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RESEARCH ARTICLE

A new record for the flora of Iraq: *Astragalus eremophilus* Boiss. (Fabaceae), with taxonomic notes and distribution

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Abstract

This study aimed to identify and record the species *Astragalus eremophilus* Boiss. in Iraq, that belongs to the section Harpilobus. The species was collected during field trips around the Gazelle Reserve, adjacent to Wadi Al-Amsad, located at an altitude of 625 m and about 16 km south of Rutba town within the Western Desert District (DWD) of Iraq, which is located within the Saharo-Sindian region. A comprehensive morphological comparison was made between the newly recorded species and 2 similar species belonging to the same section (Harpilobus) namely *Astragalus corrugatus* Bertol. and *Astragalus hauarensis* Boiss.

Keywords: floristic records; Papilionoideae; taxonomic study

Introduction

Fabaceae Lindl. (1836) (Leguminosae) belongs to the order Fabales and is considered the third largest family of flowering plants, as it includes 807 accepted genera and more than 19325 species (1). The genus *Astragalus* L. belongs to the subfamily Papilionoideae and is regarded as the largest genus in the plant kingdom, being divided into 154 sections, including 3095 accepted species distributed all over the world (2).

The species *Astragalus eremophilus* Boiss. belongs to the Harpilobus section. This species comprises 2 subspecies, *A. eremophilus* subsp. *eremophilus* and *A. eremophilus* subsp. *makranicus* Podlech. The newly recorded element in the present study corresponds to *A. eremophilus* subsp. *eremophilus*, whereas the second subspecies (*A. eremophilus* subsp. *makranicus*) have not been reported from Iraq. This species has a wide distribution represented by 3 of the 7 phytogeographical regions of the world (3). These regions are according to the area of land where this species grows, namely the Saharo-Sindian, Sudan-Deccanian and Irano-Turanian regions, based on the world map (4) (Fig. 1). It is considered one of the common species in the Arabian Peninsula (Southern Iraq), represented by the State of Qatar, Saudi Arabia, Oman and the United Arab Emirates, respectively (5–8).

In addition to its occurrence in Western Iraq, the species is also distributed in several neighboring countries, including Jordan (9, 10), Palestine and Sinai (11), Egypt and Sudan (12), as well as Libya, Algeria, Morocco and Mauritania (13). As for Eastern Iraq, the species is widely distributed in the desert regions of Iran (14–16) and Pakistan (17).

The most important result of this study is the recording of the species *A. eremophilus* for the first time in Iraq, specifically around the Gazelle Reserve in Western Desert District, which is located within the Saharo-Sindian region. A comprehensive review of the scientific references of wild plants was conducted, including the flora of Iraq (18), flora of Lowland Iraq (19) and Al-Rawi Bulletin (20), which includes the geographical distribution of wild plants in Iraq. We also conducted a survey to ensure that there were no specimens of the species in all Iraqi Herbaria.

Materials and Methods

Collection of specimens

Around the Gazelle Reserve located 16 km south of Rutba town, at an altitude of 625 m (Between latitude 32° 52' 45" to 32° 53' 55" N and longitude of 40° 11' 55" to 40° 15' 25" E). The plant specimens were collected during the field trips in the spring of 2025 in the western desert of Iraq. The location of the current study is shown on a map of Iraqi districts with a satellite image of the exact location of the species collection (Fig. 2).

Identification of the species

The species was collected and identified during this study based on the floras of the neighboring countries where this species grows. They are flora Iranica (21), Saudi Arabia (6) and nearby countries, including Egypt (12), United Arab Emirates (8), Qatar (5), Libya (13) and Oman (7). In addition to confirming the first record of the species by the Iraqi National Herbarium (BAG), where the specimens were deposited 61570, 61571 and 61572 (Fig. 3), the remaining specimens are preserved at the Anbar University Herbarium (AUH).

