Plant Sci. Arc.
Plant Science Archives
An International Journal of Plant Biology

Original Research Article
ISSN 2518-6965
Journal Homepage: www.plantarc.com

Crocus libani and *Crocus terbolensis* (Iridaceae): Two New Endemic Species from Lebanon

Khodr Addam*, and Mounir Bou-Hamdan

Integrative Research and Environmental Center, AUL Beirut, Lebanon

Citation: Khodr Addam, and Mounir Bou-Hamdan (2026). *Crocus libani* and *Crocus terbolensis* (Iridaceae): Two New Endemic Species from Lebanon. *Plant Science Archives.* **DOI: https://doi.org/10.51470/PSA.2026.11.3.01**

Corresponding Author: **Khodr Addam** | E-Mail: **(draddam@hotmail.com)**

Received 04 April 2026 | Revised 06 May 2026 | Accepted 05 June 2026 | Available Online 10 July 2026

ABSTRACT

Taxonomic investigations within the North Governorate of Lebanon (NGL)—encompassing the Zgharta, Bsharri, Miniyeh-Dinnieh, and Koura districts—have culminated in the discovery of two novel species: Crocus libani K. Addam & M. Bou-Hamdan sp. nov. and Crocus terbolensis K. Addam & M. Bou-Hamdan sp. nov. (Iridaceae). These newly circumscribed taxa exhibit distinct morphological divergence not only from currently documented Lebanese Crocus representatives but also from globally recognized congeners. Identification is confirmed through a precise set of measurable and descriptive physical characteristics. Plant material and morphological analyses were conducted, measurements, colors, and other details given in the description are based on both herbarium and fresh materials. Morphological data were taken from more than 10 specimens of each. Crocus libani is distinguished from closely related species by its old corm that turns from white to pale orange-pink dotted with many fine dark orange dots, with thick roots; light brown papery outer tunic dotted with fine dark brown dots and splitting into parallel strips resembling thick fibers; tunic neck varies in length relative to other congeners; four cataphylls; colorful anthers, purple to reddish- brown with yellow margins; .exhibits large seeds, measuring 3.5 to 4 mm in length. Crocus terbolensis differs from its congeners in possessing white to cream in color and striped with brown transverse lines giving the impression that the bulb is composed of several layers; longer tunic neck up to 10 mm; papillose long filaments up to 10 mm; papillose style, divided around or lower than the bottom of the anthers; middle-sized flower segments smaller than C. laevigatus and bigger than C. pumilus; big seed size up to 4.5 mm long, and 2.5 mm wide (up 2 mm long only on the other similar species). Crocus libani displays an extensive altitudinal distribution (60–1500 m a.s.l., including Horsh Ehden), thriving under high winter rainfall (700–1500 mm), high summer humidity. Crocus terebolensis is confined to semi-mountainous Mediterranean climates at 600 m a.s.l. where topography buffers coastal heat and dictates distinct wet-dry seasonality. Voucher specimens (Holotypes) are deposited in Dr. Addam Herbarium AUL Beirut-Lebanon, (DAH-AUL). The primary objective of this study is to elucidate the morpho-anatomical attributes of two distinct Crocus species, thereby substantiating their status as novel global records. The empirical data, morphometric profiles, and high-resolution close-up photographs of fresh specimens generated during this investigation serve to refine current taxonomic descriptions. Furthermore, the anatomical data presented represents novel findings for these taxa, establishing a robust, reproducible diagnostic framework for the identification of newly discovered Crocus lineages.

Keywords: *Crocus libani sp. nov, Crocus terbolensis sp. nov, Iridaceae, new world record, taxonomy, North Lebanon, Mediterranean.*

INTRODUCTION

Taxonomically assigned to the order Asparagales, the monocotyledonous family Iridaceae is globally recognized to encompass a fluctuating baseline of approximately 66 to 69 accepted genera. According to authoritative data curated by the Encyclopædia Britannica, the family systematically circumscribes 66 distinct genera containing roughly 2,200 species, a baseline that directly aligns with modern, phylgetically supported botanical treatments [1].

Conversely, the Plants of the World Online (POWO) database maintained by the Royal Botanic Gardens, Kew, recognizes 70 accepted genera within the Iridaceae family. This discrepancy highlights the slight taxonomic variances among primary global repositories, which stem directly from continuous, real-time updates in genus-level delimitations driven by modern phylogenetic data [2]. Despite ongoing systematic shifts within global vascular flora classifications, the suprageneric architecture and relative species volume of the family Iridaceae have maintained notable taxonomic stability in recent years [3].

Comprising a major evolutionary lineage within the family Iridaceae, the genus Crocus Linnaeus is globally recognized as a complex taxonomic entity characterized by ambiguous species boundaries and historically problematic classifications [4].

The statistics of Kew plant of the world till July 2026 revealed that there exist 257 accepted species of Crocus. While hundreds are not yet accepted [5]. Establishing a definitive taxonomic framework for the genus *Crocus* is structurally problematic, continually challenging established methods of botanical nomenclature [6]. Historically, the alpha-taxonomy of the genus *Crocus* has leaned heavily on macro-morphological diagnostics, including corm and tunic architecture, foliar anatomy, perianth segment merosity and pigmentation patterns, and phenological milestones such as anthesis periods. Nevertheless, pronounced phenotypic plasticity and the prevalence of cryptic speciation frequently obfuscate unambiguous species delimitation, a confounding factor that is particularly acute across under-surveyed refugia within the Mediterranean Basin and the Levant [7].

Conducted within the 2023–2025 timeframe, contemporary integrative systematic and taxonomic investigations prioritized the resolution of cryptic species complexes, the elucidation of polyploid evolutionary origins, and the formal description of micro-endemic taxa. These advancements were accomplished by synthesizing macro-morphological examinations, cytogenetic profiles, and high-throughput genomic data [8].

Molecular phylogenetic studies have revealed a complex evolutionary history for the genus, including multiple instances of hybridization, polyploidy, and geographically driven divergence [9].

Pronounced chromosome plasticity (2n=6 to 2n=70) and high rates of intraspecific cytogenetic variation characterize the severe karyological instability of *Crocus* [10].

This pervasive aneuploidy complicates taxonomic classification by obscuring the group's fundamental base chromosome number [11].

As one of the planet's premier biodiversity hotspots [12], the Mediterranean Basin is globally distinguished by its exceptional floristic richness [13] and, despite comprising only 1% of the Earth's terrestrial surface, hosts roughly 25,000 plant taxa—approximately 10% of global species—shaped by a unique paleogeographic history. This region is defined by pronounced endemism, with 60% of native species being regional endemics, and a third of the total flora exhibiting restricted distributions, primarily classified as either narrow or disjunct, which form a critical focus for conservation science [14].

