Taxonomic revision of the broad-margined calyx species of Scrophularia (Scrophulariaceae) in Iran, with one new species

Massoud Ranjbar & Narges Rahchamani

Abstract

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The species of *Scrophularia* L. (*Scrophulariaceae*) with broad-margined calyx are taxonomically revised. The studied group includes *S. haematantha* Boiss. & Heldr., *S. kollakii* S.A. Ahmad, *S. mesopotamica* Boiss., *S. pruinosa* Boiss., *S. rosulata* Stiefelh., *S. sanguinea* Grau, *S. sulaimanica* S.A. Ahmad and *S. valida* Grau, all of them characterized by having a farinaceous indumentum, a broad-margined calyx and a gland-dotted staminode. One new species from Iran belonging to this group is here described, i.e., *S. sardashtensis* Ranjbar & Rahch. *Scrophularia kollakii* and *S. sulaimanica* are also recorded in Iran for the first time. Macro and micro-morphological characters of this species are examined and compared with the related taxa. Detailed descriptions and distribution maps are provided for the nine species treated. Additionally, the names *S. haematantha, S. pruinosa* and *S. rosulata* are lectotypified.

Keywords

SCROPHULARIACEAE – *Scrophularia* – Iran – New species – Nomenclature – Taxonomy

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Introduction

The genus *Scrophularia* L. is one of the largest genera of the family *Scrophulariaceae* with about 200–300 species (Willis, 1973; Mabberley, 2008). In Iran, this genus is represented by c. 60 species (Grau, 1981; Attar, 2011; Ranjbar et al., 2017), which are still in need of revision (Ranjbar et al., 2016; Ranjbar & Rahchamani, 2018, 2019).

The shape of the calyx margin has a remarkable taxonomic value in *Scrophularia* because of its considerable variability. It can be broad or narrow, undulate or flat, entire or incised and white or purple. In this contribution, we revise a group of species with broad-margined calyx including *S. haematantha* Boiss. & Heldr., *S. kollakii* S.A. Ahmad, *S. mesopotamica* Boiss., *S. pruinosa* Boiss., *S. rosulata* Stiefelh., *S. sanguinea* Grau, *S. sulaimanica* S.A. Ahmad and *S. valida* Grau. These species are characterized by having a farinaceous indumentum, a broad (except for *S. rosulata*) and white (except for *S. mesopotamica*) margined calyx, a similar corolla shape and color, and a gland-dotted staminode. They differ in plant indumentum density, leaf shape, corolla size and staminode indumentum and shape. As a result of this revision, one new species is formally described below. All the species treated herein are part of the Irano-Turanian and Euxino-Hyrcanian element (Zohary, 2004) and grow in mountainous regions at elevations between 1000–2500 m.

On a palynological note, it should be emphasised that *Scrophulariaceae* is an eurypalynous family (Erdtman, 1952), and therefore, pollen characters are important in description, recognition of species and even sometimes in delimitation of sections (Ortega-Olivencia & Devesa-Alcaraz, 1992). A pollen morphological study of the whole family was conducted by Varghese (1968).

The present study is based on field work carried out in different regions of Iran from 2011 to 2018. Additionally, herbarium specimens of *Scrophularia* deposited at BASU and T were revised, as well as digital images of material kept at B, E, FL, FUMH, G, GZU, JE, K, LD, LE, MA, P, S and W. In order to characterise the leaf indumentum, small pieces of the abaxial leaf surfaces were mounted on brass stubs and examined by using a Scanning Electron Microscope (JEOL JSM-840A) at different magnifications. To study the seed and pollen characters, mature seeds and pollen were mounted on stubs and observed by using the aforementioned device.

Morphology

Leaves, corolla and calyx

The species treated in this contribution present a high variability in leaf size, shape and margin. With exception of *Scrophularia haematantha,* which displays entire leaves, the cauline leaves usually vary from entire to incised or divided. The corolla is often large, the calyx is broad-margined (except for *S. rosulata*) and the staminode is gland-dotted (see Fig. 1).

Indumentum

Stems and leaves are generally covered with farinaceous hairs composed of a cup-shaped apical part and a cylindrical base. The apical part has five cells whereas the base has one or two cells. Although the indumentum type is similar in all the studied species, differences exist in trichome length and density. The glandular hairs, when present, have a sack-shaped apical part and a short base consisting of a single cell (see Fig. 2A, B).

Table 1. – The pollen morphological characters of *Scrophularia* L. species examined in this study. Abbreviations: per = perprolate, pro = prolate.

Characters	*S. sulaimanica*	*S. haematantha*	*S. kollakii*	*S. mesopotamica*	*S. pruinosa*	*S. sanguinea*	*S. sardashtensis*	*S. valida*
Polar axis [µm]	46.158	39.203	40.576	42.321	41.209	36.534	43.821	44.852
Equatorial axis [µm]	22.682	20.882	19.643	20.567	19.984	20.061	19.965	21.433
P/E ratio	2.035	1.877	2.065	2.057	2.062	1.821	2.194	2.092
Shape of the grains	per	pro	per	per	per	pro	per	per
Colpi length [µm]	42.665	35.984	37.389	35.985	37.785	33.268	41.239	40.615
Colpi width [µm]	2.834	2.421	2.575	2.427	2.562	2.501	2.407	2.443
Numb. lumina per 100 µm²	70	162	131	95	131	93	109	86
Diam. lumina [µm]	0.987	0.756	0.802	0.989	0.933	0.992	0.921	0.747

