Journal of Applied and Natural Science
17(3), 1435 - 1453 (2025)
ISSN : 0974-9411 (Print), 2231-5209 (Online)
journals.ansfoundation.org

Research Article

Study of the floristic diversity of the Maamora cork oak forest in northwest Morocco

Abdelilah Jbilou*
Laboratory of Plant, Animal Productions and Agro-industry, Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco
Ouafae Benkhnigue
Scientific Institute, Mohammed V University in Rabat, Morocco
Ahmed Chriqui
Laboratory of Natural Resources and Sustainable Development, Department of Biology, Ibn Tofail University, Kenitra, Morocco
Hind Elaidi
Laboratory of Plant, Animal Productions and Agro-industry, Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco
Lahcen Zidane
Laboratory of Plant, Animal Productions and Agro-industry, Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco
Jamila Dahmani
Laboratory of Plant, Animal Productions and Agro-industry, Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco
Nadia Belahbib
Laboratory of Plant, Animal Productions and Agro-industry, Faculty of Sciences, Ibn Tofail University, Kenitra, Morocco

*Corresponding author. E-mail: Jbilou.abdelilah@uit.ac.ma

Article Info
https://doi.org/10.31018/jans.v17i3.6782
Received: May 02, 2025
Revised: September 05, 2025
Accepted: September 15, 2025

How to Cite
Jbilou, A. *et al.* (2025). Study of the floristic diversity of the Maamora cork oak forest in northwest Morocco. *Journal of Applied and Natural Science*, 17(3), 1435 - 1453. https://doi.org/10.31018/jans.v17i3.6782

Abstract
The Maamora forest, located in northwest Morocco, is one of the largest continuous cork oak forests in the Mediterranean basin. Since the last comprehensive floristic survey in 2005, the forest has been highly affected by human activities and climate change, making an updated list of its plant diversity both timely and necessary. This study aimed to renew the knowledge of the floristic composition of the forest and assess its actual ecological context. During 95 days of fieldwork between 2021 and 2023, a systematic sampling was conducted across 57 representative sites within the natural cork oak zone. The survey documented 171 species and subspecies, distributed across 132 genera and 38 families, with 64 taxa recently reported in the Maamora. The most represented families were Asteraceae (26 species), Fabaceae (23 species), Poaceae (19 species), and Caryophyllaceae (13 species). The life-form spectrum was dominated by therophytes (60.82%), followed by geophytes (16.37%) and hemicryptophytes (10.53%). A total of 22 endemic species were recorded, including 9 strictly endemic to Morocco. Although most species (84%) were found not to be concerned by the IUCN red list, 41% of the endemic taxa were classified as threatened. This updated inventory highlights ongoing ecological changes in the Maamora forest and provides a valuable reference for future conservation strategies and sustainable forest management in the region.

Keywords: Checklist, Conservation, Cork oak forest, Ecology, Plant diversity

INTRODUCTION

Throughout the Mediterranean basin, Morocco boasts a diversity of forest ecosystems and natural resources that make it an exceptional heritage. Faced with increasing threats from human activities and climatic restrictions, the country has decided to implement a sustainable management policy to conserve its natural resources (Chriqui *et al*., 2024). Among these forest ecosystems, the cork oak forest occupies a vital place. They cover some 2.1 million hectares worldwide, mainly in Mediterranean countries such as Portugal, Spain,

France, Italy, Morocco, Algeria, and Tunisia (Aronson *et al*., 2009). These woods, which are essential for preserving biodiversity and combating desertification, provide a vital resource for cork production and a habitat for many plant species, including endemics. According to Aafi (2007), Morocco is home to around 20% of the world's cork oak forests, covering a total area of around 340,000 hectares. These cork oak forests are found mainly in the Rif, Middle Atlas, High Atlas, and Atlantic coastal plains, including the Maamora. The two main categories of cork oak forests in Morocco are mountain cork oak forests, which are found in the Rif and Atlas, on more fertilized soils and at a wide range of altitudes below 1,200 m (Quézel and Médail, 2003), and coastal cork oak forests, which are found in plains and low-lying areas characterized by the predominance of sandy soils, including the Maamora forest (Aafi, 2007).

The floral association includes a variety of characteristic Mediterranean species, such as rockrose (Cistus sp.), arbutus (Arbutus unedo), and various grasses. These ecosystems are also home to a rich biodiversity, particularly of protected birds and mammals. The Maamora, an Atlanto-Mediterranean forest, is known as one of the most extensive continuous cork oak forests in the world (Aafi, 2007). It flourished in a Mediterranean climatic environment influenced by Atlantic currents. Several national organizations have conducted various studies on the floristic diversity of this forest ecosystem (Sauvage, 1961; Reille, 1977; Dahmani, 1994; Belahbib et al., 2001, 2004; Aafi et al., 2005; Aafi, 2007; Jbilou *et al*., 2023, 2025a). The present study aimed to enrich and update the present state of knowledge about plant diversity at this site while analyzing the ecological context that influences its evolution, particularly by considering the lengthening or shortening of certain seasonal periods in the region.

MATERIALS AND METHODS

Study area

The Maamora, one of the w
orld's largest continuous subalpine forests, was formed in a Mediterranean climate influenced by the Atlantic Ocean (Aafi, 2007). This forest extends over approximately 133,000 hectares and is located in northwestern Morocco, close to the Atlantic coast between Rabat and Kénitra and moving inland between Tiflet and Khémisset in the south and between Sidi Yahya and Sidi Slimane in the north (Fig. 1). It lies between 6° and 6°45' West longitudes and 34° and 34°20' North latitudes and belongs to North Atlantic Morocco (Man-3) according to the biogeographical subdivision of Morocco's terrestrial domain made by Fennane and Ibn Tattou (1998) (Fig. 2). The Maamora is 68.8 km long from west to east and 38.2 km wide from north to south (Aafi, 2007). However, this extent has undergone a significant reduction due to man-made constraints and climatic changes (El Boukhari *et al*., 2016); its current area is at the limit of 60,000 ha.

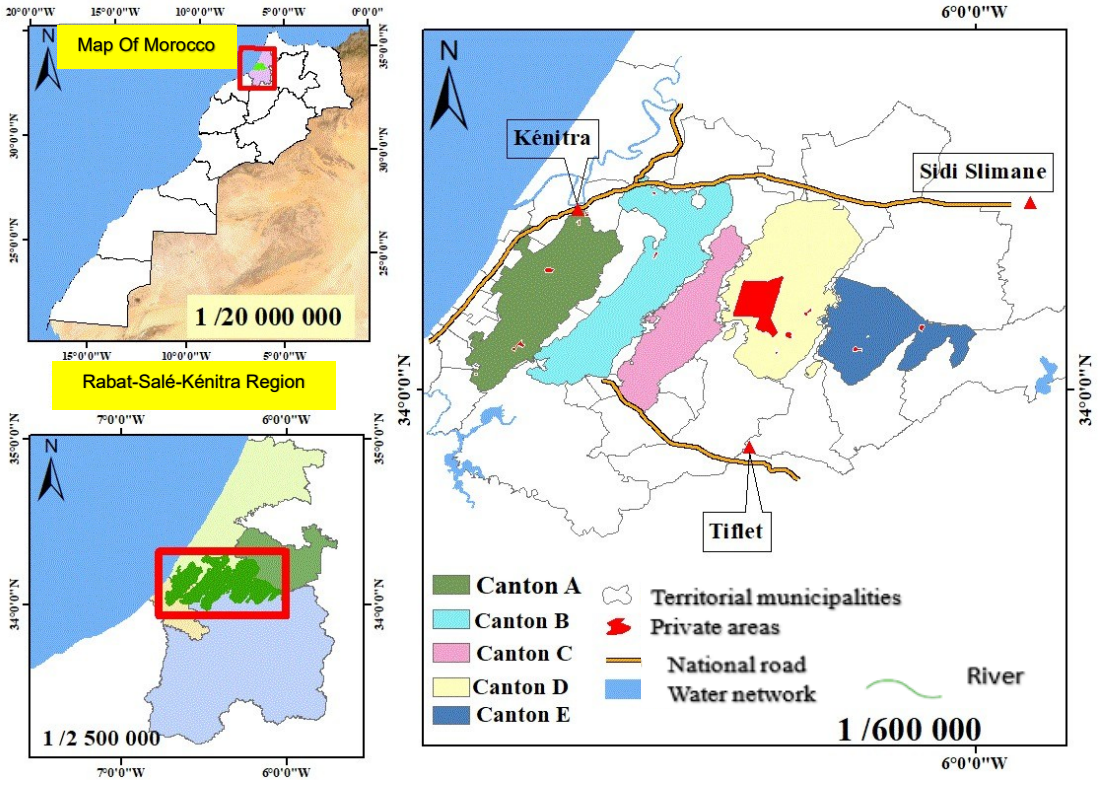

Fig. 1. *Geographical situation of the Maamora forest in Morocco*

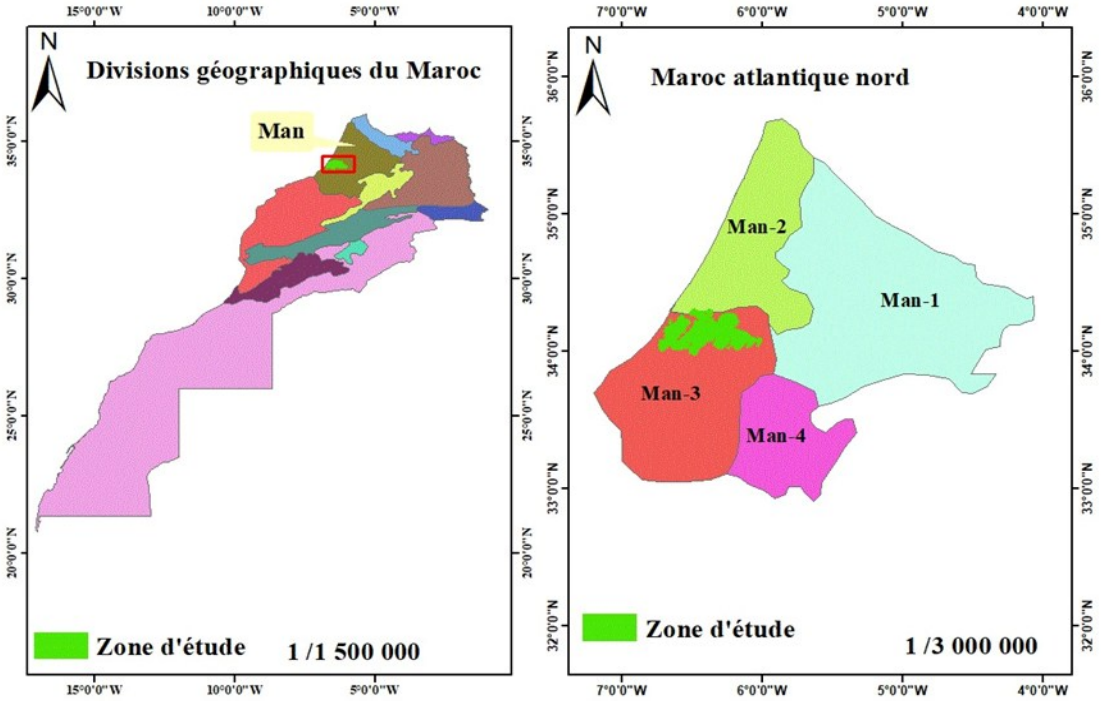

Fig. 2. *Situation of the Maamora according to Fennane and Ibn Tattou's biogeographical divisions in 1998 (the rest of the colored areas = other biogeographical regions; Man: Northern Atlantic Morocco)*