Crucially, attention must be directed toward the critical, underlying vulnerabilities introduced by prolonged human activity; centuries of intensive anthropogenic interference have historically altered and degraded these indigenous ecosystems [13].

This structural destabilization severely compromises the region's resilience, leaving it profoundly susceptible to imminent and severe macroclimatic shifts. Consequently, localized conservation strategies have become an absolute imperative to mitigate escalating environmental and climatic disruptions [15].

From a phytogeographical perspective, the genus Crocus L. (Iridaceae) is primarily centered within the Mediterranean floristic Basin encompassing Lebanon, Palestine, Syria, Jordan, Turkey, and Cyprus with extensive populations radiating into southwestern Europe, southwestern Asia, western China, and the Irano-Turanian phytochorion [16].

This geographic distribution strictly aligns with a classic Mediterranean bioclimatic profile defined by mild winters, torrid, arid summers, and transitional autumn-spring precipitation regimes. Consequently, these macroclimatic constraints directly mirror the environmental conditions characterizing the Lebanese Levant [7].

Synthesizing these findings, the Lebanese territory functions as a pivotal meso-hotspot of Mediterranean phylodiversity, supporting an exceptional concentration of species richness relative to its restricted spatial area. This structural biodiversity is driven by the confluence of a Mediterranean macroclimate, highly heterogeneous lithology, and complex rugged topography, providing stable, specialized microhabitats and evolutionary refugia for endemic plant lineages [17].

Notably, Lebanon acts as an essential center of diversification for hyper-endemic geophytes, with critical representation in Crocus, Colchicum, and Romulea (Iridaceae and Colchicaceae).

Because of these distinct eco-evolutionary dynamics, species featuring prominent local distributions are often characterized by global rarity, rendering the preservation of these habitats a critical imperative for global biodiversity initiatives [18, 3, 19, 20].

The taxonomic framework of Levantine flora relies on three foundational historical treatises. The cornerstone was laid by Post (1896; revised by Dinsmore, 1932) through the definitive *Flora of Syria, Palestine, and Sinai* [21].

This botanical lineage culminated in Mouterde's (1966–1984) monumental three-volume *Nouvelle Flore du Liban et de la Syrie*, which remains a primary authority due to its exhaustive, accompanying iconographic atlas [22].

Bouloumoy (1930) subsequently advanced regional phytogeography in *Flore du Liban et de la Syrie* by integrating diagnostic illustrative plates [23].

Within their respective floristic works, these authors identified the following *Crocus* taxa: C. hyemalis Boiss. & Blanche., C. graveolens Boiss. & Reut., C. kotschyanus K. Koch,C. pallasii subsp. pallasii, C. pallasii subsp.haussknechtii (Boiss. & Reut. ex Maw) B.Mathew., C. ochroleucus Boiss. & Gaill., C. vitellinus Wahlenb., C. thiebautii Mouterde, C. haussknechtii (Boiss. & Reut. ex Maw) Boiss., C. cancellatus Herb.C., C. cancellstus damascenus (Herb.) Mont, C. cancellatus var. cilicius Maw. Crocus aleppicus Baker, Crocus gaillardotii (Boiss. & C.I.Blanche) Maw [7].

Building upon the historical baseline established by early botanical surveys, contemporary discoveries of novel Crocus taxa by Addam and Bou-Hamdan (2014, 2019) reinforce Lebanon's status as a critical center of speciation within the Mediterranean hotspot. These recent taxonomic additions—most notably Crocus baalbekensis and its distinct sub-taxa—demonstrate that the complex geomorphology of the Lebanese Levant provides specialized microhabitats that actively drive localized diversification and niche partitioning within the genus Crocus.

Nineteen new taxa established by Addam and Bou-Hamdan include *Crocus baalbekensis* K. Addam & M. Bou-Hamdan along with its infraspecific variants. These encompass five new subspecies: *C. baalbekensis* subsp. *ahlansis*, subsp. *anthopotamus*, subsp. *fakihansis*, subsp. *harbatansis*, and subsp. *rassomensis* (all Addam & Bou-Hamdan, subsp. nov.); ten new varieties: *C. baalbekensis* var. *decorus*, var. *flavo-album*, var. *fluctus*, var. *makniensis*, var. *rasbaalbekensis*, var. *rihaensis*, var. *shaathensis*, var. *shlifensis*, var. *tnaiyetensis*, and var. *youninensis* (all Addam & Bou-Hamdan, var. nov.); and three forms: *f. assiensis*, *f. bella*, and *f. ornata* Addam & Bou-Hamdan.

Of the 19 recently identified taxa (comprising species, subspecies, varieties, and forms), 13 have already been accepted by Kew and other repositories, while the rest await formal recognition. In addition to these previous discoveries, this study introduces two new records: *Crocus libani K. Addam & M. Bou-Hamdan, sp. nov., and Crocus terbolensis K. Addam & M. Bou-Hamdan, sp. nov.* These additions significantly contribute to the known diversity of the genus *Crocus* within Lebanese flora [24].

Expanding upon the existing taxonomic baseline, this study documents two novel species*: Crocus libani K. Addam & M. Bou-Hamdan sp. nov. and Crocus terbolensis K. Addam & M. Bou-Hamdan sp. nov.* These discoveries substantially augment the known species richness of the genus Crocus within the Lebanese flora, further underscoring the region's evolutionary complexity [24].

The pioneering botanical explorations conducted by Khodr Addam and Mounir Bou-Hamdan have fundamentally transformed the understanding of regional biodiversity, positioning their discoveries as a monumental milestone in Levantine plant taxonomy.

Their collaborative research marks a historic milestone in the botanical exploration of Crocus within the Levant, yielding unprecedented, globally recognized discoveries within the Lebanese flora. Spanning 29 years of rigorous, uninterrupted field investigations and taxonomic analysis, their groundbreaking investigations have fundamentally reconfigured the regional phytogeographical paradigm. Most notably, it has established new global records within the genera Crocus, Romulea, and the family Orchidaceae, alongside documenting tens of novel familial records previously unrecorded in Lebanon. The data published to date represent merely the preliminary output of a vast, ongoing compendium of findings. This lifework is driven by a critical conservation objective: to systematically unveil and advocate for the protection of Lebanon's highly endemic, yet severely understudied, botanical heritage. Unlocking this cryptic biodiversity demands a rare synthesis of advanced taxonomic expertise, acute field-observation skills, and an enduring commitment to ecological preservation [25, 26, 3, 7, 4, 19, 27, 28, 29, 30, 17].

MATERIALS AND METHODS

Field Surveys and Specimen Collection

Observations and description of *Crocus libani* K. Addam & M. Bou-Hamdan sp. nov. and *Crocus terbolensis* K. Addam & M. Bou-Hamdan sp. nov. were based on live material. Hundreds of these two new species were observed in many villages within the North Governorate of Lebanon (NGL) from many districts (Zgharta, Bsharri, Miniyeh-Dinnieh and Koura).

