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ARTICLE

Chenopodium khorasanica (Amaranthaceae), a new species from Iran

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ABSTRACT *Chenopodium khorasanica* (Amaranthaceae) is described as new species from north-east of Khorasan province (Iran). The new species is compared with its closest relative *Chenopodium sosnowskyi* Kappeler and *Chenopodium vulvaria* L.. This species is similar to *Ch. sosnowskyi* in having hair shape of leaf, habit and petiole size. *Ch. khorasanica* differs from *Ch. sosnowskyi* in having stem height, hair length of leaf, hairs density surface of leaf, inflorescence height, number of flowers in gap, ornamentation of surface cell of seed. This species similar to *Ch. vulvaria* in having hair shape of leaves, petiole length and without stomata of perianth surface leaf margin and number of flowers in gap. This species differs from *Ch. vulvaria* in having stem height, habit, blade shape of leaf, hairs length of leaf, hair density surface of leaf, smelling of decaying fish and leaf dorsal color. Information about the species, morphology, micromorphology, habitats and distribution is provided.
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KEY WORDS

Chenopodium khorasanica
distribution
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micromorphology
morphology
new species

Ìntroduction

Chenopodium of the Chenopodiaceae (Amaranthaceae s.l. in APG III 2009), a genus of approximately 150 species worldwide. *Chenopodium* L. is represented by 15 species in Iran (Assadi 2001). In Flora of the USSR (Iljin 1936) this genus includes 30 species and 4 subspecies, 14 of them occur in Iran. In Flora of Turkey (Aellen 1967) it contains 11 species of which 9 species occur in Iran. In Flora Iranica (Uotila 1997) and in a few local taxonomical studies (Malekloo et al. 2010; Rahiminejad and Ghaemmaghami 2005) 16 species are recorded from Iran. In 2008–2014, during field work by authors on herbarium specimens (TARI and FUMH), a new taxon was observed.

Materials and Methods

This study was mainly based on plant materials deposited in different Iranian herbaria FUMH and TARI (abbreviations according to Holmgren et al. 1998). Several field trips have also been conducted in different parts of Iran and the specimens collected were similarly deposited in the same herbaria. The list of voucher and the pollen specimens deposited in TARI and FUMH herbaria is summarized in Table 1.

Measurements of vegetative and floral parts as well as from the seeds were carried out under a stereomicroscope (Olympus SZH model BRG).

Pollen grains and seeds of three taxa of the genus *Chenopodium* were also studied by scanning electron microscopy (SEM). The study on taxa is mainly based on plant materials deposited in FUMH herbarium (acronyms according to Thiers 2008).

For SEM, the protocol described by Davies (1999) was used with some modifications. The specimens were mounted on 12.5 mm diameter stubs and attached with sticky tabs. They were coated in a sputter coater model KYKY SBC with approximately 25 μm of gold-palladium. The specimens were examined and photographed by a Leica/Leo Stereoscan S440I SEM (Leica) at an accelerating voltage of 10-15 kV. The terminology used for describing the pollen grains features was in general as published by Moore et al. (1991), McAndrews and Swanson (1967), Tsukada (1967) and Punt et al. (1999, 2007).

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Table 1. The voucher and pollen specimens deposited in TARI and FUMH herbaria.

Species	Specimens
Ch. khorasanica	Representative material. Iran: Khorasan, Bojnurd, west of Bojnurd, between Darkesh and Dare Halgheh, margin of river, 1300 m, Jouharchi and Zangooei (FUMH 36913).
Ch. sosnowskyi	Iran: Tehran Province, East-north of Tehran, toward Amoul, 60 km, Polur, Rineh village, 2400 m, Foroughi (IRAN 2539); Azerbaijan province, Kalibar, 69 km toward Khodaafarin, near Khodaafarin, 250 m, Assadi and Akhani (TARI 61573); Semnan province, Semnan, Shahmirzad, Tash Mountains, 2120-2350 m, Termeh et al. (IRAN 39374); Shahmirzad, toward Chashm, 2800 m, Iranshahr and Zargani (IRAN 15279).
Ch. vulvaria	Iran: Tehran Province, Damavand, Homand, Absard, 1950 m, Akhani (TARI 65330); Khorasan province, Torbate-Heidarieh, North of Torbat-Heidarieh, Robate Sefid, 1700-2000 m, Ronemark and Sardabi (TARI 23586); Azerbaijan province, Meshkinshahr, Fakhrabad, 1250 m, Foroughi (TARI 6442). Mazandaran province, Chalous road, toward Karaj, Siahbisheh, 2100 m, Sabeti (TARI 1846). Semnan Province, Semnan, Shahmirzad toward Foladmohaleh village, 1550 m, Hamdi (IAUGH 1250).