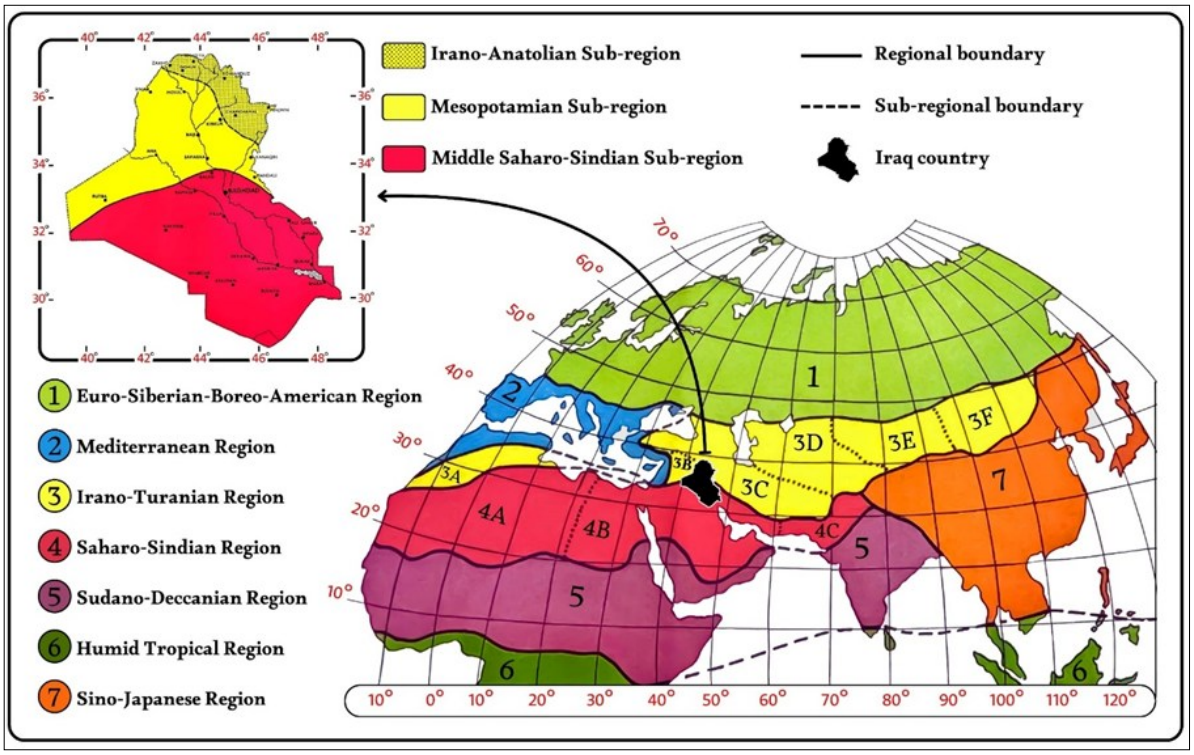

Fig. 1. Phytogeographic regions of the Northern Hemisphere in the Old World (4).

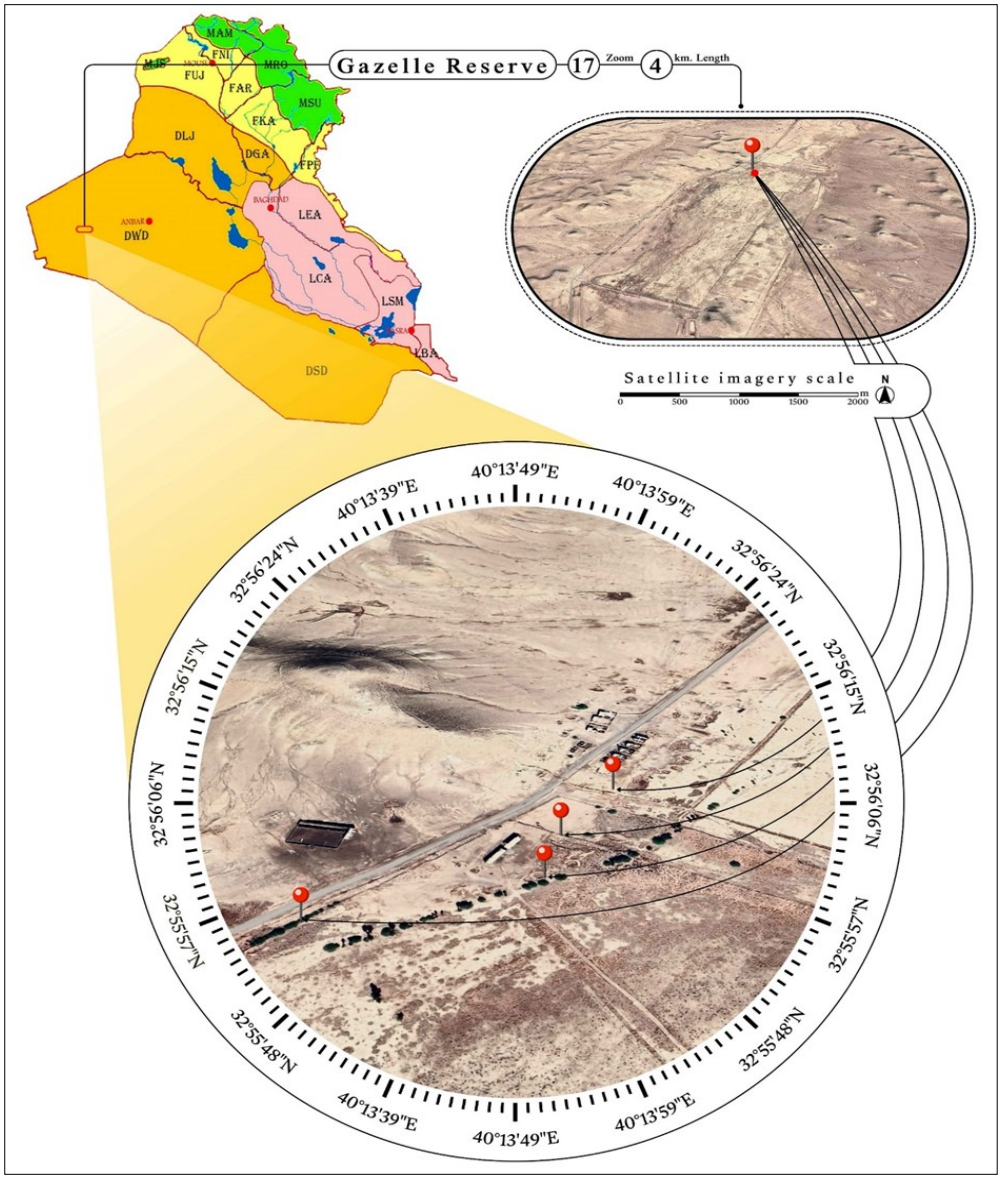

Fig. 2. Satellite image of the study area (Gazelle Reserve, 16 km South of Rutba town) (4).

