

# Gagea iranshahrii (Liliaceae), a new species from the Atrak River basin

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## Abstract

A new species of *Gagea iranshahrii* \*\*\*\*\* & \*\*\*\*\* (Liliaceae, *G. sect. Stipitatae* (Pascher) Davlianidze) has been described from the basin of the Atrak River basin, Iran and Turkmenistan. Morphological features and a distribution map are given. Differences from four superficially similar taxa are indicated. The new species differs in the totality of features and, especially, in the presence of a relatively large, rounded vegetative bulb, which forms annually throughout the entire ontogenesis.

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### Abstract

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**Keywords :** *Gagea* , Liliaceae, Iran, Turkmenistan, New species

### 1. Introduction

During an expedition to Golestan province, NE Iran, a new taxa of *Gagea* Salisb. was discovered in the basin of the Atrak River (also called Etrek, Atrek) on the dry foothills of the eastern part of the Alborz ridge (Figs. 1- 3). Identification of the sample with the help of modern literary sources (e.g. Wendelbo and Rechinger 1990, Zarrei et al. 2007, 2011), placed it next to *G. tenera* Pascher. But the habitus and according to the totality of signs, this taxon belongs to sect. *Stipitatae* (Pascher) Davlianidze. This finding showed the greatest similarity with *G. subtilis* Vved. from the Western Pamir-Alai, *G. vanensis* Tekşen et Erkul from Eastern Turkey (Tekşen and Erkul 2015) and *G. namanganica* Levichev & Karimov from the Fergana valley (Levichev et al. in pres.).

According to herbarium materials, the same plant was identified from four more points: on the slopes of Kopet Dag and on the hills of the Big Balkhans in Turkmenistan (Fig. 3). The samples clearly differed from all the previously named and known representatives of the genus. The habitats of the new taxon are located far beyond the two centers of the modern diversity of the genus in the Western Tien Shan and in the Western Pamir-Alai, but inside the hypothetical area of its origin in the Irano-Turanian region of Near Asia (Levichev 1999b, Peterson et al. 2019).

In the lily family (Liliaceae), the genus *Gagea* is the largest, with more than 330 species. Its representatives are distributed in temperate and subtropical regions of Eurasia, as well as along the Mediterranean coast of Africa (Levichev 2011, 2013). The largest number of species of the genus is concentrated in Southwest

and Central Asia (Rechinger 1986, Peterson et al. 2008, 2009, Peruzzi 2012). According to our calculations, more than 220 of its species are currently concentrated in region “No. 1” in Southwest Asia (see map charts: Levichev 1999b, Levichev 2008). In the same region, on the western spurs of the slopes of the Tien Shan and Pamir-Alai descending to the Turan lowland, there are both centers of modern diversity of the genus, numbering more than 80 and 110 species, respectively. This is significantly more than for any other geographically compact (and larger) territories. For example, 37 species and 3 subspecies are known for the Caucasus region (Levichev 2006, Timukhin et al. 2010), 36 species in Pakistan (Ali and Levichev 2007), 31 species along the slopes of the Himalayas (from Pakistan to Nepal). According to Flora Iranica (Wendelbo and Rechinger 1990) with subsequent additions (Zarrei and Zarre 2005; Zarrei et al. 2007, 2010, 2011; Ajani et al. 2010), 35 species are mentioned for the territory of Iran. Excluding synonyms, within these limits (according to our analysis) there are 29 species of *Gagea*, and considering the one described in this publication, reached up to 30.

The flora of the Golestan province, NE Iran, is very diverse. 1,302 species are known from Golestan National Park (GNP) (Akhani 1998), which is about 19% of vascular plants of Iran. In the flora of GNP, several contrasting phytogeographic regions come into contact, which create such a high floral diversity. Recently, the vegetation and flora composition of the Ghorkhod Protected Area (GPA) adjacent to the GNP in North Khorassan has been studied in depth (Memariani et al. 2016). The flora of northeastern Golestan province remains insufficiently studied and is limited to a few additions from easily accessible places (Hamdi et al. 2006, Khasanov et al. 2006, Ranjbar 2007). In addition, the recognition and taxonomy of representatives of the genus *Gagea* is complicated due to the insufficient amount of material from this region, and is also associated with the loss of many diagnostic features during herbarization (Rechinger 1986).

