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# STUDY OF THE FLORISTIC DIVERSITY OF JBEL ZERHOUN, MOROCCO

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## Abstract

The Zerhoun massif culminates at 978 m altitude in a series of mountains perpendicular to the Atlantic Ocean. The rugged relief of the dition would be a refuge for a remarkable plant biodiversity that the present study aims to evaluate. The sampling follows an altitudinal gradient. The plant material collected and identified shows the presence of 209 taxa affiliated to 156 genera and 49 families of which the best represented are: the *Fabaceae* (27), *Asteraceae* (23 taxa), *Poaceae* (22), followed by the *Lamiaceae* (16), Caryophyllaceae (11) and *Apiaceae* (11). The area hosts to 13 endemic taxa and could be considered a biodiversity hot spot.

Keywords: flora, plant inventory, species, Jbel Zerhoun, Chorology, endemism, Morocco

## INTRODUCTION

In a global context of biodiversity preservation, the study of the flora and vegetation of the Mediterranean basin is of great interest, given its great richness related to the heterogeneity of historical, paleogeographic, paleoclimatic, ecological and geological factors that characterize it, as well as the secular impact of anthropic pressure (Quezel *et al*., 1980).

Due to its Mediterranean climate, its characteristics and its geomorphological position, Morocco enjoys the existence of an extremely rich and diversified flora. Compared to other countries of the Maghreb, Morocco remains the richest in terms of floristic wealth. The Algerian flora is currently represented by 3000 species and 1000 genera (Hanifi, 1991), that of Tunisia has 2103 species and 742 genera (Nabli, 1991), while the total Moroccan flora is currently represented by 5211 species and subspecies, divided into 155 families and 981 genera (Fennane et Ibn Tatou, 2012). The present study is based on an inventory of the flora of Jbel Zerhoun, with a floristic analysis based on significant parameters: overall composition (number of taxa), endemism, rarity, geographical distribution, biological types and chorology. In comparison with other mountains in Morocco such as jbel Ayachi, jbel Maâsker (Taleb and Fennane, 2008) and Jbel Lakraa (Benarchid *et al*., 2018), Jbel Zerhoun remains the richest in terms of floristic richness. It is in this context that we undertook the study of the vascular flora of Jbel Zerhoun, in order to fill the gaps in the current state of knowledge on the vascular flora of the latter which has not yet been explored in depth and to characterize the biology, ecology, biogeography, endemism and rarity of vascular species for better management and conservation of these natural resources. Apart the passage of Sauvage (1933) and Emberger (1939), no purely botanical study has been conducted in the area except for an ethnobotanical study in the Massif de Zerhoun (Slimani *et al.*, 2016) which identified 111 medicinal plants used by the natives in phytotherapy.

## MATERIALS AND METHODS

### Study Area

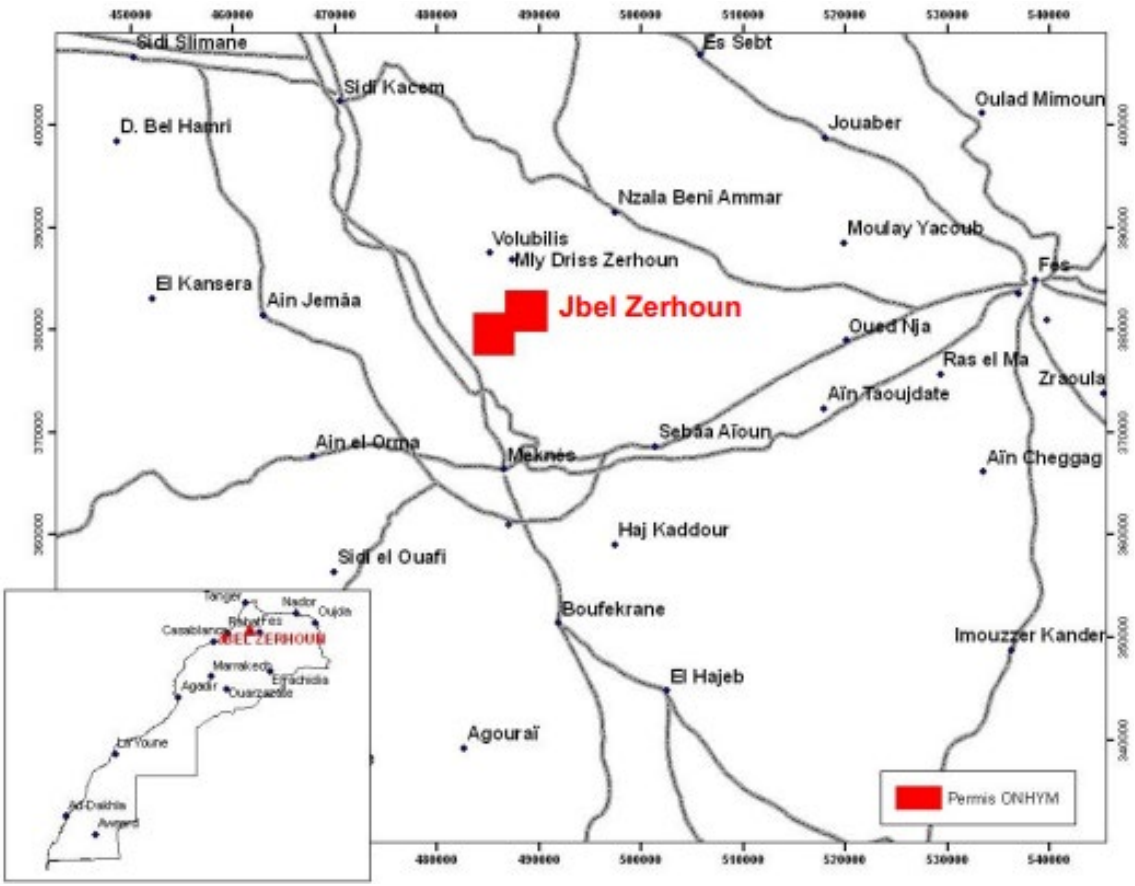
Jbel Zerhoun, is a whole mountain ridge, is located in the “Moulay Driss Zerhoun ( = Massif Zerhoun)” urban commune, 25 km north of the city of Meknes.

The area is administratively part of the province of Meknes, northern Morocco. The Jbel Zerhoun occupies the western part of the southern branch of the eastern South African arc; it has a general E-W to ESE-WNW orientation. It is a subvertical to overturned south-facing propagating fold (Bargach, 2011).

The climatic data closest to Jebl Zerhoun are recuperated from the Meknes station. The climate of the Meknes region is typically Mediterranean, with very hot and dry summers and not very cold winters. The bioclimate is semi-arid at the foot of the massif and sub-humid at higher altitudes. The average annual temperature calculated for the period (1991–2020) is 17.9 °C (Infoclimat, 2022). Maximum and minimum temperatures during the year 2022 are 25.1 °C and 11.1 °C respectively. Elevations across the massif range from less than 300 m in the fertile plain west of Moulay Idriss Zerhoun, to the summit of Jbel Zerhoun, which rises to more than 1,000 m. Average annual precipitation is 580 mm (CCA, 2018; Kmoch *et al.*, 2018; Infoclimat, 2022; Boudik *et al.*, 2023).

From the geological point of view, the sector of Jbel Zerhoun is located in the domain of the prerifane wrinkles which is individualized at the top of the Middle Lias in the continental platform. According to ONHYM (2012), the carbonate sedimentation dominates the Jurassic series ends with marnocalcareous sandstones, limestones, and dolomites; these sandstones, generally very coarse, are known as «Sandstone of Zerhoun». If the presence of these sandstones is noted in most of the prerifane wrinkles, they are very developed on Jbel Zerhoun where they are intercalated in carbonate or clay-carbonate sediments (Faugères *et al.*, 1976). The Zerhoun massif is crossed, in its eastern part, by a fault that passes through the anticlinal hinge separating an external flank with an incomplete Jurassic series (Lower and Middle Liassic) from an internal flank with a more complete Jurassic series (Liassic and Bajocian). This normal and synsedimentary fault has caused a subsidence of the northern compartment and an uplift of the southern one (Haddaoui *et al.*, 1997).

The vegetation of the area described by Sauvage (1933), shows plant formations with *Chamaerops humilis, Oleo-lentiscetum* with facies with *Calycotome intermedia* and facies with *Ziziphus lotus*, green oak forest, with facies with *Pistacia terebinthus* and facies with *Adenocarpus transiens* and cistaie. Apart from these botanical descriptions and those of Emberger (1939), which are quite summary, no thorough investigation has been undertaken on the plant diversity of the area. The main crops grown in the area are cereals, vegetables, olives and oranges.