Fig. 3. Documentation of herbarium specimens of the species *Astragalus eremophilus* in the Iraqi National Herbarium (BAG) and the Anbar University Herbarium (AUH).

Taxonomic and anatomical study

The present study focused on the morphological description of the species based on both vegetative and reproductive organs. Measurements were obtained using a dissecting microscope based on 15 plant samples of the species. Pollen grains were also examined using a scanning electron microscope (SEM) at a magnification of 3000X. The stem was subjected to an anatomical study through cross-sections prepared using the direct manual cutting method was followed using a razor blade and safranin-fast green stains with glycerin, following the method described by Mousa, which is represented by cutting under the dissecting microscope (22). The type of stomatal complex was also investigated and determined, depending on the epidermal layer removed from the leaves by manual peeling. Laboratory procedures were carried out at the AUH. All results were supported by images using a professional camera (Canon EOS 5D Mark IV) and an Olympus microscope (CX33). The taxonomic treatment data were organised in tables and the study was keen to conduct a morphological comparison between the newly recorded species (*A. eremophilus*) and the only 2 species belonging to the same section (Harpilobus), *A. corrugatus* and *A. hauarensis*.

Results and Discussion

Newly recorded species

Astragalus eremophilus Boiss. Diagn. Pl. Orient. 2:54 (1843); Post, Fl. Syr. Pal. Sin. 1:378(1932); Boulos, Fl. Egy. 1:327 (1999); Chaudhary, Fl. Saudi Arab. 2:78 (2001); Karim & Fawzi, Fl. Un. Arab Em. 2:310 (2007); Abdel Bary, Fl. Qa. 1:415 (2012).

Type

Saudi Arabia, sandy desert near Jeddah (Arabia Felix), 20 January 1836, Schimper, W.P.H. 777 (holotype: E, barcode E00385412, Royal Botanic Garden Edinburgh).

Taxonomic treatment

Annual herbs, branched from the base, 15–28 cm length (Fig. 4) with ordinary tap roots, yellowish white-very pale brown. Stems procumbent, white-hairy or villous (unicellular hairs), pale green. Leaves alternate, imparipinnate, petiolate, leaflets 11–15, opposite to subopposite, narrowly elliptic to narrowly obovate, margin entire, apex rounded or obtuse, base acute, blade conduplicate, olive green, lower cauline leaves 4.3–4.8 × 1.4–1.7 cm, leaflets 0.5–0.9 × 0.3–0.4 cm, upper cauline leaves 2.7–2.9 × 1.3–1.5 cm, leaflets 0.3–0.5 × 0.2–0.3 cm with pinnately reticulate venation, white villous on both surfaces. Stipules deltoid, 3.6–4.1 × 2.0–2.2 mm, margin semi-entire, apex acute-acuminate, white villous, yellowish green. Inflorescences indeterminate, simple racemes, 2–3 flowered (rarely 5), peduncle 3.1–3.8 × 0.10–0.12 cm, pedicels 0.8–1.0 mm long, densely villous. Bracts lanceolate, very small (1.0–1.2 × 0.2–0.3 mm). Calyx gamosepalous, consisting of 5 unequal lobes, base united, narrowly lanceolate, margin entire, apex acuminate, villous, light green, teeth equal to the tube or slightly longer, calyx tube 2.7–2.9 × 2.0–2.3 mm, teeth 3.0–3.3 × 0.4–0.6 mm. Corolla papilionaceous (Fig. 5), pale sulphur yellow, standard narrowly obovate, margin entire, apex rounded-truncate, base acute-obtuse, glabrous, 5.9–6.1 × 3.0–3.2 mm, wings 2, oblong with lateral claw, apex acuminate, base caudate, 5.8–6.1 × 1.4–1.6 mm, keel almost completely united of 2 petals, very broadly oblanceolate, apex rounded, base caudate, 6.0–6.2 × 2.7–2.9 mm. Stamens 10, diadelphous, 9 united in one cylindrical delphous, surrounded the pistil, as well as one free stamen, 6.0–6.2 × 0.15–0.18 mm, yellowish green, anthers ellipsoid, pale yellowish brown, versatile attachment. Pollen grains yellow-cream, tricolporate, subprolate-prolate, triangular convex, dimensions: small, depending on pollen size classification by Erdtman, equatorial axis 16.8–18.0 µm, polar axis 23.0–24.5 µm, ornamentation microreticulate-perforate (Fig. 6) (23). Pistil simple, glabrous, greenish yellow, 3.5–3.8 × 0.20–0.22 mm, style terminal, linear, glabrous, greenish yellow, 1.3–1.8 × 0.10–0.12 mm, stigma

Fig. 4. Field image of the species *Astragalus eremophilus* in the study area: (A) Leaf; (B) Flower and (C) Fruit.

