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Floristic diversity of *Quercus suber* woodlands in Kabylia (north eastern Algeria). Checklist and brief analysis

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Abstract. The *Quercus suber* woodlands growing in Algeria are of high ecological importance, even if they have a narrow distribution, and are mainly located in the north eastern part of the country. The objective of this paper is to assess the floristic diversity of the cork oak woodlands in Kabylia (north eastern Algeria), by describing the taxonomical (at families, genera, species and subspecies ranks), biological and chorological diversity of the vascular flora, and to discuss conservation of the flora, focusing on endemics. Overall, 311 vascular plant taxa are recorded in the investigated area. Twenty-nine taxa are endemics and Algerian law protects eight of them. Biological spectrum reveals ecological features and anthropic pressure, while chorological spectrum provides information in climatic and biogeographical terms. The presence of 34 plant taxa with high value that are range-restricted and/or endemics in these woodlands is especially significant, as well as three threatened or near threatened species. Accordingly, measures for protection of floristic diversity in this area are recommended.
Keywords: chorological elements, conservation, cork oak, endemics, life forms, Mediterranean ecosystems, range-restricted, vascular flora.

[es] Diversidad florística de los bosques de Quercus suber en Cabilia (noreste de Argelia). Checklist y breve analisis

Resumen. Los bosques de *Quercus suber* que crecen en Argelia tienen una gran importancia ecológica, aunque su distribución es reducida, localizados principalmente en la parte nororiental del país. El objetivo de este trabajo es evaluar la diversidad de la flora vascular de los alcornocales de Cabilia (noreste de Argelia), desde el punto de vista taxonómico (por familias, géneros, especies y subespecies), biológico y corológico, y evaluar la conservación de la flora, centrándose en las especies endémicas. Se registran 311 taxones de plantas vasculares en el área investigada. Veintinueve taxones son endémicos, estando ocho de ellos protegidos por la ley argelina. El espectro biológico revela características ecológicas y de presión antrópica, mientras que el espectro corológico proporciona información sobre aspectos climáticos y biogeográficos. Es especialmente significativa la presencia en estos bosques de 34 taxones de plantas de alto valor, con distribución restringida y/o endémicas, así como de tres especies amenazadas o casi amenazadas. Como conclusión se recomiendan medidas para la protección de la diversidad florística en esta zona.
Palabras clave: alcornoque, conservación, ecosistemas mediterráneos, elementos corológicos, endemismos, formas vitales, distribución restringida, flora vascular.

Introduction

The cork oak (*Quercus suber* L.) is one of the most important tree species in the western Mediterranean basin, given its high ecological, landscape and socioeconomic importance (Pollastrini et al. 2018). Since ancient times its forests were managed to favour livestock, obtain wood, firewood, and cork (Rodríguez-Guitián et al. 2021). Besides, cork oak habitats are recognized as having both cultural and biodiversity value (Vogiatzakis et al. 2005; Simonson & Allen 2014). The cork oak forests, which support a high level of biodiversity and traditional livelihoods (Bugalho et al. 2011), are good examples in the Mediterranean region of the balance between preservation and development for the benefit of people and nature (CIB 2008). Cork oak is well adapted to the xerothermic conditions of the Mediterranean region by developing open canopy that permit adequate light to reach the ground floor thus favouring the growth of a diverse flora (cf. Bennadja et al. 2013).

According to Díaz-Villa et al. (2003), more than 135 species of vascular plants can be found per 0.1 ha of cork oak woodlands. This forest type is home to a large number of typical Mediterranean woodland species, and the understorey layer, rich

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in grasses and forbs, including several plant species of importance for conservation (Cano-Ortiz et al. 2021). *Quercus suber* forests are included in Directive 92/43/CEE of the European Union as a natural habitat of community interest (Agrillo et al. 2018; Cano-Ortiz et al. 2021).

In Algeria, the cork oak forest is one of the most important forest types, in terms of covered area, mostly extending along the humid coastal areas of the north eastern Algeria, from the east of Algiers to the Tunisian border. This area belongs to the "Kabylias-Numidia-Kroumiria" regional hotspot of biodiversity (Véla & Benhouhou 2007), known for its high floristic diversity, high number of endemic species, but also its great loss of habitats (FAO 2013).

The floristic aspect of biodiversity is of great importance, and its consideration is an important tool (Vrahnakis et al. 2014), when conservation of threatened ecosystems are the main priorities. The floristic inventory of a given area is the first step and a necessary requirement for assessing plant diversity (Harris et al. 2012). However, research on the floristic diversity of cork oak woodlands is relatively limited; we can mention Agrillo et al. (2018), which characterize *Quercus suber* woodlands in Europe, Perez Latorre et al. (1993) in Andalusia (Spain), or Sauvage (1961) and Aafi et al. (2005) in Morocco.

In Algeria, floristic studies have been renewed in the period from the 2000s until today. However, for the cork oak woodlands of Algeria in particular, information about their floristic diversity is scarce, but we can mention some studies in El Kala National Park (Iboukassene 2008), the Tlemcen Mounts (Letreuch-Belarouci et al. 2009), the North-eastern Algeria (Bennadja et al. 2013), Edough peninsula (Hamel et al. 2019), and in Djebel Bissa (Zemmar et al. 2020).

In the Kabylia region (Tizi Ouzou wilaya), despite their large extent in this area (29458 ha) and their floristic interest, the cork oak forests have only been the subject of a phytosociological study (Meddour 2010). Otherwise, the cork oak forests of Kabylia (e.g. Beni Ghobri forest) are a good example of "human-shaped ecosystems" in the Mediterranean Basin (Bugalho et al. 2011). These cork oak forests have suffered greatly from major fires, and huge areas were burned every year. In this context, Hamel (2015) studied the postfire floristic composition of Mizrana cork oak forest.

However, their comprehensive floristic survey is lacking. The present contribution is thus intending to contribute to the knowledge of floristic diversity of the cork oak forests of Kabylia, in particular in the main forests of Béni Ghobri, Mizrana and Tamgout, and in the marginal cork oak forest of Beni Kouffi, at the chorological and ecological limits of this territory. The research also falls within a more general contribution towards the floristic knowledge of the woodlands of Algeria, an area where limited biogeographical and ecological data are available (Simeone et al. 2010).

Material and methods

Study area

The framework of our study (Fig. 1) is the *wilaya* (province) of Tizi Ouzou, which is located in the north of Algeria, slightly east of Algiers. Its administrative boundaries are to the north, the Mediterranean Sea, with a seafront of 85 km, to the east, the wilaya of Bejaia, to the west, the wilaya of Boumerdes and to the south, the wilaya of Bouira. It is located between the longitudes 3°47'42" to 4°43'28"E and the latitudes 36°26'07"N to 36°53'55"N. With a total area of 295793 ha, the wilaya is one of the most forested areas in the country, with a total forest range of 64093 ha, corresponding to an afforestation rate of 22% (BNEDER 2008).

The cork oak forests are clearly dominant, they occupy 29458 ha, i.e. 46% of the global forest area of the wilaya, which represent 12.8% of the national area of this forest type. They are usually found on deep cool soils originating from acid rocks (sandstones), where they represent the climactic forest.

The climate of the region varies from humid to subhumid (mild to temperate winters), and it is characterized by a hot and dry summer and a cold and rainy winter (Meddour 2010). In the Djurdjura massif (elevation > 1000 m), mean annual rainfall is around 1500 mm, while in the Sébaou valley (Beni Ghobri and Tamgout) is around 1100 mm, and in the coastal zone (Mizrana, Azzefoun) 700 mm (Meddour 2010).

The cork oak woodlands are very unevenly distributed. It is especially in the eastern part of the *wilaya* that they have their greatest extension. The most important woodlands (Fig. 1, Tab. 1) are located on the coastal area (Mizrana forest), in Tamgout and Beni Ghobri forests. It forms either monospecific stands (e.g. at Mizrana), or mixed stands with deciduous oaks *Quercus canariensis* Willd. and *Quercus afares* Pomel (e.g. Tamgout and Béni Ghobri) or even with *Quercus ilex* subsp. *ballota* (Desf.) Samp. (Béni Kouffi/Ait Ali), in a more continental and dry locations (Meddour 2010). The eastern coast of the wilaya, in particular in Azeffoun is degraded and has given way to high maquis with *Erica* and *Arbutus* species at low altitudes, and reforestation with non-native tree-species (pines and eucalyptus).

They belong to four syntaxa: *Sileno imbricatae-Quercetum suberis* (Balansaeo-Quercion rotundifoliae), a mesophilous association on siliceous soils and in the humid ombrotype; *Cytiso villosi-Quercetum suberis* (Erico-Quercion ilicis), a mesophilous association with two subassociations (*quercetosum canariensis* and *myrtetosum communis*), both localized in the humid ombrotype and confined on markedly acid soils; *Erico arboreae-Myrtetum communis* (Ericion arboreae), thermophilous secondary shrubland association developed in the subhumid ombrotype, on flysch substrates (Meddour et al. 2022).