According to Aafi (2007), the Maamora forest was demarcated and carved up between 1917 and 1919 to regulate and control the exploitation of its natural resources. This spatial management made it possible to divide the forest into 3 large geographical units (Western, Central, and Eastern Maamora) encompassing 5 parts called cantons (A, B, C, D, and E) that are also delimited according to the main watercourses (El Boukhari *et al*., 2015) (Fig. 1). Each canton is characterized by a very different surface area compared to the other, as well as a variation in its place in administrative management (cork production, grazing, areas for restoring faunistic and floristic biodiversity, etc.). (Aafi, 2007; Melloul and Zhar, 2017 and Berrichi, 2018) Geomorphologically, the Maamora cork oak forest extends over a gently sloping plateau that is characterized by a predominantly flat relief with minor undulations and moderate altitudes, ranging from 8 up to 300m across the eastern Maamora (Aafi, 2007). The climate of this ecosystem is Mediterranean with hot, dry summers and mild, wet winters (Aafi *et al*., 2005). Analysis of the climatic data reveals a difference across the forest from west to east, with precipitation of 600mm per year in the western part and 450mm in the eastern part. Climate change has affected the area by transferring the bioclimate from sub-humid to semi-arid (Challi *et al.* 2024). Average maximum temperatures reach 12°C in the coldest month and 37°C in the hottest, while minimum temperatures fluctuate between 5°C and 25°C (INFOCLIMAT, 2024).

The Maamora is based on Quaternary sediments of fluvio-marine origin, abundant in sands and silts. According to Bourrouilh (1973), these deposits indicate a geological evolution characterized by cycles of transgressive and regressive marine movements. This dune-type and slightly acidic soil covers a clay floor with a very slight proportion of some slopes not exceeding 3%, implying vulnerability due to good to excessive drainage (Lepoutre, 1965; El Boukhari *et al*., 2016). Maamora's hydrological network is influenced by the high permeability of the soil, which favors the appearance of intermittent streams and temporary Oueds (Rivers). Oued Sebou, one of Morocco's major rivers, determines the forest's northeastern border and collects water from neighboring regions. Meanwhile, Oued Beth and other smaller Oueds, such as Oued Sidi Taïbi, play a local role during the rainy season. The area also has significant underground resources, thanks to a superficial water table fed by rainfall and seepage. This water table, which extends as far as the Gharb plain, is crucial for irrigation, domestic needs, and the preservation of the forest ecosystem.

Sampling

To produce the most complete floristic catalogue possible, surveys were carried out in the 4 cantons (A, B, C, and D) that are most representative of the cork oak's natural environment; canton E was excluded from the present inventory due to the heavy artificialization of this part of the cork oak forest and the transformation of the forest environment into agricultural land which have been observed in the field. The systematic sam-

pling method seemed to be the most effective way of ensuring that all types of vegetation stands were covered fairly. Technical equipment included a high-resolution telephone camera, 2-metre tape, and paper forms for recording ecological characteristics of vegetation and environment (Jongman *et al*., 1995). For geographical data, the present study used the itineraries provided by the map platform (Google Maps, 2024). As the division of the study area had already been carried out (delimitation of cantons), the study reserved the choice of points to be surveyed until the field visit (Fig. 3). The sampling points along these transects had no defined distance, but were set in a heterogeneous way, taking into account the topographical and landscape conditions of each point. The study inventories also avoided ruderal vegetation, forest track clearings, and permanent and seasonal submerged areas. The localities of the inventory points were presented using geographic coordinates extracted by the GPS Essentials application (GPS Essentials, 2024), and cartographic representation was made using ArcGIS 10.8 software. Several criteria have been included: the density of each vegetation stratum, exposure, pedology, altitudes, vegetation series, and the artificialization rate.

The field surveys took place from April 2021 to May 2024, corresponding to a total of 95 survey days. This enabled us to investigate the floristic composition of the cork oak woodland at various times of the year, in particular during the two main seasons (spring and summer) that are favourable to vegetative growth and flowering for the majority of plants. To preserve the study environment and stimulate pollination of autumn-flowering plants, the field trips have been done during winter and autumn, aiming to increase the number of species identified.

All species recorded were collected for floristic identification. The herbarium preparation stage began with pressing, drying, and mounting on boards. All the herbaria were preserved in the laboratory of Plant, Animal Productions and Agro-industry at Ibn Tofail University, and some were also stored at the Rabat Scientific Institute. Very rare plants, or those of minimal abundance, were not included in this project so as not to contribute to their extinction at the local and national level. Floristic identifications are made based on observation and comparison of morpho-ecological characters with Moroccan and foreign floristic determination manuals: Flore pratique du Maroc (Fennane *et al*., 1999, 2007, 2014), Flora of North Africa (Maire 1952–1967), catalog of vascular plants of Northern Morocco (Valdés *et al*., 2002), Nouvelle Flore d'Algérie et Des Régions Désertiques Méridionales (Quézel and Santana, 1962, 1963), Flora of New Zealand (Hooker, 1852), Flora of Mauritania (Barry and Celles, 1991) and Flora of Belgium (Durand and Pittier, 1893). The taxon nomenclature adopted is that of the official digital databases (WFO, https://wfoplantlist.org/plant-list; IPNI, https://www.ipni.org/n/198427-1; JSTOR, https://www.jstor.org/; POWO, https://powo.science.kew.org/). The observation of certain species required a comparison with those of the GBIF numerical base (https://www.gbif.org/fr/).

The Flore Pratique du Maroc (Fennane *et al*., 1999, 2007, 2014) was used as a reference to identify homotypic and heterotypic synonyms, various bioclimatic levels, as well as biological and ecological habitat classifications. This includes the flowering period, altitude, and indications of edaphism on both local and national scales, in the form of altitude bands, bioclimatic stages, geographical distribution in Morocco, and endemism. The establishment of the local distribution of taxa in the Maamora has been based on in situ observations. Data concerning the rarity and degree of threat to species are derived from the Red Book of Moroccan vascular flora (Fennane, 2021), which aligns with the new IUCN Red List classifications. The biological form types of the plants inventoried are classified according to Raunkier (1934). The taxa inventoried were listed by family, then by genus, and in alphabetical order, each completed by biological type, ecological characteristics, endemism, flowering period, and geographical distribution in Morocco and the Maamora.

RESULTS

Floristic analysis

As part of this research project, an inventory of the flora of the Maamora has been caried out through 57 sampling points spread over four cantons (Fig. 3). The inventory included 171 species and subspecies (Appendix A), identified throughout the Maamora cork oak forest and belonging to 132 genera and 38 families in a single systematic group (Angiosperms), with no Pteridophytes and the observation of a few Gymnosperms in reforestation areas close to the natural cork oak forest, such as *Pinus halepensis* mill., *Pinus brutia* Ten., *Pinus canariensis* C.Sm. ex DC., *Pinus pinaster* Aiton, *Pinus pinea* L., *Hesperocyparis macrocarpa* (Hartw.) Bartel et *Hesperocyparis arizonica* (Greene) Bartel.

The Asteraceae family is the most abundant, encompassing 26 taxa (15%), closely followed by the Fabaceae with 23 taxa (14%), the Poaceae with 19 taxa (11%), and the Caryophyllaceae, represented by 13 taxa (8%) (Fig. 4). This floristic inventory records 132 genera, representing 14.04% of the national diversity, which includes 940 genera (Ibn Tattou and Fennane, 1989). Among these, *Festuca* Tourn. ex L. and *Trifolium* Tourn. ex L. exhibit the highest taxonomic richness (4 species each), followed by *Drimia* Jacq. ex Willd., *Euphorbia* L., *Loeflingia* L., and *Ornithopus* L., each represented by three species.