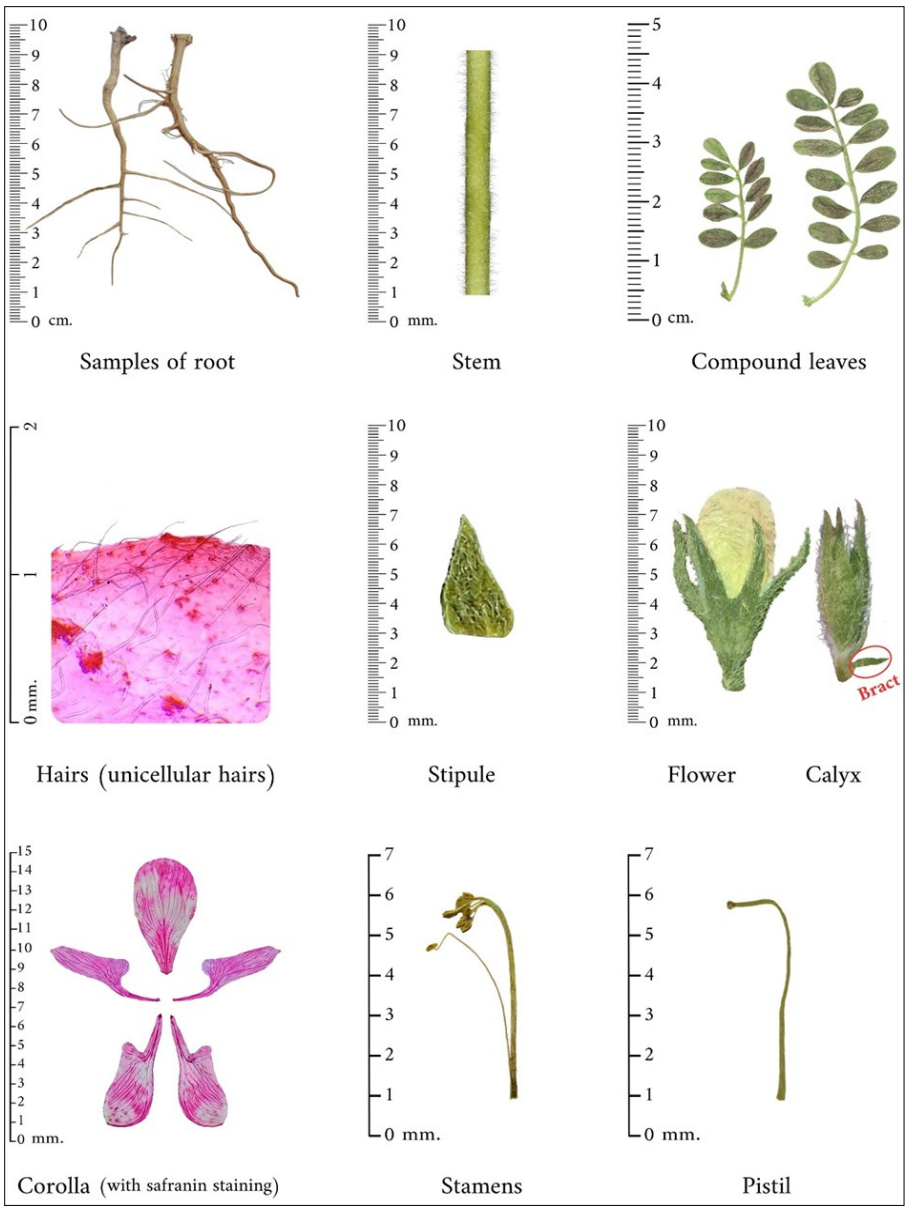

Fig. 5. Vegetative and floral parts of the species *Astragalus eremophilus* (these images were captured using the software provided with the advanced Canon EOS-5D Mark IV camera).

