



RESEARCH ARTICLE

A new record of *Astragalus boeticus* L. (Fabaceae) from Iraq: Integrative taxonomic evidence and global distribution mapping

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Abstract

The field surveys of the genus *Astragalus boeticus* L. conducted in the Jabal Sinjar District (MJS), northern Iraq, during spring 2025 resulted in the first record of *A. boeticus*. in the Flora of Iraq. The study was based on the examination of 12 specimens and the identity of this species was confirmed through regional floristic treatments from neighbouring countries, alongside a critical revision of national herbaria and relevant literature. This study provides an advanced taxonomic assessment based on detailed morphological characterisation of vegetative and reproductive organs, supported by anatomical investigation of the stem, petiole and stomatal complex, together with field and microscopic documentation, as well as the use of light microscopy and scanning electron microscopy (SEM) to support the anatomical and micromorphological documentation. A comparative analysis with the morphologically similar species *Astragalus hamosus* L. is included to highlight the diagnostic differences. Global distribution data were used to place the species within its broader biogeographical context. Voucher specimens were deposited in the Iraqi National Herbarium (BAG) and the Anbar University Herbarium (AUH), supporting the validation of *A. boeticus* as a verified new record for the Flora of Iraq.

Keywords: *Astragalus*; Fabaceae; Iraq flora; new record; Papilionoideae; species documentation

Introduction

The family Fabaceae Lindl. is one of the largest and most widely distributed families of flowering plants in the world, ranking third after Asteraceae and Orchidaceae (1). It comprises 805 accepted genera and more than 19500 species with a worldwide distribution, predominantly occurring in warm temperate regions of both hemispheres (2). The family was formally named by Lindley in 1836 deriving its name from the genus *Faba* Mill. (3).

Although Fabaceae is the preferred name in modern taxonomic usage, the earlier name Leguminosae Juss., proposed by Jussieu in 1789 is still widely used in Floras as an alternative, reflecting the characteristic legume fruit that defines this group of plants (4).

Within Fabaceae, the genus *Astragalus* represents the largest genus of vascular plants, including approximately 3113 accepted species distributed across 154 sections (2, 5). Species of *Astragalus* are primarily found in temperate and semi-temperate regions worldwide, where they exhibit remarkable morphological diversity and ecological adaptability. This genus has been the subject of extensive taxonomic work, beginning with the comprehensive infrageneric classification proposed by Bunge in 1869, who recognised numerous species organised into subgenera

and sections (6). Subsequent treatments, including those presented in Flora Orientalis further refined the classification and expanded the understanding of species diversity within the genus (7). More recently, Maassoumi provided an updated global taxonomic synthesis, reporting thousands of species classified into numerous sections across both the Old World and New World (8).

Despite this extensive taxonomic effort, the floristic knowledge of *Astragalus* in several regions, including Iraq, remains incomplete (5, 9). According to the Flora of Iraq, the genus is represented by 116 species distributed across 36 sections, with most species occurring in mountainous regions (10). However, since this account is based on an older floristic treatment, this number may represent an underestimate of the actual diversity of *Astragalus* in Iraq. Moreover, the wide geographical distribution of many *Astragalus* species in neighbouring countries suggests that the possibility of unrecorded taxa within Iraq remains high. In particular, morphologically similar species are often overlooked or misidentified, highlighting the need for integrative taxonomic approaches that combine detailed morphological evidence as the primary basis, followed by micromorphological characters and supported by anatomical evidence from the most taxonomically informative organs.

Astragalus boeticus is a species with a broad distribution across the Mediterranean region, North Africa and parts of Southwest Asia, including countries such as Jordan (11), Turkey (12), Iran (13), Syria, Palestine and Sinai (14). Additional records indicate its presence in North Africa and Southern Europe, particularly in Mediterranean coastal regions (15, 16). The species is taxonomically placed within section *Cyamodes*, where it is recognised as the sole representative and has been treated within the subgenus *Trimeniaeus* in recent classifications (17). Beyond its taxonomic significance, *A. boeticus* has also been reported to possess bioactive compounds and ethnobotanical uses, including its historical use as a coffee substitute in parts of Europe (18, 19). This traditional use, together with its local vernacular name GAHWAT ALJABAL, adds an ethnobotanical dimension to the species beyond its taxonomic significance.

In this context, the recording of *A. boeticus* in Iraq represents a significant addition to the national flora and contributes to refining the known geographical distribution of the species. Therefore, the present study aims to provide an integrative taxonomic assessment of *A. boeticus* based on detailed morphological and anatomical investigations, supported by comparative analysis with closely related taxa. By combining field observations, microscopic analyses and distributional data, this study seeks to clarify the taxonomic identity of the species and to enhance the current understanding of the genus *Astragalus* in Iraq.

Materials and methods

Study area

The study area is located near the mountain road connecting Sinjar city and Karsi village, approximately 16 km to the northwest of Sinjar, precisely located on the northern slope of the mountain within the Jabal Sinjar District (MJS), at an elevation of 850 m above sea level, between latitudes 36°22'09" to 36°22'15" N and longitudes 41°42'58" to 41°43'04" E. The elevation of the study area was determined using a handheld altimeter, which is used in field surveys. This study relied on the physiographic map of Iraq with satellite imagery, which was spatially documented using GIS Pro (Fig. 1).

Specimen collection and documentation

In mid-spring 2025, the target species was collected with several fresh, flowering and fruiting specimens during the botanical field survey conducted to collect selected wild plant species of the genus *Astragalus* in Jabal Sinjar. Additionally, the individual plants of this species were documented in their natural habitat through photography covering all vegetative and reproductive organs using a Canon EOS-5D IV camera (Fig. 2).

Species identification and voucher deposition

Species identification was performed using authoritative regional and international floras, including Flora Iranica (13), Flora of Turkey and the East Aegean Islands (12), Flora of Jordan (11), Flora of Syria, Palestine and Sinai (14), Flora of Egypt (15), Flora of Libya (20) and Flora Europaea (21). Voucher specimens were prepared following standard herbarium procedures and deposited in the Iraqi National Herbarium (BAG) and Anbar University Herbarium (AUH) (Fig. 3). Each specimen was labelled with complete collection data, including locality, date, habitat, altitude, collector and soil characteristics.

Taxonomic and anatomical study

A total of 12 specimens were selected for detailed morphological examination. Vegetative and reproductive organs were studied using a dissecting microscope (Swift M29TZ) and a compound light microscope (Olympus CX33). Pollen grains and seed coat ornamentation were examined using scanning electron microscopy (SEM). Samples were sputter-coated with gold prior to examination and observed under an accelerating voltage of 5/10 kV. Pollen grains were examined at 3000× magnification, whereas seed coat ornamentation was studied at 50×, 3000× and 6000×. Morphometric data were recorded and arranged for tabulation and comparative analysis.

For anatomical investigation, transverse sections of the stem and petiole were manually prepared using a razor blade under a dissecting microscope. Fresh plant materials were fixed and preserved in formalin-acetic acid-alcohol (FAA) solution prior to sectioning to maintain tissue integrity and facilitate anatomical preparation. Sections were stained with safranin and examined under a compound microscope, without the use of additional counterstains. Stomatal complexes of the leaflet epidermis were investigated after stripping and removing the superficial epidermal layer. The scientific terms employed in this study were based on the terminology provided by Beentje (22) and Radford (23). A morphological comparison was conducted between the newly recorded species and the morphologically similar species *A. hamosus*, which occurs naturally in Iraq.