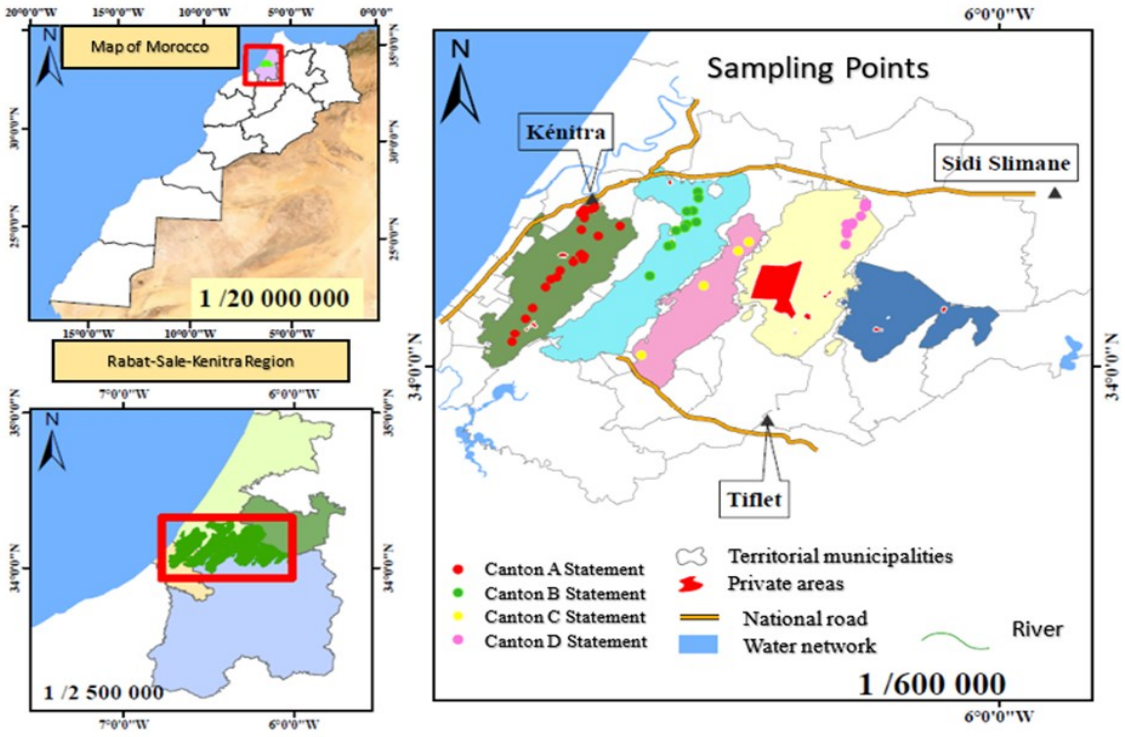

Fig. 3. *Location of sampling points (R in Maamora forest, Morocco)*

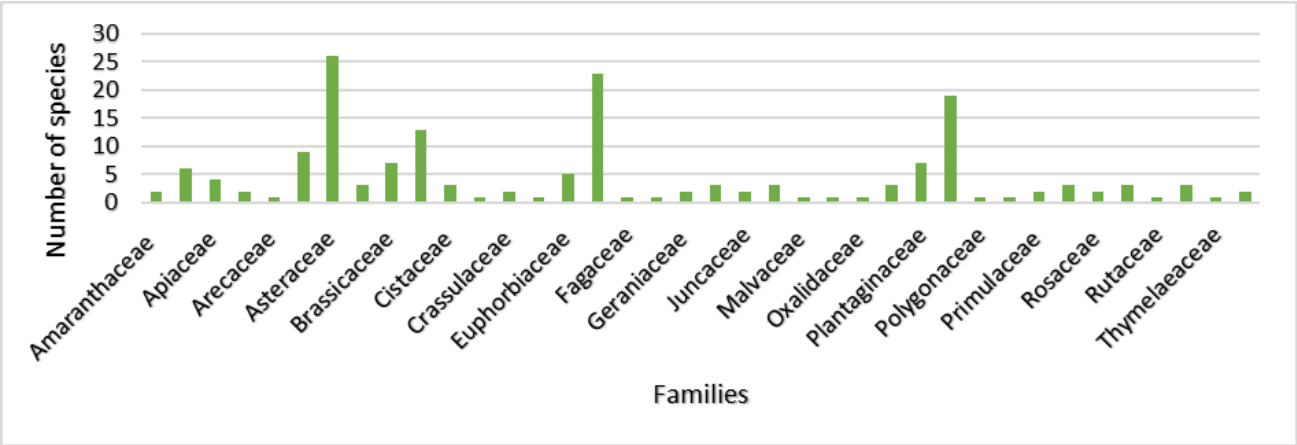

Fig. 4. *Number of species by families*

The floristic diversity of the Maamora cork oak forest is influenced by both natural and anthropogenic factors, as evidenced by the cataloged 23 taxa distributed across seven distinct categories of introduced species. These include 10 naturalized taxa (*Amaranthus deflexus* L., *Narcissus papyraceus* subsp. *polyanthos* (Loisel.) Asch. & Graebn., *Arctotheca calendula* (L.) K.Lewin, *Cotula australis* Hook.f., *Erigeron bonariensis* L., *Ricinus communis* L., *Lupinus luteus* L., *Lycium europaeum* L., *Nicotiana glauca* Graham, and *Solanum linnaeanum* Hepper & P.-M.L.Jaeger), 3 weed species (*Gamochaeta antillana* (Urb.) Anderb., *Heterotheca subaxillaris* (Lam.) Britton & Rusby, and *Vicia hybrida* L.), 2 ruderal species (*Amaranthus deflexus* and *Marrobium vulgare* L.), 1 invasive species (*Cotula australis*), 1 xenophyte (*Lupinus luteus*), and 1 anthropochore (*Portulaca oleracea* L.).

A notable proportion of nitrophilous species was also identified, adapting to nitrogen-rich soils (*Capsella bursa-pastoris* (L.) Medik., *Hordeum murinum* subsp. *leporinum* (Link) Arcang., *Portulaca oleracea*, *Urtica membranacea* Poir. ex Savigny, and *U. urens* L.) (Fig. 5).

The catalog included 64 species and subspecies reported for the first time in the cork oak forest, including the 57 species recently found by Jbilou *et al*. (2025a), compared with the study by Sauvage (1961) and Aafi *et al*. (2005). In addition, a species has been discovered for the first time in Morocco (*Cotula australis*) as part of a previous floristic investigation of the study area (Jbilou *et al*., 2023).

Spectrum of life forms

The biological spectrum of vascular plants in the Maamora forest is dominated by therophytes (60.82%),

Table 1. Details of subspecies present as species in the study of Aafi *et al. (*2005).

Name after Aafi	*Name in this study*
Asparagus aphyllus	*Asparagus aphyllus* subsp. *aphyllus*
Scolymus hispanicus	*Scolymus hispanicus* subsp. *hispanicus*
Spergula arvensis	*Spergula arvensis* subsp. *arvensis*
Ononis natrix	*Ononis natrix* subsp. *natrix*
Serapias lingua	*Serapias lingua* subsp. *lingua*
Plantago coronopus	*Plantago coronopus* subsp. *cupanii*
Galium viscosum	*Galium viscosum* subsp. *rifanum*

followed by geophytes (16.37%), hemicryptophytes (10.53%), phanerophytes (8.77%), and lastly chamaephytes, which constitute the least represented group (3.51%) (Fig. 6).

Endemism

Endemism was identified in 22 species, representing 2.50% of Morocco's endemic flora (Rankou *et al*., 2013). These species belong to 14 families, primarily Asteraceae (5 taxa), Caryophyllaceae (4 taxa), and Poaceae (2 taxa), while other families (Rosaceae, Rubiaceae, Thymelaeaceae, Amaryllidaceae, Araceae, Asparagaceae, Crassulaceae, Fabaceae, Iridaceae, Plantaginaceae, and Brassicaceae) are represented by a single species each.

Five taxa are strictly endemic to Morocco (*Ammochloa involucrata* Murb., *Mibora maroccana* (Maire) Maire, *Galium viscosum* subsp. *rifanum* (Emb. & Maire) Maire, *Filago carpetana* subsp. *maroccana* (Braun-Blanq. & Maire) Dobignard, and *Loeflingia baetica* subsp. *vaucheri* (Briq.) A.Galán, Molina Abril & Sard.Rosc.), while nine are endemic to Morocco, the Iberian Peninsula, and Algeria (*Hypochaeris salzmanniana* DC., *Tolpis nemoralis* Font Quer, *Arenaria emarginata* subsp. *emarginata*, *Sedum mucizonia* (Ortega) Raym.-Hamet, *Crocus salzmannii* J.Gay, *Biarum tenuifolium* subsp. *arundanum* (Boiss. & Reut.) Nyman, *Anthericum baeticum* (Boiss.) Steud., *Carduus myriacanthus* Salzm. ex DC., *Cynara humilis* L.). Seven taxa are endemic to Morocco and the Iberian Peninsula (*Thymelaea lythroides* Barratte & Murb., *Pyrus bourgaeana*, *Acis trichophylla* Sweet ex G.Don, *Marcus-kochia triloba* (L.) Al-Shehbaz, *Loeflingia baetica* Lag., *Stauracanthus spectabilis* Webb, and *Linaria incarnata* (Vent.) Spreng.), and one species is endemic to Morocco and the Canary Islands (*Spergularia fimbriata* Boiss. & Reut.).

Threatened flora

Assessment of species status using the Moroccan Red List (Fennane, 2021) revealed that 159 taxa (92.95%) are not at immediate risk of extinction, and 7 species were classified as vulnerable (*Biarum tenuifolium* subsp. *arundanum*, *Filago carpetana* subsp. *maroccana*, *Stauracanthus spectabilis*, *Ammochloa involucrata*, *Eragrostis atrovirens* (Roem. & Schult.) Steud., *Mibora maroccana*, and *Thymelaea lythroides*), 4 near-threatened species (*Acis trichophylla*, *Crocus salzmanii*, *Centaurium maritimum* (L.) Fritsch, and *Juncus bufonius* L.), and 1 endangered species (*Pyrus bourgaeana*) (Fig. 7).