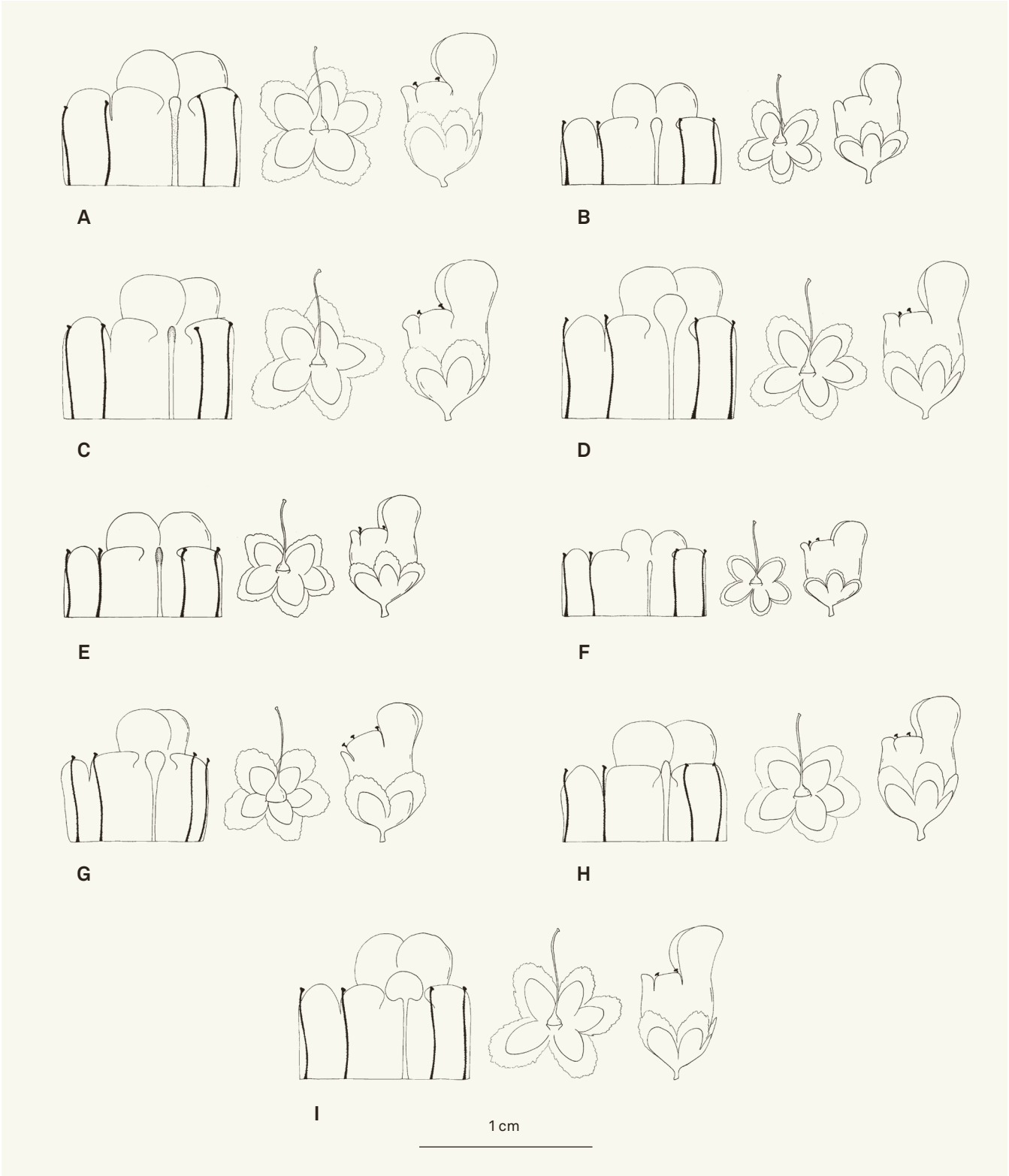


Fig. 1. – Flower structure. **A.** *Scrophularia sulaimanica* S.A. Ahmad; **B.** *Scrophularia haematantha* Boiss. & Heldr.; **C.** *Scrophularia kollakii* S.A. Ahmad; **D.** *Scrophularia mesopotamica* Boiss.; **E.** *Scrophularia pruinosa* Boiss.; **F.** *Scrophularia rosulata* Stiefelh.; **G.** *Scrophularia sanguinea* Grau; **H.** *Scrophularia sardashtensis* Ranjbar & Rahch.; **I.** *Scrophularia valida* Grau.
[left to right: corolla, stamens and staminode; calyx, ovary and style; corolla and calyx] [Drawing: N. Rahchamani]

Pollen

Analyses based on 8 out of the 9 studied species (pollen of *Scrophularia rosulata* was not available to us) indicate that pollen grains are tricolporate and their shapes vary from perprolate to prolate. The polar axis (P) ranges from 37 µm to 46 µm, and the equatorial axis (E) from 20 µm to 23 µm; the colpus length varies from 33 µm to 43 µm, and the average of the colpus width is about 2.5 µm. *Scrophularia sulaimanica* is the species with largest pollen, whilst *S. sanguinea* displays the smallest grains. SEM micrographs revealed that the tectum is microreticulate and the lumina is irregularly distributed. The largest lumina was observed in *S. sanguinea* (Fig. 2C) and the smallest one in *S. valida* (Fig. 2D). See Table 1.

Seeds

Seeds are elliptic to ovate; seed length ranges from 1.3 mm to 1.8 mm and the width from 0.5 mm to 1 mm. SEM micrographs revealed that the seeds of this species group have broad cavities and that the epidermal cells appear as regular polygons. There are some differences in number of transversal ridges, which varies from 3–5 (e.g. *Scrophularia sulaimanica*, *S. mesopotamica* (Fig. 2E), *S. sardashtensis* Ranjbar & Rahch.) to 5–7 (e.g. *S. kollakii*, *S. pruinosa* (Fig. 2F), *S. sanguinea*).

Key to the broad-margined calyx species of Scrophularia in Iran

1. Corollas 4.5–6 mm long; styles 3–4.5 mm long 2
1a. Corollas 6–9 mm long; styles (4–)4.5–7.5 mm long 4
2. Stems glabrous ..... ***S. haematantha***
2a. Stems loosely to densely farinaceous-pubescent 3
3. Inflorescences 15–25 cm long; calyx margins up to 0.5 mm wide; staminodes as long as lower corolla lobe ..... ***S. pruinosa***
3a. Inflorescences 20–45 cm long; calyx margins up to 0.2 mm wide; staminodes shorter than lower corolla lobe ..... ***S. rosulata***
4. Corollas > 8 mm long 5
4a. Corollas < 8 mm long 6
5. Plants 90–110 cm tall; calyx margins purple; staminodes orbiculate ..... ***S. mesopotamica***
5a. Plants 60–80 cm tall; calyx margins white; staminodes reniform ..... ***S. valida***
6. Staminodes oblong to orbiculate 7
6a. Staminodes linear to oblong 8
7. Leaves glabrous to sparsely glandular or very sparsely farinaceous-pubescent; inflorescence bracts up to 20 mm long; calyces 2.5–3 mm long, with margins up to 1.5 mm wide; staminodes as long as lower corolla lobe ..... ***S. sanguinea***
7a. Leaves glabrous to very sparsely farinaceous-pubescent; inflorescence bracts up to 3 mm long; calyces 3–3.5 mm long, with margins up to 1 mm wide; staminodes shorter than lower corolla lobe ..... ***S. sulaimanica***
8. Peduncles up to 25 mm long; corollas 6.5–7 mm long; calyx margins up to 1.5 mm wide; staminodes longer than lower corolla lobe ..... ***S. sardashtensis***
8a. Peduncles up to 20 mm long; corollas 7–8 mm long; calyx margins up to 1 mm wide; staminodes shorter than lower corolla lobe ..... ***S. kollakii***

Taxonomy

1. ***Scrophularia haematantha*** Boiss. & Heldr. in Boiss., Fl. Orient. 4(2): 415. 1879.

Lectotypus (designated here): **Iran. Prov. Kermanshah:** "in schistosis montium Avroman [Oraman] et Schahu [Shahu]", VI.1867, *Haussknecht 734* (G-BOIS [G00751561] image!; isolecto-: JE [JE00012134, JE00012135] images!, W [W0017317] image!). **Syntypus: Iran. Prov. Kermanshah:** ibid. loco, *Haussknecht 733* (G-BOIS [G00751562] image!).

