lamiaceae family) had fewer endangered species than expected. Any significant association between life-forms and risk categories was found.

Measures of goodness-of-fit of logistic regression (Table 5.1) showed that multiple models (using all variables) fitted better than simple models (using only AOO). Similarly, the accuracy in predicting independent test observations slightly increased in both multiple models. The sensitivity and specificity measures of the binary models were roughly balanced (results of the binary classification are in Supplementary Material). The deviance table of the binary logistic model (Table 5.2 below) indicated that all variables except the *Human influence* had a significant association with the response, but logically AOO was by far the variable that reduced the most the residual deviance of the null model. Although far from AOO, Habitat was the second most relevant variable. Only *Coast*, *Rocky*, *Steppic* and *Wetland* were significant in the model and all had positive coefficient (Table 5.2), indicating that plants growing on these habitats are more likely to be threatened. *Wetland* had the highest effect size followed by *Coast*. The taxonomic rank had also a positive coefficient, indicating that there was a higher relative frequency of threatened taxa at the species level than at the subspecies level. The two significant levels of region were *CM+PYR* and *CRE+IS* and both had negative coefficient.

Table 5.1 Comparison of goodness-of-fit measures (residual deviance and AIC) and accuracy (calculated by 10-fold cross validation) of the 4 logistic models.

	Simple Model (only AOO)			Multiple Model (all variables)		
	Accuracy	*Deviance*	*AIC*	*Accuracy*	*Deviance*	*AIC*
Binary response: non-threatened/threatened	0.74	724	728	0.79	633	688
3-Ordinal response: low risk/high risk/very high risk	0.57	1190	1196	0.63	1080	1136

Table 5.2 Binary logistic model of conservation status (threatened/non-threatened) using logarithm of AOO, elevation mean, taxonomic rank, life-form, habitat, region and human influence as predictors. The table of deviance (below) shows the drop in residual deviance when adding each variable one at a time.

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-1.16	0.51	-2.30	0.02	*
AOO	-1.52	0.14	-10.77	0.00	***
Elevation mean	-0.15	0.19	-0.79	0.43	
Species rank	0.82	0.22	3.97	0.00	***
Life-form Ge	-0.14	0.53	-0.25	0.80	
Life-form He	0.34	0.23	1.47	0.14	
Life-form Ph	1.07	0.65	1.91	0.06	.
Life-form Th	0.83	0.39	2.13	0.04	*
Alpine	-0.71	0.58	-1.24	0.21	
Coast	2.03	0.79	2.58	0.01	**
Forest	0.90	0.64	1.41	0.16	
Grassland	1.09	0.53	2.07	0.06	.
Med. scrub	0.75	0.49	1.52	0.13	
Rocky	1.25	0.44	2.86	0.00	***
Ruderal	0.96	0.71	1.35	0.18	
Steppic	1.27	0.60	2.08	0.04	*
Wetland	2.55	0.60	4.28	0.00	***
CM+PYR	-0.69	0.33	-2.07	0.04	*
CRE+IS	-0.84	0.35	-2.42	0.02	*
NWC+NWQ	0.00	0.33	0.00	1.00	
SWC+SWQ	-0.20	0.39	-0.52	0.60	
Human influence	0.00	0.10	0.15	0.87	

Null deviance: 910.4 on 680 df Residual deviance: 633.61 on 660 df AIC: 687.61

All continuous predictors are mean-centered and scaled by 1 standard deviation

Analysis of deviance table (terms added sequentially)

	Df	Deviance	Resid. Df	Resid. Dev	Pr(>Chi)	
NULL			680	910.4		
AOO	1	182.54	679	727.86	< 2e-16	***
Elevation mean	1	15.62	678	712.24	1.32e-4	***
Species rank	1	12.16	677	700.08	4.88e-4	***
Life-form	4	10.52	673	689.56	3.25e-2	*
Habitat	9	29.38	664	660.18	5.60e-4	***
Region	4	14.55	660	633.61	3.69e-3	**
Human influence	1	0.01	659	633.6	0.988	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1

Discussion

Narrow endemics are adapted to stressful habitats and soil conditions

In terms of habitat characteristics, the greatest richness of endemics in the Iberian Peninsula was found in mid-altitude rocky environments. Open Mediterranean scrub like low maquis were also highly related to endemism; while coastal habitats, steppic scrub and alpine formations were only relevant in some specific regions. All these habitats usually contain a high number of narrow endemics, and consequently most of them were also positively associated with the range size rarity. This pattern of endemics predominantly inhabiting rocky and open shrubby habitats is consistent with that observed in many other Mediterranean regions (e.g. Médail & Verlaque, 1997; Quézel & Médail, 2003; Lavergne et al., 2004; Dimopoulos et al., 2016).

Narrow endemic species are therefore more adapted to physically and climatically stressful habitats in which aboveground competition is relatively low. Succession to dense vegetation in steep, open and rocky habitats is slow or even prevented by local geomorphology and soil aridity (Escudero, 1996). Besides impeding vegetation succession, these harsh habitats remain relatively unchanged in relation to the human activity and grazing animals (Lavergne et al., 2005). This habitat stability may be crucial for the persistence of endemic species (Thompson et al., 2005). Grasslands also contained a substantial portion of Iberian endemics; however, this habitat was negatively related to endemism, just like wetlands, ruderal communities and forests. Endemics characteristic of these habitats had in addition larger range sizes on average. Narrow endemics have been proven to be less able to compete for resources (Drury, 1974; Lavergne et al., 2004) and consequently they are fairly scarce in more productive habitats like forests, grasslands or wetlands.

Coastal habitats were significantly associated with endemism in the Balearic Islands and the southern Atlantic coast, where there is a great diversity of environments, including cliffs and extensive sand plains and dunes (Pereira et al., 2016). Coastal endemics were furthermore highly associated with the range size rarity (Fig. 5.4) and, indeed, they had the smallest range size on average (Fig. 5.3a). This can be partially explained by the high contribution of the island endemics to this group (36%), but also by the current limited availability of coastal habitats, which have been dramatically altered throughout most of the territory. In fact, the overall lowland endemics (altitudinal range below 400 m) had narrower ranges than expected by chance. The intense human impact and the consequent reduction of favorable habitats, along with the greater interspecific competition due to the relative increased number of native and exotic species in low-lying areas (Médail & Verlaque, 1997), have most probably contributed to constraint the range of lowland endemics.

Our results also showed that alpine endemics or those with high elevation optimum (above 1800 m) are more likely to be rare. However, most of the high elevation specialists with narrow distributions occur in the Baetic System (68%), particularly in Sierra Nevada. High elevation ecosystems have been shown to remarkably increase the speciation rate and foster the endemism in certain cold-adapted plant lineages (Hughes & Atchison, 2015; Ohlemüller et al., 2008). The Cantabrian and Pyrenees alpine habitats were positively associated with endemism (Fig. 5.2), but endemics occurring there appear to be widely distributed because the high mountains arise on a continuum, as has also been observed on high elevation endemics of the European Alps (Smyčka et al., 2017). Thus, some species like *Saxifraga praetermissa, Festuca glacialis* or *Oreochloa elegans* are found in numerous summits of the Pyrenean-Cantabrian range. In contrast, Sierra Nevada has a modest size and is geographically isolated; thereby it acts as a "sky island" and most of the endemics occurring in the highest belt are confined to a small area.

With regard to the soils, Iberian endemics show either a strong preference for, or avoidance of, calcareous substrates; while endemics tolerant to both siliceous and calcareous soils are uncommon. Similarly to other Mediterranean regions (Médail & Verlaque, 1997), calcareous substrates sustain, on average, a larger proportion of endemic species than siliceous ones in the Iberian Peninsula, which is particularly noticeable in rocky habitats (65% of rupicolous endemics grow preferably on limestone bedrocks). As stated in Chapter 4, calcareous lithologies provide harsher environments and many plant lineages may have diversified through repeated specialization in contrasting and stressful soils (see also Molina-Venegas et al., 2015). On the other hand, carbonate rocks are also more prone to create microrefugia by its high topographic relief, which enables species to survive periods of climatic oscillation into more favorable positions (Dobrowski, 2011; Harrison & Noss, 2017).

Perhaps the best illustration of edaphic specialization in the Iberian Peninsula is that of the gypsophile flora, which is restricted to gypsum outcrops in semiarid areas of the eastern side. In these climatic conditions, the physical and chemical limitations imposed by gypsum soils have the strongest impact on plant development (Escudero et al., 2015), giving rise to a specialized flora very rich in endemic plants (nearly 70% of endemism). Although the range size rarity of the gypsum Iberian endemics has been stressed (Escudero et al., 2015; Mota et al., 2017), our results show that this ecological trait is not as constraining as others. About 22% of all gypsum endemics are certainly very narrowly distributed (e.g. *Teucrium lepicephalum*); however, there are many (27%) with very wide ranges (e.g. *Herniaria fruticosa*) that can be found in most Iberian gypsum outcrops. Recognized dolomite and serpentine specialized plants are basically found in the Baetic range (Mota et al., 2008) and, unlike gypsum flora, are highly associated with rarity.

In any event, the large number of narrow endemics that are adapted to stressful habitats and behave as edaphic specialists support the hypothesis that plants are particularly prone to strong divergent selection caused by fine-scale environmental heterogeneity. Thus ecological differentiation related to soil properties and microhabitat conditions seems to be a key determinant to explain isolation and speciation at a regional scale (Thompson et al., 2005; Anacker & Strauss, 2013; Molina-Venegas et al., 2016; Harrison & Noss, 2017).

Adaptation to particular environmental conditions also determines the dominant life-forms, and there is phylogenetic evidence of higher diversification in herbaceous and subshrub clades in the Mediterranean region. Thus, as in other regions of the Mediterranean Basin (e.g. Georghiou & Delipetrou, 2010; Giménez et al., 2004; Quézel, 1995) Iberian endemics are mostly represented by dwarf shrubs (chamaephytes) and perennial herbs (hemicryptophytes). On the opposite, annual endemics are rare in the Iberian Peninsula, especially compared to native species, in which annual life-form is very common. Annual plants are capable to avoid harsh conditions by remaining in the seed bank or limiting their life cycle to short favorable periods. This fact reduces their probabilities of extinction, but also might entail a lower rate of speciation of annual lineages (Soltis et al., 2013; Baldwin, 2014).

Ecological settings and lineages more prone to contain threatened species

Range size was the most determinant variable when predicting the conservation status of Iberian endemics, which is logical given that AOO is one of the assessment criteria used in the IUCN. Although this was foreseeable, it reinforces the previously observed trend (Gaston & He, 2010) that occupancy measured on a medium-scale (e.g. using 10×10 km cells) is broadly proportional to population size. It also indicates that the distribution pattern defined as sparse (Rabinowitz, 1981), i.e. widespread species that never occur at high densities, is unusual in endemic species, while it is known to be frequent in Iberian non-endemic threatened species. Notwithstanding the above, there are several cases in which range size is not in line with conservation status. In this way, we have identified some geographical and ecological settings that significantly condition the conservation status of the species once the effect of AOO is accounted.

Lack of proportionality between range size and abundance is particularly common in endemics of small islands. For example, *Galium friedrichii* and *Carduus ibicensis*, endemic to Pytyuses (the smallest Balearic Islands), are regarded as rare at the spatial scale of this study but they occur at levels of abundance greater than those of many other non-endemic species found there. Something similar happens with endemics of high mountains that function as ‘sky islands’. For example, *Viola crassiuscula* and *Lepidium stylatum* grow on the high lands of Sierra Nevada and are found in just three grid cells of 10×10 km each; however, they are not regarded as threatened because occur very abundantly throughout the suitable habitat of the mountaintop. All this partially explains the significantly lower average AOO obtained for the threatened plants of the Balearic region and the alpine habitat. Endemics occurring in the Pyrenees, Cantabrian Mountains and Iberian System were also somewhat less likely to be threatened than those of the other regions. Mountainous territories are in general less disturbed in terms of land-use changes and fragmentation, and they normally tend to have a proportionally lower number of species at risk (e.g. Médail & Verlaque, 1997; Silcok & Fensham, 2018).

Wetland habitats were not positively associated with endemism and rarity (Fig. 5.3, 5.4), but instead the endemics growing there were very likely to be threatened. One of the reasons is that most hygrophilous endemics grow on peat bogs, temporary ponds and damp meadows, whose real occupancies within the 10×10 km cells are generally very small. On the other hand, wetlands have been severely altered in the Mediterranean region by numerous causes, including desiccation, changes on the hydrological regime, pollution, overgrazing or exotic plant invasions (Rhazi et al., 2001; Zacharias & Zamparas, 2010). Thus, some species growing in wet lowland areas such as *Rhaponticum longifolium*, *Succisella carvalhoana* have relatively large range sizes and number of occurrence records, but they are regarded as vulnerable since face population reduction, severe fragmentation and continuing decline (Carapeto et al., in press). Another extreme example is that of the critically endangered *Avellara fistulosa,* which was recorded from several swampy areas in the western and southwestern Iberian coast throughout the 20th century, and at present only one extant population (recently reintroduced in another locality) is confirmed in Doñana National Park (SW Spain) (Fernández-Mazuecos et al., 2016).

Coastal and steppic habitats have also been shown to contain more threatened taxa than expected by chance. As stated, human action has shaped the current range of many coastal endemics and some populations of various taxa such as *Linaria polygalifolia* subsp. *lamarkii* or *Seseli farrenyi* are documented to have disappeared over the last two decades due to the increasing pressure from tourism (Plaza & Rodríguez, 2009; Rovira, 2008). On the other hand, the habitat fragmentation in steppic areas caused mainly by intensive agriculture has severely reduced the range and population size of some endemics such as *Vella pseudocytisus* subsp. *pseudocytisus* (Benito et al., 2004) or *Linaria nigricans* (Peñas et al., 2011) that have both co-evolved with traditional farming.

Plant lineages were significantly associated with risk categories, thus endemic species of Geranieae, Sileneae, *Limonium* or *Armeria* are more likely to be narrowly distributed and threatened than expected by chance. On the contrary, lineages like *Teucrium*, Stachydeae, Mentheae and *Saxifraga* are more likely to consist of wide range size and/or non-threatened endemics. It should be noted that some lineages that are likely to be rare have frequently apomictic reproduction (e.g. *Limonium*; Róis et al.,

2016) or hybridization (e.g. *Armeria;* Fuertes-Aguilar & Nieto-Feliner, 2003) and they tend to create small but distinct populations that sometimes have been considered as species. In any event, the results suggest that closely related species tend to have more similar biologies, and thus they are also likely to have more similar abundances and range sizes (Gaston, 1994). On the other hand, the Iberian threatened taxa match the previously observed pattern for rare species (Schwartz & Simberloff, 2001) to be highly clustered in species-rich lineages. Thus, many Iberian threatened species belonging to rapidly diversifying lineages, in which both extinction and speciation are quick (Davies et al., 2011; Knapp, 2011), would be just intrinsically rare and at risk of extinction.

Conservation guidance

The large number of taxa classified as Data Deficient (11%) as well as uncatalogued potentially threatened taxa (false positives in the binary classification) makes it advisable the revision and data acquisition for some taxa included in the list. With regard to conservation practice, according to Gaston & Fuller (2007), it is recommendable to identify not only the sites where very rare species at high risk of extinction occur, but also those harboring species that are suffering population depletions. In this sense, we have identified and ranked certain ecological settings that are more prone to contain threatened species than others as a result of greater human degradation, including in decreasing order, low-lying wetlands, coastal habitats and steppic scrub.

Agriculture, biological invasions and urbanization have been identified as the main drivers of plant extinction in Mediterranean hotspots (Le Roux et al., 2019). The former particularly affects steppic habitats while the two latter impact coastal habitats more intensely. Despite that, only 25% of the AOO of the steppic threatened endemics and about 45% of the coastal ones occur within terrestrial protected areas (mean for total threatened taxa is about 55%). Gaps in conservation of steppic Iberian flora (particularly gypsophile) were already detected (Martínez-Hernández et al., 2011), and other authors have proposed including some of the massive gypsum outcrops in a micro-reserve network (Mota et al., 2011; Escudero et al., 2015). Similar actions are even more urgently needed in coastal areas, particularly in the most species-rich spots of the southern half. Protected areas should also ensure the effective protection of plant communities, since the current pressure from tourism is untenable in almost every Iberian coastal area, whether or not they are protected.

On the contrary, 92% of occupancy of threatened alpine endemics and 67% of those inhabiting rocky habitats occur within protected areas. Furthermore, many montane and alpine narrow endemics are not currently regarded as threatened. Nevertheless, it must be taken into account that warming effects are predicted to be stronger at higher elevations and centers of endemism situated there are very vulnerable as a whole (Ohlemüller et al., 2008). Reductions in snow cover, faster melting and decreases in soil moisture may lead to range shifts, alterations in species composition and dominances and high extinction risk (CaraDonna et al., 2014; Munson & Sher, 2015). This is particularly alarming in the isolated Sierra Nevada, where the permafrost has drastically declined since the second half of the 20th century (Gómez-Ortiz et al., 2014) and many of its endemics and threatened plants occur on alpine bogs and marshy grasslands highly conditioned by the snow dynamics (Pérez-Luque et al., 2015). These potential future threats have often been neglected in the assessments, and perhaps some uncatalogued alpine endemics should be reconsidered for inclusion. Direct conservation actions are limited beyond seeding or translocation attempts. Efforts should rather be aimed to assessing and monitoring the effects of climate change on plant biodiversity, as for instance project GLORIA (www.gloria.ac.at) do in 6 target Spanish high mountain regions.

Even though wetlands are not particularly rich in endemics, they are undoubtedly priority habitats for plant conservation. First, because a large proportion of non-endemic Iberian threatened taxa (nearly 30%) occur in this type of habitats. And second, because wetlands have the most distinct taxonomic composition of all the habitats compared. Wetland threatened endemics are fairly covered in the territory (60% within protected areas), but still they are highly affected by the increasingly hydrological changes. Le Roux et al. (2019) have shown that hydrological disturbance is precisely the primary driver of plant extinctions in biodiversity coldspots. Likewise, wetlands are also very vulnerable to drought under future climate change scenarios (Silcock & Fensham, 2018). Thus, its conservation depends not only on the preservation of sites, but also on the proper water management.

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Appendix Chapter 5

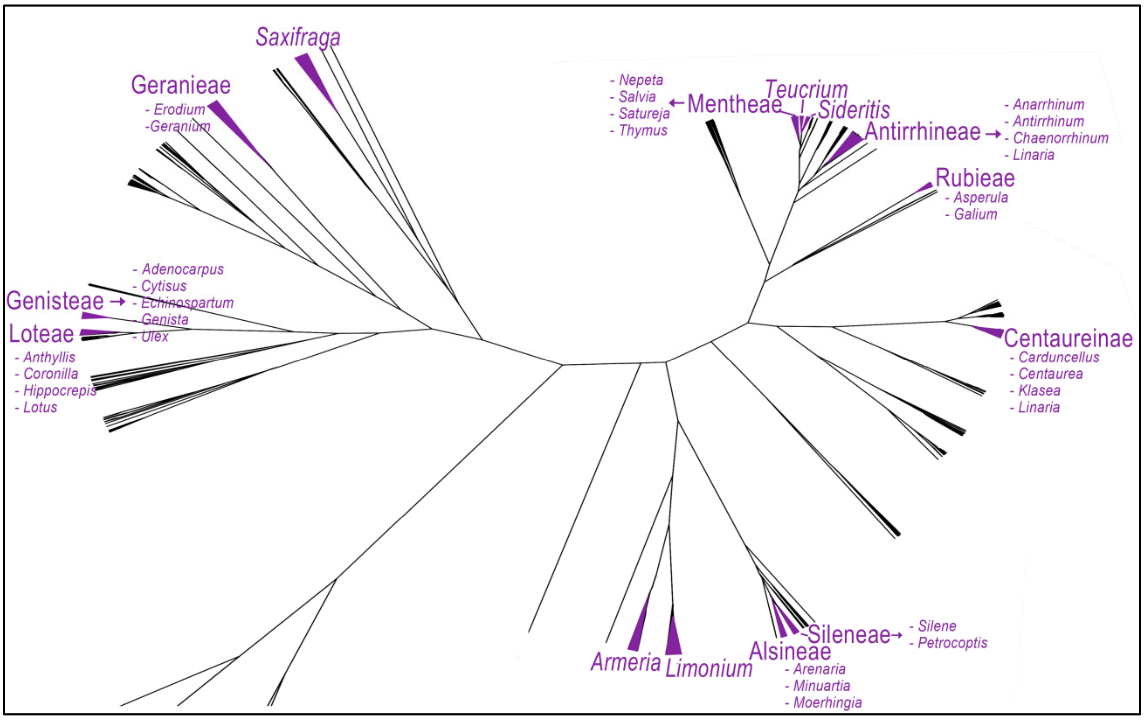

Fig. A5.1 Diagram of the phylogenetic tree of the Iberian endemic flora including the 15 most species-rich lineages. Four lineages are represented at genus level and eleven at subtribe or tribe level (included genera are also indicated). These lineages account for 45% of all endemics.

Table A5.1 Chi-square tests of homogeneity to determine whether endemic taxa (*freq End*) and total native taxa (*freq Nat*) are distributed in the same frequency with regard to categories of habitat, soil and life-form. The ratio between the frequency of endemic taxa and the frequency of total native taxa (*ratio freq*) for a given category estimates its degree of association with endemism (values>1 indicate positive association and values<1 indicate negative association). Significance (*sig*) of association for a given category is assessed with Bonferroni confidence intervals (*low Int* and *Up Int*).

Habitat **Chi-squared=879.1; p-value<2.2e-16**

	n End	*freq End*	*n Nat*	*freq Nat*	*ratio freq*	*chi res*	*low Int*	*Up Int*	*sig*
Rocky	435	0.27	569	0.11	2.50	19.99	0.24	0.30	sig
Med. Scrub	255	0.16	486	0.09	1.72	8.87	0.13	0.18	sig
Grassland	203	0.12	1177	0.22	0.57	-8.14	0.10	0.15	sig
Sclerophyll	143	0.09	363	0.07	1.29	3.14	0.07	0.11	ns
Coast	136	0.08	357	0.07	1.24	2.67	0.07	0.10	ns
Steppic	108	0.07	175	0.03	2.02	7.55	0.05	0.08	sig
Alpine	83	0.05	168	0.03	1.61	4.50	0.04	0.07	sig
Wetland	82	0.05	798	0.15	0.34	-10.28	0.03	0.07	sig
Ruderal	82	0.05	713	0.13	0.38	-9.12	0.03	0.07	sig
Heath	73	0.04	232	0.04	1.02	0.32	0.03	0.06	ns
Forest	31	0.02	343	0.06	0.30	-7.16	0.01	0.03	sig

Soil **Chi-squared=353.3; p-value<2.2e-16**

	n End	*freq End*	*n Nat*	*freq Nat*	*ratio freq*	*chi res*	*low Int*	*Up Int*	*sig*
Si	399	0.25	1092	0.20	1.24	3.90	0.22	0.28	sig
Ca	666	0.41	1549	0.28	1.45	8.88	0.38	0.44	sig
Indifferent	362	0.22	2532	0.46	0.48	-12.88	0.20	0.25	sig
Special	192	0.12	308	0.06	2.11	9.66	0.10	0.14	sig

Life-form			**Chi-squared=445.6; p-value<2.2e-16**						
	n End	*freq End*	*n Nat*	*freq Nat*	*ratio freq*	*chi res*	*low Int*	*Up Int*	*sig*
Ph	80	0.05	432	0.08	0.62	-4.30	0.04	0.06	sig
Ch	562	0.35	972	0.18	1.94	15.99	0.32	0.38	sig
He	702	0.44	2106	0.39	1.12	2.96	0.40	0.47	sig
Ge	93	0.06	486	0.09	0.64	-4.31	0.04	0.07	sig
Th	173	0.11	1404	0.26	0.41	-12.00	0.09	0.13	sig

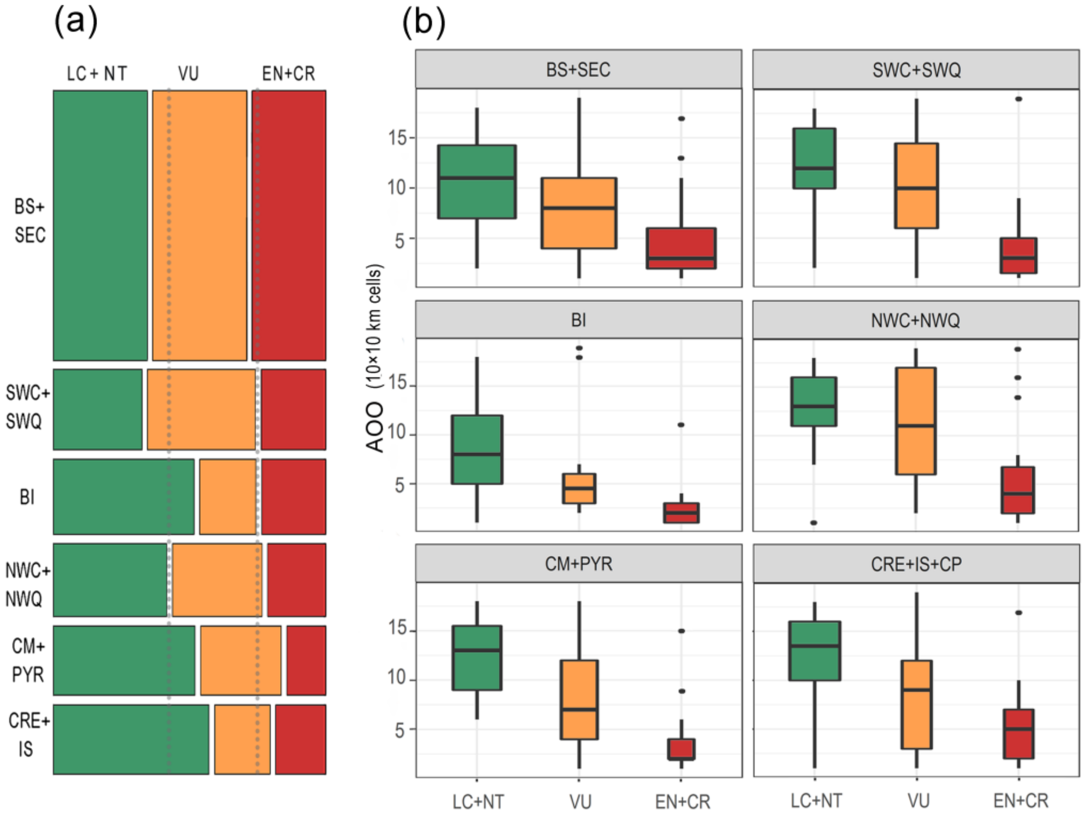

Fig. A5.2 (a) Mosaic plot of the relative frequency of narrow endemic taxa per risk category and Region. Chi-square test of independence: p-value=8.11e-05. (b) Boxplot of AOO and risk categories per Region (the width of the box is proportional to the sample size). ANOVA test (mean AOO among Regions), category VU: p-value=8.67e-04; Tukey multiple comparisons (p-value<0.05): BI-NWC+NWQ, BI-SWQ+SWC. ANOVA test (mean AOO among Regions), category EN+CR: p-value=0.041; Tukey multiple comparisons (p-value<0.05): BI-CRE+IS, BI-NWC+NWQ.

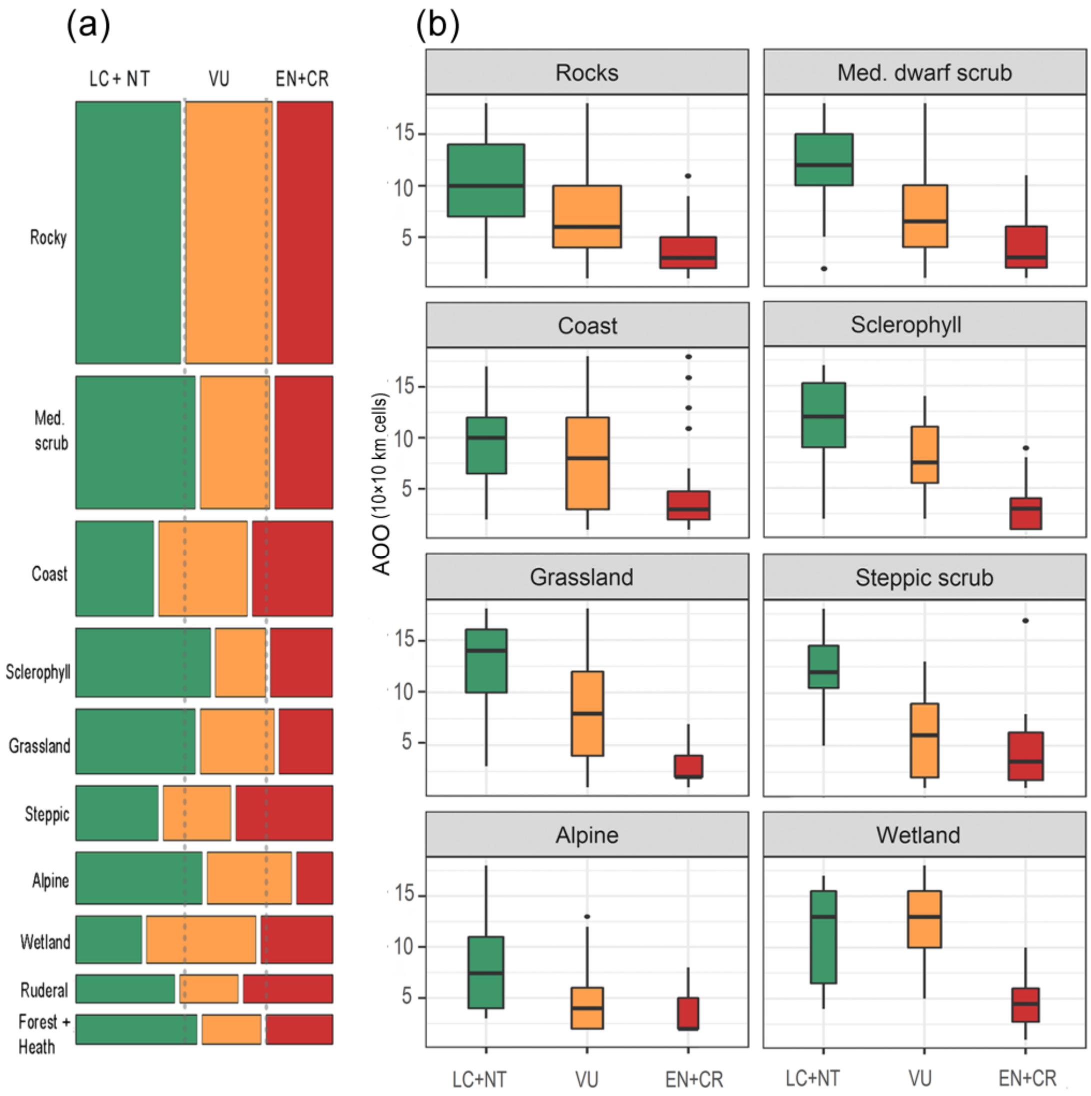

Fig. A5.3 (a) Mosaic plot of the relative frequency of narrow endemic taxa per risk category and Habitat. Chi-square test of independence: p-value=0.022. (b) Boxplot of AOO and risk categories per Habitat (Ruderal and Forest not plotted; the width of the box is proportional to the sample size). ANOVA test (mean AOO among Habitats), category VU: p-value=0.0003; Tukey multiple comparisons (p-value<0.05): Wetland-Alpine, Wetland-Med. scrub, Wetland-Rocky and Wetland-Steppic. ANOVA test (mean AOO among Habitats), category EN+CR: p-value=0.78.

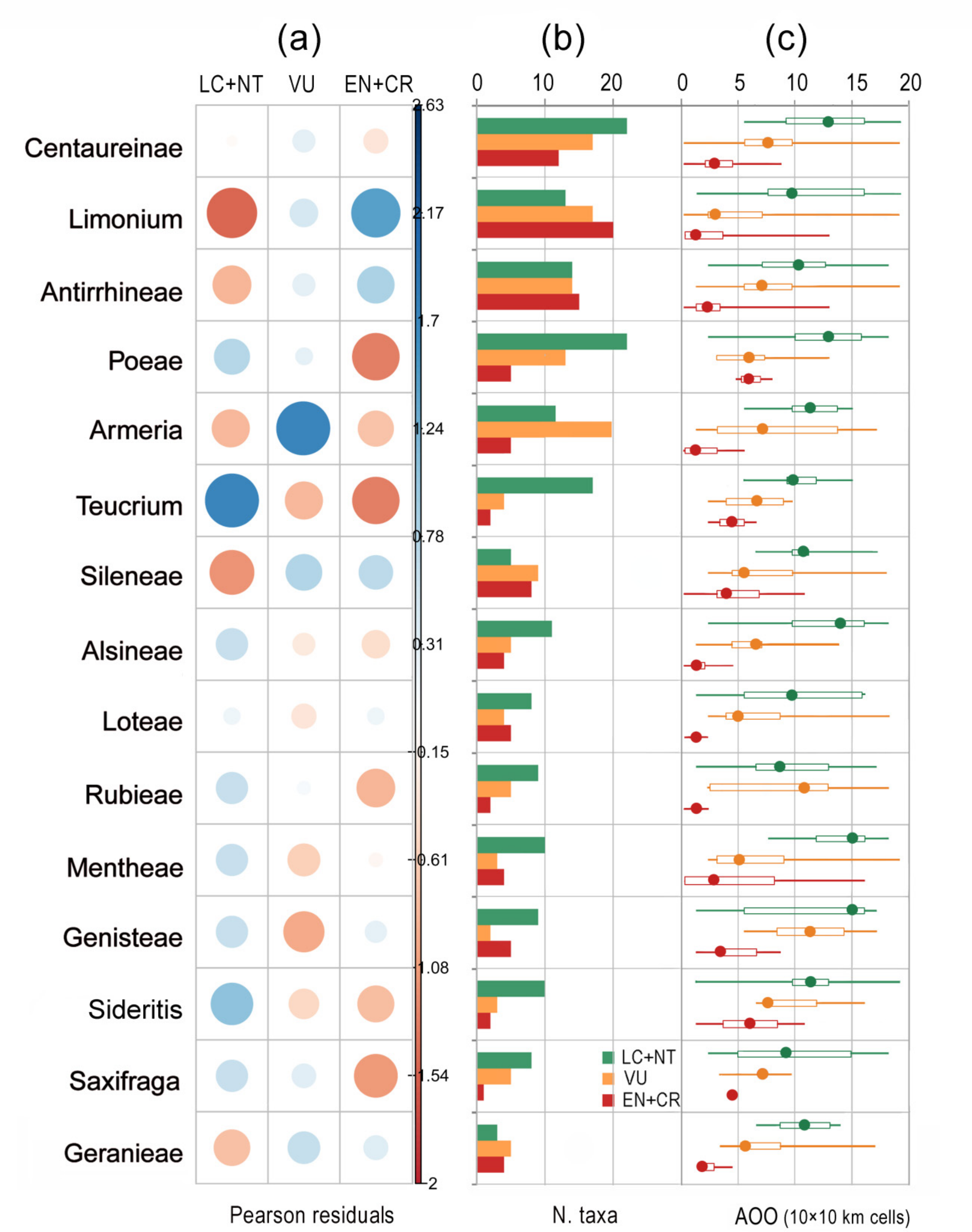

Fig. A5.4 (a) Pearson residuals of the chi-square test of independence between the 15 most species-rich Lineages and the risk categories; the size of the circle is proportional to the amount of the cell contribution and the color indicates the sign (+ in blue, – in red). Pearson's chi-squared test: p-value=0.004. (b) Number of taxa per risk category. (c) Boxplots of AOO and risk categories. Kruskal-Wallis test (mean AOO among Lineages), category VU: p-value=0.508. Kruskal-Wallis test (mean AOO among Lineages), category EN+CR: p-value=0.155.

General discussion

After reviewing the history of description of the Iberian flora from 1753 to the present in Chapter 1, we have ascertained that botanical activity has been very uneven over these 265 years. Two important peaks in the Iberian plants descriptions have been identified: the first associated to the extensive botanical exploration of the Baetic Mountains hotspot by Boissier (mid-19th century), and the second to the taxonomic revisions for *Flora iberica* (late 20th). Although a large number of authors have contributed to the description, about half of the Iberian endemics have been described only by 16 authors, most of whom lived in the 19th century.

As found in other studies (e.g. Gaston et al., 1995; Diniz-Filho et al., 2005; Cavallin et al., 2016), our results show that description dates are determined by species range sizes but, in contrast, they are not affected by life-form types, suggesting that variations in body size and seasonality have not hindered plant discovery in the Mediterranean region. On the other hand, the pattern of described species per area is related to spatial richness and human influence, indicating that many endemic species were described in species-rich areas, but also in populated and accessible areas. The flattening of discovery curve in the last years indicates that new species are becoming increasingly scarce, but also suggests that the inventory is still incomplete. However, our results demonstrate that changes in discovery effort have been governed by socio-historical factors and consequently the discovery curves are not reliable to indicate the final approach to completeness.

According to our last update showed in Chapter 2, the Iberian flora consists of 1357 endemic species (1823 taxa), which accounts for 24% of all native species (26% of all native taxa). Nearly half of the endemics are regarded as narrow endemics, since they are restricted to well-defined small areas. Richness and endemism of the Iberian Peninsula are comparable to those of other regions in the Mediterranean Basin. Apparently, rates of endemism are similar in Greece, higher in Turkey and lower in Italy and Morocco. The Iberian endemic flora is largely clustered in species-rich lineages, including some genera widely represented throughout most of the Mediterranean Basin such as *Centaurea, Silene* and *Limonium,* and others like *Armeria, Linaria* and *Teucrium* that have their main centers of diversity in the Iberian Peninsula.

The highest endemic species richness occurs in the main Iberian mountain ranges as a result of several causes. On the one hand, high elevation boosts allopatric speciation due to orographic isolation, on the other, geomorphological complexity provides a great diversity of environments and buffer climatic fluctuations, allowing for the coexistence of species with disparate ecological requirements and enabling species to survive periods of climatic oscillation (Favarger, 1972; Jetz et al., 2004; Ohlemüller et al., 2008; Dobrowski, 2011).

The Baetic System has by far the highest values of weighted endemism. Its exceptional proportion of narrow endemic species compared to other Iberian mountain ranges can be explained by a complex interaction of environmental factors, including a fragmented orography and contrasting climate and soil conditions, and historical causes. The latter include ameliorated climatic conditions during the glacial-interglacial fluctuations of the Pleistocene due to the lower latitude, maritime influence and wide altitudinal range (from 0 to >3000 m a.s.l.), which led to low extinction rates and increased diversification (Carrión et al., 2003; Médail & Diadema, 2009; Molina-Venegas et al., 2013).

High weighted endemism also occurs in the Balearic Islands, which is expected given their isolated nature. To a lesser degree, some coastal areas of southern Iberia have a considerable number of narrow endemics. Indeed, the main centers of endemism in Portugal are found in the central and southern coastal regions, particularly the peninsulas of Sintra and Setúbal and the Algarve region. The great diversity of coastal habitats, including cliffs and extensive sand plains and dunes (Pereira et al., 2016), together with the maritime influence that generates regional climatic stability (Harrison & Noss, 2017), have likely played an important role to foster and maintain endemism in the Balearic Islands and southwestern coast.

The examination of the effects of spatial scale and sampling intensity have shown that measures of taxonomic diversity are affected by systematic bias in plant data collections, particularly at finer resolution, but it does not obscure the spatial patterns of richness. The weighted endemism metric, which emphasizes range-restricted taxa and is buffered against poor sampling of any particular grid cell by considering species occurrences across all grid cells (Baldwin et al., 2017), appear to be suitable for identifying areas of significantly high endemism in the Iberian Peninsula.

The partitioning analysis based on the endemic species distribution carried out in Chapter 3 has enabled us to distinguish eleven regions, most of which appear to be geographically and ecologically meaningful. The regions including the Cantabrian Mountains, the Pyrenees, the Baetic System and the Balearic Islands have in addition a large proportion of defining species whose distributions are not completely congruent but overlap in a large portion. Thus, in a broad approach (e.g. Linder, 2001; Aagesen et al., 2013) all these regions could be regarded as areas of endemism at large scale.

Similarly to regionalization proposed by Moreno-Saiz et al. (2013), our classification reflects a primary longitudinal division between a basic eastern and an acidic western region, highlighting the importance of lithology in shaping the species composition in the Iberian Peninsula, both at regional and at large scale (Liu et al., 2020; Moreno-Saiz et al., 2013). Secondarily, the large coincidence of our three northernmost regions with the Eurosiberian region (Rivas-Martínez et al., 1990; 2002) also supports the traditional climatic division between Eurosiberian and Mediterranean regions.

Thanks to analytical tools from the emerging field of spatial phylogenetics, in Chapter 5 we have provided robust insights into the environmental factors driving recent plant diversification in the Mediterranean Basin. While the importance of lithology in shaping community structure is illustrated in Chapter 3, we go a step further here showing, for the first time, quantitative evidence of the role of soil properties as a key driver of recent plant diversification in the Iberian Peninsula. Centers of recent plant diversification of angiosperms as a whole, and particularly of Eudicots, are defined by a combination of environmental stressors including high values of soil pH and dry-seasonal climatic conditions.

Many of the most species-rich Mediterranean plant lineages are highly diversified in eastern and particularly southeastern Iberia (e.g. *Limonium*, *Centaurea*, *Linaria*, *Teucrium*, *Thymus*, *Sideritis* and *Helianthemum*). The rapid evolutionary radiation of these Eudicot lineages during the Plio-Pleistocene (see Lledó et al., 2005; Hilpold et al., 2014; Blanco-Pastor & Vargas, 2013; Fernández-Mazuecos & Vargas, 2015; Salmaki et al., 2016; Martín-Hernanz et al., 2019) may be linked to phylogenetically conserved traits adapted to particular environmental conditions, such as marked summer drought and stressful substrates.

Contrary to Eudicot clades, recent diversification of Monocots is not associated with soil conditions, and only weakly with low precipitation seasonality and high elevation. The recent speciation of some Monocot lineages (e.g. *Festuca*, Marques et al., 2016; *Carex*, Jiménez-Mejías et al., 2017) in the Pyrenean-Cantabrian range, Central System and Sierra Nevada has probably been fostered by orographic isolation, as documented for several plant clades characteristic of high-mountain environments (Comes & Kadereit, 2003). In any event, the contrasting environmental drivers of diversification in Eudicots and Monocots highlight the importance of analyzing spatial phylogenetic patterns at multiple phylogenetic scales to get a better understanding of the processes that shape biodiversity.