1: *Geographical location map (ONHYM, 2012)*

I: *Geographical coordinates, altitude and substrate type of the surveys carried out at Jbel Zerhoun*

| Survey | GPS coordinates | Altitude (m) | Substrate |
|---|---|---|---|
| R1 | 34°1'35"N, -5°29'43"W | 895 | Limestone |
| R2 | 34°1'27"N, -5°31'40"W | 741 | marl-limestone |
| R3 | 34°1'25"N, -5°31'56"W | 699 | marl-limestone |
| R4 | 34°2'11"N, -5°29'32"W | 826 | Limestone |
| R5 | 34°2'8"N, -5°29'44"W | 897 | Limestone sandstone |
| R6 | 34°1'53"N, -5°30'18"W | 971 | Limestone |
| R7 | 34°1'54,6"N, -5°31'18,5"W | 978 | Limestone sandstone |
| R8 | 34°1'48,2"N, -5°31'23,1"W | 871 | Limestone sandstone |
| R9 | 34°1'55"N, -5°30'20"W | 949 | Limestone sandstone |
| R10 | 34°1'33"N, -5°33'12"W | 608 | Limestone sandstone |
| R11 | 34°8'50"N, -5°32'3"W | 749 | Limestone |
| R12 | 34°1'11,3"N, -5°29'4,6"W | 929 | Limestone |
| R13 | 34°1'36"N, -5°33'59"W | 656 | Limestone |

## Methodology

The sampling adopted is a stratified type according to an altitudinal gradient. Jbel Zerhoun has been explored from all sides, covering the entire area. The factors considered are altitude, exposure, slope, and geological substrate. Thus, 13 floristic surveys of 400 $m^2$ each were conducted, taking care to note for each survey, the geographical coordinates using a GPS device (GPS essentials), (Tab. I).

In the laboratory, we proceeded to the determination of the collected species through specialized documents (Fennane *et al*., 1999, 2007, 2014; Quezel and Santa 1962, 1963). After identification, the samples were dried and stored in an herbarium. According to the phylogenetic classification (APG IV, 2016), the determined species are classified by family and in alphabetical order starting with Pteridophytes, then Gymnosperms and finally Angiosperms and, the nomenclature of plant taxa follow the International Plant Names Index (IPNI, https://www.ipni.org/).

Subsequently, based on the Catalogue of rare, threatened or endemic vascular plants of Morocco (Fennane and Ibn Tattou, 1998) and the Red Book of the vascular flora of Morocco (Fennane, 2021), we selected the rare, threatened or endemic species as well as the conservation status of each taxon present in the dition, adopting the same abbreviations. For each species, the scientific name, biological type, range in the geographical divisions of Morocco are mentioned (Fennane *et al*., 1999, 2007, 2014).

The chorology of the species on a global scale is then specified according to Fennane and Ibn Tattou, (2005); Ibn Tattou and Fennane (2008); Quezel and Santa (1962–1963).

## RESULT

The inventories carried out in Jbel Zerhoun following the altitudinal gradient in surveys large enough to note almost all the species of the association individual, have led us to establish a catalog of 209 taxa (Tab. II).

II: *Floristic list, Life forms spectrum, assessment criteria (Fennane, 2021), rarity and endemism (Fennane & Ibn Tattou, 1998) of flora of Jbel Zerhoun, Morocco*

