

ORNITHOGALUM KHUZESTANICUM (HYACINTHACEAE), A NEW SPECIES FROM IRAN

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Ornithogalum khuzestanicum (Hyacinthaceae) is described and illustrated as a new species from the subalpine areas in Khuzestan province, Iran. The new species is similar to *O. brachystachys* C. Koch and *O. arcuatum* Stev. in leaf shape, bulb shape and inflorescence shape, but differs by its stem length, margin of leaf, inflorescence length, bracts length, pedicels and ornamentation form on testa cell of seed and also pollen characters are different. The new species is currently known only from eastern Khuzestan, near the border of western Charmahale-Bakhtiari and Kohgiluyeh va -Boierahmad.

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گونه جدید *Ornithogalum khuzestanicum* (Hyacinthaceae) از خوزستان

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O. brachystachys C. به عنوان گونه جدید از خوزستان شرح داده می‌شود. این گونه مشابه گونه‌های

O. arcuatum Stev. و Koch بوده و از نظر طول ساقه، حاشیه برگ، طول گل آذین، طول برگه، طول دمگل و تزیینات سطح بذر و دانه

گرده با آنها اختلاف دارد.

INTRODUCTION

The genus *Ornithogalum* (Hyacinthaceae) contains 200-250 species worldwide and about 14 species in Iran. It is mainly distributed in Europe, Asia, Africa and Madagascar areas (Martinez Azorin et al. 2010 and Manning JC et al. 2007). The genus is divided into 3 subgenera (subgen. *Beryllis* (Salisb) Baker, subgen. *Ornithogalum* (Syn.: subgen. *Heliochamos* Baker) and subgen. *Caruelia* (Parl) Baker). This genus in Flora of the USSR (Krashennikovm 1935) consists of 24 species that 4 of them occur in Iran. In Flora of Turkey (Cullen 1985) 23 species reported that 6 of them occur in Iran. In Flora Iranica (Rechinger 1990) 12 species reported from Iran. In the Flora de l'Iran (Parsa 1950) 19 species and 8 varieties reported from Iran. The aim of this study was to prepare the draft of Flora of Iran

(Assadi 1989) by the third author and to do a biosystematic study of the genus in Iran by the first author as a dissertation of Ph. D. Therefore, the studies of morphology, anatomy, micromorphology of seed and pollen grains were carried out. Among the specimens, a specimen from the subgenus *Beryllis* (Salisb) Baker seemed to be interesting that further studies showed that it is a new species that is described in this paper. The subgenus *Beryllis* is distributed in Asia and Europe (Moret et al. 1986). Seven species of this subgenus occur in Iran, which are difficult to determine due to overlapping of floral characters. Maroofi (2010) described a new species from Kurdistan province belonging to this subgenus. The only reliable characters useful in separation of these

species are from seed surface morphology and pollen characters.

MATERIAL AND METHODS

This study was mainly based on plant material deposited in TARI herbarium (abbreviation according to Holmgren & al. 1998). Measurements of vegetative and floral parts as well as from the seeds were done under a stereomicroscope (Olympus SZH). Pollen grains and seeds of three taxa of the genus *Ornithogalum* were studied by scanning electron microscope (SEM). Samples were obtained mostly from fresh collected herbarium specimens. The voucher and the pollen specimens are deposited in TARI herbarium. For SEM, we used the protocol explained by Moret & al. (2009) with some modifications. The specimens were mounted on 12.5 mm diameter stubs and attached with sticky tabs and then coated in a sputter coater with approximately 25 µm of Gold-Paladium. The specimens were examined and photographed by a LEO scanning electron microscope (SEM) model 440 I, at an accelerating voltage of 10–15 kv. Cross-section of exine and seeds were also examined. The number of tecta perforations (according to Punt et al. 2007) per 25 µm² and length of larger perforations in proximal face and distal face were measured. The terminology used for describing the pollen grains features followed in general Moore & al. (1991) and Punt & al. (1994) and seed terminology Moret & al. (2009). The preperates were studied using an optical microscope Nikon modle Alphaphot- 2YS2 and photographed with a Canon A 630 camera.