The approach used here was addressed at identifying centers of recent *in situ* diversification (neoendemism) and centers of paleoendemism should be interpreted with caution. Nevertheless, we have obtained high relative phylogenetic endemism in areas where there is available evidence for the presence of paleoendemic species, such as the eastern Balearic Islands (Mallorca and Menorca), the Cazorla Mountains in the Baetic region, the central-southern Pyrenees and the mountains of northern Portugal and northwestern Spain, this latter including the largest number of endemic genera. Further investigation, possibly using phylogenies of endemic and non-endemic species, will shed more light on the distribution of paleoendemic Mediterranean lineages.

In Chapter 5 we have shown that endemic plants are ecologically differentiated. Similarly to other areas of the Mediterranean region (Médail & Verlaque, 1997; Quézel & Médail, 2003), Iberian narrow endemics seem to be prevalently adapted to climatically and physically harsh habitats with reduced aboveground competition. They are primarily found inhabiting mid-altitude calcareous rocky habitats, and secondarily open Mediterranean shrubby formations. Coastal, steppic and alpine habitats are also rich in narrow endemics in some specific regions. In addition, most endemics show either a strong preference for, or avoidance of, calcareous substrates, and many narrow endemics are linked to special stressful substrates such as gypsum or dolomites. All this reinforces the hypothesis that plants are particularly prone to strong divergent selection caused by fine-scale environmental heterogeneity and, as a result, soil properties and habitat conditions may play an important role in ecological segregation and diversification at a regional scale (Rundle & Nosil, 2005; Anacker & Strauss, 2013; Molina-Venegas et al., 2016).

On the other hand, we have adapted the IUCN categories to our endemic species list and a quarter of all Iberia endemics (455 taxa) are regarded as threatened. A large number of endangered species belong to rapidly diversifying lineages, in which both extinction and speciation are expected to be quick (Davies et al., 2011; Knapp, 2011), and thus they are likely to be intrinsically rare and at risk of extinction. However, we have identified and ranked certain ecological settings that are more prone to contain threatened species than others as a result of greater human degradation. These include, in decreasing order, low-lying wetlands, coastal habitats and steppic scrub.

This result is in line with the statement that hydrological disturbance, agriculture, biological invasions and urbanization are the main drivers of plant extinction in Mediterranean hotspots (Le Roux et al., 2019), since the three environments recognized by us are particularly affected by all these threats types. Paradoxically, the areas of occupancy of the Iberian endemics occurring in these habitats are relatively little protected. On the contrary, a large proportion of montane and alpine habitats are protected and many endemics in them are regarded as non-threatened at present. However, warming effects are predicted to be stronger at higher elevations (Ohlemüller et al., 2008) and potential future threats such as reductions in snow cover and decreases in soil moisture have often been overlooked in the assessments. High-altitude endemics of the isolated Sierra Nevada are particularly vulnerable to these threats and consequently the major Iberian center of endemism is at risk as a whole.

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Conclusions

1) Two important peaks in the Iberian plants descriptions have been identified: the first associated to the extensive botanical exploration of the Baetic Mountains hotspot by Boissier (mid-19th century), and the second to the taxonomic revisions for *Flora iberica* (late 20th).

2) The spatial pattern of species description showed that many endemic species have been described in species-rich areas, but also in populated and accessible areas; while the temporal pattern showed that narrow endemics have been described later.

3) Changes in discovery effort have been governed by socio-historical factors and consequently the discovery curves are not reliable to indicate the degree of completeness of the description process.

4) According to our last update, the Iberian flora consists of 1357 endemic species (1823 taxa), which accounts for 24% of all native species (26% of all native taxa). Iberian endemics are mostly narrowly distributed and clustered in species-rich lineages

5) High endemic richness occurs in the main Iberian mountain ranges as a result of orographic isolation, geomorphological complexity and buffering of climatic fluctuations. The high weighted endemism values of the Balearic Islands and, to a lesser extent, of the central and southern coast of Portugal, are partly due to the great diversity of coastal habitats and regional climatic stability.

6) The exceptional concentration of narrow endemic species in the Baetic System can be explained by the wide altitudinal range, fragmented orography, contrasting climate and soil conditions, and low extinction rates during the glacial-interglacial fluctuations.

7) Eleven regions have been distinguished through partitioning analysis, most of which are geographically and ecologically meaningful. The regions including the Cantabrian Mountains, the Pyrenees, the Baetic System and the Balearic Islands could be regarded as areas of endemism at large scale.

8) The dendrogram of inter-cluster distances reflected a primary division between a basic eastern and an acidic western region, which highlights the importance of lithology in shaping the species composition in the Iberian Peninsula.

9) Recent diversification of angiosperms as a whole, and particularly of Eudicots, has been boosted by environmental stressors including high values of soil pH and dry-seasonal climatic conditions. A key role of soil properties in recent diversification of an entire endemic flora is revealed and quantified for the first time.

10) Diversification of Monocots has not been associated with soil conditions but with high elevation and less seasonal climate. The contrasting drivers of diversification in Eudicots and Monocots highlight the importance of analyzing spatial phylogenetic patterns at multiple phylogenetic scales.

11) High relative phylogenetic endemism was obtained in areas where there is available evidence for the presence of paleoendemic species, such as the Balearic Islands, the Cazorla Mountains, the central-southern Pyrenees and the mountains of northern Portugal and northwestern Spain, this latter including the largest number of endemic genera.

12) Iberian narrow endemics are prevalently adapted to harsh habitats with reduced aboveground competition and stressful lithological substrates. All this reinforces the hypothesis that soil properties and habitat conditions may play an important role in ecological segregation and speciation at a regional scale.

13) Nearly a quarter of all Iberian endemics (455 taxa) are regarded as threatened. Many narrow endemics are thought to be intrinsically rare. Nevertheless, some ecological settings are more prone to contain threatened species than others as a result of greater human degradation, including in decreasing order, low-lying wetlands, coastal habitats and steppic scrub.

14) Paradoxically, the areas of occupancy of the species occurring in these habitats are relatively less protected. On the contrary, a large proportion of montane and alpine habitats are protected and many endemics found there are regarded as non-threatened at present. However, some centers of endemism located at high elevations such as Sierra Nevada are at risk due to global warming.

Supplementary Material

Annotated checklist of the Iberian and Balearic endemic flora including distribution, ecological traits and conservation status information.

Field descriptions

Family: following APG classification (APG IV, 2016. An update of the Angiosperms Phylogeny Group classification for the orders and families of flowering plants: APG IV. Bot. J. Linn. Soc. 181: 1-20).

Taxon: accepted name with authority. Names preceded by (?) have doubtfully been reported from North Africa.

TAX (taxonomic reference framework): **AA**, López-González, G., 2001. Los árboles y arbustos de la Península Ibérica y Baleares. 2 vols: 1731 pp. Mundi Prensa, Madrid; **CF**, Devesa, J.A., Catalán, P., Muller, J., Cebolla, C. & Ortúñez Rubio, E., 2013. Checklist de Festuca L. (Poaceae) en la Península Iberica. Lagascalia 33:183-274; **EM,** Euro+Med (2006-): Euro+Med PlantBase - the information resource for Euro-Mediterranean plant diversity, http://ww2.bgbm.org/EuroPlusMed; **FI,** Castroviejo, S. (coord.gen.), 1986-. Flora iberica, vols. 1-21, Real Jardín Botánico-CSIC, Madrid [editors and genera authors at www.floraiberica.org]; **OP**, Original publication of the taxon description.

Regions: BI, Balearic Islands; **BS**, Baetic System; **CM**, Cantabrian Mountains; **CRE**, Catalan Coastal Range and Ebro depression; **IS**, Iberian System; **NWC**, Northwestern coast; **NWM**, Northwestern Mountains; **PYR**, Pyrenees; **SEC**, Southeastern coast; **SWC**, Southwestern coast; **SWQ**, Southwestern quadrant.

Numbers indicate de degree of fidelity and specificity of the taxa to the regions. It is based on the phi-values (see Chapter 3) ranked from 1 to 3, "+" indicates occasional presence in a given region (phi-value < 0).

LF (Raunkiaer's life-forms): phanerophyte (Ph), chamaephyte (Ch), hemicryptophyte (He), therophyte (Th), geophyte (Ge) and hydrophyre (Hy).

HAB (habitat): **A,** alpine grasslands and scrub, snow patch communities, rock glaciers and moraines **C,** coastal marshes, sands and sea-cliffs; **F,** temperate deciduous, conifer and mixed forests; **G,** perennial grasslands, meadows and therophyte communities; **H,** heaths, 'piornales' and other silicicolous messic shrubby formations; **M,** Mediterranean dwarf scrub, low 'maquis', thorn-cushion formations; **Ro**, rock pavements, inland cliffs, screes and boulders; **Ru,** ruderal areas, frequently disturbed places, fields, gardens; **Sc,** live oaks woodlands and sclerophyll secondary formations; **St,** gypsicolous and halo-nitrophilous steppic scrub; **W,** wetlands, bogs, mires, springs, fens, river and lake shores, standing waters, seasonally flooded depressions and streambanks.

ALT (altitudinal range): altitudinal limits, extreme values not included.

LIT (lithological preference): **Ca,** calcareous; **Si,** siliceous; **Gyp,** gypsum; **Dol,** dolomite; **Ser,** serpentine; **Hal,** haline soils.

AOO (area of occupancy): total number of 10 × 10 km grid cells in which the taxa occur.

CAT (IUCN category): **EX,** extinct; **EW,** extinct in the wild; **CR,** critically endangered; **EN,** endangered; **VU,** vulnerable; **NT,** near threatened; **LC,** least concern; **DD,** data deficient**.** Newly assessed taxa or reassigned to a different status from that of the National Red Lists are indicated with an asterisk (*). True positives and false positives in the binary classification (see Chapter 4) are indicated with (+), true negatives and false negatives are indicated with (-).

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
ALISMATACEAE																		
Baldellia alpestris (Coss.) M. Laínz	FI	.	.	1	.	1	2	2	.	.	.	.	Hy	W	250-1940	Si	107	LC
Baldellia repens subsp. *baetica* Talavera & Casimiro-Soriguer	FI	.	.	.	.	.	.	.	.	.	2	+	Hy	W	0-80	Si	23	LC
AMARANTHACEAE																		
Salsola papillosa Willk.	FI	.	+	.	.	.	.	.	.	2	.	.	Ph	St	50-300	.	18	LC+
AMARYLLIDACEAE																		
Allium grosii Font Quer	FI	2	.	.	.	.	.	.	.	.	.	.	Ge	Ro	0-200	Ca	5	LC
Allium melananthum Coincy	FI	.	+	.	.	.	.	.	.	2	.	.	Ge	M	0-800	.	21	LC
Allium palentinum Losa & P. Monts.	FI	.	.	3	.	.	.	.	.	.	.	.	Ge	Ro	1600-2230	Ca	27	LC
Allium pruinatum Link ex Spreng.	FI	.	.	.	.	.	.	+	.	.	3	+	Ge	Sc	0-700	.	58	LC*
Allium pyrenaicum Costa & Vayr.	FI	.	.	.	.	.	.	.	2	.	.	.	Ge	F,Ro	600-1300	Ca	14	NT+
Allium rouyi Gaut.	FI	.	3	.	.	.	.	.	.	.	.	.	Ge	Ro,M	200-1900	Ca	31	LC*
Allium schmitzii Cout.	FI	.	.	.	.	.	.	1	.	.	+	1	Ge	Ro	50-1200	.	19	VU-
Allium stearnii Pastor & Valdés	FI	.	2	+	2	+	.	.	+	+	+	+	Ge	R	350-800	.	119	LC
Leucojum valentinum Pau	FI	.	.	.	+	.	.	.	.	2	.	.	Ge	M,G	0-200	Ca	14	LC+
Narcissus cyclamineus DC.	FI	.	.	.	.	.	3	+	.	.	.	.	Ge	G,G	0-650	.	46	LC
Narcissus gaditanus Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	+	2	.	Ge	C,Sc	0-700	.	48	NT*
Narcissus hedraeanthus (Webb & Heldr.) Colmeiro	FI	.	2	.	.	.	.	.	.	.	.	+	Ge	Sc,G	300-1800	.	45	LC
Narcissus hedraeanthus subsp. *hedraeanthus* (Webb & Heldr.) Colmeiro	FI	.	2	.	.	.	.	.	.	.	.	.	Ge	Sc	1000-1800	.	23	LC
Narcissus hedraeanthus subsp. *luteolentus* (Barra & G. López) Aedo	FI	.	+	.	.	.	.	.	.	.	.	1	Ge	Sc	300-950	.	20	LC
Narcissus jonquilla L.	FI	.	1	.	.	+	.	+	.	.	2	3	Ge	W,G	100-1200	.	128	LC
Narcissus minor subsp. *asturiensis* (Jord.) Barra & G. López	FI	.	.	1	.	.	2	2	.	.	.	.	Ge	G	1000-2150	.	86	LC
Narcissus moschatus L.	FI	.	.	.	.	.	.	.	3	.	.	.	Ge	G,G	680-2450	.	71	LC
Narcissus moschatus subsp. *moleroi* (Fern. Casas) Aedo	FI	.	.	.	.	.	.	.	2	.	.	.	Ge	F	850-2450	.	28	LC
Narcissus moschatus subsp. *moschatus* L.	FI	.	.	.	.	.	.	.	3	.	.	.	Ge	F	680-2320	.	42	LC
Narcissus pseudonarcissus subsp. *munozii-garmendiae* (Fern. Casas) Fern. Casas	FI	.	.	.	.	.	.	.	.	.	.	2	Ge	W,F	520-900	.	15	VU+
Narcissus pseudonarcissus subsp. *nevadensis* (Pugsley) A. Fern.	FI	.	3	.	.	.	.	.	.	+	.	.	Ge	W,G	750-2250	Si	45	LC*
Narcissus pseudonarcissus subsp. *portensis* (Pugsley) A. Fern.	FI	.	.	.	.	3	+	1	.	+	+	+	Ge	W,G	500-1850	Si	109	LC
Narcissus rupicola Dufour ex Schult. & Schult. fil.	FI	.	.	.	.	1	.	3	.	.	.	1	Ge	Ro,H	550-2000	Si	175	LC
Narcissus scaberulus Henriq.	FI	.	1	.	.	.	.	1	.	.	2	.	Ge	Ro,H	50-1850	.	44	LC
Narcissus scaberulus subsp. *calcicola* (Mendonça) Aedo	FI	.	+	.	.	.	.	.	.	.	2	.	Ge	Ro	50-200	Ca	32	LC
Narcissus scaberulus subsp. *scaberulus* Henriq.	FI	.	.	.	.	.	.	1	.	.	.	.	Ge	Sc,Ro	50-350	Si	13	LC+
Narcissus triandrus subsp. *pallidulus* (Graells) Rivas Goday	FI	.	1	.	.	2	.	2	.	.	+	2	Ge	Sc,G	150-1800	.	332	LC
APIACEAE																		
Angelica major Lag.	FI	.	.	2	.	1	2	1	+	.	.	.	He	W,H	40-2100	Si	127	LC
Angelica pachycarpa Lange	FI	.	.	+	.	.	3	.	.	.	+	.	He	C	0-50	Hal	34	LC
Angelica razulii Gouan	FI	.	.	+	.	.	.	.	2	.	.	.	He	W	700-2000	Si	76	LC
Apium bermejoi L. Llorens	FI	2	.	.	.	.	.	.	.	.	.	.	He	C	50-100	Si,Hal	1	CR
Athamanta hispanica Degen & Hervier	FI	.	1	.	.	.	.	.	.	1	.	.	He	Ro	1200-1500	.	5	VU+
Bunium balearicum (Sennen) Mateo & López Udias	FI	2	.	.	+	.	.	.	.	2	.	.	Ge	R	0-1200	Ca	14	LC
Bunium macuca subsp. *nivale* (Boiss.) Mateo & López Udias	FI	.	2	.	.	.	.	.	.	.	.	.	Ge	A	1900-3300	Si	4	LC+
Bupleurum acutifolium Boiss.	FI	.	1	.	.	.	.	.	.	.	+	.	Ch	M	150-800	.	14	VU-
Bupleurum angulosum L.	FI	.	.	1	+	.	.	.	3	.	.	.	He	Ro	550-2450	Ca	101	LC
Bupleurum barceloi Coss. ex Willk.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Ro	200-1100	Ca	5	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Bupleurum fruticescens subsp. *fruticescens* Loefl. ex L.	FI	.	.	+	2	2	.	.	+	2	.	.	Ch	Sc	0-1600	Ca	109	LC
Conopodium arvense (Coss.) Calest.	FI	.	+	1	1	1	.	1	1	1	.	1	Ge	Sc,Ro	200-1700	Ca	224	LC
Conopodium bunioides subsp. *bunioides* (Boiss.) Calest.	FI	.	1	.	.	.	.	1	.	.	.	.	Ge	Ro	1250-3300	Si	13	LC+
Conopodium majus subsp. *marizianum* (Samp.) López Udias & Mateo	FI	.	.	2	.	.	1	3	.	.	.	+	Ge	H	200-2100	.	114	LC
Conopodium subcarneum (Boiss. & Reut.) Boiss. & Reut.	FI	.	.	2	.	2	1	1	.	.	+	+	Ge	H	200-1900	Si	101	LC
Conopodium thalictrifolium (Boiss.) Calest.	FI	.	3	.	.	.	.	.	.	2	.	.	Ge	Ro	0-1900	Ca	72	LC
Daucus arcanus García-Martín & Silvestre	FI	.	.	.	.	.	.	.	.	.	1	+	Th	C,Ro	0-900	Hal	3	EN+
Daucus carota subsp. *cantabricus* A. Pujadas	FI	.	.	2	.	+	.	.	.	.	.	.	He	H	600-1500	Si	20	LC
Daucus carota subsp. *halophilus* (Brot.) A. Pujadas	FI	.	.	.	.	.	.	.	.	.	2	.	He	C	10-50	Hal	12	NT-
Daucus carota subsp. *majoricus* A. Pujadas	FI	2	.	.	.	.	.	.	.	.	.	.	He	C	0-50	Ca	6	LC
Dethawia splendens (Lapeyr.) Kerguélen	FI	.	.	3	.	.	.	.	2	.	.	.	He	Ro	900-2650	Ca	99	LC
Dethawia splendens subsp. *cantabrica* (A. Bolòs) Kerguélen	FI	.	.	3	.	.	.	.	.	.	.	.	He	Ro	900-2400	Ca	30	LC
Dethawia splendens subsp. *splendens* (Lapeyr.) Kerguélen	FI	.	.	.	.	.	.	.	1	.	.	.	He	Ro	1500-2400	Ca	41	LC
Distichoselinum tenuifolium (Lag.) García-Martín & Silvestre	FI	.	2	.	.	.	.	.	.	2	1	+	He	M	0-1300	Ca	199	LC
Elaeoselinum asclepium subsp. *millefolium* (Boiss.) García-Martín & Silvestre	FI	.	2	.	.	.	.	.	.	.	+	.	He	Ro	200-1400	.	21	LC
Endressia castellana Coincy	FI	.	.	3	.	2	.	.	+	.	.	.	He	W	600-1300	Ca	103	LC
Endressia pyrenaica (J. Gay ex DC.) J. Gay	FI	.	.	.	.	.	.	.	2	.	.	.	He	G	1440-2350	Si	34	LC
Eryngium duriaei J. Gay ex Boiss.	FI	.	.	1	.	.	1	2	.	.	.	.	He	Ro,H	30-2400	Si	49	LC
Eryngium galioides Lam.	FI	.	.	+	.	1	.	2	.	.	2	1	Th	W	0-900	.	85	LC
Eryngium grosii Font Quer	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	700-1700	Ca,Dol	5	EN+
Eryngium huteri Porta	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	2000-2400	Ca	5	VU+
Ferula communis subsp. *cardonae* Sánchez Cuxart & M. Bernal	FI	2	.	.	.	.	.	.	.	.	.	.	He	Sc	0-350	Ca	2	DD*
Ferula communis subsp. *catalaunica* (Pau ex C. Vicioso) Sánchez Cuxart & M. Bernal	FI	.	+	.	+	+	.	+	.	1	1	1	He	Sc	0-1600	Ca	112	LC
Ferula loscosii (Lange) Willk.	FI	.	+	.	2	+	.	.	.	1	.	+	He	St,M	100-500	Ca	39	NT*
Ferulago brachyloba Boiss. & Reut.	FI	.	+	.	.	+	.	1	.	.	.	2	He	Sc	200-1100	Si	23	LC
Ferulago capillaris (Link ex Spreng.) Cout.	FI	.	.	+	.	.	.	2	.	.	.	.	He	Sc	900-1400	Si	21	LC
Ferulago granatensis Boiss.	FI	.	2	.	.	.	.	.	.	.	.	+	He	Sc,M	1000-1600	Ca	13	LC+
Ferulago ternatifolia Solanas & al.	FI	.	1	.	.	.	.	.	.	1	.	.	He	M	380-1800	Ca	8	VU+
Guillonea scabra (Cav.) Coss.	FI	.	2	.	+	+	.	.	.	2	.	.	He	M	200-1200	Ca	119	LC
Guillonea scabra subsp. *canescens* (Boiss.) Nyman	FI	.	2	.	.	.	.	.	.	.	.	.	He	Sc,M	800-1200	Ca	60	LC
Guillonea scabra subsp. *scabra* (Cav.) Coss.	FI	.	.	.	+	+	.	.	.	2	.	.	He	Sc,M	40-1200	Ca	70	LC
Laserpitium eliasii Sennen & Pau	FI	.	.	3	.	+	+	1	+	.	.	.	He	Sc	800-1300	.	142	LC
Laserpitium eliasii subsp. *eliasii* Sennen & Pau	FI	.	.	2	.	+	.	.	+	.	.	.	He	G	800-1300	Ca	60	LC
Laserpitium eliasii subsp. *ordunae* P. Monts.	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro,G	400-600	Ca	6	DD*
Laserpitium eliasii subsp. *thalictrifolium* (Samp.) P. Monts.	FI	.	.	.	.	.	+	2	.	.	.	.	He	F	600-1100	Si	50	LC
Laserpitium gallicum subsp. *majoricum* Romo	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	200-1400	Ca	2	DD*
Laserpitium gallicum subsp. *orospedanum* Solanas & al.	FI	.	2	.	.	.	.	.	.	+	.	.	He	M	1500-1800	Ca	14	LC+
Laserpitium gallicum subsp. *paradoxum* (A. Bolòs & Font Quer) P. Monts.	FI	.	.	.	.	.	.	.	1	.	.	.	He	Ro,M	800-1850	Ca	8	LC+
Laserpitium latifolium subsp. *merinoi* P. Monts.	FI	.	.	.	.	.	+	1	.	.	.	.	He	F	250-1200	Si	1	DD*
Laserpitium latifolium subsp. *nevadense* Mart. Lirola & al.	FI	.	2	.	.	.	.	.	.	.	.	.	He	F	1300-1300	Si	3	CR+
Laserpitium longiradium Boiss.	FI	.	1	.	.	.	.	.	.	.	.	.	He	Sc	1300-1500	Ca	2	CR+
Laserpitium nestleri subsp. *lainzii* P. Monts.	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro	1800-2010	Ca	2	DD*