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| I. PTERIDOPHYTES | | | | | | |
| ASPLENIACEAE | | | | | | |
| *Asplenium adiantum-nigrum* L. | G | LC | | R12 | AA, HA, Man | Subcosmp |
| *Asplenium trichomanes* L. | Hem | LC | | R5, R9 | HA, MA, Mam, Man, Om, LM, R | Subcosmp |
| *Asplenium Ceterach* L. | G | LC | | R4, R5, R12 | As, AA, HA, MA, Mam, Man, Om, LM, R | Euras.-temp |
| PTERIDACEAE | | | | | | |
| *Pteridium aquilinum* (L.) Kuhn. | G | LC | | R6, R7 | HA, MA, Man, R | Subcosmp |
| SELAGINELLACEAE | | | | | | |
| *Selaginella denticulata* (L.) Spring. | Hem | LC | | R4 | HA, MA, Mam, Man, Om, LM, R | Atl-Med |
| II. GYMNOSPERMS | | | | | | |
| CUPRESSACEAE | | | | | | |
| *Juniperus oxycedrus* L. | Ph | LC | | R13 | As, AA, HA, MA, Man, Om, LM, R | Atl. Circum. Med |
| III. ANGIOSPERMAE, MONOCOTYLEDONAE | | | | | | |
| AMARYLLIDACEAE. | | | | | | |
| *Allium paniculatum* L. | G | LC | | R10 | A, Sad, SAf, SH, H | Paleo-temp. |
| ARACEAE | | | | | | |
| *Arisarum vulgare* O.Targ.Tozz. | GT | LC | | R4, R5, R6, R9, R10, R11, R12 | All geographic divisions | Circum. Med. |
| ARECACEAE | | | | | | |
| *Chamaerops humilis* L. | Ph | LC | | R1, R2, R3, R4, R6, R8, R9, R10, R11, R12, R13 | AA, HA, MA, Mam, Man, Om, LM, R | W. Med. |
| ASPARAGACEAE | | | | | | |
| *Asparagus albus* L. | Ph | LC | | R10 | AA (Tazeroualt; j. Kest) HA, MA, Mam, Man, Op, Om (Bni Snassène), LM, R. | W Med. |
| *Asparagus aphyllus* L. | Ph | LC | | R7 | Mam (Haouz Rehamna), Man, Op, LM, West? R | W. Med |
| *Asparagus horridus* L. | Ch | LC | | R4, R5, R7 | All geographic divisions | Macar. Med. |
| *Drimia maritima* (L.) Stearn. | G | LC | | R2, R3, R5, R6, R8, R9, R10, R11, R13 | All geographic divisions | Can. Med |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| *Hyacinthoides lingulata* Poir. | G | LC | | R4 | Mam (Chaouia- Doukkala), Man, Om (Bni Snassène), LM, R | ENA |
| *Muscari comosum* (L.) Mill. | G | LC | | R4 | As, AA, HA, MA, Mam, Man, Op, Om (Guenfouda), LM, R | Med |
| ASPHODELACEAE | | | | | | |
| *Asphodelus ramosus* L. | G | LC | | R3, R10, R13 | All geographic divisions | Can. Med |
| DIOSCOREACEAE | | | | | | |
| *Dioscorea communis* (L.) Caddick & Wilkin. | G | LC | | R5, R12 | AA (Ifni Mountains), HA, MA, Mam, Man, Om, LM? R | Atl. Med |
| LILIACEAE | | | | | | |
| *Gagea durieui* Parl. ex Trab. | G | LC | EIA | R7 | AA, HA, MA, Mam, Man, Op, Om, LM, R | S Spain; Morocco; Algeria. |
| ORCHIDACEAE | | | | | | |
| *Ophrys fusca* subsp. *durieui* (Rchb.f.) Soó | G | EN | RR | R4 | MA (j. Rhnim), Man (Zerhoun; Ain Cheggag), Om. | Sicily. |
| *Ophrys lutea* Cav. | G | LC | | R12 | HA, MA, Mam, Man, Om, LM, R | Med. |
| POACEAE | | | | | | |
| *Aira caryophyllea* L. | Th | LC | | R1 | HA?, MA, (Tazekka) Man, LM?, R | Subcosmop. |
| *Alopecurus arundinaceus* Poir. | Hem | LC | | R4 | AA, HA, MA, Man (Prerif-Middle Sebou), Op, Om (Debdou), LM? R | Med, W Asia and Macar. |
| *Anthoxanthum odoratum* L. | Hem | LC | | R2, R13 | HA, (j. Gourza; j. Guerdouz; Zerektène), MA, Man (Bou-charen near Larache), Om (Debdou), R (Timellatine; Jbel Lakraâ) | Circumbor. |
| *Avena sterilis* L. | Th | LC | | R10 | All geographic divisions | Macar. -Med-Irano-Tour. |
| *Brachypodium distachyon* (L.) P. Beauv. | Th | LC | | R1, R3, R8 | All geographic divisions | Paleo-subtrop. |
| *Briza maxima* L. | Th | LC | | R9 | HA, MA, Mam, Man, Om, LM, R | Paleo-subtrop. |
| *Briza minor* L. | Th | LC | | R6, R9 | AA, HA, MA, Mam, Man, Om, LM, R | Subcosmop. |
| *Bromus hordeaceus* L. | Th | LC | | R1, R3, R4, R5, R6, R7, R8, R10, R12, R13 | Ms (O. Aâbar in N of Abattih on Smara-Tantan road), AA, HA, MA, Mam, Man, Op, Om, LM, R | Paleotemp. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| *Bromus madritensis* L. | Th | LC | | R8 | Ms (Assa), As, AA, HA, MA, Mam (W of Chichaoua; Amsittène), Op, (Oulad Settout, Moulouya alluvium), Om, (Jerada)? LM, R | Eur. Med. |
| *Catapodium rigidum* (L.) C.E. Hubb. | Th | LC | | R6, R13 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Macar. -Euras. |
| *Cynosurus echinatus* L. | Th | LC | | R5, R6, R9, R12 | MA, Man, Om (Bni Snassène), LM, R | Med.-Macar. |
| *Dactylis glomerata* L. | Th | LC | | R13 | As, AA, HA, MA, Mam, Man, Op, Om, LM, R | Med; Macar; Euras. |
| *Festuca geniculata* (L.) Lag. & Rodr | Th | LC | | R10 | As, AA, HA, MA, Mam, Man, Op, Om, LM, R | Med. Macar. |
| *Gastridium ventricosum* (Gouan) Schinz & Thell. | Th | LC | | R13 | Ms (O. Noun to Sidi Aroussi, 20 km W of Abouda), AA, HA, Mam, Man, Om, LM, R | Med. |
| *Hyparrhenia hirta* (L.) Stapf. | Hem | LC | | R2, R3, R8, R10, R13 | Ms (lower valley of the western Draâ)?, MA (around Taza, 930 m), Mam (Marrakech)?, Man, LM, R | Paleotrop. |
| *Lagurus ovatus* L. | Th | LC | | R4 | All geographic divisions | Macar. -Med. |
| *Lamarckia aurea* (L.) Moench. | Th | LC | | R13 | All geographic divisions | Macar. -Med.-Ethiopia |
| *Melica minuta* L. | Hem | LC | | R1, R3, R5, R11, R13 | HA, MA, Man, Op, Om, LM, R | Med; Canary Islands. |
| *Oloptum miliaceum* (L.) Röser & Hamasha | Hem | LC | | R4, R8 | All geographic divisions | Med-Irano-Tour. |
| *Patzkea coerulescens* (Desf.) H.Scholz | Hem. | LC | | R11 | AA, HA, MA, Mam, Man, Om, (Bni Snassène), LM, R | Iber. -Maur. -Sicily. |
| *Piptatherum caerulescens* (Desf.) Beauv. | Hem | LC | | R1, R5 | All geographic divisions | Med. |
| *Stipellula capensis* (Thunb.) Röser & Hamasha | Th | LC | | R3, R10, R11, R13 | All geographic divisions | Circummed. |
| SMILACACEAE | | | | | | |
| *Smilax aspera* L. | Ph | LC | | R1, R3, R4, R5, R6, R7, R8, R9, R11, R12 | As, AA, HA, MA, Mam, Man, Om, LM, R | Macar. Med, Ethiopia, India. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| IV. ANGIOSPERMAE, DICOTYLEDONAE | | | | | | |
| ADOXACEAE | | | | | | |
| *Viburnum tinus* L. | Ph | LC | | R4, R5, R6, R7, R8, R9, R12 | HA, MA, Man, Om (Bni Snassène), LM, R | Med. |
| ANACARDIACEAE | | | | | | |
| *Pistacia lentiscus* L. | Ph | LC | | R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13 | As, AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Pistacia saportae* Burnat. | Ph | NA | | R3 | MA (gorges around Taza; Atchana on the E side of Guelb Errahal), Rif (gorges around Boured) | Western Med. |
| *Pistacia terebinthus* L. | Ph | LC | | R1, R9, R10, R11 | All geographic divisions | Med. |
| *Searsia pentaphylla* (Jacq.) Desf. | Ph | LC | | R13 | All geographic divisions | W Med. |
| APIACEAE | | | | | | |
| *Ammoides pusilla* (Brot.) Breistr. | Th | LC | | R13 | MA, Mam, Man, Op (between Mezguittem and Saka), Om (Bni Snassène), LM, R | Med. |
| *Eryngium campestre* L. | Hem | LC | | R2, R10, R13 | HA, MA central, Mam, Man (Prerif) Om (Bni Snassène), LM, R | Eur. Med. |
| *Eryngium tricuspidatum* L. | Hem | LC | | R4, R6, R8, R9, R10, R12 | Ms, AA, HA, MA, Mam, Man, Om, LM, R | W. Med. |
| *Eryngium triquetrum* Vahl. | Hem | LC | | R10 | HA, MA, Mam, Man, Op, Om, LM, R | N Afr- Sicily. |
| *Kundmannia sicula* (L.) DC. | G | LC | | R5, R9, R12 | AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Scandix pecten-veneris* L. | Th | LC | | R9 | All geographic divisions except Ms | Eur. Med. |
| *Thapsia foetida* L. | G | LC | | R8 | AA, HA, MA, Mam, Man, R | N Morocco and SW Iberian Peninsula. |
| *Thapsia garganica* L. | G | NA | | R10 | Ms?, HA, MA, Mam, Man Op Om LM R. | Med. |
| *Thapsia meoides* (Desf.) Guss | G | LC | R? | R4, R13 | AA (Ifni mounts), HA (j. Ouaskal; Isk Rached), MA (Bab Azhar; between Ouaouizaght and Taguelft), Mam (Souss; Derouate; Jbilète) | Med. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| *Torilis arvensis* (Huds.) Link. | Th | LC | | R1, R7, R9, R12 | HA, MA, Mam, Man, Op, Om, LM, R | Paleo-Temp. |
| *Torilis nodosa* (L.) Gaertn. | Th | LC | | R13 | All geographical divisions of Morocco | Euras. |
| ARISTOLOCHIACEAE | | | | | | |
| *Aristolochia baetica* L. | Ph | LC | | R13 | AA, HA, Mam, Man, Om, LM, R | Iberian-Mar. |
| ASTERACEAE | | | | | | |
| *Andryala integrifolia* L. | Th | LC | | R4, R8 | AA, HA, MA, Mam, Man, Op, LM, R | W.Med. |
| *Atractylis cancellata* L. | Th | LC | | R1, R2, R8, R11 | All geographic divisions | Circummed. |
| *Bellis annua* L. | Th | LC | | R4 | HA, MA, Mam, Man, Op, Om, LM, R | Circummed. |
| *Calendula arvensis* L. | Th | LC | | R2 | All geographic divisions | Sub- Med. |
| *Carduus myriacanthus* DC. | Th | LC | | R5 | Mam, Man, LM, R | S and SW Spain; NW Africa. |
| *Carduus pycnocephalus* L. | Hem | LC | | R13 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Euras. |
| *Carlina hispanica* Lam. | Hem | LC | | R1, R2, R3, R13 | HA (Ayachi), MA, Mam, Man, Op, Om, LM, R | Euras. |
| *Carlina racemosa* L. | Th | LC | | R8 | HA, MA, Mam, Man, Om, LM, R | Iberia. N Afr., Sicily |
| *Centaurea melitensis* L. | Th | LC | | R1, R3 | Circummed. Ms Oriental, As, AA, HA, MA, Mam, Man, Op, Om, LM, R. | Circummed. |
| *Centaurea pullata* L. | Hem | LC | | R2 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Med. |
| *Centaurea sulphurea* Willd. | Th | LC | | R1, R2, R3, R4, R8, R13 | AA (Ifni Mountains), HA, MA, Mam, Man, Op (Lower Moulouya), Om, LM, R | Iberian.-Maur. |
| *Cirsium ducellieri* Maire. | Hem | CR | E; RR | R13 | MA (Bekrit; Senoual valley to Aghbalou Bou- Ichatefel), Man, (Prerif) | Morocco |
| *Cladanthus mixtus* (L.) Chevall. | Th | LC | | R1, R8 | HA, MA, Mam, Man, Op, Om, LM, R | Med. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| *Cynara humilis* L. | G | LC | E IAC? | R8 | HA, MA, Mam, Man, LM western, R | Iberian-Maur. |
| *Filago germanica* L. | Th | LC | | R2, R3, R11 | HA, MA, Mam, Man, Op, Om, LM, R | Eur. |
| *Filago pyramidata* L. | Th | LC | | R1, R4, R8, R9, R13 | Ms, AA, HA, MA, Mam, Man, Op, Om, LM, R | Med. |
| *Leontodon saxatilis* Lam. | Th | LC | | R13 | AA Western, HA, MA, Mam, Man, Op, Om, LM, R | W Med. |
| *Logfia gallica* (L.) *Coss. & Germ.* | Th | LC | | R6, R8, R10, R11 | AA, HA, MA, Mam, Man, Op (lower Moulouya), Om, LM, R | Submed, SubAtl. |
| *Pallenis spinosa* (L.) Cass. | Hem | LC | | R1, R2, R3, R8, R11, R13 | All geographic divisions | Eur-Med. |
| *Phagnalon rupestre* (L.) DC. | Ch | LC | | R1, R3 | Oceanic Ms (Hassi Zehar; ...?), HA, MA, Mam, Man, Op (lower Moulouya), Om, LM, R | Circummed. |
| *Phagnalon saxatile* (L.) Cass. | Ch | LC | | R1, R3, R4, R5, R7, R8, R9, R10, R11, R12, R13 | Oceanic Ms, (NE of Tan-Tan; SW of Ait Jerrar), AA, HA, MA, Mam, Man, Op, Om, LM, R | W. Med. |
| *Tolpis barbata* (L.) Gaertn. | Th | LC | | R10 | Man, Op, Om, LM, R | Med. |
| *Urospermum picroides* (L.) Scop. ex F.W.Schmidt. | Th | LC | | R9, R11, R12 | All geographic divisions | S and EW Eur., N Afr., W and SW Asia and Macar. |
| BORAGINACEAE | | | | | | |
| *Buglossoides arvensis* (L.) I.M. Johnst. | Th | LC | | R8 | All geographic divisions except Ms. | Med. |
| *Cynoglossum clandestinum* Desf. | Th | LC | | R4 | Ms (Guelmim), AA, HA, MA central (around Itto), Mam, Man, Op, Om, LM, R | W Med. |
| *Echium creticum* L. subsp. *Creticum* | Th | NA | | R2 | Non-Saharan Morocco | W Med. |
| *Neatostema apulum* (L.) I.M. Johnst. | Th | LC | | R4, R10 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Med. |
| BRASSICACEAE | | | | | | |
| *Alyssum alyssoides* (L.) L. | Th | LC | R | R13 | HA (J. Maâsker, 2800 m), MA (Ifrane; Aguelmame Sidi Ali), Op (east of Midelt), R (J. Lakrâa) | Eur., NW Afr SW Asia to India. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| *Arabis hirsuta* (L.) Scop. | Hem | NA | RR | R5 | MA (Bou-Iblane, Meskdal about 2200 m); (n.v). | Circum-bor. |
| *Biscutella didyma* L. | Th | LC | | R2, R4, R13 | All geographic divisions | Med. |
| CAMPANULACEAE | | | | | | |
| *Campanula dichotoma* L. | Th | LC | | R4, R11, R13 | All geographic divisions | Med. |
| *Campanula lusitanica* L. | Th | LC | EI | R4, R5, R12 | AA, HA, MA, Mam, Man, Om, LM, R | Spain; Portugal; NW Africa |
| *Campanula rapunculus* L. | Hem | LC | | R4 | Western AA, HA, MA, Mam, Man, Om, LM, R | Eur. Med. |
| *Feeria angustifolia* (Schousb.) Buser | Ch | LC | E | R11 | HA, MA, Mam, Man, Op (lower Moulouya), R | Morocco |
| CAPRIFOLIACEAE | | | | | | |
| *Lonicera implexa* Aiton | Ph | LC | | R1, R3, R4, R5, R6, R7, R9, R12 | As, AA, Western HA, MA, Mam, Man, Om, LM, R | Med. and Macar. |
| *Scabiosa atropurpurea* L. | Hem | LC | | R1, R2, R3, R4, R5, R8, R11 | HA, MA, Mam, Man, Om, LM, R | Med. |
| *Valeriana calcitrapae* L. | Th | LC | | R1 | AA, HA, MA, Mam, Man, Om (Bni Snassène), LM, R | Med. and Macar. |
| CARYOPHYLLACEAE | | | | | | |
| *Cerastium glomeratum* Thuill. | Th | LC | | R6, R9 | All geographic divisions except Ms. | Cosmop. |
| *Dianthus lusitanus* Brot. | Ch | LC. | EIA | R2 | As, AA, HA, MA, Mam, Man, R (Bni Hosmar; Ketama) | Iberian-Mar. |
| *Dianthus nudiflorus* Griff. | Th | LC | | R13 | As, AA (Tafraoute), HA, MA, Man, Om, R | Med. |
| *Herniaria hirsuta* L. | Th | LC | R | R13 | Mam (Safi), Man (Larache; Mehdiya), LM (Melilia), R (Tetouan; Tangier) | Med. |
| *Paronychia argentea* Lam. | Hem | LC | | R4 | Ms, AA, HA, MA, Mam, Man, Op, R | Med. |
| *Paronychia capitata* (L.) Lam. subsp. *Capitata.* | Hem | LC | | R1, R10 | All geographic divisions except Ms | Med. |
| *Paronychia chlorothyrsa* Murb. | Hem | LC | | R3 | All geographic divisions | Med. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| *Paronychia echinulata* Chater. | Th. | LC | | R4, R5, R8, R11, R13 | HA (Mgouna; Iouaridène), MA, Mam (Khénifra), Man, LM (Melilia), R | Med. |
| *Polycarpon tetraphyllum* (L.) L. | Th | LC | | R4, R6, R24, R38, R39, R13, R40 | Ms, AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Silene gallica* L. | Th | LC | | R4, R47 | All geographic divisions except Ms and As | Paleo-temp. |
| *Silene vulgaris* (Moench) Garcke. | G | LC | | R4, R9, R37 | All geographic divisions | Euras, N Afr, and Mar. |
| CISTACEAE | | | | | | |
| *Cistus albidus* L. | Ph | LC | | All relevés (R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13), | Mam, Man, Om, LM, R | W Med. |
| *Cistus salviifolius* L. | Ch | LC | | R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12 | AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Fumana fontanesii* Clauson ex Pomel. | Ph | LC | | R2, R8 | HA, MA, Mam, Man, R | SE Iberian Peninsula, Morocco |
| *Fumana thymifolia* (L.) Spach ex Webb. | Ch | LC | | R2, R3, R11 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Med. |
| CONVOLVULACEAE | | | | | | |
| *Convolvulus althaeoides* L. | Hem | LC | | R1, R2, R3, R8, R9, R10, R11, R12, R13 | All geographic divisions, rare in arid and desert regions | Macar. Med. |
| *Cuscuta epithymum* (L.) L. | Th | LC | | R3 | Non-Saharan Morocco | Cosmop. |
| CRASSULACEAE | | | | | | |
| *Petrosedum forsterianum* (Sm.) Grulich | Ch | LC | | R12 | MA, Man, R | W Eur. Mar. |
| *Umbilicus rupestris* (Salisb.) Dandy. | G | LC | | R5, R10 | HA, MA, Mam, Man, Om, LM, R | Atl. Med. |
| ERICACEAE | | | | | | |
| *Arbutus unedo* L. | Ph | LC | | R1, R4, R5, R6, R7, R8, R9, R12 | AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| EUPHORBIACEAE | | | | | | |
| *Euphorbia dracunculoides* subsp. *glebulosa* (Coss. & Durieu) Maire. | Hem | LC | | R13 | Ms, As, HA, Mam (Souss), Man?, LM, R oriental., | Algeria; Tunisia; Libya. |
| *Euphorbia falcata* L. | Th | LC | | R10 | All geographic divisions except Ms | Med. As. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| *Euphorbia medicaginea* Boiss. | Th | LC | | R13 | MA, Mam, Man, Om (Bni Snassène), LM, R | Iberian. Maur. |
| *Mercurialis annua* L. | Th | LC | | R13 | All geographic divisions | Med. W As. |
| FABACEAE | | | | | | |
| *Adenocarpus telonensis* (Loisel.) DC. | Ph | LC | | R1, R4, R5, R6, R7, R8, R9, R12 | MA, Man (Zerhoun; Zgharine), R | Iberian Peninsula, Fr. and Mar. |
| *Anthyllis hamosa* Desf. | Th | LC | | R2, R10, R11, R13 | AA, Western Mam, Man, R. | Iberian. Maur. |
| *Anthyllis vulneraria* L. | Hem | LC | | R3 | Non-Saharan Morocco | Eur. Med. |
| *Biserrula epiglottis* (L.) Coulot, Rabaute & J.-M.Tison | Th | LC | | R10, R13 | AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Calicotome infesta* (C. Presl) Guss.. | Ph | LC | | R3, R10 | MA, Man (Prerif; middle Sebou), Om LM, R | S and SW Esp. NW Afr. |
| *Ceratonia siliqua* L. | Ph | LC | | R1, R3, R4, R10, R11, R13 | As, AA, HA, MA, Mam, Man, Op?, Om, LM, R | Med. |
| *Coronilla valentina* subsp. *pentaphylla* (Desf.) Batt. | Ph | LC | | R1 | HA, MA, Mam (Bni Moussa), Man (Prerif), Om (Bni Snassène), LM. | Med. |
| *Coronilla valentina* L. | Ph | LC | | R9, R12 | AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Coronilla viminalis* Salisb. | Ph | LC | EC | R3, R11 | Ms (O. Noun; Khneg Lehmam), AA, HA, MA, Mam, Man, Op (NE of Midelt), R | Canares; Morocco |
| *Cytisus arboreus* (Desf.) DC. | Ph | LC | | R1, R3, R7, R9, R12 | AA, HA, MA, Mam, Man, Om, LM, R | W. Med. |
| *Ebenus pinnata* Aiton. | Ch | LC | | R1, R3 | AA, HA, MA, Mam, Man, Op, Om, LM, R | ENA. |
| *Erophaca baetica* (L.) Boiss. | G | LC | | R1, R2, R3, R4, R5, R6, R8, R9, R11, R12 | AA, HA, Mam, Man, Om (Bni Snassène), LM, R | Med. |
| *Lotus rectus* L. | Ch | DD | | R3 | AA (o. Noun), HA, MA, Mam, Man, Om (Bni Snassène), R. | Med. |
| *Medicago minima* (L.) L. | Th | LC | | R8, R13 | All geographic divisions | Eur. Med. |
| *Ononis natrix* L. | Ch | LC | | R3, R11 | All geographic divisions | Med. |
| *Ononis thomsonii* Oliver. | Hem | NT | E | R8 | AA (Saghro), HA, MA, Man (Zerhoun), R (j. Lakraâ; j. Kelti) | Morocco |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| *Ornithopus compressus* L. | Th | LC | | R4 | AA, HA, MA, Mam, Man, R | Med. |
| *Scorpiurus muricatus* L. | Th | LC | | R8 | (Ms), AA, HA, MA, Mam, Man, Op, Om, LM, R | Med. |
| *Trifolium angustifolium* L. | Th | LC | | R1, R2, R4, R8, R9, R10, R11 | AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Trifolium campestre* Schreb. | Th | LC | | R4, R5, R6, R7, R9, R12 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Paleo-temp. |
| *Trifolium cherleri* L. | Th | LC | | R4 | HA, MA, Mam (Chaouia-Doikkala), Man, Om (Bni Snassène)?, LM, R | Med. |
| *Trifolium stellatum* L. | Th | LC | | R2, R5, R12 | Western AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Trifolium tomentosum* L. | Th | LC | | R5, R12 | AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Vicia benghalensis* L. | Th | LC | | R4 | All geographic divisions | Med. |
| *Vicia disperma* DC. | Th | LC | | R4 | Western AA, MA, Mam, Man, Om (Bni Snassène), LM, R | W Med. |
| *Vicia lutea* L. | Th | LC | | R4 | All geographic divisions | Med. |
| *Vicia sativa* L. subsp *sativa.* | Th | LC | | R4 | Northern Morocco and else where | Med; Macar ; Eur ; Asia |
| FAGACEAE | | | | | | |
| *Quercus rotundifolia* lam. | Ph | LC | | R1, R2, R3, R4, R5, R6, R7, R8, R9, R12 | All geographic divisions except Ms and Op | Med. |
| *Quercus suber* L. | Ph | LC | | R1 | HA, MA, Man, Om, LM, R | W. Med. |
| GENTIANACEAE | | | | | | |
| *Blackstonia perfoliata* (L.) Huds. | Th | LC | | R4, R6 | HA, MA, Man, Om, LM, R | Med. |
| *Centaurium erythraea* Rafn. | Th | DD | | R4 | Western AA, HA, MA, Mam, Man, Om, LM, R | Eur. Med. |
| *Schenkia spicata* (L.) G.Mans. | Th | NT | | R11 | Ms, As?,Western AA, HA, MA, Mam, Man, Om (Bni Snassène), LM, R | Med. |