DISCUSSION

The floristic inventory of the cork oak forest of Maamora comprises 171 species and subspecies, representing 20.11% of the flora of Moroccan cork oak forests as recorded by Sauvage in 1961. This inventory holds significant relevance compared to earlier studies, such as that of Aafi *et al*. (2005), which documented 408 species. The approximately 58% reduction in vascular flora in Maamora can be primarily attributed to the specificity of the inventory methodology, which excluded plants from anthropized or heavily frequented areas such as roadsides and edges. This floristic richness is influenced by anthropogenic and climatic pressures between the species inventoried; 30 taxa were found to be unique in this investigation, including a significant

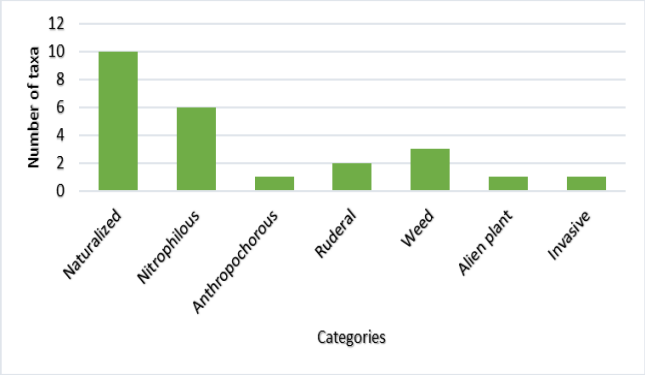

Fig. 5. *Number of species by specific ecological aspect*

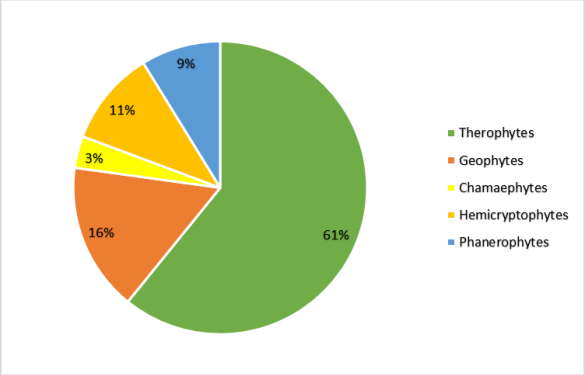

Fig. 6. *Presence rate of Maamora cork oak forest species according to their biological spectrum*

Appendix A. Floristic catalog, endemism, biological type, bioclimatic region, flowering period; IUCN red list status; geographical distribution in Morocco and local distribution in each canton of the flora of the Maamora cork oak forest (North-East Morocco)

Families Species	Ende-mism	Biologi-cal life form spectrum	Bioclimatic stages	Flower-ing peri-od	IUCN Red List status	Geograph-ical distribu-tion in Mo-rocco	Geographi-cal distribu-tion in Maamora
AMARANTHACEAE							
Amaranthus deflexus		Th	*Ar*, *SAd*	*P*, *E*, *A*	LC	Mam, Man, Op, R	B
Amaranthus viridis		Th	*SAd*	*P*, *E*, *A*	LC	Mam, Man	A
AMARYLLIDACEAE							
Allium camaemoly		GB	*SAd*, *SH*	*A*, *H*, *P*	LC	MA, Mam (Nouacer), Man, Op (Midelt), LM, R	A, B
Allium paniculatum		GB	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	All over Mo-rocco	A
Acis autumnalis		GB	*(S)*, *Ar*, *SAd*, *SH*	*(A)*, *H*, *P*	LC	Ms, Mam, Man, R	A
Acis trichophylla	●I	GB	*SAd*, *SH*	*H*, *P*	NT	Mam, Man, R	C
Iris planifolia		GB	*SAd*, *SH*	*H*, *P*	LC	MA, Mam, Man, Om, LM, R	A
Narcissus papyraceus subsp. *polyanthos*		GB	*SAd*, *SH*	*H*, *P*	LC	MA, Mam, Man, R	A
APIACEAE							
Bunium bulbocastanum		G	*Ar*, *SAd*, *SH*, *Hu*	*P*	NA	AA, MA, Mam, Man, Op, Om (Bni Snassène), LM, R oriental	D
Ferula communis		G	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	All over Mo-rocco	A
Thapsia transtagana		GT	*Ar*, *SAd*, *SH*, *Hu*	*P*	LC	Ms?, HA, MA, Mam, Man, Op, Om, LM, R	B, D
Torilis nodosa		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*	LC	All over Mo-rocco	B, D
ARACEAE							
Arisarum vulgare		GT	*Ar*, *SAd*	*H*, *P*, *(E)*	LC	Tout le Maroc	All cantons
Biarum tenuifolium subsp. *arundanum*	●IA	GT	*SAd*, *SH*	*P*, *E*	VU	MA, Man, R	B, C
ARECACEAE							
Chamaerops humilis		NPh	*Ar*, *SAd*, *SAf*, *SH*	*P*, *(E)*	LC	AA, HA, MA, All cantons	All cantons
ASPARAGACEAE							
Anthericum baeticum	●IA	G	*Hu*	*P*, *(E)*	LC	; HA, MA, Man, LM, R	B
Asparagus albus		NPh	*Ar*, *SAd*, *SAf*, *SH*	*E*, *A*	LC	AA, HA, MA, Mam, Man, Op, Om, LM	A, B
Asparagus aphyllus subsp. *aphyllus*		NPh	*Ar*, *SAd*, *SH*	*E*, *A*	LC	Mam, Man, Op, LM, R	A, B, C
Dipcadi serotinum		GB	*Ar*, *SAd*, *SH*	*A*, *H*, *P*	LC	Tout le Maroc	A
Drimia fugax		GB	*Ar*, *SAd*, *SH*	*E*, *A*	DD	MA, Mam, Man	All cantons

Contd……..

Appendix A. Contd…….

Drimia maritima		GB	*Ar*, *SAd*, *SH*, *Hu*	*E*, *A*	LC	Ms océanique, AA, HA, MA, Mam, Man, Op, Om, LM, R	All cantons
Drimia purpurascens		GB	*SAd*, *SH*	*E*, *A*	DD	Mam, Man, Om, LM, R	C
Ornithogalum algeriense subsp. *algeriense*		GB	*SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	AA, HA, MA, Mam, Man, Om, LM, R	A
Prospero autumnal		GB	*SAd*, *SH*, *Hu*	*A*	LC	Ms océanique, HA, MA, Mam, Man, Om, LM, R	A
ASTERACEAE							
Andryala integrifolia		Th-b	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *E*, *(A)*	LC	AA, HA, MA, Mam, Man, Op, LM, R	D
Arctotheca calendula		Th	*SAd*, *SH*	*P*, *E*	NA	Mam, Man, LM, R	A, B, D
Bellis annua		Th	*Ar*, *SAd*, *SH*, *Hu*	*H*, *P*, *(E)*	LC	HA, MA, Mam, Man, Op, Om, LM, R ;	B
Carduus myriacanthus	●IA	Th	*Ar*, *SAd*, *SH*	*P*	LC	Mam, Man, LM ,R	A, B, D
Carlina hispanica		Hém	*Ar SAd*, *SH*, *Hu*	*E*, *(A)*	LC	HA, MA, Mam, Man, Op, Om, LM,	A
Carlina racemosa		Th	*Ar SAd*, *SH*, *Hu*	*P, E*, *(A)*	LC	HA, MA, Mam, Man, Op, Om, LM, R	A, D
Cladanthus mixtus		Th	*Ar*, *SAd*, *SH*, *Hu*	*P*, *E*	LC	HA, MA, Mam, Man, Op, Om, LM, R	B
Cotula australis		Th	*SAd*, *SH*	*Toute l'année*	LC	Man	All cantons
Cynara humilis	●IA	G	*Ar*, *SAd*, *SH*, *Hu*	*P*, *E*	LC	HA, MA, Mam, Man, LM occi-dental, R	B
Echinops spinosissimus subsp. *spinosus*		Hém	*S*, *Ar*, *SAd*	*P*, *E*, *(A)*	LC	Ms, Man, Op, LM, R	A
Erigeron bonariensis		Th	*Ar*, *SAd*, *SAf, SH, Hu*	*Toute l'année*	NA	AA, HA, MA, Mam, Man, Op, Om, LM, R	A
Filago carpetana subsp. *maroccana*	●	Th	*SAd*, *SH*, *Hu*	*(H)*, *P*, *(E)*	VU	Mam, Man, R	All cantons
Filago pygmaea		Th	*Ar*, *SAd*, *SH*, *Hu*	*(H)*, *P*, *(E)*	LC	AA, HA, MA, Mam, Man, Op?, Om, LM, R	A, B, D
Gamochaeta antillana		Th	*SAd*	*P*	NA	Man (Gharb), R (Cap	D

Contd……..

Appendix A. Contd…….

Heteranthemis viscide-hirta		Th	*Ar*, *SAd*, *SH*	*P*	LC	Mam, Man, R occidental	B
Heterotheca subaxillaris		Th	*SAd*, *SH*	*A*, (*H*), *P*, *E*	NA	Man (Sidi Yahya Gharb, autoroute Rabat-Meknès)	A, B, D
Hypochaeris glabra		Th	*SH*	*P*, *E*	LC	Man, Op, LM, R	B
Hypochaeris salzmanniana	●IA	Th	*SAd*	*P*	LC	Man, Op, R	A
Leontodon saxatilis		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	AA occi-dental, HA, MA, Mam, Man, Op, Om, LM, R	All cantons
Logfia gallica		Th	*SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	AA, HA, MA, Mam, Man, Op (Basse	All cantons
Reichardia picroides		Hém	*SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	HA, MA, Mam, Man, Om, LM, R	A
Scolymus hispanicus subsp. *Hispanicus*		Hém	*S*, *Ar*, *SAd, SAf, SH, Hu*	*P*, *E*	LC	Ms (Rissani), AA, HA, MA, Mam, Man, Op, Om, LM, R	A, B
Senecio vulgaris		Th	*Ar*, *SAd, SAf, SH, Hu*	*Toute l'année*	LC	AA, HA, MA, Mam, Man, Op, Om, LM,	A
Sonchus tenerrimus		Th	*Ar*, *SAd*, *SH*	*H*, *P*, *E*, *(A)*	LC	Tout le Maroc	D
Tolpis barbata		Th	*SAd*, *SH*	*P*, *E*	LC	Man, Op, Om, LM R	A, B, D
Tolpis nemoralis	●I	Hém	*SAd*, *SH*, *Hu*	*P*, *E*	LC	Mam (Chaouia-Doukkala),	B
BORAGINACEAE							
Echium plantagineum		Th	*Ar, SAd*, *SH*, *Hu*	*P*	LC	Tout le Maroc sauf sahara	A
Heliotropium europaeum		Th	*Ar, SAd*, *SAf* ,*SH*, *Hu*	*P*, *E*	LC	AA, HA, Mam, Man, Op, Om, LM,	A
Myosotis discolor Subsp. *dubia*		Th	*Ar, SAd*, *SAf*, *SH*, *Hu*, *HM*		LC	AA, HA, Man, R	A
BRASSICACEAE							
Biscutella didyma		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*(H)*, *P*, *E*	LC	Tout le Maroc	A, B, C
Capsella bursa-pastoris		Th	*Tous les*	*Toute*	LC	Tout le Maroc	A, B
Diplotaxis catholica		Th	*Ar*, *Sad*, *SH*, *(Hu)*	*(H)*, *P*, *E*	LC	MA, Man, Om, R	A
Eruca vesicaria		Th	*SAd*, *(SAf)*	*P*, *(E)*	LC	Mam, LM	C
Lobularia libyca		Th	*S*, *Ar*, *Sad*	*H*, *P*	LC	Ms, AA, Mam, Man, Op, R	A

Contd……..

