

## *Linaria kavirensis* (Scrophulariaceae), a new species from Iran

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*Linaria kavirensis* Hamdi & Assadi (Scrophulariaceae) is described and illustrated as a new species from the central desert and eastern provinces of Iran. It belongs in sect. *Supinae* and is compared with the morphologically close *L. simplex*, from which it differs by having filiform vs. linear leaves, shorter bracts (1.5–2 mm vs. 2 × 0.5–0.7 mm), shorter corolla (5–6 mm vs. 7–7.5 mm), shorter spur (1.5–1.7 mm vs. 2.5–3 mm), smaller capsules (3–3.5 mm vs. 4–4.5 mm), and smaller seeds with smooth vs. tuberculate surface. In addition, *L. kavirensis* is compared with *L. arvensis* and *L. micrantha* by means of scanning electron micrographs of seed and capsule surfaces.

Key words: *Linaria*, micro-morphology, new species, taxonomy

### Introduction

The genus *Linaria* is widely distributed throughout the northern hemisphere, with its centre of diversity in the Mediterranean basin, west-south Asia, and eastern Asia; it is naturalized elsewhere in temperate regions (Hong 1983, Sutton 1988). *Linaria* comprises annual or perennial herbs growing in a wide variety of habitats, including dry and sandy soils and rocky slopes.

The genus is divided into seven sections mainly based on seed morphology. The seeds in sect. *Supinae* are sub-disciform and mostly winged. It has 42 species worldwide, of which four occur in Iran. Section *Supinae* is divided

into three subsections based on capsule morphology and size of the seed wings. Geographically, sect. *Supinae* is distributed in central and southern Europe, west and south Asia and north Africa.

During the course of revision of *Linaria* for the ongoing project of the Flora of Iran, many specimens preserved in Iranian herbaria (TARI, IRAN, TUH, FUMH), as well as new collections of fresh material were examined. We collected some specimens of *Linaria* from the mountainous central and east subalpine regions of Iran that did not correspond to any of the species known in the genus, although morphologically they resembled *L. simplex*. In order to ascertain

whether the morphological differences between these specimens and *L. simplex* merited the recognition of a new species of *Linaria*, we conducted a comparative morphological study.

## Material and methods

This study is mainly based on plant material deposited in the Iranian herbaria FUMH, IRAN, TARI, TUH (abbreviations according to Holmgren & Holmgren 1998). Several field trips were conducted in different parts of Iran, and the specimens collected were deposited in these herbaria. Measurements of vegetative and floral parts as well as seeds were carried out under a stereomicroscope (Olympus SZH).

In the Antirrhineae seed coat features have been reported to have paramount importance in the systematic relationships between taxa at different ranks and even in species delimitation (Elisens 1985, Sutton 1988). Thus, to investigate the seed coat sculpturing, mature seeds were mounted directly on 12.5 mm diameter stubs attached with sticky tape and then coated in a sputter coater with a gold/palladium layer approximately 25  $\mu\text{m}$  thick. Morphological observations were carried out with LEO 440I Scanning Electron Microscope. The terminology used for describing the seed coat features followed Sutton (1988) and Segarra and Mateu (2001). To check the stability of the morphological characters and their putative taxonomic use, several specimens from the same and from different populations were examined.

From each part of *L. micrantha*, *L. arvensis*, *L. simplex* and *L. kavirensis*, ten samples and their seeds from different varieties were taken into study.

## Results and discussion

***Linaria kavirensis* Hamdi & Assadi, sp. nova** (Figs. 1–4)

*Differt ab L. simplex* corolla 5–6 mm (nec 7–7.5 mm) longa, calyce 3–3.5 mm longis (nec 4–4.5) et 0.6–0.8 mm latis (nec 1.2–1.5 mm), et semina laevia nec tuberculatis.

ETYMOLOGY: “Kavir” is the Persian word for large deserts.

HOLOTYPE: Iran. Yazd province, Taft, Taft-Kuh, 1000–1300 m, 24.IV.1995 *Dehghanzadeh 26052* (TUH).