RESULTS AND DISCUSSION

New species

Ornithogalum khuzestanicum Heidaryan, Hamdi & Assadi, **sp. nov.** (Fig. 1).

Typus. Iran. Khuzestan; km 15 Baghe-Malek to Izeh, 700 m, in a valley, 20.04.1982, Assadi and Aboohamzeh 38796 (holotypus TARI); Khuzestan Prov., Ahvaz to Shushtar, Mollasani, 40 m, 16.03.1986, Mozaffarian (TARI 62703).

Scapus 22-25 (-30) cm altus. Folia 8-10 mm lata, lanceolata. Racemus cylindricus, 40-45 cm longus. Floribus 40-60. Bracteae 17-37 mm longae. Tepala 15-17 mm longa. Capsula 7-8 mm longa, elliptico-oblonga.

Perennial plant, 60-65 cm high. Bulb ovoid, 4.5×4.5 cm, without bulblets; outer tunics brown; inners whitish, membranous. Scape usually erect, 22-25(-30) cm high, glabrous. Leaves 4-5, spreading, lanceolate, glabrous, 27-32 cm×8-10 mm, longer than scape, flat or slightly canaliculate, gradually tapering to acute apex,

scabrid at the margin, shorter than raceme. Inflorescence 40-45×6-7 cm, dense, 40-60 flowered; pedicels 12-20 mm in flowering stage and 25-30 mm in fruiting stage, longer than perianth segments. Bracts 17-37×2-3 mm, lanceolate, acute, shorter than pedicels. Perianth segments 15-17×3-3.5 mm, milky-white to yellow inside, milky-white with narrow dark green sometimes-brownish margin on the outside, oblong-ovoid. Filaments 8-8.5×1.8-2.2 mm; anthers 3-3.5 mm long, yellow, linear, flattened. Ovary 5×4 mm, ovoid-oblong, longer than style; style 4-4.5 mm long. Capsule 7-8 ×5-6 mm, elliptic-oblong. Seeds 6-8 in each capsule, black, 1.7×3.7 mm in diameter, mucous at the tip.

Etymology. The new species named after Khuzestan province in S. W. Iran.

Affinities (Tables 1 & 2; Figs. 1 & 2). This species belongs to the subgen. *Beryllis* (Salisb) Baker. The new species is compared with its closest relatives *Ornithogalum brachystachys* C. Koch. and *O. arcuatum* Stev. *O. khuzestanicum* is similar to *O. brachystachys* in scape length, leaves shape, number of leaves and pedicel length in flowering stage. But, differs in being taller (vs. 25-60 cm long), scabrid leaf margin (roughly aculeate and plus minus prickly or spine-like, visible on the fleshy to leathery herbaceous leaves) (vs. smooth or ciliate), flower number (vs. 35-40), longer bracts (vs. 10-14×1 mm long), longer perianth segment (vs. 9-15×2-3 mm long), longer anther (vs. 2-2.5 mm long), bigger seeds (vs. 2-2.2 mm long), longer style (vs. 3-3.2 mm long). *O. khuzestanicum* is similar to *O. arcuatum* in leaf shape and number of flowers. But differs in having smaller scape (vs. 40-42 cm long), scabrid leaf margin (vs. smooth), leaf size (vs. 35-40×10-20), longer perianth segment (vs. 10-15×5 mm long), longer anther (vs. 2-2.5 mm long), bigger seeds (vs. 1.5-2 mm long), longer style (vs. 2-3 mm long). *O. khuzestanicum* is similar to *O. sanandajense* in leaf shape, bulbs shape, scape length and pedicel angle. But differs in the having bigger bulbs (vs. 1.5-3×3.5 cm long), scabrid leaf margin (vs. smooth or ciliate), leaf size (vs. up to 20 cm), tallness (vs. 20-36 cm long), longer raceme (vs. 4-11 cm long), flower number (vs. 10-38), longer bract (vs. 7.5-13×1-2 cm long), longer pedicel in flower (vs. 1-7 cm long), longer pedicel in fruit (vs. 7 cm long), acute bracts tip (vs. acuminate).