Results and Discussion

Chenopodium khorasanica Hamdi S. M. M. & Malekloo M. sp. nov. (Fig. 1).

Typus: Iran. Khorasan; Bojnurd, western south of Bojnurd, Rein, Zoy Rein toward Garmak, 1550-1620 m, Memariani, Zangooei and Arjmandi (holotype: FUMH 38278) (Fig. 2).

Annual, 15-20 cm, usually erect, with sessile glands hairs on the stem and longer hairs on the leaf, stems green striped, often branched especially in upper parts. Leaves of basal; lamina 11-22 × 4-11 mm long, longer petiole, (3-)5-8 mm long, usually dispolar rhombic-ovate, sometimes narrowly elliptic, margin of entire, usually obtuse-subacute at apex, mostly green-dark, glaucous-green, sometimes whitish especially in margins. Bracts linear, entire, mostly with sessile glands hair on the surface, 1.2-1.5 mm long. Inflorescence mostly leafy, 10-20 mm long, axillary and terminal; composed of small, dens glomerules arranged spicately. Flower, number

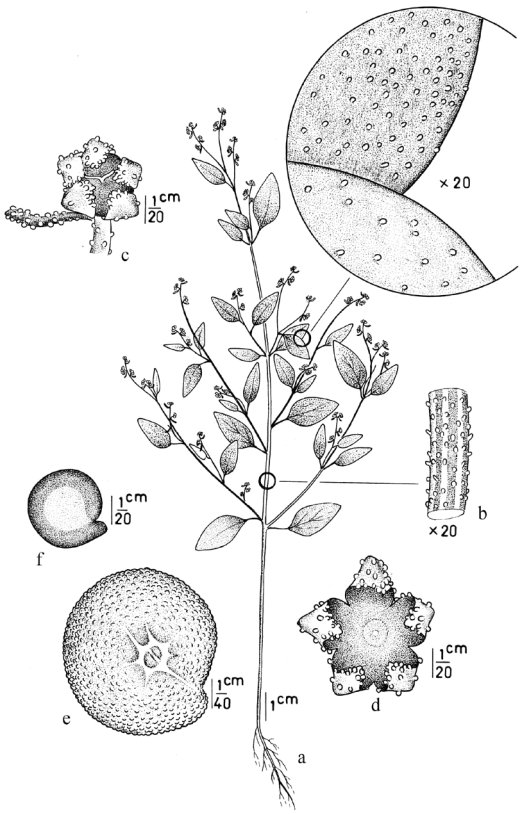

Figure 1. *Chenopodium khorasanica* habit (a), part of stem (b), flower (c and d), fruit (e), and seed (f). Drawn from the FUMH 36913 (Bojnourd, toward the west, between Darkesh and Haver, Halgheh Valley, margin of river, 7/16/2005, 1500 m, Joharchi and Zangooei).