Glaucous annual herbs, erect. Fertile stems 15–35 cm long, branched at base, with alternate leaves above and opposite leaves at base. Leaves 10–15  $\times$  0.4–0.6 mm, filiform, acute. Inflorescence lax both in flowering and fruiting stages, 7–15 cm long, with 6–12 flowers. Bracts 1.5–2  $\times$  0.6 mm, scarious at margins, subacute, lanceolate, glandular-villous. Pedicels 0.8–1 mm long. Calyx lobes equal, 3–3.5  $\times$  0.6–0.8 mm, subacute, lanceolate, scarious at margins, glandular-villous. Corolla 5–6 mm long, yellow with violet veins or tinged with violet; tube 1 mm width at mouth; sinus of adaxial lip 1 mm, lip apices 1.5 mm distant from each other; spur 1.5–1.7 mm long, 0.5–0.7 mm width at base, straight, shorter than rest of corolla. Style 1 mm long. Fertile Stamens 4, didynamus; tall stamen 2.3–2.5 mm long, short stamen 1.8–2.2 mm long; staminode minute, 0.1 mm long. Capsule 3–3.5 mm. Seeds 1.5–1.6 mm, reniform, dark-grey, discoid, smooth; wing 0.5–0.6 mm width.

DISTRIBUTION AND HABITAT: *Linaria kavirensis* is distributed at hill sides close to the Iranian central deserts, the so-called Kavir-e Lut (Fig. 2). In these habitats typical plant genera are *Stipa*, *Bromus*, *Astragalus*, *Acantholimon*, and *Acanthophyllum*.

*Linaria kavirensis* might be confused with *L. simplex*, *L. arvensis* and *L. micrantha*. The four species are compared in Table 1 and can be identified with the key below.

### Key to species

1. Seed surface smooth ..... *L. kavirensis*
1. Seed surface tuberculate ..... 2
2. Spur straight, 1 mm; corolla 4.5–5 mm, light blue–dark blue ..... *L. micrantha*
2. Spur straight-curved, at least 1 mm; corolla 5–7 mm, light blue or yellow ..... 3
3. Corolla light blue, 5–5.5 mm; spur straight-curved, 2 mm ..... *L. arvensis*
3. Corolla yellow with violet veins, 7–7.5 mm; spur straight, 2.5 mm ..... *L. simplex*

Seed characters provide valuable characters in delimiting taxa at specific and sectional level in