This approach was implemented to ensure maximum diagnostic precision and to facilitate the comprehensive morphological characterization of the newly described taxa. Given that *Crocus* species often lose critical diagnostic traits during the desiccation process, all measurements and evaluations were performed *in situ*. While this methodology required intensive field labor, it allowed for the preservation and documentation of subtle morphological nuances often lost in herbarium specimens, particularly regarding the coloration and geometry of the tepals, as well as the precise dimensions of the anthers and style branches. Datasets were compiled from a minimum of ten representative individuals per taxon, ensuring a robust morphological profile derived from living populations.

This rigorous taxonomic methodology was embedded within a longitudinal, 29-year (1997-2026) field study, during which all historically documented Lebanese *Crocus* taxa were successfully authenticated—with the singular exception of *Crocus gaillardotii* (Boiss. & C.I.Blanche) Maw. Notwithstanding the elusive status of the latter species, systematic field surveys persisted unabated, with targeted empirical data acquisition and structural sampling for the newly identified taxa spanning continuously from 2011 to 2026.

Description of new species

***Crocus libani* K. Addam & M. Bou-Hamdan sp. nov (Figure 1).**

Holotype: Lebanon, Zgharta District, Village Arbet Qozhaya,1250 m elevation, 34.2987°N, 35.9396°E in flower, 11 November 2020, Ass. No. 18112058001 DAH-AUL (Dr.Addam Herbarium AUL) (Figure 5).

Figure 1: Crocus libani sp. nov.

Plant, 50-110 mm. Stem, 30-90 mm. Corm, 14-18 mm in diameter, ovoid with thick roots, old corm under the tunics turns pale orang-pink and dotted with many fine dark orange dots. Tunics, light brown to brown outer tunic, papery dotted with fine dark brown dots, splitting into parallel strips resembling thick fibers from its midpoint towards the base. Tunic neck, 6-8 mm long, prolonged main tunic splits into narrow segments. Basal rings are absent. Prophyll is absent. Cataphylls, 4, membranous, white-creamy to pale brown, the upper one is more transparency with prominent ribs and greenish apex. Leaves, 4-10, dark green, glabrous, 40-90 mm long, shorter than the flowers and not exceeding them at anthesis, 1-1.8(-2) mm wide, without ribs in lateral channels, the white stripe less than 1/3 of the leaf width. Bract and bracteole, membranous, white, bract longer than bracteole. Perianth tube, white, exceeds the bract apex by 10 to 40 mm, ribbed and striped purplish in the upper part. Throat, glabrous, yellow to light orange. Filaments, 6-8 mm long, glabrous to pubescent with few scattered hairs, dark yellow to light orange. Anthers, 8-12 mm long, mostly arrow-shaped, purple to reddish-brown with yellow margins. Connective, white to pale purple, membranous, semi-transparent. Style, divided from its lower quarter into 3 branches and each branch divided into 4 slenders (occasionally, each slender element becomes progressively further divided), orange branches, exceeding or equaling the anthers, rarely shorter. Flower, fragrant. Flower segments, narrowly elliptic or oblanceolate, subacute, 20-30 mm long and 5-8 mm wide, the inner segments are shorter by 1 to 3 mm, subequal in width, both sides are white, the outside with short dark purple stripes at the base (sometimes with pale purple). Outer segments, 22-30 mm long and 5-8 mm wide, white on both sides, the outside striped with three purple stripes, the main stripe (up to 0.5 mm wide) extends upwards from the upper part of the tube to the lower quarter of the segment where it is flanked by two shorter strips, one on each side, the side stripes branch off from the opposite side of the middle one into thinner obtuse stripes,

sometimes a short middle stripe appear at the tip of the segments. Inner segments, 20-28 mm long and 5-8 mm wide, white on both sides, the outside dark purple stripes are shorter than the outer segment stripes, and very close to each other, sometimes look like a single stripe, and as the outer segment, the main stripe extends upwards from the upper part of the tube. Capsule, ellipsoid, 6-10 mm long and up to 6 mm wide, raised well above ground at maturity (30-40 mm). Seeds, subglobose to oblong, 3.5-4 mm long, reddish-brown, with a prominent caruncle and a distinct raphe (conical 1-1.5 mm), testa coarsely undulate (Figure 2).

Figure 2: Taxonomic dissection of Crocus libani sp. nov.

Location:

The investigation focuses on eight representative localities within the North Governorate of Lebanon (NGL), spanning a significant altitudinal range from coastal plains to high-montane environments. These sites are situated across the Zgharta, Bsharri, Koura, and Miniyeh-Dinnieh Districts, representing diverse geomorphological and socio-spatial contexts (Figure 3)

Arbet Qozhaya (34.2987°N, 35.9396°E): Zgharta District, this village is located 25 km from Zgharta and 85 km from Beirut at elevation of 1,250 m (a.s.l.) [31] (Figure 4).

Bousit (34.4440°N, 35.9181°E), Zgharta District, situated 97.3 km from the national capital Beirut, 15.3 km from Tripoli, at an elevation of 590 m [32].

Ehden (34.3019°N, 35.9725°E): A high-altitude settlement in the Zgharta District, 120 km north of Beirut and 30 km from Tripoli and represents the highest altitude point of the study at 1,500 m above sea level (a.s.l.) [33].

Mazraat El-Naher (34.2837°N, 35.9207°E): Qadisha Valley at the administrative boundary of the Zgharta and Bsharri Districts, 85 km from Beirut , 24 km from Tripoli at an elevation of 580 m (a.s.l.).

Tourza (34.2827°N, 35.9039°E): Bsharri District, 82.4 km from Beirut, 21.6 km from Tripoli at an elevation of 660 m(a.s.l.) [34].

Rechdebine (34.2947°N, 35.8603°E): Koura District at 650 m, 18.1 km from Tripoli, 100 km north of Beirut at an elevation of 650 m(a.s.l.) [35].

Jabal Terbol (North) (34.4458°N, 35.9378°E): Miniyeh-Dinnieh District, 98 km from Beirut, between 15 and 20 km from Tripoli at an altitude of 650 m(a.s.l.).

Anfeh (34.3535°N, 35.7446°E): A coastal municipality in the Koura District characterized by maritime activities, approximately 65 km north of Beirut, 15 km south of Tripoli and represents the lowest altitudinal point of the study at 55 m above sea level (a.s.l.) [36].