Perennial herbs, erect, 35–70 cm tall. *Stems* numerous, thin, woody, glabrous, green to gray. *Leaves* rather coriaceous, glabrous to very sparsely farinaceous (especially on abaxial surface), green to gray; venation pinnate, prominent and brown on abaxial surface. *Lower leaves* opposite to whorled, elliptic to rhomboid, 20–65 × 15–25 mm, acute at apex, entire, dentate (with 4–7 teeth per side, up to 3 mm long), petiolate; petioles up to 60 mm long. *Upper leaves* opposite or alternate to whorled, elliptic to lanceolate, 25–55 × 15–25 mm, acute at apex, entire, dentate (with 5–9 teeth per side, up to 3 mm long) sessile to petiolate; petioles up to 15 mm long. *Inflorescences* 35–45 cm long, paniculate, bracteate; cymes dichasial, few-flowered; bracts up to 10 mm long, lanceolate, acute at apex, entire, glabrous, green to gray. *Peduncles* 15 mm long; pedicels 5 mm long, sparsely glandular-pubescent; bracteoles up to 3 mm long, linear to lanceolate, acute at apex, entire, glabrous, green. *Calyces* 2–2.5 mm long; sepals equal, ovate to orbiculate, obtuse at apex, green; margin up to 1 mm wide, undulate, incised, glabrous, white. *Corollas* 5.5–6 mm long, rather urceolate; lobes unequal, 5-lobed, obtuse, tube greenish; superior lobes purple, glabrous. *Stamens* 4, fertile, 4.5–5 mm long, exserted; filaments white, loosely gland-dotted; anthers whitish. *Staminodes* oblong to orbiculate, shorter than lower corolla lobe, sparsely gland-dotted on margin and abaxial surface. *Styles* 4–4.5 mm long, glabrous. *Ovaries* 1–1.5 × 1–1.5 mm, globose. *Capsules* 4–4.5 × 4–4.5 mm, globose, mucronate (mucro up to 2 mm long), glabrous, brown. *Seeds* 1.2–1.5 × 0.8–1 mm, elliptic to ovate, black.

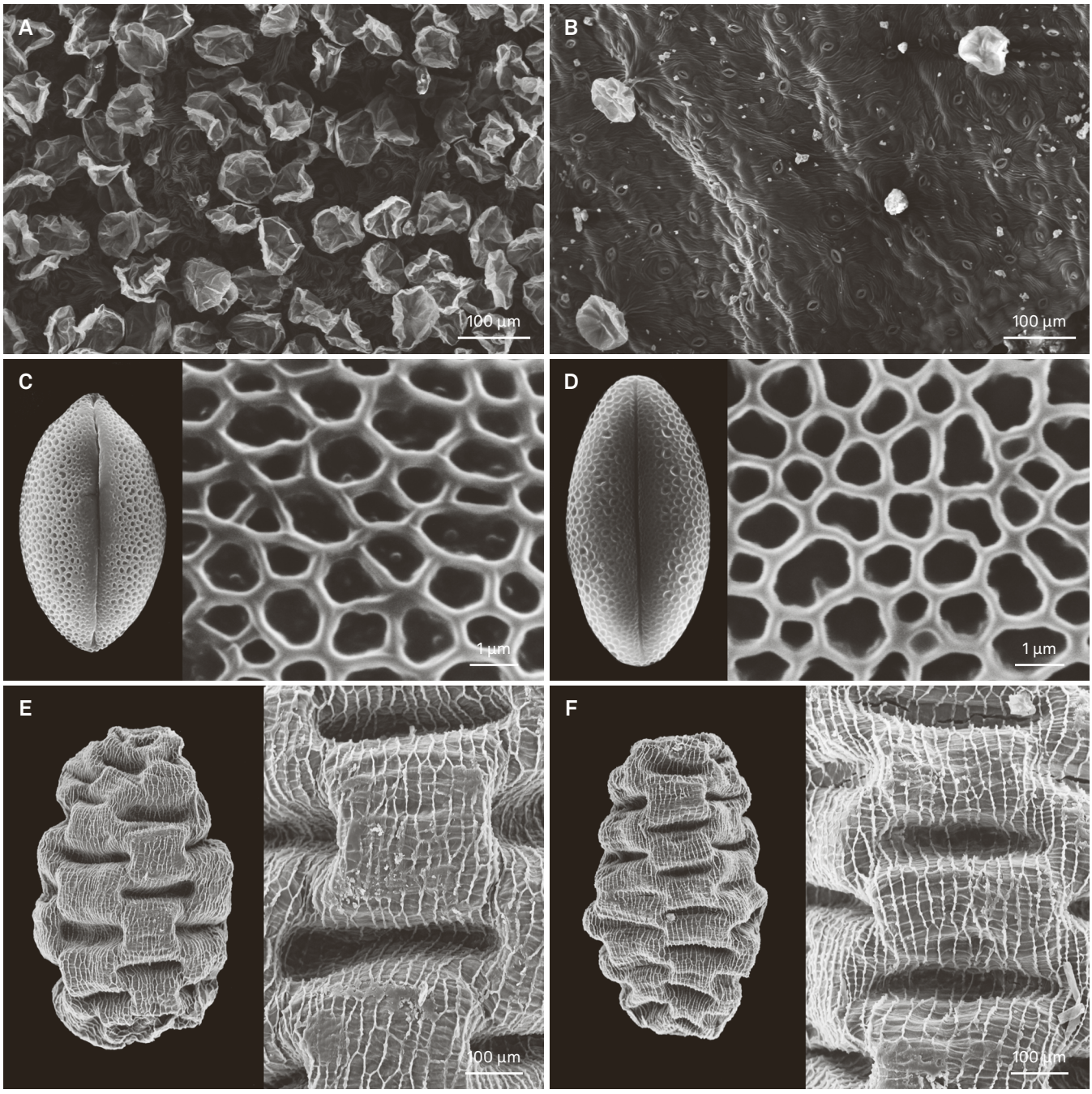


Fig. 2. – SEM micrographs. Leaf indumentum: **A.** *Scrophularia pruinosa* Boiss.; **B.** *Scrophularia sulaimanica* S.A. Ahmad. Pollen grains: **C.** *Scrophularia sanguinea* Grau; **D.** *Scrophularia valida* Grau. Seeds: **E.** *Scrophularia mesopotamica* Boiss.; **F.** *Scrophularia pruinosa* Boiss. [**A:** *Kotschy 138*, BASU; **B:** *Ranjbar 38350*, BASU; **C:** *Ranjbar 36870*, BASU; **D:** *Ranjbar 41305*, BASU; **E:** *Ranjbar 38159*, BASU; **F:** *Zeraatkar s.n.*, SUH]

Distribution, ecology and phenology. – *Scrophularia haematantha* is an Irano-Turanian element. This species has a restricted distribution area in W Iran; it has only been collected in Kermanshah Province, at elevations of 1500–2000 m (Fig. 3).

Flowers and fruits have been observed from April to June.

Notes. – Two Haussknecht's specimens perfectly match the locotype indication provided in the protologue, i.e., *Haussknecht 733* and *734* (G-BOIS). The former comprises a single sheet in fruit whereas the latter is composed of one sheet in fruit and another one in flower. As this latter collection appears to be more complete and informative, it is designated as the lectotype of the name *Scrophularia haematantha*.

The species was synonymised with *Scrophularia pruinosa* (Grau, 1981). However, they differ in plant indumentum, leaf shape and margin and staminode shape and indumentum, which lead us to treat them as distinct species.

Additional specimen examined. – **Iran. Prov. Kermanshah:** before Paveh, Tazehabad, c. 10 km to Paveh, 1757 m, 12.V.2014, *Ranjbar 1757* (BASU).

2. ***Scrophularia kollakii*** S.A. Ahmad in Harvard Pap. Bot. 21: 93. 2016.

Holotypus: Iraq. Prov. Sulaimani: Azmar Mt., on the road to Khamza village, 35°38'57"N 45°27'20"E, 1570 m, 25.IV.2015, *Ahmad et al. 15-1227* (KBFH; iso-: KBFH).