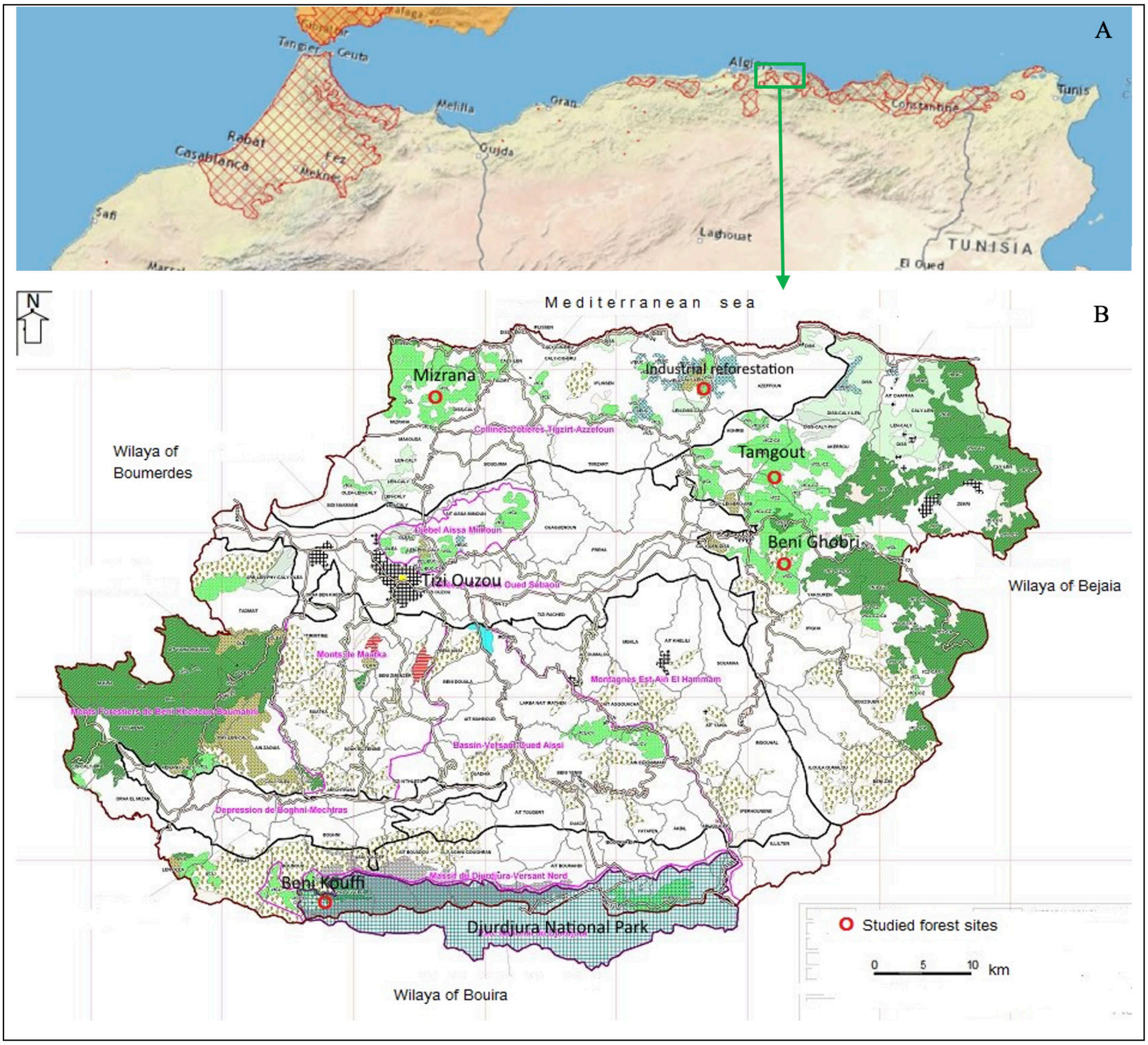


Figure 1. A. Range of *Quercus suber* in the Maghreb and Southern Iberian Penisnula (after Gil & Varela 2008), B. Location of the study area (forest sites) (from BNEDER 2008)

The structure of these woodlands is largely shaped by recurrent fires that ravaged them on different dates. Hence, they are often shrublands with open canopy of *Quercus suber*, and rarely dense forests.

In addition, coastal municipalities such as Mizrana, Azeffoun and Aghrib, present an extremely high fire risk, i.e. more than 20 wildfires on average per year (Sahar et al. 2019).

In terms of phytogeography, the area belongs to the Mediterranean region, the "Kabylian-Numidian" sector of the North African-Mediterranean province, and to the phytogeographical subsector of "Great Kabylia", labelled K1 (Quézel & Santa 1962–1963; Meddour 2010).

Table 1. Characteristics of cork oak forests studied in the wilaya of Tizi Ouzou (BNEDER 2008; Meddour 2010)

	Beni Kouffi (Djurdjura)	Beni Ghobri	Tamgout	Mizrana	Aghrib-Azeffoun (reforestation)
Area (ha)	158	6939	3829	2669	436
Dominant tree species	*Quercus suber, Q. ilex*	*Quercus suber, Q. canariensis, Q. afares*	*Quercus suber, Q. canariensis, Q. afares*	*Quercus suber,* maquis	*Eucalyptus* spp., *Pinus* spp., maquis (*Q. suber*)
Highest altitude (m a.s.l.)	1140	1291	1278	895	845
Coordinates	36°29' - 36°30'N, 3°58' - 3°59' E	36°40' - 36°45'N, 4°22' - 4°35'E	36°45'- 36°50' N, 4°19' - 4°27' E	36°50'- 36°53' N, 4°00' - 4°07' E	36°48' - 36°53' N, 4°19' - 4°25' E

Geology	Numidian sandstones and poundingues	Numidian sand-stones and scree	Numidian sand-stones and scree	Numidian sand-stones and sands	Numidian flysch (sandstones and clays)
Ombrotypes	humid temperate to fresh	humid temperate to fresh	subhumid and humid temperate	subhumid and humid mild to temperate	subhumid warm to mild
Thermotypes	Upper Mesomed-iterranean	Upper Mesomed-iterranean	Lower Mesomed-iterranean	Lower Mesomed-iterranean	Thermomediter-ranean
Mean annual rainfall (mm)	1078	1132	1001	902	720
Mean annual temperature (°C)	14,6	15,25	15,5	16,68	17,5

Data collection

The vascular plant checklist of the cork oak woodlands is based exclusively on our field observations and collections. Fieldwork was carried out during the growing and flowering seasons of the period 2006 to 2008 and 2014 to 2016, in cork oak forests and their successional maquis (Meddour 2010; Hamel 2015) in five locations that were selected to represent various localities, with comprehensive spatial, ecological, and seasonal sampling efforts. We have completed the floristic inventory by the search of bulbous plants in three autumns. Floristic inventories were carried out on relatively homogeneous sites in terms of physiognomy and structure of the vegetation (Serra et al. 2002), and sampled in representative patches of vegetation (Simonson & Allen 2014), based on a large land survey.

A dataset of 235 vegetation-plots was collected in the forests of Beni Ghobri, Mizrana, Tamgout, Beni Kouffi and the coastal maquis of the Azeffoun-Aghrib region (Fig. 2).