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Ligusticum lucidum subsp. *huteri* (Porta) O. Bolòs	FI	2	.	.	.	.	.	.	.	.	.	.	He	Ro,G	1300-1400	.	1	CR
Naufraga balearica Constance & Cannon	FI	2	.	.	.	.	.	.	.	.	.	.	Ge	C	25-200	Ca	2	CR
Pastinaca lucida L.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	500-1400	Ca	13	LC
Peucedanum officinale subsp. *brachyradium* García-Martín & Silvestre	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	W	800-900	.	1	CR+
Pimpinella bicknellii Briq.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Sc	150-850	Ca	6	VU
Pimpinella espanensis M. Hiroe	FI	.	2	.	+	2	.	.	.	1	.	.	He	Sc,F	600-2000	Ca	44	LC
Pimpinella procumbens (Boiss.) Pau	FI	.	2	.	.	.	.	.	.	.	.	.	He	A	2400-2950	Si	6	VU+
Rivasmartinezia cazorlana Blanca & al.	OP	.	1	.	.	.	.	.	.	.	.	.	He	Sc,Ro	1680-1700	Ca	1	CR*+
Rivasmartinezia vazquezii Fern. Prieto & Cires	OP	.	.	1	.	.	.	.	.	.	.	.	He	Ro	1250-1250	Ca	1	CR*+
Scandix australis subsp. *brevirostris* (Boiss. & Reut.) Thell.	FI	.	.	2	.	.	.	.	.	.	.	.	Th	M,G	800-1000	.	3	DD*
Scandix australis subsp. *microcarpa* (Lange) Thell.	FI	.	1	.	+	1	.	1	.	.	.	1	Th	Sc	500-950	.	89	LC
Seseli cantabricum Lange	FI	.	.	3	.	2	.	.	.	.	.	.	He	H	0-1700	.	148	LC
Seseli farrenyi Molero & J. Pujadas	FI	.	.	.	.	.	.	.	1	.	.	.	He	C	0-100	.	1	EN+
Seseli intricatum Boiss.	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	Ro	1600-1900	Ca	2	EN+
Seseli montanum subsp. *granatense* (Willk.) C. Pardo	FI	.	3	.	.	.	.	.	.	1	.	.	Ge	M	1200-2350	.	44	LC
Seseli montanum subsp. *peixotoanum* (Samp.) M. Laínz	FI	.	.	.	.	.	+	1	.	.	.	.	Ge	Ro	250-900	Ser	9	DD*
Thapsia gymnesica Rosselló & A. Pujadas	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	10-500	.	17	LC
Thapsia minor Hoffmanns. & Link	FI	.	.	+	.	+	+	2	.	.	2	1	He	Sc,H	200-1300	Si	166	LC
Trinia castroviejoi Gómez Nav. & al.	OP	.	.	.	.	+	.	.	.	2	.	.	He	Sc,M	700-1200	Ca	10	LC+
Trinia dufourii DC.	FI	.	.	1	+	+	.	.	.	.	.	.	He	St	300-300	.	8	LC+
Xatardia scabra (Lapeyr.) Meisn.	FI	.	.	.	.	.	.	.	2	.	.	.	He	A	1700-2900	.	23	LC
ARACEAE																		
Arum pictum subsp. *sagittifolium* Rosselló & L. Sáez	FI	3	.	.	.	.	.	.	.	.	.	.	Ge	Sc	40-350	Ca	25	LC
Biarum carratracense (Haens. ex Willk.) Font Quer	FI	.	3	.	.	.	.	.	.	.	.	+	Ge	G	300-1520	Ca	45	LC
Biarum mendax P.C. Boyce	FI	.	+	.	.	.	.	.	.	.	.	3	Ge	Ru,G	50-600	Ca	37	LC
ARALIACEAE																		
Hedera helix subsp. *rhizomatifera* McAllister	FI	.	1	.	.	+	.	.	.	2	.	.	Ph	Ro	1000-1500	.	9	DD*
Hedera maderensis subsp. *iberica* McAllister	FI	.	.	.	.	.	.	+	.	.	3	+	Ph	Sc	0-800	.	26	LC
ARISTOLOCHIACEAE																		
Aristolochia bianorii Sennen & Pau	FI	3	.	.	.	.	.	.	.	.	.	.	Ge	Ro,M	0-1000	Ca	10	LC
Aristolochia castellana (Nardi) Costa	OP	.	.	.	.	+	.	2	.	.	.	.	Ge	Sc	600-1500	Si	30	LC
ASPARAGACEAE																		
Asparagus macrorrhizus Pedrol & al.	FI	.	.	.	.	.	.	.	.	1	.	.	Ge	C	0-10	.	3	CR+
Bellevalia dubia subsp. *hackelii* (Freyn) Feinbrun	FI	.	.	.	.	.	.	.	.	.	2	.	Ge	Sc	15-500	Si	25	LC
Brimeura duvigneaudii (L. Llorens) Rosselló & al.	FI	3	.	.	.	.	.	.	.	.	.	.	Ge	Ro	70-560	Ca	5	CR
Brimeura duvigneaudii subsp. *duvigneaudii* (L. Llorens) Rosselló & al.	FI	2	.	.	.	.	.	.	.	.	.	.	Ge	Ro	70-560	Ca	2	CR
Brimeura duvigneaudii subsp. *occultata* L. Sáez & al.	FI	2	.	.	.	.	.	.	.	.	.	.	Ge	Ro	270-280	Ca	2	CR
Hyacinthoides hispanica (Mill.) Rothm.	FI	.	1	.	.	+	+	2	.	.	2	2	Ge	Sc,F	50-2000	.	272	LC
Hyacinthoides paivae S. Ortiz & Rodr. Oubiña	FI	.	.	.	.	.	1	1	.	.	.	.	Ge	Sc,G	5-1500	Si	34	LC
Hyacinthoides reverchonii (Degen & Hervier) Speta	FI	.	2	.	.	.	.	.	.	.	.	.	Ge	Sc,Ro	600-1700	Ca	13	LC+
Muscari cazorlanum C. Soriano & al.	FI	.	1	.	.	.	.	.	.	.	.	.	Ge	Ro	500-1200	Ca	4	VU+
Muscari matritensis Ruiz Rejón & al.	FI	.	1	.	.	+	.	+	.	.	.	.	Ge	M,G	600-2000	.	8	DD*
Ornithogalum concinnum Salisb.	FI	.	.	.	.	.	+	3	.	.	+	1	Ge	H,G	0-2000	Si	185	LC
Paradisea lusitanica (Cout.) Samp.	FI	.	.	.	.	.	+	3	.	.	.	+	Ge	G	50-1300	.	61	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
ASPLENIACEAE																		
Asplenium majoricum Litard.	FI	2	.	.	+	.	.	.	.	2	.	.	He	Ro	0-300	Ca	20	VU
Asplenium petrarchae subsp. *bivalens* (D.E. Mey.) Lovis & Reichst.	FI	.	1	.	.	.	.	.	.	2	.	.	He	Ro	0-1400	.	22	LC
ASTERACEAE																		
Achillea ceretanica (Sennen) I. Soriano	FI	.	.	.	.	.	.	.	2	.	.	.	He	G	1100-2200	.	8	DD*
Achillea chamaemelifolia Pourr.	FI	.	.	.	.	.	.	.	3	.	.	.	He	Ro	500-2300	Si	29	LC
Anthemis alpestris (Hoffmanns. & Link) R. Fern.	FI	.	+	+	+	2	.	1	.	.	.	+	He	G	800-1700	Si	45	LC
Anthemis bourgaei Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	1	.	Th	C,Sc	50-60	Ca	2	EN+
Anthemis funkii (Willk.) Benedí	FI	.	1	.	.	.	.	.	.	.	.	.	Th	R	800-900	.	2	EX
Anthemis pedunculata subsp. *turolensis* (Caball.) Oberpr.	FI	.	.	.	.	2	.	.	.	.	.	.	He	G	900-1200	Ca	7	DD*
Arnica montana subsp. *atlantica* A. Bolòs	FI	.	.	1	.	.	3	1	.	.	+	.	He	G	10-1250	Si	55	LC
Artemisia aethiopica L.	FI	.	.	.	.	.	.	.	.	3	.	.	Ch	St	0-500	.	44	LC
Artemisia assoana Willk.	FI	.	+	+	.	3	.	.	.	.	.	.	Ch	M	900-1350	Ca	64	LC
Artemisia granatensis Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	A	2500-3400	Si	7	CR-
Aster aragonensis Asso	FI	.	.	2	+	2	+	1	.	+	+	+	He	G	300-1800	.	140	LC
Aster pyrenaeus DC.	FI	.	.	1	.	.	.	.	1	.	.	.	He	G	300-900	Ca	11	VU-
Aster willkommii Sch. Bip.	FI	.	+	1	1	2	.	.	2	+	.	.	He	M,G	200-1200	Ca	159	LC
Avellara fistulosa (Brot.) Blanca & C. Díaz	FI	.	.	.	.	.	1	.	.	.	1	.	Ge	W	0-10	.	6	CR+
Bellis cordifolia (Kunze) Willk.	FI	.	.	.	.	.	.	.	.	.	1	.	He	Sc	120-550	Si	1	EN+
Bellium artrutxense P. Fraga & Roselló	FI	3	.	.	.	.	.	.	.	.	.	.	Th	M	0-150	Ca	6	VU
Calendula suffruticosa subsp. *greuteri* Ohle	FI	.	1	.	.	.	.	.	+	.	.	.	He	C	0-700	.	6	DD*
Calendula suffruticosa subsp. *algarbiensis* (Boiss.) Nyman	FI	.	.	.	.	.	1	.	.	.	3	.	He	C	0-150	.	34	LC
Calendula suffruticosa subsp. *carbonellii* Ohle	FI	.	+	.	.	.	.	.	.	.	1	.	He	C	0-150	.	4	DD*
Carduncellus balearicus (J.J. Rodr.) G. López	FI	2	.	.	.	.	.	.	.	.	.	.	Ph	C,M	10-100	Si	3	VU
Carduncellus cuatrecasasii G. López	FI	.	2	.	.	.	.	.	.	.	.	1	He	M	400-1600	Ca	19	LC+
Carduncellus dianius Webb	FI	2	.	.	.	.	.	.	.	1	.	.	He	C,Ro	0-400	Ca	12	VU+
Carduncellus hispanicus Boiss. ex DC.	FI	.	2	.	.	1	.	.	.	1	.	.	He	M	200-1800	Ca	48	LC
Carduncellus hispanicus subsp. *araneosus* (Boiss. & Reut.) G. López	FI	.	2	.	.	1	.	.	.	1	.	.	He	M	600-1000	Ca	44	LC
Carduncellus hispanicus subsp. *hispanicus* Boiss. ex DC.	FI	.	1	.	.	.	.	.	.	.	.	.	He	M	200-1800	Ca	20	LC
Carduncellus hispanicus subsp. *intercedens* (Degen & Hervier) G. López	FI	.	1	.	.	.	.	.	.	.	.	.	He	M	300-1700	Ca	20	LC
Carduus asturicus Franco	FI	.	.	.	.	.	1	+	.	.	.	.	Th	R	400-1800	Si	6	DD*
Carduus broteri (Welw. ex Mariz) Cout.	FI	.	.	.	.	.	.	1	.	.	2	.	He	R	0-300	Ca	32	LC
Carduus carlinoides subsp. *hispanicus* (Kazmi) Franco	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro,A	1900-3200	Ca	2	NT-
Carduus carpetanus Boiss. & Reut.	FI	.	.	2	.	2	+	2	+	.	.	.	He	R	450-1960	Si	339	LC
Carduus carpetanus subsp. *braun-blanquetii* (P. Monts.) Rivas Mart.	FI	.	.	.	.	.	.	.	1	.	.	.	He	Ro,Ru	1230-1860	Si	1	DD*
Carduus carpetanus subsp. *carpetanus* Boiss. & Reut.	FI	.	.	2	.	2	+	2	.	.	.	.	He	Ru,G	450-1960	Si	330	LC
Carduus ibicensis (Devesa & Talavera) Rosselló & N. Torres	FI	2	.	.	.	.	.	.	.	.	.	.	Th	R	0-300	.	5	LC
Carduus meonanthus subsp. *valentinus* (Boiss. & Reut.) Devesa & Talavera	FI	.	+	.	.	.	.	.	.	3	.	.	Th	R	10-500	Ca	29	LC
Carduus nigrescens subsp. *hispanicus* (Franco) O. Bolòs & Vigo	FI	.	.	.	.	.	.	.	.	2	.	.	He	R	50-1200	Ca	25	LC
Carduus paui Devesa & Talavera	FI	.	.	.	.	2	.	.	.	.	.	.	He	F	1300-2020	Ca	16	LC+
Carduus platypus Lange	FI	.	2	1	.	1	.	2	.	+	+	+	He	F	280-2500	.	206	LC
Carduus platypus subsp. *granatensis* (Willk.) Nyman	FI	.	2	.	.	1	.	+	.	.	.	+	He	M	400-2500	Ca	116	LC
Carduus platypus subsp. *platypus* Lange	FI	.	.	2	.	.	.	2	.	.	+	+	He	G	280-1600	Si	54	LC
Carduus rivasgodayanus Devesa & Talavera	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ru,Sc	800-1200	Ca	7	EN+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Carduus santacreui (Devesa & Talavera) Devesa	FI	.	.	.	.	.	.	.	.	.	1	.	He	R	0-100	Si	1	EN+
Castrilanthemum debeauxii (Degen & al.) Vogt & Oberpr.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	M,G	1700-1900	Ca	6	CR+
Centaurea alba subsp. *alba* L.	FI	.	.	.	.	1	.	1	.	.	.	+	Ch	Sc	3-2000	.	120	LC
Centaurea alba subsp. *aristifera* (Pau ex Vicioso) E. López & Devesa	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	M	530-1450	Ca	16	LC+
Centaurea alba subsp. *tartesiana* Talavera	FI	.	.	.	.	.	.	.	.	.	.	2	Ch	Sc	500-1000	Si	11	LC+
Centaurea amblensis Graells	FI	.	.	.	.	+	.	2	.	.	.	+	He	Sc,G	800-1500	Si	41	LC
Centaurea amblensis subsp. *amblensis* Graells	FI	.	.	.	.	.	.	1	.	.	.	.	He	Sc	800-1500	Si	39	LC
Centaurea amblensis subsp. *tentudaica* (Rivas Goday) Rivas Mart.	FI	.	.	.	.	.	.	.	.	.	.	1	He	Sc	910-1070	Si	2	VU+
Centaurea antennata Dufour	FI	.	2	.	+	.	.	.	.	2	.	.	Ch	M	220-1500	Ca	59	LC
Centaurea antennata subsp. *antennata* Dufour	FI	.	.	.	1	.	.	.	.	+	.	.	Ch	M	220-700	Ca	17	LC+
Centaurea antennata subsp. *meridionalis* (O. Bolòs & Vigo) Serra & M.B. Crespo	FI	.	2	.	.	.	.	.	.	2	.	.	Ch	M	700-1500	Ca	27	LC
Centaurea argecillensis Gredilla	FI	.	.	.	.	2	.	.	.	.	.	.	He	Sc	800-1300	Ca	6	LC+
Centaurea aristata Hoffmanns. & Link	FI	.	.	+	.	2	.	2	.	.	.	+	He	Sc,G	100-1290	.	180	LC
Centaurea aspera subsp. *stenophylla* (Dufour) Nyman	FI	+	+	.	1	1	.	.	.	3	+	.	Ch	R	0-1100	.	117	LC
Centaurea avilae Pau	FI	.	.	.	.	.	.	1	.	.	.	.	He	Ro,G	1700-2200	Si	11	VU-
Centaurea barrasii Pau	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	St	0-500	.	1	VU+
Centaurea beltranii (Pau) Blanca	FI	.	.	.	.	.	.	.	.	2	.	.	He	M	0-1000	.	10	DD*
Centaurea bethurica E. López & Devesa	FI	.	.	.	.	.	.	.	.	.	.	2	He	Sc	200-1000	Si	19	LC+
Centaurea boissieri subsp. *funkii* (Sch. Bip. ex Willk.) Blanca	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	900-1700	Dol	15	VU-
Centaurea boissieri subsp. *integrifolia* (Willk.) Blanca & Suár.-Sant.	FI	.	.	.	1	1	.	.	.	1	.	.	He	Ro,M	100-1700	.	65	LC
Centaurea boissieri subsp. *mariolensis* (Rouy) Dostál	FI	.	.	.	.	.	.	.	.	2	.	.	He	M	600-1400	Ca	30	LC
Centaurea boissieri subsp. *pinae* (Pau) Dostál	FI	.	.	.	+	3	.	.	.	+	.	.	He	Ro,M	600-2000	.	106	LC
Centaurea boissieri subsp. *prostrata* (Coss.) Dostál	FI	.	2	.	.	.	.	.	.	2	.	.	He	Ro,M	300-1600	Ca	29	LC
Centaurea boissieri subsp. *willkommii* (Sch. Bip. ex Willk.) Dostál	FI	.	3	.	.	.	.	.	.	1	.	+	He	Ro,M	600-1700	Ca	38	LC
Centaurea bombycina Boiss. ex DC.	FI	.	1	.	.	.	.	.	.	.	.	.	He	M	700-1700	Ca,Dol	10	VU
Centaurea bombycina subsp. *bombycina* Boiss. ex DC.	FI	.	1	.	.	.	.	.	.	.	.	.	He	M	700-1700	Ca,Dol	7	VU-
Centaurea bombycina subsp. *xeranthemoides* (Lange ex Willk.) Blanca & al.	FI	.	1	.	.	.	.	.	.	.	.	.	He	M	800-1700	Ca,Dol	1	VU+
Centaurea borjae Valdés Berm. & Rivas Goday	FI	.	.	.	.	.	1	.	.	.	.	.	He	C,H	100-490	Si	7	EN+
Centaurea carratracensis Lange	FI	.	1	.	.	.	.	.	.	.	.	.	He	M	300-1000	Ser	5	EN+
Centaurea castellanoides subsp. *arundana* E. López & Devesa	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ru,Sc	700-1500	Ca	6	DD*
Centaurea castellanoides subsp. *castellanoides* Talavera	FI	.	3	.	.	+	.	.	.	.	.	.	He	Ru,Sc	620-1700	Ca	33	LC
Centaurea castellanoides subsp. *talaverae* E. López & Devesa	FI	.	1	.	.	2	.	.	.	+	.	.	He	Ru,Sc	530-1200	Ca	36	LC
Centaurea castellanoides Talavera	FI	.	2	.	.	1	.	.	.	+	.	+	He	Ru,Sc	530-1700	Ca	80	LC
Centaurea citricolor Font Quer	FI	.	.	.	.	.	.	.	.	.	.	2	He	Ru,Sc	600-1300	Si	12	LC+
Centaurea corcubionensis M. Laínz	FI	.	.	.	.	.	3	.	.	.	.	.	He	C,H	10-600	Si	15	LC+
Centaurea cordubensis Font Quer	FI	.	.	.	.	.	.	.	.	.	.	3	He	Sc	20-1000	.	53	LC
Centaurea costae Willk.	FI	.	.	.	1	.	.	.	3	.	.	.	He	F	450-1900	.	76	LC
Centaurea crocata Franco	FI	.	.	.	.	.	.	.	.	.	1	.	He	Sc	100-850	Si	8	VU+
Centaurea emigrantis Bubani	FI	.	.	.	1	.	.	.	2	.	.	.	He	M	350-1200	Ca	34	LC
Centaurea emporitana Vayr. ex Hayek	FI	.	.	.	1	.	.	.	2	.	.	.	He	Ru,Sc	5-600	Ca	8	LC+
Centaurea exarata Boiss. ex Coss.	FI	.	.	.	.	.	.	.	.	.	3	.	He	C,W	0-30	.	19	VU+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Centaurea fabregatii Mateo & M.B. Crespo	FI	.	.	.	1	.	.	.	.	+	.	.	He	M	0-1100	Ca	4	DD*
Centaurea gadorensis Blanca	FI	.	2	.	.	.	.	.	.	.	.	.	He	M	1300-1900	Ca	5	VU+
Centaurea gallaecica (M. Laínz) Arnelas & Devesa	FI	.	.	.	.	.	2	.	.	.	.	.	He	H	150-700	Ser	10	VU+
Centaurea genesii-lopezii Fern. Casas & Susanna	FI	.	1	.	.	.	.	.	.	.	.	.	He	M	1200-1650	Ca	1	CR+
Centaurea granatensis DC.	FI	.	3	.	.	.	.	.	.	.	.	.	He	M,G	700-2000	Ca	74	LC
Centaurea haenseleri (Boiss.) Boiss. & Reut.	FI	.	1	.	.	.	.	.	.	.	.	.	He	Sc,M	520-1400	Ser	3	EN+
Centaurea hyssopifolia Vahl	FI	.	.	.	.	2	.	.	.	.	.	.	Ch	St	500-750	Ca,Gyp	43	LC
Centaurea jaennensis Degen & Debeaux	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1000-2000	Ca	9	LC-
Centaurea janeri Graells	FI	.	.	2	.	.	1	1	.	.	.	.	He	M,G	400-1900	Si	37	LC
Centaurea janeri subsp. *babiana* M. Laínz	FI	.	.	3	.	.	.	+	.	.	.	.	He	M	400-1900	Si	22	LC
Centaurea janeri subsp. *janeri* Graells	FI	.	.	.	.	.	.	2	.	.	.	.	He	M	980-1700	Si	15	LC+
Centaurea kunkelii N. Garcia	FI	.	1	.	.	.	.	.	.	.	.	.	He	R	700-1100	Ca	2	CR+
Centaurea lagascana Graells	FI	.	.	3	.	1	.	+	.	.	.	.	He	G,G	700-2000	Ca	51	LC
Centaurea lainzii Fern. Casas	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ru,Sc	400-1400	Ser	4	CR+
Centaurea langei Nyman	FI	.	.	2	.	.	1	2	.	.	.	+	He	Sc,G	100-1800	Si	140	LC
Centaurea langei subsp. *coutinhoi* (Franco) E. López & al.	FI	.	.	.	.	.	.	1	.	.	.	1	He	Sc,G	350-1000	.	7	DD
Centaurea langei subsp. *dominguezii* E. López & al.	FI	.	.	.	.	.	.	.	.	.	.	1	He	Sc,G	650-700	Si	2	DD*
Centaurea langei subsp. *exilis* (Arènes) E. López & al.	FI	.	.	.	.	.	.	1	.	.	.	.	He	Sc,G	220-1050	Si	55	LC
Centaurea langei subsp. *geresensis* (Arènes) E. López & al.	FI	.	.	.	.	.	+	1	.	.	.	.	He	Sc,G	100-1300	Si	5	DD*
Centaurea langei subsp. *kheilii* (Pau) E. López & al.	FI	.	.	.	.	.	.	1	.	.	.	.	He	Sc,G	430-1620	Si	2	DD*
Centaurea langei subsp. *langei* Nyman	FI	.	.	1	.	.	1	2	.	.	.	.	He	Sc,G	100-1800	Si	32	LC
Centaurea langei subsp. *rothmaleriana* (Arènes) E. López & al.	FI	.	.	.	.	.	.	2	.	.	.	.	He	Sc,G	900-1500	Si	26	NT
Centaurea legionis-septimae Fern. Casas & Susanna	FI	.	.	2	.	.	.	.	.	.	.	.	He	R	1000-1200	Ca	3	DD*
Centaurea limbata Hoffmanns. & Link	FI	.	.	.	.	.	3	1	.	.	+	.	He	Sc	1-1000	Si	72	LC
Centaurea limbata subsp. *limbata* Hoffmanns. & Link	FI	.	.	.	.	.	3	+	.	.	+	.	He	Sc	1-260	Si	48	LC
Centaurea limbata subsp. *lusitana* (Arènes) E. López & Devesa	FI	.	.	.	.	.	.	1	.	.	.	.	He	Sc,H	200-1000	Si	8	DD*
Centaurea linifolia L.	FI	.	.	.	3	+	.	.	+	1	.	.	Ch	Sc,M	0-1600	Ca	152	LC
Centaurea lusitanica Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	2	.	He	Ru,Sc	30-200	.	13	LC+
Centaurea malacitana Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ru,M	300-1000	.	8	LC-
Centaurea mariana Nyman	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1150-1900	Ca	9	VU+
Centaurea molesworthiae E. López & al.	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	M	200-650	Si	3	EN*+
Centaurea nigra subsp. *rivularis* (Brot.) Cout.	FI	.	.	2	.	.	2	2	.	.	.	+	He	H,G	10-1500	Si	174	LC
Centaurea occasus Fern. Casas	FI	.	.	.	.	.	.	.	.	.	1	.	He	M	150-400	Ca	5	VU+
Centaurea ornata Willd.	FI	.	2	1	1	2	.	1	+	1	+	1	He	Ru,M	100-1900	Ca	327	LC
Centaurea paniculata subsp. *oscensis* Pau ex E. López & Devesa	FI	.	.	.	1	.	.	.	+	.	.	.	He	Sc,M	300-700	Ca	15	LC+
Centaurea paui Loscos ex Willk.	FI	.	.	.	.	.	.	.	.	1	.	.	He	Ro,M	200-1400	Si	7	LC-
Centaurea pinnata Pau ex Vicioso	FI	.	.	.	.	2	.	.	.	.	.	.	He	M	500-1200	Si	17	NT+
Centaurea podospermifolia Loscos & J. Pardo	FI	.	.	.	1	.	.	.	.	.	.	.	He	Sc,G	400-1100	Ca	9	NT+
Centaurea prolongoi Boiss. ex DC.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro,G	100-1600	Ca	29	NT*
Centaurea pulvinata (Blanca) Blanca	FI	.	2	.	.	.	.	.	.	.	.	.	He	M	1500-2000	Si	10	VU-
Centaurea resupinata subsp. *dufourii* (Dostál) Greuter	FI	.	.	.	.	.	.	.	.	2	.	.	He	M	0-1000	Ca	47	LC
Centaurea rouyi Coincy	FI	.	.	.	.	.	.	.	.	2	.	.	He	Ro,M	5-1400	Ca	22	LC
Centaurea sagredoi Blanca	FI	.	1	.	.	.	.	.	.	+	.	.	He	M	1100-1700	Si	6	VU+
Centaurea saxicola Lag.	FI	.	.	.	.	.	.	.	.	2	.	.	He	Ro	1-450	Ca	16	NT+
Centaurea saxifraga Coincy	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	1350-1450	Ca	1	CR+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Centaurea schousboei Lange	FI	.	.	.	.	.	.	.	.	.	.	1	He	Sc	500-1000	Si	5	DD*
Centaurea stuessyi Arnelas & al.	FI	.	.	.	2	.	.	.	.	.	.	.	Ch	Sc,M	350-1000	Ca	13	LC+
Centaurea susannae Invernón & Devesa	FI	.	.	.	.	.	.	.	.	.	1	.	He	C,M	20-100	.	3	DD*
Centaurea toletana Boiss. & Reut.	FI	.	+	.	.	2	.	.	.	.	.	+	He	Sc,G	700-1800	Ca	29	LC
Centaurea ultreiae Silva Pando	FI	.	.	.	.	.	1	.	.	.	.	.	He	H	400-500	Si	3	CR+
Cheirolophus uliginosus (Brot.) Dostál	FI	.	.	.	.	.	+	+	.	.	3	+	He	W	0-100	.	49	LC
Cirsium acaulon subsp. *gregarium* (Boiss. ex DC.) Talavera	FI	.	3	.	.	.	.	.	.	.	.	.	He	W,G	2000-2900	Si	26	LC
Cirsium gaditanum Talavera & Valdés	FI	.	2	.	.	.	.	.	.	.	.	.	He	W	600-1200	Ca	6	NT-
Cirsium glabrum DC.	FI	.	.	.	.	.	.	.	2	.	.	.	Ge	Ro	1000-2500	Ca	28	LC
Cirsium richterianum subsp. *giraudiasii* (Sennen & Pau) Talavera & Valdés	FI	.	.	2	.	2	.	.	.	.	.	.	He	Ru,G	700-1700	Ca	24	LC
Cirsium rosulatum Talavera & Valdés	FI	.	2	.	.	.	.	.	.	.	.	.	He	W	1000-1700	Ca	7	VU+
Cirsium valentinum Porta & Rigo	FI	.	.	.	.	1	.	.	.	2	.	.	He	M	500-2000	Ca	20	LC
Cirsium welwitschii Coss.	FI	.	.	.	.	.	.	.	.	.	2	.	He	W	0-100	Si	5	EN+
Cota oretana (Carretero) Oberpr. & Greuter	FI	.	.	.	.	.	.	.	.	.	.	1	Th	R	650-900	Si	10	LC-
Crepis bermejana M. Talavera & al.	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	530-950	Ser	1	DD*
Crepis granatensis (Willk.) Blanca & Cueto	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1600-2300	Ca	8	EN+
Crepis novoana S. Ortiz & al.	FI	.	.	.	.	.	1	.	.	.	.	.	He	C	0-80	.	1	CR+
Crepis oporinoides Froel.	FI	.	3	.	.	.	.	.	.	.	.	.	He	A	1700-3200	.	18	LC+
Crepis triasii (Cambess.) Fr.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	50-1450	Ca	26	LC
Cynara algarbiensis Coss. ex Mariz	FI	.	.	.	.	.	.	.	.	.	2	+	He	Ru,Sc	10-900	.	30	LC*
Cynara baetica subsp. *baetica* (Spreng.) Pau	FI	.	2	.	.	.	.	.	.	.	.	.	He	R	400-1700	.	15	VU-
Cynara tournefortii Boiss. & Reut.	FI	.	1	.	.	+	.	.	.	.	1	1	He	Ru,M	186-1200	Ca	28	VU*
Dittrichia viscosa subsp. *revoluta* (Hoffmanns. & Link) P. Silva & Tutin	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C,Ru	0-200	.	37	LC
Doronicum carpetanum subsp. *carpetanum* Willk. in Willk. & Lange	FI	.	.	.	.	.	.	1	.	.	.	.	He	Ro,H	900-2300	.	40	LC
Doronicum carpetanum subsp. *diazii* (Perez Morales & Penas) Alv. Fern.	FI	.	.	2	.	+	+	1	.	.	.	.	He	Ro	1700-2100	.	33	LC
Doronicum carpetanum subsp. *kuepferi* (R. Chacón) Alv. Fern.	FI	.	.	.	.	.	.	2	.	.	.	.	He	Ro	1800-2500	.	12	LC+
Doronicum carpetanum subsp. *pubescens* (Perez Morales & al.) Aizpuru	FI	.	.	+	.	.	+	1	.	.	.	.	He	F,H	0-2200	.	20	LC
Doronicum carpetanum Willk.	FI	.	.	2	.	1	1	1	.	.	.	.	He	F,H	0-2500	.	120	LC
Erigeron cabelloi A. Pujadas & al.	FI	.	.	.	.	.	.	.	1	.	.	.	He	A	2500-2600	Si	1	EN*+
Erigeron frigidus DC.	FI	.	2	.	.	.	.	.	.	.	.	.	He	A	3000-3460	Si	3	EN+
Filago petro-ianii Rita & Dittrich	FI	2	.	.	.	.	.	.	.	.	.	.	Th	M	0-100	Ca	7	VU
Helichrysum crassifolium (L.) D. Don	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Ro	0-1300	Ca	21	LC
Helminthotheca spinosa (DC.) Talavera & Tremetsberger	FI	.	.	.	.	.	.	.	.	.	3	1	He	Sc	100-400	Si	46	LC
Hieracium aragonense Scheele	FI	+	1	2	+	1	.	.	.	1	.	.	He	Ro	200-2100	Ca	106	LC
Hieracium bombycinum Rchb. fil.	FI	.	.	3	.	+	.	+	+	.	.	.	He	Ro	800-2200	Ca	109	LC
Hieracium bourgaei Boiss.	FI	.	3	.	.	.	.	.	.	1	.	.	He	Ro	300-2000	Ca	33	LC
Hieracium elisaeanum Willk.	FI	1	2	+	+	2	.	.	.	1	.	.	He	Ro	600-1900	Ca	57	LC
Hieracium gymnocerinthe Arv.-Touv & Gaut.	FI	.	.	2	.	.	.	.	3	.	.	.	He	Ro	600-2000	.	77	LC
Hieracium lainzii de Retz	FI	.	.	3	.	.	.	.	.	.	.	.	He	Ro	1000-1950	Ca	22	LC
Hieracium mixtum Froel.	FI	.	.	3	.	+	.	+	2	.	.	.	He	Ro	600-2200	Ca	81	LC
Hieracium ramondii Griseb.	FI	.	.	1	.	.	.	.	3	.	.	.	He	Ro	900-2400	.	32	NT
Hieracium recoderi de Retz	FI	.	.	.	1	.	.	.	2	.	.	.	He	Ro	900-1500	.	5	CR+
Hieracium spathulatum Scheele	FI	.	+	2	+	2	.	.	+	+	.	.	He	Ro	400-2400	Ca	47	LC
Hispidella hispanica Lam.	FI	.	.	.	.	1	+	3	.	.	.	+	Th	M,G	700-1600	.	179	LC
Hymenostemma pseudanthemis (Kunze) Willk.	FI	.	1	.	.	.	.	.	.	.	1	.	Th	Sc	10-900	.	10	VU+
Hypochaeris rutea Talavera	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	800-900	Ca	2	CR+
Inula langeana Beck	FI	.	.	2	.	+	.	.	.	.	.	.	He	Sc	1050-1200	Ca	29	LC
Jurinea fontqueri Cuatrec.	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	1650-1850	Ca	1	CR+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Jurinea pinnata (Lag. ex Pers.) DC.	FI	.	2	.	+	1	.	.	.	1	.	.	Ch	St,M	630-1900	Ca,Gyp	59	LC
Klasea algarbiensis (Cantó) Cantó	FI	.	.	.	.	.	.	.	.	.	1	.	He	M	5-100	Si	8	VU+
Klasea boetica subsp. *lusitanica* (Cantó) Cantó & Rivas Mart.	FI	.	.	.	.	.	.	.	.	.	3	.	He	Sc	30-700	.	28	LC*
Klasea flavescens subsp. *flavescens* (L.) Holub	FI	.	1	.	.	1	.	.	.	.	.	.	He	Ru,M	350-1500	Ca	40	LC
Klasea flavescens subsp. *leucantha* (Cav.) Cantó & Rivas Mart.	FI	.	1	.	2	+	.	.	.	3	.	.	He	St	50-500	Ca,Gyp	124	LC
Klasea integrifolia (Vahl) Greuter	FI	.	.	.	.	+	.	+	.	.	2	1	He	Sc	20-1000	Si	70	LC
Klasea integrifolia subsp. *integrifolia* (Vahl) Greuter	FI	.	.	.	.	+	.	+	.	.	2	1	He	Sc	30-1000	Si	50	LC
Klasea integrifolia subsp. *monardii* (Dufour) Cantó	FI	.	.	.	.	.	.	+	.	.	2	1	He	Sc	20-600	Si	36	LC
Klasea legionensis (Lacaita) Holub	FI	.	.	.	.	.	.	1	.	.	.	.	He	F	900-1400	Si	5	EN+
Lactuca perennis subsp. *granatensis* Charpin & Fern. Casas	FI	.	3	.	.	.	.	.	.	.	.	.	He	Ro,G	1800-2200	Ca	17	LC-
Launaea cervicornis (Boiss.) Font Quer & Rothm.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-100	.	49	LC
Leontodon boryi DC.	FI	.	2	.	.	.	.	.	.	.	.	.	He	A	1800-3300	.	7	NT+
Leontodon farinosus Merino & Pau	FI	.	.	.	.	.	1	2	.	.	.	.	He	Ro	300-1400	.	19	VU-
Leontodon hispidus subsp. *bourgaeanus* (Willk.) Rivas Mart. & Sáenz de Rivas	FI	.	.	.	.	2	.	1	.	.	.	.	He	F	890-2000	Si	22	LC
Lepidophorum repandum (L.) DC.	FI	.	.	.	.	.	2	1	.	.	2	+	He	Sc	10-850	.	70	LC
Leucanthemopsis cuneata (Pau) Holub	FI	.	.	.	.	1	.	.	.	.	.	.	He	G	1400-2225	.	20	LC
Leucanthemopsis flaveola (Hoffmanns. & Link) Heywood	FI	.	.	.	.	.	.	2	.	.	.	+	Ch	Ro,G	500-1500	Si	53	LC
Leucanthemopsis pallida (Mill.) Heywood	FI	.	.	.	.	2	.	1	.	1	.	.	He	Ro,G	1000-1500	.	44	LC
Leucanthemopsis pallida subsp. *pallida* (Mill.) Heywood	FI	.	.	.	.	2	.	1	.	.	.	.	He	G	1000-2020	Si	28	LC
Leucanthemopsis pallida subsp. *virescens* (Pau) Heywood	FI	.	.	.	.	1	.	.	.	2	.	.	He	Ro	800-1600	.	16	LC+
Leucanthemopsis pectinata (L.) G. López & C.E. Jarvis	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	A	2000-3400	Si	5	LC-
Leucanthemopsis pulverulenta (Lag.) Heywood	FI	.	.	+	.	2	.	2	.	.	.	.	Ch	G	300-2000	.	137	LC
Leucanthemopsis spathulifolia (Gay) Fern. Casas	FI	.	3	.	.	.	.	.	.	.	.	.	He	Sc	1100-1900	Ca,Dol	17	LC+
Leucanthemum ageratifolium Pau	FI	.	.	.	2	2	.	.	2	+	.	.	Th	R	300-1500	.	99	LC
Leucanthemum aligulatum Vogt	FI	.	1	1	.	.	.	.	2	.	.	.	He	M	600-1600	Ca	20	LC
Leucanthemum cacuminis Vogt	FI	.	.	3	.	.	.	+	+	.	.	.	He	G	1000-1900	.	48	LC
Leucanthemum catalaunicum Vogt	FI	.	.	.	.	.	.	.	2	.	.	.	He	A,G	1600-2400	.	27	LC
Leucanthemum corunnense Lago	FI	.	.	.	.	.	1	.	.	.	.	.	He	C	5-50	.	3	DD*
Leucanthemum eliasii (Sennen & Pau) Vogt	FI	.	.	3	.	.	.	.	.	.	.	.	He	Ro	250-1000	.	20	LC
Leucanthemum favargeri Vogt	FI	.	.	.	.	.	.	.	2	.	.	.	He	M	700-1100	Ca	8	DD*
Leucanthemum gallaecicum Rodr. Oubiña & S. Ortiz	FI	.	.	.	.	.	2	.	.	.	.	.	He	G	320-655	Ser	2	EN+
Leucanthemum gracilicaule (Dufour) Pau	FI	.	.	.	.	.	.	.	.	3	.	.	He	M,G	300-1300	Ca	42	LC
Leucanthemum maestracense Vogt & F.H. Hellw.	FI	.	.	.	1	1	.	.	.	+	.	.	He	M,G	450-1500	.	24	LC
Leucanthemum montserratianum Vogt	FI	.	.	.	2	.	.	.	.	.	.	.	He	Ro,M	450-1500	Ca	4	LC
Leucanthemum pluriflorum Pau	FI	.	.	.	.	.	3	.	.	.	.	.	He	C	0-280	Si	22	LC
Leucanthemum pseudosylvaticum (Vogt) Vogt & Oberpr.	FI	.	.	.	.	.	+	2	.	.	+	+	He	Ru,Sc	100-1600	.	43	LC
Leucanthemum pyrenaicum Vogt	FI	.	.	.	.	.	.	.	3	.	.	.	He	Ro	1800-2600	.	39	LC
Leucanthemum sylvaticum (Brot.) Nyman	FI	.	.	.	.	.	2	+	.	.	+	.	He	C,Sc	0-800	.	23	LC
Leucanthemum sylvaticum subsp. *merinoi* (Vogt & Castrov.) Vogt & Oberpr.	FI	.	.	.	.	.	2	.	.	.	.	.	Ch	C	0-150	Si	12	LC+
Leucanthemum sylvaticum subsp. *sylvaticum* (Brot.) Nyman	FI	.	.	.	.	.	+	1	.	.	1	.	He	Sc	250-800	.	11	LC+
Mantisalca cabezudoi E. Ruiz & Devesa	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	1600-1800	.	7	DD*

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Mantisalca spinulosa (Rouy) E. Ruiz & Devesa	FI	.	+	.	.	2	.	.	.	+	.	.	Th	R	500-900	Ca	17	LC+
Mauranthemum paludosum subsp. *ebusitanum* (Vogt) Vogt & Operpr.	FI	2	.	.	.	.	.	.	.	.	.	.	Th	Ro,G	140-400	.	3	EN
Onopordum corymbosum subsp. *corymbosum* Willk.	FI	.	+	.	1	1	.	.	.	1	.	.	He	R	220-1200	Ca,Gyp	50	LC
Onopordum hinojense Talavera & al.	FI	.	.	.	.	.	.	.	.	.	1	.	He	Sc	0-16	.	3	CR+
Onopordum nervosum Boiss.	FI	.	2	.	1	1	.	+	.	1	+	1	He	R	0-1500	Ca	136	LC
Phalacrocarpum oppositifolium (Brot.) Willk.	FI	.	.	3	.	.	1	2	.	.	.	.	Ch	Ro,H	400-1200	Si	142	LC
Phalacrocarpum oppositifolium subsp. *anomalum* (Lag.) Vogt & Greuter	FI	.	.	3	.	.	+	+	.	.	.	.	Ch	Ro,H	500-2100	Si	82	LC
Phalacrocarpum oppositifolium subsp. *hoffmannseggii* (Samp.) Nieto Fel.	FI	.	.	.	.	.	+	2	.	.	.	.	Ch	Ro,H	600-1700	Si	25	LC
Phalacrocarpum oppositifolium subsp. *oppositifolium* (Brot.) Willk.	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Ro	900-1700	Si	24	LC
Pilosella breviscapa (DC.) Soják	FI	.	.	.	.	.	.	.	3	.	.	.	He	A,G	1900-3000	Si	58	LC
Pilosella galiciana (Pau) M. Laínz	FI	.	.	1	.	1	.	1	.	.	.	.	He	G	1200-2450	Si	33	LC
Pilosella lactocantabrica Mateo & Egido	FI	.	.	+	.	.	.	1	.	.	.	.	He	W	1300-2000	Si	4	DD*
Pilosella leptobrachia (Arv.-Touv. & Gaut.) Mateo	FI	.	.	.	2	1	.	.	1	.	.	.	He	H	300-1900	Si	20	LC
Pilosella vahlii (Froel.) F.W. Schultz & Sch. Bip.	FI	.	.	1	.	2	.	+	.	.	.	.	He	G	1600-2400	Si	59	LC
Prolongoa hispanica G. López & C.E. Jarvis	FI	.	2	.	+	1	.	.	.	.	.	1	Th	G	350-1700	.	75	LC
Ptilostemon hispanicus (Lam.) Greuter	FI	.	3	.	.	.	.	.	.	.	+	.	Ch	M	500-1700	Ca	110	LC
Rhaponticoides fraylensis (Sch. Bip. ex Nyman) M.V. Agab. & Greuter	FI	.	.	.	.	.	.	.	.	.	2	.	He	Sc	50-500	Si	11	LC+
Rhaponticum centauroides (L.) O. Bolòs	FI	.	.	.	.	.	.	.	3	.	.	.	He	G	1500-1900	Ca	40	LC
Rhaponticum longifolium subsp. *longifolium* (Hoffmanns. & Link) Dittrich	FI	.	.	.	.	.	.	.	.	.	2	.	He	W	100-656	Si	14	VU
Rothmaleria granatensis (DC.) Font Quer	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1100-1800	Dol	16	VU+
Santolina ageratifolia Asso	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	Ru,Sc	1400-1400	Si	6	VU-
Santolina benthamiana Jord. & Fourr.	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	G	1500-2000	.	42	LC
Santolina elegans DC.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro,M	1700-2100	Ca,Dol	11	VU+
Santolina impressa Hoffmanns. & Link	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C	5-62	Si	17	LC+
Santolina magonica (O. Bolòs & al.) Romo	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	M	0-1400	.	14	LC
Santolina magonica subsp. *magonica* (O. Bolòs & al.) Romo	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	M	0-1400	.	13	LC
Santolina magonica subsp. *vedraensis* (O. Bolòs & Vigo) Romo	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	M	50-380	.	1	LC
Santolina melidensis (Rodr. Oubiña & S. Ortiz) Rodr. Oubiña & S. Ortiz	FI	.	.	.	.	.	1	.	.	.	.	.	Ch	M	300-430	Ser	1	CR-
Santolina montiberica (Riv.-Guerra) R. Carbajal & al.	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	M	700-1200	Ca	1	DD*
Santolina oblongifolia Boiss.	FI	.	.	.	.	.	.	2	.	.	.	.	Ch	Ru,H	700-2400	Si	24	LC
Santolina rosmarinifolia L.	FI	.	.	+	.	2	.	2	.	.	+	+	Ch	M	300-2100	Ca	181	LC
Santolina semidentata Hoffmanns. & Link.	FI	.	.	2	.	.	+	2	.	.	.	.	Ch	H,M	300-1100	.	63	LC
Santolina viscosa Lag.	FI	.	+	.	.	.	.	.	.	2	.	.	Ch	St	0-600	Gyp	24	LC
Scorzonera albicans Coss.	FI	.	3	.	.	.	.	.	.	.	.	.	He	Ro,M	600-2000	Ca,Dol	19	LC+
Scorzonera baetica (DC.) Boiss.	FI	.	1	.	.	.	.	.	.	.	1	+	He	M,G	300-1500	.	46	LC
Scorzonera reverchonii Debeaux & Hervier	FI	.	2	.	.	.	.	.	.	.	.	.	He	G	800-2000	Ca	14	NT+
Scorzoneroides carpetana (Lange) Greuter	FI	.	1	1	+	2	.	1	2	.	.	.	He	W,G	700-3040	.	149	LC
Scorzoneroides carpetana subsp. *carpetana* Moreno Moral & al.	FI	.	.	2	+	2	.	1	.	.	.	.	He	G	700-1700	.	110	LC
Scorzoneroides carpetana subsp. *duboisii* (Sennen) Gallego	FI	.	.	.	.	.	.	.	3	.	.	.	He	W,G	1550-2600	Si	16	LC+
Scorzoneroides carpetana subsp. *nevadensis* (Lange) Izuzq.	FI	.	2	.	.	.	.	.	.	.	.	.	He	W,G	1450-3040	.	17	LC+
Scorzoneroides microcephala (DC.) Holub	FI	.	2	.	.	.	.	.	.	.	.	.	He	W,A	2400-3100	Si	5	EN+
Scorzoneroides pyrenaica subsp. *cantabrica* (Widder) Carlón & al.	FI	.	.	2	.	+	.	1	.	.	.	.	He	G	1700-2200	Si	33	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Senecio boissieri DC.	FI	.	2	1	.	.	.	+	+	.	.	.	Ch	Ro,A	2100-3300	.	28	LC
Senecio carpetanus Boiss. & Reut.	FI	.	.	2	.	2	.	.	.	.	.	.	He	W,H	500-1500	.	45	LC
Senecio legionensis L.	FI	.	.	2	.	.	1	+	.	.	.	.	He	W	400-1450	Si	34	LC*
Senecio lopezii Boiss.	FI	.	1	.	.	.	.	.	.	.	1	.	He	Sc	110-1125	Si	13	LC-
Senecio nebrodensis L.	FI	.	+	2	.	+	.	1	.	.	.	.	He	H,G	1500-3000	.	64	LC
Senecio nevadensis Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	A	2600-3300	Si	3	VU-
Senecio petraeus Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	200-900	Ca	9	LC-
Senecio pyrenaicus L.	FI	.	+	2	.	1	.	+	2	.	.	.	He	Ro,G	1000-2750	.	156	LC
Senecio quinqueradiatus DC.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	1700-2500	.	14	VU+
Senecio varicosus L. fil.	FI	3	.	.	.	.	.	.	.	.	.	.	Th	C	0-200	Hal	20	LC
Sonchus bulbosus subsp. *willkommii* (Burnat & Barbey) N. Kilian & Greuter	FI	3	.	.	.	.	.	.	.	.	.	.	He	C,Sc	0-1300	Hal	17	LC
Sonchus crassifolius Willd.	FI	.	.	.	1	1	.	.	.	+	.	.	He	St	200-1000	Gyp	36	LC
Staehelina baetica DC.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro,M	500-1800	Ser	12	LC+
Tanacetum mucronulatum (Hoffmanns. & Link) Heywood	FI	.	.	.	.	.	.	1	.	.	1	.	He	Sc	100-800	Si	10	DD*
Tanacetum vahlii DC.	FI	.	.	.	.	2	.	.	.	.	.	.	Th	Ro,G	1000-1500	Si	24	VU
Taraxacum ayllonense A. Galán & Vicente Orell	FI	.	.	.	.	1	.	.	.	.	.	.	He	G	1750-1750	Si	2	DD*
Taraxacum cantabricum A. Galán & Vicente Orell	FI	.	.	1	.	.	.	.	1	.	.	.	He	G	770-2400	.	2	DD*
Taraxacum columnare Pau	FI	.	.	.	+	1	.	+	.	1	.	.	He	Ru,G	0-1700	Ca	20	LC
Taraxacum decastroi A. Galán & Vicente Orell	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1500-2300	.	1	DD*
Taraxacum duriense Soest	FI	.	.	+	.	.	+	1	.	.	+	.	He	C,Ru	0-1000	.	45	LC
Taraxacum estrelense A. Galán & Vicente Orell	FI	.	.	.	.	.	.	2	.	.	.	.	He	G	700-1960	Si	5	DD*
Taraxacum gaditanum Talavera	FI	1	.	.	1	.	.	.	.	+	+	.	He	C	0-550	.	18	LC*+
Taraxacum hispanicum H. Lindb.	FI	.	+	+	+	1	.	.	.	+	+	1	He	R	180-1600	.	30	LC
Taraxacum iberanthum Sahlin	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1100-1900	.	2	CR+
Taraxacum lacianense A. Galán & Vicente Orell	FI	.	.	1	.	.	.	.	.	.	.	.	He	G	1500-1500	Si	1	DD*
Taraxacum litophyllum De Langhe & Soest	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1200-1200	.	1	DD
Taraxacum majoricense A. Galán & L. Sáez	FI	2	.	.	.	.	.	.	.	.	.	.	He	G	1200-1400	.	1	DD*
Taraxacum malato-belizii Soest	FI	.	.	.	.	1	.	1	.	+	+	.	He	Ru,G	790-1600	Si	20	LC
Taraxacum mimuloides H. Lindb.	FI	.	.	.	+	1	.	+	.	1	+	+	He	Ru,St	200-1760	Ca	20	LC
Taraxacum navacerradense A.J. Richards	FI	.	.	.	.	.	.	1	.	.	.	.	He	F	1000-1100	.	1	DD*
Taraxacum nevadense H. Lindb.	FI	.	1	1	.	.	.	1	.	.	.	.	He	A	1700-3100	.	6	DD*
Taraxacum penyalarense A. Galán & al.	FI	.	.	.	.	.	.	1	.	.	.	.	He	F	1800-1850	Si	1	DD*
Taraxacum pinto-silvae Soest	FI	.	.	1	+	+	+	1	+	+	+	+	He	G	0-1850	Si	20	LC
Taraxacum praesigne Sahlin	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1100-1500	.	1	DD
Taraxacum pyrenaicum Reut.	FI	.	.	.	.	.	.	.	1	.	.	.	He	A,G	1500-2810	Si	1	DD*
Taraxacum tarraconense Sennen	FI	1	.	.	1	1	.	.	.	1	.	.	He	Ru,G	0-1600	.	14	LC+
Taraxacum triforme Soest	FI	.	.	.	.	.	.	.	.	.	1	.	He	F	700-700	.	1	DD*
Taraxacum vinosum Soest	FI	.	.	.	.	.	.	.	1	.	.	.	He	Sc,G	60-210	Si	1	CR+
Tephroseris elodes DC.	FI	.	1	.	.	.	.	1	.	.	.	.	He	W	1400-2400	.	19	LC
Tephroseris elodes subsp. *coincyi* (Rouy) Holub	FI	.	.	.	.	.	.	2	.	.	.	.	He	W	1400-1800	Si	13	VU+
Tephroseris elodes subsp. *elodes* (DC.) Holub	FI	.	2	.	.	.	.	.	.	.	.	.	He	W	1400-2400	Si	6	EN+
Thrincia lusitanica M. Talavera & Talavera	FI	.	.	.	.	.	.	.	.	.	1	.	He	C	20-50	Ca	1	DD*
Tragopogon castellanus Leresche & Levier	FI	.	.	2	+	2	.	+	+	.	.	.	He	Ru,G	300-1200	Ca	33	LC
Tragopogon cazorlanus C. Díaz & Blanca	FI	.	1	.	.	.	.	.	.	.	.	.	He	M,G	900-1300	Ca	10	NT+
Tragopogon lainzii Suár.-Sant. & al.	FI	.	2	.	.	.	.	.	.	.	.	.	He	G	450-1600	Ca	9	DD*
Tragopogon pseudocastellanus Blanca & C. Díaz	FI	.	.	1	.	.	.	.	.	.	.	.	He	R	1200-1250	.	1	CR+
Vogtia microphylla (DC.) Oberpr. & Sonboli	FI	.	+	.	.	1	.	1	.	.	+	1	Th	Ru,G	150-1050	Si	32	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
BERBERIDACEAE																		
Berberis vulgaris subsp. *seroi* O. Bolòs & Vigo	FI	.	.	+	1	2	.	.	2	.	.	.	Ph	Sc,F	600-1900	Ca	55	LC
BORAGINACEAE																		
Anchusa calcarea Boiss.	FI	.	+	.	.	.	1	.	.	.	3	+	He	C,M	0-250	Ca	55	LC
Anchusa calcarea subsp. *calcarea* Boiss.	FI	.	+	.	.	.	1	.	.	.	2	+	He	C	0-50	.	25	LC
Anchusa calcarea subsp. *losadae* (Valdés) Valdés	FI	.	+	.	.	.	.	.	.	.	1	+	He	M	50-250	Ca	9	LC+
Anchusa puechii Valdés	FI	.	2	.	.	.	.	.	.	.	+	1	Th	R	100-700	.	23	VU
Anchusa undulata subsp. *granatensis* (Boiss.) Valdés	FI	.	2	.	.	+	.	+	.	+	+	2	Th	R	100-1800	.	56	LC
Cynoglossum melananthum Pau	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Sc,G	1000-1900	.	10	LC-
Echium albicans Lag. & Rodr.	FI	.	3	.	.	.	.	.	.	.	.	.	He	Ro,M	200-2000	Ca	43	LC
Echium albicans subsp. *albicans* Lag. & Rodr.	FI	.	3	.	.	.	.	.	.	.	.	.	He	Ro,M	350-2000	Dol	43	LC
Echium albicans subsp. *fruticescens* (Coincy) Valdés	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro,M	200-400	.	5	LC-
Echium cantabricum (M. Laínz) Fern. Casas & M. Laínz	FI	.	.	1	.	.	.	.	.	.	.	.	He	G	1400-1400	.	1	DD
Echium lusitanicum L.	FI	.	.	.	.	.	1	2	.	.	.	.	He	Sc,G	350-900	.	67	LC
Echium rosulatum Lange	FI	.	.	.	.	.	2	2	.	.	+	+	He	Sc,H	0-900	Si	105	LC
Echium rosulatum subsp. *davaei* (Rouy) Cout.	FI	.	.	.	.	.	.	.	.	.	1	.	He	C	0-20	Si	1	NT+
Echium rosulatum subsp. *rosulatum* Lange	FI	.	.	.	.	.	2	2	.	.	+	+	He	C,Sc	0-900	Si	104	LC
Echium salmanticum Lag.	FI	.	.	.	.	.	.	2	.	.	.	.	He	G	300-1250	Si	28	LC
Glandora diffusa (Lag.) D.C. Thomas	FI	.	.	3	.	.	2	+	.	.	.	.	Ch	F,H	50-2100	Si	190	LC
Glandora nitida (Ern) D.C. Thomas	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	500-2000	Ca,Dol	9	EN+
Glandora oleifolia (Lapeyr.) D.C. Thomas	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro	400-1500	Ca	5	VU+
Gyrocaryum oppositifolium Valdés	FI	.	.	.	.	.	.	1	.	.	.	+	Th	Sc	500-900	Si	3	CR+
Myosotis discolor subsp. *rosmatina* Valdés	FI	.	.	.	.	.	.	2	.	.	.	.	Th	F	1000-1400	.	6	DD*
Myosotis hervei Sennen	FI	.	.	.	+	+	.	.	3	.	.	.	He	W	750-1800	Si	51	LC
Myosotis minutiflora subsp. *segobrigensis* Valdés	FI	.	.	.	.	1	.	+	.	.	.	.	Th	G	850-1200	.	5	DD*
Myosotis persoonii Rouy	FI	.	.	1	.	1	.	2	.	.	+	+	Th	G	600-1500	.	101	LC
Myosotis stolonifera (J. Gay ex A. DC.) Leresche & Levier	FI	.	.	1	.	1	1	2	.	.	.	+	He	W	300-1800	Si	82	LC
Myosotis taverae Valdés	FI	.	2	.	.	.	.	.	.	.	.	.	Th	G	1800-2300	Ca	4	DD*
Omphalodes brassicifolia (Lag.) Sweet	FI	.	.	.	.	.	.	1	.	.	.	+	Th	R	500-1100	Si	8	EN+
Omphalodes commutata G. López	FI	.	2	.	.	.	.	.	.	.	.	+	Th	Ro	100-1750	Ca	14	VU+
Omphalodes kuzinskyana Willk.	FI	.	.	.	.	.	.	.	.	.	1	.	Th	C	0-50	.	4	CR+
Omphalodes littoralis subsp. *gallaecica* M. Laínz	FI	.	.	.	.	.	3	.	.	.	.	.	Th	C	0-80	.	19	EN-
Omphalodes nitida (Hoffmanns. & Link ex Willd.) Hoffmanns. & Link	FI	.	.	+	.	.	3	2	.	.	.	.	He	F,H	90-1600	.	216	LC
Onosma bubanii Stroh	FI	.	.	.	.	.	.	.	3	.	.	.	He	A,G	1700-2500	Ca	20	LC
Onosma tricerosperma subsp. *granatensis* (Debeaux & Degen) Stroh	FI	.	2	.	.	1	.	.	.	.	.	.	Th	M,G	800-1700	Ca	31	LC
Solenanthus reverchonii Debeaux ex Degen	FI	.	2	.	.	.	.	.	.	.	.	.	He	M	1700-1800	Ca	3	CR+
BRASSICACEAE																		
Alyssum cacuminum Španiel & al.	OP	.	.	.	.	.	.	.	2	.	.	.	He	A,G	1800-2850	.	3	DD*
Alyssum gadorense P. Küpfer	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1600-2050	Ca	2	VU+
Alyssum gallaecicum (S. Ortiz) Španiel & al.	OP	.	.	1	.	.	2	.	.	.	.	.	He	C	0-20	.	17	VU+
Alyssum nevadense Wilmott ex P.W. Ball & T.R. Dudley	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	A	2000-3400	Si	3	VU+
Arabis juressi Rothm.	FI	.	.	+	.	.	2	2	.	.	.	.	He	F	200-1000	Si	43	LC*
Arabis margaritae Talavera	FI	.	1	.	.	.	.	.	.	.	.	.	He	A	1500-2500	Ca	2	CR+
Arabis sadina (Samp.) Cout.	FI	.	.	.	.	.	.	.	.	.	2	.	He	Sc	100-400	.	17	LC+
Arabis soyeri subsp. *soyeri* Reut. & A. Huet	FI	.	.	.	.	.	.	.	2	.	.	.	He	W,A	1800-2800	Ca	12	VU