Appendix A. Contd…….

Lobularia maritima		Ch	*Ar*, *SAd*, *SAf*; *SH*	*possible toute l'année*	LC	AA, HA, MA, Mam, Man, Op, Om, R	A
Marcus-kochia triloba	●I	Th	*S*, *Ar*, *SAd*	*H*, *P*	LC	Ms, AA, Mam, Man, R (Tanger)	All cantons
CARYOPHYLLACEAE							
Arenaria emarginata subsp. *emarginata*	●IA	Th	*Ar*, *SAd*, *SH*, *Hu*	*P*, *E*	LC	AA, HA, Mam, Man R	A, B, D
Cerastium glomeratum		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*H*, *P*, *E*	LC	Tout le Maroc sauf dans Ms	A, D
Illecebrum verticillatum		Th	*SAd*, *SH*, *H*	*P*, *E*	LC	Mam, Man, R	A
Loeflingia baetica	●I	Th	*Ar*, *SAd, SH, Hu*	*P*, *E*	LC	Ms, Mam, Man, LM, R	A
Loeflingia baetica subsp. *vaucheri*	●	Th	*SH*, *Hu*	*P*, *E*	LC	Man, R	A, B, C
Loeflingia hispanica		Th	*S*, *Ar*, *SAd*, *SH*, *Hu*	*P*, *E*	LC	Ms, Mam, Man, LM, R	A, B, C
Paronychia argentea		Hém	*Ar*, *SAd*, *SAf*, *SH, Hu*	*H*, *P*, *E*	LC	Ms, AA, HA, MA, Mam, Man, Op, R	B, C, D
Paronychia echinulata		Th	*SAd*, *SH*	*P*	LC	HA (Mgoun ; Iouaridène), MA, Mam (Khénifra), Man, LM (Melilia), R	All cantons
Polycarpon tetraphyllum		Th	*S*, *Ar*, *SAd*, *SH*, *Hu*	*P*, *E*	LC	Ms, AA, HA, MA, Mam, Man, Om,	All cantons
Spergula arvensis subsp. *arvensis*		Th	*Ar*, *SAd*, *SH*	*H*, *P*	LC	Mam, Man, R (Tanger)	All cantons
Spergula arvensis subsp. *chieusseana*		Th	*Ar*, *SAd*, *SH*	*P*	LC	HA, MA, Mam, Man, R	A
Spergularia fimbriata	●IC	Hém	*Ar*, *SAd*, *SH*	*H*, *P*	LC	AA, HA, Mam, Man, R	A
Stellaria apetala		Th	*SAd*, *SAf*, *SH*, *Hu*	*H*, *P*, *E*	LC	AA, HA, MA, Mam, Man,	A, B, C
CISTACEAE							
Cistus halimifolius		Nph	*SAd*, *SH*, *Hu*	*P*	LC	Mam, Man, R	D
Cistus salviifolius		Ch	*SAd*, *SAf*, *SH*, *Hu*	*P*	LC	AA, HA, MA, Mam, Man, Om, LM, R	A, C, D
Tuberaria guttata		Th	*SAd*, *SH*, *Hu*	*P*	LC	AA, HA, MA, Mam, Man,	All cantons
COLCHICACEAE							
Colchicum filifolium		G	*SAd*, *SH*, *Hu*	*A*	LC	MA, Mam,	B, D
CRASSULACEAE							
Crassula tillaea		Th	*SAd SH Hu*	*H*, *P*	LC	HA MA Mam Man Op LM R	B

Contd……..

Appendix A. Contd…….

	●IA					
Sedum mucizonia	Th	*Ar*, *SA*, *SH*, *Hu*	*P*, *E*	LC	HA, MA, Mam, Man, Op, Om, LM,	B, D
CUCURBITACEAE						
Citrullus colocynthis	GT	*S*, *Ar*, *SAd* ; Ms	*E*	LC	Ms, As, AA, Mam, Man, Op, LM, R	A
EUPHORBIACEAE						
Euphorbia exigua	Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	Tout le Maroc sauf Ms	A, C
Euphorbia falcata	Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	Tout le Maroc sauf Ms	C
Euphorbia peplus	Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*Toute l'année*	LC	Tout le Maroc	B
Mercurialis annua		*S*, *Ar*, *SAd*, *SAf*, *SH*, *Hu*	*(A)*, *H*, *P*, *E*	LC	Tout le Maroc	A
Ricinus communis	Ph	*Ar*, *SAd*, *SAf*, *SH*	*E*, *A*	NA	Tout le Maroc	A
FABACEAE						
Anthyllis hamosa	Th	*(S)*, *Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	Tout le Maroc	B
Cullen americanum	Th	*SAd*, *SH*	*P*	LC	Mam, Man, R	A
Genista linifolia	Nph	*SAd*, *SH*	A	LC	Mam, Man, R	A
Lotus palustris	Th	*SAd*, *SH*, *Hu*	*P*, *(E)*	LC	Mam, Man, R	D
Lotus ornithopodioides	Th	*SAd*, *SH*	*P*	LC	AA, Mam (Chaouïa ; Doukkala), Man, Om (Bni Snassène), LM, R	A
Lupinus angustifolius	Th	*SAd*, *SH*	*P*	LC	AA, HA, MA, Mam (Souss), Man, R	A, B, D
Lupinus luteus	Th	*S*, *Ar*, *SAd*	*H*, *P*, *(E)*	LC	Mam (Chaouïa - Doukkala), Man, R	B
Medicago laciniata	Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	(*H*), *P*, *(E*	LC	Ms, As, AA, HA, Mam, Man (Mechraâ Ejjebbouj), Op, LM	A
Medicago polymorpha	Th	*S*, *Ar*, *SAd*, *SAf*, *SH*, *Hu*	(*H*), *P*, *(E)*	LC	AA, HA, Mam, Man, Op, LM, R	A
Melilotus indicus	Th	*(S)*, *Ar*, *SAd*, *SAf*, *SH*, *Hu*	(*H*), *P*, *(E)*	LC	Ms, AA, HA, Mam, Man, Op, Om, LM, R	A
Melilotus sulcatus	Th	*Ar*, *SAd*, *SAf*, *SH*	*P*, *E*	LC	Ms, AA, HA, Mam, Man, Op, LM, R	A, C
Ononis natrix subsp. *natrix*	Ch	*Ar*, *SAd*, *SAf*, *SH*	*P*, *E*	LC	Man, Op, Om (Bni Snassène),	B

Contd……..

Appendix A. Contd…….

Ornithopus compressus		Th	*Ar*, *SAd*,	*P*	LC	AA, HA, MA,	A, B, C
Ornithopus pinnatus		Th	*SAd*, *SH*	*P*	LC	Man, R	All cantons
Ornithopus sativus		Th	*SAd*, *SH*	*P*	LC	Man, Mam	B, D
Retama monosperma		Th	*S*, *Ar*, *SAd*, *SH*	*H*, *P*	LC	Ms, AA, HA, Mam, Man, Om, LM, R	B
Spartium junceum		Th	*SAd*, *SH*	*P*	NA	Mam, Man, R	A
Stauracanthus spectabilis	●I	Nph	*SAd*, *SH*	*H*, *P*	VU	Man, R	A, B
Trifolium campestre		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	AA, HA, MA, Mam, Man, Op, Om, LM,	A
Trifolium glomeratum		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *(E)*	LC	AA, HA, MA, Mam, Man,	A
Trifolium subterraneum		Th	*SAd*, *SAf*, *SH*, *Hu*	*P*, *(E)*	LC	AA, HA, MA, Mam, Man,	B
Trifolium tomentosum		Th	*Ar, SAd*, *SAf*, *SH*, *Hu*	*P*, *(E)*	LC	AA, HA, MA, Mam, Man,	B
Vicia hybrida		Th	*SAd*	*P*	NA	Man	B, C
FAGACEAE							
Quercus suber		Ph	; *SAd*, *SH*, *Hu*	*H*, *P*, *(E)*	LC	HA, MA, Man, Om, LM, R	All cantons
GENTIANACEAE							
Centaurium maritimum		Th	*SAd*, *SH*	*P*	NT	MA, Mam,	A
GERANIACEAE							
Erodium aethiopicum		Th	*Ar*, *SAd*, *SH*	*(H)*, *P*, *(E)*	LC	AA, HA, Mam, Man,	A, B, C
Geranium molle		Th	*Ar*, *SAd*, *SH*, *Hu*	*H*, *P*, *(E)*	LC	AA, HA, MA, Mam, Man, Op, Om, LM, R	All cantons
IRIDACEAE							
Crocus salzmannii	●IA	GB	*SAd*, *SH*, *Hu*	*A*	NT	HA, Mam, Man, LM, R	All cantons
Gladiolus italicus		G	*A*, *SAd*, *SH*	*P*	LC	AA, HA, MA central, Mam, Man, Op, LM,	D
Romulea bulbocodium		G	*SAd*, *SAf*, *SH*, *Hu*	*H*, *P*	LC	AA occi-dental, MA, Mam, Man, Op, Om, LM, R	All cantons
JUNCACEAE							
Juncus bufonius		Th	*S*, *Ar*, *SAd*,	*P*, *E*	NT	Tout le Maroc	A, D
Juncinella capitata		Th	*Ar*, *SAd*, *SH*, *Hu*	*P*, *E*	LC	HA, MA, Mam (Chaouïa-Doukkala ; Souss), Man, R	D

Contd……..