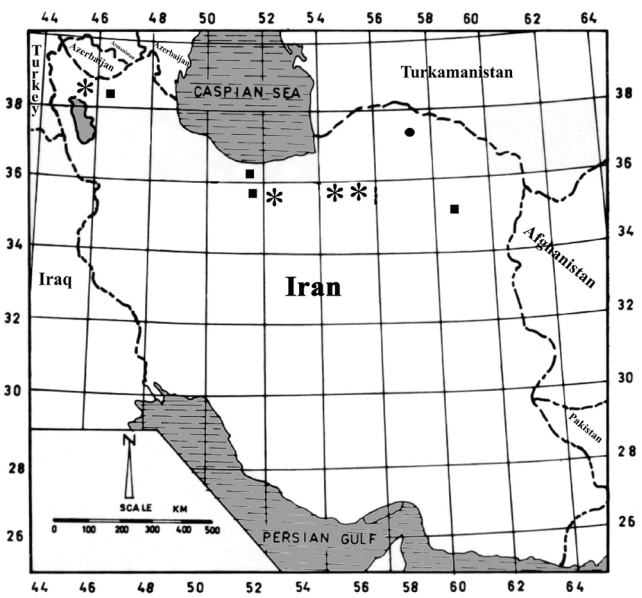

Figure 2. Distribution map of *Ch. vulvaria, Ch. khorasanica* and *Ch. sosnowskyi* in Iran. ■*Chenopodium vulvaria* ●*Chenopodium khorasanica* **Chenopodium sosnowskyi*

Table 2. Comparison of the new species with *Ch. sosnowskyi* and *Ch. vulvaria*.

Characters	*Ch. khorasanica*	*Ch. sosnowskyi*	*Ch. vulvaria*
Stem (cm)	15-20	30	30
Habit	erect	erect	recumbent
Blades of lower leaves (mm)	11-22×4-11	17-22×8-12	6-14×5-8
Blades shape of leaves	dipolar rhombic/ovate	triangle, dispolar rhombic	rhombic, triangle
Hairs shape of leaf	bubble	bubble	bubble
Hairs length of leaf (µm)	90-100	8-15	55-60
Hairs per 100 µm² of leaf	12-15	4-5	5-6
Smelling of decaying fish	-	-	+
Leaf dorsal color	mostly green-dark	green	grey
Leaf margin	smooth	smooth	smooth
Petiole (mm)	5-8	6-10	3-7
Inflorescence (mm)	10-20	5-10	4-15
Number of flowers in gap	3-5	7-8	3-5
Perianth segment length(mm)	0.8-1.3	1-1.2	1-1.3
Perianth segment stomata	-	+	-
Stigma length (mm)	0.3	0.2	0.8
Size of seed (mm)	1.6	1.2	0.8-1
Size of surface cells of seed (µm)	25-35×18-24	36-38×16-18	17-20×6-8
Size of surface cells of perianth segment (µm)	35-55×16-24	24-25×18-19	10.5-11×8.2-8.8
Ornamentation of surface cells of seed	smooth/granular-concave	smooth/concave	granular/rough
Shape of seed	spherical	elliptic	subspherical
Shape of surface cells of seed	irregular pentagonal and hexagonal	irregular tetragonal and pentagonal	irregular polygonal
Seed hillum	circle/central	circle/lateral	circle/central
Number of conical tubercles per 5 µm² on exine surface	65-75	70-75	25-30
Pores diameter of pollen surface (µm)	0.9-1.1	1.15-1.20	1.5-1.7
Pollen diameter (µm)	18.5	17.5	17.85
Pores numbers on pollen surface	50	70	40

of flowers in gap 3-5, terminal flower bisexual, with 4-5 perianth segments and 1-3 stamens: lateral flowers mostly female. Perianth segments free to base, 0.8-1.3 mm length, without stomata, with sessile glands, obovate. Apex ± truncate, dark green, swollen in apical part. Stigma 2, short. Fruit pericarp thin, greenish. Seeds vertical in the lateral flowers, horizontal in the terminal ones, black, 1.4-1.6 mm long.

Distribution and habitat

Taxon lives in above 1520 m. There is proof its presence in the region of west south of Bojnurd (Fig. 2). Its presence seems to be limited to the subalpine bioclimatic belt of the Khorasan (Iran-Touranian province, Eurosiberian region). From a phytosociological point of view, it is part of the communities of grassland.