Seed coat micromorphology (Coskuncelebi et al. 2000; Moret J. et al. 2009 and Leszek Bednorz & Aneta Czarna. 2008) provides further differences. Cells shape of testa seed in *O. khuzestanicum* is irregularly polygonal, ornamentation form of cell is convex-smooth, anticlinal walls 10-12 (µm), polar pole pollen diameter 48-50 (µm), equatorial pole pollen diameter

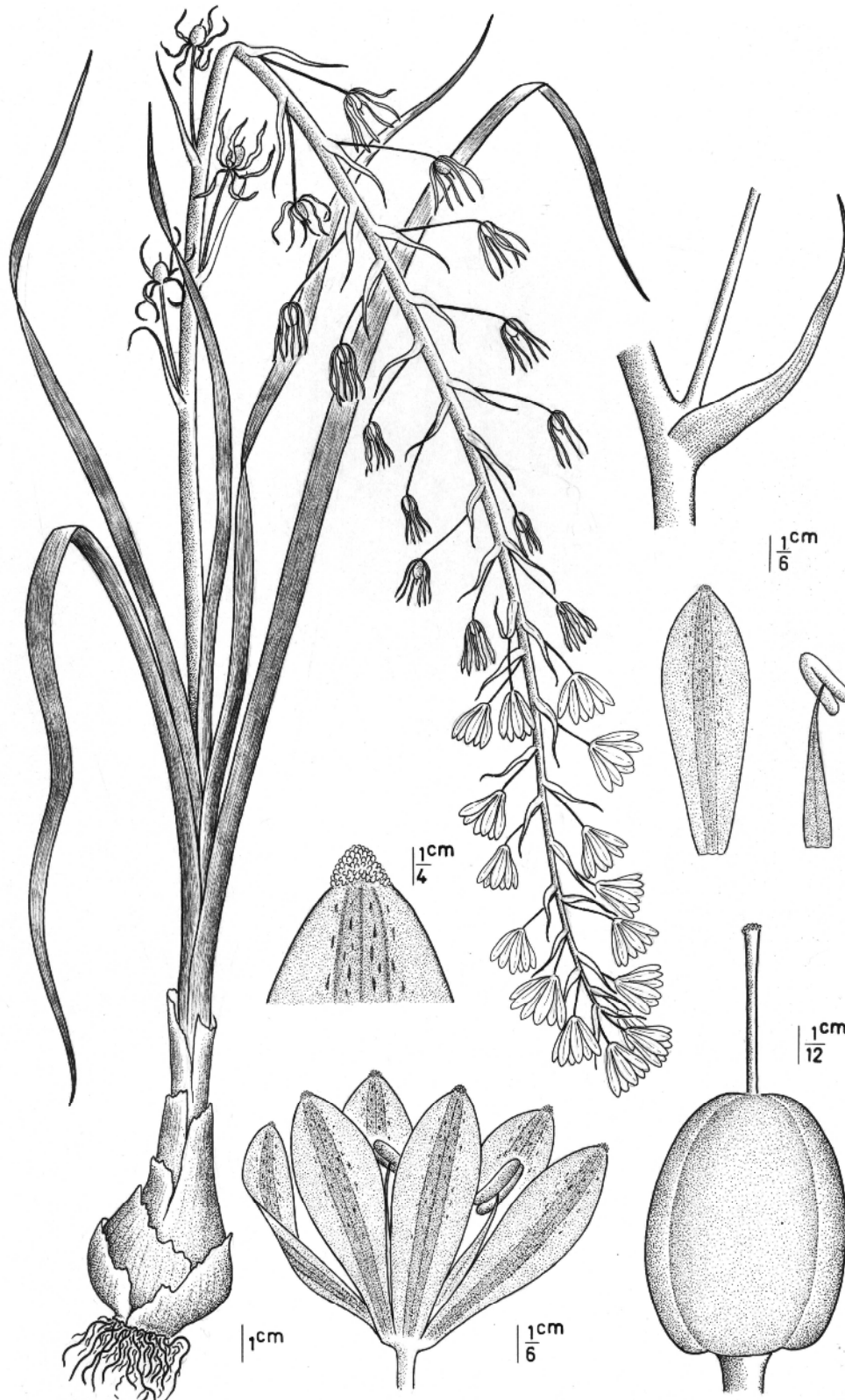


Fig. 1. *Ornithogalum khuzestanicum* (holotypus).