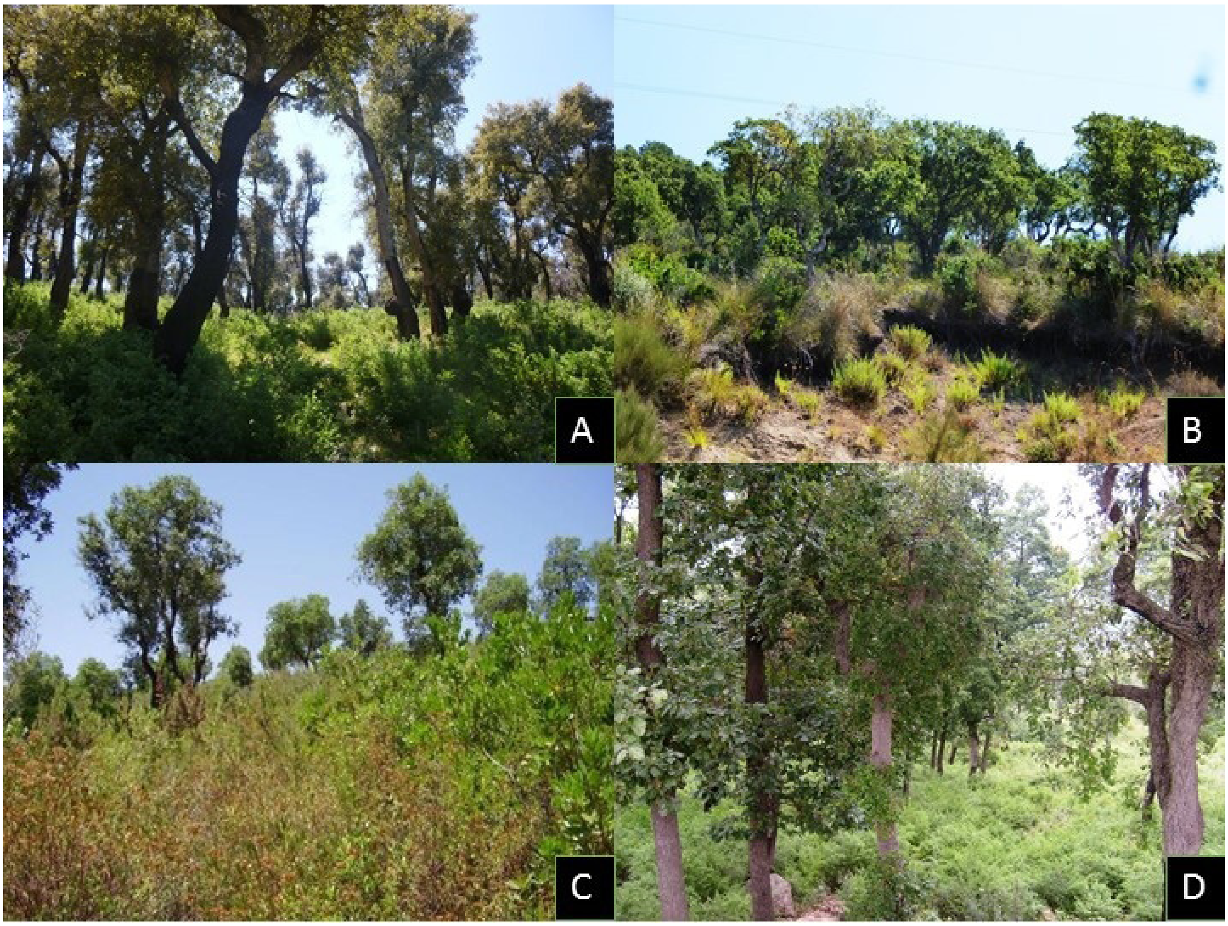


Figure 2. Different types of cork oak woodlands studied: A. Mesomediterranean humid cork oak forest at Mizrana forest. B. Mesomediterranean subhumid cork oak forest at Tamgout forest. C. Thermomediterranean subhumid maquis at Azzefoun, coastal area. D. Mesomediterranean humid cork oak forest at Beni Ghobri forest. All photos R. Meddour

These vegetation-plots are new data or were extracted from the doctoral thesis (unpublished) of Meddour (2010), i.e., a sub-dataset of 84 vegetation-plots, concerning the same forest area. Plot size varies from 100 to 250 m², according to the minimum area method (Barkman 1989), and due to the heterogeneity of the tree stands (Frosch & Deil 2011). For instance, Agrillo et al. (2018) used plots ranging from 20 to 500 m² to characterize habitat types of *Quercus suber* woodlands in Europe, and Perez Latorre et al. (1993) used plots from 50 to 400 m² in Andalusia (southern Iberian Peninsula). The floristic composition, i.e., all the vascular plant taxa present in a given plot, was recorded. Taxa are defined as species and subspecies; when a species has subspecies, then only its subspecies are counted (Panitsa & Kontopanou 2017). Thus, plant taxa recorded overall were grouped in a checklist. Information from floristic inventories, plant specimen collections, and photo records were combined. Voucher specimens of plant species collected in the field are kept in the R. Meddour Herbarium, preserved at Mouloud Mammeri University. Besides voucher specimens, photographs are a valuable means of checking the identity of plant species; therefore, several photographs of the flora were taken during field trips.

Data analysis

The plants were identified using the *New Flora of Algeria* of Quézel & Santa (1962-1963), which is updated under the name eflora Maghreb (2019 onwards). Their taxonomic nomenclature is updated according to Dobignard & Chatelain (2010-2013) and African Plant database (APD 2012 onwards). The accepted scientific names and authorities of all plants mentioned in the checklist are provided. Families are organized based on PPG I (2016) for pteridophytes and Christenhusz et al. (2011) for gymnosperms. For angiosperms, families' circumscriptions follow the Angiosperm Phylogeny Group IV (APG IV 2016).

The checklist has been enriched with information about the life forms and chorological types of the taxa, their national protection status (according to the executive decree n° 12-03 on 4 January 2012; JORA 2012), and their conservation status following the IUCN Red List of Threatened Species, which provides the global extinction risk status (IUCN 2021).

The life forms and subforms, based on the classification of Raunkiaer (1934), were expressed following Carazo-Montijano & Fernandez-Lopez (2006), and verified directly in the field. The chorological elements are also drawn from Carazo-Montijano & Fernandez-Lopez (2006). Biological and chorological spectrums were calculated based on species frequencies. For the calculation of life form spectrum, the various subforms were grouped into major life forms based on Raunkiaer's system (Raunkiaer 1934). For the calculation of the chorological spectrum, elements were grouped into wider categories as designed by Carazo-Montijano (2006). For "endemic" taxa Dobignard & Chatelain (2010–2013) were consulted, and this status was checked against main databases with chorological maps (APD 2012 onwards; Euro+Med PlantBase 2006 onwards; POWO 2017 onwards). According to these sources, the "Algerian endemic" status is attributed to plant taxa occurring solely in Algerian territory, and the subendemic status to those occurring in Algeria and a neighbouring country, i.e. in Algeria and Morocco, or in Algeria and Tunisia, and Maghrebian endemic status to those occurring in Algeria and neighbouring countries (Morocco, Tunisia, Libya).

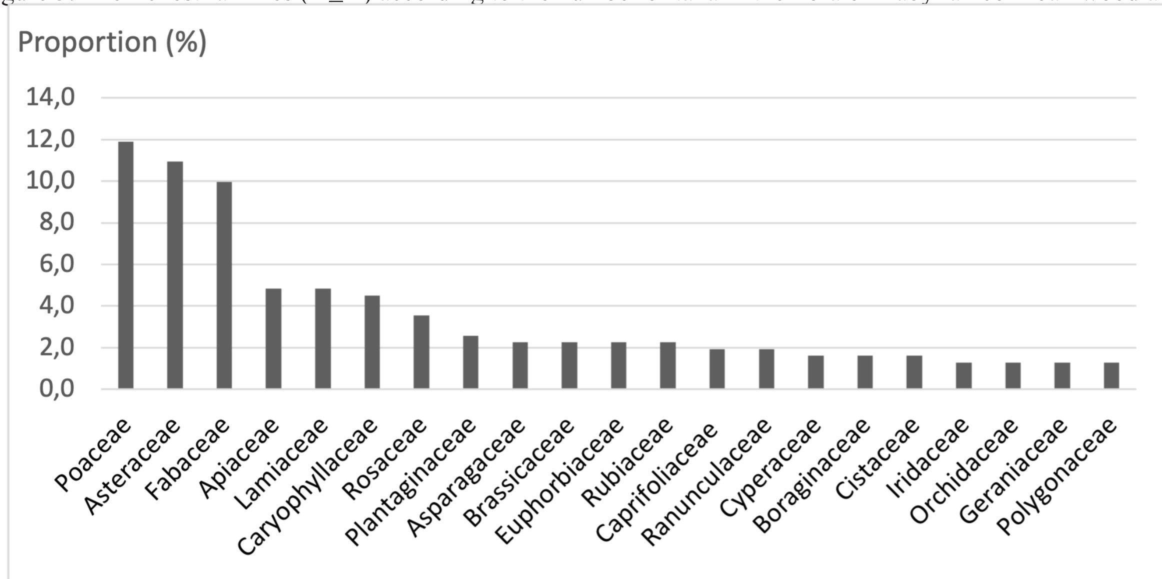
As Dimopoulos et al. (2013) indicated, the "range-restricted" taxa of a given area have rarely been evaluated, although they offer important information on the exclusiveness of a flora. Range-restricted taxa are characterised by a restricted distribution and populations occurring along a linear distance not exceeding 500 km (Dimopoulos et al. 2013). Current knowledge on the distribution of plant taxa in the 20 phytogeographical subsectors of Algeria, as recognized by Quézel & Santa (1962–1963), enables those taxa with a distribution restricted to a few subsectors in Algeria to be indicated. This data pinpoints species occurring in only 1 to 3 adjacent subsectors (< 500 km), particularly those exclusive to the Kabylian-Numidian sector (K1-2-3). This analysis will provide an assessment of range-restricted taxa, and could be used as an initial stage in selecting taxa of conservation priority (Norton et al. 2009).

Results

Taxonomic diversity

Based on 235 vegetation-plots, the vascular flora of the cork oak forests of Kabylia encompasses 311 taxa, i.e. 288 species (including 67 autonyms), and 23 subspecies, belonging to 66 families and 209 genera (Annex 1). A small number of taxa represent the Pteridophyta (9 taxa, 2.9% of the whole flora) and the Pinophyta (2 taxa, 0.6%). Angiosperms (Magnoliophyta) comprise the largest group of vascular plants, with 300 taxa (96.5%). Among them, dicotyledons (Magnoliopsida) are the most diverse group with 233 taxa (74.9%), while monocotyledons (Liliopsida) include 67 taxa (21.5%). The most represented family of the overall flora is *Poaceae* with 37 taxa, followed by *Asteraceae* with 34 taxa, and *Fabaceae* with 31 taxa (Fig. 3). These three families represent 32.8% of the total taxa recorded. The richest genera are *Trifolium* (eight taxa), *Silene* (7), *Euphorbia* (6) and *Carex* (5); these genera represent 8.4% of the flora.

Figure 3. The richest families (n ≥ 4) according to the number of taxa in the flora of Kabylian cork oak woodlands



Life form spectrum

The life form spectrum shows clearly that hemicryptophytes are the most numerous in the cork oak woodlands flora (112 taxa, 36%), followed by therophytes (104, 33.4%), while other life forms are represented by smaller percentages: geophytes (12.5%), phanerophytes (10%), nanophanerophytes (4.2%), and chamaephytes (3.9%). Among these life forms, 18 taxa (5.8% of the overall flora) are lianas, e.g. *Aristolochia* spp., *Clematis* spp., *Lonicera* spp., *Rubus* spp., *Vicia* spp., etc.