Key including the most reliable identification characters for distinguishing Ch. khorasanica, Ch. sosnowskyi and Ch. vulvaria

1. stem erect, without of smelling of decaying fish…… **2**

1. stem recumbent, with of smelling of decaying fish…… *Ch. vulvaria*

2. stem length 15-20 cm, petiole 5-8 mm long, leaf dorsal color is mostly green dark ……*Ch. khorasanica*

2. stem length 30 cm, petiole 6-10 mm long, leaf dorsal color is green ..... *Ch. sosnowskyi*

Morphological differentiation of the three taxa of Chenopodium

The new species is compared with its closest relatives *Ch. sosnowskyi* Kappeler (1927) and *Ch. vulvaria* L. (1753). Morphological differences amongst these three taxa are indicated in Table 2. They can be distinguished from each other by a numbers of morphological and micromorphological characters. *Ch. khorasanica* is similar to *Ch. sosnowskyi* in habit, hair shape of leaves and leaf margin. But, differs in having longer hair of leaf is 90-100 (vs. 8-15 µm long), numbers of hair per 100 µm² of leaf is 12-15 (vs. 4-5), higher

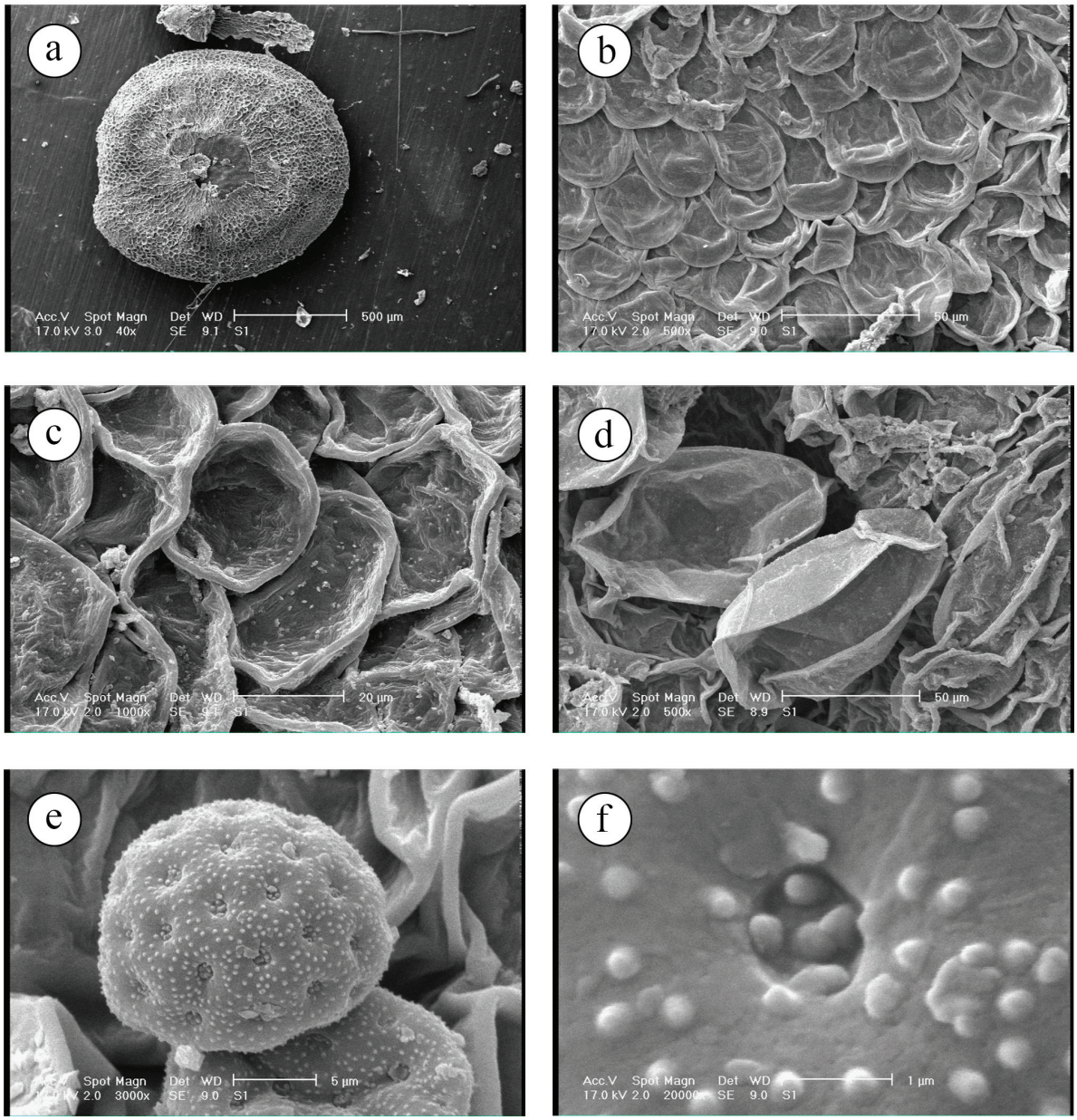