Table 1. Comparison of morphological characters of *Ornithogalum khuzestanicum* and close affinities.

Species	<i>O. khuzestanicum</i>	<i>O. brachystachys</i>	<i>O. sanandajense</i>	<i>O. arcuatum</i>
Bulbs size [cm]	4.5×4.5	2-3×2-3	1.5-3×3-3.5	2.5×4
Bulbs shape	ovoid	spherical-ovoid	ovoid	ovoid
Bulbs colour	Milky white to brown	Milky white to dark	Milky white	Milky white to brown
Scape [cm]	22-25 (-30)	23-31	16-25	40-42
Plant (height) [cm]	65	25-60	20-36	60-100
Leaf number	4-5	4-8	2-8	3-7
Leaf shape	lanceolate	lanceolate-canaliculate	lanceolate	lanceolate
Leaf length[cm]	27-32	14-30	Up to 20	35-40
Leaf broad [mm]	8-10	3-9	5-9	10-20
Leaf color	green glaucous	green glaucous	green	green
Margin of leaf	scabrid	smooth or ciliate	smooth or ciliate	smooth
Pedicel angle with inflorescence	45-90	30-45	45	45
Raceme length [cm]	40-45	6-26	4-11	20-60
Flowers number	40-60	35-40	10-38	55-60
Bracts [mm]	17-37×2-3	10-14×1	7.5-13×1-2	20-30
Bracts tip	acute	acute	acuminate	acute
Pedicle length in flower (mm)	12-20	8-12	1-4(-7)	15-25
Pedicle length in fruit(mm)	25-30	10-12	7	30-60
Prianth color inside	Milky white to yellow	Milky white	white	Milky white to yellow
Prianth color outside	milky white with narrow green dark sometimes brown margin	milky white with narrow green dark sometimes brown margin	pale brownish to white	Milky white with narrow green dark
Perianth segment [mm]	15-17×3-3.5	9-15×2-3	12-14×2-3	10-15×5
Perianth segment shape	oblong -ovoid	oblong-oblancoate	linear to oblong , apex rather convolved	obovate-elliptic
Midrib colour of segment	green dark	green to yellow	brownish to brown-greenish or green	green dark
Anther length [mm]	3-3.5	2-2.5	5	2-3
Stalk of stamen [mm]	8-8.5×1.8-2.2	4-5	4×2-4	5-7
Ovary [mm]	5×4	2-5×1-4	4-5	3-5×2-4
Capsule shape	elliptic-oblong	spherical-ovoid	rather ovoid	ovoid
Capsule size	7-8×5-6	9-10×6-7	7	7-8×10-11
Style length [mm]	4-4.5	3-3.2	2-4	2-3

15-18 (μm) and pores number on surface of exine per 2 (μm^2) is 50-53 while cells shape of testa seed in *O. brachystachys* is irregularly polygonal, ornamentation form of cell is concave to convex-tuberculate and microtuberculate, anticlinal walls 4-8 (-10) (μm), polar pole pollen diameter 47 (μm), equatorial pole pollen diameter 23 (μm) and pores number on surface of exine per 2 (μm^2) is 19-26 and cells shape of testa seed in the *O. arcuatum* is irregularly polygonal, ornamentation form of cell is concave to convex -smooth, anticlinal

walls 3-4 (μm), polar pole pollen diameter 56 (μm), equatorial pole pollen diameter 24 (μm) and pores number on surface of exine per 2 (μm^2) is 10-12. Cells shape of testa seed in the *O. sanandajense* is irregularly polygonal, ornamentation form of cell is convex-tuberculate, anticlinal walls 2-3 (μm), polar pole pollen diameter 40-42 (μm), equatorial pole pollen diameter 18-20 (μm) and pores number on surface of exine per 2 (μm^2) is 17-20. While in the new taxon, the length and width of testa cells are longer than *O.*