Results and discussion

New Record

Astragalus boeticus is documented here as a new record for the Flora of Iraq based on recent field collections from Jabal Sinjar District (MJS). The absence of this species from the Iraqi flora is confirmed through a critical review of the principal botanical references, including Flora of Iraq (10), Flora of Lowland Iraq (24) and the Bulletin of Wild Plants and Their Geographical Distribution in Iraq (25), together with earlier contributions by Handel-Mazzetti (26) and Zohary (27). Furthermore, the floristic survey of Jabal Sinjar conducted by Khalaf (28) did not record this species and extensive Iraqi herbaria examinations verified the absence of preserved specimens of *A. boeticus* in Iraqi collections.

Within the annual representatives of *Astragalus* documented in Iraq, *A. hamosus* exhibits the closest morphological similarity to *A. boeticus*. Nevertheless, a set of clear diagnostic characters was identified, allowing reliable separation between the two species and supporting the recognition of *A. boeticus* as a distinct taxon newly recorded in the country. A detailed comparative analysis of the diagnostic features is provided in Table (1).

All the referenced Floras treat the species *A. boeticus* alone in a distinct and separate section *Cyamodes* and this aligns with the phylogenetic study of the genus *Astragalus* (17), which resolved phylogenetic relationships based on molecular evidence and it clearly indicated that *A. hamosus* was the genetically closest relative to *A. boeticus*. Likewise, in another molecular phylogenetic study of the annual species in the same genus (*Astragalus*), the two species were shown to share a high degree of similarity (29).

Table 1. The morphological differences between the newly recorded species (*Astragalus boeticus*) and the similar species (*Astragalus hamosus**)

Characters	<i>Astragalus boeticus</i>	<i>Astragalus hamosus</i>
Compound leaf length (mm)	88–123	30–150
Flowers in Inflorescences	2–9 (6)	10
Bract (mm)	3.3–3.8, sagitate, green	2–3, subulate, membranous
Calyx tube length (mm)	2.8–3.0	3.5–5.0
Style length (mm)	2.3	1.0
Corolla color	White-cream or yellow	Yellowish-white or pale violet
Standard length (mm)	10.3–11.7	5–8
Wings length (mm)	6.5–7.3	4.25–6.00
Keel length (mm)	6.0–6.4	4.00–5.25
Seed shape and length (mm)	Subreniform, 4.2	Quadrate, 2.0
Fruit shape	Linear straight	Falcate
Fruit apex	Beaked	Apex acute, not beaked
Ovary shape and surface	Very narrowly ovoid, glabrous	Linear, appressed hairy

*The morphological characteristics of *Astragalus hamosus* were compiled based on descriptions provided in the Flora of Iraq (10).

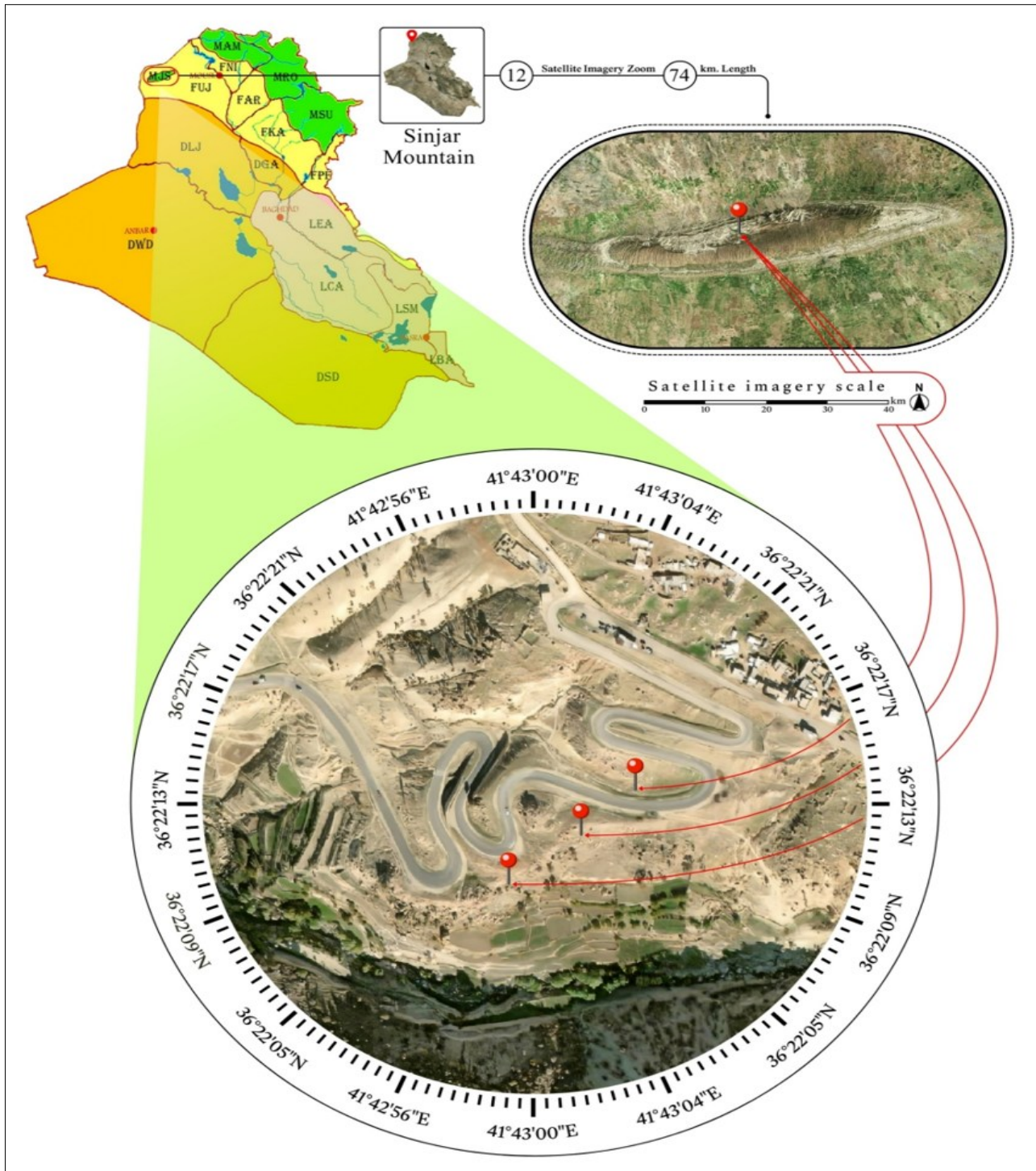


Fig. 1. Satellite image of the study area (Karsi village, 16 km Northwest of Sinjar city in the Jabal Sinjar District, MJS). *Source: Satellite image prepared using GIS Pro (38).