Figure 3. Scanning electron micrographs of seed, pollen and perianth of *Ch. khorasanica* FUMH 36913 (Bojnourd, toward the west, between Darkesh and Haver, Halgheh valley, margin of river, 7/16/2005, 1500 m, Joharchi and Zangooei). View of seed (a), ornamentation of seed (b and c), ornamentation of prianth (d), pollen isopolar view (e), and surface ornamentation of exine (f). Scale bar = 500 µm (a), 50 µm (b), 20 µm (c), 50 µm (d), 5 µm (e), 1 µm (f).

inflorescence (vs. 5-10 mm), numbers of flower in gap are 3-5 (vs. 7-8), without of stomata perianth surface (vs. with stomata). *Ch. khorasanica* is similar to *Ch. vulvaria* in having hair shape of leaves, leaf margin, petiole length and without stomata of perianth surface. But differs from *Ch. vulvaria* in having habit is erect (vs. recumbent), blade shape of leaves is rhombic-ovate (vs. rhombic-triangle), hair length of leaf is 90-100 µm (vs. 55-60 µm), numbers of hair per 100 µm² of leaf is 12-15 (vs. 5-6), without smelling of decaying fish (vs. with smelling of decaying fish). Seed coat and pollen micromorphology (Hamdi et al. 2009; Malekloo et al. 2008, 2010; Pinar and Inceoğlu 1999) provide further traits for the differentiation: cells shape of seed and seed size in the *Ch. khorasanica* is irregular pentagonal and hexagonal, shape is spherical, ornamentation from of cell is concave-smooth to granular, pollen diameter is 18-18.5 µm, numbers of conical