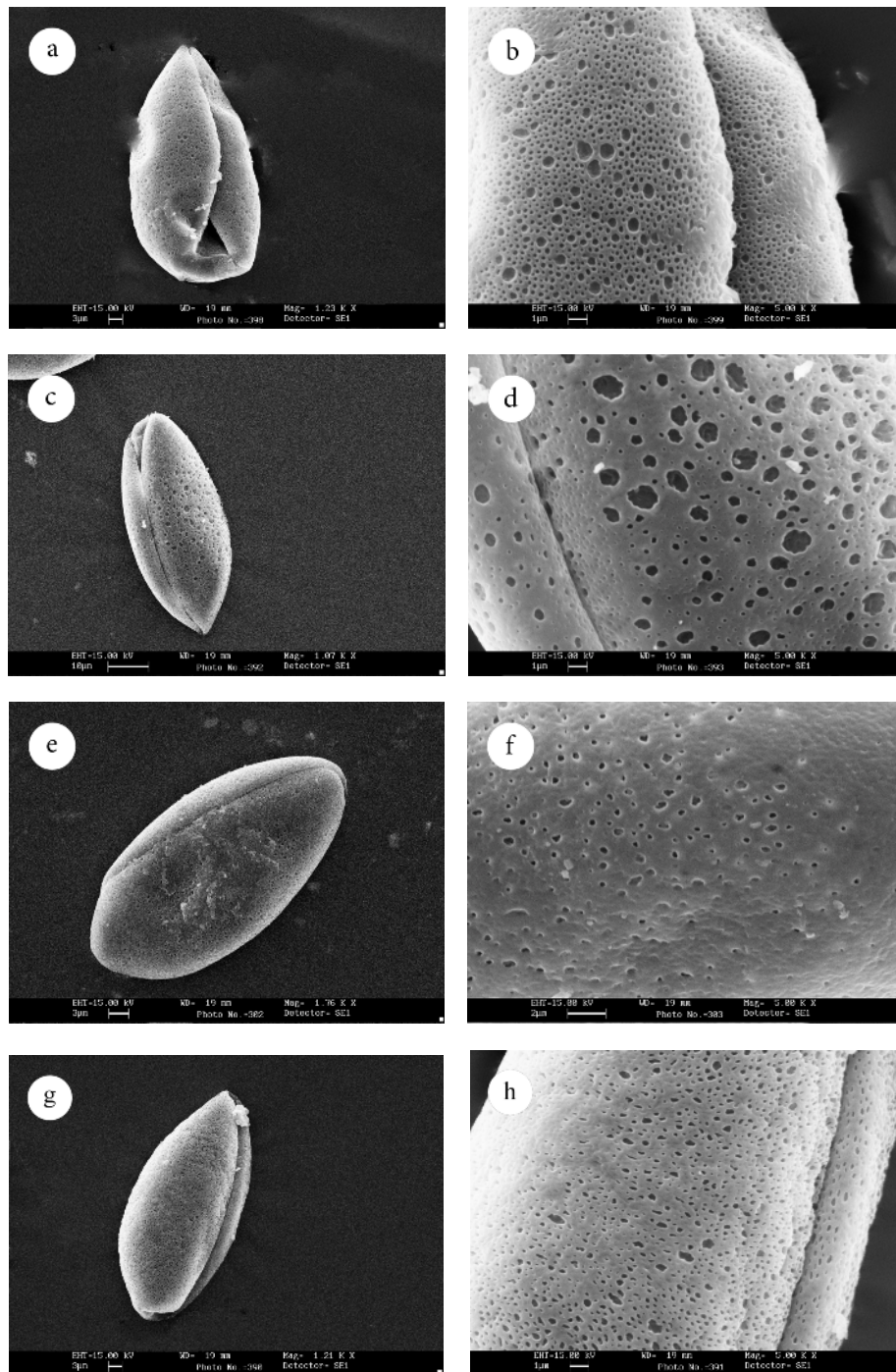


Fig. 2. Scanning electron microscopy photographs of *Ornithogalum* pollen grains. a-b: *O. khuzestanicum*, distal polar view (a), details of ornamentation exine (b); -c-d: *O. arcuatum*, distal polar view (c), details of ornamentation exine (d); -e-f: *O. brachystachys*, distal polar view (e), details of ornamentation exine (f); -g-h: *O. sanandajense*, distal polar view (g), details of ornamentation exine (h). Specimens the same as in table 1. Scale bars: c = 30 μm , a, e & g = 3 μm , f = 2 μm , b, d & h = 1 μm .