Appendix A. Contd…….

LAMIACEAE							
Marrubium vulgare		Ch	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *E*	LC	Tout le Maroc	A
Lamium amplexicaule		Th	*S*, *Ar*, *SAd*, *SAf*, *SH*, *Hu*	*H*, *P*, *E*	LC	Tout le Maroc	C
Lavandula stoechas subsp. *stoechas*		Ch	*SAd*, *SH*	*P*	LC	Mam, Man, LM, Om, R	A
MALVACEAE							
Malva sylvestris		Hém	*Tous les bioclimats*	*(H)*, *P*, *E*	LC	AA, HA, MA, Mam, Man, Op, Om, LM,	A, B
ORCHIDACEAE							
Serapias lingua subsp. *lingua*		GT	*SAd*, *SH*, *Hu*	*P*	LC	HA (jbel Guerdouz), MA, Mam, Man, R	B
OROBANCHACEAE							
Orobanche nana		G(-p)	*SAd*	*A*	DD	Man, Ms oriental, As, HA (gorges du Ziz)	D
OXALIDACEAE							
Oxalix corniculata		G	*SAd*, *SH*, *(Hu)*	*P*, *E*	LC	AA (Dar Cheikh à Aït Toudma), HA, MA, Mam, Man, Om (Bni Snassène), R occidental	A
PAPAVERACEAE							
Fumaria capreolata		Th	*Ar, SAd*, *SAf*, *SH*	*H*, *P*, *E*	LC	HA, MA, Mam, Man, Om, LM, R	A
Papaver somniferum subsp. *setigerum*		Th	*Ar, SAd*, *SAf*, *SH*	(*H*), *P*	LC	*SH* ; AA, HA, MA, Mam, Man, Om,	A
PLANTAGINACEAE							
Kickxia cirrhosa		Th	*SAd*, *SH*	*P*, *(E)*	DD	Man, R occidenta	A
Linaria incarnata	●I	Th	*SAd*, *SH*	*P*, *(E)*	DD	AA, HA, Mam, Man, R	A, B, D
Linaria simplex		Th	*S*, *Ar*, *SAd*, *SAf*, *SH*, *Hu*	*(H)*, *P*, *(E)*	LC	Ms océanique, As, AA, HA, MA, Mam (Haouz), Man, Om, LM, R	A, C
Misopates orontium		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*, *HM*	*P*, *E*	LC	Tout le Maroc sauf saharien	A, B, D
Veronica arvensis		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*H*, *P*	LC	As, AA, HA, MA, Mam, Man, Op, Om, LM, R	A, B

Contd……..

Appendix A. Contd…….

Plantago coronopus subsp. *cupanii*		Hém	*SAd*, *SH*, *Hu*	*P*, *E*	LC	AA, HA, MA, Mam, Man, Op?, Om, LM, R	All cantons
Plantago lanceolata		Hém	*Ar*, *SAd*	*P*, *E*	LC	AA (Ifni),	B
POACEAE							
Achnatherum paradoxum		Hém	*SH*, *Hu*	*P*, *E*	LC	HA, MA, Man,	D
Ammochloa involucrata	•	Hém	*SAd*, *SH*	*(H)*, *P*	VU	Mam, Man, R	A
Anthoxanthum odoratum		Th	*SAd*, *SH*	*(H)*, *P*, *(E)*	LC	HA, MA, Man, Om, R	A, B, D
Brachypodium sylvaticum		Hém	*SH*, *Hu*	*P*, *(E)*	LC	HA, MA, Man,	D
Briza minor		Th	*Ar*, *SAf*, *SH*, *Hu*	*(H)*, *P*, *(E)*	LC	AA, HA, MA, Mam, Man,	A, B
Bromus diandrus		Th	*Ar*, *SAd*, *SH*	*(H)*, *P*	LC	AA, HA, MA, Mam (Chaouïa-Doukkala), Man, Op, Om, LM occi-	B
Bromus hordeaceus subsp. *hordeaceus*		Th	*S*, *Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*, *(E)*	LC	AA, HA, MA, Mam, Man, Op, Om, LM,	B
Cynodon dactylon		GR	*S*, *Ar*, *SAd*, *SAf*, *SH*, *Hu*	*Toute l'année*	LC	Tous le Maroc	A
Eragrostis atrovirens		Hém	*SAd*, *SH*	*P*, *E*, (*A)*	VU	Man, R	A
Festuca ambigua		Th	*Ar*, *SAd*, *SAf*, *SH*	*(H)*, *P*, *(E)*	LC	AA, HA, MA, Mam, Man, Op, Om, LM,	A
Festuca bromoides		Th	*Ar*, *SAd*, *SH*	*(H)*, *P*	LC	AA, HA, MA, Mam, Man,	A, B, D
Festuca ligustica		Th	*SAd*, *SH*	*P*, *(E)*	LC	HA, Man, Op	A, B
Festuca myuros		Th	*Ar*, *SAd*, *SH*	*(H)*, *P*	LC	AA, HA, MA, Mam, Man, LM, R	A, B
Gastridium ventricosum		Th	*Ar*, *SAf*, *SH*, *Hu*	*P*, *(E)*	LC	Ms, AA, HA, MA, Mam, Man, Om, LM, R	A
Hordeum murinum subsp. *leporinum*		Th	*S*, *Ar*, *SAf*, *SH*, *Hu*	*(H)*, *P*, *E*	LC	Tout le Maroc	A, B, D
Lolium perenne		Hém	*Ar*, *SAf*, *SAd*, *SH*, *Hu*	*P*, *E*	LC	AA, HA, MA, Mam, Man,	A
Mibora maroccana	•	Th	*SAd*, *SAf*,	*(A)*, *H*, *P*	VU	Mam Man	All cantons
Phalaris aquatica		Hém	*Ar*, *SAf*, *SAd*, *SH*	*P*, *(E)*	LC	HA, Mam, Man, R	A
Poa annua		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*, *HM*	*Toute l'année*	LC	Tout le Maroc sauf Maroc	C
POLYGONACEAE							
Rumex bucephalophorus subsp. *galli cus*		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*H*, *P*	LC	HA, MA, Mam, Man, Op, Om LM,	All cantons

Contd……..

Appendix A. Contd…….

PORTULACACEAE							
Portulaca oleracea		Th	*Ar*, *SAd*, *SAf*, *SH*	*P*, *E*	LC	Tout le Maroc	A
PRIMULACEAE							
Lysimachia linum-stellatum		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*	LC	Tout le Maroc sauf Sahara	All cantons
Lysimachia talaverae		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*Toute l'année*	LC	As, HA, MA, Mam, Man, Op, R	B, D
RANUNCULACEAE							
Delphinium nanum		Th	*SH*, *Hu*	*P*	NA	HA, MA, Mam, Man, Op, LM, R	A, D
Ranunculus bullatus		Hém	*SAd*, *SAf*, *SH*, *Hu*	*A*, *H*	LC	AA, HA, MA, Mam, Man, Om, LM, R	A, B
Ranunculus paludosus		Hém	*SAd*, *SH*, *Hu*	*H*, *P*	LC	AA, HA, MA, Mam, Man, Op, LM, R	B, D
ROSACEAE							
Alchemilla microcarpa		Th	*SAd*, *SH*	*P*, *E*	LC	HA, Man, Om, LM, R	A, B, C
Pyrus bourgaeana	●I	Ph	*SAd*, *SH*	*P*	EN	MA, Mam, Man, R	A, C
RUBIACEAE							
Galium murale		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*(H)*, *P*, *(E)*	LC	Ms, AA, HA, MA, Mam, Man, Op, Om, LM, R	All cantons
Galium viscosum subsp. *rifanum*	●	Th	*SH*, *Hu*	*(H)*, *P*, *(E)*	LC	Man, R	All cantons
Sherardia arvensis		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*H*, *P*, *(E)*	LC	Tout le Maroc	A, B, C
RUTACEAE							
Ruta chalepensis		Ch	*Ar*, *SAd*, *SAf*, *SH*	*P*, *E*	LC	Mam, Man, Om, R	All cantons
SOLANACEAE							
Lycium europaeum		Nph	*Ar*, *SAd*, *SH*	*P*, *E*	NA	Mam, Man, Op, Om, LM, R	A
Nicotiana glauca		Nph	*Ar*, *SAd*, *SH*	*P*, *E*, *A*	NA	Ms, Mam, Man, Om, LM, R	All cantons
Solanum linnaeanum		Nph	*Ar*, *SAd*, *SH*	*P*, *E*	NA	Mam, Man, Om, LM, R	A
THYMELAEACEAE							
Thymelaea lythroides	●I	Nph	*SAd*, *SH*	*A, (H)*, *P*	VU	Man (Gharb ; Zemmours), R (Tangérois) ;	A, B , C
URTICACEAE							
Urtica membranacea		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*P*	LC	HA, MA, Mam, Man, Op, Om, LM, R	B
Urtica urens		Th	*Ar*, *SAd*, *SAf*, *SH*, *Hu*	*H*, *P*	LC	As, HA, MA, Mam, Man, Op, Om, LM, R	All cantons

Abbreviations. Endemism: ●: endemic to Morocco, ●**I**: endemic to Morocco and the Iberian Peninsula, ●**A**: endemic to Morocco and Algeria.., ●**T**: endemic to Morocco and Tunisia, ●**C**: endemic to Morocco and the Canary Islands, ●**IA**: endemic to Morocco and the Iberian Peninsula and Algeria, ●**IC**: endemic to Morocco and the Canary Islands; Biological form spectrum: Ph: phanerophyte, Nph: nanophanerophyte, Ch: chamaephyte, Hem: hemicryptophyte, G: geophyte, GB: bulb geophyte, GR: rhizome geophyte, GT: tuber geophyte, Th: therophyte, Th-b: biennial therophyte, (-p): parasite; Bioclimatic region: *S*: Saharan, *Ar* : Arid, *SAd*: Mild Semi-Arid (m > 0°C), *SAf*: Cold Semi-Arid (m < 0°C), *SH*: Subhumid, *Hu*: Humid, *HM*: High Mountains; Flowering period: *H*; Winter, *P*: Spring, *E*: Summer, *A*: Autumn; IUCN Red List status: LC: low risk of extinction, VU: vulnerable taxon ,NT: taxon close to the threshold of threatened categories or which could be threatened if specific conservation measures were not taken according to the red book of the vascular flora of Morocco, DD: insufficient red list status data, EN: endangered taxon, NA: Naturalized; Geographical distribution in Morocco: As: Saharan Atlas, AA: Anti Atlas, HA: High Atlas, MA: Middle Atlas, Mam: Middle Atlantic Morocco, Man: North Atlantic Morocco, Ms: Saharan Morocco, Op: Eastern Moroccan Plateaux, Om: Eastern Moroccan Mountains, LM: Mediterranean Coast, R: Rif; Geographical distribution in Maamora: A: Canton A, B: Canton B, C: Canton C, D: Canton D.