Chorological spectrum and endemic taxa

Regarding the chorological analysis, it appears a high prevalence of the Mediterranean category with its nine elements, which altogether comprise 64.6% of the overall flora (Tab. 2). Among them, the importance of the Iberian-Maghrebian taxa are notable, comprising 5.8% of the flora. The Mediterranean taxa are followed by the widely distributed taxa (19.3%). The taxa of European influence contribute the lowest proportion to the flora (6.1%). The endemic category (9.3%), including four elements distributed in neighbouring North African countries, accounts for 29 endemic and subendemic taxa (with 21 species, and 8 subspecies).

Table 2. Distribution of chorological elements of the flora of Kabylian cork oak woodlands

Chorological elements	Number of taxa	Proportion (%)
Endemic elements	29	9,3
• Algerian endemic	6	1,9
• Algerian-Moroccan endemic	3	1,0
• Algerian-Tunisian endemic	8	2,6
• Maghrebian endemic	12	3,9
Mediterranean elements	201	64,6
• Iberian-Maghrebian	18	5,8
• Circummediterranean	47	15,1
• Western Mediterranean	37	11,9
• Mediterranean-Macaronesian	65	20,9
• Mediterranean-Atlantic	11	3,5
• Southern Mediterranean	12	3,9
• Mediterranean-Turanian	6	1,9
• Mediterranean-Turanian-Macaronesian	4	1,3
• Central Mediterranean	1	0,3
Elements of European influence	19	6,1

• Eurasian	11	3,5
• European-Caucasian	5	1,6
• European	3	1,0
Elements of wide distribution	62	19,3
• Paleotemperate	33	10,6
• Subcosmopolitan	10	3,2
• Cosmopolitan	5	1,6
• Circumboreal	8	2,6
• Paleosubtropical	4	1,3
Allochtonous (element)	2	0,6
• Introduced from America (naturalised)	2	0,6
Total	311	100

Taxa with high patrimonial value

This floristic analysis highlights a significant number of 34 taxa of conservation priority (endemics and/or range-restricted taxa, and threatened or near threatened plants), at national and worldwide levels (Tab. 3, Fig. 4).

Endemic taxa. Among the 29 endemics present in the cork oak woodlands of Kabylia, there are six Algerian endemic taxa (*Ammoides atlantica* (Coss. & Dur.) H. Wolff, *Aristolochia fontanesii* Boiss. & Reut., *Vicia ochroleuca* subsp. *atlantica* (Pomel) Greuter & Burdet, *Origanum floribundum* Munby, *Teucrium kabylicum* Batt., and *Festuca atlantica* Duv.-Jouve ex Claus. subsp. *atlantica*), representing 1.9% of the entire local flora (Tab. 3).

Figure 4. Some taxa with high patrimonial value of conservation interest present in the flora of cork oak woodlands of Kabylia: A. *Hyacinthoides aristidis*, B. *Phlomis bovei* subsp. *bovei,* C. *Vicia ochroleuca* subsp. *atlantica,* D. *Genista ulicina,* E. *Scutellaria columnae* subsp. *columnae,* F. *Cephalaria mauritanica,* G. *Teucrium kabylicum*. All photos R. Meddour (except photo G. from K. Rebbas)

Range-restricted taxa. Besides the endemic taxa, the data point out nine plants that are exclusives and restricted to the Kabylian-Numidian sector (K) in Algeria, species only found in K1, K2 and K3 subsectors (Tab. 3). These range-restricted plants are *Myosotis speciosa* Pomel*, Lathyrus niger* (L.) Bernh.*, Teucrium kabylicum, Hyacinthoides aristidis* (Coss.) Rothm.*, Drymochloa grandis* (Coss. & Durieu) Holub*, Genista ulicina* Spach*, Scutellaria columnae* All. subsp. *columnae, Erica scoparia* L.*,* and *Euphorbia biumbellata* Poir.

Table 3. Taxa with high patrimonial value of conservation concern, based on criteria of endemism and restrictedness, with their threats and protection statuses, recorded in the flora of Kabylian cork oak woodlands

Taxa with high patrimonial value	Endemics	Range-restricted taxa[1]	Conservation status[2]	Protection[3]
Ammoides atlantica (Coss. & Dur.) H. Wolff	A			
Arabis pubescens (Desf.) Poir.	Mag			
Aristolochia fontanesii Boiss. & Reut.	A			
Cephalaria mauritanica Pomel	A-M	K1, A2		
Conopodium glaberrimum (Desf.) Engstrand	Mag			
Cyclamen africanum Boiss. & Reut.	Mag			P
Drymochloa grandis (Coss. & Durieu) Holub	A-T	K1-2-3		
Elaeoselinum fontanesii Boiss.	Mag			
Erica scoparia L.		K1-2-3		
Eryngium tricuspidatum subsp. *bovei* (Boiss.) Breton	Mag			
Euphorbia biumbellata Poir.		K1-2-3		
Festuca atlantica Duv.-Jouve ex Claus. subsp. *atlantica*	A			
Genista ferox (Poir.) Dum. Cours.	Mag		LC	
Genista ulicina Spach	Mag	K1-2-3		
Geranium atlanticum Boiss. & Reut.	Mag			
Hedera algeriensis Hibberd	A-T			
Hyacinthoides aristidis (Coss.) Rothm.	A-T	K1-2-3		
Knautia mauritanica Pomel	Mag			
Lathyrus niger (L.) Bernh.		K1-2	LC	
Linum corymbiferum Desf. subsp. *corymbiferum*	A-T			
Myosotis speciosa Pomel	A-M	K1-2		
Ononis hispida Desf. subsp. *hispida*	Mag			
Origanum floribundum Munby	A	K1, A2		P
Origanum vulgare subsp. *glandulosum* (Desf.) Ietswaart	A-T		NT	
Phlomis bovei de Noé subsp. *bovei*	A-T		NT	P
Plagius maghrebinus Vogt & Greuter	Mag			
Scutellaria columnae All. subsp. *columnae*		K1-2-3		
Sedum pubescens Vahl	A-T			
Silene imbricata Desf.	A-M	K1, A1-2		
Silene patula Desf. subsp. *patula*	Mag			
Teucrium kabylicum Batt.	A	K1-2-3	VU	P
Thymus numidicus Poir.	A			
Torilis africana Spreng.		K1-2, A2		
Vicia ochroleuca subsp. *atlantica* (Pomel) Greuter & Burdet	A	K1-2, A2		

Abbreviations: A: Algerian endemic, AM: Algerian-Moroccan endemic, AT: Algerian-Tunisian endemic, Mag: Maghrebian; K1: Grande Kabylie (including Djurdjura), K2: Petite Kabylie (including Babors), K3: Numidia (from Skikda to El Kala), A1: Algiers Coast, A2: Tellian Atlas of Algiers; VU: vulnerable, NT: near threatened, LC: least concern; P: protected. Sources: [1]Quézel & Santa 1962-1963), [2]Walter & Gillett 1998; IUCN 2021, [3]JORA 2012.

In addition, five taxa are present in two Algerian phytogeographical sectors (K and A), but only in 2-3 adjoining subsectors, these are *Origanum floribundum, Silene imbricata* Desf.*, Vicia ochroleuca* subsp. *atlantica, Cephalaria mauritanica* Pomel*,* and *Torilis africana* Spreng.

Conservation status and protection at national level. Concerning their conservation status, three Algerian endemic taxa recorded in the present flora were previously included in the 1997 IUCN Red List of threatened species. Two of them (*Origanum floribundum*, *Phlomis bovei* de Noé subsp. *bovei*) were formerly considered as near threatened (NT), and *Teucrium kabylicum*, as vulnerable (VU). These three plants are of priority for protection. At present, 45 taxa are assessed globally by IUCN and considered as least concern (LC), e.g., *Genista ferox* (Poir.) Dum. Cours., while *Quercus canariensis* is considered as data deficient (DD), at the global level across its natural range. With respect to the national protection status, eight taxa amongst the flora recorded in the cork oak woodlands are included in the list of protected plants in Algeria, including only four high value taxa, *Origanum floribundum, Teucrium kabylicum, Phlomis bovei* subsp*. bovei,* and *Cyclamen africanum* Boiss. & Reut.

Discussion

Floristic diversity

In terms of floristic diversity, the Kabylian cork oak woodlands are richer (311 taxa) than those of other Algerian regions, such as in Edough peninsula (123 vascular plant taxa), Djebel Bissa (151), Theniet el Had (157), El Kala (162), Tlemcen (211 taxa), Chréa (213), and north eastern Algeria (272) (Iboukassene 2008; Letreuch-Belarouci et al. 2009; Sarmoum et al. 2013; Bennadja et al. 2013; Mekideche et al. 2018; Hamel et al. 2019; Zemmar et al. 2020).