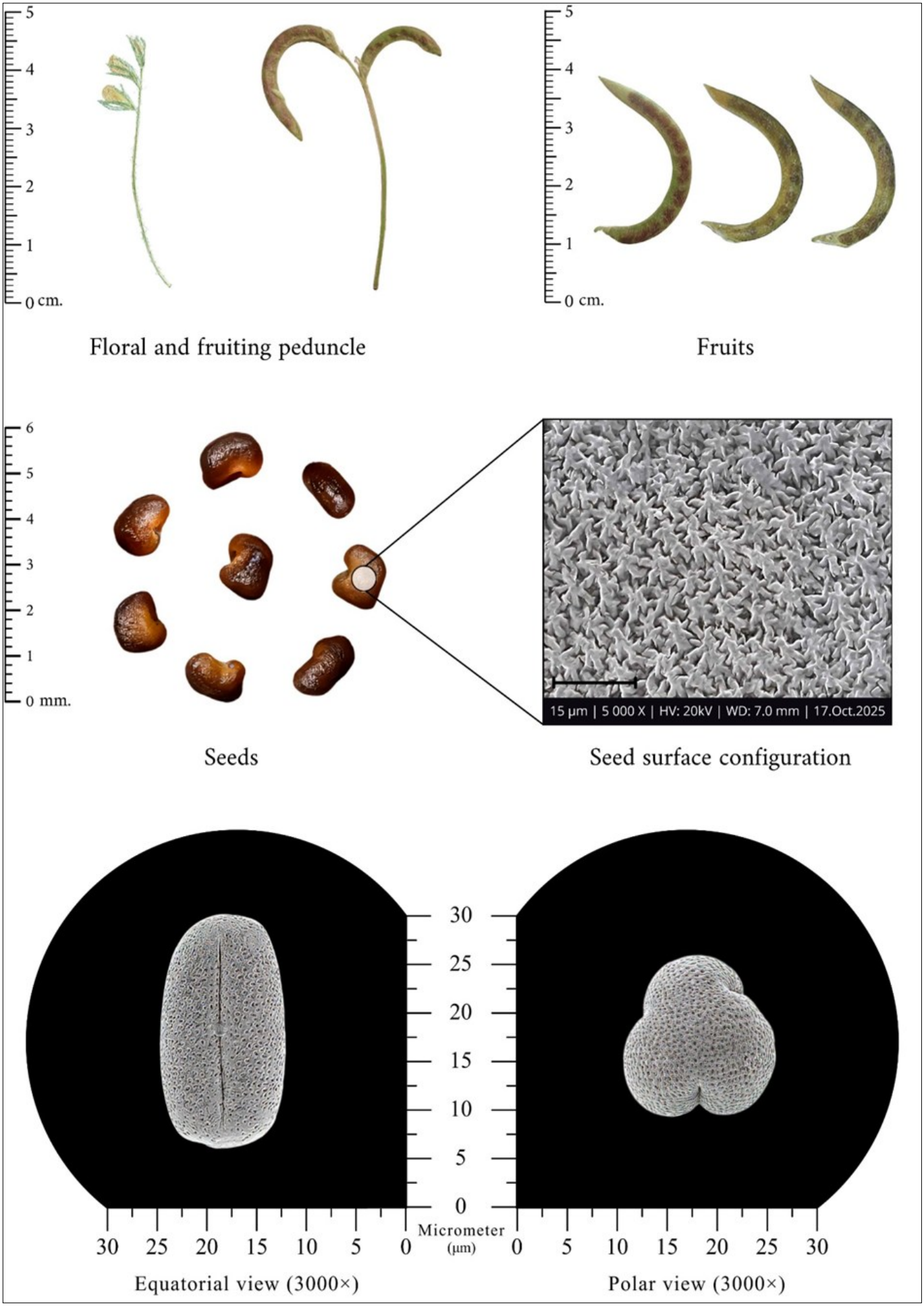

Fig. 6. Reproductive parts and scanning electron micrographs showing the detailed seed surface configuration and pollen grain of *Astragalus eremophilus*.

linear, glandular, 0.7–0.9 × 0.15–0.18 mm. Fruit pod (dehiscent dry simple fruit), linear in outline, strongly falcate, white-villous, yellowish green-greenish brown, 25–32 × 2.5–2.8 mm, triangular beaked at apex, compressed on both sides, 3.5–4.5 × 1.5–1.8 mm, glabrous, pale yellow-cream. Seeds many, each pod containing 20–24 seeds; seeds broadly reniform, pale brown, stellate configuration, 1.4–1.6 × 1.1–1.3 mm.

Specimens studied

Western desert district (DWD): Gazelle Reserve, 16 km. South of Rutba, 625 m alt, 13/3/2025, Othman M. Othman & Sukeyna Abaas Aliwy, 61570 (BAG): Gazelle Reserve, 16 km. South of Rutba, 625 m alt, 18/3/2025, Othman M Othman, 5984 (AUH).

Stomatal complex

Based on the upper and lower epidermal layers of the leaf, it was found that the type of stomatal complex was anomocytic (also termed irregular-celled stomata), which is characterised by the absence of specialised subsidiary cells. The guard cells are very narrowly kidney-shaped, 23–28 × 7–9 µm (Fig. 7).

Stem anatomy

The transverse section of the mature stem is characterised by being circular, slightly polygonal (Fig. 8), with a diameter of about 1200 µm, covered by a thick layer of cuticle up to 8 µm. The epidermis consists of small-medium elongated cells 34–42 µm thick. The cortex consists of one row of small, regular chlorenchyma cells 25–28 µm thick, as a continuous layer under the epidermis and one row of ordinary parenchyma cells, 30–35

Fig. 7. Stomatal complex in the lower epidermis of the leaf of *Astragalus eremophilus*.