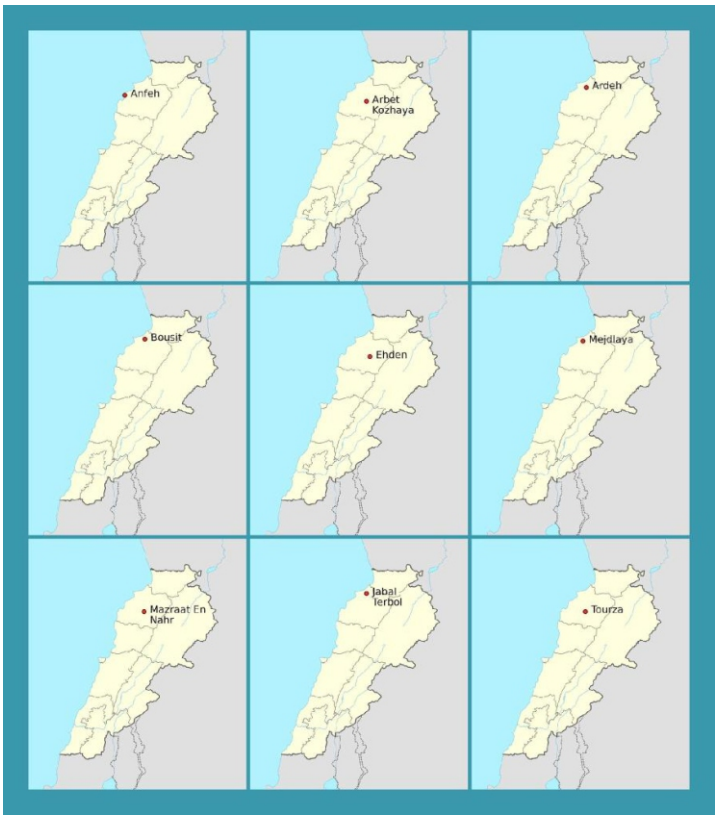

Figure 3: Location of Crocus libani and Crocus terbolensis in NGO Lebanon.

Figure 4: Map of Lebanon showing the routes from Beirut to Arbet Qozhaya and Bousit.

Habitat

Altitudinal Plasticity and Bioclimatic Drivers of *Crocus libani* Populations from Coastal to Montane.

Crocus libani exhibits a broad altitudinal distribution, extending from coastal regions at 60m to elevations of 1500m in Horsh Ehden. This plant is characterized by its spread in northern Lebanon on the western slopes of the western Lebanon mountain range, in areas that experience the highest rainfall rates in winter and are exposed to high humidity in summer, with significant temperature differences between the coast and the mountain. Within these zones, species actively proliferate across *diverse* topographies—including forest valleys and open landscapes integrating into complex Mediterranean ecosystems characterized by high levels of biodiversity.

Ecological Niche and Phytosociological Associations of Crocus libani

The exceptional presence of Crocus libani within this study area represents a significant ecological milestone, thriving within a complex vegetative mosaic that spans Mediterranean maquis and montane scrub ecosystems. The habitat is characterized by an overstory of Pinus brutia and the resilient Quercus coccifera, which provide the shifting light conditions essential for geophyte development. In the mid-tier and shrub layers, *Crocus libani* demonstrates a high degree of niche overlap with Berberis libanotica, Rosa canina, and Cotoneaster nummularius, often colonizing the well-drained, calcareous lithosols found in the areas of these woody perennials [37].

The herbaceous stratum reveals a rich competitive and temporal assemblage; C. libani coexists with fellow irids and autumn-flowering geophytes, including Crocus cancellatus, Crocus graveolens, Colchicum steveni, and Colchicum hierosolymitanum. The ecological resilience of this record-breaking population is further evidenced by its integration into a diverse community of heliophilous species such as Cistus creticus, Pistacia terebinthus, and Cyclamen persicum. Furthermore, the site is defined by a robust aromatic Mediterranean component, where C. libani is found interspersed with Origanum syriacum, Salvia fruticosa, Thymbra spicata, and Anchusa strigosa. The presence of the rare Stachys annua subsp. ammophila underscores the high conservation value of this specific microhabitat, suggesting an optimal pedo-climatic environment for the proliferation of C. libani at unprecedented densities or scales.

Flowering time: November-December-(January).

Etymology: The epithet *libani* is Lat. for "of Lebanon". In bot. Lat., it is the gen. sing. form of the 2nd-declension masc. noun *Libanus* (classical Lat. name for Lebanon, referencing the country and its two mountain ranges. Mt. Lebanon and Anti-Lebanon) [38].

The root *Libanus* derives from Anc. Gr. *Líbanos (Λίβανος)*. Contextually, *libanus* denotes either frankincense or the Lebanon mountain range. Hist., during classical antiquity, Lebanon was known as Phoenicia [39, 40].

Voucher Specimen Holotype Crocus libani K. Addam & M. Bou-Hamdan Species nova deposited in Dr. Addam Herbarium AUL Beirut-Lebanon, (DAH-AUL). Accension No.18112058001. Collected (from Arbet Qozhaya) and described by Mr. Mounir Bou-Hamdan at 18.XI.2020. Identified by Dr. Khodr Addam.

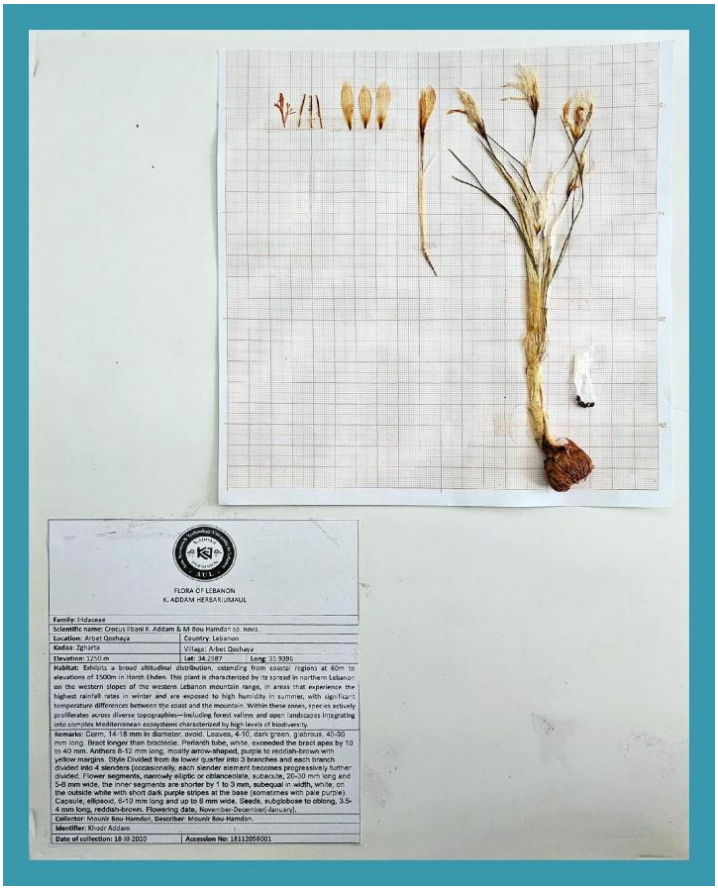

Figure 5: Holotype of Crocus libani sp. nov. deposited in DAH-AUL, Lebanon.