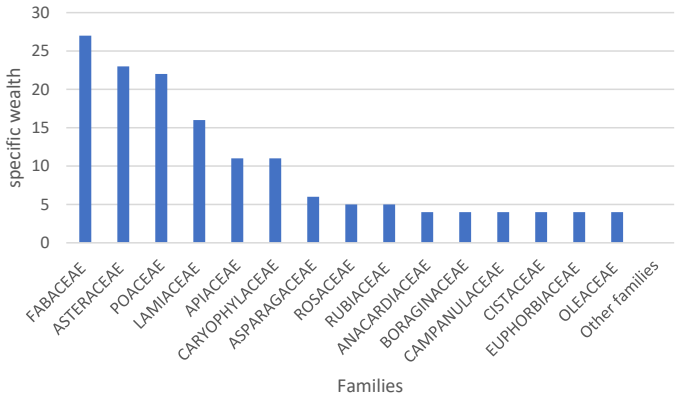
| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| GERANIACEAE | | | | | | |
| *Erodium alnifolium* Guss. | Th | NA | RR | R4 | Man (J. Zerhoun) | C. Med. |
| *Geranium purpureum* Vill. | Th | LC | | R5, R6, R7, R9, R12 | AA, HA, MA, Mam, Man, Om, LM, R | Cosmop. |
| *Geranium rotundifolium* L. | Th | LC | | R9 | All divisions except Ms | Eur. |
| HYPERICACEAE | | | | | | |
| *Hypericum montanum* L. | Ch | NT | | R6 | MA Man (Zerhoun) R | Eur.; Asian |
| *Hypericum perfoliatum* L. | Ch | LC | | R4, R8 | Mam Man Om LM R | Med. Macar. Eur. Asia |
| LAMIACEAE | | | | | | |
| *Ajuga iva* (L.) S chreb. | Hem | LC | | R1 | All geographic divisions | Med. |
| *Cleonia lusitanica* (L.) L. | Th | LC | | R1, R2, R3, R10 | HA, MA, Mam, Man, Op (Bni Snassène), LM, R | Iberian-Maur. |
| *Clinopodium nepeta* (L.) Kuntze | Ch | LC | | R4, R5, R7, R9 | HA MA Man Om LM R | Euras. |
| *Lavandula multifida* L. | Ch | LC | | R2, R3, R10, R11, R13 | All geographic divisions (except Non-Saharan Morocco) | Med. |
| *Lavandula stoechas* L. | Ch | LC | | R2, R4, R5, R7, R8, R10, R12 | Mam, Man, LM, Om, R | Med. |
| *Mentha pulegium* L. | Hem | LC | | R5 | All geographic divisions (except Non-Saharan Morocco) | Euras. |
| *Origanum compactum* L. | Ch | VU | EI | R4 | MA, Mam, Man, R | S Spain; N Africa |
| *Phlomis herba-venti* L. | Hem | LC | | R4 | Ms?, As, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Prasium majus* L. | Ph | LC | | R3, R10 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Med. |
| *Pseudodictamnus hirsutus* subsp. *Hirsutus* | Ch | LC | | R10 | All geographic divisions (except Non-Saharan Morocco) | Iberian-Maur. |
| *Salvia verbenaca* L. | Hem | LC | | R2 | All geographic divisions | Med. Atl. |
| *Stachys ocymastrum* (L.) Briq. | Th | LC | | R13 | Morocco not Saharan | W. Med. |
| *Teucrium decipiens* Coss. & Balansa. | Th | LC | E | R1, R4, R10, R11, R13 | HA, MA, Mam, Man, Om (Bni Snassène), LM, R | Morocco |
| *Teucrium fruticans* L. | Ph | LC | | R4, R12 | (Ms), AA, HA, MA, Mam, Man, Om, LM, R | Med. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| *Teucrium polium* L. | Ch | LC | | R2, R3 | HA, MA, Mam, Man, Op, Om, LM, R | Eur. Med. |
| *Teucrium pseudo-chamaepitys* L. | Ch | LC | | R1, R2, R3 | HA, MA, Mam, Man, Op, Om, LM, R | W Med. |
| LINACEAE | | | | | | |
| *Linum strictum* L. | Th | LC | | R2, R8, R13 | All geographic divisions | Med. |
| *Linum usitatissimum* L. | Th | NA | | R10 | Cultivated and subspontaneous especially in Mam Man, LM, R | Med. |
| MALVACEAE | | | | | | |
| *Malva hispanica* L. | Th | LC | EIA | R1, R8, R10, R11 | AA, HA, MA, Mam, Man, LM, Om, R | Iberian-Maur. |
| *Malva olbia* (L.) Alef. | Ph | LC | | R2, R13 | MA, Mam, Man, LM (Ahfir), R | Med. |
| OLEACEAE | | | | | | |
| *Chrysojasminum fruticans* (L.) Banfi | Ph | LC | | R2, R3, R4, R6, R9, R10, R11, R12 | As, AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Fraxinus angustifolia* Vahl. | Ph | LC | | R4, R9 | HA, MA, Mam, Man Om, LM, R | Eur. |
| *Olea europaea* L. | Ph | LC | | R1, R2, R3, R4, R4, R5, R6, R8, R10, R11, R13 | Non-Saharan Morocco | Med. |
| *Phillyrea latifolia* L. | Ph | LC | | R2, R3, R4, R5, R7, R8, R12 | As, AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| PLANTAGINACEAE | | | | | | |
| *Globularia alypum* L. | Ch | LC | | R1, R2, R3, R8, R10 | All geographic divisions | Med. |
| *Misopates orontium* (L.) Raf. | Th | LC | | R11 | Non-Saharan Morocco | Med. |
| *Veronica hederifolia* L. | Th | LC | | R9 | As, AA (Siroua), HA, MA, Man, Om (Bni Snassène), LM R. | Paleo-temp. |
| PRIMULACEAE | | | | | | |
| *Lysimachia arvensis* (L.) *U.Manns & Anderb.* | Th | LC | | R6, R9, R11, R13 | All geographic divisions | Sub. Cosmop. |
| RANUNCULACEAE | | | | | | |
| *Clematis cirrhosa* L. | Ph | LC | | R1, R5, R9 | MA, Mam, Man, Om, LM, R | Med. |
| *Ranunculus bullatus* L. | Hem | LC | | R4, R9 | AA, HA, MA, Mam, Man, Om, LM, R | Med. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| RESEDACEAE | | | | | | |
| *Reseda lutea* L. | Th | LC | | R2, R4 | All geographic divisions except As | Eur. |
| RHAMNACEAE | | | | | | |
| *Rhamnus alaternus* L. | Ph | LC | | R2, R4, R5, R6, R7, R9, R12 | AA, HA, MA, Mam, Man, Om, LM, R | Med. |
| *Rhamnus oleoides* L. | Ph | LC | | R3, R4, R6, R10, R11, R13 | All geographic divisions | W. Med. |
| *Ziziphus lotus* (L.) Lam. | Ph | LC | | R10 | All geographic divisions | North Africa; Spain; Sicily; Greece; Anatolia; Near East. |
| ROSACEAE | | | | | | |
| *Crataegus monogyna* Jacq. = *Crataegus oxyacantha* L. | Ph | LC | | R4, R5, R6, R7, R9, R10, R12 | All geographic divisions except Ms and As | Eur. Med. |
| *Potentilla reptans* L. | Hem | LC | | R9 | HA, MA, Mam, Man, Op, Om, LM, R | Euras. |
| *Rosa canina* L. | Nph | LC | | R6, R9 | AA, HA, MA, Man, Om, R | Euras. |
| *Rubus ulmifolius* Schott.hedges | Nph | LC | | R4, R5, R6, R7, R9, R12 | All geographic divisions except Ms and As | Eur. Med. |
| *Sanguisorba minor* Scop. | GR | LC | | R1, R4, R5, R6, R8, R9, R12, R13 | Everywhere except in Ms and LM | Med; Macar; Eur; Asia |
| RUBIACEAE | | | | | | |
| *Crucianella angustifolia* L. | Th | LC | | R10, R13 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Eur. Med. |
| *Cynanchica aristata* (L.f.) P.Caputo & Del Guacchio | Ch | LC | | R3 | AA (Siroua), HA, MA, Mam (Souss), Man (Zaiane), Om (Bni Snassène), LM?, R | Eur. Med. |
| *Galium bourgaeanum* Coss. | Hem | LC | EA | R7, R8 | AA, HA, MA (El Hajeb), Mam (Agadir- Irhir; j. Kharrouba in Tadnest), Man (j. Zerhoun; Lakouar rocks near Oualili), R (Kef El-Ghar) | Western Algeria |
| *Rubia peregrina* L. | Ch | LC | | R1, R4, R5, R6, R7, R9, R10 | HA, MA, Mam, Man, Om, LM, R | Med. Atl. |
| *Sherardia arvensis* L. | Th | LC | | R1, R5, R9, R12 | All geographic divisions | Euras. |