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Arabis stenocarpa Boiss. & Reut.	FI	.	+	.	.	1	.	3	.	.	.	+	He	Sc	850-1500	Si	127	LC
Biscutella fontqueri Guinea & Heywood	FI	.	.	.	1	2	.	.	.	+	.	.	Ch	Ro,M	900-1300	Ca	30	LC
Biscutella glacialis (Boiss. & Reut.) Jord.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	A,G	1000-3500	.	11	LC+
Biscutella sempervirens L.	FI	+	2	.	.	.	.	.	.	2	+	.	Ch	Ro,M	25-2700	Ca	76	LC
Biscutella sempervirens subsp. *sempervirens* L.	FI	+	2	.	.	.	.	.	.	2	.	.	Ch	Ro,M	10-2700	Ca	69	LC
Biscutella sempervirens subsp. *vicentina* (Samp.) Malag.	FI	.	+	.	.	.	.	.	.	.	1	.	Ch	Ro,M	50-110	Ca	7	NT+
Boleum asperum (Pers.) Desv.	FI	.	.	.	2	.	.	.	.	.	.	.	Ph	St,M	80-370	Ca,Gyp	22	LC
Brassica balearica Pers.	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	Ro	400-1400	Ca	4	LC
Brassica repanda subsp. *almeriensis* Gómez-Campo	FI	.	2	.	.	.	.	.	.	.	.	.	He	G	1100-2000	.	8	VU-
Brassica repanda subsp. *blancoana* (Boiss.) Heywood	FI	.	2	.	.	1	.	.	.	1	.	.	He	Ro	500-1800	.	36	LC
Brassica repanda subsp. *cadevallii* (Font Quer) Heywood	FI	.	.	.	.	.	.	.	2	.	.	.	He	Ro	400-1400	Ca	15	LC+
Brassica repanda subsp. *cantabrica* (Font Quer) Heywood	FI	.	.	3	.	.	.	.	.	.	.	.	He	Ro,M	700-1300	Ca	16	LC+
Brassica repanda subsp. *dertosensis* Molero & Rovira	FI	.	.	.	2	.	.	.	.	.	.	.	He	Ro,M	400-1300	Ca	9	NT+
Brassica repanda subsp. *gypsicola* Gómez-Campo	FI	.	.	.	.	1	.	.	.	.	.	.	He	St	600-800	Gyp	18	LC+
Brassica repanda subsp. *latisiliqua* (Boiss. & Reut.) Heywood	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	800-2000	Dol	12	LC+
Brassica repanda subsp. *maritima* (Rouy ex Willk.) Heywood	FI	.	.	.	.	.	.	.	.	2	.	.	He	Ro	300-500	Ca	13	LC+
Brassica repanda subsp. *nudicaulis* (Lag.) Heywood	FI	.	.	.	.	2	.	.	.	2	.	.	He	M	500-1000	Ca	59	LC
Brassica repanda subsp. *turbonis* (P. Monts.) J.M. Monts. & Romo	FI	.	.	.	.	.	.	.	3	.	.	.	He	Ro	1300-2500	Ca	13	LC+
Cardamine pratensis subsp. *nuriae* (Sennen) Sennen	FI	.	.	+	.	+	.	+	2	.	.	.	He	W,G	1600-2400	Si	39	LC
Cardamine raphanifolia subsp. *gallaecica* M. Laínz	FI	.	.	+	.	.	+	1	.	.	.	.	He	W	1100-1800	Si	17	VU-
Clypeola eriocarpa Cav.	FI	.	2	.	.	1	.	.	.	.	.	.	Th	Ru,St	500-1600	Ca	17	CR-
Cochlearia aragonensis H.J. Coste & Soulié	FI	.	.	1	.	+	.	.	1	.	.	.	He	Ro	600-1800	Ca	10	LC-
Cochlearia aragonensis subsp. *aragonensis* H.J. Coste & Soulié	FI	.	.	.	.	+	.	.	1	.	.	.	He	Ro	600-1800	Ca	7	VU
Cochlearia aragonensis subsp. *navarrana* (P. Monts.) Vogt	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro	1000-1200	Ca	2	VU+
Cochlearia glastifolia L.	FI	.	1	.	+	1	+	.	.	.	+	.	Th	W	600-800	.	39	LC
Coincya longirostra (Boiss.) Greuter & Burdet	FI	.	.	.	.	.	.	.	.	.	.	2	He	Ro	620-800	Si	29	VU*
Coincya monensis subsp. *nevadensis* (Willk.) Leadlay	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	2300-3200	Si	7	NT-
Coincya monensis subsp. *puberula* (Pau) Leadlay	FI	.	.	.	.	.	.	2	.	.	.	.	He	Ro,Ru	0-800	Si	6	DD
Coincya rupestris Porta & Rigo ex Rouy	FI	.	1	.	.	.	.	.	.	.	.	1	He	Ro	830-1100	.	25	LC
Coincya rupestris subsp. *leptocarpa* (Gonz. Albo) Leadlay	FI	.	+	.	.	.	.	.	.	.	.	1	He	Ro	830-1100	Si	18	VU-
Coincya rupestris subsp. *rupestris* Porta & Rigo ex Rouy	FI	.	1	.	.	.	.	.	.	.	.	1	He	Ro	1000-1100	Ca	7	CR+
Coincya transtagana (Cout.) Clem.-Muñoz & Hern.-Berm.	FI	.	.	.	.	.	.	.	.	.	+	2	Th	Ru,G	200-300	.	20	LC
Coronopus navasii Pau	FI	.	+	.	.	1	.	.	.	.	.	.	He	W	1600-2200	.	8	CR+
Diplotaxis ibicensis (Pau) Gómez-Campo	FI	3	.	.	.	.	.	.	.	+	.	.	He	C	0-100	Ca	18	LC
Diplotaxis ilorcitana (Sennen) Aedo & al.	FI	.	.	.	1	.	.	.	.	3	.	.	Th	Ru,St	0-600	Gyp	46	LC
Diplotaxis siifolia subsp. *vicentina* (Welw. ex Samp.) Mart.-Laborde	FI	.	.	.	.	.	.	.	.	.	2	.	Th	C	10-100	Ca	4	VU+
Draba aizoides subsp. *cantabriae* (M. Laínz) M. Laínz	FI	.	.	2	.	.	.	.	.	.	.	.	Ch	Ro	1600-2400	Ca	18	LC+
Draba dedeana Boiss. & Reut.	FI	.	.	3	.	2	.	.	+	.	.	.	Ch	Ro	650-2600	Ca	133	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Draba hispanica subsp. *laderoi* Rivas Mart. & al.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	2500-3200	Si	7	NT-
Draba hispanica subsp. *lebrunii* P. Monts.	FI	.	.	2	.	.	.	.	.	.	.	.	Ch	Ro	1300-1980	Ca	6	EN-
Draba subnivalis Braun-Blanq.	FI	.	.	.	.	.	.	.	1	.	.	.	Ch	A	1700-2500	.	19	NT+
Erucastrum virgatum subsp. *baeticum* (Boiss.) Gómez-Campo	FI	.	2	.	.	.	.	.	.	2	.	.	He	R	20-500	Ca	37	LC
Erucastrum virgatum subsp. *brachycarpum* (Rouy) Gómez-Campo	FI	.	.	.	.	.	.	.	.	3	.	.	He	Ro	50-1000	Ca	44	LC
Erucastrum virgatum subsp. *pseudosinapis* (Lange) Gómez-Campo	FI	.	2	.	.	.	.	.	.	2	.	.	Th	R	50-400	Gyp	23	LC
Erysimum baeticum (Heywood) Polatschek	FI	.	2	.	.	.	.	.	.	.	.	.	He	Sc,G	1300-2500	.	16	LC+
Erysimum cazorlense (Heywood) Holub	FI	.	3	.	.	.	.	.	.	.	.	.	He	Sc,G	1400-2100	Ca	18	VU-
Erysimum duriaei Boiss.	FI	.	.	2	.	.	1	.	.	.	.	.	Ch	Ro	400-2300	Ca	41	LC
Erysimum fitzii Polatschek	FI	.	1	.	.	.	.	.	.	.	.	.	He	M	1200-1800	Ca	3	VU+
Erysimum gomezcampoi Polatschek	FI	.	.	.	+	2	.	.	.	2	.	.	Ch	Ro,M	600-1400	Ca	55	LC
Erysimum gorbeanum Polatschek	FI	.	.	3	.	+	.	+	1	.	.	.	Ch	Ro	350-2300	Ca	44	LC
Erysimum javalambrense Mateo & al.	OP	.	.	.	.	1	.	.	.	.	.	.	He	Ro,M	1800-2000	Ca	3	NT-
Erysimum lagascae Rivas Goday & Bellot	FI	.	.	.	.	+	.	+	.	.	.	1	He	Ro	400-1350	Si	15	LC+
Erysimum linifolium (Pourr. ex Pers.) J. Gay	FI	.	.	1	.	.	1	2	.	.	.	.	Ch	Ro	0-1850	Si	92	LC
Erysimum mediohispanicum Polatschek	FI	.	2	+	.	2	.	.	.	.	.	.	Ch	M	600-1600	Ca	66	LC
Erysimum merxmuelleri Polatschek	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Sc,Ro	700-1200	Si	7	DD*
Erysimum myriophyllum Lange	FI	.	3	.	.	.	.	.	.	.	.	.	He	Ro	750-1900	Ca,Dol	15	VU-
Erysimum nevadense Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro,M	1700-2800	.	12	LC-
Erysimum popovii Rothm.	FI	.	2	.	.	.	.	.	.	.	.	.	He	M	500-2000	Ca	16	LC+
Erysimum rondae Polatschek	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	700-1700	Ca	13	VU-
Erysimum seipkae Polatschek	FI	.	.	.	.	.	.	.	3	.	.	.	He	Ro	500-2700	.	56	LC
Euzomodendron bourgaeanum Coss.	FI	.	1	.	.	.	.	.	.	1	.	.	Ch	St	100-500	Ca,Gyp	10	VU-
Guiraoa arvensis Coss.	FI	.	+	.	.	.	.	.	.	3	.	.	Th	Ru,St	30-1300	Gyp	35	LC
Hormathophylla baetica P. Küpfer	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1500-1900	Ca,Dol	3	VU+
Hormathophylla cadevalliana (Pau) T.R. Dudley	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1100-1800	Ca	10	VU+
Hormathophylla longicaulis (Boiss.) Cullen & T.R. Dudley	FI	.	3	.	.	.	.	.	.	+	.	.	Ch	M	1100-1800	Ca	42	LC
Hormathophylla purpurea (Lag. & Rodr.) P. Küpfer	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	A	2000-3400	Si	2	VU+
Hormathophylla reverchonii (Degen & Hervier) Cullen & T.R. Dudley	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1200-1800	Ca	5	EN+
Hornungia petraea subsp. *aragonensis* (Loscos & J. Pardo) Malag.	FI	.	.	.	2	1	.	.	.	.	.	.	Th	Ro	500-1400	Ca	22	LC
Hugueninia tanacetifolia subsp. *suffruticosa* (H.J. Coste & Soulié) P.W. Ball	FI	.	.	2	.	.	.	.	1	.	.	.	He	W	800-2050	.	28	LC
Iberis bernardiana Godr. & Gren.	FI	.	.	.	.	.	.	.	3	.	.	.	Th	Ro	900-2000	Ca	22	LC
Iberis carnosa subsp. *embergeri* (Serve) Moreno	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	3000-3200	.	2	EN+
Iberis carnosa subsp. *hegelmaieri* (Willk.) Moreno	FI	.	.	.	+	.	.	.	.	3	.	.	He	Ro	800-1000	.	42	LC
Iberis carnosa subsp. *nafarroana* Moreno	FI	.	.	1	.	.	.	.	.	.	.	.	He	Ro	500-700	.	2	DD
Iberis ciliata subsp. *welwitschii* (Boiss.) Moreno	FI	.	+	.	.	.	.	.	.	.	3	.	He	C	0-100	.	29	LC
Iberis fontqueri Pau	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	700-1100	Ca,Ser	11	VU+
Iberis grosii Pau	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	800-1000	Ca	7	VU+
Iberis nazarita subsp. *nazarita* Moreno	FI	.	3	.	.	.	.	.	.	.	.	.	He	Ro	500-1600	Ca,Ser	32	NT
Iberis pectinata Boiss.	FI	.	2	.	.	1	.	.	.	1	1	+	Th	Ro	100-800	.	59	LC
Iberis procumbens Lange	FI	.	.	.	.	.	2	.	.	.	2	.	He	C	0-400	.	60	LC
Iberis procumbens subsp. *microcarpa* Franco & P. Silva	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C	50-400	.	12	LC+
Iberis procumbens subsp. *procumbens* Lange	FI	.	.	.	.	.	2	.	.	.	2	.	Ch	C	0-50	Si	45	LC
Iberis saxatilis subsp. *cinerea* (Poir.) Font Quer	FI	.	2	.	.	1	.	.	.	2	.	.	Ch	Ro	500-1700	.	44	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Iberis spathulata DC.	FI	.	.	.	.	.	.	.	3	.	.	.	Th	A	2000-3050	.	14	LC+
Isatis platyloba Link ex Steud.	FI	.	.	.	.	+	.	2	.	.	.	.	Th	R	400-950	.	20	VU
Jonopsidium abulense (Pau) Rothm.	FI	.	.	+	.	1	+	2	.	.	+	+	Th	R	420-1470	.	50	LC
Jonopsidium acaule (Desf.) Rchb.	FI	.	.	.	.	.	.	.	.	.	2	.	Th	C,Ru	0-100	.	23	LC
Kernera boissieri Reut.	FI	.	3	.	.	.	.	.	.	+	.	.	He	Ro	1500-2500	Ca	22	VU
Lepidium cardamines L.	FI	.	.	.	.	2	.	.	.	.	.	.	He	St	400-800	Gyp	39	LC
Lepidium petrophilum Coss.	FI	.	3	.	.	.	.	.	.	.	.	+	He	Ro	900-2000	Ca	25	LC
Lepidium stylatum Lag. & Rodr.	FI	.	1	.	.	.	.	.	.	.	.	.	He	A	2800-3480	Si	3	NT-
Lepidium villarsii subsp. *anticarium* (Valdés Berm. & G. López) Hern.-Berm.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1000-1400	.	6	VU+
Lycocarpus fugax (Lag.) O.E. Schulz	FI	.	+	.	.	.	.	.	.	2	.	.	Th	R	400-800	.	23	LC
Matthiola perennis Conti	FI	.	.	3	.	.	.	+	.	.	.	.	Ch	Ro	1200-2300	Ca	32	LC
Moricandia foetida Bourg. ex Coss.	FI	.	+	.	.	.	.	.	.	2	.	.	He	St	0-400	Ca	12	LC-
Moricandia moricandioides (Boiss.) Heywood	FI	.	3	.	1	1	.	.	.	1	.	+	Th	St	300-700	Ca	139	LC
Moricandia moricandioides subsp. *baetica* (Boiss. & Reut.) Sobrino Vesperinas	FI	.	1	.	1	.	.	.	.	.	.	+	Th	St	300-700	Ca	25	LC
Moricandia moricandioides subsp. *cavanillesiana* (Font Quer & A. Bolòs) Greuter & Burdet	FI	.	.	.	2	.	.	.	.	.	.	.	Th	St	300-500	Ca,Gyp	25	LC
Moricandia moricandioides subsp. *giennensis* Valdés Berm.	FI	.	3	.	.	.	.	.	.	.	.	.	Th	St	300-700	Ca	12	LC+
Moricandia moricandioides subsp. *moricandioides* (Boiss.) Heywood	FI	.	2	.	.	1	.	.	.	2	.	.	Th	St	300-700	Ca	90	LC
Murbeckiella sousae Rothm.	FI	.	.	.	.	.	.	2	.	.	.	.	He	Ro	200-1300	Si	26	LC
Rorippa valdes-bermejoi (Castrov.) Mart.-Laborde & Castrov.	FI	.	.	.	.	.	.	.	.	.	1	.	Hy	W	0-20	.	2	CR+
Sisymbrella aspera subsp. *praeterita* Heywood	FI	.	.	.	.	.	.	.	1	.	.	.	He	W	800-1800	.	7	LC-
Sisymbrium assoanum Loscos & J. Pardo	FI	.	.	.	1	1	.	.	.	+	.	.	He	R	200-950	Ca	12	LC+
Sisymbrium cavanillesianum Castrov. & Valdés Berm.	FI	.	.	.	.	1	.	.	.	.	.	.	Th	Ru,St	50-750	Gyp	13	VU+
Teesdaliopsis conferta (Lag.) Rothm.	FI	.	.	2	.	.	.	1	.	.	.	.	He	Ro,H	1500-2200	Si	40	LC
Thlaspi nevadense Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	He	A	2500-2600	Si	4	VU-
Thlaspi stenopterum Boiss. & Reut.	FI	.	.	+	.	3	.	+	.	.	.	.	He	Ro,H	700-2000	Si	66	LC
Vella castrilensis Vivero & al.	OP	.	1	.	.	.	.	.	.	.	.	.	Ch	M	1650-1900	Ca	2	CR-
Vella lucentina M.B. Crespo	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	M	300-400	.	4	EN+
Vella pseudocytisus subsp. *paui* Gómez-Campo	FI	.	.	.	.	1	.	.	.	.	.	.	Ph	M	500-1000	Ca	7	EN-
Vella pseudocytisus subsp. *pseudocytisus* L.	FI	.	1	.	.	1	.	.	.	.	.	.	Ph	St	450-550	Gyp	7	EN
Vella spinosa Boiss.	FI	.	3	.	.	.	.	.	.	+	.	.	Ch	M	1300-2200	Ca	45	LC
CAMPANULACEAE																		
Campanula adsurgens Levier & Leresche	FI	.	.	+	.	.	.	1	.	.	.	.	He	Ro	500-2000	Ca	17	LC+
Campanula affinis Schult.	FI	.	.	.	2	.	.	.	.	.	.	.	He	Ro	150-1230	Ca	12	LC+
Campanula arvatica Lag.	FI	.	.	3	.	.	.	.	.	.	.	.	He	Ro	500-2000	Ca	37	LC
Campanula cabezudoi Cano-Maqueda & Talavera	FI	.	3	.	.	.	.	.	.	.	.	.	Th	Ro,G	400-2200	Ca	25	VU
Campanula cantabrica Feer	FI	.	.	2	.	.	.	+	.	.	.	.	He	Ro,G	1000-2000	Ca	21	LC
Campanula decumbens A. DC.	FI	.	1	.	.	2	.	.	.	.	.	.	Th	Ro	400-1700	Ca	55	LC
Campanula dieckii Lange	FI	.	2	.	.	2	.	+	.	.	+	.	Th	G	600-2300	Ca	73	LC
Campanula herminii Hoffmanns. & Link	FI	.	+	+	.	.	.	2	.	.	.	.	He	H,G	600-3000	Si	49	LC
Campanula jaubertiana Timb.-Lagr.	FI	.	.	.	.	.	.	.	3	.	.	.	He	Ro	1500-2800	Ca	20	LC
Campanula matritensis A. DC.	FI	.	1	.	.	2	.	2	.	.	2	2	Th	Sc,G	0-2200	.	304	LC
Campanula precatoria Timb.-Lagr.	FI	.	.	.	.	.	.	.	2	.	.	.	He	H,G	1300-2000	.	37	LC
Campanula primulifolia Brot.	FI	.	.	.	.	.	.	.	.	.	1	+	He	W,Sc	10-800	Si	13	VU*+
Campanula semisecta Murb.	FI	.	1	.	.	+	.	.	.	2	.	.	He	Ro,G	200-1700	.	30	LC
Campanula specularioides Coss.	FI	.	1	.	.	.	.	.	.	.	.	.	Th	Ro	500-1650	Ca	11	EN+
Campanula transtagana R. Fern.	FI	.	+	.	.	.	.	.	.	.	1	2	Th	G	50-800	Si	43	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Jasione cavanillesii C. Vicioso	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro,A	1650-2460	Ca	9	LC+
Jasione crispa subsp. *crispa* (Pourr.) Samp.	FI	.	.	2	.	1	.	1	2	.	.	.	He	G	1600-2600	.	100	LC
Jasione crispa subsp. *mariana* (Willk.) Rivas Mart.	FI	.	+	.	.	.	.	+	.	.	.	3	He	Ro	300-700	.	46	LC
Jasione crispa subsp. *tomentosa* (A. DC.) Rivas Mart.	FI	.	.	.	.	.	.	+	.	.	.	2	He	M	1000-1500	Si	48	LC
Jasione crispa subsp. *tristis* (Bory) G. López	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1700-3470	Si	4	DD*
Jasione mansanetiana R. Roselló & Peris	FI	.	.	.	.	+	.	.	.	1	.	.	He	Ro	300-700	Ca	8	EN+
Jasione penicillata Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	M	300-2000	Dol	12	VU+
Solenopsis balearica (E. Wimm.) Aldasoro & al.	FI	2	.	.	.	.	.	.	.	.	.	.	He	C,Ro	30-900	.	2	VU

CAPRIFOLIACEAE

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Cephalaria boetica Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro,M	500-1350	Ser	5	NT-
Cephalaria linearifolia Lange	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1000-2000	Ca	10	LC+
Cephalaria squamiflora subsp. *balearica* (Coss. ex Willk.) Greuter	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	Ro	400-1400	Ca	7	LC
Dipsacus comosus Hoffmanns. & Link	FI	.	.	.	.	.	.	+	.	.	2	1	He	W,G	0-800	.	35	LC
Knautia numantina (Pau) Devesa & al.	FI	.	.	.	.	1	.	.	.	.	.	.	He	F	1200-1650	Si	1	DD*
Knautia rupicola (Willk.) Font Quer	FI	.	.	.	2	+	.	.	.	.	.	.	He	Ro,G	200-1400	Ca	24	LC
Knautia subscaposa Boiss. & Reut.	FI	.	1	2	+	2	.	+	.	1	.	.	He	M,G	30-2000	Ca	112	LC
Lomelosia pulsatilloides (Boiss.) Greuter & Burdet	FI	.	+	.	+	.	.	.	2	.	.	.	Ch	M	400-1250	Ca	40	LC
Lomelosia pulsatilloides subsp. *macropoda* (Costa ex Willk.) Greuter & Burdet	FI	.	.	.	1	.	.	.	2	.	.	.	Ch	Ro,M	400-1250	Ca	39	LC
Lomelosia pulsatilloides subsp. *pulsatilloides* (Boiss.) Greuter & Burdet	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	Ro,M	1500-2100	Ca,Dol	3	VU+
Lonicera pyrenaica subsp. *majoricensis* (Gand.) Gand.	FI	2	.	.	.	.	.	.	.	.	.	.	Ph	Ro	1100-1420	.	4	VU
Lonicera splendida Boiss.	FI	.	3	.	.	+	.	.	.	1	.	.	Ph	Sc	900-1600	Ca	51	LC
Pseudoscabiosa saxatilis (Cav.) Devesa	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	Ro	10-1520	Ca	24	LC
Pterocephalidium diandrum (Lag.) G. López	FI	.	+	+	.	1	.	2	.	.	2	2	Th	M,G	0-1300	Si	149	LC
Pterocephalus spathulatus (Lag.) Coult.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro,M	1100-2260	Ca,Dol	43	LC
Pycnocomon intermedium (Lag.) Greuter & Burdet	FI	.	+	.	.	.	.	+	.	.	3	+	He	C,Sc	0-250	.	46	LC
Scabiosa andryalifolia (Pau) Devesa	FI	.	2	.	.	.	.	.	.	+	.	.	He	Sc,Ro	1000-1800	Ca	22	LC
Scabiosa galianoi Devesa & al.	FI	.	1	.	.	1	.	.	.	.	1	1	Th	Ru,G	100-1100	Ca	10	DD*
Scabiosa turolensis subsp. *turolensis* Pau	FI	.	3	.	.	1	.	.	.	2	.	.	He	Ro,M	200-2300	Ca	112	LC
Succisa pinnatifida Lange	FI	.	.	.	.	.	2	+	.	.	+	.	He	W,G	10-200	.	16	VU*+
Succisella andreae-molinae Pajarón & Escudero	FI	.	2	.	.	.	.	.	.	.	.	.	He	W	900-1500	Si	10	EN+
Succisella carvalhoana (Mariz) Baksay	FI	.	.	.	.	.	.	2	.	.	.	.	He	W	400-1200	Si	18	VU+
Succisella microcephala (Willk.) Beck	FI	.	.	.	.	+	.	1	.	.	.	+	He	W	400-1600	Si	8	VU+
Valeriana longiflora subsp. *longiflora* Willk.	FI	.	.	.	.	+	.	.	2	.	.	.	Ch	Ro	600-2000	Ca	23	LC
Valeriana longiflora subsp. *paui* (Cámara) P. Monts.	FI	.	.	.	+	.	.	.	1	.	.	.	Ch	Ro	300-1540	Ca	6	LC+
Valeriana longiflora Willk.	FI	.	.	.	+	+	.	.	2	.	.	.	Ch	Ro	300-2000	Ca	31	LC
Valeriana tripteris subsp. *tarraconensis* (Pau) Devesa & al.	FI	.	.	.	1	+	.	.	.	.	.	.	He	Ro	600-1300	Ca	13	LC+
Valerianella fusiformis Pau	FI	.	.	3	.	+	.	.	.	.	.	.	Th	Ro,G	700-1400	Ca	27	LC
Valerianella locusta subsp. *lusitanica* (Pau ex Font Quer) M. Laínz	FI	.	.	+	.	1	+	+	.	.	.	.	Th	G	5-1200	.	11	LC+
Valerianella martinii Loscos	FI	.	.	.	+	2	.	.	.	.	.	.	Th	R	800-1600	Ca	14	NT+
Valerianella multidentata Loscos & J. Pardo	FI	.	.	.	2	1	.	.	.	.	.	.	Th	St	200-565	Ca	16	NT+

CARYOPHYLLACEAE

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Arenaria aggregata subsp. *pseudoarmeriastrum* (Rouy) G. López & Nieto Fel.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	Ro	0-600	Ca,Dol	17	DD
Arenaria alfacarensis Pamp.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1500-2000	Ca	16	NT+
Arenaria algarbiensis Welw. ex Willk.	FI	.	.	.	.	.	.	.	.	.	2	.	Th	C	0-100	.	20	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Arenaria arcuatociliata G. López & Nieto Fel.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	800-1200	Ca	14	VU-
Arenaria armerina subsp. *caesia* (Boiss.) C. Díaz & al.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1200-2000	Ca,Dol	16	LC+
Arenaria arundana Gallego	FI	.	3	.	.	.	.	.	.	.	.	.	Th	Ro	700-1500	Ca,Dol	21	LC
Arenaria capillipes (Boiss.) Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	900-1400	Ser	3	NT-
Arenaria cavanillesiana (Font Quer & Rivas Goday) Nieto Fel.	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	St	500-750	Gyp	11	LC+
Arenaria conimbricensis Brot.	FI	.	.	.	2	1	.	.	+	.	1	1	Th	Ro,G	150-1200	Ca	84	LC
Arenaria conimbricensis subsp. *conimbricensis* Brot.	FI	.	.	.	1	1	.	.	+	.	1	1	Th	Ro,G	150-1200	Ca	42	LC
Arenaria conimbricensis subsp. *viridis* (Font Quer) Font Quer	FI	.	.	.	2	+	.	.	.	.	.	.	He	Ro	800-1400	Ca	12	NT+
Arenaria delaguardiae G. López & Nieto Fel.	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	Ro	500-1500	Ca,Dol	5	VU+
Arenaria erinacea Boiss.	FI	.	1	3	.	2	.	+	.	.	.	.	Ch	M	900-2200	Ca	115	LC
Arenaria favargeri (Nieto Fel.) G. López & Nieto Fel.	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	St	600-750	Gyp	2	VU+
Arenaria fontqueri Cardona & J.M. Monts.	FI	.	.	.	+	.	.	.	3	.	.	.	He	Ro	800-1850	Ca	33	LC
Arenaria fontqueri subsp. *fontqueri* Cardona & J.M. Monts.	FI	.	.	.	.	.	.	.	1	.	.	.	He	Ro	740-1050	Ca	1	DD*
Arenaria fontqueri subsp. *hispanica* (H.J. Coste & Soulié) Cardona & J.M. Monts.	FI	.	.	.	+	.	.	.	3	.	.	.	Th	Ro,G	800-1850	Ca	32	LC
Arenaria grandiflora subsp. *bolosii* (Cañig.) P. Küpfer	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	Ro	1000-1400	Ca	1	CR
Arenaria grandiflora subsp. *incrassata* (Lange) C. Vicioso	FI	.	.	3	.	.	+	+	.	.	.	.	Ch	Ro,G	500-1500	Ca	60	LC
Arenaria modesta subsp. *tenuis* (J. Gay) G. López & Nieto Fel.	FI	.	3	.	.	.	.	.	.	.	.	.	Th	Ro	700-1900	Ca	25	LC
Arenaria montana subsp. *intricata* (Ser.) Pau	FI	.	1	.	.	.	.	.	.	3	.	.	Th	M	40-900	.	76	LC
Arenaria nevadensis Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	A	3000-3000	Si	2	CR+
Arenaria obtusiflora Kunze	FI	.	+	2	+	2	.	+	.	+	.	.	Th	Ro,G	800-2000	Ca	148	LC
Arenaria obtusiflora subsp. *ciliaris* (Loscos) Font Quer	FI	.	+	2	+	3	.	+	.	.	.	.	Th	M	800-2000	.	133	LC
Arenaria obtusiflora subsp. *obtusiflora* Kunze	FI	.	.	.	.	+	.	.	.	1	.	.	Th	Ro,G	800-1200	Ca	4	DD*
Arenaria oscensis (Pau) P. Monts.	FI	.	.	.	+	.	.	.	2	.	.	.	Ch	St,M	1000-1700	Ca	30	LC
Arenaria querioides Pourr. ex Willk.	FI	.	.	.	.	.	.	3	.	.	.	.	Ch	Ro	900-2000	Si	64	LC
Arenaria racemosa Willk.	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	Ro	800-1600	Ca,Dol	7	VU+
Arenaria retusa Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	500-900	Ser	18	LC+
Arenaria tetraquetra L.	FI	.	2	.	.	1	.	.	1	.	.	.	Ch	M	1400-3400	.	48	LC
Arenaria tetraquetra subsp. *amabilis* (Bory) H. Lindb.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	2400-3400	Si	9	LC+
Arenaria tetraquetra subsp. *murcica* (Font Quer) Favarger & Nieto Fel.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro,G	1600-2250	Ca	18	LC+
Arenaria tetraquetra subsp. *tetraquetra* L.	FI	.	.	.	.	1	.	.	2	.	.	.	Ch	M	1400-2500	Ca	21	LC
Arenaria tomentosa Willk.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1000-2200	Ca,Dol	7	VU+
Arenaria valentina Boiss.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	Ro	0-1200	Ca	25	LC
Arenaria vitoriana Uribe-Ech. & Alejandre	FI	.	.	2	.	2	.	.	.	.	.	.	Ch	Ro	850-1180	Ca	31	LC
Cerastium pyrenaicum J. Gay	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	A	2000-3000	Si	35	LC
Dianthus algetanus Graells ex F.N. Williams	FI	.	.	.	.	2	.	.	.	1	.	.	Ch	M,G	650-1050	Si	24	LC
Dianthus algetanus subsp. *algetanus* Graells ex F.N. Williams	FI	.	.	.	.	+	.	.	.	1	.	.	Ch	M	650-1050	Si	13	LC+
Dianthus algetanus subsp. *turolensis* (Pau) M. Bernal & al.	FI	.	.	.	.	2	.	.	.	+	.	.	Ch	M	900-1700	Si	13	LC+
Dianthus benearnensis Loret	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	G	500-2300	.	38	LC
Dianthus broteri Boiss. & Reut.	FI	.	2	.	1	.	.	.	.	2	2	.	Ch	Ro,M	0-1800	.	204	LC
Dianthus charidemi Pau	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	C,Ro	0-200	Si	4	VU+
Dianthus cintranus Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C,Ro	100-550	Ca	10	LC+
Dianthus cintranus subsp. *barbatus* R. Fern. & Franco	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	Ro	100-550	Ca	4	VU+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Dianthus cintranus subsp. *cintranus* Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	Ro	50-200	Ca	9	EN
Dianthus costae Willk.	FI	.	.	.	+	.	.	.	2	.	.	.	Ch	M,G	250-1250	Ca	12	LC+
Dianthus crassipes R. Roem.	FI	.	+	.	.	.	.	.	.	.	1	2	Ch	Sc,M	300-1800	.	46	LC
Dianthus gredensis Pau ex Caball.	FI	.	.	.	.	.	.	2	.	.	.	.	Ch	G	1250-2550	Si	11	LC+
Dianthus langeanus Willk.	FI	.	.	2	.	.	1	2	.	.	.	.	Ch	H,G	250-2200	Si	90	LC
Dianthus laricifolius Boiss. & Reut.	FI	.	.	.	.	2	1	3	.	.	.	.	Ch	Ro,G	150-1500	.	183	LC
Dianthus laricifolius subsp. *caespitosifolius* (Planellas) M. Laínz	FI	.	.	.	.	.	2	1	.	.	.	.	Ch	Ro	25-700	Si	45	LC*
Dianthus laricifolius subsp. *laricifolius* Boiss. & Reut.	FI	.	.	.	.	1	.	2	.	.	.	.	Ch	Ro,G	150-1500	Si	75	LC
Dianthus laricifolius subsp. *marizii* (Samp.) Franco	FI	.	.	.	.	.	.	2	.	.	.	.	Ch	Ro	200-850	Ser	13	LC+
Dianthus laricifolius subsp. *merinoi* (M. Laínz) M. Laínz	FI	.	.	.	.	.	+	2	.	.	.	.	Ch	Ro	350-1000	.	26	LC
Dianthus legionensis (Willk.) F.N. Williams	FI	.	.	1	.	1	.	2	.	.	.	.	Ch	H,G	750-2000	Si	53	LC
Dianthus multiaffinis Pau	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	Sc,Ro	450-1000	Si	4	DD*
Dianthus multiceps Costa ex Willk.	FI	.	.	.	1	.	.	.	2	.	.	.	Ch	Ro,G	100-800	.	61	LC
Dianthus multiceps subsp. *multiceps* Costa ex Willk.	FI	.	.	.	1	.	.	.	1	.	.	.	Ch	Ro,G	100-800	Ca	50	LC
Dianthus multiceps subsp. *praepyrenaicus* M. Bernal	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro,G	800-1700	.	9	LC+
Dianthus pungens subsp. *hispanicus* (Asso) O. Bolòs & Vigo	FI	.	1	1	1	2	.	.	1	1	.	.	Ch	M,G	0-1700	Ca	257	LC
Dianthus toletanus Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	.	2	Ch	M	700-1300	Si	8	NT-
Gypsophila bermejoi G. López	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	St	700-800	Gyp	11	LC+
Gypsophila montserratii Fern. Casas	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	600-1400	Ca	9	VU+
Gypsophila struthium L.	FI	.	1	.	2	2	.	.	+	1	.	.	Ch	St	200-1100	Gyp	183	LC
Gypsophila struthium subsp. *hispanica* (Willk.) G. López	FI	.	.	.	2	2	.	.	+	+	.	.	Ch	St	200-1100	Gyp	108	LC
Gypsophila struthium subsp. *struthium* L.	FI	.	1	.	.	1	.	.	.	2	.	.	Ch	St	400-900	Gyp	70	LC
Gypsophila tomentosa L.	FI	.	+	.	+	1	.	.	.	1	.	.	He	St	450-900	Gyp	44	LC
Herniaria algarvica Chaudhri	FI	.	.	.	.	.	.	.	.	.	2	.	Th	C	0-60	.	3	EN+
Herniaria baetica Boiss. & Reut.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	700-2000	.	16	LC+
Herniaria boissieri subsp. *boissieri* J. Gay	FI	.	2	.	.	.	.	.	.	.	.	.	He	H	2100-3300	.	3	NT-
Herniaria fruticosa L.	FI	.	+	.	2	1	.	.	+	2	.	.	Ch	St	0-1200	Gyp	137	LC
Herniaria lusitanica Chaudhri	FI	.	+	.	.	+	1	1	.	.	+	1	Th	R	0-1500	.	80	LC
Herniaria lusitanica subsp. *berlengiana* Chaudhri	FI	.	.	.	.	.	.	.	.	.	1	.	He	Ro	0-10	Si	1	EN+
Herniaria lusitanica subsp. *lusitanica* Chaudhri	FI	.	+	.	.	+	1	1	.	.	+	1	Th	R	0-1500	.	79	LC
Herniaria maritima Link	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C	0-20	.	18	LC+
Herniaria scabrida subsp. *guadarramica* Chaudhri	FI	.	.	.	.	+	.	+	.	.	.	.	He	Ro	300-1500	Si	8	DD*
Minuartia campestris subsp. *campestris* L.	FI	.	+	.	1	1	.	.	+	1	.	+	Th	St	400-1500	Gyp	34	LC
Minuartia cerastiifolia (Ramond ex DC.) Graebn.	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	A	2300-3200	Ca	24	LC
Minuartia valentina (Pau) Sennen	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	Ro	400-1000	Si	6	LC-
Moehringia fontqueri Pau	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	A	2300-2400	Si	2	EN+
Moehringia intricata subsp. *castellana* J.M. Monts.	FI	.	.	.	.	2	.	.	.	.	.	.	He	Ro	900-1300	Ca	15	LC+
Moehringia intricata subsp. *intricata* Willk.	FI	.	3	.	.	.	.	.	.	+	.	.	He	Ro	1000-2000	Ca	38	NT*
Moehringia intricata subsp. *tejedensis* (Huter & al.) J.M. Monts.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1500-1900	Ca	5	CR+
Moehringia intricata Willk.	FI	.	3	.	.	1	.	.	.	+	.	.	He	Ro	900-2000	Ca	63	LC
Ortegia hispanica Loefl. ex L.	FI	.	.	+	.	1	+	3	.	.	.	+	Ch	R	300-1500	Si	84	LC
Paronychia kapela subsp. *baetica* P. Küpfer	FI	.	2	.	.	.	.	.	.	.	.	.	He	M,G	1700-2300	Ca	13	LC+
Paronychia rouyana Coincy	FI	.	.	.	.	2	.	+	.	+	.	1	Th	G	800-1500	Si	36	LC
Paronychia suffruticosa (L.) DC.	FI	.	2	.	.	+	.	.	.	2	.	.	Ch	M	0-1900	Ca	167	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Paronychia suffruticosa subsp. *hirsuta* Chaudhri	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	M	0-700	Ca	20	LC
Paronychia suffruticosa subsp. *suffruticosa* (L.) DC.	FI	.	+	.	.	+	.	.	.	3	.	.	Ch	M	0-1900	Ca	150	LC
Petrocoptis crassifolia Rouy	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro	650-1800	Ca	11	NT+
Petrocoptis grandiflora Rothm.	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Ro	400-500	Ca	6	VU+
Petrocoptis guarensis Fern. Casas	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro	520-1340	Ca	5	VU+
Petrocoptis hispanica (Willk.) Pau	FI	.	.	1	.	.	.	.	2	.	.	.	Ch	Ro	400-1700	Ca	25	LC
Petrocoptis montserratii Fern. Casas	FI	.	.	.	+	.	.	.	1	.	.	.	Ch	Ro	800-1850	Ca	4	VU+
Petrocoptis montsicciana O. Bolòs & Rivas Mart.	FI	.	.	.	1	.	.	.	2	.	.	.	Ch	Ro	280-1200	Ca	10	NT-
Petrocoptis pardoi Pau	FI	.	.	.	1	.	.	.	.	.	.	.	Ch	Ro	300-500	Ca	13	VU-
Petrocoptis pseudoviscosa Fern. Casas	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro	800-1000	Ca	3	VU+
Petrocoptis pyrenaica (Bergeret) A. Braun ex Walp.	FI	.	.	3	.	.	.	+	1	.	.	.	Ch	Ro	280-2500	Ca	105	LC
Petrocoptis pyrenaica subsp. *glaucifolia* (Lag.) P. Monts. & Fern. Casas	FI	.	.	3	.	.	.	.	.	.	.	.	Ch	Ro	0-2000	Ca	56	LC
Petrocoptis pyrenaica subsp. *pyrenaica* (Bergeret) A. Braun ex Walp.	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro	280-2500	Ca	11	LC+
Petrocoptis pyrenaica subsp. *viscosa* (Rothm.) P. Monts. & Fern. Casas	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Ro	700-1100	Ca	5	EN+
Polycarpon dunense P. Fraga & Roselló	OP	2	.	.	.	.	.	.	.	.	.	.	Th	C	0-5	.	3	EN*
Polycarpon polycarpoides subsp. *colomense* (Porta) Pedrol	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-100	.	25	LC
Sagina merinoi Pau ex Merino	FI	.	.	.	.	.	2	.	.	.	.	.	Ch	Ro,H	0-600	Ser	14	LC-
Saponaria caespitosa DC.	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	Ro	1500-2200	Ca	40	LC
Silene acutifolia Link ex Rohrb.	FI	.	.	.	.	.	+	2	.	.	.	+	He	Ro	700-1400	Si	62	LC
Silene almolae J. Gay	FI	.	2	.	.	1	.	.	.	.	.	.	Th	M	400-1200	Ca	26	LC
Silene borderei Jord.	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	G	1800-2800	Ca	22	LC
Silene cambessedesii Boiss. & Reut.	FI	3	.	.	.	.	.	.	.	+	.	.	Th	C	0-10	.	18	VU
Silene ciliata Pourr.	FI	.	.	2	.	1	.	1	2	.	.	.	He	G	1100-2700	Si	178	LC
Silene cintrana Rothm.	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	C	0-500	Si	7	NT+
Silene coutinhoi Rothm. & P. Silva	FI	.	.	+	.	1	.	2	.	.	.	+	Ch	F	400-1200	Si	95	LC
Silene diclinis (Lag.) M. Laínz	FI	.	.	.	.	.	.	.	.	2	.	.	He	G	100-400	Ca	7	EN+
Silene fernandezii Jeanm.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	700-1100	Ser	8	EN+
Silene foetida Link	FI	.	.	2	.	.	.	1	.	.	.	.	He	Ro	1650-2000	Si	21	LC
Silene foetida subsp. *foetida* Link	FI	.	.	.	.	.	.	1	.	.	.	.	He	Ro	1900-1900	Si	1	EN+
Silene foetida subsp. *gayana* Talavera	FI	.	.	2	.	.	.	1	.	.	.	.	He	Ro	1650-2000	Si	20	LC
Silene gaditana Talavera & Bocquet	FI	.	+	.	.	.	.	.	.	.	1	.	Th	G	200-900	Si	9	VU+
Silene gazulensis A.Galán	OP	.	1	.	.	.	.	.	.	.	.	.	He	Ro	210-220	Ca	1	CR+
Silene germana J. Gay	FI	.	3	.	.	.	.	.	.	.	.	.	Th	Ro,G	700-1800	Ca,Dol	47	LC
Silene hifacensis Rouy ex Willk.	FI	2	.	.	.	.	.	.	.	+	.	.	He	C	0-200	Ca	11	EN
Silene inaperta subsp. *serpentinicola* Talavera	FI	.	2	.	.	.	.	.	.	.	.	.	He	G	500-800	Ser	4	EN+
Silene legionensis Lag.	FI	.	+	2	.	2	.	1	+	.	.	.	He	H,G	400-2000	.	267	LC
Silene littorea subsp. *adscendens* (Lag.) Rivas Goday	FI	.	1	.	.	.	.	.	.	1	.	.	Th	C,St	0-300	.	10	VU+
Silene longicilia (Brot.) Otth	FI	.	.	.	.	.	.	+	.	.	2	.	Ch	Ro,M	0-650	Ca	44	LC
Silene mariana Pau	FI	.	2	.	.	.	.	.	.	.	.	2	Th	G	100-1200	Ca	22	NT
Silene marizii Samp.	FI	.	.	.	.	.	1	2	.	.	.	.	Ch	Ro	600-1500	Si	29	LC*
Silene mellifera Boiss. & Reut.	FI	.	2	.	+	2	.	+	.	2	+	+	He	Ro	500-2500	.	215	LC
Silene mollissima (L.) Pers.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Ro	50-1300	Ca	17	LC
Silene psammitis subsp. *psammitis* Link ex Spreng.	FI	.	+	.	.	+	.	1	.	.	+	2	Th	G	200-1500	.	46	LC
Silene rothmaleri P. Silva	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	C	40-40	Ca	6	NT-
Silene scabriflora subsp. *gallaecica* Talavera	FI	.	.	.	.	.	2	.	.	.	.	.	Th	C	0-10	Si	3	DD*
Silene scabriflora subsp. *megacalycina* Talavera	FI	.	.	.	.	.	1	+	.	.	.	.	Th	G	500-800	Si	6	DD
Silene sennenii Pau	FI	.	.	.	.	.	.	.	1	.	.	.	He	Ru,M	50-200	.	3	EN+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Silene stockenii Chater	FI	.	1	.	.	.	.	.	.	.	+	.	Th	G	200-200	Ca	4	CR-
Silene tomentosa Otth	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	C	0-40	Ca	3	DD*
Spergula viscosa Lag.	FI	.	.	2	.	.	.	+	.	.	.	.	He	Ro	1600-2600	Si	29	NT*
Spergularia australis (Samp.) Prain	FI	.	.	.	.	.	1	.	.	.	+	.	Ch	C	0-50	.	3	VU-
Spergularia capillacea (Kindb.) Willk.	FI	.	.	2	.	1	1	2	.	.	.	.	He	R	0-2300	Si	92	LC
CISTACEAE																		
Cistus heterophyllus subsp. *carthaginensis* (Pau) M.B. Crespo & Mateo	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	M	100-500	.	6	CR+
Cistus ladanifer subsp. *sulcatus* (Demoly) P. Monts.	FI	.	.	.	.	.	.	.	.	.	1	.	Ph	C	0-100	Ca	3	LC-
Cistus libanotis L.	FI	.	.	.	.	.	.	.	.	.	3	.	Ph	C,Sc	0-100	.	44	LC
Fumana baetica Güemes	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	M	1800-2200	Ca,Dol	24	LC
Fumana hispidula Loscos & J. Pardo	FI	.	2	.	1	+	.	.	.	3	.	.	Ch	M	0-1000	.	160	LC
Fumana lacidulemiensis Güemes	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	M	1000-1500	Ca	1	EN+
Halimium atriplicifolium subsp. *atriplicifolium* (Lam.) Spach	FI	.	2	.	.	.	.	+	.	1	.	1	Ph	Sc	100-1650	Si	90	LC
Helianthemum almeriense Pau	FI	.	2	.	.	.	.	.	.	2	.	.	Ch	St,M	0-800	Ca	85	LC
Helianthemum alypoides Losa & Rivas Goday	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	St	350-500	Gyp	8	VU+
Helianthemum apenninum subsp. *cantabricum* (M. Laínz) G. López	FI	.	.	3	.	.	+	.	.	.	.	.	Ch	M	350-2000	Ca	49	LC
Helianthemum apenninum subsp. *cavanillesianum* (M. Laínz) G. López	FI	.	2	.	.	.	.	.	.	2	.	.	Ch	M	500-1800	Ca	56	LC
Helianthemum apenninum subsp. *estevei* (Peinado & Mart. Parras) G. López	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1400-1600	Dol	4	VU+
Helianthemum apenninum subsp. *suffruticosum* (Boiss.) G. López	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	900-2400	.	20	LC
Helianthemum apenninum subsp. *urrielense* (M. Laínz) G. López	FI	.	.	2	.	.	.	.	.	.	.	.	Ch	Ro	1750-2300	Ca	12	LC+
Helianthemum asperum Lag. ex Dunal	FI	.	2	.	.	1	.	.	.	2	.	+	Ch	M	0-1200	Ca	102	LC
Helianthemum cinereum subsp. *cinereum* (Cav.) Pers.	FI	.	+	.	.	+	.	.	.	3	.	.	Ch	M	0-1200	Ca	58	LC
Helianthemum cinereum subsp. *guadiccianum* (Font Quer & Rothm.) G. López	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	1100-1800	Ca	36	LC
Helianthemum cinereum subsp. *hieronymi* (Sennen) G. López	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	M	400-1500	Ca	6	LC-
Helianthemum marifolium subsp. *andalusicum* (Font Quer & Rothm.) G. López	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	300-1400	Ca	12	LC+
Helianthemum marifolium subsp. *conquense* Borja & Rivas Goday ex G. López	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	St	900-1000	Gyp	7	LC-
Helianthemum marifolium subsp. *frigidulum* (Cuatrec.) G. López	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1100-1900	Ca,Dol	8	VU+
Helianthemum marifolium subsp. *molle* (Cav.) G. López	FI	.	.	.	1	1	.	.	.	+	.	.	Ch	St	100-1800	Ca	27	LC
Helianthemum motae Sánchez-Gómez & al.	OP	.	.	.	.	.	.	.	.	1	.	.	Ch	St	0-20	.	2	EN*+
Helianthemum pannosum Boiss.	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	M	1500-1900	Ca,Dol	1	VU+
Helianthemum polygonoides Peinado & al.	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	St	600-600	.	5	CR+
Helianthemum viscidulum Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1170-1800	Ca,Dol	13	LC+
Helianthemum viscidulum subsp. *raynaudii* (Ortega Oliv. & al.) G. López	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1400-1400	Dol	3	EN+
Helianthemum viscidulum subsp. *viscidulum* Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1170-1800	Dol	10	NT
Tuberaria brevipes Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	2	.	Th	C	0-160	.	8	DD*
Tuberaria globulariifolia (Lam.) Willk.	FI	.	.	+	.	.	2	2	.	.	+	.	Ch	H	0-1500	Si	62	LC
COLCHICACEAE																		
Colchicum multiflorum Brot.	FI	.	.	.	.	1	.	1	.	.	.	+	Ge	Sc,G	600-1200	Si	23	LC
Merendera androcymbioides Valdés	FI	.	2	.	.	.	.	.	.	.	+	.	Ge	Sc	500-1200	Ca	9	NT+
CONVOLVULACEAE																		
Convolvulus boissieri Steud.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro,M	700-2300	Ca,Dol	25	LC
Convolvulus fernandesii P. Silva & Teles	FI	.	.	.	.	.	.	.	.	.	1	.	Ph	C	100-125	Ca,Dol	1	EN+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
CRASSULACEAE																		
Pistorinia hispanica (L.) DC.	FI	.	2	2	.	2	.	1	.	.	.	+	Th	Ro,G	0-1700	.	267	LC
Sedum arenarium Brot.	FI	.	.	+	.	+	2	3	.	.	+	1	Th	Ro,M	100-1800	.	226	LC
Sedum candollei Raym.-Hamet	FI	.	+	1	.	+	.	1	2	.	.	.	Th	Ro,A	1500-3000	Si	88	LC
Sedum lagascae Pau	FI	.	.	.	.	.	.	2	.	.	.	.	Th	W	1000-2000	.	56	LC
Sedum pedicellatum Boiss. & Reut.	FI	.	.	.	.	1	.	2	.	.	.	.	Th	Ro,G	600-2000	.	57	LC
Sedum pruinatum Brot.	FI	.	.	.	.	.	+	2	.	.	.	.	Ch	Ro	100-1000	Si	23	LC*
Sempervivum minutum (Kunze ex Willk.) Nyman ex Pau	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	Ro	1650-3200	Si	7	LC+
Sempervivum vicentei Pau	FI	.	.	2	.	1	.	1	.	.	.	.	Ch	Ro	600-2300	.	63	LC
CUPRESSACEAE																		
Juniperus navicularis Gand.	FI	.	.	.	.	.	.	.	.	.	3	.	Ph	C,Sc	0-1000	.	34	NT*
CYPERACEAE																		
Carex asturica Boiss.	FI	.	.	2	.	1	1	1	.	.	.	.	He	H	700-2100	.	87	LC
Carex camposii Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	He	W,A	1500-3000	Si	18	LC-
Carex caudata (Kük.) Pereda & M. Laínz	FI	.	.	3	.	.	.	.	.	.	.	.	He	F	600-2050	.	38	LC
Carex durieui Steud. ex Kunze	FI	.	.	+	.	.	3	.	.	.	+	.	He	W	10-900	Si	53	LC
Carex elata subsp. *reuteriana* (Boiss.) Luceño & Aedo	FI	.	.	1	.	+	1	2	.	.	+	1	He	W	300-1900	.	174	LC
Carex elata subsp. *tartessiana* Luceño & Aedo	FI	.	+	.	.	.	.	.	.	.	+	2	He	W	20-500	.	31	LC
Carex furva Webb	FI	.	1	1	.	.	.	1	.	.	.	.	He	A	1800-3100	.	3	LC+
Carex lainzii Luceño & al.	FI	.	.	.	.	1	.	+	.	.	.	.	He	W	700-1100	.	4	EN+
Carex lucennoiberica Maguilla & M. Escudero	OP	.	1	1	.	.	.	1	.	.	.	.	He	W,A	1800-3100	.	24	NT*
Carex macrostyla Lapeyr.	FI	.	.	2	.	.	.	.	3	.	.	.	He	A	1400-2500	.	86	LC
Carex nevadensis Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	He	W,A	2000-3085	Si	4	NT-
Carex rorulenta Porta	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	50-1400	Ca	22	LC
DIOSCOREACEAE																		
Borderea chouardii (Gaussen) Heslot	FI	.	.	.	.	.	.	.	1	.	.	.	Ge	Ro	740-930	Ca	2	CR+
Borderea pyrenaica Bubani & Bordère ex Miégev.	FI	.	.	.	.	.	.	.	2	.	.	.	Ge	A	1800-2600	Ca	19	LC+
ERICACEAE																		
Erica andevalensis Cabezudo & J. Rivera	FI	.	.	.	.	.	.	.	.	.	1	1	Ph	W	320-650	.	19	VU+
Rhododendron ponticum subsp. *baeticum* (Boiss. & Reut.) Hand.-Mazz.	FI	.	+	.	.	.	+	+	.	.	2	.	Ph	Sc	0-850	Si	26	LC
EUPHORBIACEAE																		
Euphorbia boetica Boiss.	FI	.	+	.	.	.	.	.	.	+	3	+	Ch	Sc	0-100	Si	59	LC
Euphorbia fontqueriana Greuter	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	Ro	1000-1100	Ca,Dol	3	CR
Euphorbia isatidifolia Lam.	FI	.	+	.	2	+	.	.	.	2	.	.	Ge	M	50-1300	Ca	62	LC
Euphorbia maresii Knoche	FI	3	.	.	.	.	.	.	.	.	.	.	He	M	0-1450	Ca	19	LC
Euphorbia maresii subsp. *balearica* (Willk.) Malag. ex Molero & al.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro,M	650-1450	Ca	3	VU
Euphorbia maresii subsp. *maresii* Knoche	FI	3	.	.	.	.	.	.	.	.	.	.	He	C	0-400	Ca	12	LC
Euphorbia margalidiana Kuhbier & Lewej.	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-50	.	1	CR
Euphorbia matritensis Boiss.	FI	.	.	.	.	1	.	1	.	.	.	.	Ch	Ru,St	200-900	.	14	LC+
Euphorbia minuta Loscos & J. Pardo	FI	.	+	1	2	1	.	.	1	1	.	.	Ch	St,M	100-1100	Ca	154	LC
Euphorbia nevadensis Boiss. & Reut.	FI	.	+	1	2	2	.	+	1	+	.	.	He	Ro,G	300-3000	.	111	LC
Euphorbia nevadensis subsp. *aragonensis* (Loscos & J. Pardo) O. Bolòs & Vigo	FI	.	.	1	1	+	.	.	1	.	.	.	He	Ro	300-1400	Ca	36	LC
Euphorbia nevadensis subsp. *bolosii* Molero & Rovira	FI	.	.	.	2	+	.	.	1	.	.	.	He	Ro,M	500-1400	Ca	40	LC
Euphorbia nevadensis subsp. *nevadensis* Boiss. & Reut.	FI	.	+	.	.	2	.	+	.	1	.	.	He	Ro	1200-3000	Si	19	LC
Euphorbia oxyphylla Boiss.	FI	.	.	.	.	.	.	3	.	.	.	+	Ch	H	300-1700	Si	73	LC
Euphorbia paniculata subsp. *monchiquensis* (Franco & P. Silva) Vicens & al.	FI	.	.	.	.	.	.	.	.	.	2	+	Ch	Sc	100-600	Si	12	LC+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Euphorbia paniculata subsp. *welwitschii* (Boiss. & Reut.) Vicens & al.	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	Sc	50-200	Ca	15	NT+
Euphorbia pedroi Molero & Rovira	FI	.	.	.	.	.	.	.	.	.	1	.	Ph	C	10-110	Ca	1	EN+
Euphorbia polygalifolia Boiss. & Reut. ex Boiss.	FI	.	.	2	.	.	2	.	.	.	.	.	He	G	100-1800	Si	74	LC
Euphorbia polygalifolia subsp. *hirta* (Lange) M. Laínz	FI	.	.	+	.	.	3	.	.	.	.	.	He	H,G	100-1100	Si	36	LC
Euphorbia polygalifolia subsp. *polygalifolia* Boiss. & Reut. ex Boiss.	FI	.	.	3	.	.	.	.	.	.	.	.	He	H	700-1800	Si	38	LC
Euphorbia pyrenaica Jord.	FI	.	.	2	.	.	.	.	1	.	.	.	He	Ro	1500-2500	Ca	38	LC
Euphorbia uliginosa Welw. ex Boiss.	FI	.	.	.	.	.	1	.	.	.	2	.	He	W	100-400	.	23	NT*
FABACEAE																		
Adenocarpus complicatus subsp. *anisochilus* (Boiss.) Franco	AA	.	.	.	.	.	.	.	.	.	1	.	Ph	Sc	400-700	Si	7	DD
Adenocarpus complicatus subsp. *aureus* (Cav.) C. Vicioso	AA	.	.	.	.	+	.	2	.	.	.	+	Ph	Sc	100-900	.	39	LC
Adenocarpus hispanicus (Lam.) DC.	AA	.	.	.	.	1	.	2	.	.	.	1	Ph	H	800-2100	.	64	LC
Adenocarpus hispanicus subsp. *argyrophyllus* (Rivas Goday) Rivas Goday	AA	.	.	.	.	.	.	2	.	.	.	1	Ph	H	800-1800	Si	49	LC
Adenocarpus hispanicus subsp. *hispanicus* (Lam.) DC.	AA	.	.	.	.	2	.	1	.	.	.	.	Ph	H	800-2100	Si	19	LC+
Anthyllis hystrix (Willk. ex Barceló) Cardona & al.	FI	2	.	.	.	.	.	.	.	.	.	.	Ph	C	5-200	.	7	NT
Anthyllis onobrychioides Cav.	FI	.	1	.	.	.	.	.	.	2	.	.	Ch	Ro,M	200-1500	Ca,Dol	24	LC
Anthyllis ramburii Boiss.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	1000-1800	Ca	16	NT+
Anthyllis rupestris Coss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1500-1800	Ca	3	CR+
Anthyllis tejedensis subsp. *plumosa* (Cullen ex E. Domínguez) Benedí	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	M	750-1300	Ca,Dol	5	VU+
Anthyllis vulneraria subsp. *arundana* (Boiss. & Reut.) H. Lindb.	FI	.	3	.	.	.	.	.	.	.	.	.	He	M	1200-1700	.	43	LC
Anthyllis vulneraria subsp. *balearica* (Coss. ex Marès & Vigin.) O. Bolòs & Vigo	FI	2	.	.	.	.	.	.	.	.	.	.	He	Ro	700-1400	.	3	LC
Anthyllis vulneraria subsp. *microcephala* (Willk.) Benedí	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1600-2000	.	10	LC+
Astragalus alopecuroides subsp. *grosii* (Pau) Rivas Goday & Rivas Mart.	FI	.	1	.	.	.	.	.	.	2	.	.	He	St	300-600	Gyp	23	LC
Astragalus balearicus Chater	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	M	0-1350	Ca	12	LC
Astragalus castroviejoi Talavera & Sánchez-Gómez	OP	.	1	.	.	.	.	.	.	.	.	.	Th	St	780-850	Gyp	4	EN*+
Astragalus cavanillesii Podlech	FI	.	2	.	.	.	.	.	.	+	.	.	He	M	800-1200	Ca	10	CR+
Astragalus clusianus Soldano	FI	.	2	.	+	1	.	.	.	+	.	+	Ch	M	500-1200	Ca	44	LC
Astragalus devesae Talavera & al.	OP	.	.	.	.	.	.	1	.	.	.	.	He	Sc	1100-1200	Si	4	CR+
Astragalus gines-lopezii Talavera & al.	FI	.	.	.	.	.	.	.	.	.	.	1	He	Ru,Sc	650-1000	Ca	1	EN+
Astragalus hispanicus Coss. ex Bunge	FI	.	1	.	.	.	.	.	.	2	.	.	Ch	St,M	0-800	Ca	43	LC
Astragalus nevadensis Boiss.	FI	.	2	.	.	2	.	.	.	.	.	.	Ch	M	1000-2800	.	63	LC
Astragalus nevadensis subsp. *muticus* (Pau) Zarre & Podlech	FI	.	.	.	.	3	.	.	.	.	.	.	Ch	M	1000-1800	Ca	37	LC
Astragalus nevadensis subsp. *nevadensis* Boiss.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	M	1600-2800	.	27	LC
Astragalus nitidiflorus Jiménez Mun. & Pau	FI	.	.	.	.	.	.	.	.	1	.	.	He	G	0-200	.	2	CR+
Astragalus tremolsianus Pau	FI	.	1	.	.	.	.	.	.	.	.	.	He	G	2100-2300	Ca,Dol	2	CR+
Astragalus turolensis subsp. *turolensis* Pau	FI	.	.	+	1	2	.	.	.	.	.	.	He	St,M	480-800	Ca	58	LC
Colutea arborescens subsp. *hispanica* (Talavera & Arista) Mateo & M.B. Crespo	AA	.	3	.	+	1	.	.	.	1	.	+	Ph	Sc	500-1350	Ca	90	LC
Coronilla montserratii P. Fraga & Roselló	OP	2	.	.	.	.	.	.	.	.	.	.	Th	C	5-80	.	6	NT*
Coronilla talaverae Lahora & Sánchez-Gómez	OP	.	.	.	.	.	.	.	.	2	.	.	Ph	St	5-60	Ca	2	EN*+
Cytisus commutatus (Willk.) Briq.	AA	.	.	2	.	.	2	.	.	.	.	.	Ph	Sc	0-900	.	60	LC
Cytisus grandiflorus subsp. *cabezudoi* Talavera	AA	.	.	.	.	.	.	.	.	.	2	.	Ph	Sc	0-100	Si	17	LC*+
Cytisus insularis S. Ortiz & Pulgar	OP	.	.	.	.	.	2	.	.	.	.	.	Ph	C	0-100	Si	4	EN+
Cytisus malacitanus Boiss.	AA	.	2	.	.	.	.	.	.	.	.	.	Ch	M	400-1200	Ca	24	NT