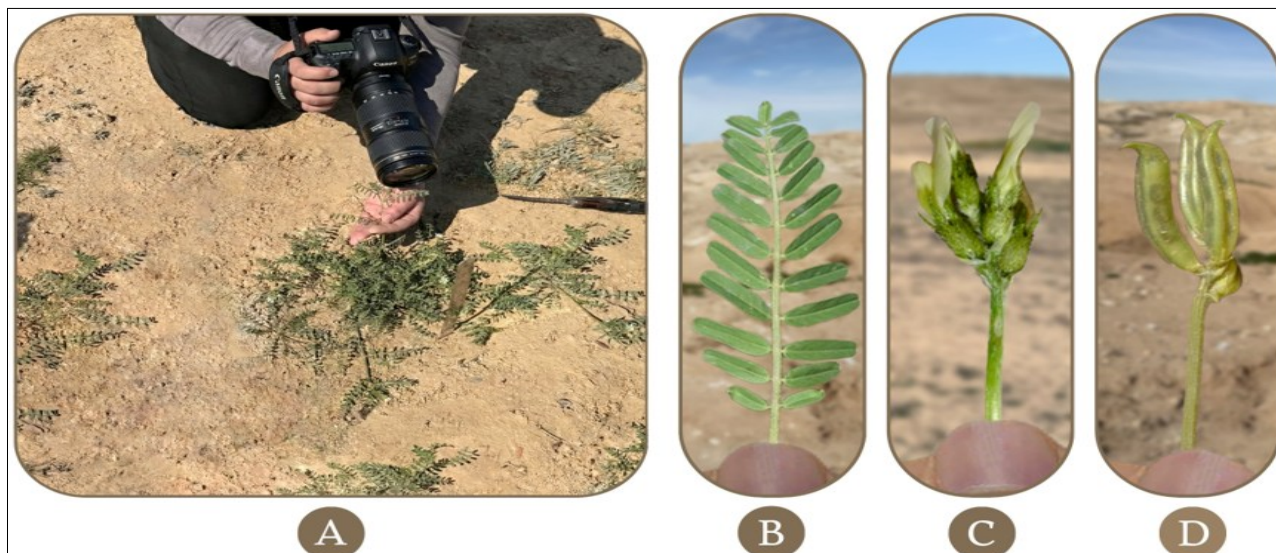


Fig. 2. The field photographs using Canon camera in the study area. A: *Astragalus boeticus* in its natural habitat; B: Compound leaf; C: Flowers; D: Fruits.



Fig. 3. Herbarium specimens of *Astragalus boeticus* deposited in the Anbar University Herbarium (AUH; voucher no. 6715) and the Iraqi National Herbarium (BAG; voucher no. 61901).

Taxonomic treatment

***Astragalus boeticus* L.:** First published in Sp. Pl.: 758 (1753).

Selected references: Boissier, Fl. Orient. 2:236 (1872); Post, Fl. Syr. Pals and Sinai. 1:381 (1932); Davis, Fl. of Turkey. 3:66 (1970); Tutin and Heywood, Fl. Europaea. 2:111 (1981); Boulos, Fl. Egypt. 1:322 (1999); Podlech, Fl. Iranica. 174:585 (1999).

Morphological description

Annual herb, 25–38 cm tall, with a well-developed taproot; root cream to dull yellow, 60–75 × 3.2–4.7 mm. Stems branched from the base, ascending or procumbent, 170–230 × 1.7–3.4 mm (length × diameter), cylindrical, soft-corrugated, dull greenish yellow,

covered with white hairs 0.4–0.9 mm long. Leaves alternate, imparipinnate, petiolate; leaflets in 8–12 pairs, subsessile, narrowly elliptic to oblong or narrowly obovate, margin entire, apex slightly retuse, base acute, pale green; lower cauline leaves 105–138 × 25–28 mm, leaflets 12–14 × 4–5 mm; upper cauline leaves 75–98 × 12–14 mm, leaflets 5–7 × 2–3 mm, with scattered white hairs on the abaxial surface only; venation reticulate (pinnate). Stipules deltoid, entire, apex acute to acuminate, green to yellowish green, with white villous hairs, 6.2–7.5 × 4.0–5.1 mm. Inflorescence a simple raceme, 35–66 mm long, bearing 2–9 flowers; peduncle 22–50 × 1.1–1.4 mm; pedicels 0.9–1.1 mm; bracts sagittate, 3.3–3.8 × 1.5–1.8 mm. Calyx tubular, gamosepalous, composed of five unequal sepals, dark green, covered with black hairs 0.4–0.6 mm long; teeth