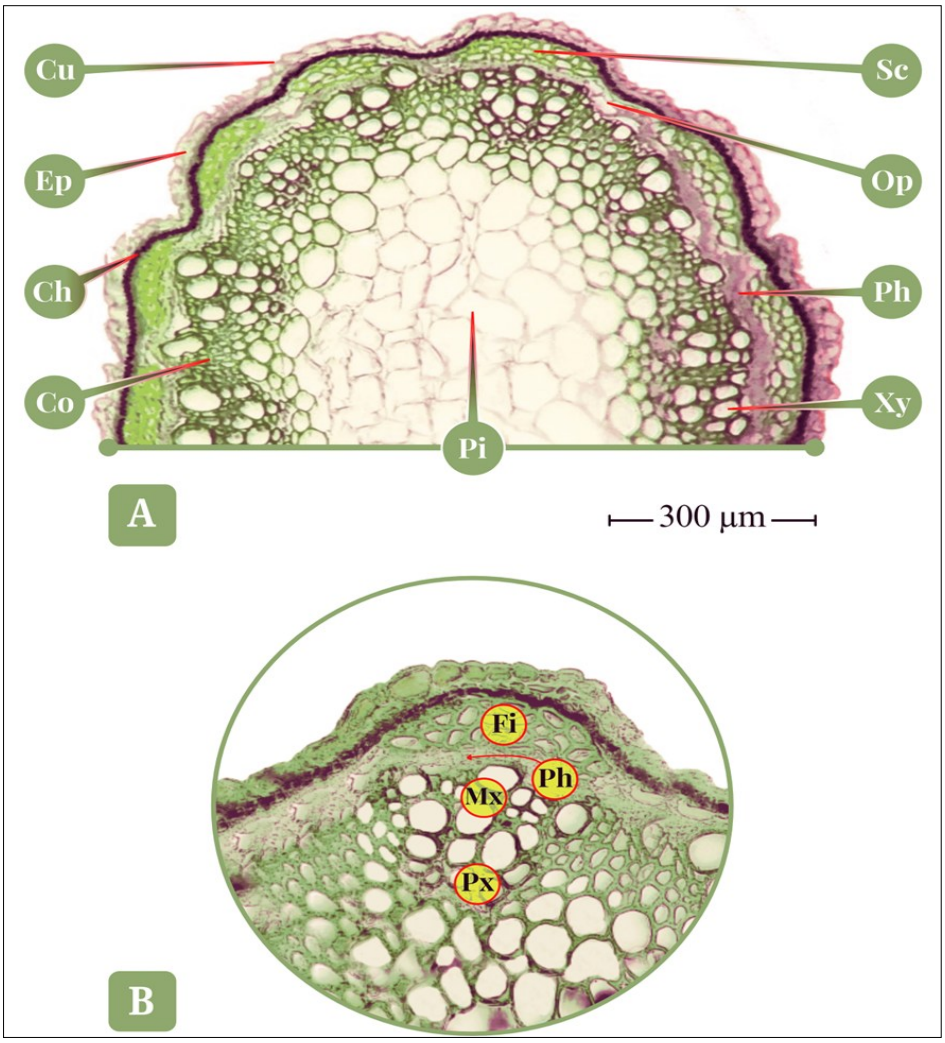

Fig. 8. (A) Transverse section of the stem of *Astragalus eremophilus* (100X); (B) Vascular bundle components (400X).

Ch: Chlorenchyma Co: Collenchyma Cu: Cuticle Ep: Epidermis
Fi: Fibers Mx: Metaxylem Op: Ordinary parenchyma Ph: Phloem
Pi: Pith Px: Protoxylem Sc: Sclerenchyma Xy: Xylem

μm thick, in small clusters confined between the bundle caps. The vascular cylinder is very wide, consisting of 12–14 regularly distributed collateral vascular bundles, close to each other, they are separated by 3–5 rows of angular collenchyma, 90–120 μm thick, each bundle 220–260 μm thick and consists of a bundle sheath characterised by a thickness of 55–70 μm, consisting of 3–4 rows of sclerenchyma tissue (fibres). The phloem is 32–35 μm thick and in 2–3 rows. The xylem is very broad and efficient (135–155 μm), consists of 3–4 arms in a bundle, each arm has 3–5 vessels, the diameter of each vessel is about 40–60 μm, especially in the metaxylem. The pith area is very broad and circular in shape, its diameter is equal to half the diameter of the cross section of the stem (about 600 μm) and it consists of the large parenchyma cells, very thin walled, which causes them to break down with the age of the plant. This anatomical description is one of the common patterns in annual plants with weak, prostrate stems of the Fabaceae family (24, 25). An anatomical study of 5 species of the genus *Astragalus* in Iraq indicated the importance of anatomical characters that successfully supported the variation of morphological and physiological characters (26).

Geographical distribution

Based on the global geographical distribution map of *A. eremophilus* (Fig. 9), its occurrence in Iraq is consistent with its known distribution range. It grows in 3 global phytogeographic regions surrounding Iraq, which is located almost in the middle of them. This species is considered a desert plant, depending on the environments in which it grows, as it often grows in sandy soils and barren lands, according to many studies in Saudi Arabia (27–29). It was first time recorded in the United Arab Emirates (30). The climate change is a pressing factor that encourages some species to migrate and invade environments that are more suitable for the species and its sustainability (31). An increase in the migration of species within at least one geographical region due to global climate change (32).