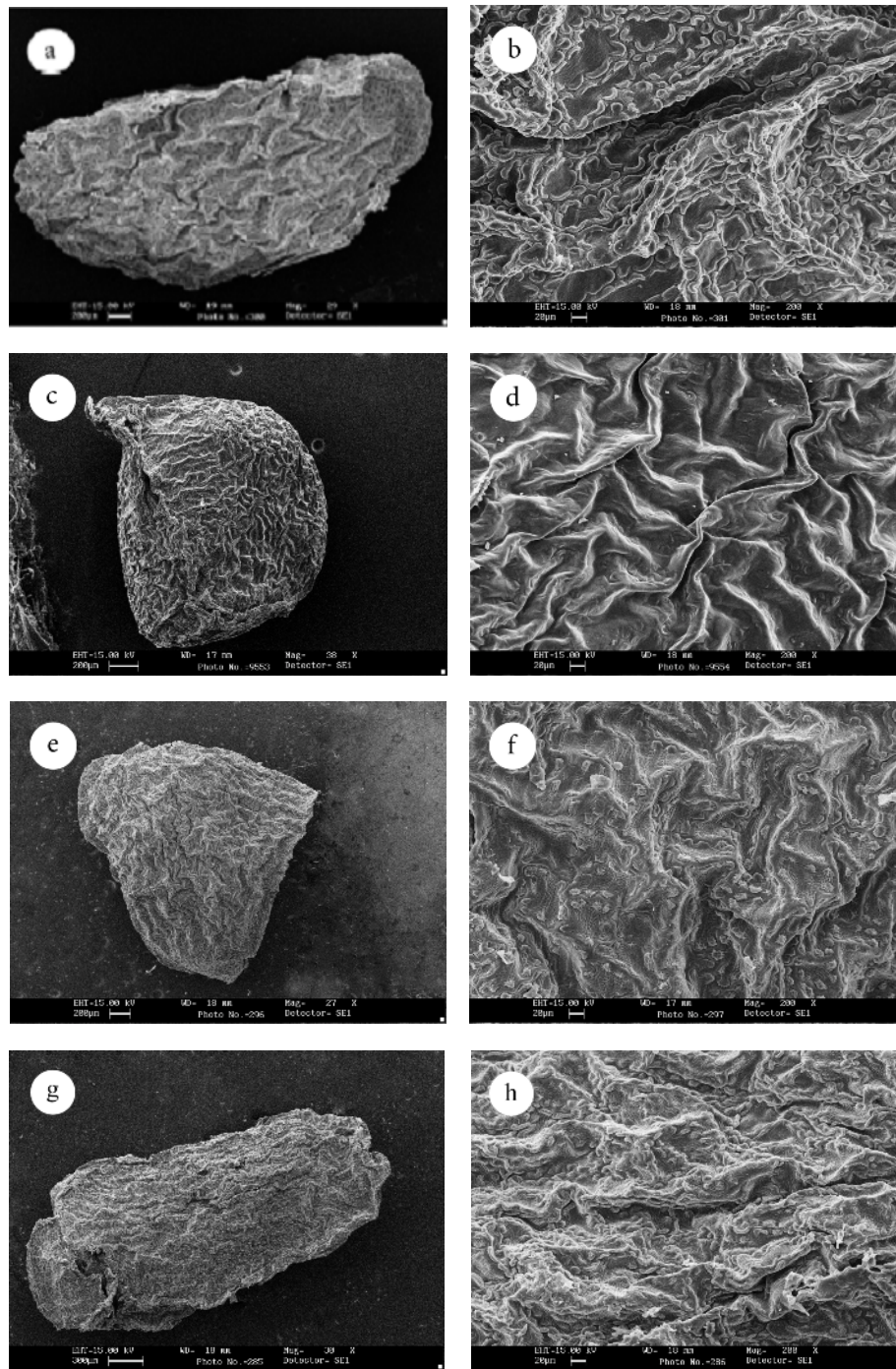


Fig. 3. Scanning electron micrographs of seeds of *Ornithogalum*. a-b: *O. khouzestanicum* from (Assadi and Aboohamzeh 38796, view of seed (a), ornamentation of seed (b); -c-d: *O. arcuatum* (Tehran 32 km to Amol, Plour, 2400 m, Babakhanlo & Amin14387), view of seed (c), ornamentation of seed (d); -e-f: *O. brachystachys* from (Azerbaijan, Jolfa, to Marand km 32, 1350 m, Foroughi 5657), view of seed (e), ornamentation of seed (f); -g-h: *O. sanandajense* (Kordestan, Sanandaj to Kamyaran, km 38, 1500-2400 m, Fatahei, Tavakoli & Khaledian 503), view of seed (g), ornamentation of seed (h). Scale bars: a, c & e=200 μm, b, d, f & h = 20 μm, g=300 μm.

Table 2. Comparison of micromorphological characters of *Ornithogalum khuzestanicum* and close affinities.

Species	<i>O. khuzestanicum</i>	<i>O. brachystachys</i>	<i>O. sanandajense</i>	<i>O. arcuatum</i>
Characters				
Seed size [mm]	1.7×3.7	2.4-2.5×1.8-2	3-3.2×1.2-1.3	1.5-2×1.2-1.4
Seed number	6-8	5-7	4-6	5-10
Tip of seed	muticous	muticous	muticous	mucronate
Seed length/width	1.2	1.3	3	1.3
Seed shape	oblong	oblong to trigonous	oblong	subspherical
Cells size of testa seed (µm)	100-120 (-140)×20-40 (-80)	60-69×40-56	80-100×30-35	40-45×15-20
Ornamentation form of cells	convex-smooth	concave to convex-tuberculate and microtuberculate	convex-tuberculate	concave to convex-smooth