2 *Crocus terbolensis K. Addam & M. Bou-Hamdan, Species Nova* (Figure 6).

Holotype: Lebanon, Minieh-Danniyeh District of North Lebanon, Bousit - Mount Terbol, 538m elevation, 34.4439°N, 35.9105°E,in flower, 16 December 2018, Ass. No. 1612201858001 DAH-AUL.(Dr.Addam Herbarium AUL) (Figure 8).

Figure 6: Crocus terbolensis sp. nov.

Plant, 40-80 mm (till the flower tip). Stem, 20-60 mm. Corm, ovoid to pyriform, 8 - 15 in diameter, white to cream in color and striped with brown transverse lines giving the impression that the bulb is composed of several layers. Tunics, coriaceous, split into long, narrowly straight to arched triangular teeth, each triangle splitting into narrow strips from its bottom third towards the base. Tunic neck, up to 10 mm long, formed by a prolonged main tunic and only shortly split at the very top. Basal rings, absent. Prophyll, absent. Cataphylls, 3 - 4, membranous, white, ribbed, tinged greenish at the apex, occasionally purplish. Leaves, (2)3 - 5(7), glabrous (rarely sparsely ciliated along the keel), green to dark green, up to 2.5 mm wide and to 120 mm length (up to 240 mm after anthesis), lateral channels without ribs, the white stripe around 1/4 of the leaf width or slightly wider; appears before or with the flowers and usually overtopping the flowers at anthesis, (Lower during periods of limited rainfall). Bract and bracteole, subequal, membranous, white, sometimes its veins are tinged greenish at the apex. Perianth tube, whitish, near the top striped lighter or darker greyish to purplish. Throat, yellow to orange, somewhat lighter at the starry edge, glabrous. Filaments, 5 - 10 mm long, yellow to orange (the same color as in the throat), papillose, sometimes glabrous. Anthers, 5-10 mm long, membranous, white to pale yellow, their shapes become spiral and sickle, pollen white. Connective, membranous, semi-transparent, white to pale yellow. Style, light to dark orange, papillose, divided around or lower than the bottom of the anthers into many branches, ending at the tips of the anthers to significantly exceeding them, sometimes shorter. Flower, 1 - 4, usually fragrant, the inside white. Flower segments, inner segments are shorter than the outer segments, inside color are white with visible veins, occasionally with pale blue stripes symmetrical to the outside striping, and invisible white veins with the speckled outside. Outer segments, (18-)22-28(-30) mm long and (6-)7-9(-10) mm wide, the outside ground color white (rarely light yellow), with yellow to goldy yellow (rarely buff) backs on lower quarter, and usually marked with 3 deep blue stripes (the middle one mostly reached the segment tip), or speckled with short vertical deep blue thin lines distributed across the entire segment and concentrated into three upward speckled stripes towards the segment tip . Inner segments, (16-)20-26(-28) mm long and (4-)5-7(-8) mm wide, the outside ground color white (rarely light yellow), with yellow to goldy-yellow (rarely buff) backs on lower quarter, and usually marked with 3 deep blue stripes (from the segment bottom upwards to its middle), or speckled with short vertical deep blue thin lines on its lower quarter upwards as a middle speckled stripe to the segment tip. Capsule, ellipsoid with tapered top, up to 10 mm long and 5-7 mm wide, straw-purple to dark brown, raised up to 50 mm above ground at maturity. Seeds, subglobose to ellipsoid, slightly angular, 3.5 - 4.5 mm length, 2 - 2.5 mm wide (or diameter), reddish to dark reddish, with a prominent caruncle and an indistinct raphe, testa rugose, coriaceous (Figure 7).

Figure 7: Taxonomic dissection of Crocus terbolensis.

Location:

Geographic Distribution: The investigation encompasses three representative localities within the North Governorate of Lebanon (NGL), specifically focused on the Zgharta District. The study area reflects a significant mid-altitude gradient, with elevations ranging from 240 m to 538 m above sea level (a.s.l.). These sites were selected to capture diverse geomorphological contexts and varying degrees of proximity to the regional hub of Tripoli and the national capital, Beirut (Figure 3).

Bousit–Jabal Terbol (North): (34.4439°N, 35.9105°E): Situated at the northern extent of the study area, approximately 10–12 km northeast of Tripoli and 98 km from Beirut, at a high elevation of 538 m (a.s.l.) [41] (Figure 4).

Majdalaiya (34.4431°N, 35.8957°E): roughly 11 km from Tripoli and 93 km from Beirut, lower altitudinal limit of the current dataset, at a high elevation of 240 m (a.s.l.) [42].

Ardeh (34.4323°N, 35.9108°E): 10.5 km from Tripoli and 94.8 km from Beirut, at the piedmont (base) of the mountain range at an elevation of 327 m (a.s.l.) [43].

Habitat:

Altitudinal Plasticity and Bioclimatic Drivers of *Crocus terbolensis* Populations.

Located in North Lebanon overlooking the Minieh-Dinnieh and Zgharta districts, Mount Terbol features a semi-mountainous Mediterranean climate dictated by its elevation of slightly over 600 meters above sea level.

This topography mitigates typical coastal heat, resulting in high seasonal thermal contrast and distinct wet-dry periods.

The winter regime (December to February) is characterized by high precipitation, persistent cloud cover, and frequent frost. Typical low temperatures range from 2°C to 5°C, though severe cold fronts routinely drop conditions below freezing. While rainfall is heavy, snowfall remains common at this altitude during major winter storm events.

Conversely, the summer regime (June to August) is highly arid, sun-exposed, and stable. Constant sea-to-mountain breezes provide regular ventilation to the region. Diurnal temperatures fluctuate from mean daytime highs of 26°C to 32°C to cool nocturnal lows ranging between 15°C and 18°C.

Annual precipitation in the Danniyeh mountains generally exceeds 900 mm, underscoring the region's ecological importance in northern Lebanon [44].

The terrain is steep and rugged, dominated by limestone formations and a prominent peak overlooking the coastal plains. Crocus terbolensis is found in the southern slopes of Mount Terbol at an altitude between 200 and 600 meters above sea level. The mountain's base consists of hard limestone / dolomite rocks and soil ranging from calcareous to loam. In open areas, only a few small shrubs grow due to the thinness of the soil above the rocky base of the mountain on these slopes [45].