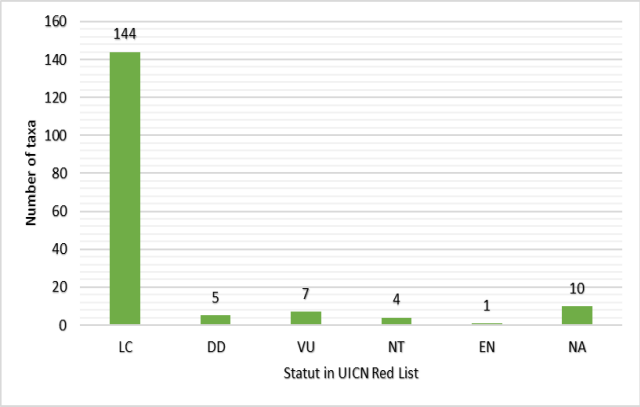

Fig. 7. *Distribution of taxa by IUCN Red List status according to Fennane (2021)*

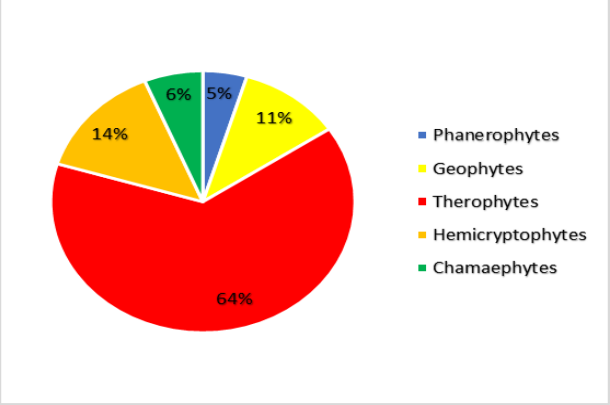

Fig. 8. *Life form spectrum of the new species of the Maamora forest*

number of introduced species. Although their presence increases the cork oak forest's floristic richness, it also presents a risk because they may displace native species, upsetting the ecosystem's delicate balance (Fennane *et al*., 1999).

The significant presence of nitrophilous species (6 taxa) indicates substrate instability due to human activities, especially overgrazing, which results in overfertilization and represents a strain on rural populations. Because of their adaptability to extremely acidic substrates, calcifuge species—like *Quercus suber* L.—act as indicators of podzolic and acidic soils, which are a defining property of Moroccan cork oak forests (Sauvage, 1961). The presence of anthropochorous plants, ruderals, weeds, and xenophytes within the forest cover reflects the disturbance of the natural forest environment (Bouahim *et al*., 2010). A rapid expansion of *Cotula australis* reported by Jbilou *et al*. (2023) reveals that invasive plants are taking the place of native species. Parasitic plants also give us an idea of the instability of this ecosystem. According to field observations in the reforestation areas visited during the trips, a phenomenon of strong parasitism has been noted, exerted by *Acacia mearnsii* De Wild. on *Quercus suber* seedlings and other gymnosperms, taking advantage of the lower part of the parasitized plant for unusual growth and propagation of the parasitic plant. Also, the declaration of the appearance of a new Urticaceae, *Parietaria officinalis*, which is a ruderal species, in Kenitra, as the closest urban area to the Maamora forest, is a sign of threat that could be in strong competition with native and endemic species in the event of propagation in the forest area (Jbilou *et al*., 2025b).

The majority of identified taxa are therophytes (104 taxa), which display a high capacity for adaptation to pronounced seasonality fostered by the Mediterranean climate characterized by dry summers and wet winters (Grime, 2001; Raunkiaer, 1934). These are followed by geophytes (28 taxa), which are well adapted to drought, especially during the driest part of the year, and to soil modifications resulting from overexploitation (Quézel and Médail, 2003). In third position are hemicryptophytes, represented by 18 taxa (10.53%). This proportion is below the optimal range for ecosystems, which varies between 20% and 30%, according to Grime (2001). Their low abundance in the cork oak forest pointed to a lack of ecological resilience and erosion risks. Because they support primary production, habitat preservation, microclimate development, and carbon sequestration, phanerophytes are essential in forested areas. However, Maamora's low frequency reduces climate regulation, which in turn causes a decrease in vegetation cover. The lack of representation of chamaephytes is indicative of the erratic climate that is necessary for the emergence of this biological type (Kent and Coker, 2012). The results of the present study align with the work of Aafi *et al*. (2005), which also highlighted the dominance of therophytes.

Among the 879 species that constituted Morocco's strict endemic flora (Fennane and Ibn Tattou, 2012), 22 endemic species are present in the Maamora cork oak forest, representing 2.5%. The Asteraceae family is the richest in endemism, which is consistent with Elaidi *et al*. (2024), who reported that a significant proportion of Moroccan Asteraceae were endemic (41%). Comparisons with Aafi *et al*. (2005) revealed the absence of 17 endemic species and subspecies, including *Ornithogalum broteroi* M. Mainz, *Asphodelus gracilis* (Br.-Bl. & Maire) Maire, *Micropyrum mamoraeum* (Maire) Stace, and others, alongside the appearance of five newly documented endemic species: *Anthericum baeticum*, *Filago carpetana* subsp. *maroccana*, *Tolpis nemoralis*, *Linaria incarnata*, and *Loeflingia baetica*. Additionally, differences in the endemic status of 12 taxa listed by Aafi *et al*. (2005) were noted, including *Acis trichophylla*, *Galium viscosum* subsp. *rifanum*, *Crocus salzmanii*, and others. Increased population pressure (HCP, 2024), tourism and recreational activities in forested areas, restoration techniques that involve total vegetation cover removal (Belghazi *et al*., 2011), and errors in

earlier research could all be responsible for the observed variation in endemicity rates since 2005. Most endemic taxa are under threat (86.95%), underscoring the vulnerability of the endemic richness of this cork oak forest.

Recently identified species constitute a significant proportion of the total taxa, contributing not only to floristic diversification but also to a deeper understanding of biodiversity evolution. Additionally, they demonstrate how vegetation can adapt to this delicate ecology (Benabid, 2000). In the Maamora cork oak forest, 64 newly discovered species and subspecies have been investigated, including two that were left out of Aafi *et al*. (2005) in contrast to Sauvage's analysis (1952): *Allium paniculatum* and *Biarum tenuifolium* subsp. *arundanum*. Also, it is reported in Appendix A that Jbilou *et al*. (2023) discovered *Cotula australis*, which is the first record for Morocco. Seven taxa have also had their subspecies status clarified (Table 1).

It is also important to note some clarifications for the genus *Ulex* L., which corresponds to the synonym of *Stauracanthus* Link for certain species present in the Maamora cork oak forest, such as *Stauracanthus spectabilis*, which was mentioned in the study by Aafi (2005) under the name *Ulex stauracanthus*. However, this nomenclature is not valid, as it implies the use of two names belonging to two different genera. In the Maamora forest, of the 64 new species identified, 41 taxa (64.06%) were therophytes, while 9 were hemicryptophytes (14.06%), 7 were geophytes (10.93%), 4 were chamaephytes (6.25%) and, finally, 3 were phanerophytes representing 4.68% of the total (Fig. 8).

Conclusion

The true plant diversity of the Maamora cork oak forest has undergone significant changes due to the expansion of certain species with specific ecological aspects, thus affecting the richness of native species and subspecies. The parasitism caused by exotic species as *Acacia mearnsii,* on native species, especially *Quercus suber*, during replanting has probably resulted in the failure of all restoration initiatives aimed at safeguarding the forest environment of the Maamora forest. This calls for a revision and reconstruction of the planting material intended for forest management. Examination of the biological spectrum revealed a prevalence of therophytes, indicating adaptation to frequent disturbances, particularly those of human origin, and to specific seasonal weather conditions. Despite a 13.45% decline in the number of endemic species recorded, these represent a unique and fragile biological heritage that must be preserved, with particular emphasis on the 9% that are threatened. The Maamora forest needs to be enhanced and its place in the Moroccan biogeographical context carefully protected.