Anticlinal walls (µm)	10-12	4-8 (-10)	2-3	3-4
Polar pole pollen dia. (µm)	48-50	47	40-42	50-56
Equatorial pole pollen dia. (µm)	15-18	23	18-20	20-24
Pores number on polar surface per 2 (µm ²)	50-53	19-26	17-20	10-12
Pore diameter maximum (µm)	1-1.3	0.7-1	0.9-1	1.7-2
Pore diameter minimum (µm)	0.2	0.1	0.1	0.2

brachystachys, *O. sanandajense* and *O. arcuatum*. Ornamentation form on testa cell is also different because in the new taxon it is more convex-smooth, but in *O. brachystachys* are concave to convex-tuberculate and microtuberculate and in *O. arcuatum* are concave to convex-smooth and in *O. sanandajense* are convex-tuberculate. (Coskuncelebi et al. 2000; Moret et al. 2009 and Leszek Bednorz & Aneta Czarna 2008).

Identification key to the new species and close affinities

1. Raceme length 4-11 cm; pedicel length in flower 1-7 and in fruit 7 mm; bracts tip acuminate **O. sanandajense**
1. Raceme length 6-60 cm; pedicel length in flower 8-25 and in fruit 10-60 mm; bracts tip acute **2**
2. Margin of leaves scabrid; bulbs size 4.5×4.5 cm **O. khuzestanicum**
2. Margin of leaves ciliate or smooth; bulbs size 2-3×4.5 cm **3**
3. Leaves ciliate at the margin, 14-30 cm×3-9 mm **O. brachystachys**
3. Leaves smooth at the margin, 35-40 cm×10-20 mm long **O. arcuatum**

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