Ecological Niche and Phytosociological Associations of Crocus *terbolensis*

Crocus terbolensis thrives within a complex phytosociological assemblage characteristic of Eastern Mediterranean garrigue and phrygana ecosystems. This specimen flourished in a high-competition substrate dominated by sclerophyllous and aromatic taxa, including Pistacia lentiscus, Sarcopoterium spinosum, and Calicotome villosa, suggesting an optimized niche exploitation of the terra rossa soils typically associated with these communities. The presence of diverse labiates and geophytes—notably Origanum syriacum, Micromeria myrtifolia, and Asphodelus ramosus subsp. ramosus—indicates a micro-environment with superior nutrient cycling and hydrological stability. Furthermore, the sympatric occurrence of Crocus graveolens and Cyclamen persicum underscores a unique localized phenology, where the C. terbolensis individual achieved its record dimensions by effectively navigating the selective pressures of a densely populated herbaceous layer comprising Teucrium polium, Eryngium creticum, and Petrosedum sediforme.

Flowering time: November – January.

Etymology: The specific epithet *terbolensis* denotes to Jabal Terbol, a coastal mountain in Northern Lebanon, which historically named Tur-Baal: the ancient Phoenician name for the mountain was "Tur Baal," where "Tur" (or "Tura") means mountain, and "Baal" is the name of the Phoenician god (the god of fertility and storms). Over time, with the succession of civilizations and languages, the two words merged to become Terbol, located roughly 6 miles from Tripoli [46, 47].

Voucher Specimen Holotype: *Crocus terbolensis K.* Addam & M. Bou- Hamdan Species nova deposited in Dr. Addam Herbarium AUL Lebanon, (DAH-AUL). Accession No. 1612201858001. Collected (from Bousit-Jabal Terbol North) and identified by Dr. Khodr Addam at 16.XII.2018. Described by Mr. Mounir Bou-Hamdan (Figure 8).

Figure 8: Holotype of Crocus terbolensis sp. nov. deposited in DAH-AUL, Lebanon.

DISCUSSION

Crocus libani is widely distributed across the western slopes of the Mount Lebanon range. This taxon thrives within the bioclimatic zones characterized by Lebanon's maximum annual precipitation levels. It exhibits pronounced eurytopic traits, spanning a wide altitudinal gradient from coastal lowlands to montane elevations, alongside significant edaphic plasticity across calcareous, mixed, and argillaceous (clay-rich) substrates. Population clusters proliferate preferentially in pristine, open habitats insulated from anthropogenic disturbances—such as agricultural encroachment or urbanization—as well as within heliophilic gaps and clearings interspersed throughout dense silvatic ecosystems.

Conversely, *Crocus terbolensis* exhibits a highly localized distribution, restricted exclusively to the southern aspect of the coastal Mount Terbol. This steno-ecologic taxon is confined to a narrow altitudinal belt ranging between 200 and 600 meters above sea level, where it functions as a primary obligate to calcareous substrates, with marginal occurrences in mixed soil profiles.

The microhabitats of *C. terbolensis* are characterized by an extremely attenuated, shallow topsoil horizon overlying a lithic, consolidated limestone bedrock matrix. This severe edaphic restriction and the underlying impermeable lithology collectively preclude the establishment of macro-arboreal vegetation or dense forest formations. Consequently, Mount Terbol presents a distinct, barren karst landscape. This unique geomorphological configuration provides the exclusive microenvironment preferred by *C. terbolensis*, rendering it entirely endemic to this specific locality within the Lebanese territory.

Spatial mapping indicates that populations manifest predominantly across open, unshaded terrains with highly variable density dynamics, while concurrently displaying a diffuse, scattered pattern within sparse shrublands and stunted, widely spaced arboreal patches. Accordingly, this species is classified as an exceptionally rare, critically endangered steno-ecologic endemic that requires highly specialized microenvironmental and bioclimatic parameters for its vegetative growth and survival

From a taxonomical point of view, *Crocus libani* is distinguished from closely related species by its old corm that turns from white to pale orange-pink dotted with many fine dark orange dots, with thick roots; light brown papery outer tunic dotted with fine dark brown dots and splitting into parallel strips resembling thick fibers; tunic neck varies in length relative to other congeners especially *Crocus aleppicus* and *Crocus hyemalis* (Figure 9); four cataphylls; colorful anthers, purple to reddish-brown with yellow margins; .exhibits large seeds, measuring 3.5 to 4 mm in length. *Crocus terbolensis* differs from its congeners in possessing white to cream in color and striped with brown transverse lines giving the impression that the bulb is composed of several layers; longer tunic neck up to 10 mm; papillose long filaments up to 10 mm; papillose style, divided around or lower than the bottom of the anthers; middle-sized flower segments smaller than *Crocus laevigatus* and bigger than *C. pumilus*; big seed size up to 4.5 mm long, and 2.5 mm wide (up 2 mm long only on the other similar species) (Figure 9).

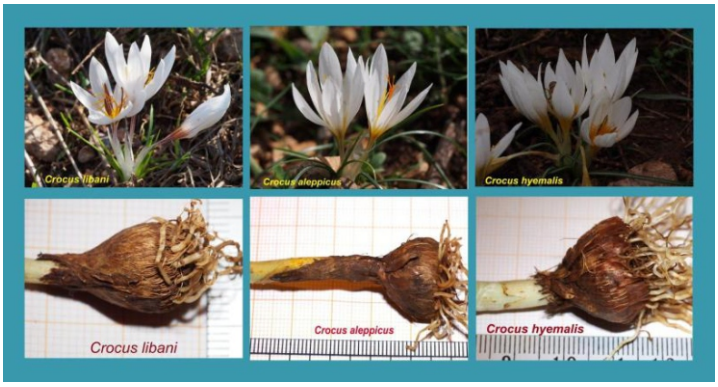

Figure 9. Comparison of C. libani, C. aleppicus, and C. hyemalis: flowers (top row) and corms with tunics (bottom row).

CONCLUSION

The formal description and taxonomic validation of *Crocus libani* K. Addam & M. Bou-Hamdan, sp. nov. and *Crocus terbolensis* K. Addam & M. Bou-Hamdan, sp. nova. signify a profound advancement in the systematics of the family Iridaceae within Lebanon and the broader Mediterranean basin. By synthesizing rigorous macro-morphological characterization with comprehensive micro-anatomical evaluations of all vegetative and reproductive organs of the discovered taxa, this study establishes a robust empirical framework that confirms the distinct specific status of these novelties within the Lebanese flora.

The taxonomic status of these discoveries is substantiated by extensive, long-term empirical data. This baseline evidence encompasses detailed morphological illustrations, 29 years of comprehensive field research, and 15 years of systematic phenological monitoring and taxonomic rendering dedicated explicitly to these two *Crocus* species.