| Division, Families and Species | Biological Type | Assessment Criteria | Endemism/ Rarity | Occurrence in the study area (relevés see table 1) | Geographic distribution in Morocco | Chorology |
|---|---|---|---|---|---|---|
| RUTACEAE | | | | | | |
| *Ruta angustifolia* Pers. | Ch | LC | | R3 | HA, MA, Mam, Man, Om (Bni Snassène), LM,R | C-W Med. |
| *Ruta montana* (L.) L. | Ch | LC | | R1, R2, R3, R4, R10, R12 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Circummed. |
| SOLANACEAE | | | | | | |
| *Solanum nigrum* L. | Th | LC | | R12 | AA, HA, MA, Mam, Man, Op, Om, LM, R | Cosmop. |
| *Withania frutescens* (L.) Pauquy. | Ph | LC | | R4 | All geographic divisions | Iberian-Mar. |
| THYMELAEACEAE | | | | | | |
| *Daphne gnidium* L. | Ch | LC | | R4, R5, R6, R7, R9, R10, R12 | All geographic divisions | Med, Iberian Peninsula, S Fr, W and S Italy, S Greece, N Afr. |
| *Thymelaea salsa* Murb. | Th | LC | EIA | R13 | AA (Ida-ou-Gnidif), HA, MA, Mam (Tadla; around Boujaâd; Bni Moussa), Man, Op?, LM? R? | Euras. |
| VERBENACEAE | | | | | | |
| *Verbena officinalis* L. | Ch | LC | | R5, R12 | Ms (Assa), AA, HA, MA, Mam, Man, Op, Om, LM, R | Subcosmop. |