However, comparisons of floristic richness with other studies must be done with caution, since in our case this variable might be linked to the fact that we sampled in different vegetation structures and different ecological situations (littoral, sublittoral, montane, up to 1300 m a.s.l.), over a vast territory. Indeed, species richness is strongly affected by sampling effort (both in time and in space) and the number and area of plots (Ribeiro et al. 2007), since there is a direct relationship between these parameters and species richness. That is why in Morocco, Aafi et al. (2005), with a higher sampling effort (400 plots), recorded 408 vascular plants in the forest of Mamora, which is considered the largest lowland cork oak forest in the world. However, it is possible that among those 408 taxa, also wetlands species, typical of La Mamora, crossed by many *wadis* (Aafi et al. 2005), were included and they are not linked to the *Quercus suber* forests.

The dominant families of vascular plants were *Poaceae* and *Asteraceae* (14.9% and 10.5% of the species total, respectively), followed by *Fabaceae*. This pattern conforms to the cork oak woodlands in general, where they are often among the most species-rich families (see Aafi et al. 2005; Letreuch-Belarouci et al. 2009; Mekideche et al. 2018; Medjahdi et al. 2018; Hamel et al. 2019; Zemmar et al. 2020). This is not surprising, because, even at national level, these families also harbour the largest number of taxa in the floras of Algeria (Dobignard & Chatelain 2010-2013), Morocco (Fennane & Rejdali 2019), and south of the Iberian Peninsula (Blanca et al. 2011). This is likewise the case of the overall Mediterranean Maghreb (Quézel 2000). The richest genera are *Trifolium* (eight taxa)*, Silene, Euphorbia* and *Carex*. The first three genera are also among the richest in taxa in the cork oak forest of Mamora, Morocco (Aafi et al. 2005).

The life forms and chorological elements as ecological indicators

Life forms

The proportion of the life forms in the ecosystem gives not only a descriptive and physiognomic value, but also an ecological significance (Vanden Bergen 1982).

Hemicryptophytes prevail in the sampled flora (36%), closely followed by therophytes (33.4%).

Prevalence of hemicryptophytes demonstrates plant resistance to the winter cold in high-mountains (Ellenberg 1988). Indeed, Cain (1950) showed a trend of increasing proportions of hemicryptophytes on many mountain slopes. According to Floret et al. (1990), this situation was mainly due to the abundance of rainfall and the winter cold, as it is prevailing in the Kabylian area (subhumid and humid bioclimates, in their cool and fresh variants; see Meddour 2010). Besides, Barbero et al. (1990) report that the abundance of hemicryptophytes in the Maghreb countries is due also to the richness of the soil in organic matter.

On the other hand, the rate of therophytes is usually high (between 25 and 50%) in Mediterranean forest formations (Barbero & Quézel 1989). These annual species dominate throughout the Mediterranean cork oak forests (Iboukassene 2008). Therophytes represent 38% in El Kala cork oak forest (Ouelmouhoub & Benhouhou 2007), up to 50% in the western cork oak forest of Theniet el Had (Sarmoum et al. 2013), and in the flora of the Mamora cork oak forest in Morocco (Aafi et al. 2005). The relatively high representation of therophytes highlights the clear Mediterranean climate of the studied area (cf. Mele et al. 2006), with marked sea influence (Selvi 2010) and indicates warm, and periodically dry climate conditions (Rožac et al. 2018). This richness in therophytes is linked to summer drought and short growing seasons (Floret et al. 1990; Larson et al. 2000), as well as an impact of human disturbance (Rožac et al. 2018). It becomes much greater when the environment opens up under the effect of drought (Daget 1980) and disturbances (Grime 1977), mainly overgrazing. This latter increases the number of therophytes (Letreuch-Belarouci et al. 2009; Hamel et al. 2019), which mainly consist of opportunistic species associated with disturbances (Barbero & Quézel 1989; Ribeiro et al. 2007). This is reinforced by the observation that after recurrent wildfires, many therophytes established in large numbers, particularly of Fabaceae and Poaceae families, in cork oak woodlands of Algeria (Wojterski 1990; Mekideche et al. 2018). However, compared to similar cork oak forests, the Kabylia region showed a slightly lower level of "therophytisation" (Barbero et al. 1990).

There are also many phanerophytes and nanophanerophytes (14.2%), mostly small-sized, active in colonising clearings, and specially areas that have been hit by recurrent wildfires (Farris et al. 2007). Among this set, 10% represents the tree flora, i.e., a little more than that recorded on the Babors massif (8.5%) by Gharzouli & Djellouli (2005).

The chamaephytes, weakly represented (c. 4%), are probably inhibited by the large development of the phanerophytes.

Chorological analysis

The chorological analysis (table 2) showed a strong prevalence of the Mediterranean floristic category (up to 65%) in the flora of the region and demonstrates the Mediterranean character of its climate (cf. Mele et al. 2006), with summer drought even with the elevation. This finding was consistent with the results of Zemmar et al. (2020) and Sarmoum et al. (2013), where this category appeared to be clearly predominant (50 to 72% respectively). This is also the case for the Northern Algeria (Quézel 1964), where this chorological category represents 57% of the national flora, and in all the North African countries (Quézel 2000).

There are only two naturalised alien species (*Erigeron bonariensis* L. and *E. canadensis* L.) introduced from America in the study area. Cork oak forests, a natural habitat although disturbed in our case, are not easy to be invaded, given the severe competition induced by numerous woody species (Vieri & Sebastiani 1987).

Endemism and regional hotspot of biodiversity under anthropic pressure

The endemic floristic category, including Algerian endemics and subendemics distributed in neighbouring North African countries, accounting for 9.3% (table 2), is noteworthy when compared to the findings in other Algerian cork oak woodlands. For instance, it accounts 4% in Bissa forest (Zemmar et al. 2020), 5.7% in Theniet el Had (Sarmoum et al. 2013), and 5.6% in Tlemcen mountains (Medjahdi et al. 2018), and in the Mamora forest (Aafi et al. 2005).

However, the rate of endemics increases in mountains with altitude (1300-2000 m) and varied between 10 and 20% of the whole flora, with deciduous oaks and orophilous conifers ecosystems, e.g. 14% in Djurdjura massif (Meddour & Sahar 2021) and 16% in Babors mounts (Gharzouli & Djellouli 2005). The noteworthy presence of the endemic and subendemic taxa (nearly 10%) exemplifies that the study region belongs to the regional hotspot of "Kabylias-Numidia-Kroumiria", and is really an area with high endemism in Algeria and of conservation concern (Véla & Benhouhou 2007). However, this regional hotspot is known for its high floristic diversity, and high number of endemic species, but also its great loss of habitats (FAO 2013). Indeed, the cork oak forests of Kabylia cover nowadays very limited areas and their ecosystems' degradation is worrying. They were more widespread than now in the past: from 45000 ha (Lapie 1909), they were reduced to 37000 ha (Boudy 1955). Then, according to BNEDER (2008), this "human-shaped ecosystem" occupies only 29458 ha, that is a large reduction of 35% in a century, due to recurrent fires and overgrazing, despite its resilience (i.e. ability to recover after fire) (Schaffhauser et al. 2012). To this regression of the area is added the threat of extinction of rare or endemic plants (Benabid 2000), as intense and recurrent fires generally reduce floristic diversity locally (Schaffhauser et al. 2012) and degradation from frequent fires and overgrazing may leads to the paucity of floristic diversity of the cork oak woodlands (Simonson & Allen 2014).

Taxa with high patrimonial value and their conservation priority

As a final point, this floristic analysis highlights 34 taxa (table 3) of conservation priority (Algerian endemics and/or range-restricted plants, and threatened plants) in the flora recorded in the cork oak woodlands of Kabylia. Amongst them, only four high value taxa are mentioned in the list of protected plants in Algeria (JORA 2012). Therefore, 30 endemic and range-restricted taxa, even if there are not yet assessed by IUCN, remain to be considered and added to the national list of protected plants, for example some endemics: *Vicia ochroleuca* subsp. *atlantica, Aristolochia fontanesii, Thymus numidicus* Poir., *Genista ulicina, Cephalaria mauritanica, Drymochloa grandis, Silene imbricata, Myosotis speciosa*, and *Hyacinthoides aristidis.* This significant number of taxa of conservation priority (Norton et al. 2009), at local and national levels, determines the crucial importance of the cork oak woodlands for the conservation of vascular plant diversity, and enhances their role as a "key biodiversity area" for plants in Algeria (Yahi et al. 2012; Benhouhou et al. 2018).

Conclusions

The study region of Kabylia is located in an area of extreme biological importance and one of the priority areas for biodiversity conservation in Algeria. Their rich cork oak woodlands make an important contribution to regional biodiversity and natural heritage, and represent a vegetation ecosystem of high priority for conservation.

The present checklist of the flora of cork oak woodlands of Kabylia, with 311 taxa, has been performed as a first step to make more accessible the data collected and still unpublished, in order to facilitate subsequent taxonomic work and further botanical research and biodiversity conservation planning. We have described the floristic diversity values of these human-shaped ecosystems, the threats they face (overuse, grazing and fires), and conservation priority they request in the Kabylian region. This work also made it possible to draw up the list of 29 range-restricted and endemic taxa of these cork oak woodlands and to propose them to an assessment of their threats by IUCN and to add them to the national list of protected plants.

Annex 1. Checklist of vascular plants recorded

Abbreviations or symbols used in the floristic list: endemics (€), range-restricted (#).