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Cytisus multiflorus (L'Hér.) Sweet	AA	.	.	1	.	+	1	3	.	.	.	+	Ph	Sc	120-1500	Si	401	LC
Cytisus scoparius subsp. *reverchonii* (Degen & Hervier) Rivas Goday & Rivas Mart.	AA	.	3	.	.	+	.	.	.	2	.	.	Ph	Sc	1000-2000	Ca	50	LC
Echinospartum barnadesii (Graells) Rothm.	AA	.	.	.	.	.	.	3	.	.	.	+	Ph	Sc	800-2250	Si	107	LC
Echinospartum barnadesii subsp. *barnadesii* (Graells) Rothm.	AA	.	.	.	.	.	.	2	.	.	.	.	Ph	H	1400-2250	Si	24	LC
Echinospartum barnadesii subsp. *dorsisericeum* G. López	AA	.	.	.	.	.	.	3	.	.	.	+	Ph	M	750-1900	Si	83	LC
Echinospartum boissieri (Spach) Rothm.	AA	.	3	.	.	.	.	.	.	.	.	.	Ch	M	1100-2200	Ca	60	LC
Genista acanthoclada subsp. *fasciculata* (Knoche) O. Bolos & Vigo	AA	3	.	.	.	.	.	.	.	.	.	.	Ch	M	10-1000	Ca	6	VU
Genista berberidea Lange	AA	.	.	.	.	.	3	.	.	.	.	.	Ph	W	10-560	.	30	LC
Genista cinerea subsp. *cinerascens* (Lange) Nyman	AA	.	.	.	.	1	.	2	.	.	.	+	Ph	H	400-1800	Si	136	LC
Genista cinerea subsp. *leptoclada* (Willk.) O. Bolòs & Molin.	AA	3	.	.	.	.	.	.	.	.	.	.	Ph	Ro	100-1350	Ca	6	LC
Genista dorycnifolia Font Quer	AA	2	.	.	.	.	.	.	.	.	.	.	Ph	Sc	0-200	Ca	2	NT
Genista falcata Brot.	AA	.	.	.	.	+	+	3	.	.	.	1	Ph	Sc	300-1250	Si	157	LC
Genista haenseleri Boiss.	AA	.	2	.	.	.	.	.	.	.	.	.	Ph	M	100-600	Ca,Dol	7	EN+
Genista hirsuta subsp. *hirsuta* Vahl	FI	.	.	.	.	+	.	+	.	.	2	2	Ph	Sc	0-1100	.	91	LC
Genista hystrix Lange	AA	.	.	+	.	.	1	3	.	.	.	+	Ch	H	900-1000	Si	171	LC
Genista legionensis (Pau) M. Laínz	AA	.	.	3	.	.	.	.	.	.	.	.	Ch	Ro,M	1100-2200	Ca	49	LC
Genista micrantha Gómez Ortega	AA	.	.	3	.	+	1	1	.	.	.	.	Ch	H	1000-1600	.	170	LC
Genista obtusiramea J. Gay ex Spach	AA	.	.	3	.	+	.	1	.	.	.	.	Ch	H	1400-2200	Si	85	LC
Genista patens DC.	AA	.	+	.	2	+	.	.	.	2	.	.	Ph	Sc	700-1800	Ca	59	LC
Genista polyanthos R. Roem. ex Willk.	AA	.	.	.	.	+	.	+	.	.	1	3	Ph	H	100-1080	Si	126	LC
Genista pumila (Debeaux & É. Rev. ex Hervier) Vierh.	AA	.	2	.	.	2	.	.	.	2	.	.	Ch	M	400-1700	Ca	221	LC
Genista pumila subsp. *pumila* (Debeaux & É. Rev. ex Hervier) Vierh.	FI	.	2	.	.	1	.	.	.	2	.	.	Ch	M	400-1700	Ca	86	LC
Genista pumila subsp. *rigidissima* (Vierh.) Talavera & L. Sáez	AA	.	.	.	.	3	.	.	.	.	.	.	Ch	M	900-1300	Ca	87	LC
Genista sanabrensis Valdés Berm. & al.	AA	.	.	+	.	.	.	1	.	.	.	.	Ch	H	1600-2100	Si	16	LC+
Genista teretifolia Willk.	AA	.	.	2	.	.	.	.	2	.	.	.	Ph	G	600-1400	.	29	LC
Genista tournefortii subsp. *tournefortii* Spach	FI	.	.	.	.	.	.	+	.	.	2	2	Ch	Sc	800-1500	Si	41	LC
Genista tribracteolata (Webb) Pau	AA	.	+	.	.	.	.	.	.	.	1	.	Ch	Sc,Ro	500-1000	Si	9	CR-
Genista tridentata subsp. *tridentata* L.	FI	.	.	.	.	.	2	+	.	.	2	.	Ch	Sc,H	0-200	Si	137	LC
Genista umbellata subsp. *equisetiformis* (Spach) Rivas Goday & Rivas Mart.	AA	.	3	.	.	.	.	.	.	.	.	.	Ph	M	100-2000	.	48	LC
Genista valentina (Willd. ex Spreng.) Steud.	AA	.	.	.	.	.	.	.	.	3	.	.	Ph	Sc,M	0-500	Ca	57	LC
Genista valentina subsp. *jimenezii* (Pau) Mateo & M.B. Crespo	AA	.	.	.	.	.	.	.	.	3	.	.	Ph	Sc	0-350	Ca	20	LC
Genista valentina subsp. *valentina* (Willd. ex Spreng.) Steud.	FI	.	.	.	.	.	.	.	.	3	.	.	Ph	M	100-500	Ca	37	LC
Genista versicolor Boiss.	AA	.	2	.	.	.	.	.	.	.	.	.	Ch	H	1600-2500	Si	26	LC
Hedysarum boveanum subsp. *costaetalentii* (López Bernal & al.) Valdés	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1800-2000	Ca	4	VU+
Hedysarum boveanum subsp. *palentinum* Valdés	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	St	800-900	Gyp	8	LC+
Hippocrepis balearica Jacq.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Ro	10-1030	Ca	16	LC
Hippocrepis bourgaei (Nyman) Hervier	FI	.	2	.	+	+	.	.	.	2	.	.	Ch	St,M	900-1400	Ca	46	LC
Hippocrepis carpetana Lassen	FI	.	.	.	.	+	.	1	.	.	.	.	Ch	M	1000-1450	Ca	11	LC+
Hippocrepis castroviejoi Talavera & E. Domínguez	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1200-2100	Ca	6	VU-
Hippocrepis commutata Pau	FI	.	.	+	1	2	+	1	.	.	.	.	Ch	St,M	600-900	Ca	141	LC
Hippocrepis eriocarpa (Boiss.) Boiss.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	1100-1800	Ca,Dol	20	VU
Hippocrepis fruticescens Sennen	FI	.	+	.	1	+	.	.	.	2	.	.	Ch	Sc	50-600	Ca	43	LC
Hippocrepis grosii (Pau) Boira & al.	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C,Ro	80-240	Ca	2	EN
Hippocrepis nevadensis (Hrabětová) Talavera & E. Domínguez	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	M	1800-2300	Ca	3	VU+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Hippocrepis prostrata Boiss.	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	Ro	2100-2100	Ca	1	CR+
Hippocrepis rupestris Laza	FI	.	2	.	.	.	.	.	.	.	+	+	Ch	Sc	30-700	Ca	28	LC
Hippocrepis scabra DC.	FI	.	2	.	.	.	.	.	.	2	.	.	Ch	St,M	20-100	Ca	66	LC
Hippocrepis squamata (Cav.) Coss.	FI	.	1	.	.	1	.	.	.	2	.	.	Ch	Ro,M	700-2400	Ca	53	LC
Hippocrepis tavera-mendozae Talavera & E. Domínguez	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	450-1000	Ca	2	CR+
Hippocrepis valentina Boiss.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	C,Ro	10-800	Ca	16	LC+
Lotus corniculatus subsp. *glacialis* (Boiss.) Valdés	FI	.	2	.	.	.	.	.	.	.	.	.	He	G	2000-3300	.	5	LC-
Lotus lourdes-santiagoi F.J. Pina & Valdés	OP	.	+	.	.	.	.	.	.	.	2	.	Th	W	20-1100	Si	20	LC
Lotus tetraphyllus L.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	M	30-1000	Ca	26	LC
Lupinus gredensis Gand.	FI	.	.	.	.	+	1	3	.	.	.	+	Th	R	0-1500	Si	62	LC
Lupinus hispanicus Boiss. & Reut.	FI	.	+	.	.	1	.	2	.	.	.	1	Th	R	600-1600	Si	136	LC
Lupinus mariae-josephi H. Pascual	OP	.	.	.	.	.	.	.	.	2	.	.	Th	M	170-400	Ca	4	CR+
Medicago citrina (Font Quer) Greuter	FI	3	.	.	.	.	.	.	.	+	.	.	Ph	C	10-50	Hal	4	CR
Onobrychis matritensis Boiss. & Reut.	FI	.	+	.	.	2	.	.	.	.	.	.	Ch	St,M	600-1000	Ca,Gyp	36	LC
Onobrychis reuteri Leresche	FI	.	.	3	.	.	.	.	.	.	.	.	Ch	G	1000-1200	Ca	25	NT
Onobrychis stenorhiza DC.	FI	.	2	.	.	.	.	.	.	3	.	.	Ch	M	0-1300	Ca	71	LC
Ononis azcaratei Devesa	FI	.	.	.	.	.	.	.	.	.	1	.	He	Sc	0-100	.	2	CR+
Ononis crispa L.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C,M	0-10	Ca	10	LC
Ononis hackelii Lange	FI	.	.	.	.	.	.	.	.	.	1	.	Th	C	0-10	.	3	VU+
Ononis tridentata subsp. *angustifolia* (Lange) Devesa & G. López	FI	.	1	.	.	+	.	.	+	1	.	.	Ph	St	300-900	Gyp	20	LC
Ononis tridentata subsp. *crassifolia* (Dufour ex Boiss.) Nyman	FI	.	2	.	.	.	.	.	.	.	.	.	Ph	St	700-1100	Gyp	11	LC+
Ononis varelae Devesa	FI	.	.	.	.	.	.	.	.	.	.	2	Th	Sc	200-900	Si	11	VU+
Ononis viscosa subsp. *crotalarioides* (Coss.) Širj.	FI	.	2	.	.	1	.	+	.	.	.	+	Th	Ru,G	200-500	.	32	LC
Oxytropis foucaudii Gillot	FI	.	.	1	.	.	.	.	2	.	.	.	He	A,G	1800-2700	Ca	30	LC
Oxytropis jabalambrensis (Pau) Podlech	FI	.	.	.	.	2	.	.	.	.	.	.	He	Ro	1950-2000	Ca	5	EN+
Stauracanthus lusitanicus subsp. *lusitanicus* (L.) Cubas	AA	.	.	.	.	.	.	.	.	.	3	+	Ph	C,Sc	0-800	.	76	LC
Ulex argenteus subsp. *argenteus* Welw. ex Webb	AA	.	.	.	.	.	.	.	.	.	2	.	Ph	C,M	0-400	.	29	LC
Ulex argenteus subsp. *subsericeus* (Cout.) Rothm.	AA	.	.	.	.	.	.	.	.	.	2	.	Ph	C	0-50	.	17	VU+
Ulex argenteus Welw. ex Webb	AA	.	.	.	.	.	.	.	.	.	2	.	Ph	C,Sc	0-400	.	47	LC
Ulex australis Clemente	AA	.	.	.	.	.	.	.	.	.	3	+	Ph	C,Sc	0-100	.	88	LC
Ulex australis subsp. *australis* Clemente	AA	.	.	.	.	.	.	.	.	.	2	.	Ph	C,Sc	0-100	.	17	LC+
Ulex australis subsp. *welwitschianus* (Planch.) Espírito Santo & al.	AA	.	.	.	.	.	.	.	.	.	3	+	Ph	C,Sc	0-100	.	63	LC
Ulex baeticus subsp. *baeticus* Boiss.	AA	.	2	.	.	.	.	.	.	.	+	.	Ph	M	400-1900	.	12	LC
Ulex baeticus subsp. *glabrescens* (Webb) Cubas	AA	.	1	.	.	.	.	.	.	.	1	.	Ph	Sc	0-600	Si	17	LC+
Ulex canescens Lange	AA	.	.	.	.	.	.	.	.	1	.	.	Ph	M	0-500	.	2	EN-
Ulex densus Welw. ex Webb	AA	.	.	.	.	.	.	.	.	.	2	.	Ch	Sc	0-250	Ca	16	LC+
Ulex erinaceus Welw. ex Webb	AA	.	.	.	.	.	.	.	.	.	1	.	Ch	M	50-80	Ca	2	VU+
Ulex eriocladus C. Vicioso	AA	.	.	.	.	.	.	.	.	.	+	3	Ph	Sc,M	100-500	Si	117	LC
Ulex europaeus subsp. *latebracteatus* (Mariz) Rothm.	AA	.	.	.	.	.	2	1	.	.	+	.	Ph	H	0-400	.	39	LC
Ulex jussiaei Webb	AA	.	.	.	.	.	.	.	.	.	2	.	Ph	Sc	0-400	Si	26	LC
Ulex micranthus Lange	AA	.	.	.	.	.	2	+	.	.	1	.	Ph	H	0-1000	Si	37	LC
Ulex parviflorus subsp. *airensis* (Espírito Santo & al.) Rivas Mart.	AA	.	.	.	.	.	.	.	.	.	2	+	Ph	Sc,M	0-400	Ca	34	LC
Vicia argentea Lapeyr.	FI	.	.	.	.	.	.	.	2	.	.	.	He	A	1800-2500	Ca	13	VU-
Vicia bifoliolata J.J. Rodr.	FI	2	.	.	.	.	.	.	.	.	.	.	Th	Sc,H	0-20	Si	3	CR
Vicia glauca subsp. *giennensis* (Cuatrec.) Blanca & F. Valle	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	1800-1800	.	1	VU+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
FAGACEAE																		
Quercus petraea subsp. *huguetiana* Franco & G. López	FI	.	.	+	1	+	.	.	1	.	.	.	Ph	F	300-1500	.	4	DD*
GENTIANACEAE																		
Centaurium quadrifolium subsp. *linariifolium* (Lam.) G. López	FI	.	1	.	1	+	.	.	.	1	.	.	He	M,G	200-2000	Dol	64	LC
Centaurium quadrifolium subsp. *quadrifolium* (L.) G. López & C.E. Jarvis	FI	.	+	.	.	1	.	.	.	+	.	.	Th	St	500-1000	Ca	39	LC
Centaurium somedanum M. Laínz	FI	.	.	1	.	.	.	.	.	.	.	.	He	W	600-1700	Si	9	VU-
Gentiana boryi Boiss.	FI	.	1	1	.	.	.	1	.	.	.	.	He	W,G	1000-2900	Si	17	VU-
Gentiana burseri subsp. *burseri* Lapeyr.	FI	.	.	.	.	.	.	.	3	.	.	.	He	H	1100-2400	Si	60	LC
Gentiana lutea subsp. *montserratii* (Vivant ex Greuter) Romo	FI	.	.	.	.	.	.	.	3	.	.	.	He	G	1200-2500	Ca	33	LC
Gentiana sierrae Briq.	FI	.	2	.	.	.	.	.	.	.	.	.	He	W,A	2100-3160	Si	7	VU-
GERANIACEAE																		
Erodium aguilellae López Udias & al.	FI	.	.	.	+	.	.	.	.	1	.	.	He	Ro,M	100-800	Ca	11	NT-
Erodium astragaloides Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro,G	1700-1900	Ca,Dol	4	CR+
Erodium boissieri Coss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1400-2000	Ca,Dol	4	VU+
Erodium carvifolium Boiss. & Reut.	FI	.	.	+	.	2	.	1	.	.	.	.	He	G	1000-2000	.	47	LC
Erodium celtibericum Pau	FI	.	.	.	1	2	.	.	.	+	.	.	Ch	Ro,M	1400-2050	Ca	14	LC+
Erodium cheilanthifolium Boiss.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro,M	1400-3200	.	46	LC
Erodium daucoides Boiss.	FI	.	2	2	.	1	.	.	.	.	.	.	He	Ro,G	800-2300	Ca	69	LC*
Erodium macrocalyx (G. López) López Udias & al.	FI	.	.	.	.	1	.	.	.	.	.	.	He	Ro	1200-1800	Ca	6	VU+
Erodium manescavii Coss.	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	700-1500	.	17	VU-
Erodium paularense Fern. Gonz. & Izco	FI	.	.	.	.	1	.	+	.	.	.	.	Ch	Ro	1000-1500	Ca	3	EN+
Erodium recoderi Auriault & Guitt.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	700-1300	Ca	6	VU+
Erodium reichardii (Murray) DC.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Ro	20-1400	Ca	7	LC
Erodium rupestre (Pourr. ex Cav.) Marcet	FI	.	.	.	+	.	.	.	3	.	.	.	Ch	Ro	1000-1400	.	28	LC
Erodium rupicola Boiss.	FI	.	1	.	.	.	.	.	.	+	.	.	He	Ro	1500-2100	Si	9	VU+
Erodium sanguis-christi Sennen	FI	.	.	.	2	.	.	.	.	2	.	.	Th	M	0-500	Ca	26	LC
Erodium saxatile Cav. ex Pau	FI	.	1	.	.	.	.	.	.	3	.	.	He	Ro	300-1800	Ca	46	LC
Geranium cazorlense Heywood	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	1800-2000	Ca	2	CR+
Geranium cinereum Cav.	FI	.	.	+	.	.	.	.	3	.	.	.	He	Ro,G	1200-2450	Ca	43	LC
Geranium dolomiticum Rothm.	FI	.	.	.	.	.	.	1	.	.	.	.	He	Ro	1450-1650	Ca,Dol	2	CR+
Geranium pyrenaicum subsp. *lusitanicum* (Samp.) S. Ortiz	FI	.	.	+	.	+	.	3	.	.	.	.	He	R	400-1850	.	44	LC
Geranium subargenteum Lange	FI	.	.	3	.	.	.	.	.	.	.	.	He	G	1300-2200	.	24	LC
GESNERIACEAE																		
Ramonda myconi (L.) Rchb.	FI	.	.	.	1	.	.	.	3	.	.	.	He	Ro	500-2000	Ca	166	LC
HYPERICACEAE																		
Hypericum balearicum L.	FI	3	.	.	.	.	.	.	.	.	.	.	Ph	Sc	5-1500	Ca	19	LC
Hypericum caprifolium Boiss.	FI	.	2	1	+	1	.	.	.	1	.	.	He	W	300-1600	Ca	91	LC
Hypericum ericoides subsp. *ericoides* L.	FI	.	+	.	.	.	.	.	.	3	.	.	Ch	Ro	0-1900	Ca	70	LC
Hypericum hircinum subsp. *cambessedesii* (Coss. ex Barceló) Sauvage	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	W	600-1000	Ca	5	VU
Hypericum richeri subsp. *burseri* (DC.) Nyman	FI	.	.	3	.	.	.	+	2	.	.	.	He	H	900-2500	Si	164	LC
IRIDACEAE																		
Crocus cambessedesii J. Gay	FI	3	.	.	.	.	.	.	.	.	.	.	Ge	Ro,M	20-1400	Ca	28	LC
Crocus carpetanus Boiss. & Reut.	FI	.	.	+	.	.	.	3	.	.	.	+	Ge	G	300-1900	Si	122	LC
Crocus clusii J. Gay	FI	.	.	.	.	.	+	.	.	.	1	1	Ge	G	0-120	.	10	DD*
Xiphion boissieri (Henriq.) Rodion.	FI	.	.	.	.	.	1	1	.	.	.	.	Ge	H	500-1450	Si	14	NT*+
Xiphion filifolium (Boiss.) Klatt	FI	.	2	.	.	.	.	.	.	.	+	.	Ge	Sc	300-1270	.	14	LC+
Xiphion latifolium Mill.	FI	.	.	2	.	+	+	+	2	.	.	.	Ge	G	900-2400	.	160	LC
Xiphion serotinum (Willk.) Soják	FI	.	2	.	.	+	.	.	.	.	.	.	Ge	G	950-1600	Ca	26	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
ISOETACEAE																		
Isoetes asturicense (M. Laínz) Rivas Mart. & Prada	FI	.	.	1	.	.	.	1	.	.	.	+	Hy	W	1500-2200	.	18	VU+
Isoetes fluitans M.I. Romero	OP	.	.	.	.	.	2	.	.	.	.	.	Hy	W	0-600	Si	16	EN+
JUNCACEAE																		
Juncus emmanuelis A. Fern. & J.G. Garcia	FI	.	.	.	.	.	.	.	.	.	3	+	Ge	W	0-200	.	30	LC
Juncus fernandez-carvajaliae Romero Zarco & Aranda	OP	.	.	.	.	.	.	.	.	.	.	1	Th	W	675-675	.	2	DD*
Juncus rugosus Steud.	FI	.	.	.	.	.	.	.	.	.	3	+	He	W	0-500	.	77	LC
Luzula caespitosa (J. Gay ex E. Mey.) Steud.	FI	.	.	2	.	1	.	1	.	.	.	.	He	G	1600-2500	Si	72	LC
Luzula lactea (Link) E. Mey.	FI	.	.	2	.	1	1	2	.	.	.	+	He	H	600-1890	Si	206	LC
LAMIACEAE																		
Calamintha rouyana (Briq.) Rouy	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	Ro	900-1400	Ca	6	VU
Galeopsis ladanum subsp. *carpetana* (Willk.) O. Bolòs & Vigo	FI	.	.	1	.	2	.	+	.	.	.	.	Th	Ro	1200-1700	Si	48	LC
Galeopsis pyrenaica Bartl.	FI	.	.	.	.	.	.	.	3	.	.	.	Th	Ro	900-2800	Si	106	LC
Lamium coutinhoi J.G. Garcia	FI	.	.	.	.	.	.	1	.	.	.	.	Th	R	400-900	Si	10	NT+
Lamium gevorense (Gómez Hern.) Gómez Hern. & A. Pujadas	FI	.	.	.	.	.	.	.	.	.	.	1	Th	R	200-700	Si	4	DD*
Lavandula lanata Boiss.	FI	.	3	.	.	.	.	.	.	+	.	.	Ph	M	800-2030	Ca	76	LC
Lavandula stoechas subsp. *luisieri* (Rozeira) Rozeira	FI	.	.	.	.	+	+	1	.	.	2	2	Ch	Sc	120-1010	Si	172	LC
Micromeria filiformis subsp. *filiformis* (Aiton) Benth.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Ro	10-1000	Ca	42	LC
Nepeta caerulea Aiton	FI	.	.	1	.	1	.	1	.	.	.	.	He	H	750-1600	.	26	LC
Nepeta nepetella subsp. *aragonensis* (Lam.) Nyman	FI	.	.	+	1	2	.	+	.	1	.	.	He	M	50-1400	.	151	LC
Nepeta nepetella subsp. *laciniata* (Willk.) Aedo	FI	.	2	.	.	.	.	.	.	.	.	.	He	W	1600-3100	.	13	LC+
Phlomis crinita subsp. *crinita* Cav.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	M	85-1400	Ca	54	LC
Phlomis crinita subsp. *malacitana* (Pau) Cabezudo & al.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1200-2200	Ca	15	LC+
Phlomis italica L.	FI	3	.	.	.	.	.	.	.	.	.	.	Ph	Sc,M	150-1400	Ca	12	LC
Rosmarinus tomentosus Hub.-Mor. & Maire	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	C,Ro	10-300	Ca,Dol	6	EN-
Salvia candelabrum Boiss.	FI	.	3	.	.	.	.	.	.	.	.	.	Ph	Ro,M	200-1350	Ca	25	VU
Salvia lavandulifolia subsp. *lavandulifolia* Vahl	FI	.	1	1	1	2	.	.	+	+	.	.	Ch	M	250-2100	Ca	159	LC
Salvia lavandulifolia subsp. *mariolensis* (Figuerola) Alcaraz & De la Torre	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	Sc,M	700-1400	Ca	27	LC
Salvia lavandulifolia subsp. *oxyodon* (Webb & Heldr.) Rivas Goday & Rivas Mart.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Sc,M	700-2100	Ca	40	LC
Salvia lavandulifolia subsp. *vellerea* (Cuatrec.) Rivas Goday & Rivas Mart.	FI	.	3	.	1	.	.	.	.	1	.	.	Ch	Sc,M	300-2100	Ca	56	LC
Salvia phlomoides subsp. *boissieri* (De Noé) Rosúa & Blanca	FI	.	3	.	.	.	.	.	.	.	.	.	He	M	800-1400	Ca	16	LC-
Salvia phlomoides subsp. *phlomoides* Asso	FI	.	1	.	.	2	.	.	.	.	.	.	He	M	600-1200	Ca	50	LC
Salvia sclareoides Brot.	FI	.	+	.	.	.	.	.	.	.	3	+	He	Sc,M	0-500	.	40	LC
Salvia valentina Vahl	FI	.	.	.	2	+	.	.	+	2	.	.	He	G	50-1050	Ca	43	LC
Satureja innota (Pau) Font Quer	FI	.	.	.	1	1	.	.	.	2	.	.	Ch	M	50-1000	Ca	18	LC+
Satureja intricata Lange	FI	.	2	.	+	2	.	.	.	1	.	.	Ch	M	350-2150	Ca	122	LC
Scutellaria balearica Barceló	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	50-1400	Ca	8	LC
Scutellaria orientalis subsp. *hispanica* (Boiss.) Greuter & Burdet	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1450-2400	Ca	12	LC+
Sideritis bourgaeana Boiss. & Reut.	FI	.	1	.	.	.	.	.	.	2	.	.	Ch	St,M	20-780	Ca	26	LC
Sideritis bubanii Font Quer	FI	.	.	.	.	1	.	.	2	.	.	.	Ch	Ru,M	940-1850	Si	13	LC-
Sideritis carbonellii Socorro	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1800-2400	Ca	11	LC+
Sideritis chamaedryfolia Cav.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	M	50-750	Ca	19	VU+
Sideritis dianica D. Rivera & al.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	M	150-940	Ca	10	LC+
Sideritis glacialis Boiss.	FI	.	2	.	.	+	.	.	.	.	.	.	Ch	M,G	1500-3250	Ca	26	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Sideritis glauca Cav.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	Ro	50-700	Ca	7	VU+
Sideritis ibanyezii Pau	FI	.	+	.	.	.	.	.	.	2	.	.	Ch	St,M	20-950	.	13	LC+
Sideritis ilicifolia Willd.	FI	.	.	.	3	.	.	.	+	.	.	.	Ch	St,M	200-1000	Ca	58	LC
Sideritis lacaitae Font Quer	FI	.	+	.	.	.	.	.	.	.	.	2	Ch	M	200-1040	Si	21	LC
Sideritis lasiantha Pers.	FI	.	1	.	.	.	.	.	.	2	.	.	Ch	M	230-1800	.	19	NT-
Sideritis laxespicata (Degen & Debeaux) Socorro & al.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	650-1760	Ca	9	NT-
Sideritis leucantha Cav.	FI	.	1	.	.	.	.	.	.	3	.	.	Ch	M	30-1250	Ca	57	LC
Sideritis lurida J. Gay ex Lacaita	FI	.	.	2	.	+	+	+	.	.	.	.	Ch	Sc,H	750-2200	Si	22	LC
Sideritis montserratiana Stübing & al.	FI	.	.	.	.	+	.	1	.	.	.	.	Ch	M	400-1440	Si	8	DD*
Sideritis osteoxylla (Pau ex Vicioso) Alcaraz & al.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	M	20-200	.	3	LC+
Sideritis ovata Cav.	FI	.	.	3	.	.	.	.	.	.	.	.	Ch	Ro	300-1300	Ca	23	LC
Sideritis paulii Pau	FI	.	.	.	.	.	.	.	.	.	.	2	Ch	Sc,M	640-1030	Si	26	LC
Sideritis pungens Benth.	FI	.	+	+	+	2	.	.	.	+	.	.	Ch	M,G	270-2000	Ca	115	LC
Sideritis reverchonii Willk.	FI	.	2	.	.	.	.	.	.	.	+	.	Ch	M	100-550	Ca	11	EN-
Sideritis serrata Lag.	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	M	600-1000	Ca	2	CR-
Sideritis spinulosa Barnades ex Asso	FI	.	.	.	2	2	.	.	.	.	.	.	Ch	St,M	300-1500	Ca	77	LC
Sideritis stachydioides Willk.	FI	.	1	.	.	.	.	.	.	+	.	.	Ch	Ro	1000-2000	Ca	8	VU+
Sideritis tragoriganum Lag.	FI	.	1	.	+	+	.	.	.	3	.	.	Ch	M	30-1300	Ca	97	LC
Teucrium algarbiense (Cout.) Cout.	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	M	0-100	Si	10	NT+
Teucrium angustissimum Schreb.	FI	.	.	.	.	1	.	.	.	1	.	.	Ch	St,M	300-900	Ca	6	DD*
Teucrium asiaticum L.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	M	600-900	Ca	8	LC
Teucrium aureum subsp. *turdetanum* Devesa & Valdés Berm.	FI	.	3	.	.	.	.	.	.	+	.	.	Ch	G	1700-2000	.	48	LC
Teucrium balthazaris Sennen	FI	.	+	.	.	.	.	.	.	2	.	.	Ch	St	300-500	Gyp	26	NT
Teucrium bicoloreum Pau ex Vicioso	FI	.	2	.	.	.	.	.	.	1	.	.	Ch	M	1000-2000	Ca	20	LC
Teucrium buxifolium Schreb.	FI	.	1	.	.	.	.	.	.	3	.	.	Ch	Ro	100-1300	Ca	47	LC
Teucrium capitatum subsp. *gracillimum* (Rouy) Valdés Berm.	FI	.	2	.	.	.	.	.	.	3	.	.	Ch	M	0-1500	.	147	LC
Teucrium capitatum subsp. *majoricum* (Rouy) T. Navarro & Rosúa	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	M	0-500	Ca	24	LC
Teucrium carolipaui subsp. *carolipaui* Vicioso ex Pau	FI	.	.	.	.	.	.	.	.	3	.	.	Ch	C,M	0-700	Ca,Gyp	59	LC
Teucrium carolipaui subsp. *fontqueri* (Sennen) Rivas Mart.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	M	0-550	Ca	10	NT+
Teucrium carolipaui Vicioso ex Pau	FI	.	.	.	.	.	.	.	.	3	.	.	Ch	C,St	0-650	Ca	68	LC
Teucrium carthaginense Lange	FI	.	.	.	.	.	.	.	.	3	.	.	Ch	St,M	30-70	Si	22	NT
Teucrium charidemi Sandwith	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	Ro,M	0-450	Si	10	NT+
Teucrium chrysotrichum Lange	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro,M	100-800	Ca,Dol	10	NT-
Teucrium cossonii D. Wood	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Ro	50-1000	.	7	NT
Teucrium edetanum M.B. Crespo & al.	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	M	100-250	Ca	5	VU+
Teucrium eriocephalum subsp. *almeriense* (C.E. Hubb. & Sandwith) T. Navarro & Rosúa	FI	.	1	.	.	.	.	.	.	+	.	.	Ch	C,M	0-100	.	12	NT+
Teucrium eriocephalum subsp. *eriocephalum* Willk.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	100-1000	ca	43	LC
Teucrium eriocephalum Willk.	FI	.	2	.	.	.	.	.	.	1	.	.	Ch	St,M	0-1000	.	55	LC
Teucrium expassum Pau	FI	.	.	2	+	3	.	.	.	+	.	.	Ch	M	1500-2200	Ca	129	LC
Teucrium fragile Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	50-1300	Ca	11	LC-
Teucrium franchetianum Rouy & Coincy	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	St,M	400-900	Ca	13	NT+
Teucrium freynii É. Rev. ex Willk.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	Ro	0-700	.	23	LC
Teucrium gnaphalodes L'Hér.	FI	.	2	.	2	2	.	.	.	2	.	.	Ch	M	200-1200	Ca	260	LC
Teucrium haenseleri Boiss.	FI	.	2	.	.	.	.	+	.	.	2	2	Ch	M	0-1000	.	72	LC
Teucrium hieronymi Sennen	FI	.	1	.	.	.	.	.	.	+	.	.	Ch	M	0-500	Ca	6	NT-
Teucrium hifacense Pau	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	Ro	0-1490	Ca	24	LC
Teucrium homotrichum (Font Quer) Rivas Mart.	FI	.	.	.	.	+	.	.	.	3	.	.	Ch	M	0-600	Ca	106	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Teucrium intricatum Lange	FI	.	1	.	.	.	.	.	.	+	.	.	Ch	Ro	0-500	Ca	12	NT+
Teucrium lanigerum Lag.	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	St	0-400	.	15	LC+
Teucrium leonis Sennen	FI	.	3	.	.	.	.	.	.	1	.	.	Ch	M	1000-1500	Ca	47	LC*
Teucrium lepicephalum Pau	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	St	100-300	Gyp	7	EN+
Teucrium libanitis Schreb.	FI	.	.	.	.	.	.	.	.	3	.	.	Ch	St	60-850	Gyp	63	LC
Teucrium lusitanicum Schreb.	FI	.	3	.	.	.	.	.	.	1	1	.	Ch	St,M	0-1000	.	82	LC
Teucrium lusitanicum subsp. *aureoforme* (Rouy) Valdés Berm. & Sánchez Crespo	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	900-1500	.	12	LC+
Teucrium lusitanicum subsp. *lusitanicum* Schreb.	FI	.	3	.	.	.	.	.	.	1	1	.	Ch	Sc	0-1000	.	70	LC
Teucrium moleromesae Sánchez Gómez & al.	OP	.	2	.	.	.	.	.	.	.	.	.	He	St	950-1150	Ca	2	EN*+
Teucrium murcicum Sennen	FI	1	+	.	.	.	.	.	.	3	.	.	Ch	St,M	0-1000	Ca	49	LC
Teucrium oxylepis Font Quer	FI	.	1	.	.	.	.	+	.	.	.	1	Ch	M	900-2100	.	10	VU-
Teucrium pugionifolium Pau	FI	.	.	.	.	1	.	.	.	2	.	.	Ch	Ro,M	600-2000	Ca	15	LC+
Teucrium pumilum Loefl. ex L.	FI	.	.	.	.	2	.	.	.	.	.	.	Ch	St	500-800	Ca,Gyp	31	LC
Teucrium pyrenaicum subsp. *guarensis* P. Monts.	FI	.	.	.	1	+	.	.	3	.	.	.	Ch	Ro,G	1500-2500	Ca	151	LC
Teucrium reverchonii Willk. ex Hack.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	300-1200	Ca	14	LC+
Teucrium rivasii Rigual ex Greuter & Burdet	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	Ro	100-1300	Ca	31	LC
Teucrium rivas-martinezii Alcaraz & al.	FI	.	+	.	.	.	.	.	.	1	.	.	Ch	Ro	500-1500	Ca	7	LC+
Teucrium rixanense Ruiz Torre & Ruiz Cast.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Sc,M	0-900	.	3	EN*+
Teucrium salviastrum Schreb.	FI	.	.	.	.	.	.	2	.	.	.	.	Ch	Ro	900-1300	Si	30	LC
Teucrium similatum T. Navarro & Rosúa	FI	.	3	.	.	.	.	.	.	+	.	+	Ch	Ro	1400-1800	Ca	45	LC
Teucrium terciae (Sánchez Gómez & al.) Sánchez Gómez & al.	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	Ro	400-1200	Ca	3	VU-
Teucrium thymifolium Schreb.	FI	.	1	.	.	+	.	.	.	3	.	.	Ch	Ro	800-1480	Ca	69	LC
Teucrium turredanum Losa & Rivas Goday	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	St	200-400	Ca,Gyp	9	VU+
Teucrium vincentinum Rouy	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	C	0-100	.	10	NT+
Teucrium webbianum Boiss.	FI	.	3	.	.	.	.	.	.	+	.	.	Ch	Sc	800-1500	Ca	66	LC
Thymus albicans Hoffmanns. & Link	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C,Sc	10-70	.	19	VU*+
Thymus antoninae Rouy & Coincy	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	St,M	300-500	Ca	12	NT+
Thymus baeticus Boiss. ex Lacaita	FI	.	3	.	.	.	.	.	.	+	+	.	Ch	St,M	30-1300	Ca	121	LC
Thymus bracteatus Lange ex Cutanda	FI	.	.	.	.	2	.	1	.	.	.	.	Ch	H,M	1200-1800	Si	66	LC
Thymus camphoratus Hoffmanns. & Link	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C	0-110	Ca	25	LC
Thymus capitellatus Hoffmanns. & Link	FI	.	.	.	.	.	.	.	.	.	3	.	Ch	C,Sc	0-145	.	45	LC
Thymus carnosus Boiss.	FI	.	.	.	.	.	.	.	.	.	3	.	Ch	C	0-74	.	34	LC*