**Abbreviations:** Biological type: **Ph**: Phanerophyte. **Ch**: Camephyte. **Hem**: Hemicryptophyte. **G**: Geophyte. **Th**: Therophyte. Distribution in the geographical divisions of Morocco: **Ms**: Saharan Morocco. **As**: Saharan Atlas. **AA**: Anti-Atlas. **HA**: High Atlas. **MA**: Middle Atlas. **Mam**: Middle Morocco Atlantic. **Man**: Morocco North Atlantic. **Op**: Plateaux of eastern Morocco. **Om**: Mountains of eastern Morocco. **LM**: Mediterranean coast. **A**: Rif. Chorology: **Afr**: Africa. **Ibero-Maur**: Ibero-Mauritanian. **Tue**: Morocco. **Alg**: Algeria. **Macar**: Macaronesian. **Canar**: Canary. **Ital**: Italian. **Med**: Mediterranean. **Too much**: tropical. **Paleo-too**: Paleo-tropical. **Paleo-temp**: Paleo-temperate. **Irano-Tour**: Iranian-Turanian. **Eur**: European. **Euras**: Eurasian. **Atl**: Atlantic. Endemism: **E**: endemic to Morocco. **EI**: endemic to Morocco and the Iberian Peninsula. **EA**: endemic to Morocco and Algeria. **EC**: endemic to Morocco and the Canary Islands. For rarity we based ourselves on the catalogue of rare, threatened, or endemic vascular plants of Morocco (Fennane & Ibn Tattou, 1998). **R?** Suseptible to be rare in Morocco. **RR**: Very rare in Morocco. **SD**: Data deficient. **LC**: Least Concern (Low Extinction Rate). **NA**: Not applicable (suspicious presence). **VU /VU(e)**: Vulnerable. **NT**: Near Threatened (close to the threshold of threatened categories or could be threatened if specific conservation measures were not taken).