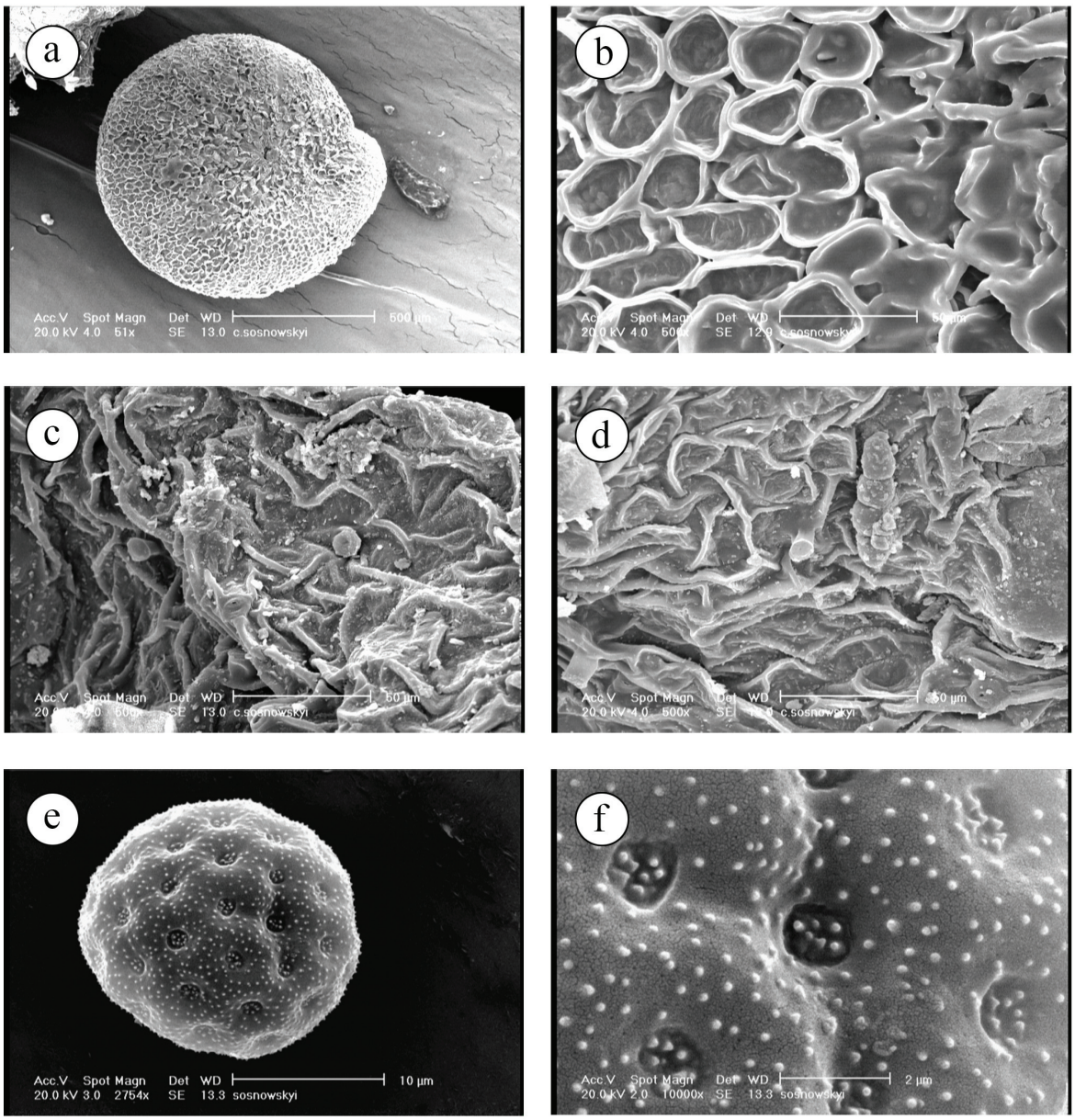

Figure 4. Scanning electron micrographs of seed, pollen and prianth of *Ch. sosnowsky* TARI 61573 (Azabaijan, Kalibar, 69 km to Khodafarin, 250 m, Assadi and Akhani). View of seed (a), ornamentation of seed (b and c), ornamentation of prianth (d), pollen isopolar view (e), and surface ornamentation of exine (f). Scale bar = 500 µm (a), 50 µm (b), 50 µm (c), 50 µm (d), 10 µm (e), 2 µm (f).

tubercles per 5 µm^2 on exine surface is 65-75, pore diameter of pollen surface 0.9-1.1 µm and pore numbers on pollen surface is 50, while cells shape of seed and seed size in the *Ch. sosnowskyi* is irregular tetragonal and pentagonal, seed shape is elliptic, ornamentation from of cell is concave-smooth, pollen diameter is 17.5 µm, numbers of conical tubercles 5 µm^2 on exine surface is 70-75, pore diameter of pollen surface 1.15-1.20 µm and pores numbers on pollen surface is 70 and also while cells shape of seed and seed size in the *Ch. vulvaria* is irregular polygonal, seed shape is subspherical, ornamentation from of cell is granular-tough, pollen diameter is 17.85 µm, numbers of conical tubercles per 5 µm^2 on exine surface is 25-30, pore diameter of pollen surface 1.5-1.7 µm and pores numbers on pollen surface is 40. While the new taxon, the length and width of testa cells of perianth segments are longer than the *Ch. sosnowskyi* and *Ch. vulvaria* (Figs. 3-5