Thymus fontqueri (Jalas) Molero & Rovira	FI	.	.	.	+	.	.	.	3	.	.	.	Ch	M	460-1720	Ca	27	LC
Thymus funkii Coss.	FI	.	1	.	.	.	.	.	.	2	.	.	Ch	St,M	400-1800	Ca,Gyp	28	LC
Thymus funkii subsp. *burilloi* Sánchez Gómez	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	M	1100-1700	Ca	3	VU+
Thymus funkii subsp. *funkii* Coss.	FI	.	1	.	.	.	.	.	.	2	.	.	Ch	M	400-1100	Ca	28	LC
Thymus funkii subsp. *sabulicola* (Coss.) Sánchez Gómez	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	600-1800	Ca,Dol	12	NT+
Thymus granatensis Boiss.	FI	.	3	.	.	.	.	.	.	1	.	.	Ch	M	600-2200	Ca	57	LC
Thymus granatensis subsp. *granatensis* Boiss.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro,M	600-2200	Dol	34	LC
Thymus granatensis subsp. *micranthus* (Willk.) O. Bolòs & Vigo	FI	.	2	.	.	.	.	.	.	1	.	.	Ch	Ro,M	900-1900	Dol	23	LC
Thymus herba-barona subsp. *bivalens* Mayol & al.	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	Sc,M	950-1150	.	1	CR
Thymus hyemalis subsp. *hyemalis* Lange	FI	.	1	.	.	.	.	.	.	2	.	.	Ch	M	0-500	.	68	LC
Thymus hyemalis subsp. *millefloris* (D. Rivera & al.) R. Morales	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	M	300-300	.	1	CR-
Thymus lacaitae Pau	FI	.	.	.	.	1	.	.	.	+	.	.	Ch	St,M	400-900	Ca,Gyp	63	LC
Thymus leptophyllus Lange	FI	.	.	.	+	3	.	.	.	+	.	.	Ch	M	700-2000	Ca	104	LC
Thymus leptophyllus subsp. *izcoi* (Rivas Mart. & al.) R. Morales	FI	.	.	.	.	3	.	.	.	.	.	.	Ch	Sc,G	900-1900	Ca	41	LC
Thymus leptophyllus subsp. *leptophyllus* Lange	FI	.	.	.	.	3	.	.	.	.	.	.	Ch	Sc	700-1200	Ca	28	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Thymus leptophyllus subsp. *paui* R. Morales	FI	.	.	.	+	2	.	.	.	+	.	.	Ch	M	1150-2000	Ca	45	LC
Thymus longiflorus Boiss.	FI	.	2	.	.	.	.	.	.	2	.	.	Ch	Ro,M	250-1500	Ca,Dol	63	LC
Thymus loscosii Willk.	FI	.	.	+	2	2	.	.	+	.	.	.	Ch	St,M	130-1010	.	67	LC
Thymus lotocephalus G. López & R. Morales	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	C,Sc	50-450	.	15	NT+
Thymus mastichina (L.) L.	FI	.	2	2	+	2	+	2	+	+	1	2	Ch	M	10-1800	Si	1059	LC
Thymus mastichina subsp. *donyanae* R. Morales	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C,M	10-80	Si	12	LC+
Thymus mastichina subsp. *mastichina* (L.) L.	FI	.	2	1	+	1	+	2	+	+	1	2	Ch	M	10-1800	Si	1049	LC
Thymus mastigophorus Lacaita	FI	.	.	3	.	1	.	.	.	.	.	.	Ch	M	500-1300	Ca	136	LC
Thymus membranaceus Boiss.	FI	.	2	.	.	.	.	.	.	2	.	.	Ch	St,M	10-2180	Ca	66	LC
Thymus moroderi Pau ex Mart. Mart.	FI	.	.	.	.	.	.	.	.	3	.	.	Ch	St,M	10-400	Ca	59	NT
Thymus orospedanus Villar	FI	.	3	.	.	.	.	.	.	+	.	.	Ch	M	600-2000	Ca	83	LC
Thymus piperella L.	FI	.	.	.	.	.	.	.	.	3	.	.	Ch	M	10-1210	Ca	81	LC
Thymus richardii subsp. *ebusitanus* (Font Quer) Jalas	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	Ro	10-250	Ca	4	VU
Thymus richardii subsp. *vigoi* Riera & al.	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	M	130-600	Ca	1	VU*+
Thymus serpylloides Bory	FI	.	3	.	.	.	.	.	.	1	.	.	Ch	Ro,M	1600-3400	.	44	LC
Thymus serpylloides subsp. *gadorensis* (Pau) Jalas	FI	.	3	.	.	.	.	.	.	1	.	.	Ch	M	1240-2200	.	38	LC
Thymus serpylloides subsp. *serpylloides* Bory	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	2000-3400	Si	9	LC+
Thymus villosus L.	FI	.	.	.	.	.	.	.	.	.	3	1	Ch	Sc,G	160-1120	Si	69	LC
Thymus villosus subsp. *lusitanicus* (Boiss.) Cout.	FI	.	.	.	.	.	.	.	.	.	2	1	Ch	Ro	230-800	Si	28	LC
Thymus villosus subsp. *velascoi* R. Morales & G. López	FI	.	.	.	.	.	.	.	.	.	.	1	Ch	M	880-1120	Si	3	DD*
Thymus villosus subsp. *villosus* L.	FI	.	.	.	.	.	.	.	.	.	3	.	Ch	Sc,M	160-440	Si	35	LC
Thymus vulgaris subsp. *aestivus* (Reut. ex Willk.) A. Bolòs & O. Bolòs	FI	1	.	.	1	.	.	.	.	3	.	.	Ch	M	0-900	.	108	LC
Thymus willkommii Ronniger	FI	.	.	.	2	.	.	.	.	.	.	.	Ch	Ro,M	800-1450	Ca	15	NT+
Thymus zygis subsp. *sylvestris* (Hoffmanns. & Link) Cout.	FI	.	+	.	.	1	.	1	.	+	1	2	Ch	M	60-1050	Ca,Gyp	221	LC
Thymus zygis subsp. *zygis* Loefl. ex L.	FI	.	.	1	1	2	+	2	.	.	.	.	Ch	Sc,M	280-1600	.	302	LC
Ziziphora aragonensis Pau	FI	.	.	.	1	1	.	.	.	+	.	+	Th	Sc,M	120-1000	Si	20	LC
LENTIBULARIACEAE																		
Pinguicula dertosensis (Cañig.) Mateo & M.B. Crespo	FI	.	1	.	1	+	.	.	.	.	.	.	He	W,Ro	600-1700	Ca	11	VU+
Pinguicula longifolia subsp. *longifolia* Ramond ex DC.	FI	.	.	.	.	.	.	.	2	.	.	.	He	W,Ro	900-2000	Ca	14	LC+
Pinguicula mundi Blanca & al.	FI	.	1	.	.	1	.	.	.	.	.	.	He	W,Ro	900-1600	Ca	14	VU+
Pinguicula nevadensis (H. Lindb.) Casper	FI	.	2	.	.	.	.	.	.	.	.	.	He	W,A	2000-3100	Si	4	EN+
Pinguicula saetabensis M.B.Crespo & al.	OP	.	.	.	.	.	.	.	.	1	.	.	He	W,Ro	400-600	Ca	3	EN*+
Pinguicula vallisneriifolia Webb	FI	.	2	.	.	.	.	.	.	.	.	.	He	W,Ro	600-1700	Ca	11	VU+
LILIACEAE																		
Fritillaria caballeroi F.M. Vázquez	FI	.	.	.	.	.	.	1	.	.	.	.	Ge	H,G	1500-2300	Si	6	VU+
Fritillaria legionensis Llamas & J. Andrés	FI	.	.	2	.	.	.	+	.	.	.	.	Ge	G	1200-2000	Si	11	VU+
Fritillaria stenophylla Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	3	.	Ge	C,M	0-200	.	34	LC
LINACEAE																		
Linum salsoloides Lam.	AA	.	.	.	.	2	.	.	.	.	.	.	Ch	M	600-1300	.	30	LC
LYTHRACEAE																		
Lythrum flexuosum Lag.	FI	.	.	.	.	1	.	.	.	1	.	+	Th	St	500-1000	Hal	56	LC
MALVACEAE																		
Lavatera oblongifolia Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ph	M	680-1120	Ca	12	VU+
Malva trifida Cav.	FI	.	.	.	2	1	.	.	.	+	.	.	Th	Ru,G	100-1200	.	67	LC
MARSILEACEAE																		
Marsilea batardae Launert	FI	.	.	.	.	.	.	.	.	.	1	3	Hy	W	200-400	.	58	NT*
ORCHIDACEAE																		
Epipactis cardina Benito & C.E. Hermos.	FI	.	1	.	+	1	.	.	.	1	.	.	Ge	Sc	1200-1800	Ca	36	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Ophrys bertolonii subsp. *balearica* (P. Delforge) L. Sáez & Rosselló	FI	3	.	.	.	.	.	.	.	.	.	.	Ge	Sc	0-1200	.	5	LC
Ophrys speculum subsp. *lusitanica* O. Danesch & E. Danesch	FI	.	+	.	.	.	.	+	.	.	2	.	Ge	Sc	0-500	.	20	LC
Orchis cazorlensis Lacaita	FI	1	2	+	+	2	.	.	+	.	.	.	Ge	M,G	900-1850	.	56	LC
Serapias perez-chiscanoi Acedo	FI	.	.	.	.	.	.	+	.	.	1	2	Ge	G	100-400	Si	43	NT
OROBANCHACEAE																		
Nothobartsia spicata (Ramond) Bolliger & Molau	FI	.	.	1	.	.	.	.	+	.	.	.	He	H,G	5-400	Ca	35	LC*
Odontitella virgata (Link) Rothm.	FI	.	+	1	+	2	+	1	.	.	1	+	Th	H,G	0-1200	Si	127	LC
Odontites kaliformis (Pourr. ex Willd.) Pau	FI	.	.	.	+	.	.	.	.	2	.	.	Th	M	0-550	Ca	9	EN+
Odontites pyrenaeus (Bubani) Rothm.	FI	.	.	.	+	.	.	.	3	.	.	.	Th	Ro	600-1600	Ca	28	LC
Odontites pyrenaeus subsp. *abilianus* P. Monts.	FI	.	.	.	.	.	.	.	2	.	.	.	Th	Sc,M	700-1000	.	9	NT+
Odontites pyrenaeus subsp. *pyrenaeus* (Bubani) Rothm.	FI	.	.	.	+	.	.	.	3	.	.	.	Th	Sc,M	850-1600	.	20	LC
Odontites recordonii Burnat & Barbey	FI	.	+	1	2	1	.	.	+	1	.	.	Th	M,G	0-1100	Ca	54	LC
Odontites viscosus subsp. *asturicus* M. Laínz	FI	.	.	2	.	.	.	+	.	.	.	.	Th	G	1600-1950	Ca	15	EN+
Odontites viscosus subsp. *granatensis* (Boiss.) Bolliger	FI	.	1	.	.	.	.	.	.	.	.	.	Th	M	2000-2250	Ca	1	CR+
Orobanche almeriensis A. Pujadas	OP	.	2	.	.	.	.	.	.	+	.	.	Ge	R	200-1500	Ca	10	VU-
Orobanche austrohispanica M.J.Y. Foley	FI	.	2	.	.	.	.	.	.	+	.	.	Ge	M	0-1700	Ca	24	LC
Orobanche ballotae A. Pujadas	FI	.	2	.	.	.	.	.	.	2	.	+	Ge	St	20-1500	.	34	LC
Orobanche clausonis subsp. *hesperina* (J.A. Guim.) M.J.Y. Foley	FI	.	1	.	.	.	.	.	.	+	1	.	Ge	Sc,G	0-300	.	8	DD*
Orobanche lycoctoni Rhiner	OP	.	.	1	.	.	.	.	.	.	.	.	Ge	G	400-1500	.	4	VU+
Orobanche montserratii A. Pujadas & D. Gómez	OP	.	.	.	.	.	.	.	1	.	.	.	Ge	W,F	900-1450	.	4	EN+
Orobanche portoilicitana Pujadas & Crespo	OP	.	.	.	1	1	.	.	.	2	.	.	Ge	C	0-900	.	30	LC
Pedicularis mixta Gren.	FI	.	.	2	.	.	.	+	1	.	.	.	He	W,G	1150-2400	Si	75	LC
Pedicularis pyrenaica J. Gay	FI	.	.	1	.	.	.	.	3	.	.	.	He	W,G	1300-2300	Si	105	LC
Pedicularis pyrenaica subsp. *praetermissa* I. Soriano & al.	FI	.	.	.	.	.	.	.	1	.	.	.	He	A,M	1950-2400	Si	10	DD*
Pedicularis pyrenaica subsp. *pyrenaica* J. Gay	FI	.	.	2	.	.	.	.	1	.	.	.	He	G	1300-2300	Si	100	LC
Pedicularis schizocalyx (Lange) Steininger	FI	.	.	3	.	1	.	1	+	.	.	.	He	G	600-1800	Si	88	LC
Pedicularis verticillata subsp. *caespitosa* (Webb) I. Soriano	FI	.	1	.	.	.	.	.	.	.	.	.	He	A	2500-3200	Si	2	VU*+
PAEONIACEAE																		
Paeonia broteri Boiss. & Reut.	FI	.	2	.	.	+	.	2	.	.	1	2	Ge	Sc	100-1850	.	298	LC
Paeonia cambessedesii (Willk.) Willk.	FI	3	.	.	.	.	.	.	.	.	.	.	Ge	Ro	30-1400	Ca	21	LC
PAPAVERACEAE																		
Papaver lapeyrousianum Gutermann	FI	.	1	.	.	.	.	.	2	.	.	.	He	A	2000-3400	.	19	LC+
Platycapnos tenuiloba subsp. *parallela* Lidén	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	500-1000	Dol	6	VU+
Sarcocapnos baetica (Boiss. & Reut.) Nyman	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	900-2000	Ca	54	NT
Sarcocapnos baetica subsp. *baetica* (Boiss. & Reut.) Nyman	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	900-2000	Ca	40	LC
Sarcocapnos baetica subsp. *integrifolia* (Boiss.) Nyman	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1000-1500	Ca	12	VU+
Sarcocapnos crassifolia subsp. *speciosa* (Boiss.) Rouy	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	800-2500	Ca	41	LC
PHYLLANTHACEAE																		
Flueggea tinctoria (L.) G.L. Webster	FI	.	.	.	.	+	.	+	.	.	+	3	Ph	W	20-800	Si	203	LC
PINACEAE																		
Abies pinsapo Boiss.	_	.	1	.	.	.	.	.	.	.	.	.	Ph	F		.	17	VU
PLANTAGINACEAE																		
Anarrhinum duriminium (Brot.) Pers.	FI	.	.	.	.	.	2	2	.	.	.	.	He	Ro	0-700	Si	98	LC
Anarrhinum longipedicellatum R. Fern.	FI	.	.	.	.	.	1	1	.	.	.	.	He	Ro	50-1000	Si	18	LC+
Antirrhinum braun-blanquetii Rothm.	FI	.	.	3	.	+	.	+	.	.	.	.	He	Ro	0-1300	Ca	67	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Antirrhinum charidemi Lange	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	Ro	70-440	Si	3	CR+
Antirrhinum controversum Pau	FI	.	1	.	.	.	.	.	.	2	.	.	He	Ro	20-1600	.	40	LC
Antirrhinum graniticum Rothm.	FI	.	2	.	.	1	.	2	.	.	+	+	He	Ro	300-1300	.	138	LC
Antirrhinum grosii Font Quer	FI	.	.	.	.	.	.	1	.	.	.	.	He	Ro,A	1800-2200	Si	12	LC+
Antirrhinum linkianum Boiss. & Reut.	FI	.	.	.	.	.	+	+	.	.	2	.	He	Ro	0-1000	.	47	LC*
Antirrhinum litigiosum Pau	FI	.	1	.	2	2	.	.	.	2	.	.	He	Ro	0-1500	Ca	120	LC
Antirrhinum lopesianum Rothm.	FI	.	.	.	.	.	.	2	.	.	.	.	Ch	Ro	350-550	.	6	VU*+
Antirrhinum meonanthum Hoffmanns. & Link	FI	.	.	2	.	1	1	1	.	.	.	.	He	Ro	0-1600	.	70	LC
Antirrhinum microphyllum Rothm.	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	Ro	600-1000	Ca	2	VU+
Antirrhinum molle L.	FI	.	.	.	1	.	.	.	3	.	.	.	Ch	Ro	300-1800	Ca	64	LC
Antirrhinum mollissimum (Pau) Rothm.	FI	.	1	.	.	.	.	.	.	+	.	.	Ch	Ro	50-1900	.	9	LC+
Antirrhinum onubense (Fern. Casas) Fern. Casas	FI	.	.	.	.	.	.	.	.	.	1	2	Ch	Ro	400-700	.	32	LC
Antirrhinum pertegasii Pau ex Rothm.	FI	.	.	.	1	.	.	.	.	.	.	.	Ch	Ro	500-1100	Ca	7	EN+
Antirrhinum pulverulentum Lázaro Ibiza	FI	.	.	.	.	2	.	.	.	.	.	.	Ch	Ro	700-2000	Ca	23	LC
Antirrhinum subbaeticum Güemes & al.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	750-1300	Ca	4	EN+
Antirrhinum valentinum Font Quer	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	Ro	100-600	Ca	6	VU+
Chaenorhinum crassifolium subsp. *crassifolium* (Cav.) Kostel.	FI	+	1	.	.	1	.	.	.	2	.	.	He	Ro	0-2000	Ca	180	LC
Chaenorhinum formenterae Gand.	FI	3	.	.	.	.	.	.	.	.	.	.	Th	C	0-460	.	12	NT
Chaenorhinum gamezii Güemes & al.	OP	.	.	.	.	.	.	.	.	.	.	1	Th	St	640-890	Gyp	2	EN+
Chaenorhinum glareosum (Boiss.) Willk.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	A	1800-3400	Si	4	LC-
Chaenorhinum grandiflorum (Coss.) Willk.	FI	.	2	.	.	.	.	.	.	2	.	.	Th	St	150-1550	Ca	35	LC
Chaenorhinum grandiflorum subsp. *carthaginense* (Pau) Benedí	FI	.	1	.	.	.	.	.	.	2	.	.	Th	R	500-1550	Ca	25	NT
Chaenorhinum grandiflorum subsp. *grandiflorum* (Coss.) Willk.	FI	.	.	.	.	.	.	.	.	2	.	.	Th	St	150-600	Ca,Gyp	10	NT+
Chaenorhinum macropodum (Boiss. & Reut.) Lange	FI	.	3	.	.	+	.	.	.	+	.	.	He	Ro	600-2000	Ca	64	LC
Chaenorhinum macropodum subsp. *degenii* (Hervier) R. Fern.	FI	.	3	.	.	+	.	.	.	+	.	.	He	Ro	400-1900	Ca	43	LC
Chaenorhinum macropodum subsp. *macropodum* (Boiss. & Reut.) Lange	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	600-2000	Ca	12	LC+
Chaenorhinum origanifolium subsp. *cotiellae* P. Monts. & G. Monts.	FI	.	.	.	.	.	.	.	1	.	.	.	He	Ro	1950-2300	Ca	1	DD*
Chaenorhinum origanifolium subsp. *rodriguezii* (Porta) Güemes	FI	2	.	.	.	.	.	.	.	.	.	.	He	Ro	900-1400	Ca	2	EN+
Chaenorhinum raveyi (Boiss.) Pau	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	600-1200	Ca,Dol	11	LC-
Chaenorhinum reyesii (C. Vicioso & Pau) Benedí	FI	.	+	.	1	1	.	.	.	1	.	.	Th	St	250-700	Gyp	40	LC
Chaenorhinum robustum Loscos	FI	.	+	.	.	2	.	.	.	2	.	.	Th	Ro	400-1500	Ca	39	LC
Chaenorhinum segoviense (Reut. ex Rouy) Rouy	FI	.	.	.	.	2	.	+	.	.	.	.	He	Ro	800-1800	Ca	27	LC
Chaenorhinum segoviense subsp. *segoviense* (Reut. ex Rouy) Rouy	FI	.	.	.	.	1	.	+	.	.	.	.	He	Ro	800-1200	Ca	10	DD*
Chaenorhinum segoviense subsp. *semiglabrum* Loidi & A. Galán	FI	.	.	.	.	2	.	.	.	.	.	.	He	Ro	800-1800	Ca	5	DD*
Chaenorhinum serpyllifolium (Lange) Lange	FI	.	.	1	.	2	.	.	.	+	+	.	Th	M,G	0-1600	Ca	55	LC
Chaenorhinum serpyllifolium subsp. *lusitanicum* R. Fern.	FI	.	.	.	.	.	.	.	.	.	1	.	Th	C	0-10	Ca	2	EN+
Chaenorhinum serpyllifolium subsp. *serpyllifolium* (Lange) Lange	FI	.	.	1	.	1	.	.	.	1	.	.	Th	M,G	400-1600	Ca	29	LC
Chaenorhinum tenellum (Cav.) Lange	FI	.	.	.	.	.	.	.	.	2	.	.	He	Ro	350-1100	Ca	13	NT+
Cymbalaria fragilis (J.J. Rodr.) A. Chev.	FI	2	.	.	.	.	.	.	.	.	.	.	He	Ro	100-150	Ca	4	CR
Digitalis mariana Boiss.	FI	.	.	.	.	.	.	.	.	.	.	3	He	Ro	200-1300	Si	62	LC
Digitalis mariana subsp. *heywoodii* (P. Silva & M. Silva) Hinz	FI	.	.	.	.	.	.	.	.	.	.	2	He	Ro	150-400	Si	27	LC
Digitalis mariana subsp. *mariana* Boiss.	FI	.	.	.	.	.	.	.	.	.	.	2	He	Ro	500-1000	Si	32	LC
Digitalis minor L.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	0-1400	Ca	24	LC
Digitalis obscura subsp. *obscura* L.	FI	.	2	.	1	2	.	.	.	2	.	.	Ch	Sc	500-1500	Ca	285	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Digitalis parviflora Jacq.	FI	.	.	3	.	1	.	+	.	.	.	.	He	H,G	500-2000	Ca	144	LC
Digitalis purpurea subsp. *amandiana* (Samp.) Hinz	FI	.	.	.	.	.	1	1	.	.	.	.	He	Sc,Ro	150-500	Si	11	LC+
Digitalis purpurea subsp. *toletana* (Font Quer) Hinz	FI	.	.	.	.	.	.	.	.	.	.	2	He	Ro	500-1300	Si	11	LC+
Digitalis thapsi L.	FI	.	.	.	.	1	.	3	.	.	+	1	He	Ro,G	500-1500	Si	246	LC
Gadoria falukei Güemes & Mota	OP	.	1	.	.	.	.	.	.	.	.	.	He	Ro	540-580	Ca	1	CR*+
Globularia fuxeensis Giraudias	FI	.	.	2	.	.	.	.	2	.	.	.	He	G	1100-2100	Ca	76	LC
Globularia majoricensis Gand.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	200-900	Ca	8	LC
Globularia spinosa L.	FI	.	3	.	.	.	.	.	.	+	.	.	He	Sc,Ro	700-2250	Ca	57	LC
Gratiola linifolia Vahl	FI	.	.	.	.	.	.	2	.	.	1	1	He	W	0-900	Si	41	LC
Lafuentea rotundifolia Lag.	FI	.	2	.	.	.	.	.	.	2	.	.	Ch	Ro	0-600	Ca	29	LC
Linaria accitensis L. Sáez & al.	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	810-950	.	1	CR*+
Linaria aeruginea (Gouan) Cav.	FI	+	2	.	1	2	.	1	+	+	.	+	He	Ro,M	150-3300	Ca	249	LC
Linaria aeruginea subsp. *aeruginea* (Gouan) Cav.	FI	.	2	.	.	2	.	1	.	+	.	+	He	Ro	800-2200	Ca	150	LC
Linaria aeruginea subsp. *cardonica* (Font Quer) L. Sáez & M. Sainz	FI	.	.	.	2	.	.	.	.	.	.	.	He	Ro,M	150-1400	Ca	34	LC
Linaria aeruginea subsp. *nevadensis* (Boiss.) D.A. Sutton	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	2300-3300	Si	6	DD*
Linaria aeruginea subsp. *pruinosa* (Sennen & Pau) Chater & Valdés	FI	2	.	.	.	.	.	.	.	.	.	.	He	Ro,M	800-1430	Ca	3	NT
Linaria algarviana Chav.	FI	.	.	.	.	.	.	.	.	.	1	.	Th	C	0-150	.	17	NT-
Linaria alpina subsp. *filicaulis* (Boiss. ex Leresche & Levier) M. Laínz	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro	250-2500	.	23	LC
Linaria amethystea subsp. *amethystea* (Vent.) Hoffmanns. & Link	FI	.	1	+	.	1	.	1	.	.	1	1	Th	C,M	0-2500	.	142	LC
Linaria amethystea subsp. *ignescens* (Kunze) D.A. Sutton	FI	.	.	.	.	.	.	.	.	.	1	.	Th	M	0-1000	Ca	3	DD*
Linaria amethystea subsp. *multipunctata* (Brot.) Chater & D.A. Webb	FI	.	.	.	.	.	.	.	.	.	2	.	Th	M	0-300	.	4	DD
Linaria amoi Campo ex Amo	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	600-1900	Ca,Dol	10	VU+
Linaria argillicola Juan & al.	OP	.	1	.	.	.	.	.	.	.	.	.	He	St	600-800	Gyp	2	CR*+
Linaria badalii Loscos	FI	.	.	3	.	2	.	.	1	.	.	.	Th	Ro,M	450-2200	.	111	LC
Linaria bipunctata (L.) Chaz.	FI	.	.	.	.	1	.	+	.	.	1	+	Th	C,M	0-1050	.	45	LC
Linaria bipunctata subsp. *bipunctata* (L.) Chaz.	FI	.	.	.	.	1	.	+	.	.	+	+	Th	Ru,M	300-1050	.	32	LC
Linaria bipunctata subsp. *glutinosa* (Hoffmanns. & Link) D.A. Sutton	FI	.	.	.	.	.	.	.	.	.	2	.	Th	C	0-130	.	15	LC+
Linaria bubanii Font Quer	FI	.	.	.	+	.	.	.	2	.	.	.	Th	Ro	300-2200	Ca	22	LC
Linaria caesia (Pers.) F. Dietr.	FI	.	.	.	.	1	.	+	.	.	.	.	He	R	600-1450	.	51	LC
Linaria cavanillesii Chav.	FI	.	+	.	.	.	.	.	.	3	.	.	Ch	Ro	100-1450	Ca	47	LC
Linaria clementei Haens.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro,M	200-1400	Ca,Dol	10	VU-
Linaria depauperata Leresche ex Lange	FI	.	.	.	1	+	.	.	.	3	.	.	Th	C,Ro	0-1810	Ca	97	LC
Linaria depauperata subsp. *depauperata* Leresche ex Lange	FI	.	.	.	.	.	.	.	.	2	.	.	Th	Ro,M	100-1500	Ca	32	LC
Linaria depauperata subsp. *hegelmaieri* (Lange) De la Torre & al.	FI	.	.	.	.	.	.	.	.	3	.	.	Th	C	0-1000	.	24	VU
Linaria depauperata subsp. *ilergabona* (M.B. Crespo & Arán) L. Sáez	FI	.	.	.	1	+	.	.	.	+	.	.	Th	Ro,M	150-1810	Ca	30	LC
Linaria diffusa Hoffmanns. & Link	FI	.	.	.	.	.	.	1	.	.	.	.	Th	R	10-500	.	4	DD*
Linaria elegans Cav.	FI	.	.	2	.	1	1	2	.	.	.	+	Th	H,M	100-1900	Si	171	LC
Linaria glacialis Boiss.	FI	.	1	.	.	.	.	.	.	.	.	.	He	A	2700-3400	.	2	VU+
Linaria glauca (L.) Chaz.	FI	.	.	.	.	2	.	.	.	+	.	.	Th	Ro	600-1210	Ca	35	LC
Linaria glauca subsp. *glauca* (L.) Chaz.	FI	.	.	.	.	1	.	.	.	.	.	.	Th	St	600-1210	Ca	34	LC
Linaria glauca subsp. *olcadium* Valdés & D.A. Webb	FI	.	.	.	.	1	.	.	.	.	.	.	He	St	700-800	Ca	2	DD*
Linaria hirta (Loefl. ex L.) Moench	FI	.	2	.	1	1	.	.	.	2	+	+	Th	R	0-1400	Ca	180	LC
Linaria huteri Lange	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro,M	500-950	Ca,Dol	3	VU+
Linaria intricata Coincy	FI	.	.	.	.	.	.	.	.	.	.	2	Th	Ro,M	500-1000	Si	6	VU+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Linaria nigricans Lange	FI	.	.	.	.	.	.	.	.	2	.	.	Th	St	0-850	.	3	EN+
Linaria nivea Boiss. & Reut.	FI	.	.	.	.	+	.	1	.	.	.	1	He	Ro	600-1800	Si	40	LC
Linaria oblongifolia (Boiss.) Boiss. & Reut.	FI	.	2	.	1	1	.	+	.	2	+	1	Th	Ro,M	0-1200	.	119	LC
Linaria oblongifolia subsp. *aragonensis* (Lange) D.A. Sutton	FI	.	1	.	1	1	.	.	.	2	.	.	Th	M,G	200-1200	Ca	73	LC
Linaria oblongifolia subsp. *benitoi* (Fern. Casas) L. Sáez & al.	FI	.	.	.	.	.	.	.	.	2	.	.	Th	Ro	15-50	Si	3	CR+
Linaria oblongifolia subsp. *haenseleri* (Boiss. & Reut.) Valdés	FI	.	2	.	.	.	.	+	.	+	+	1	Th	C,M	0-1100	.	35	LC
Linaria oblongifolia subsp. *oblongifolia* (Boiss.) Boiss. & Reut.	FI	.	1	.	.	.	.	.	.	.	.	+	Th	Ro,M	250-1220	Ca	5	DD*
Linaria oligantha Lange	FI	.	+	.	.	.	.	.	.	3	.	.	Th	St,M	0-700	Ca	22	LC
Linaria oligantha subsp. *oligantha* Lange	FI	.	.	.	.	.	.	.	.	1	.	.	Th	St,M	40-380	Gyp	15	LC
Linaria oligantha subsp. *valentina* D.A. Sutton	FI	.	.	.	.	.	.	.	.	2	.	.	Th	M	0-700	Ca	9	VU+
Linaria orbensis Carretero & Boira	FI	.	.	.	.	.	.	.	.	1	.	.	Th	R	100-660	.	4	EN+
Linaria platycalyx Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	500-1200	Ca	10	VU+
Linaria polygalifolia Hoffmanns. & Link	FI	.	.	.	.	.	3	.	.	.	2	.	He	C	0-50	.	84	LC
Linaria polygalifolia subsp. *aguillonensis* (García Mart.) Castrov. & Lago	FI	.	.	.	.	.	2	.	.	.	.	.	He	C	10-130	Si	14	EN-
Linaria polygalifolia subsp. *lamarckii* (Rouy) D.A. Sutton	FI	.	.	.	.	.	.	.	.	.	2	.	He	C	0-50	.	19	LC*+
Linaria polygalifolia subsp. *polygalifolia* Hoffmanns. & Link	FI	.	.	.	.	.	3	.	.	.	+	.	He	C	0-50	.	59	LC
Linaria propinqua Boiss. & Reut.	FI	.	.	3	.	+	.	.	+	.	.	.	He	Ro	200-1600	Ca	43	LC
Linaria qartobensis Blanca & al.	OP	.	1	.	.	.	.	.	.	.	.	.	Th	Ru,G	300-400	Ca	1	CR*+
Linaria ricardoi Cout.	FI	.	.	.	.	.	.	.	.	.	1	+	Th	R	250-250	Ca	4	EN+
Linaria salzmannii Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	300-1100	Dol	7	NT-
Linaria saturejoides Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	50-1600	Ca,Dol	27	LC
Linaria saturejoides subsp. *angustealata* (Wilmott) Malag.	FI	.	2	.	.	.	.	.	.	.	.	.	Th	Ro	1000-1600	Ca	4	NT-
Linaria saturejoides subsp. *saturejoides* Boiss.	FI	.	1	.	.	.	.	.	.	.	.	.	Th	Ro	50-1000	Ca	22	LC
Linaria saxatilis (L.) Chaz.	FI	.	.	1	.	1	1	3	.	.	.	+	He	M,G	0-2400	.	296	LC
Linaria triornithophora (L.) Willd.	FI	.	.	1	.	.	2	2	.	.	.	+	He	F,St	0-2000	.	230	LC
Linaria tristis subsp. *tristis* (L.) Mill.	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro,M	50-1400	Ca	1	DD*
Linaria tursica Valdés & Cabezudo	FI	.	.	.	.	.	.	.	.	.	2	.	Th	C	10-60	.	13	VU+
Linaria verticillata Boiss.	FI	.	3	.	.	.	.	.	.	+	.	.	He	Ro,M	260-2500	.	114	LC
Linaria verticillata subsp. *anticaria* (Boiss. & Reut.) L. Sáez & M.B. Crespo	FI	.	3	.	.	.	.	.	.	.	.	.	He	Ro	650-1200	Ca	39	LC
Linaria verticillata subsp. *cuartanensis* (Degen & Hervier) L. Sáez & M.B. Crespo	FI	.	2	.	.	.	.	.	.	+	.	.	He	Ro	700-2250	Ca	32	LC
Linaria verticillata subsp. *lilacina* (Lange) L. Sáez & M.B. Crespo	FI	.	3	.	.	.	.	.	.	.	.	.	He	Ro	600-2100	Ca	29	LC
Linaria verticillata subsp. *verticillata* Boiss.	FI	.	2	.	.	.	.	.	.	+	.	.	He	Ro	260-2500	.	27	LC
Linaria viscosa (L.) Chaz.	FI	.	2	.	.	+	.	+	.	+	2	+	Th	Ru,M	0-2600	Si	92	LC
Linaria viscosa subsp. *spicata* (Kunze) D.A. Sutton	FI	.	2	.	.	.	.	.	.	.	.	.	Th	M	600-2600	.	15	LC+
Linaria viscosa subsp. *viscosa* (L.) Chaz.	FI	.	2	.	.	+	.	+	.	1	2	.	Th	Ru,M	0-1200	.	80	LC
Plantago algarbiensis Samp.	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C	20-100	Hal	5	EN*+
Plantago asperrima Gand. ex Hervier	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1000-2100	Ca	5	DD*
Plantago monosperma Pourr.	FI	.	.	3	.	1	.	.	2	.	.	.	He	G	500-2800	.	138	LC
Plantago monosperma subsp. *discolor* (Gand.) M. Laínz	FI	.	.	3	.	1	.	.	.	.	.	.	He	Ro,G	500-1920	Ca	80	LC
Plantago monosperma subsp. *monosperma* Pourr.	FI	.	.	.	.	.	.	.	2	.	.	.	He	G	2200-2800	.	42	LC
Plantago nivalis Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	He	A	2300-3200	.	4	LC-
Pseudomisopates rivas-martinezii (Sánchez Mata) Güemes	FI	.	.	.	.	.	.	1	.	.	.	.	He	H,G	1500-2100	Si	4	CR+
Sibthorpia africana L.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Ro	0-1400	Ca	19	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Veronica aragonensis Stroh	FI	.	+	.	.	.	.	.	2	.	.	.	Ch	Ro	1400-2500	Ca	20	LC
Veronica chamaepithyoides Lam.	FI	.	.	.	.	1	.	.	.	.	.	.	Th	R	500-1000	Ca	10	CR+
Veronica mampodrensis Losa & P. Monts.	FI	.	.	3	.	.	.	.	.	.	.	.	Ch	Ro	1400-2300	.	25	LC
Veronica micrantha Hoffmanns. & Link	FI	.	.	.	.	.	1	3	.	.	.	.	He	Sc	50-1200	.	52	NT*
Veronica nevadensis (Pau) Pau	FI	.	1	.	.	+	.	2	.	.	.	.	He	W	1300-3100	.	76	LC
Veronica nummularia Gouan	FI	.	.	1	.	.	.	.	3	.	.	.	Ch	Ro,A	1600-3400	Ca	61	LC
Veronica sennenii (Pau) M.M. Mart. Ort. & E. Rico	FI	.	.	3	.	+	.	.	+	.	.	.	Ch	Sc,F	5-1400	.	44	LC
Veronica tenuifolia Asso	FI	.	+	2	2	2	.	+	1	+	.	.	Ch	M,G	200-2100	Ca	190	LC
Veronica tenuifolia subsp. *fontqueri* (Pau) M.M. Mart. Ort. & E. Rico	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	1680-2000	Ca	6	CR+
Veronica tenuifolia subsp. *javalambrensis* (Pau) Molero & J. Pujadas	FI	.	.	2	.	2	.	+	.	.	.	.	Ch	Sc,M	800-2100	Ca	108	LC
Veronica tenuifolia subsp. *tenuifolia* Asso	FI	.	.	.	2	2	.	.	1	.	.	.	Ch	Sc,M	200-900	Ca	76	LC
PLUMBAGINACEAE																		
Armeria alboi (Bernis) Nieto Fel.	FI	.	+	.	.	+	.	.	.	.	.	1	Ch	M	800-1100	Si	7	DD*
Armeria alliacea (Cav.) Hoffmanns. & Link	FI	.	.	.	.	2	.	.	.	2	.	.	He	M,G	300-2000	Ca	85	LC
Armeria alliacea subsp. *alliacea* (Cav.) Hoffmanns. & Link	FI	.	.	.	.	1	.	.	.	2	.	.	He	G	300-1500	Ca	24	LC
Armeria alliacea subsp. *matritensis* (Pau) Borja & al.	FI	.	.	.	.	3	.	.	.	.	.	.	He	Ro	600-2000	Ca	37	LC
Armeria arenaria subsp. *confusa* (Bernis) Nieto Fel.	FI	.	.	.	.	.	.	.	2	.	.	.	He	G	1500-2000	Si	16	LC+
Armeria arenaria subsp. *segoviensis* (Gand. ex Bernis) Nieto Fel.	FI	.	.	.	.	1	.	1	.	.	.	.	He	G	800-1500	Si	31	LC
Armeria arenaria subsp. *vestita* (Willk.) Nieto Fel.	FI	.	.	.	.	.	.	1	.	.	.	1	He	G	800-1200	Si	11	DD