Phenological pattern

The phenological bars (Fig. 10) for the species *A. eremophilus* showing its life cycle throughout the year. Foliage begins early November to March. Flowering begins in mid-February, reaching its peak in March with pale sulphur yellow flowers before completely stopping after mid-April. Between mid-March and mid-April, the fruits are green, ripening to greenish brown during the first half of May and then seem to start dispersing seeds until the end of June. The species *A. eremophilus* follows a clear and common phenological pattern in annual wild plant species (33).

Identification confirmation

It is necessary to confirm and support the new record of the species *A. eremophilus* by making a morphological comparison to isolate it from the 2 similar species (*A. corrugatus* and *A. hauarensis*) belonging to the same section (Harpilobus) in Iraq (Table 1).

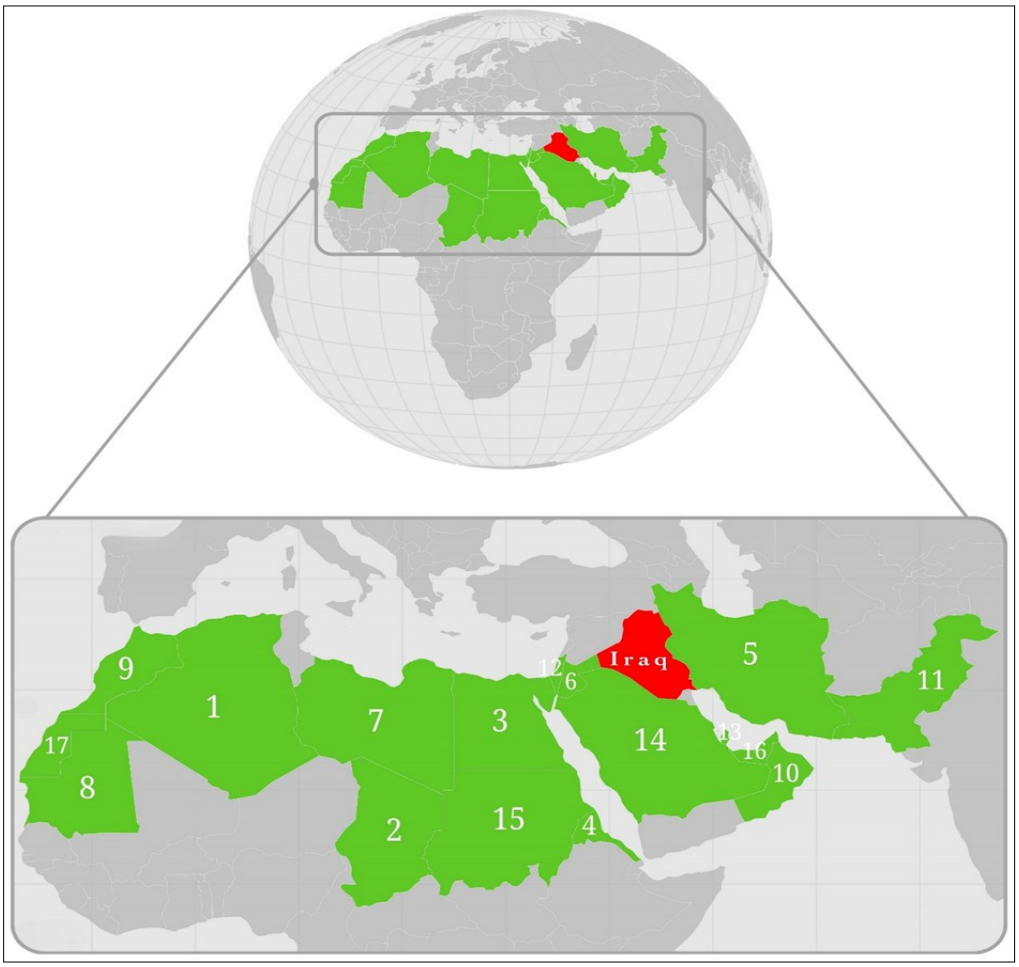

Fig. 9. Map of the world geographical distribution of the species *Astragalus eremophilus*. *The map was prepared by the author's based on the available data according to (5–7, 11–13, 19, 26).