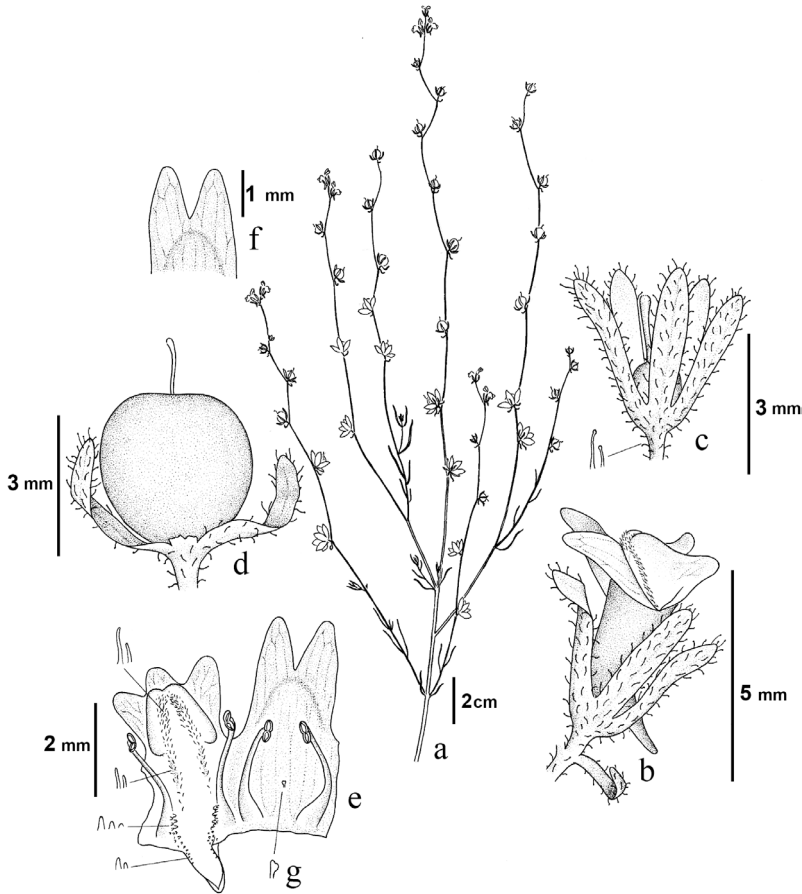


Fig. 1. *Linaria kavirensis*. — a: habit. — b: flower. — c: calyx. — d: capsule. — e: opened corolla. — f: adaxial lip sinus. — g: staminode. Drawn by M. Mehranfard (FUMH 30767).

*Linaria* (Kuprainova 1950, Elisens 1985, Sutton 1988). Testa cells and wing of the seeds help to separate *L. kavirensis* from the other three taxa (Table 1). Seed surface and wing in *L. kavirensis* is composed of irregular hexagonal cells (Fig. 3a–c), while in *L. simplex* seed surface is a mixture of irregular pentagonal and hexagonal cells (Fig. 3d–f). *Linaria micrantha* has a mixture of irregular pentagonal and heptagonal testa cells of seed and irregular and regular hexagonal testa cells of wing (Fig. 4j–l). *Linaria arvensis* has hexagonal testa cells of seed and irregular pentagonal-heptagonal testa cells of wing (Fig. 4g–i).

ADDITIONAL REPRESENTATIVE SPECIMENS EXAMINED. —

*Linaria simplex*: **Iran**. Prov. Mazandaran, Kojoure-Kohneh, 1600–1980 m, 6.VII.1982 *Termeh, Moussavi & Tehrani s.n.* (IRAN); Prov. Guilan, Bandare Anzali, 30–50 m, *Mozaffa-*