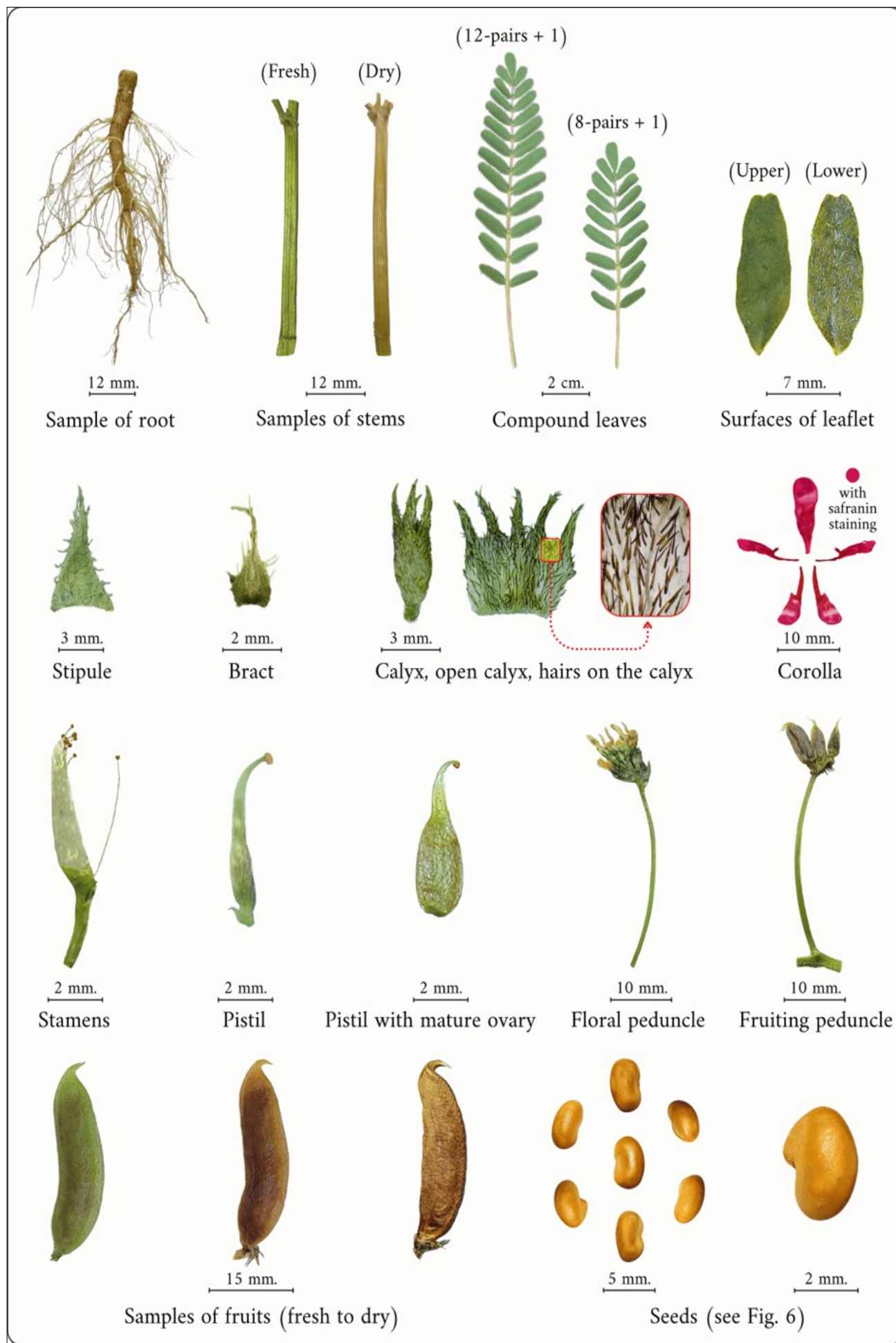


Fig. 4. Vegetative and reproductive organs of the species *Astragalus boeticus*. *(These images processed using the software provided with advanced Canon EOS 5D IV Camera).

narrowly triangular, 2.2–2.5 × 0.8–1.0 mm; calyx tube 2.8–3.0 × 2.0–2.2 mm (Fig. 4). Corolla papilionaceous, white-cream to yellowish white; standard lanceolate to very narrowly ovate, 10.3–11.7 × 3.5–4.2 mm; wings oblong with a linear claw, 6.5–7.3 × 1.1–1.3 mm; keel formed by two partially fused petals, subspathulate to narrowly oblanceolate, apex obtuse, base attenuate, 6.0–6.4 × 1.5–1.8 mm. Stamens 10, diadelphous (9 + 1), nine filaments united into a cylindrical tube surrounding the pistil, one free; filaments colorless and shiny; anthers broadly ellipsoid to ovoid, 0.28–0.33 × 0.19–0.22 mm, versatile, yellow. Pollen grains yellowish white, prolate, tricolporate, dimensions small-medium according to the pollen size classification by Erdtman (30) and as supported by recent palynological studies (31), polar axis (P) 28.4–31.7 µm, equatorial axis (E) 17.7–20.2 µm, P/E ratio 1.58, ornamentation reticulate (Fig. 5). Pistil simple, glabrous, yellowish green to translucent, 5.0–5.5 × 0.9–1.1 mm; ovary very narrowly ovoid, 2.4–2.7 × 0.9–1.1 mm; ovules arranged in two alternating rows along the carpel margin; style terminal, cylindrical, glabrous, pale white, 2.2–2.4 × 0.30–0.40 mm; stigma capitate to discoid, 0.33–0.35 × 0.22–0.25 mm. Fruit a pod, completely bilocular, linear, straight, 24–32 × 5.4–6.5 mm, greenish brown, compressed laterally, glabrous, with a hooked beak 1.8–2.3 × 0.9–1.2 mm; seeds 6–8 per fruit, subreniform, glossy yellowish brown, with irregular reticulate-spongy ornamentation (Fig. 6), 3.5–4.7 × 2.5–2.8 mm (Table 2).

Lectotype (Podlech in Sendtnera 2: 109. 1994): Herb. Linn. No. 926.22, Linnean Society of London Herbarium (LINN).

Common name: GAHWAT ALJABAL.

Homotypic synonyms

Astragalus uncinatus Moench in Methodus: 166 (1794), nom. illeg. superfl.

Tragacantha boetica (L.) Kuntze in Revis. Gen. Pl. 1: 210 (1891).

Triquetra boetica (L.) Medik. in Vorles. Churpfälz. Phys.-Ökon. Ges. 2: 376 (1787).

Heterotypic synonyms

Astragalus boeticus var. *siliquosus* Rouy in G.Rouy & J.Foucaud, Fl. France 5: 165 (1899).

Astragalus boeticus var. *subinflatus* Rouy in G.Rouy & J.Foucaud, Fl. France 5: 165 (1899).

Astragalus boeticus f. *violaceus* Maire in Bull. Soc. Hist. Nat. Afrique N. 31: 103 (1940).

Selected specimens:

MJS: Jabal Sinjar, 3 km. before Karsi village, 850 m. alt., 18.4.2025, Othman M. Othman, 61901 (BAG); about 2.9 km. before Karsi village, 850 m. alt., 18.4.2025, Othman M. Othman, 6715 (AUH).

Stem anatomy

The transverse section of the mature stem exhibits a circular to sub-polygonal shape (Fig. 7), with an approximate diameter of 1960 µm, covered by a moderately thick cuticle measuring up to 4 µm. The epidermis consists of small to medium-sized cells, which are predominantly square-shaped but occasionally appear rectangular (elongated), with a thickness of 30–32 µm. The cortex comprises two rows of small, regular collenchyma cells at the outer faces, positioned exclusively opposite the vascular bundles in the form of small clusters, with a thickness of 48–52 µm. This is followed by a continuous ring of chlorenchyma cells arranged in a single layer, measuring 33–35 µm in thickness.

The sclerenchyma tissue, composed of fibres, forms the cap of the vascular bundles, consisting of 4–5 layers and measuring 70–80 µm in thickness. Additionally, some ordinary

Table 2. The quantitative and qualitative morphological characters of vegetative and reproductive organs of *Astragalus boeticus*

Cauline leaves (C L) (mm)		
Lower C L size 123 × 26	Leaflet size 12.8 × 4.6	Number of leaflets 12 pairs
Upper C. L. size 88 × 13	Leaflet size 6.1 × 2.7	Number of leaflets 8 pairs
Inflorescences (mm)		
Infl. length 57	No. of flowers 6(2–9)	Peduncle length 42
Stipules and Bracts (mm)		
Stipule size 6.9 × 4.5	Shape Deltoid	Bract size (and shape) 3.6 × 1.7 (sagitate)
Calyx (mm)		
Calyx tube size 2.9 × 2.1	Calyx teeth size 2.3 × 0.9	Sepal dimensions Unequal
Corolla (mm)		
Standard size 10.8 × 3.7	Wings size 6.8 × 1.2	Keel size 6.2 × 1.7
Androecium (mm)		
Stamens length 5.5 × 1.4	Anther size 0.3 × 0.2	Synstemony Diadelphous
Gynoecium (mm)		
Ovary size 2.6 × 1.0	Style size 2.30 × 0.33	Stigma size 0.34 × 0.24
Fruits (mm)		
Fruit size 28.0 × 6.2	Shape linear	Beak size (and shape) 2.2 × 1.0 (hooked)
Seeds (mm)		
Seed size 4.2 × 2.6	Shape Subreniform	Number of seeds 6–8 (in each fruit)
Pollen grains (µm)		
Polar axis 29.9	Equatorial axis 18.9	Shape Prolate

*All values represent the means of measurements obtained from 12–15 individual samples.