Conflict of interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Aafi, A. (2007). Floristic diversity of the cork oak ecosystem in Morocco. Doctoral thesis, Mohammed V University, Rabat, Morocco.
2. Aafi, A., Achhal El Kadmiri, A., Benabid, A. & Rochdi, M. (2005). Floristic richness and diversity of the Mamora cork oak forest (Morocco). *Acta Botanica Malacitana*, *30*, 127–138. https://doi.org/10.24310/abm.v30i0.7187
3. Aronson, J., Pereira, J. S. & Pausas, J. G. (2009). Cork oak woodlands on the edge: Ecology, adaptive management, and restoration. Island Press.
4. Barry J.P. & Celles J.C. (1991). Flora of Mauritania. Higher Institute of Sciences, Nouakchott, and Sophia-Antipolis University, Nice, Tome I & II, 550 p.
5. Belahbib, N., Ouassou, A., Dahmani, J. & Douira, A. (2004). Contribution to the study of genetic introgression between Quercus suber L and Q. rotundifolia (Lamk.) Trabut in Morocco using microsatellite markers. *Bulletin de l'Institut Scientifique*, Rabat, life science section, 2004-2005, n°26-27, 31-34.
6. Belahbib, N., Pemonge, M. H., Ouassou, A., Sbay, H., Kremer, A. And Petit, R. J. (2001). Frequent cytoplasmic exchanges between oak species that are not closely related: Quercus suber and Q. ilex in Morocco. *Molecular Ecology*, *10*(8), 2003–2012. https://doi.org/10.1046/j.0962-1083.2001.01330.x
7. Belghazi, B., Badouzi, M., Belghazi, T. & Moujjan, S. (2011). Seedlings and plantations in the Maamora cork oak forest (Morocco). *Forêt méditerranéenne*, *t. XXXII*, n° 3, 301–314.
8. Benabid, A. (2000). Flora and ecosystems of Morocco: assessment and preservation of biodiversity. Éditions Ibis, Paris. 359 p.
9. Berrichi, H. (2018). Ecological challenges in the cantons of the Maamora cork oak forest. *Revue Marocaine de Gestion des Ressources Naturelles*, 5(3), 45-60.
10. Bouahim, S., Fennane, M. & Ibn Tattou, M. (2010). Contribution to the study of Morocco's adventitious flora: elements for a catalog. *Travaux de l'Institut Scientifique, Série Botanique*, 40, 31–46.
11. Bourrouilh, R. (1973). *Geological study of the Atlantic plains of Morocco: Sebou and Maamora basins*. Doctoral thesis, University of Bordeaux.
12. Challi, D., Abdelilah, J., Jdi, E. H., Dahmani, J. & Belahbib, N. (2024). Floristic Diversity of the Wetland, Sidi Boughaba Biological Reserve, Kénitra, Morocc In: *Lecture Notes in Networks and Systems* (Vol. 930 LNNS, pp. 127–148). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-54318-0_12
13. Chriqui, A., Benkhnigue, O., El Khadir, I., Mouniane, Y., Alaoui, S.M.H., Zidane, L. & Hmouni, D. (2024). Floristic Diversity and Potential of Site of Biological and Ecological Interest Brikcha, Prérif (North-West Morocco). *Acta Universitatis Agriculturae et Silviculturae Mendelianae Bru-*

nensis, *72*(3-4), 99-128. doi: 10.11118/actaun.2024.008
14. Dahmani, J. (1994). *Contribution to the study of artificial regeneration of cork oak (Quercus suber L.) in the Temara forest*. D.E.S. Hassan II University, Ain Chock, Casablanca, 128 p.
15. El Boukhari, M., Brhadda, N. & Gmira, N. (2015). Updated assessment and factors involved in the success of cork oak (*Quercus suber* L.) reforestation in the Maamora forest, Morocco. *Geo-Eco-Trop*, 38(2), 325–338.
16. El Boukhari, M., Brhadda, N. & Gmira, N. (2016). Contribution to the study of artificial regeneration of cork oak (*Quercus suber* L.) about the mineral content of leaves and the physicochemical parameters of soils in Maamora (Morocco). *Nature Technologie*. *environmental science*, C, 26–39.
17. Elaidi, H., Benkhnigue, O., Jbilou, A., Boudik, S., Belahbib, N., Zidane, L. & Dahmani, J. (2024). A Review of the Endemic Plants of Asteraceae Family in Morocco: Use the Artificial Intelligence for the Conservation In: International Conference on Advanced Intelligent Systems for Sustainable Development (AI2SD'2023). AI2SD 2023. Lecture Notes in Networks and Systems, vol 930. Springer, Cham. https://doi.org/10.1007/978-3-031-54318-0_2
18. Fennane, M. & Ibn Tattou, M. (2012). Statistics and comments on the current inventory of vascular flora in Morocco. *Bulletin de l'Institut Scientifique, Life Science section*, 34.
19. Fennane, M. & Ibn Tattou, M. (1998). Catalog of endemic, rare, or endangered plants in Morocco. *Bocconea 8*: 1-243.
20. Fennane, M. (2021). *Red Book of the Vascular Flora of Morocco*.Travaux de l'Institut Scientifique, Série Botanique, special N, Scientific Institut , Rabat.
21. Fennane, M., Ibn Tattou, M. & El Oualidi, J. (2014). *Flora of Morocco*, Vol 3. Travaux Institut Scientifique, Rabat, Maroc.
22. Fennane, M., Ibn Tattou, M., Mathez., J, Ouyahya, A. & El Oualidi, J. (2007). *Flora of Morocco*, Vol 2. Travaux Institut Scientifique, Rabat, Morocco.
23. Fennane, M., Ibn Tattou, M. I., Mathez, J., Ouyahya, A. & El Oualidi, J. (1999). *Flora of Morocco*, Vol 1. Travaux Institut Scientifique, Rabat, Morocco.
24. GBIF(2024). Global Biodiversity Information Facility. Retrieved November 28, 2024, https://www.gbif.org/fr/
25. GOOGLE (2025). Google Maps directions from Paris to Lyon. Retrieved January 30, 2025, https://www.google.com/maps
26. GPS ESSENTIALS (2025). Complete GPS tool for Android. Retrieved January 30, 2025, https://www.gpsessentials.com/
27. Grime, J. P. (2001). *Plant Strategies, Vegetation Processes, and Ecosystem Properties*. Wiley. New York. ISBN 0-471-49601-4, 417 pp.
28. Haut-Commissariat Au Plan (HCP). (2022). Population statistics for the Rabat-Salé-Kénitra region. Retrieved August 04, 2025, https://www.hcp.ma/Population-legale-du-Royaume-du-Maroc-repartie-par-regions-provinces-et-prefectures-et-communes-selon-les-resultats-du_a3974.html
29. Hooker, j. D. (1852). *Flora Novae-Zelandiae*, *vol*. *1*. Reeve, London, UK, 627 p.
30. Ibn Tattou M. & Fennane M. (1989). Historical overview and current state of knowledge on the vascular flora of Morocco. *Bull. Inst. Sci. Rabat*, 13, 85-94
31. INFOCLIMAT. (2024). Normales et records météorologiques. Retrieved November 21, 2024, https://www.infoclimat.fr/climatologie.
32. IPNI. (2025). International Plant Names Index. Retrieved January 08, 2025, https://www.ipni.org/
33. Jbilou, A., Benkhnigue, O., Elaidi, H., Magri, N., Zidane, L. Dahmani, J. & Belahbib, N. (2025a).Contribution to a Comparative Study of the Floristic Composition of the Maamora Cork Oak Forest (Morocco). In: Ezziyyani, M., Kacprzyk, J., Balas, V.E. (eds) International Conference on Advanced Intelligent Systems for Sustainable Development (AI2SD 2024). AI2SD 2024. Lecture Notes in Networks and Systems, vol 1402. Springer, Cham. https://doi.org/10.1007/978-3-031-91334-1_12
34. Jbilou, A., Benkhnigue, O., Elaidi, H., Zidane, L., Dahmani, J. & Belahbib, N. (2023). *Cotula australis* Hook.f. (Asteraceae), a species newly introduced in Morocco. *Check Lis*t, *19(5)*, 661–668. https://doi.org/10.15560/19.5.661
35. Jbilou, A., Benkhnigue, O., Elaidi, H., Zidane, L., Dahmani, J., & Belahbib, N. (2025b). Parietaria officinalis (Urticaceae) a new addition to the alien flora of Morocco. *Acta Botanica Malacitana*, *50*, 21820. https://doi.org/10.24310/abm.50.2025.21820
36. Jongman, R. H. G., Braak, C. J. F. T. & Tongeren, O. F. R. Van. (1995). Data Analysis in Community and Landscape Ecology. Data Analysis in Community and Landscape Ecology. Cambridge University Press. https://doi.org/10.1017/cbo9780511525575
37. JSTOR. (2024). World herbarium reference. Retrieved December 02, 2024, https://www.jstor.org/
38. Kent, M. & Coker, P. (2012). Vegetation Description and Data Analysis: A practical approach. Wiley-Black Well, Oxford, Reino Unido. 2a. Edició, 428.
39. Lepoutre, B. (1965). Artificial regeneration of cork oak and climate balance in the Maamora forest's cork oak grove. *Annale de la Recherche Forestière*, Maroc.
40. Maire, R. (1952–1987). Flora of North Africa (Maroc, Algerie, Tunisie, Tripolitaine, Cyrenaique et Sahara). Le Chevalier, Paris, vol: 1–16.
41. Melloul, M. & Zhar, A. (2017). Reforestation projects in the cantons of the Maamora cork oak forest: Case study of canton C. *Annales de l'Institut National de la Recherche Forestière*, 12(2), 20-29.
42. POWO. (2024). Plant of the World Online. Retrieved January 09, 2025, https://powo.science.kew.org/
43. Quézel, P. & Santa, S. (1962). New Flora of Algeria and Southern Desert Regions. Volume I. Published by the National Center for Scientific Research, Paris, France, 565 pp.
44. Quézel P, & Santa S. (1963). New Flora of Algeria and Southern Desert Regions. Volume II. Published by the National Center for Scientific Research, Paris, France, 494 pp.
45. Quézel, P. & Médail, F. (2003). Ecology and biogeography of Mediterranean forests. *Springer*.
46. Rankou, H., Culham, A., Jury, S. L. & Christenhusz, M. J. M. (2013). The endemic flora of Morocco. *Phytotaxa*, *78 (1)*, 1–69. https://doi.org/10.11646/phytotaxa.78.1.1
47. Raunkiaer, C. (1934). The life forms of plants and statisti-

cal plant geography. Clarendon Press.
48. Reille, M. (1977). Quelques aspects de l'activité humaine en Corse durant le Subatlantique et des conséquences sur la végétation. Supplément au Bulletin de l'AFEQ, 47, 329-342.
49. Sauvage, C. H. (1961). Flore des suberaies marocaines (Catalogues des Cryptogames vasculaires et des phanérogames). Travaux de l'Institut Scientifique Chérifien, série botanique n°22, Rabat.
50. Valdés, B., Rejdali, M., El Kadmiri, A., Jury, S. L., Montserrat, J. M. (2002). Catalogue annoté des plantes vasculaires du Nord du Maroc. Consejo Sup erior de Investigaciones Cientificas. Madrid, vol 1 & 2, 1040 p.
51. WFO. (2024). Snapshots of taxonomy. Retrieved November 21, 2024, https://wfoplantlist.org/plant-list