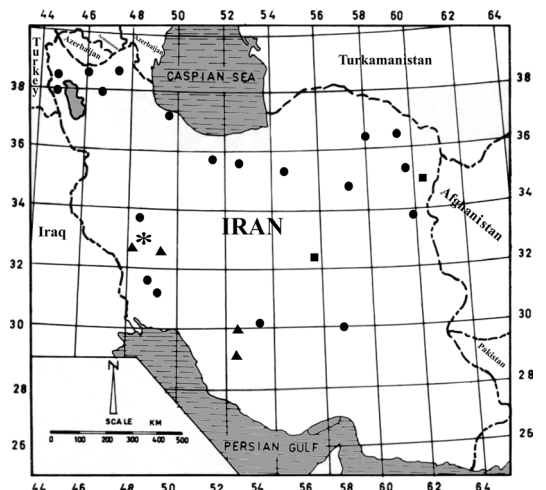
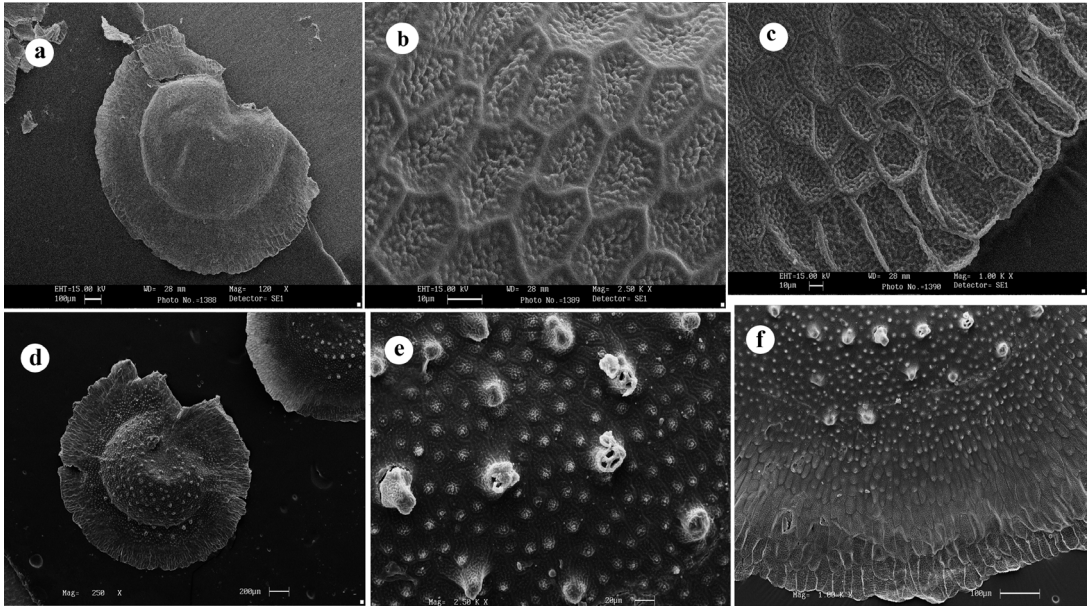
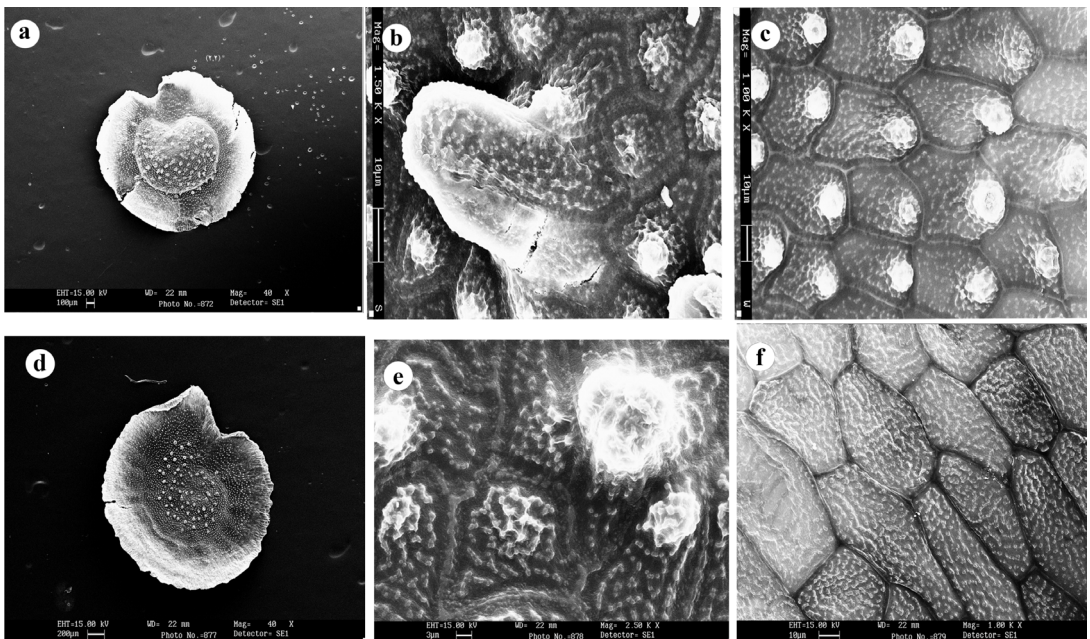


Fig. 2. Distribution of *Linaria kavirensis*, *L. arvensis*, *L. micrantha* and *L. simplex* in Iran.



**Fig. 3.** Scanning electron micrographs of seeds of *Linaria*. — **a–c:** *L. kavirensis* from TUH 26052 (Yazd, Taft, Taft-Kuh, 1000–1300 m, 26.IV.1993 M. Dehghanzadeh); — **a:** overview, — **b:** testa cells of seed corpus, — **c:** wing edge. — **d–f:** *L. simplex* from TARI 19496 (Gazvin, protected area Kavir, N. Siah-Kuh, 700 m 6.V.1976, Ronemark, Foroughi & Assadi), — **d:** overview, — **e:** testa cells of seed corpus, — **f:** wing edge. Scale bars: **a** = 100  $\mu$ m, **b** = 10  $\mu$ m, **c** = 10  $\mu$ m, **d** = 200  $\mu$ m, **e** = 20  $\mu$ m, **f** = 100  $\mu$ m.