Armeria beirana Franco	FI	.	.	.	.	.	1	2	.	.	+	.	Ch	H,G	50-1700	Si	26	LC
Armeria berlengensis Daveau	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	C	0-40	Si	1	CR+
Armeria bigerrensis (Pau ex C. Vicioso & Beltrán) Rivas Mart.	FI	.	.	.	.	1	.	1	.	.	.	.	He	Ro	1500-2500	Si	18	LC-
Armeria bigerrensis subsp. *bigerrensis* (Pau ex C. Vicioso & Beltrán) Rivas Mart.	FI	.	.	.	.	.	.	1	.	.	.	.	He	Ro,G	2000-2300	Si	10	LC
Armeria bigerrensis subsp. *losae* (Bernis) Rivas Mart. & al.	FI	.	.	.	.	2	.	.	.	.	.	.	He	Ro,G	2000-2300	Si	5	VU+
Armeria bigerrensis subsp. *microcephala* (Willk.) Nieto Fel.	FI	.	.	.	.	1	.	.	.	.	.	.	He	Ro,G	1500-2300	Si	1	VU+
Armeria bourgaei Boiss. ex Merino	FI	.	2	.	.	.	.	.	.	+	.	.	He	Ro,G	1500-2000	Ca	20	LC
Armeria bourgaei subsp. *bourgaei* Boiss. ex Merino	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1500-2000	Ca	7	DD*
Armeria bourgaei subsp. *lanceobracteata* (G.H.M. Lawr.) Nieto Fel.	FI	.	2	.	.	.	.	.	.	.	.	.	He	G	1600-2000	Ca	10	DD*
Armeria bourgaei subsp. *willkommiana* (Bernis) Nieto Fel.	FI	.	1	.	.	.	.	.	.	1	.	.	He	Ro	1500-1700	Ca	7	DD*
Armeria caballeroi (Bernis) Donad.	FI	.	.	1	.	.	.	1	.	.	.	.	He	H	900-1300	.	15	VU+
Armeria caespitosa (Gómez Ortega) Boiss.	FI	.	.	.	.	1	.	1	.	.	.	.	He	Ro	1500-2500	Si	30	LC
Armeria cantabrica Boiss. & Reut. ex Willk.	FI	.	.	3	.	.	.	+	.	.	.	.	He	Ro	1200-2400	Ca	40	LC
Armeria capitella Pau	FI	.	.	.	.	.	.	.	.	.	.	1	Ch	M,G	300-500	Si	4	DD*
Armeria castellana Boiss. & Reut. ex Leresche	FI	.	.	2	.	.	.	1	.	.	.	.	Ch	G	1000-1800	.	30	LC
Armeria castroviejoi Nieto Fel.	FI	.	.	.	.	.	.	2	.	.	.	.	He	Sc	800-1000	Si	10	DD*
Armeria ciliata (Lange) Nieto Fel.	FI	.	.	.	.	.	.	2	.	.	.	.	Ch	Ro,G	400-1500	Si	14	LC+
Armeria colorata Pau	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1100-1400	Ser	6	EN+
Armeria duriaei Boiss.	FI	.	.	2	.	.	+	2	.	.	.	.	He	Ro,G	1700-2150	Si	41	LC
Armeria eriophylla Willk.	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Ro,M	600-900	Ser	6	NT+
Armeria euscadiensis Donad. & Vivant	FI	.	.	1	.	.	.	.	.	.	.	.	He	C,H	0-50	.	6	NT-
Armeria filicaulis subsp. *alfacarensis* Nieto Fel. & al.	OP	.	1	.	.	.	.	.	.	.	.	.	Ch	Sc	1500-1500	Dol	4	VU+
Armeria filicaulis subsp. *nevadensis* Nieto Feliner	OP	.	1	.	.	.	.	.	.	.	.	.	Ch	A	1900-3000	.	4	VU+
Armeria fontqueri Pau	FI	.	.	.	2	.	.	.	.	.	.	.	He	Ro,M	900-1100	Ca	9	VU+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Armeria gaditana Boiss.	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C,G	0-100	.	10	VU+
Armeria genesiana Nieto Fel.	FI	.	.	.	.	.	.	.	.	.	.	2	Ch	Sc	600-1100	Si	20	LC
Armeria genesiana subsp. *belmonteae* (P. Silva) Nieto Fel.	FI	.	.	.	.	.	.	.	.	.	.	1	Ch	Sc	400-500	Si	2	VU+
Armeria genesiana subsp. *genesiana* Nieto Fel.	FI	.	.	.	.	.	.	.	.	.	.	2	Ch	Sc	600-1100	Si	14	VU-
Armeria godayana Font Quer	FI	.	.	.	.	2	.	.	.	.	.	.	He	Ro,G	1800-2000	Si	10	NT-
Armeria hirta Willd.	FI	.	1	.	.	.	.	.	.	.	2	.	Ch	C	0-50	.	28	LC
Armeria hispalensis Pau	FI	.	.	.	.	.	.	.	.	.	1	+	Ch	H	50-200	Si	4	DD*
Armeria humilis (Link) Schult.	FI	.	.	.	.	.	1	1	.	.	.	.	Ch	Ro,H	800-1500	Si	14	LC
Armeria humilis subsp. *humilis* (Link) Schult.	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Ro	1200-1500	Si	5	NT*+
Armeria humilis subsp. *odorata* (Samp.) P. Silva	FI	.	.	.	.	.	1	1	.	.	.	.	Ch	H	800-1500	Si	9	NT*+
Armeria langei Boiss.	FI	.	.	+	.	.	.	2	.	.	.	.	Ch	H,G	400-1200	Si	43	LC
Armeria langei subsp. *daveaui* (Cout.) P. Silva	FI	.	.	3	.	.	.	1	.	.	.	.	Ch	Sc	600-1500	Si	24	DD
Armeria langei subsp. *langei* Boiss.	FI	.	.	1	.	.	.	1	.	.	.	.	Ch	Sc	400-1200	Si	11	LC+
Armeria linkiana Nieto Fel.	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	Sc,G	0-200	Si	8	DD*
Armeria macrophylla Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C,Sc	0-40	.	17	VU+
Armeria malacitana Nieto Fel.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	400-1100	Ca	2	DD*
Armeria merinoi (Bernis) Nieto Fel.	FI	.	.	.	.	.	2	.	.	.	.	.	Ch	W,H	400-500	Ser	3	CR+
Armeria muelleri A. Huet	FI	.	.	.	.	.	.	.	2	.	.	.	He	A	2000-2800	Si	13	LC+
Armeria neglecta Girard	FI	.	.	.	.	.	.	.	.	.	.	1	Ch	H	200-300	Si	1	EX
Armeria pauana (Bernis) Nieto Fel.	FI	.	.	.	.	.	.	.	.	.	.	2	Ch	Sc	500-900	Si	15	LC+
Armeria pinifolia (Brot.) Hoffmanns. & Link	FI	.	.	.	.	.	.	.	.	.	3	.	Ch	C,Sc	0-100	.	12	VU+
Armeria pseudoarmeria (Murray) Mansf.	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	Ro,G	0-350	Si	6	VU+
Armeria pubigera (Desf.) Boiss.	FI	.	.	.	.	.	3	.	.	.	.	.	Ch	C	0-50	Si	30	LC
Armeria quichiotis (Gonz. Albo) A.W. Hill	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	Ro	800-1000	Ca	4	VU+
Armeria rivasmartinezii Sardinero & Nieto Feliner	OP	.	.	.	.	.	.	1	.	.	.	.	Ch	Ro,H	1600-2400	Si	11	NT-
Armeria rothmaleri Nieto Fel.	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Ro	500-1600	Ca,Dol	3	VU+
Armeria rouyana Daveau	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C,Sc	0-120	.	29	NT
Armeria salmantica (Bernis) Nieto Fel.	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Ro	1200-1700	Si	4	DD*
Armeria sampaioi (Bernis) Nieto Fel.	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Ro,G	1500-1990	Si	1	EN+
Armeria splendens (Lag. & Rodr.) Webb	FI	.	1	.	.	.	.	.	.	.	.	.	He	A	2400-3200	Si	2	VU+
Armeria trachyphylla Lange	FI	.	.	.	.	2	.	.	.	+	.	.	He	M,G	1000-1700	Si	10	LC-
Armeria transmontana (Samp.) G.H.M. Lawr.	FI	.	.	.	.	.	.	3	.	.	.	.	Ch	Ro	350-1200	Si	62	LC
Armeria trianoi Nieto Feliner	OP	.	1	.	.	.	.	.	.	.	.	.	Ch	Ro	1300-1500	Ca	2	DD*
Armeria velutina Welw. ex Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C,Sc	0-90	.	9	NT*+
Armeria villosa Girard	FI	.	3	.	.	+	.	.	.	+	.	+	Ch	Ro,G	700-2000	Ca	88	LC
Armeria villosa subsp. *alcaracensis* Nieto Fel.	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	M	900-1200	Ca	2	DD*
Armeria villosa subsp. *bernisii* Nieto Fel.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	1000-2200	Ca	26	LC
Armeria villosa subsp. *carratracensis* (Bernis) Nieto Fel.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	700-1000	Ser	6	EN+
Armeria villosa subsp. *longiaristata* (Boiss. & Reut.) Nieto Fel.	FI	.	3	.	.	+	.	.	.	.	.	.	Ch	Ro	1000-2000	Ca	50	LC
Armeria villosa subsp. *provillosa* (Bernis) Nieto Fel.	FI	.	1	.	.	+	.	.	.	.	.	.	Ch	Ro	800-1100	Ca	4	DD*
Armeria villosa subsp. *villosa* Girard	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	Ro	1700-1800	Ca	1	VU+
Armeria welwitschii Boiss.	FI	.	.	.	.	.	.	.	.	.	2	.	Ch	C	0-74	.	16	LC+
Limonium album (Coincy) Sennen	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	St	300-500	Hal	3	VU+
Limonium alcudianum Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-20	Hal	1	DD*
Limonium angustebracteatum Erben	FI	.	.	.	+	.	.	.	.	3	.	.	Ch	C	0-50	Hal	39	LC
Limonium antonii-llorensii L. Llorens	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	2	EN
Limonium aragonense (Debeaux) Font Quer	FI	.	.	.	+	2	.	.	.	.	.	.	He	St	650-950	Gyp	6	CR+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Limonium artruchium Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	5-30	Hal	1	DD*
Limonium balearicum (Pignatti) Brullo	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-50	Hal	10	LC
Limonium bianorii (Sennen & Pau) Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	1	DD*
Limonium biflorum (Pignatti) Pignatti	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	16	LC
Limonium boirae L. Llorens & Tébar	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	1	CR
Limonium bonafei Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	5-25	Hal	1	DD*
Limonium caesium (Girard) Kuntze	FI	.	.	.	.	.	.	.	.	3	.	.	He	C,St	10-300	Hal	36	LC
Limonium camposanum Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	2	NT
Limonium caprariense (Font Quer & Marcos) Pignatti	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	5-80	Hal	9	LC
Limonium carpetanicum Erben	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	St	500-700	Hal	4	VU+
Limonium carregadorense Erben	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	5-30	Hal	3	DD*
Limonium carthaginense (Rouy) C.E. Hubb. & Sandwith	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	C	50-200	Hal	3	VU+
Limonium catalaunicum (Willk. & Costa) Pignatti	FI	.	.	.	2	.	.	.	2	.	.	.	Ch	St	200-600	Hal	8	CR+
Limonium cavanillesii Erben	FI	.	.	.	1	.	.	.	.	.	.	.	He	C	0-30	Hal	2	CR+
Limonium cofrentanum Erben	FI	.	.	.	.	+	.	.	.	1	.	.	Ch	St	400-500	Gyp	3	DD
Limonium connivens Erben	FI	2	.	.	.	.	.	.	.	.	.	.	He	C	0-25	Hal	5	DD*
Limonium cossonianum Kuntze	FI	1	+	.	.	.	.	.	.	2	.	.	Ch	C	0-100	Hal	49	LC
Limonium costae (Willk.) Pignatti	FI	.	.	.	1	1	.	.	.	.	.	.	Ch	St	600-900	Hal	20	LC
Limonium daveaui Erben	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	C	0-20	Hal	1	DD*
Limonium dichotomum (Cav.) Kuntze	FI	.	.	.	.	1	.	.	.	.	.	.	He	St	550-750	Hal	17	LC+
Limonium dragonericum Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-50	Hal	1	DD*
Limonium dufourii (Girard) Kuntze	FI	.	.	.	+	.	.	.	.	2	.	.	Ch	C	0-25	Hal	13	CR+
Limonium ebusitanum (Font Quer) Font Quer	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-50	Hal	8	LC
Limonium erectum Erben	FI	.	.	.	.	1	.	.	.	.	.	.	He	St	600-700	Hal	1	EN+
Limonium estevei Fern. Casas	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	C	0-50	Hal	2	CR+
Limonium fontqueri (Pau) L. Llorens	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	5-20	Hal	3	VU
Limonium furfuraceum (Lag.) Kuntze	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	C	10-170	Hal	21	LC
Limonium geronense Erben	FI	.	.	.	.	.	.	.	1	.	.	.	Ch	C	0-25	Hal	4	VU+
Limonium gibertii (Sennen) Sennen	FI	3	.	.	1	.	.	.	.	.	.	.	Ch	C	5-50	Hal	16	NT
Limonium grosii L. Llorens	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	4	EN
Limonium gymnesicum Erben	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	5-25	Hal	16	LC
Limonium heterospicatum Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	1	DD*
Limonium hibericum Erben	FI	.	.	.	3	+	.	.	+	.	.	.	He	St	250-900	Hal	108	LC
Limonium insigne (Coss.) Kuntze	FI	.	1	.	.	.	.	.	.	2	.	.	He	C,M	0-400	Hal	25	LC
Limonium latebracteatum Erben	FI	.	+	.	2	+	.	.	.	+	.	.	Ch	St	300-900	Hal	19	LC+
Limonium laxiusculum Franco	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	St	5-30	Hal	3	EN+
Limonium lobetanicum Erben	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	St	400-500	Gyp	5	DD
Limonium longebracteatum Erben	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	St	650-700	Gyp	2	VU+
Limonium magallufianum L. Llorens	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-20	Hal	2	CR
Limonium majoricum Pignatti	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	3	DD*
Limonium majus (Boiss.) Erben	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	St	600-900	Hal	4	EN+
Limonium malacitanum Díez Garretas	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	C	0-50	Hal	5	CR+
Limonium marisolii L. Llorens	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	6	VU
Limonium mateoi Erben & Arán	OP	.	.	.	.	1	.	.	.	.	.	.	He	St	750-780	Hal	4	DD*
Limonium migjornense L. Llorens	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	2	CR
Limonium minoricense Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	5-30	Hal	1	DD*
Limonium minus (Boiss.) Erben	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	St	400-900	Gyp	4	EN+
Limonium minutum (L.) Chaz.	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-50	Hal	11	LC
Limonium multiflorum Erben	FI	.	.	.	.	.	.	.	.	.	2	.	He	C	0-30	Hal	11	VU+
Limonium muradense Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-50	Hal	1	DD*
Limonium nydeggeri Erben	OP	.	.	.	.	.	.	.	.	.	1	.	Ch	C	0-20	Hal	3	VU+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Limonium orellii Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-30	Hal	1	DD*
Limonium parvibracteatum Pignatti	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	C,St	10-250	Gyp	44	LC
Limonium paui Cámara & Sennen	FI	.	.	.	1	+	.	.	.	.	.	.	He	St	300-600	Gyp	5	DD*
Limonium plurisquamatum Erben	FI	.	.	.	.	.	.	.	.	.	1	.	Ch	C	0-40	Hal	5	VU+
Limonium portopetranum Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	5-50	Hal	1	DD*
Limonium pseudarticulatum Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	5-10	Hal	2	DD*
Limonium pseudebusitanum Erben	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	5-50	Ca,Hal	8	LC
Limonium pseudodictyocladum (Pignatti) L. Llorens	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-30	Hal	1	CR
Limonium quesadense Erben	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	St	500-600	Gyp	8	EN+
Limonium retusum L. Llorens	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	5	DD*
Limonium revolutum Erben	FI	.	.	.	.	.	.	.	1	.	.	.	Ch	C	5-50	Ca,Hal	3	VU+
Limonium rigualii M.B. Crespo & Erben	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	C	0-50	Hal	5	VU+
Limonium ruizii (Font Quer) Fern. Casas	FI	.	.	.	1	.	.	.	.	.	.	.	He	St	400-600	Gyp	9	VU+
Limonium santapolense Erben	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	C	0-10	Hal	11	VU+
Limonium saxicola Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	5-25	Hal	1	DD*
Limonium scorpioides Erben	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	6	LC
Limonium soboliferum Erben	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	St	700-750	Hal	1	CR+
Limonium squarrosum Erben	FI	.	.	.	.	1	.	.	.	.	.	.	He	St	500-600	Hal	1	CR+
Limonium stenophyllum Erben	FI	.	.	.	1	.	.	.	.	.	.	.	He	St	300-380	Hal	1	VU+
Limonium subglabrum Erben	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	St	700-800	Gyp	1	EN+
Limonium sucronicum Erben	FI	.	.	.	.	+	.	.	.	2	.	.	Ch	St	400-500	Gyp	8	VU+
Limonium supinum (Girard) Pignatti	FI	.	1	.	.	+	.	.	.	2	.	.	Ch	St	100-950	Gyp	37	LC
Limonium tabernense Erben	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	St	50-200	Hal	1	VU+
Limonium tamarindanum Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	5-20	Hal	1	DD*
Limonium tenuicaule Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	5-100	Hal	3	DD*
Limonium thiniense Erben	FI	.	.	.	.	+	.	.	.	3	.	.	He	C,St	10-600	Hal	23	VU
Limonium toletanum Erben	FI	.	.	.	.	1	.	.	.	.	.	.	Ch	St	500-750	Hal	2	DD*
Limonium tournefortii (Boiss.) Erben	FI	.	.	.	2	+	.	.	.	.	.	.	Ch	St	150-500	Hal	22	DD
Limonium tremolsii (Rouy) Erben	FI	.	.	.	.	.	.	.	1	.	.	.	Ch	C	5-50	Si,Hal	9	NT-
Limonium ugijarense Erben	FI	.	1	.	.	.	.	.	.	.	.	.	Ch	St	500-600	Hal	2	EN+
Limonium validum Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-20	Hal	1	DD*
Limonium viciosoi (Pau) Erben	FI	.	.	.	+	1	.	.	.	.	.	.	He	St	500-700	Gyp	9	DD
Limonium wiedmannii Erben	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	C	0-25	Hal	2	VU
POACEAE																		
Agrostis barceloi L. Sáez & Rosselló	OP	2	.	.	.	.	.	.	.	.	.	.	He	Ro	1380-1420	Ca	1	CR
Agrostis canina subsp. *granatensis* Romero García & al.	EM	.	2	.	.	.	.	.	.	.	.	.	He	A	2600-3200	Si	5	VU-
Agrostis hesperica Romero García & al.	EM	.	.	2	.	.	2	1	.	.	.	.	He	H,G	0-2000	.	61	LC
Agrostis tileni Nieto Feliner & Castroviejo	EM	.	.	2	.	.	.	1	.	.	.	.	He	G	1500-2300	.	28	LC
Anthoxanthum amarum Brot.	EM	.	.	.	.	.	3	2	.	+	.	.	He	G	1200-1400	.	99	LC
Antinoria agrostidea subsp. *natans* (Hack.) Rivas Mart.	FI	.	.	1	.	.	.	2	.	.	.	.	Hy	W	1000-2000	.	17	LC+
Brachypodium gaditanum Talavera	EM	.	1	.	.	.	.	.	.	.	1	.	He	Sc	200-800	.	16	LC+
Bromus cabrerensis Acedo & Llamas	EM	.	.	.	.	.	1	+	.	.	.	.	Th	R	300-1000	Si	5	VU+
Bromus nervosus Acedo & Llamas	EM	.	.	.	.	.	.	.	.	.	1	.	Th	Sc	10-220	.	1	DD*
Chaetopogon fasciculatus subsp. *prostratus* (Hack. & Lange) M.Laínz	EM	.	.	.	.	.	2	+	.	.	2	.	Th	W	8-35	.	25	DD*
Ctenopsis delicatula (Lag.) Paunero	EM	.	.	.	.	1	.	2	.	.	.	1	Th	G	600-1400	Si	125	LC
Dactylis glomerata subsp. *ibizensis* Stebbins & Zohary	EM	3	.	.	.	.	.	.	.	.	.	.	He	G	0-50	.	3	LC
Elytrigia curvifolia (Lange) Holub	EM	.	+	.	.	1	.	.	.	+	.	.	He	St	700-1000	Gyp	36	LC
Elytrigia pungens subsp. *fontquerii* (Melderis) Á. Löve	EM	.	.	.	.	.	.	.	.	.	.	.	He	G	400-900	.	.	DD*
Elytrigia pungens subsp. *pungens* (Pers.) Tutin	EM	.	+	+	+	+	2	+	+	.	.	.	He	C,G	10-900	.	48	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Festuca altopyrenaica Fuente & Ortúñez	CF	.	.	.	.	.	.	.	2	.	.	.	He	A,G	1800-2400	.	14	DD
Festuca ampla subsp. *simplex* (Pérez Lara) Devesa	CF	.	.	.	.	.	.	.	.	.	1	.	He	C	0-100	.	4	DD*
Festuca ampla subsp. *transtagana* (Hack.) Franco & Rocha Afonso	CF	.	1	.	.	.	.	.	.	.	1	.	He	G	200-800	Ca	7	DD*
Festuca aragonensis (Willk.) Fuente & Ortúñez	CF	.	.	.	.	1	.	.	.	.	.	.	He	M,G	1400-2315	Si	3	DD*
Festuca baetica subsp. *moleroi* (Hack.) Markgr.-Dann.	CF	.	3	.	.	.	.	.	.	.	.	.	He	Ro	2000-2300	Si	14	LC+
Festuca borderei (Hack.) K.Richt.	CF	.	.	.	.	.	.	.	3	.	.	.	He	A	2300-2900	Si	39	LC
Festuca brigantina (Markgr. -Dann.) Markgr.-Dann.	CF	.	.	.	.	.	.	1	.	.	.	.	He	M,G	700-1100	Ser	8	VU
Festuca brigantina subsp. *actyophyta* Gutiérrez Villarías	CF	.	.	.	.	.	1	.	.	.	.	.	He	Ro	0-600	Ser	6	VU+
Festuca brigantina subsp. *brigantina* Markgr.-Dann.	CF	.	.	.	.	.	.	1	.	.	.	.	He	G	800-1100	Ser	2	VU+
Festuca burnatii St. -Yves	CF	.	.	3	.	.	.	+	.	.	.	.	He	G	700-2000	Ca	48	LC
Festuca clementei Boiss.	CF	.	1	.	.	.	.	.	.	.	.	.	He	A	2700-3480	Si	9	VU+
Festuca durandoi subsp. *capillifolia* (Pau ex Willk.) Rivas Ponce & al.	CF	.	.	1	+	1	.	1	.	+	.	+	He	G,G	800-2000	Si	61	LC
Festuca duriotagana Franco & Rocha Afonso	CF	.	.	.	.	.	.	1	.	.	+	+	He	Ro	80-700	Si	12	LC-
Festuca eskia Ramond ex DC.	CF	.	.	2	.	.	.	+	3	.	.	.	He	G	1600-2850	Si	147	LC
Festuca frigida (Hack.) K.Richt.	CF	.	2	.	.	.	.	.	.	.	.	.	He	A	2300-3200	Si	4	VU+
Festuca glacialis Bureau & al.	CF	.	.	1	.	.	.	.	3	.	.	.	He	A,G	2000-2850	Ca	71	LC
Festuca gracilior (Hack.) Markgr.-Dann.	CF	.	.	1	1	1	.	.	2	1	.	.	He	M,G	0-1400	Ca	77	LC
Festuca gredensis Fuente & Ortúñez	CF	.	.	.	.	.	.	1	.	.	.	.	He	A,G	1900-2400	.	16	LC+
Festuca henriquesii Hack.	CF	.	.	.	.	.	+	1	.	.	.	.	He	G	800-1900	Si	2	EN+
Festuca heterophylla subsp. *braun-blanquetii* Fuente & al.	CF	.	.	1	.	1	.	.	.	.	.	.	He	H	700-1000	.	10	LC+
Festuca indigesta subsp. *lagascae* Cebolla & Rivas Ponce	CF	.	.	+	.	+	.	1	.	.	.	.	He	G	1800-2430	Si	17	LC+
Festuca liviensis (Verg.) Markgr.-Dann.	CF	.	.	.	.	.	.	.	3	.	.	.	He	G	1200-1600	Si	31	LC
Festuca longiauriculata Fuente & al.	CF	.	2	.	.	.	.	.	.	.	.	.	He	G	1300-2200	Si	5	DD*
Festuca marginata subsp. *andres-molinae* Fuente & Ortúñez	CF	.	.	2	+	1	.	.	+	.	.	.	He	G	400-1700	.	60	LC
Festuca michaelis Cebolla & Rivas Ponce	CF	.	.	.	.	1	.	+	.	.	.	.	He	Sc	800-1100	.	12	LC+
Festuca niphobia (St. -Yves) Kerguélen	CF	.	.	.	.	.	.	.	1	.	.	.	He	A	1800-2700	Si	15	DD*
Festuca paniculata subsp. *fontqueri* (L.) Schinz & Thell.	CF	.	.	2	.	.	.	.	1	.	.	.	He	G	1500-2300	.	32	LC
Festuca paniculata subsp. *macrostachys* Llamas & al.	CF	.	.	2	.	.	.	.	.	.	.	.	He	H	1100-1500	.	10	DD*
Festuca paniculata subsp. *multispiculata* Cebolla & Rivas Ponce	CF	.	.	+	.	.	+	2	.	.	+	1	He	G	700-1300	.	102	LC
Festuca paniculata subsp. *paui* Cebolla & Rivas Ponce	CF	.	.	.	.	2	.	.	.	1	.	.	He	Ro	800-1800	.	24	LC
Festuca paucispicula Fuente & Sánchez Mata	CF	.	.	.	1	.	.	.	.	.	.	.	He	G	800-1400	Ca	2	DD*
Festuca pseudeskia Boiss.	CF	.	2	.	.	.	.	.	.	.	.	.	He	A	2000-3300	Si	7	LC+
Festuca pyrenaica Reut.	CF	.	.	.	.	.	.	.	3	.	.	.	He	A	2000-2700	Ca	38	LC
Festuca querana Litard.	CF	.	.	.	.	.	.	2	.	.	.	.	He	W	800-1170	Si	11	LC+
Festuca reverchonii Hack.	CF	.	2	.	.	.	.	.	.	.	.	.	He	A,G	1880-2200	Ca	15	LC-
Festuca rivas-martinezii Fuente & Ortúñez	CF	.	.	1	.	+	.	2	.	.	.	.	He	G	1000-1720	Si	49	LC
Festuca rivas-martinezii subsp. *rectifolia* Fuente & Ortúñez	CF	.	.	3	.	.	.	.	.	.	.	.	He	G	1100-1200	Ca	14	LC+
Festuca rivas-martinezii subsp. *rivas-martinezii* Fuente & Ortúñez	CF	.	.	1	.	+	.	2	.	.	.	.	He	G	1000-1720	Si	38	LC
Festuca rothmaleri (Litard.) Markgr.-Dann.	CF	.	.	1	.	1	.	2	.	.	.	+	He	W	680-2270	Si	37	LC
Festuca segimonensis Fuente & al.	CF	.	2	.	.	.	.	.	.	.	.	.	He	G	1500-2200	Ca	7	DD*
Festuca summilusitana Franco & Rocha Afonso	CF	.	.	1	.	.	+	3	.	.	.	.	He	H	1200-1800	Si	84	LC
Festuca valentina (St.-Yves) Markgr.-Dann.	CF	.	.	.	1	.	.	.	.	2	.	.	He	G	700-1400	Ca	20	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Festuca vettonica Fuente & al.	CF	.	.	.	.	.	.	1	.	.	.	.	He	G	1900-2000	Si	1	DD*
Gaudinia hispanica Stace & Tutin	EM	.	.	.	.	.	.	.	.	.	2	.	Th	C	0-40	.	8	VU+
Helictochloa cintrana (Röser) Romero Zarco	EM	.	.	.	.	.	.	1	.	.	2	+	He	M	0-100	.	35	LC
Helictochloa crassifolia (Font Quer) Romero Zarco	EM	2	.	.	.	.	.	.	.	.	.	.	He	Ro	0-400	Ca	2	VU
Helictochloa hackelii (Henriq.) Romero Zarco	EM	.	.	.	.	.	.	.	.	.	1	.	He	M,G	0-300	Ca	2	VU-
Helictochloa levis (Hack.) Romero Zarco	EM	.	2	.	.	.	.	.	.	.	.	.	He	A,H	2000-3200	Si	8	CR+
Helictochloa lusitanica (Romero Zarco) Romero Zarco	EM	.	.	.	.	.	.	1	.	.	.	.	He	G	656-4056	.	3	DD
Helictochloa murcica (Holub) Romero Zarco	EM	.	+	.	.	.	.	.	.	3	.	.	He	St	200-1700	.	48	LC
Helictochloa pratensis subsp. *gonzaloi* (Sennen) Romero Zarco	EM	.	.	.	1	1	.	.	1	+	.	.	He	M	500-1500	.	39	LC
Helictochloa pratensis subsp. *iberica* (St.-Yves) Romero Zarco	EM	.	+	2	1	2	.	+	2	1	.	.	He	G	600-1800	.	315	LC
Helictochloa pratensis subsp. *requienii* (Mutel) H. Scholz	EM	.	.	.	.	.	.	.	3	.	.	.	He	G	800-1400	.	18	LC-
Helictotrichon cantabricum (Lag.) Gervais	EM	.	.	3	.	+	.	.	1	.	.	.	He	M,G	50-2200	.	126	LC
Helictotrichon filifolium subsp. *arundanum* Romero Zarco	EM	.	2	.	.	.	.	.	.	.	.	.	He	Sc	900-1800	.	11	VU-
Helictotrichon sarracenorum (Gand.) Holub	EM	.	3	.	.	.	.	.	.	.	.	.	He	G	900-2400	Ca	22	VU
Helictotrichon sedenense subsp. *gervaisii* Romero Zarco	EM	.	.	.	.	.	.	.	3	.	.	.	He	G	900-2000	Ca	15	LC+
Holcus annuus subsp. *duriensis* (P. Silva) Franco	FI	.	.	.	.	.	.	2	.	.	.	.	Th	Sc	100-700	.	13	NT+
Holcus caespitosus Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	He	A	2600-3400	Si	5	NT-
Holcus gayanus Boiss.	FI	.	.	+	.	.	1	2	.	.	.	.	Th	G	300-1550	.	75	LC
Holcus grandiflorus Boiss. & Reut.	FI	.	.	.	.	.	.	.	.	.	1	.	He	Sc	200-500	Si	7	EN+
Holcus reuteri Boiss.	FI	.	.	1	.	.	.	1	.	.	.	.	Ge	G	600-1600	Si	35	LC
Koeleria castellana Boiss. & Reut.	FI	.	.	.	.	1	.	.	.	.	.	.	He	St	400-900	Gyp	61	LC
Koeleria crassipes subsp. *filifolia* (Domin) Quintanar & A. T. Romero García	FI	.	3	.	.	.	.	.	.	.	.	.	He	G	500-2000	.	10	LC+
Koeleria dasyphylla subsp. *nevadensis* (Hack.) Quintanar & A.T. Romero	FI	.	2	.	.	.	.	.	.	.	.	.	He	G	1900-2900	Si	3	EN+
Koeleria rodriguez-graciae Quintanar & Castrov.	FI	.	.	.	.	.	2	+	.	.	.	.	He	G	300-1200	.	8	LC+
Melica bocquetii Talavera	EM	.	3	.	.	.	.	.	.	.	.	.	He	Ro	600-1900	Ca	16	DD*
Micropyrum patens (Brot.) Rothm. ex Pilg.	EM	.	+	.	.	+	+	3	.	.	+	2	Th	G	100-1400	Si	110	LC
Neoschischkinia nebulosa (Boiss. & Reut.) Tzvelev	EM	.	2	1	+	1	.	+	.	+	.	+	Th	G	250-2200	.	139	LC
Neoschischkinia truncatula subsp. *durieui* (Willk.) Valdés & H. Scholz	EM	.	.	2	.	+	2	2	.	.	.	.	He	H,G	200-2300	Si	257	LC
Oreochloa blanka Deyl	EM	.	.	+	.	.	.	.	3	.	.	.	He	A	2200-3010	Si	36	LC
Oreochloa confusa (Coincy) Rouy	EM	.	.	3	.	1	.	.	.	.	.	.	He	Ro	400-2200	.	75	LC
Periballia involucrata (Cav.) Janka	EM	.	.	+	.	2	.	3	.	.	.	1	Th	H	50-1400	Si	232	LC
Phleum brachystachyum subsp. *abbreviatum* (Boiss.) Gamisans & al.	EM	.	1	.	.	.	.	.	.	.	.	.	He	W,A	1800-3100	Si	2	VU+
Pseudarrhenatherum pallens (Link) Holub	EM	.	.	.	.	.	.	.	.	.	2	.	He	Sc	0-400	Ca	6	VU+
Puccinellia caespitosa G. Monts. & J.M. Monts.	EM	.	+	.	.	1	.	.	.	+	.	.	He	St	700-900	Hal	21	LC
Puccinellia fasciculata subsp. *pungens* (Pau) W. E.Hughes	EM	.	.	.	+	2	.	.	.	.	.	.	He	St	900-1300	Hal	12	LC+
Trisetaria dufourei (Boiss.) Paunero	EM	.	.	.	.	.	.	.	.	.	3	+	Th	C	0-50	.	28	LC
Trisetaria ovata (Cav.) Paunero	EM	.	.	2	.	2	.	2	.	.	.	+	Th	Ru,G	700-1600	Si	226	LC
Trisetaria scabriuscula (Lag.) Paunero	EM	.	1	+	.	2	.	+	.	1	+	+	Th	G	250-900	.	98	LC
Trisetum baregense Laffitte & Mi,gev.	EM	.	.	+	.	.	.	.	3	.	.	.	He	A,G	1700-2400	Si	37	LC
Trisetum glaciale Boiss.	EM	.	2	.	.	.	.	.	.	.	.	.	He	A	2600-3470	Si	4	VU+
Trisetum hispidum Lange	EM	.	.	2	.	1	.	1	.	.	.	.	He	G	1750-2300	Si	67	LC
Trisetum velutinum Boiss.	EM	.	2	.	.	.	.	.	.	2	.	.	He	Ro	500-2200	Ca,Dol	23	LC
Vulpia fontquerana Melderis & Stace	EM	.	.	.	.	+	.	.	.	.	2	.	Th	C	0-600	Hal	19	NT