Perennial herbs, erect, 30–60 cm tall. *Stems* numerous, thin, woody, purple, sparsely to loosely farinaceous-pubescent. *Leaves* light green, often purple in margin, rather chartaceous, sparsely to loosely farinaceous-pubescent (especially on abaxial surface); venation pinnate, prominent and purple on abaxial surface. *Lower leaves* opposite to whorled, ovate to elliptic, acute at apex, 20–50 × 15–35 mm, entire, crenate to dentate or double-dentate (with 6–9 teeth per side, up to 2 mm long), or divided (with 4–5 lobes per side, up to 20 mm long, each lobe with 4–6 teeth per side, up to 3 mm long), petiolate; petioles up to 70 mm long. *Upper leaves* opposite or whorled, elliptic to lanceolate, acute at apex, 20–40 × 10–30 mm, entire, dentate or double-dentate (with 4–5 teeth per side, up to 5 mm long), or divided (with 4–6 lobes per side, up to 15 mm long, each lobe with 4–5 teeth per side, up to 2 mm long), petiolate; petioles up to 30 mm long. *Inflorescences* 25–30 cm long, paniculate, bracteate; cymes dichasial, many-flowered; bracts up to 5 mm long, lanceolate, acute at apex, entire, glabrous, green. *Peduncles* 20 mm long; pedicels 5 mm long, glabrous to sparsely glandular-pubescent; bracteoles up to 2 mm long, linear to lanceolate, acute at apex, entire, glabrous, green. *Calyces* 3–3.5 mm long; sepals equal, elliptic to ovate, obtuse at apex, green; margin up to 1.5 mm wide, incised, glabrous, white. *Corollas* 7–8 mm long, rather urceolate; lobes unequal, 5-lobed, obtuse, tube greenish; superior lobes purple, glabrous. *Stamens* 4, fertile, 5.5–6 mm long, exserted; filaments white, sparsely gland-dotted; anthers whitish. *Staminodes* linear to oblong, shorter than lower corolla lobe, densely gland-dotted on margin and on abaxial and adaxial surfaces. *Styles* 5.5–6 mm long, filiform, glabrous. *Ovaries* 1–1.5 × 1–1.5 mm, globose to ovoid. *Capsules* 4.5–5 × 4.5–5 mm, globose, mucronate (mucro up to 2 mm long), glabrous, brown. *Seeds* 1.5–1.7 × 0.8–1 mm, elliptic to ovate, black.

Distribution, ecology and phenology. – *Scrophularia kollakii* is an Irano-Turanian element. It is known from Iraq (Sulaimani Province) and Iran. In this latter country, its distribution area is restricted to the provinces of Azerbaijan-e Gharbi, Kordestan and Kermanshah, at elevations of 1500–2000 m (Fig. 3).

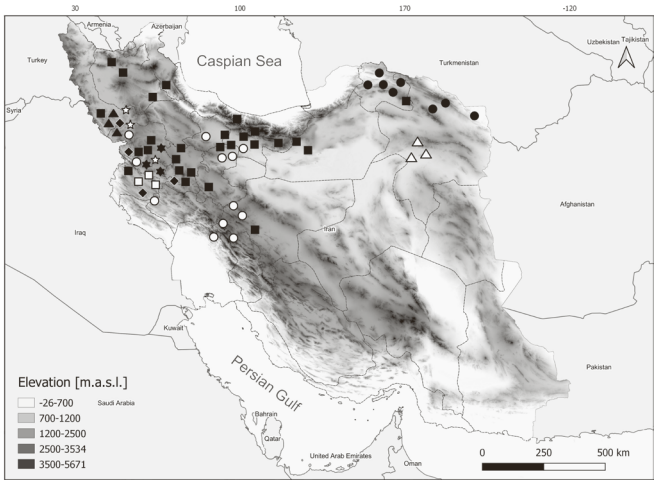


Fig. 3. – Distribution map of the broad-margined calyx species of *Scrophularia* L. in Iran. *Scrophularia haematantha* Boiss. & Heldr. (white squares), *S. kollakii* S.A. Ahmad (black stars), *S. mesopotamica* Boiss. (black triangles), *S. pruinosa* Boiss. (black squares), *S. rosulata* Stiefelh. (black circles), *S. sanguinea* Grau (white circles), *S. sardashtensis* Ranjbar & Rahch. (black diamonds), *S. sulaimanica* S.A. Ahmad (white stars), and *S. valida* Grau (white triangles).

Flowers and fruits have been observed from May to July.

Notes. – Previous to this study, *Scrophularia kollakii* was only known from the Azmar-Goizha Mountain in Iraq (Ahmad, 2016).

Specimens examined. – **Iran. Prov. Azerbaijan-e Gharbi:** 75 km to Mahabad from Sardasht, 14.VI.2015, *Ranjbar 38145* (BASU). **Prov. Kermanshah:** Cheshmeh Zageh village, 1940 m, 29.V.2012, *Ranjbar 29662* (BASU). **Prov. Kordestan:** road village Maziben, open forest oak, 35°13'14"N 46°27'58"E, 1844 m, 5.V.2016, *Ranjbar 59167* (BASU).

3. ***Scrophularia mesopotamica*** Boiss., Diagn. Pl. Orient. ser. 1, 12: 34. 1853.

Holotypus: Turkey. Prov. Şanlıurfa: "in Mesopotamia inter Orfa [Sanliurfa] and Suerek [Sivrek]", 1853, *Kotschy 57* (G [G00751437] image!; iso-: [K001096211] image!).

Perennial herbs, erect, 90–110 cm tall. *Stems* few, thick, woody, brown, purple at base, glabrous to sparsely farinaceous-pubescent. *Leaves* dark green, rather coriaceous, glabrous to sparsely farinaceous-pubescent (especially on abaxial surface); venation pinnate, prominent and brown on abaxial surface. *Lower leaves* opposite to whorled, ovate to elliptic, acute at apex, 60–100 × 20–50 mm, dentate to double-dentate, divided (with 4–5 lobes per side, up to 20 mm long, each lobe with 5–7 teeth per side, up to 3 mm long), petiolate; petioles up to 70 mm long. *Upper leaves* opposite or whorled, elliptic to

lanceolate, acute at apex, 50–80 × 30–50 mm, entire, dentate or double-dentate (with 5–7 teeth per side, up to 3 mm long), or divided (with 2–5 lobes per side, up to 15 mm long, each lobe with 4–7 teeth per side, up to 2 mm long), petiolate; petioles up to 30 mm long. *Inflorescences* 35–50 cm long, paniculate, bracteate; cymes dichasial, few-flowered; bracts up to 7 mm long, lanceolate, acute at apex, entire, glabrous, green. *Peduncles* 15 mm long; pedicels 5 mm long, glabrous to sparsely glandular-pubescent; bracteoles up to 3 mm long, linear to lanceolate, acute at apex, entire, glabrous, green. *Calyces* 3.5–4 mm long; sepals equal, ovate to orbiculate, obtuse at apex, green; margin up to 1.5 mm wide, undulate, incised, glabrous, purple. *Corollas* 8.5–9 mm long, rather urceolate; lobes unequal, 5-lobed, obtuse, tube greenish; superior lobes purple, glabrous. *Stamens* 4, fertile, 7.5–8 mm long, exserted; filaments white, loosely gland-dotted; anthers whitish. *Staminodes* orbiculate, longer than lower corolla lobe, densely gland-dotted on margin and on abaxial and adaxial surfaces. *Styles* 7–7.5 mm long, glabrous. *Ovaries* 1–1.5 × 1–1.5 mm, globose to ovoid. *Capsules* 5–6 × 5–5.4 mm, globose, mucronate (mucro up to 2 mm long), glabrous, brown. *Seeds* 1.4–1.6 × 0.9–1 mm, elliptic to ovate, black.