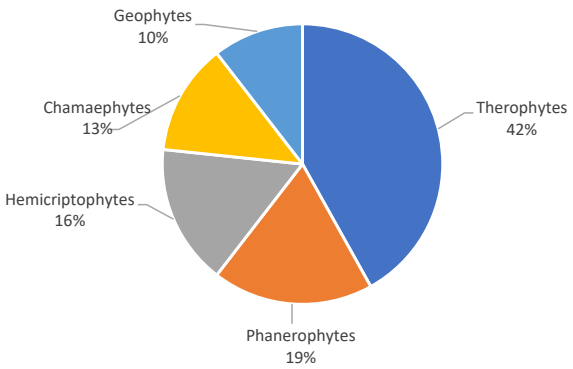



2: *Botanical families and specific wealth in the Jbel Zerhoun*

The species richness of our area is 209 species belonging to 156 genera and 49 families of vascular plants. The richest families, clearly dominating the flora of the ecosystems of Jbel Zerhoun (Fig. 2), are, Fabaceae, *Asteraceae*, Poaceae, Lamiaceae, *Carypphyllaceae* and Apiaceae, with 27, 23, 22, 16, 11 and 11 taxa respectively. The others are represented in the area by a smaller number of species, namely Asparagaceae (6 taxa), Rosaceae and *Rubiaceae* (5 taxa), *Anacardiaceae*, *Boraginaceae*, *Campanulaceae*, *Cistaceae*, Euphorbiaceae and *Oleaceae* (4 taxa), *Aspleniaceae, Brassicaceae, Caprifoliaceae, Gentianaceae, Geraniaceae, Hypericaceae, Plantaginaceae and Rhamnaceae* (3 taxa), *Orchidaceae, Convolvulaceae, Crassulaceae, Fagaceae, Linaceae, Malvaceae, Ranunculaceae, Rutaceae, Solanaceae* and *Thymelaeaceae* (2 Taxa). The remaining families contain one species each. In the study of the flora of jbel Lakraa (Benarchid *et al*., 2018) and jbel Maâsker (Taleb and Fennane, 2008), the Asteraceae family comes before the Fabaceae and the Poaceae family ranks 2nd.

## Biological Spectrum

Analysis of the biological spectrum of vegetation in the study area (Fig. 3) reveals that like the vegetation of the Mediterranean area, Therophytes are predominant over other life forms with 88 taxa (42%). They are followed by Phanerophytes with 39 species (19%). Hemicryptophytes are in third place with 34 species (16%). Chamaephytes and Geophytes are represented respectively by 27 taxa (13%) and 22 taxa (11%). This spectrum reflects the conditions of relative aridity of the environment with the semi-arid, locally subhumid bioclimate. The predominance of therophytes is an indicator of adaptation to Mediterranean environmental conditions (Taleb and Fennane, 2018). The biological spectrum of our study area shows a high degree of therophytes (42%). This is less accentuated than in jbel Lakraa, where the average percentage of therophytes was 63% (Benarchid *et al*., 2018).




3: *Jbel Zerhoun species biology spectrum*

## Extinction Threats Assessment

According to the catalogue of rare and endangered vascular plants of Morocco, established by Fennane and Ibn Tatou (1998), only one species suspected rare on the scale of Morocco is found in the Zerhoun massif; it is *Thapsia meoides*., Four species declared very rare (*Ophrys fusca* subsp. *durieui*, *Cirsium ducellieri*, *Arabis hirsuta*, *Erodium alnifolium*) and 2 rare species (*Alyssum alyssoides*, *Herniaria hirsuta*) have also been observed in the dition. This should call into question the list of rare and threatened vascular plants of Fennane and Ibn Tatou (1998).

The conservation status of the inventoried flora in the study area was determined using criteria taken from the Red Book of Moroccan Flora (Fennane, 2021) which served as a reference to characterize the study area. Thus, only one vulnerable species (VU/VU(e)) was observed in the dition: *Origanum compactum*, 3 Near Threatened (NT) species: *Ononis thomsonii*, *Schenkia spicata* and *Hypericum montanum*, six taxa of doubtful presence (NA): *Pistacia saportae*, *Thapsia garganica, Echium creticum* subsp. *creticum, Arabis hirsuta, Erodium alnifolium* and *Linum usitatissimum*. The presence of these species in the Zerhoun massif shows how much the latter can show itself as a genetic reservoir, where these plants would still be conserved. In addition, 158 species are at low risk of extinction (LC) and 2 are low data (DD) (*Lotus rectus, Centaurium erythraea*). The temperature increases recorded in

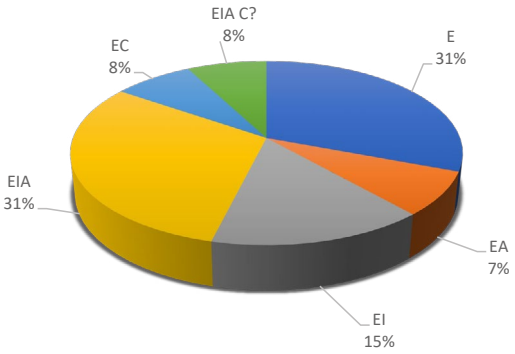
recent years and the decline in rainfall accentuate these risks (Fennane, 2021).

The investigations carried out in the Zerhoun Massif, also made it possible to specify or confirm the presence of certain species in the phytogeographical division of North Atlantic Morocco (Man). Thus, five taxa are newly recorded in this division: *Bromus madritensis, Pistacia saportae, Thapsia meoides, Alyssum alyssoides, Arabis hirsuta* and a taxa cited as doubtful (Fennane *et al.*, 2007) is confirmed: *Euphorbia dracunculoides* subsp. *gebulosa.*

## Chorology and Endemism

The endemic flora of the massif is remarkable for its richness. It has 13 species or 6.22% of the flora inventoried in the dition (Fig. 4). The rugged terrain favors the confinement of these species, which are protected from humans and grazing. Four species are then strictly endemic to Morocco (E) with 31% of the total number of endemic species inventoried: *Cirsium ducellieri, Feeria angustifolia, Ononis thomsonii, Teucrium decipiens*. The rest is shared with neighboring countries and therefore, between Morocco and Algeria, there is only one endemic species (EA): *Galium bourgaeanum*, two species are endemic to Morocco and the Iberian Peninsula (EI): *Campanula lusitanica, Origanum compactum*, 4 endemic to Morocco, Algeria and the Iberian Peninsula (EIA) with 31% of the total number of endemic species inventoried: *Gagea durieui, Dianthus lusitanus, Malva hispanica, Thymelaea salsa* and finally, only one endemic to Morocco and the Canary Islands (EC): *Coronilla viminalis*. Between Morocco, Algeria, the Iberian Peninsula, and the Canary Islands, only one species is endemic but remains doubtful in both Algeria and the Canary Islands. (EIAC ?): *Cynara humilis*.

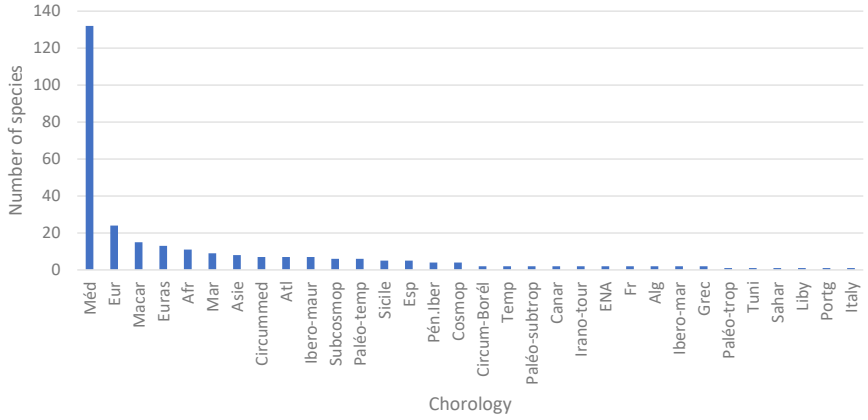
Similarly, it should be noted that among the endemics recorded, a taxa strictly endemic to Morocco (*Cirsium ducellieri)* is at the same time very rare and 1 taxon endemic to Morocco and the Iberian Peninsula is noted vulnerable: *Origanum compactum*. These two species should be the object of strategy of safeguarding especially that the second species is well required, in Morocco, as aromatic and medicinal plant.