Life forms and subforms: therophyte (T), chamaephyte (Ch), hemicryptophyte (H), geophyte (G), nanophanerophyte (NP), phanerophyte (P); reptant (rept), succulent (succ), suffruticose (suffr), bulbose (bulb), rhizomatose (rhiz), rosulate (ros), biennial (bienn), caespitose (caesp), scapose (scap), scandent (scand), lianose (lian).

Chorological elements: Cosmopolitan (Cosm), Subcosmopolitan (Subcosm), Paleosubtropical (Paleosubtrop), Paleotemperate (Paleotemp), Eurasian (Euras), European (Eur), American (Amer), Mediterranean (Med), Atlantic (Atl), Turanian (Tur), Circumboreal (Circumbor), Macaronesian (Macar), Endemic (End), Iberian-Maghrebian (Iber-Mag), Maghrebian (Mag), Algerian (Alg), Moroccan (Mor), Tunisian (Tun).

Conservation status: Least Concern (LC), Data deficient (DD). Protection at national level (P).

Families	Taxa	Life forms	Chorological elements	Conservation status	Protection
Lycophytes					
Selaginellaceae	*Selaginella denticulata* (L.) Spring	Ch rept	W Med-Macar	LC	
Ferns and fern allies					
Dennstaedtiaceae	*Pteridium aquilinum* (L.) Kuhn subsp. *aquilinum*	G rhiz	Cosm		
Cystopteridaceae	*Cystopteris fragilis* (L.) Bernh.	H caesp, G rhiz	Subcosm		
Aspleniaceae	*Asplenium ceterach* L. subsp. *ceterach*	H ros	Paleotemp		
	Asplenium onopteris L.	H ros, G rhiz	W Med-Macar		
	Asplenium trichomanes L. subsp. *trichomanes*	H ros, G rhiz	Subcosm		
Dryopteridaceae	*Polystichum aculeatum* (L.) Roth	G rhiz, H ros	Euras		
	Polystichum setiferum (Forssk.) T. Moore ex Woyn.	G rhiz, H ros	Circumbor		
Polypodiaceae	*Polypodium cambricum* L. subsp. *cambricum*	H ros, G rhiz	Med-Atl		
Gymnosperms					
Pinaceae	*Pinus halepensis* Mill.	P scap	Circummed	LC	
Cupressaceae	*Juniperus oxycedrus* L. subsp. *oxycedrus*	P caesp	Circummed	LC	P
Angiosperms					
Lauraceae	*Laurus nobilis* L.	P scap, P caesp	Med-Macar	LC	
Aristolochiaceae	€ *Aristolochia fontanesii* Boiss. & Reut.	G bulb lian	Alg End		
	Aristolochia paucinervis Pomel	G bulb lian	W Med-Macar	LC	
Araceae	*Arisarum vulgare* subsp. *hastatum* (Pomel) Dobignard	G rhiz, G bulb	Circummed		
	Arum italicum Mill. subsp. *italicum*	G rhiz	Med-Macar		
Dioscoreaceae	*Dioscorea communis* (L.) Caddick & Wilkin	G bulb lian	Med-Atl		
Colchicaceae	*Colchicum lusitanum* Brot.	G bulb	W Med		
Smilacaceae	*Smilax aspera* L.	NP lian, G rhiz	Paleosubtrop		

Orchidaceae	*Androrchis mascula* subsp. *maghrebiana* (B. Baumann & H. Baumann) W. Foelsche & Jakely	G bulb	Med-Atl		P
	Epipactis tremolsii Pau	G rhiz	W Med		
	Ophrys tenthredinifera Willd. subsp. *tenthredinifera*	G bulb	W Med		
	Serapias lingua L. subsp. *lingua*	G bulb	W Med		
Iridaceae	*Gladiolus dubius* Guss.	G bulb	W Med		
	Gladiolus italicus Mill.	G bulb	Med-Atl	LC	
	Moraea sisyrinchium (L.) Ker Gawl.	G bulb	Circummed		
	Romulea bulbocodium (L.) Sebast. & Mauri subsp. *bulbocodium*	G bulb	Circummed		
Asphodelaceae	*Asphodelus ramosus* L. subsp. *ramosus*	G rhiz	Circummed		
	Simethis mattiazzi (Vand.) G. López & Ch. E. Jarvis	G rhiz	W Med-Atl		
Amaryllidaceae	*Allium roseum* L. subsp. *roseum*	G bulb	Paleotemp		
	Allium triquetrum L.	G bulb	W Med-Macar	LC	
Asparagaceae	*Anthericum baeticum* (Boiss.) Boiss.	G rhiz	Iber-Mag		
	Asparagus acutifolius L.	G rhiz lian, NP	Circummed	LC	
	Drimia maritima (L.) Stearn subsp. *maritima*	G bulb	W Med-Macar	LC	
	€ # *Hyacinthoides aristidis* (Coss.) Rothm.	G bulb	Alg-Tun End		
	Ornithogalum baeticum Boiss.	G bulb	Iber-Mag		
	Prospero autumnale (L.) Speta	G bulb	Med-Atl		
	Ruscus hypophyllum L.	G rhiz, Ch suffr	W Med-Macar		
Juncaceae	*Luzula forsteri* (Sm.) DC.	H caesp	Circummed		
Cyperaceae	*Carex distachya* Desf.	H caesp, G rhiz	Med-Macar	LC	
	Carex flacca Schreb.	G rhiz, H caesp	Circumbor		
	Carex halleriana Asso	H caesp, G rhiz	Circummed		
	Carex muricata L.	H caesp	Circumbor		
	Carex remota L.	H caesp, G rhiz	Circumbor	LC	
Poaceae	*Aira caryophyllea* L. subsp. *caryophyllea*	T scap	Paleosubtrop		
	Aira cupaniana Guss.	T scap	W Med		
	Aira tenorei Guss.	T scap	S Med	LC	
	Ampelodesmos mauritanicus (Poir.) T. Durand & Schinz	H caesp	W Med		
	Anisantha madritensis (L.) Nevski subsp. *madritensis*	T scap	Med-Macar		
	Anisantha rubens (L.) Nevski	T scap	Med-Tur		
	Avena barbata Pott ex Link subsp. *barbata*	T scap	Med-Tur-Macar		
	Avena sterilis L. subsp. *sterilis*	T scap	Med-Tur-Macar	LC	
	Brachypodium distachyum (L.) P. Beauv.	T scap	Med-Tur Macar		
	Brachypodium phoenicoides (L.) P. Beauv. ex Roem. & Schult.	H caesp	W Med		
	Brachypodium sylvaticum (Huds.) P. Beauv.	H caesp	Paleotemp		
	Briza maxima L.	T scap	Paleosubtrop		
	Briza minor L.	T scap	Subcosm		
	Bromus hordeaceus L. subsp. *hordeaceus*	T scap	Subcosm		
	Catapodium rigidum (L.) C.E. Hubb.	T scap	Med-Macar		

	Cynodon dactylon (L.) Pers.	G rhiz, H rept	Subcosm	
	Cynosurus echinatus L.	T scap	Med-Macar	
	Cynosurus elegans Desf. subsp. *elegans*	T scap	Med-Macar	
	Dactylis glomerata L.	H caesp	Paleotemp	
	€ # *Drymochloa grandis* (Coss. & Durieu) Holub	G rhiz, H caesp	Alg-Tun End	
	Elytrigia repens (L.) Desv. ex Nevski	G rhiz	Circumbor	
	€ *Festuca atlantica* Duv.-Jouve ex Claus. subsp. *atlantica*	H caesp	Alg End	
	Festuca ovina L.	H caesp	W Med-Atl	
	Festuca triflora Desf.	H caesp	Iber-Mag	
	Gastridium ventricosum (Gouan) Schinz & Thell.	T scap	Med-Atl	
	Holcus lanatus L.	H caesp	Circumbor	
	Hordeum murinum subsp. *leporinum* (Link) Arcang.	T scap	Paleotemp	
	Lagurus ovatus L. subsp. *ovatus*	T scap	Med-Macar	
	Lolium rigidum Gaudin	T scap	Paleosubtrop	
	Melica arrecta G. Kunze	H caesp	W Med	
	Patzkea coerulescens (Desf.) H. Scholz	H caesp	SW Med	
	Phalaris aquatica L.	H caesp	Med-Macar	
	Piptatherum miliaceum (L.) Coss.	H caesp	Med-Macar	
	Poa bulbosa L. subsp. *bulbosa*	H caesp	Paleotemp	
	Poa trivialis L. subsp. *trivialis*	H caesp	Euras	
	Trisetum flavescens (L.) Beauv. subsp. *flavescens*	H caesp	Euras	
	Vulpia geniculata (L.) Link	T caesp	W Med-Macar	
Ranunculaceae	*Clematis cirrhosa* L.	P lian	Med-Tur	
	Clematis flammula L.	P lian, H scap	Circummed	
	Ficaria verna subsp. *grandiflora* (Robert) Hayek	G rhiz	Euras	
	Ranunculus macrophyllus Desf.	H scap, G rhiz	W Med-Macar	
	Ranunculus paludosus Poir. subsp. *paludosus*	H scap	Circummed	
	Ranunculus spicatus subsp. *blepharicarpos* (Boiss.) Grau	H scap	Iber-Mag	
Papaveraceae	*Fumaria capreolata* L. subsp. *capreolata*	T scap, T scand	Med-Macar	
Crassulaceae	*Sedum acre* subsp. *neglectum* (Ten.) Murb.	Ch succ	Eur Caucas.	
	€ *Sedum pubescens* Vahl	T scap succ	Alg-Tun End	
	Umbilicus rupestris (Salisb.) Dandy	G bulb	Med-Atl	
Fabaceae	*Astragalus hamosus* L.	T scap	Med-Tur	
	Astragalus pelecinus (L.) Barneby	T scap	Circummed	
	Calicotome spinosa (L.) Link	P caesp	W Med	
	Ceratonia siliqua L.	P scap	Circummed	LC
	Cytisus villosus Pourr.	P caesp	W Med	
	€ *Genista ferox* (Poir.) Dum. Cours.	NP, Ch suffr	Mag End	LC
	Genista tricuspidata Desf.	NP, Ch suffr	Iber-Mag	
	€ # *Genista ulicina* Spach	NP, Ch suffr	Mag End	
	# *Lathyrus niger* (L.) Bernh.	G rhiz	Eur Caucas.	LC
	Lotus corniculatus L. subsp. *corniculatus*	H scap	Paleotemp	
	Lotus edulis L.	T scap	Circummed	
	Lotus ornithopodioides L.	T scap	Circummed	