Distribution, ecology and phenology. – *Scrophularia mesopotamica* is an Irano-Turanian element distributed in Iran and Turkey. In Iran, it has been collected in Azerbaijan-e Gharbi and Kordestan provinces, at elevations of 1500–2000 m (Fig. 3).

Flowers and fruits have been observed in June and July.

Notes. – *Scrophularia mesopotamica* is based on *Kotschy 57* from Turkey, now in G-BOIS. An isotype has been located at K.

Additional specimens examined. – **Iran. Prov. Azerbaijan-e Gharbi:** 25 km from Mahabad to Oshnaviyeh, 14.VI.2015, *Ranjbar 38159* (BASU). **Prov. Kordestan:** 10 km from Zarineh to Saqez, before Zeyniyan village, 1958 m, 14.VI.2015, *Ranjbar 38361* (BASU).

4. ***Scrophularia pruinosa*** Boiss., Diagn. Pl. Orient. ser. 1, 12: 38. 1853.

Lectotypus (designated here): **Iran. Prov. Tehran:** "in schistosis montis Elburs [Alborz] prope Derbent [Darband]", 13.V.1843, *Kotschy 138* (G-BOIS [G00751618] image!; isolecto-: G [G00343821 fragm. on the left, G00343822, G00343823] images!, G-BOIS [G00751595] image!, FI [FI009676] image!, LE [LE00017126, LE00017127] images!, P [P03413196] image!, W [W0017315] image!). Fig. 4.

= *Scrophularia pruinosa* subsp. *iraquensis* Eig in Palest. Journ. Bot. 3: 90. 1944. **Lectotypus** (designated here): **Iraq. Prov. Erbil:** Mt. Marmarut (near Rovanduz), 1200 m, 19.IV.1932, *Guest s.n.* (HUJ [HUJ29750] image!). **Syntypus: Iraq. Prov. Erbil:** Mt. Jabal E-NE of Sari Hasan Beq, on the stony hillside, 2200 m, 24.VII.1932, *Guest s.n.* (HUJ [HUJ29748] image!, K [K001096246] image!).

= *Scrophularia davisii* Lall. in Notes Roy. Bot. Gard. Edinburgh 30: 132. 1970. **Holotypus: Turkey. Prov. Hakkâri:** SE Anatolia, Zap beneath (8 km from) Hakkâri, 1250 m, 21.VI.1966, *Davis 45367* (E [E00327358] image!).

Perennial herbs, erect, 20–70 cm tall. *Stems* few, thin, green to gray, loosely to densely farinaceous-pubescent. *Leaves* green to gray, rather coriaceous, loosely to densely farinaceous-pubescent (especially on abaxial surface); venation pinnate, prominent and green to brown on abaxial surface. *Lower leaves* opposite to whorled, orbiculate to ovate, subacute to obtuse at apex, 20–50 × 10–40 mm, entire, crenate to dentate or double-dentate (with 7–9 teeth per side, up to 2 mm long) or divided (with 2–4 lobes per side, up to 5 mm long, each lobe with 3–5 teeth per side, up to 2 mm long), petiolate; petioles up to 60 mm long. *Upper leaves* opposite to alternate, elliptic to lanceolate, obtuse to acute at apex, 20–40 × 10–20 mm, entire to incised, dentate or double-dentate (with 7–9 teeth per side, up to 3 mm long), sessile to petiolate; petioles up to 20 mm long. *Inflorescences* 15–25 cm long, paniculate, bracteate; cymes dichasial, few-flowered; bracts up to 10 mm long, lanceolate, acute at apex, entire, glabrous, green to gray. *Peduncles* 20 mm long; pedicels 5 mm long, loosely glandular-pubescent; bracteoles up to 2 mm long, linear to lanceolate, acute at apex, entire, glabrous, green to gray. *Calyces* 2–2.5 mm long; sepals equal, ovate to orbiculate, obtuse at apex, green to gray; margin up to 0.5 mm wide, undulate, incised, glabrous, white. *Corollas* 5–6 mm long, rather urceolate; lobes unequal, 5-lobed, obtuse, tube greenish; superior lobes purple, glabrous. *Stamens* 4, fertile, 4.5–5 mm long, exserted; filaments white, loosely gland-dotted; anthers whitish. *Staminodes* linear to oblong, as long as lower corolla lobe, densely gland-dotted on margin and abaxial surface, sparsely so on adaxial surface. *Styles* 3.5–4 mm long, glabrous. *Ovaries* 1–1.5 × 1–1.5 mm, globose. *Capsules* 4–4.5 mm in diam., globose, mucronate (mucro up to 2 mm long), glabrous, brown. *Seeds* 1.3–1.8 × 0.5–0.9 mm, elliptic to ovate, black.

Distribution, ecology and phenology. – *Scrophularia pruinosa* is an Irano-Turanian and Euxino-Hyrcanian element distributed in Caucasus, Iran, Iraq and Turkey. In Iran, this species is known from N, C, W and NW regions; it has been collected in Azerbaijan-e Gharbi, Azerbaijan-e Sharghi, Esfahan, Hamedan, Kermanshah, Kordestan, Markazi, Mazandaran and Tehran provinces, at elevations of 1000–2500 m (Fig. 3).

Flowers and fruits have been observed from April to June.

Notes. – Two specimens corresponding to the type collection of *Scrophularia pruinosa* are deposited in G-BOIS; the best preserved and most complete one is designated here as the lectotype [G00751618]. It should be noted that the isolectotype G00343821 includes mixed material; indeed, only the fragment on the left corresponds to *S. pruinosa* (Gautier, pers. comm.). The plant on the right hand is identified as *S. polybotrys* Boiss.

The name *Scrophularia libanotica* var. *crispato-marginata* Bornm. was treated as a synonym of *S. pruinosa* by Grau (1981), however, we could not study the original material for confirming such decision.

Additional specimens examined. – Iran. **Prov. Azerbaijan-e Sharghi:** Zanjan to Khalkhal, bifurcate Ghareh Bolagh [Bahmanabad], 1842 m, *Ranjbar 34338* (BASU). **Prov. Hamedan:** Hamedan, Alvand mountain, 4.V.1998, *Purhabibiyan & Geraili 774* (BASU); Kand Tappeh, 1600 m, 13.V.2011, *Ranjbar 26669* (BASU); Kand Tappeh, 2072 m, 7.VI.2011, *Ranjbar & Hajmoradi 26283* (BASU); Kabudar Ahang, 5 km before Kand Tappeh, 2100 m, 18.V.2006, *Ranjbar 12093* (BASU); Kivarestan, 5.V.2006, *Minayi Zaem 12098* (BASU); Asadabad, Hoseynabad village, 3.III.2007, *Rostami 12909* (BASU); Bahar, Fasijan, s.d., *Ranjbar 37377* (BASU); Famenin, Khaje Hesar village, s.d., *Rafiei s.n.* (BASU). **Prov. Kermanshah:** 20 km to Songhor, Songhor from Asad Abad, 1904 m, 29.VI.2012, *Ranjbar 29602* (BASU); Kermanshah, 20 km from Bayangan to Paveh, 1735 m, 28.V.2013, *Ranjbar 34938* (BASU). **Prov. Markazi:** Komijan to Vafs, 7 km before of Vafs, 2302 m, 23.VI.2011, *Ranjbar 27504* (BASU). **Prov. Tehran:** Darabad mountain, 31.V.1995, *Ghanrali 24568* (T); Kuh Dashteh, 35°48'24"N 51°06'33"E, 2200 m, 22.VI.2017, *Zeraatkar s.n.* (Shiraz University Herbarium); Lavasanat, 16.IV.1987, *Mirzayi 26409* (T).