4: *Endemism of the vascular vegetation of Jbel Zerhoun*

## Chorology

A phytogeographic study is an essential basis for any attempt to conserve biodiversity (Quézel, 1999). Chorology data, collected from Quezel and Santa (1962–1963), Fennane and Ibn Tattou (2005), and Ibn Tattou and Fennane (2008), for each of the species inventoried in Jbel Zerhoun, show that the Mediterranean element is best represented with a little more than 60% of the flora studied, or 125 species (Fig. 5); this number represents only 3.2% compared to the number of species of Mediterranean Morocco which counts approximately 3800 species according to Medail and Quezel (1997). In second place is the European origin with 24 species (11%). The rest of these species are distributed as follows: Macaronesian (15 species; 7%), Eurasian (13 species; 6.19%), Africa (11 species; 5.23%), Morocco (9 species; 4.28%), Asian (8 species; 3.80%), Mediterranean circum, Ibero-Mauretanian and Atlantic (7 species; 3.33%), Paleo-temperate and sub-cosmopolitan (6 species; 2.85%), Scilia and Spain (5 species; 2.38%), Cosmopolitan and Iberian Peninsila (4 species; 1.90%). The rest and represented by 2 or only one species.




5: *Chorology of species by Jbel Zerhoun*

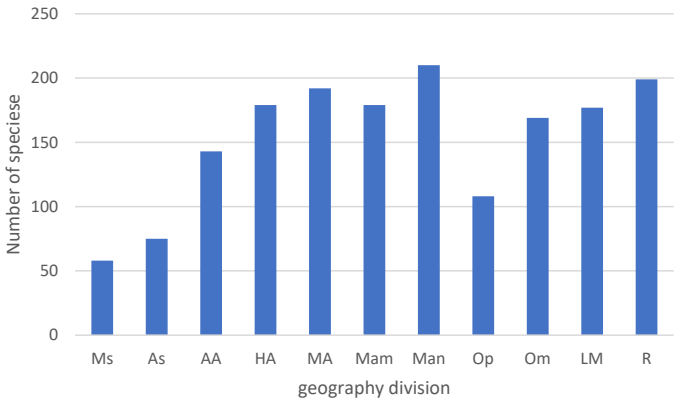
### Distribution in Morocco

The data on the geographical distribution of the species recorded in the Jbel Zerhoun (Tab. II) are gathered and organized in a histogram (Fig. 6) which shows the superiority of North Atlantic Morocco, the Rif and then Middle Atlantic Morocco and the High Atlas. Species from these phytogeographic divisions are the most represented in the dition probably due to the geographical proximity. Indeed, the 209 taxa recorded in the massif have already been cited in Man except for five species which were cited for the first time through to our investigations and one subspecies, named *Euphorbia dracunculoides* subsp. *glebulosa*, whose presence was doubtful in Man and which our study confirmed. The statistics then show the Rif (R) with 199 species, the Middle Atlas (MA) with 192 species, the Middle Atlantic Morocco (Mam) and the High Atlas (HA) with 179 species each, the Mediterranean Littoral (LM) with 177 species, the Mountains of Eastern Morocco (Om) with 169 species, the Anti-Atlas (AA) with 143 species, the Plains and Plateaus of Eastern Morocco (Op) with 108 species and finally the Saharan Atlas (As) and Saharan Morocco (Ms) with respectively 75 species and 58 species.

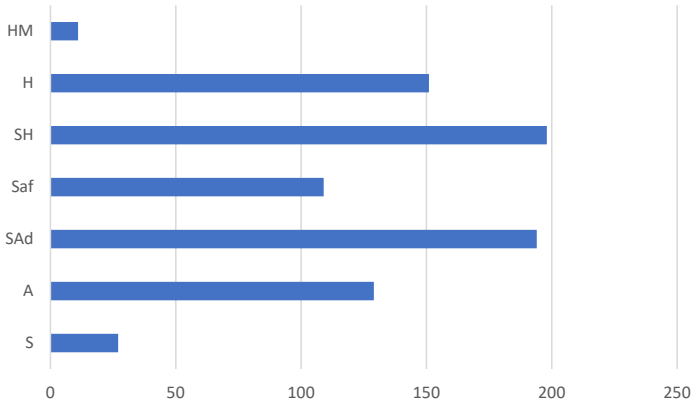
Regarding the distribution of the flora of Jbel Zerhoun according to bioclimatic stages (Fig. 7), the data (Fennane *et al.*, 1999, 2007, 2014) shown in Tab. II, show that the most important specific richness is in the subhumid (197 taxa), which is higher than the work of M Hachi *et al.* (2022) which finds 120 taxa. Then comes the mild semi-arid with 194 taxa, the humid (151 taxa), the arid (129 taxa examples: *Arisarum vulgare, Gagea durieui, Carduus myriacanthus*), the cold semi-arid (109 taxa), the Saharan (27 taxa example: *Bromus madritensis, Atractylis cancellata, Polycarpon tetraphyllum, Medicago minima*) and the high mountain bioclimate (11 taxa such as *Dactylis glomerata, Calendula arvensis, Buglossoides arvensis, Neatostema apulum, Alyssum alyssoides, Dianthus lusitanus*). The bioclimate of the Zerhoun massif is semi-arid to sub-humid, which would explain the high proportion of species in this category in the dition.

## DISCUSSION

A previous study in the Zerhoun region, in its entirety, touching all the prerifane wrinkles of the area, the slopes and valleys where the vegetation is still wild, allowed the determination of 407 species and subspecies, 257 genera and 67 families (Boudik




6: *Distribution of the flora of Jbel Zerhoun according to the phytogeographical divisions of Morocco*




7: *Bioclimatic distribution of the flora of Jbel Zerhoun*

*et al*., 2023). The plant material, from which this catalog was derived, was collected in the spring of 2022 over 28 field days. It is from this global work that we withdrew the data on Jbel Zerhoun to draw up a list of species specific. Determination of plant species from samples collected in spring 2022 resulted in a list of 209 species and subspecies in Jbel Zerhoun. This is an impressive figure, especially as it represents almost 4% of the Flora of Morocco, estimated by Fennane and Ibn Tattou (2012) at 5211 species and subspecies. Quantitative and qualitative analysis of the flora of Jbel Zerhoun has enabled us to assign the taxa recorded to 156 genera and 49 families. At the generic level, this represents almost 16% of Morocco's total genera (981; Fennane, 2012), and at the family taxonomic level, almost 32% of Morocco's vascular flora (155 families, Fennane, 2012).

In addition, a species called *Quercus faginea* reported by sauvage in 1933 but not observed by us. The specific richness noted in the Jbel Zerhoun is of great importance and the area can therefore be considered as a biodiversity hotspot.

The 209 species collected can be considered an exhaustive list, as the sampling covered the entire mountain ridge and its slopes. Finally, all local ecosystem variations were sampled. Comparing this figure with other mountains in Morocco such as Jbel Ayachi with 197 species, Jbel Maâsker with 123 species (Taleb and Fennane, 2008) and Jbel Lakraa with 124 species (Benarchid *et al*., 2018). Jbel Zerhoun has the highest number of plant species recorded among the mountains mentioned. It is important to note that plant diversity can vary depending on several factors, such as climate, altitude, soil type and other environmental conditions specific to each mountain.

## CONCLUSION

Floristic inventory is the means to identify and understand the plant diversity of a given geographical area. It also plays an essential role in the process of formulating effective management policies for the preservation of the biodiversity of a region.

At the end of the present study, which focused on the floristic inventory of Jbel Zerhoun, Morocco, the number of vascular plants inventoried amounts to 209 taxa belonging to 156 genera and 49 families. In terms of specific wealth, the *Fabaceae* family is the most important in the study area, followed by the *Asteraceae*, *Poaceae*, *Lamiaceae*, *Carypphyllaceae* and *Apiaceae*. The biological spectrum is dominated by therophytes, plants well adapted to the aridity of the summer seasons of the Mediterranean climate. The present work has allowed, in addition to highlighting a plant biodiversity of great importance, to enrich the vegetation of the study area in particular and of North Atlantic Morocco in general with 6 taxa, to confirm the presence of *Euphorbia dracunculoides* subsp. *glebulosa* whose presence was doubtful in Morocco and to draw up a list of 13 taxa endemic to Morocco and to neighboring countries; taxa that are well preserved in the rugged terrain of the massif, far from human activity, especially as some of these species are considered rare and threatened.

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