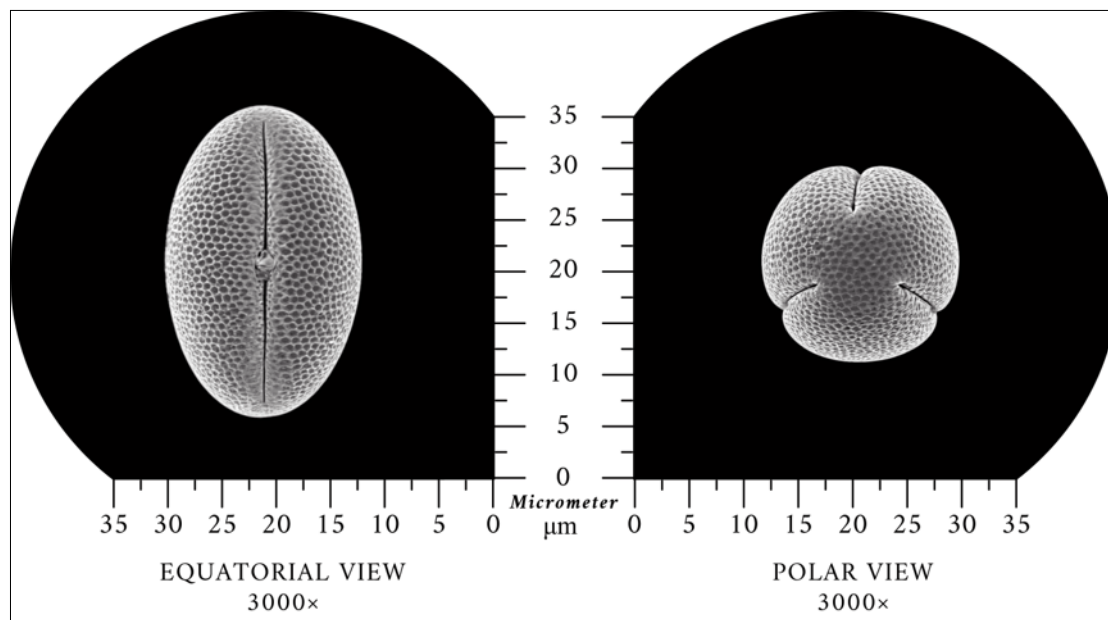


Fig. 5. Scanning electron microscopy (SEM) micrographs showing the pollen grain of *Astragalus boeticus*.

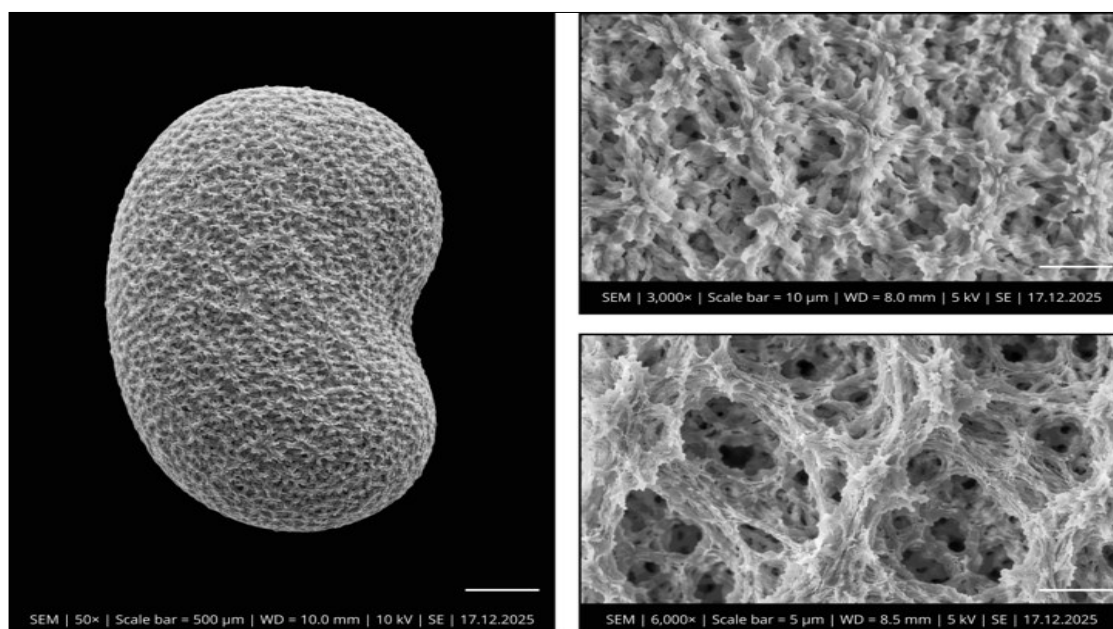


Fig. 6. Scanning electron microscopy (SEM) micrographs showing the seed coat ornamentation of *Astragalus boeticus*.

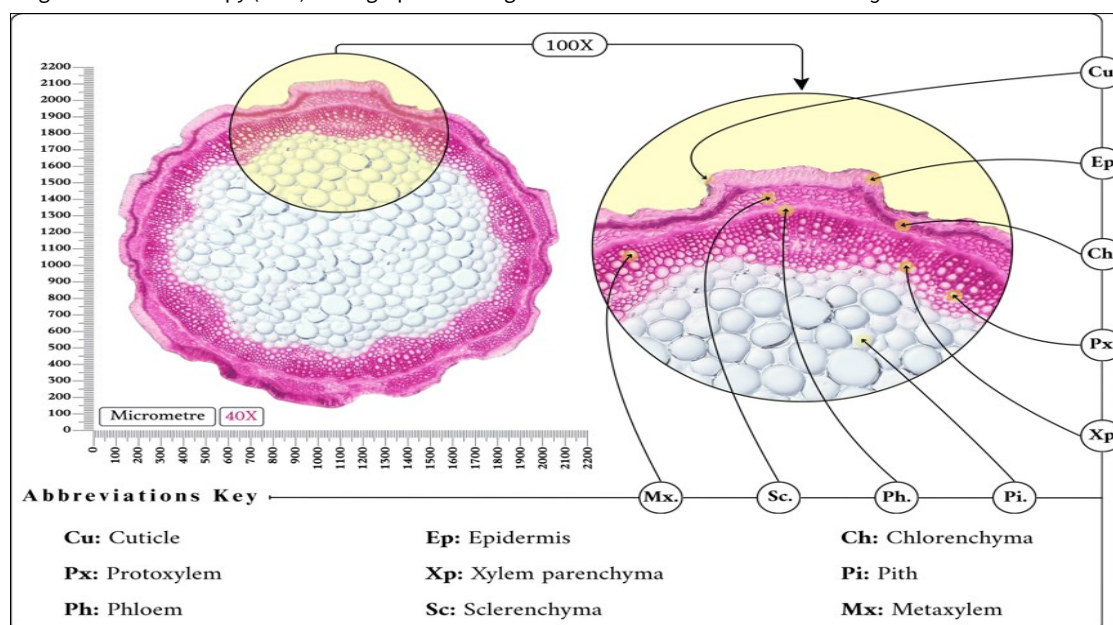


Fig. 7. Transverse section of the stem with vascular bundle components of *Astragalus boeticus*.

parenchyma cells are interspersed between these caps. The vascular cylinder is notably wide, consisting of a regular arrangement of 17–19 large and small collateral vascular bundles distributed in an alternating pattern; it includes a medium-thick (27–33 μm) phloem layer. The xylem is broad and highly efficient, measuring approximately 145 μm thickness. Each vascular bundle contains 5–8 xylem arms in the small and large bundles, respectively. Each arm comprises 3–5 vessels representing the protoxylem and metaxylem, surrounded by xylem parenchyma cells. The diameter of each vessel element is about 40 μm . The pith region is very extensive and circular in shape, composed of large ordinary parenchyma cells with diameters of approximately 150 μm , while the overall pith diameter reaches 1300 μm . This anatomical pattern of the stem is generally familiar for annual plant species with prostrate stems, as clearly mentioned in earlier studies (32, 33).