	Lotus parviflorus Desf.	T scap	Med Macar	
	Lupinus angustifolius L.	T scap	W Med	LC
	Medicago intertexta (L.) Mill.	T scap	Med-Macar	
	Medicago polymorpha L.	T scap, T rept	Paleotemp	
	€ *Ononis hispida* Desf. subsp. *hispida*	NP	Mag End	
	Scorpiurus vermiculatus L.	T scap	W Med-Macar	
	Spartium junceum L.	P caesp	Med-Macar	
	Trifolium angustifolium L.	T scap	Med-Macar	LC
	Trifolium arvense L.	T scap, H bienn	Paleotemp	
	Trifolium campestre Schreb.	T scap	Paleotemp	
	Trifolium glomeratum L.	T scap, T rept	Med-Macar	
	Trifolium phleoides Willd. subsp. *phleoides*	T scap	Circummed	
	Trifolium pratense L. subsp. *pratense*	H scap	Paleotemp	LC
	Trifolium repens L. var. *repens*	H rept	Paleotemp	
	Trifolium squarrosum L. subsp. *squarrosum*	T scap	W Med-Macar	
	Tripodion tetraphyllum (L.) Fourr.	T scap	Circummed	
	Vicia disperma DC.	T scand	W Med	
	€ # *Vicia ochroleuca* subsp. *atlantica* (Pomel) Greuter & Burdet	H scap	Alg End	
	Vicia sativa L. subsp. *sativa*	T scand	Med-Tur	LC
Rosaceae	*Agrimonia eupatoria* L. subsp. *eupatoria*	G rhiz, H scap	Eur Caucas.	
	Crataegus monogyna Jacq.	P caesp, P scap	Eur Caucas.	LC
	Geum urbanum L.	H scap	Euras	
	Potentilla micrantha Ramond ex DC.	H ros	Paleotemp	
	Prunus avium (L.) L.	P scap	Paleotemp	LC
	Prunus insititia L.	P caesp	Paleotemp	
	Rosa canina L.	NP, P caesp	Paleotemp	
	Rosa sempervirens L.	P caesp lian	Circummed	
	Rubus incanescens (DC.) Bertol.	NP scand	W Med	
	Rubus ulmifolius Schott	NP scand	Med-Macar	
	Sanguisorba minor Scop. subsp. *minor*	H scap	Circummed	
Rhamnaceae	*Rhamnus alaternus* L. subsp. *alaternus*	P caesp	Circummed	LC
Urticaceae	*Urtica membranacea* Poir.	T scap	Circummed	
Fagaceae	*Quercus canariensis* Willd.	P scap	Iber-Mag	DD
	Quercus ilex subsp. *ballota* (Desf.) Samp.	P scap, P caesp	W Med	LC
	Quercus suber L.	P caesp	W Med	LC
Violaceae	*Viola alba* subsp. *dehnhardtii* (Ten.) W. Becker	H ros	Circummed	
	Viola odorata L.	H ros	Paleotemp	
	Viola reichenbachiana Jordan ex Boreau	H scap	Euras	
Linaceae	*Linum bienne* Mill.	T scap	Med-Macar	
	€ *Linum corymbiferum* Desf. subsp. *corymbiferum*	T scap	Alg-Tun End	
	Linum tenue Desf.	T scap	Iber-Mag	
Hypericaceae	*Hypericum australe* Ten.	H scap, H bienn	W Med	
	Hypericum perfoliatum L.	H scap, Ch	Med-Macar	
	Hypericum perforatum L. subsp. *perforatum*	H scap	Subcosm	
Euphorbiaceae	# *Euphorbia biumbellata* Poir.	Ch suffr	W Med	
	Euphorbia cuneifolia Guss.	T scap	SW Med	LC

	Euphorbia medicaginea Boiss. var. *medicaginea*	T scap	Iber-Mag	
	Euphorbia paniculata Desf.	Ch suffr	Iber-Mag	LC
	Euphorbia peplus L.	T scap	W Med-Atl	
	Euphorbia pterococca Brot.	T scap	W Med-Macar	
	Mercurialis ambigua L. f.	T scap	W Med	
Geraniaceae	**€** *Geranium atlanticum* Boiss. & Reut.	H scap	Mag End	
	Geranium lucidum (Bauhin) L.	T scap	Paleotemp	
	Geranium molle L. subsp. *molle*	T scap, H scap	Paleotemp	
	Geranium purpureum Vill.	T scap, H bienn	Paleotemp	
Lythraceae	*Lythrum junceum* Banks & Sol.	H scap	W Med-Macar	LC
Myrtaceae	*Myrtus communis* L.	P caesp	Circummed	LC
Anacardiaceae	*Pistacia lentiscus* L.	P caesp, P scap	S Med-Macar	LC
Thymelaeaceae	*Daphne gnidium* L.	P caesp, NP	Med-Macar	
Cistaceae	*Cistus monspeliensis* L.	NP, Ch	Med-Macar	LC
	Cistus salviifolius L.	NP, Ch	Circummed	
	Diatelia tuberaria (L.) Demoly	G rhiz, Ch suffr	W Med-Macar	
	Fumana thymifolia (L.) Spach ex Webb subsp. *thymifolia*	Ch suffr	Circummed	
	Helianthemum syriacum (Jacq.) Dum. Cours.	Ch suffr	Circummed	
Malvaceae	*Malope malacoides* subsp. *stipulacea* (Cav.) Baker f.	H scap	W Med	
	Malva sylvestris L.	H scap, H bienn	Paleotemp	
Brassicaceae	*Alliaria petiolata* (M. Bieb.) Cavara & Grande	H bienn	Paleotemp	
	€ *Arabis pubescens* (Desf.) Poir.	H bienn	Mag End	
	Arabis turrita L.	H bienn, G rhiz	Circummed	
	Biscutella didyma L.	T scap	Med-Tur	
	Cardamine hirsuta L.	T scap	Cosm	
	Lobularia maritima (L.) Desv.	H scap, Ch suffr	Med-Macar	
	Sinapis pubescens L. subsp. *pubescens*	Ch suffr	SW Med	
Santalaceae	*Osyris alba* L.	NP, Ch	Circummed	
	Osyris lanceolata Hochst. & Steud.	NP	SW Med	LC
Polygonaceae	*Polygonum aviculare* L.	T rept	Cosm	
	Rumex conglomeratus Murray	H scap	Euras	
	Rumex crispus L. subsp. *crispus*	H scap	Subcosm	
	Rumex pulcher L. subsp. *pulcher*	H scap	Circummed	
Caryophyllaceae	*Arenaria serpyllifolia* L. subsp. *serpyllifolia*	T scap	Subcosm	
	Cerastium diffusum Pers.	T scap	Circummed	
	Cerastium glomeratum Thuill.	T scap	Cosm	
	Herniaria glabra L.	T scap, H scap	Paleotemp	
	Moehringia trinervia subsp. *pentandra* (Gay) Nyman	T scap	W Med-Macar	
	Silene coelirosa (L.) A. Br.	T scap	SW Med-Macar	
	€ # *Silene imbricata* Desf.	T scap	Alg-Mor End	
	Silene latifolia Poir.	H scap	Circumbor	
	€ *Silene patula* Desf. subsp. *patula*	H ros	Mag End	
	Silene secundiflora Otth	T scap	Iber-Mag	
	Silene tridentata Desf.	T scap	Med-Macar	
	Silene vulgaris (Moench) Garcke	H scap	Paleotemp	LC