1. Algeria 2. Chad 3. Egypt 4. Eritrea 5. Iran 6. Jordan 7. Libya 8. Mauritania
9. Morocco 10. Oman 11. Pakistan 12. Palestine 13. Qatar 14. Saudi Arabia 15. Sudan
16. United Arab Emirates 17. Western Sahara

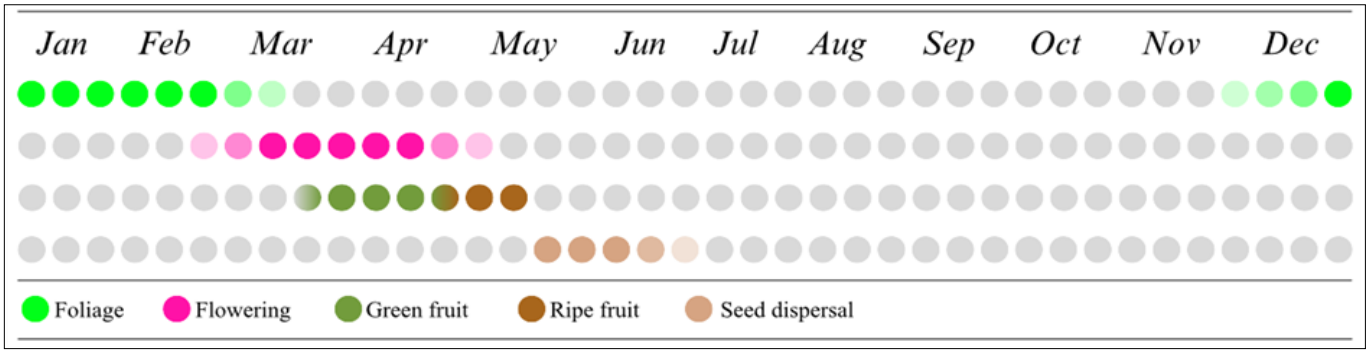

Fig. 10. Phenological bars illustrate the life cycle of the species *Astragalus eremophilus*.

Table 1. Morphological differences among the 3 similar species within the same section (Harpilobus) found in Iraq*

Species	Morpho-character	Differences
Astragalus eremophilus	Stems	Procumbent
Astragalus corrugatus		Prostrate, decumbent or ascending
Astragalus hauarensis		Prostrate, decumbent or ascending
Astragalus eremophilus	Leaves length	4.3–4.8 cm
Astragalus corrugatus		5–7 cm
Astragalus hauarensis		2–7 cm
Astragalus eremophilus	Leaflets numbers	5–7 pairs
Astragalus corrugatus		5–9 pairs
Astragalus hauarensis		1–3 pairs
Astragalus eremophilus	Stipules	Deltoid, 3.6-–4.1 mm
Astragalus corrugatus		Lanceolate-deltoid, 2.5–3.5 mm
Astragalus hauarensis		Broadly deltoid, 2.5–4.0 mm
Astragalus eremophilus	Inflorescences	2–3 (– 5) flowers
Astragalus corrugatus		1–7 flowers
Astragalus hauarensis		1–4 (– 7) flowers
Astragalus eremophilus	Calyx length	5.7–6.2 mm
Astragalus corrugatus		4–5 mm
Astragalus hauarensis		5.0–6.5 mm
Astragalus eremophilus	Calyx teeth	Equal or longer than the tube
Astragalus corrugatus		about $^{1}/_{2}$ (-$^{2}/_{3}$) as long as the tube
Astragalus hauarensis		about $^{1}/_{2}$ as long as the tube
Astragalus eremophilus	Standard	5.9–6.1 mm
Astragalus corrugatus		7–9 mm
Astragalus hauarensis		(5–) 9–13 mm
Astragalus eremophilus	Wings length	5.8–6.1 mm
Astragalus corrugatus		6–7 mm
Astragalus hauarensis		(3.5 –) 7–10 mm
Astragalus eremophilus	Keel length	6.0–6.2 mm
Astragalus corrugatus		5–6 mm
Astragalus hauarensis		(3.0 –) 6.0–8.5 mm
Astragalus eremophilus	Style length	1.5 mm
Astragalus corrugatus		1 mm
Astragalus hauarensis		3 mm
Astragalus eremophilus	Ovules numbers	20–24
Astragalus corrugatus		18–28
Astragalus hauarensis		18–22 (–28)
Astragalus eremophilus	Pod size	25–32 × 2.5–2.8 mm
Astragalus corrugatus		20–45 × 2–3 mm
Astragalus hauarensis		(10 –) 22–30 × 3–4 mm
Astragalus eremophilus	Fruit beak	Long (4 mm) and straight
Astragalus corrugatus		Short (2 mm) and recurved
Astragalus hauarensis		Short (2 mm) and curved
Astragalus eremophilus	Seeds	Broadly reniform, 1.5 mm
Astragalus corrugatus		Quadrate-wedgeshaped, 2 mm
Astragalus hauarensis		Rhomboid-Wedgeshaped, 1.5 mm

*The quantitative and qualitative characteristics of the 2 species, *A. corrugatus* and *A. hauarensis*, were obtained based on the flora of Iraq.

Conclusion

This study confirms the first verified record of *Astragalus eremophilus* within the flora of Iraq through an integrated taxonomic investigation combining detailed morphological assessment, pollen micromorphology, stem anatomy and stomatal complex characterisation. We, in turn, recommend that future studies focus on intensifying field surveys to find species that have not been recorded in the flora of Iraq.

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. MAA contributed to data discussion and manuscript revision. All authors read and approved the final manuscript.

Compliance with ethical standards

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

Ethical issues: None

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