Petiole anatomy

The transverse section of the petiole is shown as U-shaped, with a diameter of 1250 μm (Fig. 8). It consists of a single epidermal layer made up of elongated or spherical cells, tightly packed without intercellular spaces, approximately 27 μm thick and covered by a cuticle layer. Beneath the epidermis lies the hypodermis, which typically consists of a single row of collenchyma cells. The ground tissue is made up of thin-walled parenchyma cells with well-defined intercellular spaces and has a thickness ranging from 275–315 μm . The vascular bundles differ in size within the same petiole section; the largest bundle is located toward the abaxial surface, while the lateral bundles are relatively smaller. In total, 4 vascular bundles are present; each bundle features a phloem layer (approximately 33 μm thick), which is oriented toward the abaxial surface and a xylem layer (approximately 125 μm thick), oriented toward the adaxial surface. Sclerenchyma (fibres) tissue is arranged in two layers: one beneath the phloem and another above the xylem, each layer measuring between 75–90 μm in

thickness. In the lateral bundles, however, sclerenchyma tissue is positioned either laterally or toward the adaxial surface only.

Stomatal complex in the leaflets

Based on the structure of the adaxial and abaxial epidermal layers of the leaflets, the stomatal complex is an anomocytic (ranunculaceous) type, characterised by the absence of specialised subsidiary cells, it exhibits variability in the number of surrounding cells enclosing the two guard cells. The stomata are narrowly elliptic in shape, measuring 20–24 μm , while the guard cells are narrowly reniform (kidney-shaped), with dimensions of 38–44 $\times$ 13–15 μm (Fig. 9).

Environment and geographical distribution

According to environmental observations, the *A. boeticus* is distributed in small populations or as solitary individuals in the study area (MJS). Generally, it is found along roadsides and in low-lying areas with high humidity, the *A. boeticus* grows in various soil types (gravelly soil, clay soil, calcareous rocky soil) and the maximum altitude at which the species was observed is 850 m in Jabal Sinjar. This is consistent with previous observations which indicate that the species *A. boeticus* grows in Turkey at altitudes between 500–1000 m (34), in all soil types and this indicates its broad ecological adaptability, as it is commonly found in the Shaumari Reserve in Jordan (35) and in the dry environments such as Wadi Al-Hamar in Libya (36), as well as it is found in semi-desert regions with rocky hills and dry lands, in the Al-Dhahiriya region southern Palestine (37).

The distribution of *A. boeticus* spans an extensive range extending across three major phytogeographic regions, its Irano-Turanian, Mediterranean and Saharo-Sindian, depending on Guest (38), at the continental level based on the references mentioned above, the species is distributed across three continents: Asia, Africa and Europe. Jabal Sinjar District (MJS) located at the convergence point of these three phytogeographic

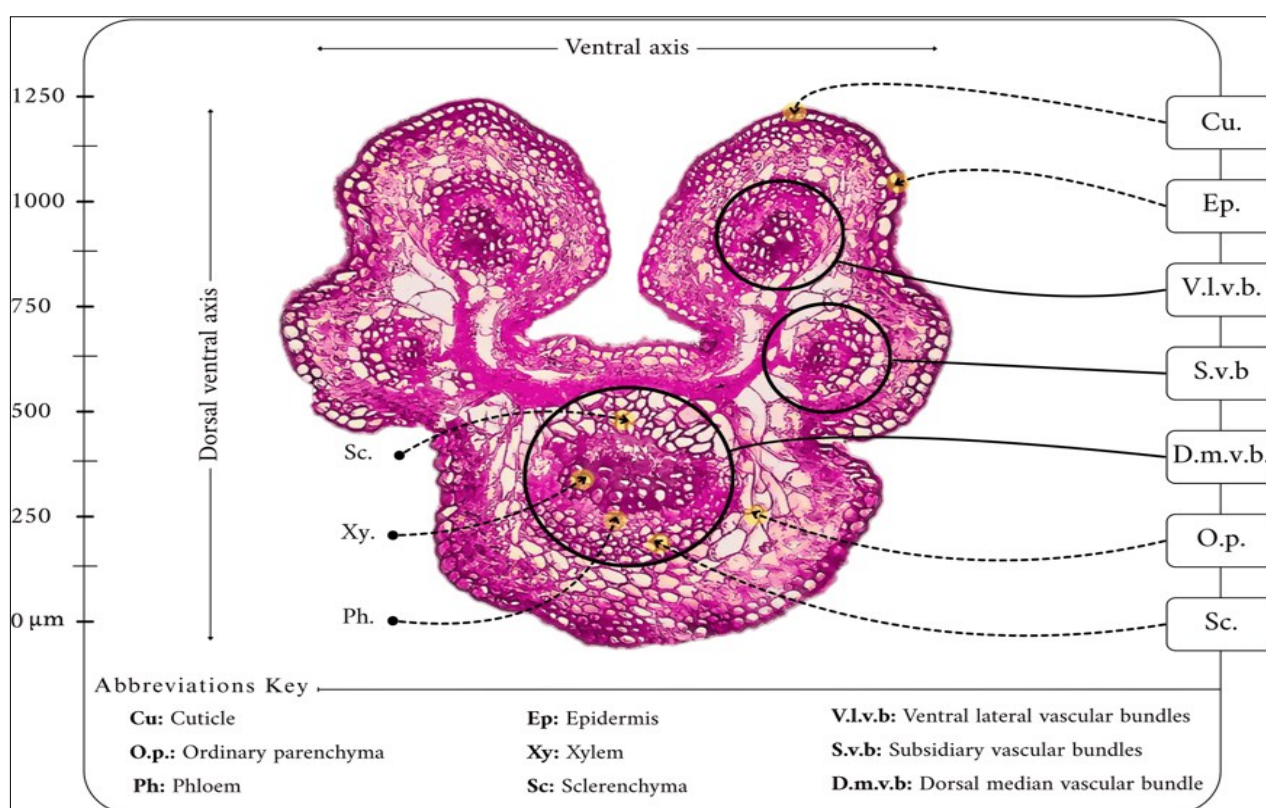


Fig. 8. Transverse anatomical section of the petiole of *Astragalus boeticus*.