This foundational research builds upon extensive historical field investigations in the region, culminating in the discovery, documentation, and description of these two discrete Iridaceae novelties, *C. libani* sp. nova and *C. terbolensis* sp. nova. For both newly described species, representative holotypes and voucher specimens were collected, identified, and formally deposited in the K. Addam Herbarium at the Arts, Sciences and Technology University in Lebanon (AUL). Collectively, these findings underscore the critical conservation priority and evolutionary significance of specific micro-refugia in driving localized speciation and maintaining high rates of endemism within the Eastern Mediterranean flora of Lebanon.

ACKNOWLEDGMENTS

We further acknowledge with gratitude the generous financial backing and continued encouragement provided by AUL University and Mr. Mohamad Imad Dalbani, founder of Dalbani Global Company, whose commitment to advancing academic efforts in environmental and plant conservation in Lebanon has been invaluable. The authors also thank Dr. Omar Addam, PhD (Data Scientist), for his assistance with the references and technical preparation of the manuscript.

Conflicts of interest: No conflicts of interest

REFERENCES

1. Encyclopaedia Britannica, "Iridaceae," [Online]. Available: https://www.britannica.com/plant/Iridaceae. [Accessed 15 8 2026].
2. Royal Botanic Gardens, Kew, "Iridaceae Juss.," [Online]. Available: https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:30001783-2. [Accessed 15 8 2026].
3. K. Addam, M. Bou-Hamdan and N. Sabbagh, "Romulea jezzinis K. Addam & M. Bou-Hamdan sp. nov. and Romulea libanotica K. Addam & M. Bou-Hamdan sp. nov. (Iridaceae), Two New Species from Lebanon," MOJ Ecology & Environmental Sciences, vol. 7, no. 3, pp. 96-103, August 2022.
4. K. Addam, M. Bou-Hamdan, J. Takkoush and K. Hout, "New ten varieties and five subspecies of Crocus baalbekensis K. Addam & M. Bou-Hamdan (Iridaceae) endemic to Lebanon added to the Lebanese flora," MOJ Ecology & Environmental Sciences, vol. 4, no. 6, pp. 281-294, December 2019.
5. Royal Botanic Gardens, Kew, "Crocus L.," [Online]. Available: https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:20293-1. [Accessed 15 8 2026].
6. D. Harpke, L. Peruzzi, H. Kerndorff, T. Karamplianis, T. Constantinidis, V. Randelovic, N. Randelovic, M. Juskovic, E. Pasche and F. R. Blattner, "Phylogeny, geographic distribution, and new taxonomic circumscription of the Crocus reticulatus species group (Iridaceae)," Turkish Journal of Botany, vol. 38, no. 6, pp. 1182-1198, 2014.
7. K. Addam, M. Bou-Hamdan, N. Sabbagh, J. Takkoush and K. Hout, "Crocus baalbekensis K. Addam & M. Bou Hamdan sp. nov. and its three forms (Iridaceae), new endemic species and forms from Lebanon, joined the Lebanese Flora," MOJ Ecology & Environmental Sciences, vol. 4, no. 2, pp. 75-83, April 2019.
8. I. Raca, D. Shuka, L. Shuka, N. E. Waminal and D. Harpke, "An Integrative Systematic Approach Reveals a New Species of Crocus Series Verni (Iridaceae) Endemic to Albania," Plants, vol. 14, no. 5, p. 741, February 2025.
9. G. Petersen, O. Seberg, S. Thorsøe, T. Jørgensen and B. Mathew, "A phylogeny of the genus Crocus (Iridaceae) based on sequence data from five plastid regions," Taxon, vol. 57, no. 2, pp. 487-499, May 2008.
10. P. Goldblatt, J. C. Manning and P. Rudall, "Iridaceae," in Flowering Plants. Monocotyledons: Lilianae (except Orchidaceae), vol. 3, K. Kubitzki, Ed., Berlin, Heidelberg, Springer, 1998, pp. 295-333.