**Fig. 4.** Scanning electron micrographs of seeds of *Linaria*. — **a–c:** *L. arvensis* from TARI 74494 (Khuzestan Prov., Dezfool, mountain Gharoon, 1000–1500 m, 17.VI.1995, Mozaffarian), — **a:** overview, — **b:** testa cells of seed corpus, — **c:** wing edge. — **d–f:** *L. micrantha* from TARI 29748 (Khuzestan Prov., Ahvaz, 30 km to Andimeshk, 350 m, 7.III.1959, Pabout), — **d:** overview, — **e:** testa cells of corpus, — **f:** wing edge. Scale bars: **a** = 100  $\mu$ m, **b** = 10  $\mu$ m, **c** = 10  $\mu$ m, **d** = 200  $\mu$ m, **e** = 3  $\mu$ m, **f** = 10  $\mu$ m.

**Table 1.** Comparison of *Linaria kavirensis*, *L. simplex*, *L. arvensis* and *L. micrantha*.

Characters	<i>L. micrantha</i>	<i>L. arvensis</i>	<i>L. simplex</i>	<i>L. kavirensis</i>
Stem (height)	15–25	20–25	15–25	15–35
Life form	annual	annual	annual	annual
Leaves size	8–12 × 1–1.2	7–10 × 0.7–1	7–15 × 1–2	10–15 × 0.4–0.6
Leaves shape	linear	linear	linear	filiform
Phyllotaxy	opposite(base)– alternate(above)	opposite(base)– alternate(above)	alternate	opposite(base)– alternate(above)
Pedicle	0.5–0.7	1.5–2	1	0.8–1
Bracts	3–3.5 × 0.8–1	2–2.5 × 0.5	2 × 0.5–0.7	1.5–2 × 0.6
Calyx lobes	2.5–3 × 1–1.2	2.5–3 × 1–1.2	4–4.5 × 1.2–1.5	3–3.5 × 0.6–0.8
Corolla	4.5–5 × 1	5–5.5 × 1.5	7–7.5 × 1–1.2	5–6 × 1
Spur (mm)	1–1.2	2–2.5	2.5–3	2.5–1.7
Ratio spur/rest of corolla	1/4	1/2	1/3	1/3
Adaxial lip sinus of corolla (mm)	1–1.2	0.5–0.7	1–1.5	1
Distance between apex of adaxial lips (mm)	2	1	1	1.5
Style length (mm)	0.6–0.8	0.4–0.6	1.5–1.7	1–1.2
Tall stamen (mm)	2.5–3	2.5–3	3.5–3.8	2.3–2.5
Short stamen (mm)	2–2.5	2–2.2	3–3.3	1.8–2.2
Staminodes (mm)	0.2	0.3	0.4	0.1
Capsule size (mm)	2 × 2	2–2.5 × 2	4 × 4.5	3 × 3.5
Seed size (mm)	1.2–1.5	1.5–1.9	1.8–2.6	1.5–1.6
Wing of seed (mm)	0.2–0.3	0.4–0.5	0.3–0.6	0.5–0.6
Seed shape	suborbicular	orbicular	reniform-orbicular	reniform
Cells shape of testa seed	irregular pentagonal- heptagonal	hexagonal	irregular pentagonal and hexagonal	irregular hexagonal
Cell shape of wing	irregular and regular hexagonal	irregular pentagonal– heptagonal	irregular pentagonal and heptagonal	irregular hexagonal
Length of test cell (µm)	34–36	25–30	36–40	22–30
Width of test cell (µm)	15–25	20–22	21–25	14–17
Length of wing cells (µm)	60–75	20–26	50–80	20–40
Width of wing cells (µm)	30–45	40–50	24–30	16–30
Ornamentation of seed	tuberculate	tuberculate	tuberculate	smooth