	Stellaria media (L.) Vill.	T rept	Circummed		
	Stellaria pallida (Dumort.) Piré	T scap, H bienn	Paleotemp		
Portulacaceae	*Portulaca oleracea* L.	T rept, T scap	Subcosm		
Primulaceae	€ *Cyclamen africanum* Boiss. & Reut.	G bulb	Mag End		P
	Lysimachia arvensis (L.) U. Manns & Anderb.	T rept	Circummed		
	Lysimachia monelli subsp. *linifolia* (L.) Peruzzi	H scap	W Med		
Ericaceae	*Arbutus unedo* L.	P caesp	Med-Macar	LC	
	Erica arborea L.	P caesp, NP	W Med-Ma-car	LC	
	# *Erica scoparia* L.	P caesp, NP	W Med		
Rubiaceae	*Asperula laevigata* L.	H scap	W Med		
	Crucianella angustifolia L.	T scap	Circummed		
	Galium aparine L.	T scap, T scand	Paleotemp		
	Galium scabrum L.	H scap, Ch	W Med		
	Galium tunetanum Lam.	H scap	Iber-Mag		
	Rubia peregrina L. subsp. *peregrina*	H scand	Med-Macar		
	Sherardia arvensis L.	T scap	Circummed		
Gentianaceae	*Blackstonia perfoliata* subsp. *grandiflora* (Viv.) Maire	T scap	SW Med		
	Centaurium erythraea Rafn	H bienn, T scap	Paleotemp	LC	
Apocynaceae	*Vincetoxicum hirundinaria* Medik. subsp. *hirundinaria*	H scap	Euras		
Convolvulaceae	*Calystegia sepium* (L.) R. Br.	H scand, G rhiz	Paleotemp		
	Convolvulus althaeoides L. subsp. *althaeoides*	H scand	Circummed		
	Convolvulus tricolor L.	T scap	W Med-Macar		
Solanaceae	*Solanum nigrum* L. subsp. *nigrum*	T scap	Cosm		
Boraginaceae	*Cerinthe major* L.	T scap	W Med		
	Cynoglossum creticum Mill.	H bienn	Med-Macar		
	Echium plantagineum L.	T scap, H bienn	W Med-Macar		
	Myosotis ramosissima Rochel subsp. *ramo-sissima*	T scap	Paleotemp		
	€ # *Myosotis speciosa* Pomel	H scap	Alg-Mor End		
Oleaceae	*Olea europaea* L. subsp. *europaea*	P scap	Circummed		
	Phillyrea angustifolia L.	P caesp	W Med		
	Phillyrea latifolia L.	P caesp, P scap	Circummed	LC	
Plantaginaceae	*Kickxia commutata* (Bernh. ex Rchb.) Fritsch	H rept	Circummed		
	Linaria multicaulis subsp. *heterophylla* (Desf.) A. Sutton	H scap	SW Med		P
	Linaria reflexa (L.) Chaz. subsp. *reflexa*	T rept	Central Med		
	Plantago coronopus L. subsp. *coronopus*	H bienn, T scap	Med-Macar		
	Plantago lanceolata L. subsp. *lanceolata*	H ros	Euras		
	Plantago serraria L.	H ros	S Med-Macar		
	Veronica agrestis L.	T scap	S Eur		
	Veronica arvensis L.	T scap	Subcosm		
Lamiaceae	*Clinopodium vulgare* subsp. *arundanum* (Boiss.) Nyman	H scap, G rhiz	Iber-Mag		
	Lamium amplexicaule L. subsp. *amplexicaule*	T scap	Paleotemp		
	Lamium flexuosum Ten. subsp. *flexuosum*	H scap	NW Med		
	Lavandula stoechas L.	NP	Circummed		
	Mentha pulegium L.	H scap, G rhiz	Med-Macar	LC	

	€ # *Origanum floribundum* Munby	H scap, Ch suffr	Alg End		P
	€ *Origanum vulgare* subsp. *glandulosum* (Desf.) Ietswaart	H scap, Ch suffr	Alg-Tun End		
	€ *Phlomis bovei* de Noé subsp. *bovei*	H scap	Alg-Tun End		P
	Prasium majus L.	Ch suffr, NP	Med-Macar		
	Prunella vulgaris L.	H scap	Circumbor	LC	
	# *Scutellaria columnae* All. subsp. *columnae*	H scap	NE Med		
	Stachys ocymastrum (L.) Briq.	T scap	W Med-Macar		
	€ # *Teucrium kabylicum* Batt.	H scap	Alg End		P
	Teucrium pseudoscorodonia Desf.	Ch suffr, G rhiz	Iber-Mag		
	€ *Thymus numidicus* Poir.	Ch rept	Alg-Tun End		
Orobanchaceae	*Bartsia trixago* L.	T scap	Med-Macar		
Acanthaceae	*Acanthus mollis* subsp. *platyphyllus* Murb.	H scap	Iber-Mag		
Aquifoliaceae	*Ilex aquifolium* L.	P caesp, P scap	Circummed	LC	
Campanulaceae	*Campanula dichotoma* L. subsp. *dichotoma*	T scap	W Med-Macar		
	Campanula rapunculus L.	H bienn	Paleotemp		
	Legousia falcata (Ten.) Janch. subsp. *falcata*	T scap	Circummed		
Asteraceae	*Andryala integrifolia* L.	T scap	W Med-Macar		
	Andryala laxiflora DC.	T scap	Iber-Mag		P
	Anthemis pedunculata Desf. subsp. *pedunculata*	H scap	Iber-Mag		
	Bellis annua L. subsp. *annua*	T scap	W Med-Macar		
	Bellis sylvestris Cirillo	H ros	Circummed		
	Carlina gummifera (L.) Less.	H ros	S Med	LC	
	Carlina lanata L.	T scap	Circummed		
	Centaurea sphaerocephala L. subsp. *sphaerocephala*	H scap	W Med		
	Cichorium pumilum Jacq.	T scap	N Med		
	Coleostephus myconis (L.) Cass. ex Rchb. f.	T scap	Med-Macar		
	Dittrichia viscosa (L.) Greuter	H scap, Ch suffr	Med-Macar		
	Erigeron bonariensis L.	T scap	N Amer		
	Erigeron canadensis L.	T scap	S Amer		
	Filago argentea (Pomel) Chrtek & Holub	T rept	SW Med		
	Filago heterantha Guss.	T scap	W Med		
	Filago pyramidata L.	T scap	S Med-Tur		
	Galactites tomentosus Moench	H bienn, T scap	W Med-Macar		
	Glebionis coronaria (L.) Spach	T scap	Med-Macar		
	Helichrysum fontanesii Cambess.	Ch suffr	W Med		
	Hyoseris radiata L.	H ros	W Med		
	Hypochaeris laevigata (L.) Ces., Pass. & Gibelli	H ros	SW Med		
	Hypochaeris radicata subsp. *platylepis* (Boiss.) Jahand. & Maire	H ros	W Med-Atl		
	Klasea flavescens subsp. *mucronata* (Desf.) Cantó & Rivas Mart.	H scap	Iber-Mag		
	Leontodon tuberosus L.	H ros	W Med		
	€ *Plagius maghrebinus* Vogt & Greuter	Ch suffr	Mag End		
	Pulicaria odora (L.) Rchb.	H scap	Circummed		

	Rhaponticoides africana (Lam.) M.V. Agab. & Greuter	H scap	Iber-Mag	
	Scolymus hispanicus L.	H bienn	Med Macar	
	Senecio leucanthemifolius Poir. subsp. *leucanthemifolius*	T scap	W Med	
	Senecio vulgaris L.	T scap	Med-Macar	
	Sonchus asper (L.) Hill subsp. *asper*	T scap, H bienn	Euras	
	Sonchus oleraceus L.	T scap, H bienn	Euras	
	Tolpis virgata (Desf.) Bertol.	H scap	Circummed	
	Urospermum dalechampii (L.) Scop. ex F.W. Schmidt	H scap	W Med	
Viburnaceae	*Viburnum tinus* L.	P caesp	W Med-Macar	LC
Caprifoliaceae	€ *Knautia mauritanica* Pomel	H scap, H bienn	Mag End	
	€ # *Cephalaria mauritanica* Pomel	H scap	Alg-Mor End	
	Fedia graciliflora Fisch. & C. A. Mey.	T scap	W Med	
	Lonicera etrusca G. Santi	P lian, P caesp	Circummed	
	Lonicera implexa Aiton	P lian, P caesp	Med-Macar	
	Sixalix atropurpurea subsp. *maritima* (L.) Greuter & Burdet	H bienn	Med-Macar	
Araliaceae	€ *Hedera algeriensis* Hibberd	P lian	Alg-Tun End	
Apiaceae	€ *Ammoides atlantica* (Coss. & Dur.) H. Wolff	H ros, H bienn	Alg End	
	Ammoides pusilla (Brot.) Breistr.	T scap	W Med	LC
	€ *Conopodium glaberrimum* (Desf.) Engstrand	G bulb	Mag End	
	Daucus carota subsp. *maximus* (Desf.) Ball	H bienn, T scap	Med-Macar	
	€ *Elaeoselinum fontanesii* Boiss.	H scap	Mag End	
	Eryngium dichotomum Desf.	H scap	SW Med	
	€ *Eryngium tricuspidatum* subsp. *bovei* (Boiss.) Breton	H scap	Mag End	
	Eryngium triquetrum Vahl subsp. *triquetrum*	H scap	SW Med	
	Ferula communis L.	H scap	Circummed	LC
	Kundmannia sicula (L.) DC.	H scap	W Med	
	Oenanthe globulosa L.	H scap	W Med	LC
	Sanicula europaea L.	H scap, G rhiz	Paleotemp	
	Thapsia garganica L. subsp. *garganica*	H scap	S Med	
	# *Torilis africana* Spreng.	T scap	Paleotemp	
	Torilis arvensis subsp. *neglecta* (Spreng.) Thell.	T scap	Med-Macar-Tur	

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