Iraq. **Prov. Erbil:** Jabal E.N.E of Seri Hassan Beg, 1981 m, 24.VII.1932, *Guest s.n.* (K).

Turkey. **Prov. Hakkâri:** Hakkari, Zap gorge beneath Cukurca, 1700–1750 m, 12.VI.1966, *Davis 44846* (E); Hakkari, Morinos Dere, opposite Marunis, 1550 m, 21.VI.1966, *Davis 45324* (E); Hakkari, Cilo Dag, in Diz Deresi, 1644 m, 6.VIII.1954, *Davis & Polunin 23903* (E).

5. ***Scrophularia rosulata*** Stiefelh. in Bot. Jahrb. Syst. 44: 475. 1910.

Lectotypus (designated here): Turkmenistan. **Prov. Ahal:** "Regio transcaspica, Ashghabad, Suluklü", 10.VII.1900, *Sintenis 805* (B [B 10 0278398] image!; isolecto-: E [E00346232] image!, LD [LD1215085, LD123046, LD1215145] images!, P [P03413199] image!, PH [PH00022908] image!, STR!, W [W19037370] image!).

= *Scrophularia dissecta* Gorschk. in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 14: 445. 1951. **Holotypus: Turkmenistan. Prov. Ahal:** Mons Nuchur, 26.VI.1914, *Samokisch s.n.* (LE [LE01027415] image!; iso-: LE [LE01027413] image!).

Perennial herbs, erect, 35–70 cm tall. *Stems* numerous, thin, dark green to gray, loosely to densely farinaceous-pubescent. *Leaves* dark green to gray, rather coriaceous, loosely to densely farinaceous-pubescent (especially on abaxial surface); venation pinnate, prominent and brown to purple on abaxial surface. *Lower leaves* opposite to whorled, ovate to elliptic, subacute to obtuse at apex, 30–60 × 15–35 mm, crenate to dentate or double-dentate, divided (with 3–5 lobes per side, up to 20 mm long, each lobe with 3–6 teeth per side, up to 3 mm long), petiolate; petioles up to 50 mm long. *Upper leaves* opposite to alternate, ovate to elliptic or lanceolate, obtuse to acute at apex, 40–90 × 20–40 mm, incised to divided, dentate or double-dentate (with 2–5 lobes per side, up to 15 mm long, each lobe with 3–5 teeth per side, up to 2 mm long), sessile to petiolate; petioles up to 30 mm long. *Inflorescences* 20–45 cm long, paniculate, bracteate; cymes dichasial, many-flowered; bracts up to 10 mm long, lanceolate, acute at apex, entire to dentate, glabrous to sparsely farinaceous-pubescent, dark green to gray. *Peduncles* 20 mm long; pedicels 2 mm long, loosely glandular-pubescent; bracteoles up to 2 mm long, linear to lanceolate, acute at apex, entire, glabrous to sparsely farinaceous-pubescent, dark green to gray. *Calyces* 1.5–2 mm long; sepals equal, ovate to elliptic, obtuse at the apex, dark green to gray; margin up to 0.2 mm wide, undulate, incised, glabrous, white. *Corollas* 4.5–5 mm long, rather urceolate; lobes unequal, 5-lobed, obtuse, tube greenish; superior lobes purple, glabrous. *Stamens* 4, fertile, 4–4.5 mm long, exserted; filaments white, loosely gland-dotted; anthers whitish. *Staminodes* linear, shorter than lower corolla lobe, loosely gland-dotted on adaxial surface. *Styles* 4–4.5 mm long, glabrous. *Ovaries* 1–1.5 × 1–1.5 mm, globose. *Capsules* 4–4.5 × 4–4.5 mm, globose, mucronate (mucro up to 1 mm long), glabrous, brown. *Seeds* 1.5–1.8 × 0.7–1 mm, elliptic to ovate, black.

Distribution, ecology and phenology. – *Scrophularia rosulata* is an Irano-Turanian element known from Afghanistan, Iran and Turkmenistan. In Iran, this species is ditributed in E and NE regions; it has been collected in Khorasan-e Shomali and Khrasan-e Razavi provinces, at elevations of 1000–2000 m (Fig. 3).

Flowers and fruits have been observed from April to July.

Notes. – Specimens corresponding to the collection *Sintenis 805* are found in B, E, LD, P, PH, STR and W. The specimens from B and W bear a label handwritten by Stiefelhagen. Since the specimen B 10 0278398 is the most complete material, it is designated here as the lectotype of the name *Scrophularia rosulata*.

Scrophularia dissecta Gorschk. is based on a Samokisch collection from Turkmenistan, which is deposited at LE and comprises two specimens. LE01027415 is considered the holotype because it shows a label indicating "typus" most probably put it down by the species author.

Additional specimens examined. – Iran. **Prov. Khorasan-e Razavi:** Ghuchan, N Bajgiran, Baba Haseleh, 1600 m, 15.VII.1992, *Faghihnia & Zangooei 22244* (FMUH). **Prov. Khorasan-e Shomali:** NW Bojnurd, Emam Dareh, 1000 m, 17.IV.2001, *Joharchi & Zangooei 33278* (FMUH).



Fig. 4. – Lectotype of *Scrophularia pruinosa* Boiss.
[*Kotschy 138*, G-BOIS: G00751618]

6. ***Scrophularia sanguinea*** Grau in Rech. f., Fl. Iranica 147: 275. 1981.

Holotypus: Iran. Prov. Kermanshah: "Kermanshah ad Bisotun", 5.V.1903, *Strauss s.n.* (B [B 10 0278393] image!; iso-: B [B 10 0715950] image!; JE [JE00013682] image!).

Perennial herbs, erect, 20–70 cm tall. *Stems* few, thin, glabrous to sparsely glandular-pubescent, dark green to brown, glabrous to sparsely farinaceous-pubescent. *Leaves* rather chartaceous, glabrous to sparsely glandular and very sparsely farinaceous-pubescent (especially on abaxial surface), dark green; venation pinnate, prominent and brown on abaxial surface. *Lower leaves* opposite to whorled, orbiculate to late ovate, 15–20 × 10–20 mm, subacute to obtuse at apex, entire, crenate to dentate or double-dentate (with 5–7 teeth per side, up to 2 mm long) or divided (with 3–5 lobes per side, up to 4 mm long, each lobe with 3–5 teeth per side, up to 1 mm long), petiolate; petioles up to 40 mm long. *Upper leaves* opposite to alternate, elliptic to lanceolate, 10–30 × 10–15 mm, acute at apex, entire, dentate to double-dentate (with 5–8 teeth per side, up to 2 mm long) or divided (with 5–7 lobes per side, up to 5 mm long, each lobe with 3–5 teeth per side, up to 1 mm long), sessile to petiolate; petioles up to 10 mm long. *Inflorescences* 10–15 cm long, paniculate, bracteate; cymes dichasial, few-flowered; bracts up to 20 mm long, lanceolate, acute at apex, entire, glabrous, green. *Peduncles* 20 mm long; pedicels 5 mm long, glabrous to sparsely glandular-pubescent; bracteoles up to 3 mm long, linear to lanceolate, acute at apex, entire, glabrous, green. *Calyces* 2.5–3 mm long; sepals equal, ovate to orbiculate, obtuse at apex, green; margin up to 1 mm wide, undulate, incised, glabrous, white. *Corollas* 6.5–7.5 mm long, rather urceolate; lobes unequal, 5-lobed, obtuse, tube greenish; superior lobes purple, glabrous. *Stamens* 4, fertile, 5.5–6 mm long, exserted; filaments white, sparsely gland-dotted; anthers whitish. *Staminodes* orbiculate, as long as lower corolla lobe, sparsely gland-dotted on margin and abaxial surface. *Styles* 5–5.5 mm long, filiform, glabrous. *Ovaries* 1–1.5 × 1–1.5 mm, globose. *Capsules* 4–4.5 × 4–4.5 mm, globose, mucronate (mucro up to 0.5 mm long), glabrous, brown. *Seeds* 1.3–1.5 × 0.5–0.9 mm, elliptic to ovate, black.