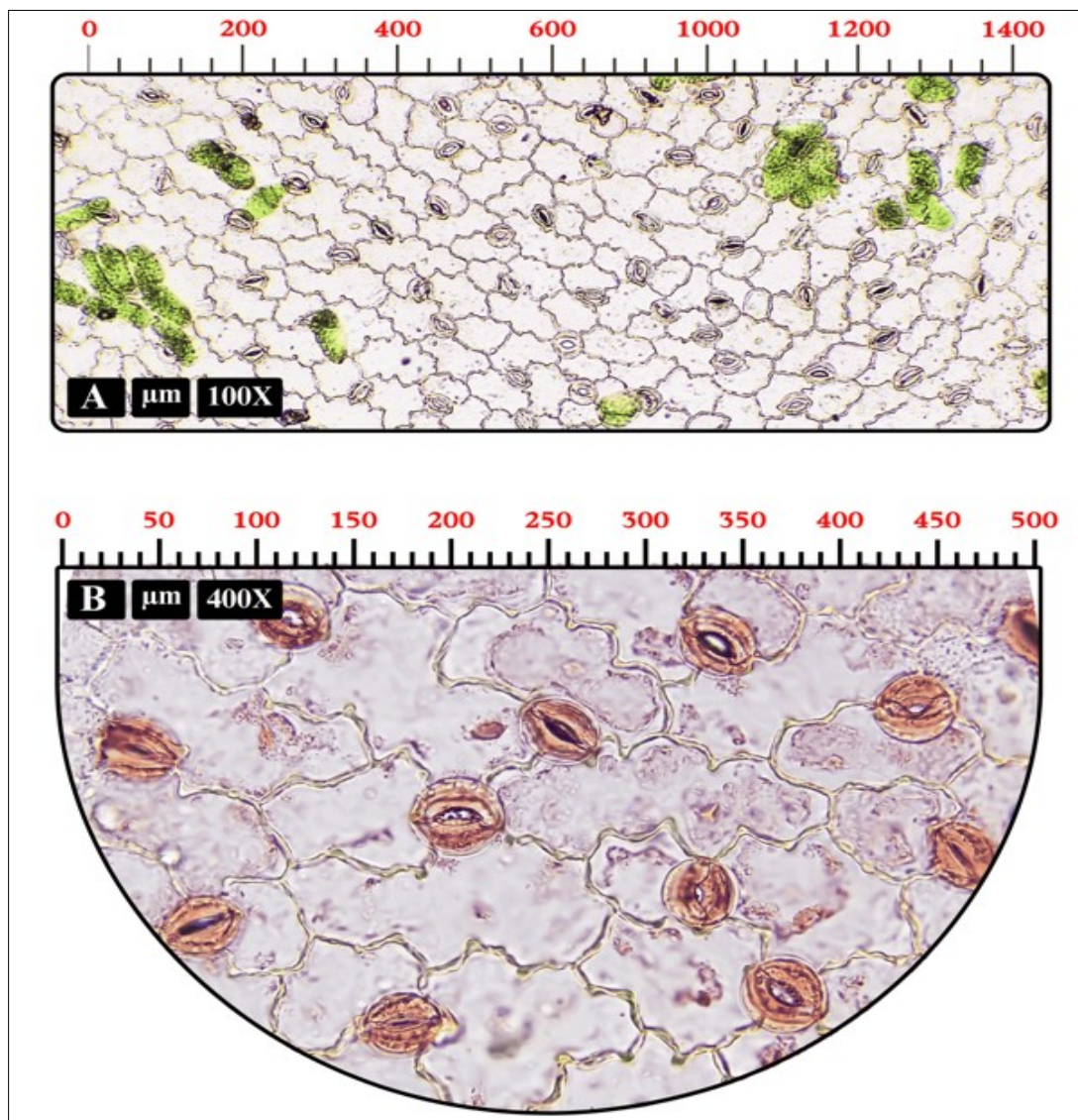


Fig. 9. Stomatal characteristics in the leaf of *Astragalus boeticus*. A: Stomatal frequency; B: Stomatal complex.

regions, which may facilitate its expansion for the species expansion into new areas and the shifts in winter climate have facilitated the migration of certain tropical species in response to rising winter temperatures (39, 40) (Fig. 10). It is worth noting during the past few years, a new record for the Iraqi flora of various species have been observed, including two species of the *Astragalus* (5, 9). Some genera of wild plants have been previously recorded (41).

Phenological patterns in natural habitat

Based on meticulous field observations conducted on more than 20 individuals of *A. boeticus* in their natural habitat in the Sinjar Mountain, a detailed phenological description was constructed to document the seasonal developmental phases of the species. The emergence of new vegetative shoots from soil level begins in early December and extends through mid-March, marking the active vegetative growth period. Flowering begins in late February and continues until early May, with a pronounced peak occurring around mid-season. Fruiting begins with the appearance of immature green pods in late March and continues until mid-April. As the season progresses, these pods gradually dry and turn brown in mid-May, indicating the development of fully mature fruits (Fig. 11). This is followed by the seed dispersal phase, which continues until the end of June. This phenological sequence reflects the

species' adaptation to a Mediterranean-type climate, completing its life cycle before the onset of intense summer aridity. The synchronisation of vegetative and reproductive stages with seasonal rainfall highlights the environmental suitability of *A. boeticus* within its habitats.

Notes on the regional and global distribution of *Astragalus boeticus*

The regional and global distribution of *A. boeticus* which is native to a wide geographical range encompassing across the Mediterranean Basin, North Africa, the Middle East and parts of southwestern Asia and southern Europe, its native distribution includes countries and regions of southern and southeastern Europe (Albania, France, Greece, Italy, Portugal, Spain, NW Balkan Peninsula and Mediterranean islands such as the Balearic Islands, Corsica, Sardinia, Sicily, Kriti, East Aegean Islands, Madeira and the Canary Islands), North Africa (Algeria, Egypt, Libya, Morocco, Tunisia, Western Sahara and the Sinai Peninsula) and the Middle East and western Asia (Cyprus, Lebanon, Syria, Palestine, Iran and Türkiye) and outside its native range Fig. 12. *Astragalus boeticus* has been introduced into parts of northern Europe, where it has been recorded in Germany, Britain and Poland (2, 4, 7, 8, 10, 12, 16, 21).