The distribution sites of new taxon are located in the northeast of Golestan province near Maraveh Tappeh. According to the meteorological station of Maraveh Tappeh, the average annual temperature and precipitation are 18.8°C and 361.5 mm, respectively. Precipitation falls mainly in winter. Based on the Köppen criteria, this climate correlates with the BWh type, that is, the climate of a hot and arid desert (Peel et al. 2007).

## 2. Material and methods

Particular attention was paid to the variability of the vegetative organs in different periods of ontogeny, which is of diagnostic importance for determining the sectional and species affiliation (e.g., Levichev 1999a, 1999b, 2011, Peterson et al. 2008; Peruzzi et al. 2008). Also, these features were analyzed on all herbarium sheets found in TARI and LE. To obtain mature seeds, live samples were placed in a container and observed in a greenhouse. Identification was carried out according to existing literature sources (Wendelbo and Rechinger 1990; Levichev 2006; Ali and Levichev 2007; Zarrei et al. 2007, 2011). Additionally, the anatomical features of the bulb, bulbil and leaves were studied from the material fixed in ethyl alcohol (70%). Manually, with a razor blade, longitudinal sections of the bulb, bulbil and cross sections of various parts of the basal leaf and peduncle were made. Sections were bleached in sodium hypochlorite for several minutes, then stained twice with cellulose carmine (phloem) and dilute methyl green (xylem). The anatomical features of the leaf were examined under a light microscope Nikon BX53 (Japan) Nikon BX53 (in TARI) and Stemi 2000 SDA (in LE) with a digital camera mounted on it. The images were then converted into graphics using Adobe Illustrator CC. 17.0.

## 3. Results and discussion

Summing up the morphological and anatomical results, we came to the conclusion that the collected samples are a new species.

*Gagea iranshahrii* \*\*\*\* & \*\*\*\*\* **sp. nov.**[sect. *Stipitatae*, ser. *Stipitatae* (Pasch.) Levichev]

**Holotype** : NE Iran, NE Golestan province, Kalaleh to Maraveh Tappeh, 4 km after Chenaran village, on foothills, 37°50'17.2"N; 55°57'24.4"E, 322 m a.s.l., 28.03.2019, \*\*\*\*\* 107616 (TARI!).

**Paratype (Supporting information):** *Turkmenistan*, Gaudan, peaks and slopes of mountains, 13 IV

[18]95, [] 5179, [legit.] Korzhinsky; Det. A. Grossheim, 1932 [as] *Gagea stipitata* Mercl.; Det. \*\*\*\* (LE) 20.12.2021 [as] *Gagea iranshahrii* \*\*\*\* & \*\*\*\* LE00052556. *Turkmenistan*, Central Kopet Dag, Chash-Depe, gorge, in the shadow of rocks, 1300 m, 14 V 1967, legit. & det. Proskuryakova [as] *Gagea chomutoviae* Pasch.; Teste \*\*\*\* (LE) March 2001 [as] *G. ova* (*G. deepening*); 38.13708, 57.52912, mons Chashdepe, April 2021 [as] *Gagea iranshahrii* \*\*\*\* & \*\*\*\*, the bulbil is finely cellular, the plant is [?] 7-8 years old - 7 donets with roots are visible; LE00052553. *Turkestanica*, Large Balkhans, on the rocky slopes of the mountains, 31 III [18]95, legit. S. Korshinsky [] 5181, Det. A. Grossheim. 1932 [as] *Gagea stipitata* Mercl.; [Det.] \*\*\*\* (LE), 20.12.2021 [as] *Gagea iranshahrii* \*\*\*\* & \*\*\*\*; LE00052555. *Turkestanica*, Large Balkhans, on the clay slopes of the mountains, 1 IV [18]95, Legit. S. Korshinsky [] 5180, Det. A. Grossheim, 1932 *Gagea stipitata* Mercl.; Det. \*\*\*\* (LE) 20.12.2021. *Gagea iranshahrii* \*\*\*\* & \*\*\*\*, the bulbil is single, shallow- and finely-celled; LE00052554.