Distribution, ecology and phenology. – *Scrophularia sanguinea* is an Irano-Turanian and Euxino-Hyrcanian element distributed in W and C Iran; it has been collected in Hamedan, Kermanshah, Kordestan, Esfahan, Lorestan and Tehran provinces, at elevations of 1500–2500 m (Fig. 3).

Flowers and fruits have been observed in April and June.

Notes. – Two Strauss specimens are deposited in B. One of them [B 10 0278393] bears a label indicating "typus", which is here considered as the holotype.

Additional specimens examined. – **Iran. Prov. Esfahan:** Khansar, Baghkal, V.2000, *Alayi 6686* (T). **Prov. Kermanshah:** before Paveh, Tazeabad, ca. 10 km to Paveh, 1757 m, 12.V.2014, *Ranjbar 36870* (BASU); Shahul Gheshlagh, 1304 m, 27.V.2013, *Ranjbar 33509* (BASU). **Prov. Markazi:** Tafresh to Nobaran, 20 km to Jaghatan, Bazarjan protected area, 1600 m, 22.IV.2010, *Ranjbar 21547* (BASU).

7. ***Scrophularia sardashtensis*** Ranjbar & Rahch., **sp. nov.** (Fig. 5).

Holotypus: Iran. Prov. Azerbaijan-e Gharbi: Mahabad toward Sardasht, 1580 m, 18.V.2011, *Ranjbar 25519* (BASU).

Scrophularia sardashtensis Ranjbar & Rahch. differs from S. pruinosa Boiss. in plant and staminode indumentum, lower leaf shape, calyx margin width, corolla and staminode length.

Perennial herbs, erect, 50–80 cm tall. *Stems* few, thick, woody, sparsely to loosely farinaceous-pubescent, green to yellow, sometimes purple at the base. *Leaves* rather chartaceous, sparsely to loosely farinaceous-pubescent (especially on abaxial surface), green to gray; venation pinnate, prominent and green to brown on abaxial surface. *Lower leaves* opposite to whorled, late ovate to elliptic, 30–90 × 20–60 mm, acute at apex, entire, dentate to double-dentate (with 5–8 teeth per side, up to 10 mm long) or divided (with 4–5 lobes per side, up to 35 mm long, each lobe with 6–8 teeth per side, up to 2 mm long), petiolate; petioles up to 60 mm long. *Upper leaves* opposite or whorled to alternate, elliptic to lanceolate, 30–70 × 15–30 mm, acute at apex, entire, dentate to double-dentate (with 5–6 teeth per side, up to 4 mm long) or divided (with 3–4 lobes per side, up to 25 mm long, each lobe with 5–7 teeth per side, up to 3 mm long), petiolate; petioles up to 20 mm long. *Inflorescences* 20–50 cm long, paniculate, bracteate; cymes dichasial, few-flowered; bracts up to 10 mm long, lanceolate, acute at apex, entire, glabrous, green. *Peduncles* 25 mm long; pedicels 5 mm long, sparsely glandular-pubescent; bracteoles up to 5 mm long, linear to lanceolate, acute at apex, entire, glabrous, green. *Calyces* 2.5–3 mm long; sepals equal, ovate to orbiculate, obtuse at apex, green; margin up to 1.5 mm wide, undulate, entire, glabrous, white. *Corollas* 6.5–7 mm long, rather urceolate; lobes unequal, 5-lobed, obtuse, tube greenish; superior lobes purple, glabrous. *Stamens* 4, fertile, 5.5–6 mm long, exserted; filaments white, loosely gland-dotted; anthers whitish. *Staminodes* linear to oblong, longer than lower corolla lobe, loosely gland-dotted on margin and abaxial surface. *Styles* 4.5–5 mm long, filiform, glabrous. *Ovaries* 1–1.5 × 1–1.5 mm, globose to ovoid. *Capsules* 5–5.5 × 5–5.5 mm, globose, mucronate (mucro up to 1.5 mm long), glabrous, brown. *Seeds* 1.5–1.7 × 0.9–1 mm, elliptic to ovate, black.

Etymology. – The specific epithet refers to the provenance of the type material, which comes from the proximities of the city of Sardasht (NW Iran).



Fig. 5. – Holotype of *Scrophularia sardashtensis* Ranjbar & Rahch. **A.** Habit; **B.** Upper cauline leaf (abaxial surface); **C.** Upper cauline leaf (adaxial surface).
[*Ranjbar 25519*, BASU]

Distribution, ecology and phenology. – *Scrophularia sardashtensis* is an Irano-Turanian element distributed in W and NW Iran; it has been collected in Azerbaijan-e Sharghi, Azerbaijan-e Gharbi, Hamedan and Kordestan provinces, at elevations of 1500–2500 m (Fig. 3).

Flowers and fruits have been observed from May to July.

Notes. – *Scrophularia sardashtensis* is similar to *S. pruinosa*, but it differs in plant indumentum (sparsely to loosely farinaceous vs. loosely to densely farinaceous in *S. pruinosa*), lower leaf shape (broadly ovate to elliptic vs. orbiculate to broadly ovate in *S. pruinosa*), calyx margin width (up to 1.5 mm, entire vs. up to 0.5 mm, incised in *S. pruinosa*), corolla length (6.5–7 mm vs. 5–6 mm in *S. pruinosa*), staminode length (longer than lower corolla lobe vs. as long as lower corolla lobe in *S. pruinosa*), staminode indumentum (loosely gland-dotted on the margin and abaxial surface vs. densely gland-dotted on the margin and on both abaxial and adaxial surfaces in *S. pruinosa*).

Additional specimens examined. – **Iran. Prov. Azerbaijan-e Sharghi:** valley road Ahar, 2200–2400 m, 7.VII.1995, *Diantnejad 008185* (T). **Prov. Hamedan:** Hamedan to Avaj, 17 km to Avaj, 2049 m, 22.VI.2011, *Ranjbar 27407* (BASU). **Prov. Kordestan:** after Salavatabad village, after Dolatabad bifurcate, 5 km to Sanandaj, 1485 km, 16.V.2011, *Ranjbar 24829* (BASU); Sanandaj to Marivan, 105 km to Marivan, before Todar village, 2057 m, 20.VI.2012, *Ranjbar 29238* (BASU); Qorveh to Sanandaj, near Dehgolan, before Hasanabad, 1600 m, 1.VI.2006, *Ranjbar 14371* (BASU); Qorveh to Sanandaj, near Dehgolan, before Hasanabad, 1850 m, 22.V.2006, *Ranjbar 12097* (BASU).