*rian* 75120 (TARI); Bandare-Anzali, 20 m, *Mozaffarian* 6778 (TARI); Bandare Anzali, 25m, *Mozaffarian* 9864 (TARI); Prov. Azerbaijan, Ardebil to Astara, near of Heiran, 950–1600 m, *Iranshahr* 39211 (IRAN); Kalibar, protected area, near Venigh, 500–900 m, *Wendelboo & Assadi* 17111 (TARI); Urmieh, Golmankhaneh, near of Urmieh Lake, 1400 m, *Wendelboo, Assadi & Shirparvar* 11967 (TARI); Urmieh, Silvana, near village, 1500–1600 m, *Ronemark & Foroughi* 19685 (TARI). Esfahan, Ghameshloo, protected area of Kalaivar, 1900 m, *Yuosefi* 503 (TARI); Fars prov., Shiraz, Saadat Abad, 1900 m, *Foroughi* 8512 (TARI); Firouz Abad, 60 km South-Eastern, 1000 m, 5.VII.1975 *Iranshahr & Termeh s. n.* (IRAN); Kerman, Jirouft, Marz Pimjan, Sefid-Kuh, 750–900 m, *Mousavi & Tehrani* 37908 (TARI); Khorasan prov., Daregaz, Gharokh Ghaz, 450 m, *Jouharchi & Zangouii* 16485 (TARI); Shirvan, Research station Deim of Khorasan, Sisab, *Rashed & Zangouii* 16056 (TARI); Boujnord, 80 km of west Boujnord, between Chamanbid & Joozak, 1300 m, *Jouharchi & Zangouii* 16627 (TARI); Boujnord, north-west of Boujnord, between Eshgh Abad & Kale-Eimani, 950 m,

*Jouharchi & Zangouii* 33247 (TARI); Kashmar, 15 km Kashmar to Rivoush, 1450 m, *Jouharchi* 33956 (TARI); Gonabad, East of Bajestan, Hojat Abad to Halali, 10 km, 1250 m, *Rafiei & Zangouii* 30546 (TARI); Nishabour, Sarvelaiat, eastern mountains Chakaneh Olia, 1750 m, *Jouharchi & Faghihnia* 18522 (TARI); Semnan prov., Shahmirzad & Foulad Mahleh, Tangeh Parvar, 1900 m, *Gahreman & Mozaffarian* 5769 (TARI); Prov. Tehran, Damavand, 2100 m, *Mozaffarian* 45379 (TARI); Ghazvin, Gazvin to Rasht, 13 km of Lushan to Rasht, 700 m, *Wendelboo & Massoumi* 19071 (TARI); Tehran, Central Kavir protected area, Siah-Kuh to East and North of Kavir, 1000–1200 m, 6.V.1976 *Ronemark, Foroughi & Assadi* (TARI); Tehran, Tehran to Karaj, Kalak village, 1500–1900 m, *Assadi & Mozaffarian* 27588 (TARI); Tehran, 1300–1500 m, 9.VI.1966 *Iranshahr* 6763 (IRAN); Tehran, Soloughan, 1230 m, 29.IV.1976 *Matin & Termeh* 7984 (IRAN). — *Linaria kavirensis* (paratypes): **Iran**. Khorasanensis prov., Torbate-Jaam, Miansara mountains, 1300 m, 25.V.1989 *Jouharchi & Zangouii* 17473 (FUMH); Torbate-Jaam, Miansara mountains, 1300 m, 23.IV.2002 *Jouhar-*

chi 34040 (FUMH). — *Linaria micrantha*: Iran. Khuozestan Prov.: Behbahan, *Mozaffarian* 62494 (TARI); Behbahan, 30 km of south of Behbahan, 320 m, *Roohipour* 159 (TARI); Andimeshk, to Khoram Abad, Pole Zel area, 400 m, *Mozaffarian* 53793 (TARI); Ahvaz, 30 km to Andimeshk, 350 m, *Pobout* 29748 (TARI); Haft Gool, Simeh Eili, 410 m, *Foroughi* 3406 (TARI); Fars Prov.: Shiraz, Saadat Abad, 1910 m, *Foroughi* 8510 (TARI); Kazeroun, 18 km to Dalaki, 800 m, *Ronemark & Mozaffarian* 26763 (TARI). — *Linaria arvensis*: Iran. Khuozestan Prov., Dezfool, mountain Gharoon, 1000–1500 m, *Mozaffarian* 74494 (TARI).

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