11. D. Harpke, S. Meng, T. Rutten, H. Kerndorff and F. R. Blattner, "Phylogeny of Crocus (Iridaceae) based on one chloroplast and two nuclear loci: Ancient hybridization and chromosome number evolution," Molecular Phylogenetics and Evolution, vol. 66, no. 3, pp. 617-627, March 2013.
12. P. Gardini, "The Terrestrial Isopods (Crustacea, Isopoda, Oniscidea) of the Mediterranean Basin Biodiversity Hotspot: An Overview," in Biodiversity Hotspot of the Mediterranean Basin, T. Pullaiah and L. Galli, Eds., Apple Academic Press, 2026, pp. 105-136.
13. A. D. Solomou, "Mediterranean Basin," in Terrestrial Biomes: Global Biome Conservation and Global Warming Impacts on Ecology and Biodiversity, 1st ed., G. L. Demolin-Leite, Ed., Academic Press (Elsevier), 2025, pp. 147-154.
14. J. D. Thompson, M. Fauché, G. Papuga and P. Gauthier, "Plant conservation in a changing Mediterranean world," Plants, People, Planet, vol. 8, no. 1, pp. 49-72, January 2026.
15. A. Cuttelod, N. García, D. Abdul Malak, H. Temple and V. Katariya, "The Mediterranean: a biodiversity hotspot under threat," in Wildlife in a Changing World: An Analysis of the 2008 IUCN Red List of Threatened Species, J. Vié, C. Hilton-Taylor and S. N. Stuart, Eds., Gland, Switzerland, IUCN, 2009.
16. A. Dolatyari, M. Tolyat Abolhasani, F. Ardalani and J. Rukšāns, "A taxonomic revision of the genus Crocus (Iridaceae) in Iran," Nordic Journal of Botany, vol. 2024, no. 6, p. e04270, June 2024.
17. K. Addam, M. Bou-Hamdan and N. Sabbagh, "Sixteen new records for the flora of Lebanon," Current Botany, vol. 11, pp. 187-199, November 2020.
18. K. Addam, M. S. Al-Zein, M. Bou-Hamdan and H. Naous, "A New Record: Cyclamen persicum Mill. var. autumnale Grey-Wilson was Added to the Native Lebanese Flora," American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS), vol. 26, no. 4, pp. 186-194, December 2016.
19. K. Addam, N. Sabbagh, M. Bou-Hamdan, H. Mohammad and K. Hout, "Ophrys holoserica (Burm. f.) Greuter subsp. shoufensis subsp. novo K. Addam & M. Bou-Hamdan (Orchidaceae), A new world record from Lebanon," International Journal of Botany Studies, vol. 3, no. 6, pp. 25-32, November 2018.
20. Secretariat of the Convention on Biological Diversity, "Lebanon - Country Profile: Status and trends of biodiversity, including benefits from biodiversity and ecosystem services," [Online]. Available: https://www.cbd.int/countries/profile/?country=lb. [Accessed 15 8 2026].
21. G. E. Post, Flora of Syria, Palestine and Sinai: a handbook of the flowering plants and ferns, native and naturalized, from the Taurus to Ras Muhammad and from the Mediterranean Sea to the Syrian Desert, 2nd ed., extensively revised and enlarged ed., vol. 2 vols., J. E. Dinsmore, Ed., Beirut: American Press, 1932-1933.
22. P. Mouterde, Nouvelle flore du Liban et de la Syrie, vol. 3 vols., Beyrouth: Éditions de l'Imprimerie Catholique, 1966-1984.
23. L. Bouloumoy, Flore du Liban et de la Syrie: texte et atlas de planches, Paris: Vigot Frères, 1930.
24. Royal Botanic Gardens, Kew, "Crocus baalbekensis Addam & Bou-Hamdan," [Online]. Available: https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:77331515-1. [Accessed 15 8 2026].
25. K. Addam and M. Bou-Hamdan, "Augmenting Lebanon's Flora: Documentation of Eighteen Newly Recorded species and Noteworthy observations on Rediscovered Taxa," Plant Science Archives, vol. 10, no. 4, pp. 70-84, November 2025.
26. K. Addam, I. D. Kebbe, J. Takkoush, K. Hout and M. Bou-Hamdan, "A New Variety from Lebanon, Ophrys apifera var. libanotica K. Addam and M. Bou-Hamdan (Orchidaceae)," Journal of Botanical Research, vol. 6, no. 1, pp. 39-46, 2015.
27. K. Addam, M. Bou-Hamdan, S. Ibrahim and L. Ibrahim, "Ophrys omegaifera subsp. gharifensis (Orchidaceae), A New Subspecies from Lebanon," Journal of Botanical Research, vol. 4, no. 1, pp. 25-27, October 2013.
28. I. D. Kebbe, K. Hout, K. Addam and M. Bou-Hamdan, "Neotinea tridentata var. libanotica (Orchidaceae), a new variety from Lebanon," Journal of Botanical Research, vol. 5, no. 1, pp. 35-38, May 2014.
29. K. Addam, H. Mohammad, M. Bou-Hamdan, J. Takkoush and F. Rifai, "Cyclamen persicum f. puniceum (Gleason) Grey-Wilson New Plant Record Joined the Lebanese Flora," International Journal of Botany Studies, vol. 2, no. 4, pp. 12-15, July 2017.
30. K. Addam, M. Bou-Hamdan, M. Y. Alameh, H. Mohammad and J. Takkoush, "Orchis troodi (Renz) P. Delforge, Orchis sitiaca (Renz) P. Delforge and Orchis anatolica subsp. albiflora subsp. novo K. Addam & M. Bou-Hamdan, three new rare orchids joined the Lebanese flora," International Journal of Botany Studies, vol. 2, no. 6, pp. 221-228, November 2017.
31. Wikipedia contributors, "Arbet Kozhaya," [Online]. Available: https://en.wikipedia.org/wiki/Arbet_Kozhaya. [Accessed 15 8 2026].
32. Wikipedia contributors, "Bousit," [Online]. Available: https://en.wikipedia.org/wiki/Bousit. [Accessed 15 8 2026].
33. Wikipedia contributors, "Ehden," [Online]. Available: https://en.wikipedia.org/wiki/Ehden. [Accessed 15 8 2026].
34. Wikipedia contributors, "Tourza," [Online]. Available: https://en.wikipedia.org/wiki/Tourza. [Accessed 15 8 2026].
35. Wikipedia contributors, "Rachedbine," [Online]. Available: https://en.wikipedia.org/wiki/Rachedbine. [Accessed 15 8 2026].
36. Wikipedia contributors, "Anfeh," [Online]. Available: https://en.wikipedia.org/wiki/Anfeh. [Accessed 15 8 2026].
37. G. Cainelli, P. De Giorgi, G. Bedini and D. Ciccarelli, "Environmental drivers and soil nutrients shape the ecological strategy of the early-flowering Mediterranean geophyte Crocus etruscus along a coast-inland gradient," Plant Biosystems, vol. 160, no. 1, p. 15, February 2026.
38. Missouri Botanical Garden, "A Grammatical Dictionary of Botanical Latin - entry: Libanus," [Online]. Available: http://www.mobot.org/mobot/latindict/keyDetail.aspx?keyWord=Libanus. [Accessed 15 8 2026].
39. Grokipedia, "Libani," [Online]. Available: https://grokipedia.com/page/libani. [Accessed 15 8 2026].
40. Olivetti Media Communication, "libanus - Declensions / Conjugations latin," [Online]. Available: https://online-latin-dictionary.com/latin-dictionary-flexion.php?lemma=LIBANUS200. [Accessed 15 8 2026].
41. GetAMap.net, "Boussit Map, Weather and Photos - Lebanon: populated place," [Online]. Available: https://www.getamap.net/maps/lebanon/liban-nord/_boussit/. [Accessed 15 8 2026].
42. Wikiwand, "Mejdlaya," [Online]. Available: https://www.wikiwand.com/en/Mejdlaya. [Accessed 15 8 2026].
43. Wikipedia contributors, "Ardeh, Lebanon," [Online]. Available: https://en.wikipedia.org/wiki/Ardeh,_Lebanon. [Accessed 15 8 2026].
44. F. Karam, "Climate change and variability in Lebanon: impact on land use and sustainable agriculture development," in Proceedings of the First Technical Workshop of the Mediterranean Component of the CLIMAGRI Project on Climate Change and Agriculture, 2002.
45. Lebanon. Ministry of Environment, "Biodiversity Assessment and Protected Areas Management: Focus on Jabal Terbol Formations," Ministry of Environment, Beirut, 2004.

46. J. Matar, "The Village of Terbol," 15 February 2012. [Online]. Available: https://www.discoverlebanon.com/en/panoramic_views/north/el_minieh_dennieh/terbol.php. [Accessed 15 8 2026].
47. Almaany, "تـــــــــــربل - Almaany Arabic Dictionary," [Online]. Available: https://www.almaany.com/ar/dict/ar-ar/%D8%AA%D8%B1%D8%A8%D9%84/. [Accessed 15 8 2026].
48. K. Addam, J. Takkoush, M. Bou-Hamdan and J. Itani, "Five Established Orchids Ophrys apifera var. chlorantha, aurita, purpurea, purpurea f. alba and flavescens (Orchidaceae) in Lebanon as Part of the Native Flora," Journal of Ecology and Environmental Sciences, vol. 6, no. 2, pp. 163-169, 2015.
49. K. Addam, N. Sabbagh, M. Bou-Hamdan, K. Jamal Eddine and J. Itani, "Phytogeography, population, habitat, ecology, threat and conservation action of Orchis anatolica Boiss. in Lebanon," International Journal of Applied Research, vol. 4, pp. 34-46, April 2018.