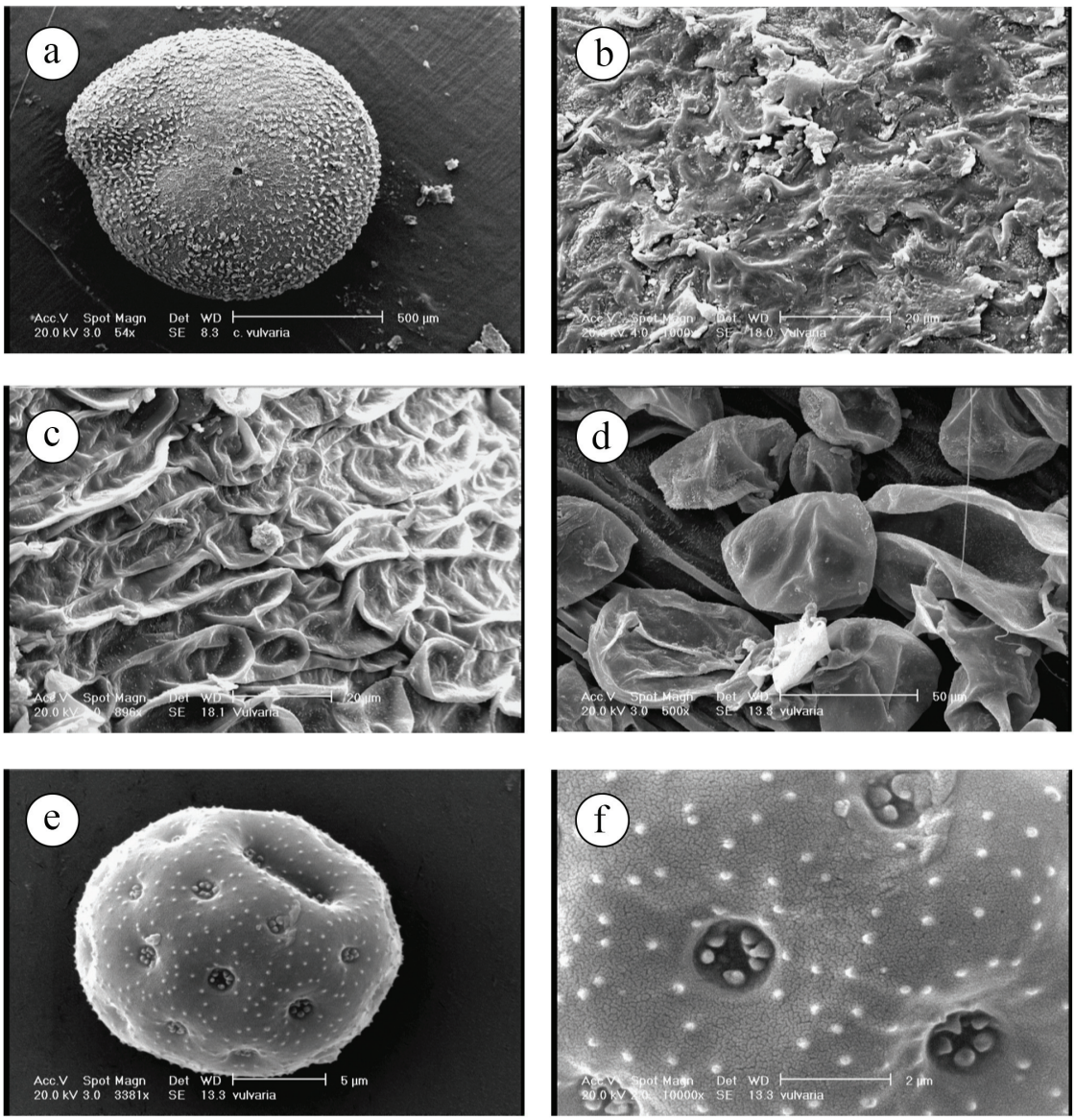

Figure 5. Scanning electron micrographs of seed, pollen and prianth of *Ch. vulvaria* IAUGH (Semnan, Shahmirzad, to Fouladmahalleh, 1550 m). View of seed (a), ornamentation of seed (b and c), ornamentation of prianth (d), pollen isopolar view (e), and surface ornamentation of exine (f). Scale bar = 500 µm (a), 20 µm (b), 20 µm (c), 50 µm (d), 5 µm (e), 2 µm (f).

and Table 2). (Hamdi et al. 2009; Malekloo et al. 2008; Pinar and Inceoğlu 1999).

Etymology: the new species belongs to the Khorasan province in N. E. Iran. (Fig. 2).

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