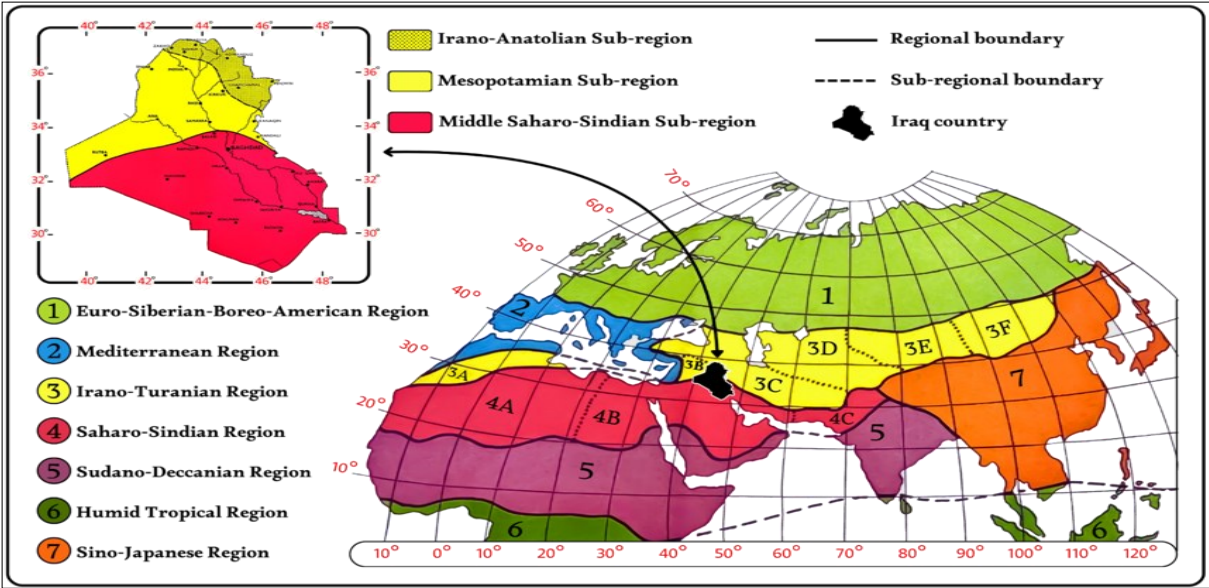


Fig. 10. Phytogeographic regions of the Northern Hemisphere in the Old World (10).

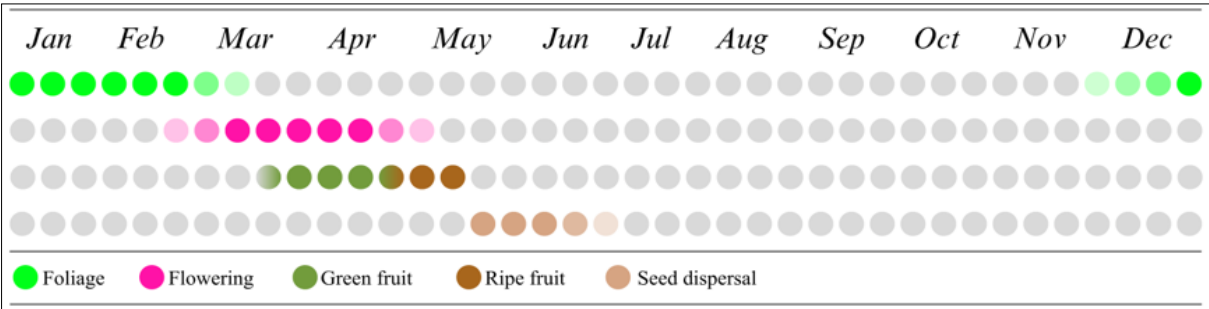


Fig. 11. Seasonal phenophases of *Astragalus boeticus* illustrated by a phenological bar chart derived from ecological monitoring data.

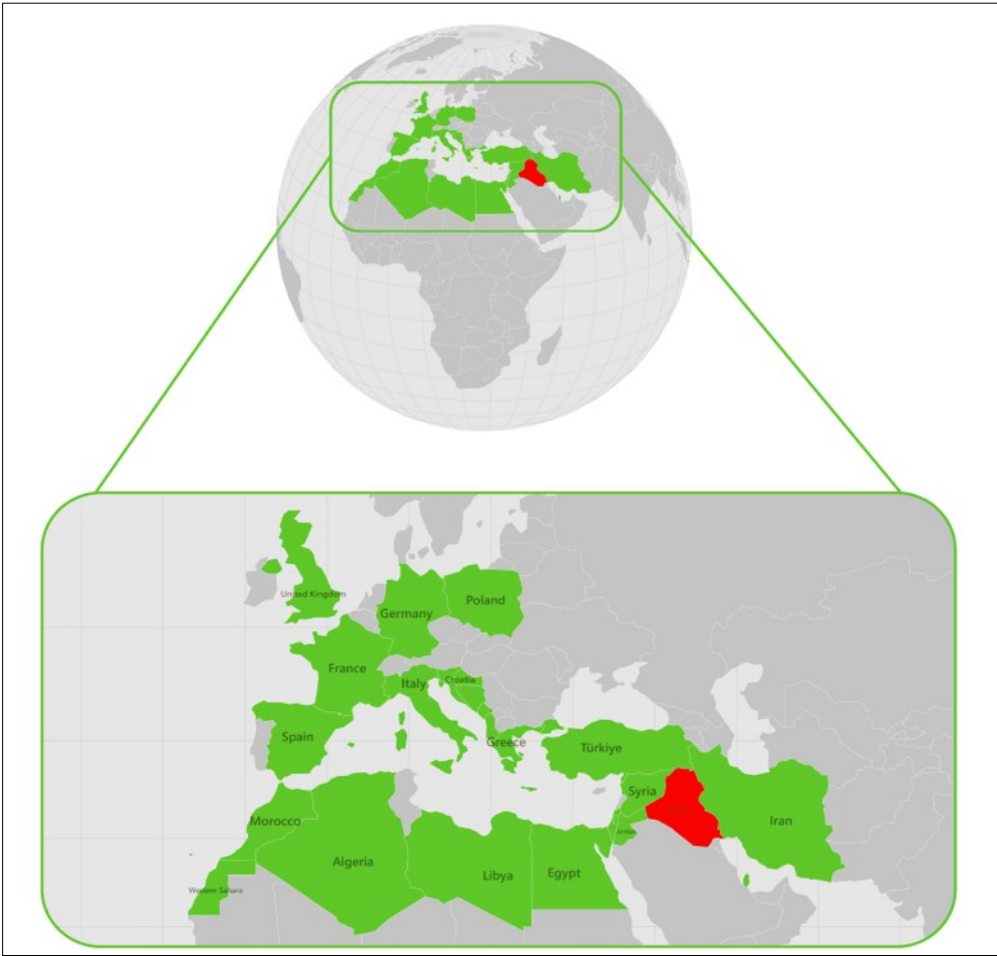


Fig. 12. The regional and global distribution of *Astragalus boeticus*. Source: Map prepared using GIS Pro and distribution data obtained from Plants of the World Online (2), Royal Botanic Gardens, Kew

Conclusion

This study confirms the documentation of *Astragalus boeticus* as a new record for the Flora of Iraq, based on field surveys conducted in the Jabal Sinjar District (MJS). The integrative taxonomic framework, combining morphological, anatomical and micromorphological evidence, supported by herbarium verification and voucher deposition in national and university herbaria, ensures the reliability of this record. The findings also highlight the floristic significance of Northern Iraq and suggesting that the Iraqi flora remains incompletely explored, particularly in mountainous regions.

Acknowledgements

The authors express their sincere gratitude to the Iraqi National Herbarium (BAG) and the Anbar University Herbarium (AUH) for their cooperation and valuable interest in documenting the record of this species, preserving the deposited specimens and providing access to recent taxonomic references and scientific resources that greatly supported the completion of this study.

Authors' contributions

OMO discovered and collected the plant, performed species identification and conducted the main taxonomic investigations. He also photographed the specimens, prepared the maps and drafted the initial version of the manuscript. SAA contributed to the taxonomic evaluation, data interpretation and critical revision of the manuscript. MAAS contributed to data discussion and manuscript revision. All authors have read and approved the final version of the manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

The authors confirm that AI tools were used exclusively for English language editing, grammatical correction and improvement of the manuscript's linguistic clarity.

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