POLYGALACEAE

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Polygala edmundi Chodat	FI	.	.	3	.	.	.	.	.	.	.	.	Ch	G	1550-2200	Ca	22	LC
Polygala microphylla L.	FI	.	+	1	.	.	1	2	.	.	1	1	Ch	H	0-1750	Si	147	LC
Polygala vayredae Costa	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	G	450-1100	Ca	4	VU+
POLYGONACEAE																		
Polygonum romanum subsp. *balearicum* Raffaelli & L. Villar	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	C	0-200	Hal	4	NT
Rumex acetosa subsp. *biformis* (Lange) Castrov. & Valdés Berm.	FI	.	.	.	.	.	3	.	.	.	.	.	He	C	0-100	Si	30	LC
Rumex papillaris Boiss. & Reut.	FI	.	+	1	.	1	.	2	.	.	.	+	He	R	500-1800	.	132	LC
Rumex suffruticosus J. Gay ex Willk.	FI	.	.	2	.	1	.	1	.	.	.	.	Ch	Ro	1400-2400	Si	70	LC
POLYPODIACEAE																		
Dryopteris corleyi Fraser-Jenk.	FI	.	.	2	.	.	.	.	.	.	.	.	He	F,H	50-650	.	6	LC-
Dryopteris pallida subsp. *balearica* (Litard.) Fraser-Jenk.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	100-1400	.	3	LC
PRIMULACEAE																		
Androsace cantabrica (Losa & P. Monts.) Kress	FI	.	.	1	.	.	.	.	.	.	.	.	He	H	1800-2200	Si	9	EN-
Androsace ciliata DC.	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	A	2100-3400	Si	35	LC
Androsace cylindrica DC.	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	Ro,A	1400-2500	Ca	35	LC
Androsace cylindrica subsp. *cylindrica* DC.	FI	.	.	.	.	.	.	.	1	.	.	.	Ch	Ro,A	1700-2400	Ca	13	LC+
Androsace cylindrica subsp. *hirtella* (Dufour) Greuter & Burdet	FI	.	.	.	.	.	.	.	1	.	.	.	Ch	Ro,A	1400-2500	Ca	20	LC
Androsace cylindrica subsp. *willkommii* P. Monts.	FI	.	.	.	.	.	.	.	1	.	.	.	Ch	Ro	1400-1800	Ca	1	VU+
Androsace pyrenaica Lam.	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro,A	1500-3000	Si	22	NT
Androsace rioxana A. Segura	FI	.	.	.	.	1	.	.	.	.	.	.	He	Ro,G	1800-2200	Si	1	EN+
Androsace vitaliana subsp. *assoana* (M. Laínz) Kress	FI	.	1	.	.	1	.	1	.	.	.	.	He	A	2000-3300	.	12	VU-
Androsace vitaliana subsp. *flosjugorum* Kress	FI	.	.	2	.	.	.	+	.	.	.	.	He	A	1900-2400	.	18	LC+
Coris hispanica Lange	FI	.	.	.	.	.	.	.	.	2	.	.	Ch	St	100-400	Gyp	13	VU-
Lysimachia minoricensis J.J. Rodr.	FI	2	.	.	.	.	.	.	.	.	.	.	He	Ro	10-10	Ca	1	EW
Primula acaulis subsp. *balearica* (Willk.) Greuter & Burdet ex Greuter	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	400-1400	Ca	3	NT
Primula elatior subsp. *lofthousei* (Hesl.-Harr.) W.W. Sm. & H.R. Fletcher	FI	.	2	.	.	.	.	.	.	.	.	.	He	W	1500-2400	Si	7	VU+
Primula subpyrenaica Aymerich & al.	OP	.	.	.	.	.	.	.	1	.	.	.	He	Ro	790-1100	Ca	1	VU*+
Soldanella alpina subsp. *cantabrica* Kress	FI	.	.	2	.	.	.	.	.	.	.	.	He	F	1150-1600	.	6	VU+
Soldanella villosa Darracq ex Labarrère	FI	.	.	2	.	.	.	.	1	.	.	.	He	W,H	70-600	.	17	VU+
RANUNCULACEAE																		
Aconitum napellus subsp. *castellanum* Molero & C. Blanché	FI	.	.	.	.	2	.	+	.	.	.	.	He	W	1200-1400	.	9	VU+
Anemone pavoniana Boiss.	FI	.	.	3	.	.	.	.	.	.	.	.	He	Ro	1000-2400	Ca	60	LC
Anemone trifolia subsp. *albida* (Mariz) Ulbr.	FI	.	.	.	.	.	3	1	.	.	.	.	He	G,G	0-1000	Si	49	LC
Aquilegia paui (Font Quer) O. Bolòs & Vigo	FI	.	.	.	1	.	.	.	.	.	.	.	He	Ro	950-1350	Ca	2	CR+
Aquilegia pyrenaica DC.	FI	.	+	2	.	.	.	.	3	.	.	.	He	Ro	1200-2250	Ca	122	LC
Aquilegia pyrenaica subsp. *cazorlensis* (Heywood) Galiano & Rivas Mart.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	1800-2000	Ca	6	EN+
Aquilegia pyrenaica subsp. *discolor* (Levier & Leresche) Pereda & M. Laínz	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro,G	1700-2200	Ca	17	LC+
Aquilegia pyrenaica subsp. *guarensis* (Losa) Rivas Mart.	FI	.	.	.	.	.	.	.	2	.	.	.	He	Ro	1500-2000	Ca	7	VU-
Aquilegia viscosa subsp. *hirsutissima* (Timb.-Lagr.) Breistr.	FI	.	.	.	.	.	.	.	2	.	.	.	He	Ro	1900-2350	Ca	30	LC
Aquilegia vulgaris subsp. *hispanica* (Willk.) Heywood	FI	.	1	1	.	1	.	+	1	.	.	.	He	F	600-2000	.	55	LC
Aquilegia vulgaris subsp. *nevadensis* (Boiss. & Reut.) T.E. Díaz	FI	.	2	.	.	.	.	.	.	.	.	.	He	G,G	1100-2500	.	9	NT+
Clematis campaniflora Brot.	FI	.	.	.	.	.	+	2	.	.	2	2	Ph	W,Sc	500-700	.	130	LC
Delphinium bolosii C. Blanché & Molero	FI	.	.	.	2	.	.	.	.	.	.	.	He	Sc,Ro	500-600	Ca	4	EN+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Delphinium emarginatum subsp. *nevadense* (Kunze) C. Blanché & Molero	FI	.	3	.	.	.	.	.	.	.	.	.	Ge	Sc	1100-1500	.	22	VU
Delphinium fissum subsp. *sordidum* (Cuatrec.) Amich & al.	FI	.	+	.	.	+	.	1	.	.	.	.	Ge	Sc	600-1800	.	8	EN-
Delphinium montanum DC.	FI	.	.	.	.	.	.	.	2	.	.	.	He	W,G	1600-2600	Ca	12	VU-
Delphinium pentagynum subsp. *formenteranum* N. Torres & al.	OP	2	.	.	.	.	.	.	.	.	.	.	He	Sc	45-50	.	1	CR
Helleborus lividus subsp. *lividus* Aiton	FI	3	.	.	.	.	.	.	.	.	.	.	Ge	Sc	200-1400	.	6	NT
Nigella papillosa subsp. *papillosa* G. López	FI	.	1	.	.	.	.	.	.	1	.	+	Th	R	300-800	.	20	LC
Ranunculus abnormis Cutanda & Willk.	FI	.	.	.	.	.	.	2	.	.	.	.	He	G	1500-2300	Si	22	LC
Ranunculus acetosellifolius Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	He	A	2400-3300	.	5	NT+
Ranunculus amplexicaulis L.	FI	.	.	2	.	+	.	+	2	.	.	.	He	H,G	1300-2450	Si	71	LC
Ranunculus angustifolius DC.	FI	.	1	.	.	.	.	.	2	.	.	.	He	W,A	1700-3000	Si	36	LC
Ranunculus barceloi Grau	FI	3	.	.	.	.	.	.	.	.	.	.	He	W	0-500	.	4	VU
Ranunculus bulbosus subsp. *castellanus* (Boiss. & Reut. ex Freyn) P.W. Ball & Heywood	FI	.	.	2	.	+	+	1	.	.	.	.	Ge	G	1400-2000	.	20	LC
Ranunculus bupleuroides Brot.	FI	.	.	.	.	.	2	2	.	.	.	.	He	H,G	20-1140	Si	39	LC*
Ranunculus cherubicus (J.A. Sánchez & al.) Fern. Prieto & al.	OP	.	1	.	.	.	.	1	.	.	.	.	He	A,G	1900-2400	Si	3	NT+
Ranunculus cherubicus subsp. *cherubicus* (J.A. Sánchez & al.) Fern. Prieto & al.	OP	.	.	.	.	.	.	1	.	.	.	.	He	G	1900-2000	Si	2	VU*
Ranunculus cherubicus subsp. *girelai* Fern .Prieto & al.	OP	.	1	.	.	.	.	.	.	.	.	.	He	A,G	2400-2400	Si	2	EN*-
Ranunculus gouanii Willd.	FI	.	.	2	.	+	.	.	3	.	.	.	He	G	1100-2350	.	89	LC
Ranunculus gregarius Brot.	FI	.	.	.	.	.	.	1	.	.	2	2	He	G	0-900	.	38	LC
Ranunculus henriquesii Freyn	FI	.	.	.	.	.	.	1	.	.	.	.	Ge	G	50-600	.	3	DD*
Ranunculus longipes Lange ex Cutanda	FI	.	.	+	.	1	1	2	.	.	.	+	Th	W	600-1000	Si	83	LC
Ranunculus malessanus Degen & Hervier	FI	.	2	.	.	.	.	.	.	.	.	.	Ge	Ro,G	1600-1900	Ca	7	NT+
Ranunculus montserratii Grau	FI	.	.	1	.	.	.	.	.	.	.	.	He	F	1400-1400	.	2	CR+
Ranunculus nigrescens Freyn	FI	.	.	2	.	1	+	2	.	.	.	.	Ge	G	950-2100	Si	117	LC
Ranunculus ollissiponensis Pers.	FI	.	+	2	.	1	+	2	.	.	1	+	Ge	H,G	200-2200	.	201	LC
Ranunculus ollissiponensis subsp. *alpinus* (Boiss. & Reut.) Grau	FI	.	.	1	.	1	.	1	.	.	.	.	Ge	H,G	1100-2200	Si	27	LC
Ranunculus ollissiponensis subsp. *ollissiponensis* Pers.	FI	.	+	1	.	1	+	2	.	.	1	+	Ge	F,H	200-1800	Si	138	LC
Ranunculus parnassiifolius subsp. *cabrerensis* Rothm.	FI	.	.	2	.	.	.	1	.	.	.	.	He	Ro	1500-2000	Si	21	LC
Ranunculus parnassiifolius subsp. *parnassiifolius* L.	FI	.	.	.	.	.	.	.	2	.	.	.	He	Ro,A	1950-2900	Si	18	LC
Ranunculus pseudomillefoliatus Grau	FI	.	1	.	.	.	.	.	.	.	+	1	Ge	W,G	700-1200	.	8	DD*
Ranunculus pyrenaeus L.	FI	.	.	.	.	.	.	.	3	.	.	.	He	W,A	1700-3000	Si	102	LC
Ranunculus ruscinonensis Landolt	FI	.	.	.	.	.	.	.	3	.	.	.	He	G	1300-2300	Si	56	LC
Ranunculus valdesii Grau	FI	.	.	.	.	1	.	+	.	.	.	.	He	Sc,F	530-1900	.	13	DD
Ranunculus weyleri Marès ex Willk.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	350-1420	Ca	3	VU
Thalictrum foetidum subsp. *valentinum* O. Bolòs & Vigo	FI	.	1	.	1	2	.	.	.	+	.	.	He	Ro	1000-2500	Ca	27	LC
Thalictrum maritimum Dufour	FI	.	.	.	1	.	.	.	.	1	.	.	He	W	0-100	.	12	VU-
Thalictrum minus subsp. *matritense* (Pau) P. Monts.	FI	.	.	.	.	1	.	.	.	.	.	+	He	W	600-1200	.	3	DD*
RESEDACEAE																		
Reseda barrelieri Bertol. ex Müll. Arg.	FI	.	2	1	+	2	.	.	+	1	.	.	He	Ro,Ru	500-2000	Ca	105	LC
Reseda complicata Bory	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro,A	2000-3100	Si	7	VU+
Reseda glauca L.	FI	.	.	1	.	.	.	.	3	.	.	.	Ch	Ro	850-2500	Ca	78	LC
Reseda gredensis (Cutanda & Willk.) Müll. Arg.	FI	.	.	.	.	.	.	2	.	.	.	.	He	Ro	1200-2300	Si	20	LC
Reseda lutea subsp. *vivantii* (P. Monts.) Rovira	FI	.	.	.	2	.	.	.	.	.	.	.	He	R	150-300	.	14	LC-
Reseda paui subsp. *almijarensis* Valdés Berm. & Kaercher	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	1000-1500	Ca,Dol	7	NT+

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Reseda paui subsp. *paui* Valdés Berm. & Kaercher	FI	.	2	.	.	.	.	.	.	2	.	.	He	R	500-1700	Ca	21	LC
Reseda paui Valdés Berm. & Kaercher	FI	.	2	.	.	.	.	.	.	2	.	.	He	R	500-1700	Ca	30	LC
Reseda stricta subsp. *funkii* (Willk.) Losa & Rivas Goday	FI	.	1	.	.	.	.	.	.	+	.	.	Th	St	0-200	Gyp	4	DD*
Reseda suffruticosa Loefl. ex Koelp.	FI	.	+	.	.	1	.	.	.	.	.	.	He	Ru,St	500-700	Ca,Gyp	29	LC
Reseda undata L.	FI	.	1	+	1	1	.	.	.	2	.	+	He	R	0-1900	Ca	166	LC
Reseda undata subsp. *gayana* (Boiss.) Valdés Berm.	FI	.	2	.	.	.	.	.	.	.	.	.	He	R	500-1400	.	23	LC
Reseda undata subsp. *leucantha* (Hegelm. ex Lange) Aránega ex Valdés Berm.	FI	.	+	.	.	+	.	.	.	3	.	.	He	Ru,St	0-600	.	41	LC
Reseda undata subsp. *undata* L.	FI	.	+	+	1	1	.	.	.	+	.	+	He	R	400-1900	.	96	LC
Reseda virgata Boiss. & Reut.	FI	.	.	.	.	1	.	2	.	.	.	.	He	R	400-1400	.	64	LC
Sesamoides prostrata (Boiss.) G. López	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro,A	1800-3050	.	6	LC+
RHAMNACEAE																		
Rhamnus ludovici-salvatoris Chodat	AA	3	.	.	.	.	.	.	.	.	.	.	Ph	Sc	0-1000	Ca	9	LC
Rhamnus lycioides subsp. *borgiae* Rivas Mart.	AA	.	.	.	.	.	.	.	.	3	.	.	Ch	Ro	100-1060	Ca	62	LC
ROSACEAE																		
Alchemilla angustata S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	H,G	1300-2350	Ca	14	DD*
Alchemilla angustiserrata S.E. Fröhner	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro,H	850-1650	Si	2	DD
Alchemilla aranica S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	W	1150-1950	.	17	DD
Alchemilla atriuscula S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	Ro	900-900	Ca	1	DD*
Alchemilla atropurpurea S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	W	1200-2200	.	21	DD*
Alchemilla burgensis S.E. Fröhner	FI	.	.	2	.	.	.	.	.	.	.	.	He	G	850-2000	Ca	4	DD*
Alchemilla catalaunica Rothm.	FI	.	.	3	.	+	.	.	3	.	.	.	He	G	650-2900	.	154	LC
Alchemilla crenulata S.E. Fröhner	FI	.	.	.	.	.	.	1	.	.	.	.	He	Ro,G	1700-1900	Si	1	DD
Alchemilla espotensis S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	H,G	1600-1800	.	1	DD*
Alchemilla fageti S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1500-1900	Ca	1	DD
Alchemilla frost-olsenii S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	Ro,G	1500-1900	Si	1	DD*
Alchemilla fulgens Buser	FI	.	.	.	.	.	.	.	2	.	.	.	He	G	950-1800	.	10	LC+
Alchemilla fulgida S.E. Fröhner	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro,G	1100-1800	Ca	6	LC-
Alchemilla hispanica S.E. Fröhner	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro,G	500-1900	.	6	LC-
Alchemilla hoppeaniformis S.E. Fröhner	FI	.	.	2	.	.	.	.	1	.	.	.	He	Ro	800-2150	Ca	9	LC+
Alchemilla hypercycla S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	G	900-900	Ca	1	DD*
Alchemilla ilerdensis S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	W	1800-2100	.	1	DD
Alchemilla impedicellata S.E. Fröhner	FI	.	.	1	.	.	.	.	1	.	.	.	He	W,G	1150-2000	Ca	2	DD*
Alchemilla iratiana S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1300-1400	.	1	DD*
Alchemilla ischnocarpa S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	W	950-1950	.	1	DD
Alchemilla lainzii S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	Ro,G	1800-2200	Si	3	DD
Alchemilla legionensis S.E. Fröhner	FI	.	.	2	.	.	.	.	.	.	.	.	He	H,G	1200-1700	Si	3	DD
Alchemilla macrochira S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	Ro	900-900	Ca	1	DD*
Alchemilla melanoscytos S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	850-1300	Ca	2	DD*
Alchemilla microcephala S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	G	1300-2350	Ca	1	DD*
Alchemilla montserratii S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1400-2200	.	2	DD*
Alchemilla mystrostigma S.E. Fröhner	FI	.	.	.	.	.	.	.	2	.	.	.	He	Ro,G	2150-2150	.	3	DD*
Alchemilla nafarroana S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1200-2650	.	1	DD*
Alchemilla nieto-felineri S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	A	2350-2350	Ca	1	DD
Alchemilla nudans S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1600-1700	.	1	DD
Alchemilla paupercula S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	1150-1650	.	1	DD
Alchemilla perspicua S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	Ro	900-900	Ca	1	DD*
Alchemilla polita S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	G	950-1650	Ca	2	DD*
Alchemilla polychroma S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	Ro,G	1650-1650	.	1	DD*
Alchemilla rugulosa S.E. Fröhner	FI	.	.	2	.	.	.	.	.	.	.	.	He	W	1000-1600	.	3	DD*
Alchemilla santanderiensis S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	Ro,G	600-1400	.	1	DD

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Alchemilla serratisaxatilis S.E. Fröhner	FI	.	.	.	.	.	.	1	.	.	.	.	He	A	1900-2300	Si	2	DD
Alchemilla sierrae Romo	FI	.	.	2	.	.	.	.	.	.	.	.	He	G	1750-2050	Ca	4	DD
Alchemilla spathulata S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	Ro	900-900	Ca	1	DD*
Alchemilla spectabilior S.E. Fröhner	FI	.	.	2	.	.	.	.	+	.	.	.	He	Ro	900-1500	Ca	4	DD*
Alchemilla subalpina S.E. Fröhner	FI	.	.	2	.	.	.	.	.	.	.	.	He	Ro,G	1350-2500	.	8	DD
Alchemilla villarii S.E. Fröhner	FI	.	.	.	.	.	.	.	1	.	.	.	He	Ro,G	1200-2650	.	2	DD*
Alchemilla vizcayensis S.E. Fröhner	FI	.	.	1	.	.	.	.	.	.	.	.	He	G	900-1150	Ca	1	DD*
Aphanes lusitanica Frost-Olsen	FI	.	.	.	.	.	.	.	.	.	1	.	Th	Sc	0-400	.	4	DD*
Cotoneaster granatensis Boiss.	FI	.	3	.	.	.	.	.	.	1	.	.	Ph	F,Ro	1200-2100	Ca	44	LC
Geum pyrenaicum Mill.	FI	.	.	1	.	.	.	.	2	.	.	.	He	G,G	1300-2300	Ca	81	LC
Potentilla alchimilloides Lapeyr.	FI	.	.	2	.	+	.	.	3	.	.	.	He	Ro	1000-2500	Ca	145	LC
Potentilla asturica Rothm.	FI	.	.	2	.	+	.	1	.	.	.	.	He	H,G	650-1900	Si	41	LC
Potentilla nevadensis Boiss.	FI	.	1	.	.	.	.	.	.	.	.	.	He	A,G	2000-3350	Si	4	NT-
Potentilla nivalis subsp. *asturica* (Font Quer & Guinea) M. Laínz	FI	.	.	2	.	.	.	.	.	.	.	.	He	A	1800-2650	Ca	11	LC+
Potentilla pyrenaica Ramond ex DC.	FI	.	.	1	.	1	.	+	2	.	.	.	He	G	1100-2400	Si	96	LC
Potentilla reuteri Boiss.	FI	.	3	.	.	.	.	.	.	.	.	.	He	G	1600-2100	Ca	16	NT+
Prunus ramburii Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ph	Sc,Ro	1200-2300	Si	22	VU
Rubus brigantinus Samp.	FI	.	.	.	.	+	.	1	.	.	.	.	Ph	Ru,Sc	550-1200	Si	10	DD*
Rubus castellarnaui Pau	FI	.	.	+	.	+	.	2	.	.	.	.	Ph	F	400-1800	Si	20	LC
Rubus castroviejoi Monasterio-Huelin	FI	.	.	+	.	.	.	1	+	.	.	.	Ph	F	700-1450	.	10	DD*
Rubus cyclops Monasterio-Huelin	FI	.	.	1	.	.	.	.	.	.	.	.	Ph	F	950-1200	Si	1	DD
Rubus galloecicus Pau	FI	.	.	1	.	.	+	1	.	.	.	.	Ph	F	700-1650	Si	8	DD*
Rubus henriquesii Samp.	FI	.	.	2	.	+	.	1	.	.	.	.	Ph	F	500-1600	Si	31	LC
Rubus lainzii H.E. Weber	FI	.	.	2	.	+	.	2	.	.	.	.	Ph	F	500-1750	.	53	LC
Rubus lucensis H.E. Weber & Monasterio-Huelin	FI	.	.	.	.	.	.	1	.	.	.	.	Ph	F	800-1400	Si	1	DD
Rubus pauanus Monasterio-Huelin	FI	.	.	.	.	+	.	.	1	.	.	.	Ph	Sc,F	1000-1500	.	2	DD
Rubus peratticus Samp.	FI	.	.	.	.	+	.	1	.	.	.	.	Ph	Ru,Sc	700-1200	Si	5	DD
Rubus sampaioanus Sudre ex Samp.	FI	.	.	.	.	.	1	2	.	.	.	.	Ph	Sc	170-1100	Si	10	DD*
Rubus urbionicus Monasterio-Huelin	FI	.	.	.	.	1	.	+	+	.	.	.	Ph	Sc,F	800-1500	Si	7	DD*
Rubus vagabundus Samp.	FI	.	.	.	.	1	.	2	+	.	.	.	Ph	Sc	500-1400	Si	17	LC+
Rubus vigoi R. Roselló & al.	FI	.	.	+	.	1	.	2	.	.	.	+	Ph	F	300-1800	Si	37	LC
Sanguisorba hybrida (L.) Font Quer	FI	.	1	.	.	+	.	1	.	.	1	2	He	Sc,F	300-900	Si	101	LC
Sanguisorba lateriflora (Coss.) A. Braun & C.D. Bouché	FI	.	2	+	.	2	.	+	.	.	.	.	Ch	G	800-2000	Ca	46	LC
Spiraea crenata subsp. *parvifolia* (Pau) Romo	FI	.	.	.	+	.	.	.	2	.	.	.	Ph	Ro	250-1300	Ca	4	EN+
RUBIACEAE																		
Asperula cynanchica subsp. *pyrenaica* (L.) Nyman	FI	.	.	2	.	.	.	.	3	.	.	.	He	Ro	1080-2300	Ca	85	LC
Asperula hirta Ramond	FI	.	.	2	.	.	.	.	2	.	.	.	He	Ro	1150-2600	Ca	74	LC
Asperula paui Font Quer	FI	3	.	.	.	.	.	.	.	1	.	.	He	C,Ro	0-500	Ca	20	LC
Asperula paui subsp. *dianensis* (Font Quer) Romo	FI	.	.	.	.	.	.	.	.	2	.	.	He	Ro	0-750	Ca	11	VU-
Asperula paui subsp. *paui* Font Quer	FI	2	.	.	.	.	.	.	.	.	.	.	He	Ro	0-250	Ca	3	VU
Galium balearicum Briq.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	425-1400	Ca	9	LC
Galium belizianum Ortega Oliv. & al.	FI	.	.	.	.	.	.	1	.	.	.	.	He	H	600-800	Si	7	VU+
Galium boissierianum (Steud.) Ehrend. & Krendl	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	M	300-1450	Ca,Dol	18	VU+
Galium brockmannii Briq.	FI	.	.	.	2	.	.	.	2	.	.	.	Ch	Ro	200-1500	Ca	22	LC
Galium broterianum Boiss. & Reut.	FI	.	.	.	.	+	+	3	.	.	+	1	He	W	10-2000	Si	197	LC
Galium crespianum J.J. Rodr.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	170-1425	Ca	17	LC
Galium erythrorrhizon Boiss. & Reut.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	800-2000	Ca,Dol	23	NT
Galium friedrichii N. Torres & al.	FI	2	.	.	.	.	.	.	.	.	.	.	He	Ro	10-450	Ca	8	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Galium glaucum subsp. *murcicum* (Boiss. & Reut.) O. Bolòs & Vigo	FI	.	1	.	.	.	.	.	.	2	.	.	Ch	Ro,M	50-1900	.	11	NT-
Galium idubedae (Pau ex Debeaux) Pau	FI	.	.	.	.	3	.	+	.	+	.	.	Ch	M	744-2000	Ca	57	LC
Galium lucidum subsp. *fruticescens* (Cav.) O. Bolòs & Vigo	FI	.	+	2	2	1	.	+	1	2	.	.	He	Ro,G	10-2050	Ca	241	LC
Galium moralesianum Ortega Oliv. & Devesa	FI	.	2	.	.	.	.	.	.	1	.	.	Ch	M	475-1300	.	9	LC-
Galium nevadense Boiss. & Reut.	FI	.	3	.	.	.	.	.	.	.	.	.	He	A,G	1750-3000	.	13	LC+
Galium papillosum subsp. *helodes* (Hoffmanns. & Link) Ortega Oliv. & Devesa	FI	.	.	.	.	.	+	2	.	.	.	.	He	F	350-1150	Si	16	LC+
Galium pruinosum Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro,M	150-2100	.	21	LC
Galium pulvinatum Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	750-2000	Ca	3	EN+
Galium rosellum (Boiss.) Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro,A	1800-3180	.	3	VU+
Galium talaveranum Ortega Oliv. & Devesa	FI	.	.	.	.	.	.	+	.	.	+	2	He	W,Sc	0-600	.	13	DD*
Galium valentinum Lange	FI	.	.	.	.	1	.	.	.	3	.	.	He	M	100-1761	Ca	52	LC
Galium viridiflorum Boiss. & Reut.	FI	.	2	.	.	.	.	.	.	.	.	.	He	W	130-1190	Ser	13	VU+
Rubia balearica (Willk.) Porta	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Sc	0-400	Ca	6	LC
Rubia balearica subsp. *balearica* (Willk.) Porta	FI	3	.	.	.	.	.	.	.	.	.	.	Ch	Ro	0-400	Ca	2	LC
Rubia balearica subsp. *caespitosa* (Font Quer & Marcos) Rosselló & al.	FI	2	.	.	.	.	.	.	.	.	.	.	Ch	Ro	0-90	Ca	1	CR
Valantia lainzii Devesa & Ortega Oliv.	FI	.	1	.	.	.	.	.	.	.	.	.	Th	C	0-5	.	1	DD*
RUTACEAE																		
Dictamnus hispanicus Webb ex Willk.	FI	.	1	.	2	1	.	.	.	2	.	.	He	Sc,M	0-1500	Ca	101	LC
Haplophyllum bastetanum F.B. Navarro & al.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	M	700-1100	Ca	2	CR+
Haplophyllum rosmarinifolium (Pers.) G. Don	FI	.	+	.	.	.	.	.	.	3	.	.	Ch	M	0-900	Ca	62	LC
SALICACEAE																		
Salix pyrenaica Gouan	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	Ro,A	1400-2500	Ca	110	LC
Salix salviifolia Brot.	FI	.	.	1	.	1	1	2	.	.	1	1	Ph	W	300-1700	Si	430	LC
Salix tarraconensis Pau	FI	.	.	.	2	.	.	.	.	.	.	.	Ph	Ro	700-1400	Ca	21	VU-
SANTALACEAE																		
Thesium catalaunicum Pedrol & M. Laínz	FI	.	.	.	.	.	.	.	2	.	.	.	He	Sc,F	1000-1500	Ca	17	LC+
SAXIFRAGACEAE																		
Saxifraga aquatica Lapeyr.	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	W,A	1700-2700	Si	53	LC
Saxifraga aretioides Lapeyr.	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro	1500-2000	Ca	41	LC
Saxifraga babiana T.E. Díaz & Fern. Prieto	FI	.	.	2	.	.	.	.	.	.	.	.	Ch	Ro	1000-1300	Ca	17	LC+
Saxifraga biternata Boiss.	FI	.	1	.	.	.	.	.	.	.	.	.	He	Ro	900-1200	Ca	5	EN+
Saxifraga bourgeana Boiss. & Reut.	FI	.	1	.	.	.	.	.	.	.	.	+	He	Ro	900-1500	Ca	7	VU+
Saxifraga camposii Boiss. & Reut.	FI	.	3	.	.	.	.	.	.	+	.	.	Ch	Ro	1100-2000	Ca	57	LC
Saxifraga camposii subsp. *camposii* Boiss. & Reut.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	1200-1900	Ca	14	LC-
Saxifraga camposii subsp. *leptophylla* (Willk.) D.A. Webb	FI	.	3	.	.	.	.	.	.	+	.	.	Ch	Ro	1100-2000	Ca	42	LC
Saxifraga canaliculata Boiss. & Reut. ex Engl.	FI	.	.	3	.	.	.	.	.	.	.	.	Ch	Ro	1000-2000	Ca	75	LC
Saxifraga catalaunica Boiss. & Reut.	FI	.	.	.	2	.	.	.	.	.	.	.	Ch	Ro	800-1200	Ca	3	NT+
Saxifraga cintrana Kuzinsky ex Willk.	FI	.	.	.	.	.	.	.	.	.	2	.	He	Ro	400-600	Ca	8	VU+
Saxifraga conifera Coss. & Durieu	FI	.	.	3	.	.	.	+	.	.	.	.	He	Ro,H	1200-2200	.	54	LC
Saxifraga corsica subsp. *cossoniana* (Boiss. & Reut.) D.A. Webb	FI	1	.	.	.	+	.	.	.	2	.	.	He	Ro	100-1500	Ca	62	LC
Saxifraga cuneata Willd.	FI	.	.	2	.	2	.	.	1	.	.	.	Ch	Ro	600-1500	Ca	160	LC
Saxifraga erioblasta Boiss. & Reut.	FI	.	3	.	.	.	.	.	.	.	.	.	Ch	Ro	1400-2600	Ca	25	LC
Saxifraga felineri P. Vargas	FI	.	.	2	.	.	.	.	.	.	.	.	Ch	Ro	1200-2200	Ca	4	VU+
Saxifraga fragilis subsp. *paniculata* (Pau) Muñoz Garm. & P. Vargas	FI	.	+	.	+	2	.	.	.	1	.	.	Ch	Ro	1000-2000	Ca	68	LC
Saxifraga gemmulosa Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro	600-1400	Ca	10	VU+
Saxifraga genesiana P. Vargas	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro	1180-1650	Si	7	VU-
Saxifraga geranioides L.	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	A	1800-3000	Si	52	LC
Saxifraga haenseleri Boiss. & Reut.	FI	.	3	.	.	.	.	.	.	+	.	.	He	Ro	1000-2000	Ca	34	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Saxifraga intricata Lapeyr.	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	Ro	1100-2500	Si	46	LC
Saxifraga latepetiolata Willk.	FI	.	+	.	.	2	.	.	.	2	.	.	He	Ro	600-1900	Ca	58	LC
Saxifraga lepismigena Planellas	FI	.	.	1	.	.	3	1	.	.	.	.	Ch	W,Ro	500-1300	Si	75	LC
Saxifraga losae Sennen ex Luizet	FI	.	.	2	.	1	.	.	1	.	.	.	Ch	Ro	600-1850	Ca	44	LC
Saxifraga media Gouan	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	Ro	1500-2400	Ca	50	LC
Saxifraga moncayensis D.A. Webb	FI	.	.	.	.	3	.	.	.	.	.	.	Ch	Ro	800-1500	Si	27	LC
Saxifraga nevadensis Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	A	2100-3460	Si	4	NT+
Saxifraga pentadactylis Lapeyr.	FI	.	.	1	.	2	+	1	2	.	.	.	Ch	Ro	1500-3100	Si	87	LC
Saxifraga pentadactylis subsp. *almanzorii* P. Vargas	FI	.	.	.	.	.	.	2	.	.	.	.	Ch	Ro,A	1800-2500	Si	14	LC-
Saxifraga pentadactylis subsp. *pentadactylis* Lapeyr.	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro	1850-3100	Si	42	LC
Saxifraga pentadactylis subsp. *willkommiana* (Boiss. ex Willk.) Rivas Mart.	FI	.	.	1	.	2	.	1	.	.	.	.	Ch	Ro	1500-2500	Si	46	LC
Saxifraga praetermissa D.A. Webb	FI	.	.	1	.	.	.	.	2	.	.	.	Ch	A	2200-2900	Ca	58	LC
Saxifraga pubescens Pourr.	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	A	2000-3200	.	57	LC
Saxifraga pubescens subsp. *iratiana* (F.W. Schultz) Engl. & Irmsch.	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	Ro	2200-3200	.	35	LC
Saxifraga pubescens subsp. *pubescens* Pourr.	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	Ro	2000-2800	.	23	LC
Saxifraga reuteriana Boiss.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	700-1500	Ca	10	NT-
Saxifraga rigoi subsp. *rigoi* Porta	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1000-2000	Ca	6	LC
Saxifraga trifurcata Schrad.	FI	.	.	3	.	.	+	+	.	.	.	.	Ch	Ro	500-1500	Ca	106	LC
Saxifraga umbrosa L.	FI	.	.	.	.	.	.	.	3	.	.	.	He	F	1500-2000	.	88	LC
Saxifraga vayredana Luizet	FI	.	.	.	+	.	.	.	1	.	.	.	Ch	Ro	700-1550	Si	9	LC+
SCROPHULARIACEAE																		
Scrophularia bourgaeana Lange	FI	.	.	.	.	.	.	2	.	.	.	.	He	W,Ro	1650-2300	Si	21	LC
Scrophularia crithmifolia Boiss.	FI	.	1	2	+	1	.	.	2	+	.	.	Ch	Ro	80-2500	.	143	LC
Scrophularia grandiflora DC.	FI	.	.	.	.	.	.	1	.	.	+	.	He	R	400-500	.	17	LC+
Scrophularia herminii Hoffmanns. & Link	FI	.	.	+	.	.	+	3	.	.	.	.	He	W,Ro	500-1800	Si	46	LC
Scrophularia oxyrhyncha Coincy	FI	.	.	.	.	.	.	.	.	.	.	2	He	Ro	500-950	Si	19	NT*+
Scrophularia pyrenaica Benth.	FI	.	.	.	.	.	.	.	3	.	.	.	He	Ro	700-2500	Ca	53	LC
Scrophularia reuteri Daveau	FI	.	.	.	.	.	.	2	.	.	.	.	He	R	600-1900	Si	31	LC
Scrophularia sublyrata Brot.	FI	.	.	.	.	.	.	2	.	.	1	1	He	Ro	300-1300	Si	75	LC
Scrophularia tanacetifolia Willd.	FI	.	1	.	.	+	.	.	.	3	.	.	Ch	Ro	0-1700	Ca	103	LC
Scrophularia valdesii Ortega Oliv. & Devesa	FI	.	.	.	.	.	.	2	.	.	.	.	He	Ro	175-700	Si	10	VU-
Scrophularia viciosoi Ortega Oliv. & Devesa	FI	.	2	.	.	.	.	.	.	.	.	.	He	Ro,Ru	1000-1200	Ca	6	CR-
Verbascum barnadesii Vahl	FI	.	.	.	.	+	.	+	.	.	2	2	He	G	300-700	Si	35	LC
Verbascum charidemi Murb.	FI	.	.	.	.	.	.	.	.	1	.	.	He	Ro	50-500	.	3	CR-
Verbascum fontqueri Benedí & J.M. Monts.	FI	.	.	.	.	.	.	.	.	2	.	.	He	M,G	100-500	Ca	10	VU-
Verbascum giganteum subsp. *giganteum* Willk.	FI	.	3	.	.	.	.	.	.	1	.	+	He	Ro,Ru	300-1750	Ca	51	LC
Verbascum giganteum subsp. *martinezii* Valdés	FI	.	.	.	.	.	.	.	.	.	2	.	He	C,Ru	0-50	Ca	11	DD
Verbascum giganteum Willk.	FI	.	2	.	.	.	.	.	.	1	1	+	He	R	0-1750	Ca	62	LC
Verbascum hervieri Degen	FI	.	2	.	.	.	.	.	.	.	.	.	He	W	450-1700	.	4	DD*
Verbascum litigiosum Samp.	FI	.	.	.	.	.	.	.	.	.	2	.	He	C	5-20	.	20	NT
Verbascum nevadense Boiss.	FI	.	1	.	.	.	.	.	.	.	.	.	He	R	1250-2600	Si	3	DD*
Verbascum prunellii V. Rodr. & Valdés Berm.	FI	.	.	.	.	.	.	.	.	1	.	.	Ch	Ru,St	300-400	.	1	CR*+
Verbascum rotundifolium subsp. *ripacurcicum* O. Bolòs & Vigo	FI	.	.	.	1	.	.	.	.	1	.	.	He	Ru,Sc	350-1250	Ca	4	DD
THYMELAEACEAE																		
Daphne rodriguezii Texidor	FI	2	.	.	.	.	.	.	.	.	.	.	Ph	Sc	10-50	.	7	VU
Thymelaea broteriana Cout.	FI	.	.	.	.	.	+	1	.	.	.	.	Ch	H	800-1500	Si	12	VU*+
Thymelaea calycina (Lapeyr.) Meisn.	FI	.	.	.	.	.	.	.	2	.	.	.	Ch	Ro	1000-2500	Ca	15	LC+
Thymelaea coridifolia (Lam.) Endl.	FI	.	.	2	.	.	2	+	.	.	.	.	Ch	H	0-2070	Si	63	LC

	TAX	BI	BS	CM	CRE	IS	NWC	NWM	PYR	SEC	SWC	SWQ	LF	HAB	ALT	LIT	AOO	CAT
Thymelaea coridifolia subsp. *coridifolia* (Lam.) Endl.	FI	.	.	1	.	.	2	.	.	.	.	.	Ch	H	0-750	Si	27	LC
Thymelaea coridifolia subsp. *dendrobryum* (Rothm.) M. Laínz	FI	.	.	2	.	.	+	+	.	.	.	.	Ch	H	1200-2070	Si	27	LC
Thymelaea granatensis (Pau) Lacaita	FI	.	2	.	.	.	.	.	.	.	.	.	Ph	M	1750-2150	Ca	12	VU+
Thymelaea procumbens A. Fern. & R. Fern.	FI	.	.	.	.	.	.	1	.	.	.	.	Ch	Sc,H	760-1080	Si	8	NT+
Thymelaea pubescens (L.) Meisn.	FI	.	1	+	+	2	.	+	2	1	.	.	Ch	M,G	400-2100	Ca	210	LC
Thymelaea pubescens subsp. *elliptica* (Boiss.) Kit Tan	FI	.	2	.	.	+	.	.	.	+	.	.	Ch	G	1000-2100	Ca	33	LC
Thymelaea pubescens subsp. *pubescens* (L.) Meisn.	FI	.	.	+	+	2	.	+	1	1	.	.	Ch	M	400-1400	Ca	145	LC
Thymelaea ruizii Loscos	FI	.	.	2	.	1	.	.	2	.	.	.	Ch	H	500-2300	.	181	LC
Thymelaea subrepens Lange	FI	.	.	.	.	2	.	.	.	.	.	.	Ch	H,G	890-1600	.	6	LC+
Thymelaea tartonraira subsp. *valentina* (Pau) O. Bolòs & Vigo	FI	2	+	.	.	.	.	.	.	2	.	.	Ch	M	0-1900	Ca	64	LC
Thymelaea tinctoria (Pourr.) Endl.	FI	.	.	.	2	+	.	.	2	1	.	.	Ch	M	0-2600	Ca	133	LC
Thymelaea tinctoria subsp. *nivalis* (Ramond) Nyman	FI	.	.	.	.	.	.	.	3	.	.	.	Ch	G	900-2600	Ca	38	LC
Thymelaea tinctoria subsp. *tinctoria* (Pourr.) Endl.	FI	.	.	.	3	+	.	.	+	1	.	.	Ch	M	0-2600	Ca	108	LC
Thymelaea velutina (Pourr. ex Cambess.) Endl.	FI	3	.	.	.	.	.	.	.	.	.	.	Ph	C,M	0-1435	.	19	LC
URTICACEAE																		
Urtica bianorii (Knoche) Paiva	FI	3	.	.	.	.	.	.	.	.	.	.	He	R	350-1000	.	7	VU
VIOLACEAE																		
Viola cazorlensis Gand.	FI	.	2	.	.	.	.	.	.	.	.	.	Ch	Ro	1000-2150	Ca	21	VU
Viola cornuta L.	FI	.	.	2	.	.	.	.	2	.	.	.	He	G	1000-2300	Ca	59	LC
Viola crassiuscula Bory	FI	.	2	.	.	.	.	.	.	.	.	.	He	A	2200-3450	Si	3	NT-
Viola diversifolia (Ging.) W. Becker	FI	.	.	.	.	.	.	.	2	.	.	.	He	A	2400-2900	Si	25	LC
Viola jaubertiana Marès & Vigin.	FI	3	.	.	.	.	.	.	.	.	.	.	He	Ro	0-1100	Ca	6	NT
Viola langeana Valentine	FI	.	.	.	.	.	.	2	.	.	.	.	He	H	600-1900	Si	26	LC
Viola montcaunica Pau	FI	.	.	.	.	2	.	+	.	.	.	.	He	G	1300-2300	Si	30	LC
Viola willkommii R. Roem.	FI	.	.	.	2	1	.	.	2	1	.	.	He	Sc,F	400-1600	Ca	90	LC
XANTHORRHOEACEAE																		
Asphodelus aestivus Brot.	FI	.	.	.	.	+	.	+	.	.	2	3	Ge	Sc,G	0-1200	Si	192	LC
Asphodelus albus subsp. *carpetanus* Z. Díaz & Valdés	FI	.	.	.	.	+	.	1	.	.	.	.	Ge	Sc	800-1400	Si	38	LC
Asphodelus bento-rainhae P. Silva	FI	.	.	.	.	.	.	2	.	.	.	.	Ge	Sc	550-1400	Si	10	LC
Asphodelus bento-rainhae subsp. *bento-rainhae* P. Silva	FI	.	.	.	.	.	.	1	.	.	.	.	Ge	Sc	550-750	Si	1	EN+
Asphodelus bento-rainhae subsp. *salmanticus* Z. Díaz & Valdés	FI	.	.	.	.	.	.	2	.	.	.	.	Ge	Sc	760-1400	Si	8	LC+
Asphodelus lusitanicus Cout.	FI	.	.	.	.	.	2	2	.	.	1	.	Ge	Sc,H	0-1200	Si	81	LC
Asphodelus serotinus Wolley-Dod	FI	.	.	+	.	1	.	2	.	.	2	1	Ge	Sc,G	0-1240	Si	149	LC

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