8. ***Scrophularia sulaimanica*** S.A. Ahmad in Kew Bull. 69(2)-9509: 1. 2014 (Fig. 6).

Holotypus: Iraq. Prov. Sulaimani: Hawraman Mts., between Darashesh and Hawar, 35°11'13"N 46°04'22"E, 1069 m, 16.VI.2012, *Ahmad 12-320* (SUFA; iso-: K [K001044999] image!, MO, SUFA).

Perennial herbs, erect, 60–100 cm tall. *Stems* numerous, thick, woody, glabrous to very sparsely farinaceous, light green to brown, purple at base. *Leaves* relatively coriaceous, glabrous to very sparsely farinaceous (especially on abaxial surface), light green; venation pinnate, prominent and light green to brown on abaxial surface. *Lower leaves* opposite to whorled, broadly lanceolate to elliptic, 50–70 × 20–35 mm, acute at apex, entire, dentate to double-dentate (with 5–6 teeth per side, up to 5 mm long) or divided (with 3–5 lobes per side, up to 25 mm long, each lobe with 4–6 teeth per side, up to 5 mm long), petiolate; petioles up to 70 mm long. *Upper leaves* opposite to whorled, broadly ovate to lanceolate, 30–60 × 15–40 mm, acute at apex, entire, dentate to double-dentate (with 5–7 teeth per side, up to 5 mm long) or divided (with 3–5 lobes per side, up to 35 mm long, each lobe with 4–5 teeth per side, up to 5 mm long), petiolate; petioles up to 20 mm long. *Inflorescences* 45–60 cm long, paniculate, bracteate; cymes dichasial, many-flowered; bracts up to 3 mm long, lanceolate, acute at apex, entire, glabrous, green. *Peduncles* 15 mm long; pedicels 5 mm long, glabrous to sparsely glandular-pubescent; bracteoles up to 1 mm long, linear to lanceolate, acute at apex, entire, glabrous, green. *Calyces* 3–3.5 mm long; sepals equal, ovate to orbiculate, obtuse at apex, green; margin up to 1 mm wide, undulate, incised, glabrous, white. *Corollas* 7–8 mm long, rather urceolate; lobes unequal, 5-lobed, obtuse, tube greenish; superior lobes purple, glabrous. *Stamens* 4, fertile, 5–5.5 mm long, exserted; filaments white, loosely gland-dotted; anthers whitish. *Staminodes* oblong to orbiculate, shorter than lower corolla lobe, sparsely gland-dotted on margin and abaxial surface. *Styles* 4–4.5 mm long, filiform, glabrous. *Ovaries* 1–1.5 × 1–1.5 mm, globose to ovoid. *Capsules* 5–5.5 × 5–5.5 mm, globose, mucronate (mucro up to 1 mm long), glabrous, brown. *Seeds* 1.4–1.8 × 0.8–1 mm, elliptic to ovate, black.

Distribution, ecology and phenology. – *Scrophularia sulaimanica* is an Irano-Turanian element. It is known from Iraq (Sulaimani Province) and Iran. In this latter country, it is restricted to Azerbaijan-e Gharbi and Kordestan provinces, thriving at elevations of 1500–2000 m (Fig. 3).

Flowers and fruits have been observed from May to July.

Notes. – Previous to this study, *Scrophularia sulaimanica* was only known from the Hawraman mountains in Iraq (Ahmad, 2014).

Additional specimens examined. – **Iran. Prov. Azerbaijan-e Gharbi:** 35 km Sardasht to Mahabad, 36°22'N 45°35'E, 1210 m, 14.VI.2015, *Ranjbar 38350* (BASU). **Prov. Kordestan:** Qorveh to Dehgolan, before Tahmaseb Gholi, 1785 m, 13.VI.2015, *Ranjbar 38453* (BASU).

9. ***Scrophularia valida*** Grau in Reich. f., Fl. Iranica 147: 275. 1981.

Holotypus: Iran. Prov. Khorasan-e Razavi: "in saxosis montium 23 km N Kashmar versus Rivash", 4.V.1975, *Rechinger 51216* (W-1994-05145 image!; iso-: B [B 10 0278388] image!, E [E00327273] image!, GZU [GZU000279100] image!, K [K001096319] image!, M [M0175591, M0175592] images!, MA [MA496749] image!, S-10-28634 image!).

Perennial herbs, erect, 60–80 cm tall. *Stems* few, thick, woody, glabrous to sparsely farinaceous-pubescent, brown to purple at base. *Leaves* rather coriaceous, glabrous to sparsely farinaceous-pubescent (especially on abaxial surface), dark green; venation pinnate, prominent and purple on abaxial surface. *Lower leaves* opposite to whorled, ovate to elliptic, 50–100 × 30–60 mm, acute to subacute at apex, entire, crenate to dentate or double-dentate (with 5–7 teeth per side, up to 3 mm long) or divided (with 4–6 lobes per side, up to 35 mm



Fig. 6. – *Scrophularia sulaimanica* S.A. Ahmad. **A.** Habit; **B.** Inflorescence; **C.** Flower; **D.** Lower cauline leaf (adaxial surface). [*Ranjbar 38350*] [Photos: M. Ranjbar]

long, each lobe with 4–6 teeth per side, up to 2 mm long), petiolate; petioles up to 50 mm long. *Upper leaves* opposite or whorled to alternate, elliptic to lanceolate, 50–90 × 20–50 mm, acute at apex, entire, dentate to double-dentate (with 5–7 teeth per side, up to 6 mm long) or divided (with 3–6 lobes per side, up to 25 mm long, each lobe with 4–6 teeth per side, up to 2 mm long), petiolate; petioles up to 40 mm long. *Inflorescences* 20–40 cm long, paniculate, bracteate; cymes dichasial, many-flowered; bracts up to 10 mm long, lanceolate, acute at apex, entire, glabrous, green. *Peduncles* 10 mm long; pedicels 1 mm long, sparsely glandular-pubescent; bracteoles up to 5 mm long, linear to lanceolate, acute at apex, entire, glabrous, green. *Calyces* 3–3.5 mm long; sepals equal, ovate, obtuse at the apex, green; margin up to 1 mm wide, undulate, incised, glabrous, white. *Corollas* 8–8.5 mm long, rather urceolate; lobes unequal, 5-lobed, obtuse, tube greenish; superior lobes purple, glabrous. *Stamens* 4, fertile, 5–5.5 mm long, exserted; filaments white, loosely gland-dotted; anthers yellowish. *Staminodes* reniform, longer than lower corolla lobe, loosely gland-dotted on abaxial surface. *Styles* 5–6 mm long, filiform, glabrous. *Ovaries* 1–1.5 × 1–1.5 mm, globose to ovoid. *Capsules* and *seeds* not seen.

Distribution, ecology and phenology. – *Scrophularia valida* is an Irano-Turanian element known from E Iran that has been collected only in Khorasan-e Razavi Province, at elevations around 1700 m (Fig. 3).

Flowers and fruits have been observed from May to July.

Notes. – The large flowers, leaves and inflorescences characterising *Scrophularia valida* provide the best diagnostic features for separating it from *S. pruinosa*.

Additional specimen examined. – Iran. **Prov. Khorasan-e Razavi:** Bardeskan to Sabzevat, 95 km to Sabzevar, 24.IV.2018, *Ranjbar 41305* (BASU).

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