**Diagnosis** : The new species differ from *G. subtilis* Vved. and *G. namanganica* Levichev et Karimov (in press.) by a round, hanging vegetative bulb (not semi-teardrop-shaped and not appressed), from *G. vanensis* Tekşen & Karaman by a single vegetative bulb (not a group), from *G. tenera* Pascher by 1 leaf under inflorescence (not 2 individually), round (not flat) vegetative bulb and rounded cross-section of the basal leaf (not grooved) with 5 vascular bundles (not 3 bundles).

Plants solitary, thin, without pubescence, 9-15 cm tall. Bulb 2.5-3.5 mm in diameter, 4-6 mm high, ovoid-pear-shaped, covered with a dark brown tunic, with a short (2-4 mm) neck and freely braided with ageotropically oriented thin sclerified roots. The vegetative bulb is single, 2 × 2-2.5 mm in diam., spherical, smooth, hanging, connected to the bulbil with a short (0.5-2 mm) similarity of a stolon. Peduncle short (1-) 2.5-4 (-5) cm, rounded in cross section (c.s.), without voids, 0.5-1 mm in diameter. Basal leaf 1, slightly exceeding the inflorescence, 10-15 cm long, up to 0.5 mm wide, in c.s. flattened rounded, semicircular, 0.3-0.7 mm in diameter. The leaves on the peduncle are alternate, decreasing; lower ones up to 5-6.5 cm long, 1-2.5 mm wide at the base, gradually narrowed in the middle and upper thirds to filiform, shorter or longer than the inflorescence; other bracts are much shorter, 3-11 mm long. Inflorescences cymose, more or less branched, 3-12-flowered; pedicels 0.8-1.5 mm in diameter. Tepals lanceolate, obtuse, shiny, yellow, abaxial side greenish; external 5.5-7 × 1.5-2.5 mm, somewhat smaller than internal, 6-7.5 × 2-2.5 mm. Stamens 3.5-4 mm long; anthers are yellow, oblong, 1-1.5 mm long, after opening they decrease, rounded. Ovary obovate; 1.5-2.5 mm tall, narrowed into a short stem. Style 2-2.5 mm long, stigma capitate. The capsule is round-oblong, 4.5 × 2.5-3 mm, narrowed into a short stem about 0.5 mm. Seeds are thick flat, triangular, about 1 mm (Figs. 1-2).

## Etymology

This species is named after Prof. Dr. Musa Iranshahr (1923-2020), an outstanding Iranian botanist, author of *Flora Iranica*, and curator of the Iranian herbarium, who devoted his life to the flora of Iran (see also Mousavi 2013).

## Distribution and morphological features

Local distribution and endemism is characteristic of most representatives of the genus *Gagea*. The totality of the localities of the described taxon also indicates its localization within the catchment area of the Atrak River with insignificant outcrops to the border areas in Kopet Dag and Big Balkhans (Fig. 3). This allows us to call it an easternmost hyrcanian endemic, the southeastern coast of the Caspian Sea and the mountain slopes in the basins of the Atrak and Gorgan rivers.

Appearance and morphological features of this taxon demonstrate kinship with *G. subtilis* Vved., *G. vanensis* (Tekşen and Erkul 2015, Figs. 1-4) and *G. namanganica* (Levichev et al., in press), as well as differences from *G. tenera* (Ali and Levichev 2007, Fig. 19 are given in Table 1.

## Habitat and state of conservation

*G. iranshahrii* is a bulbous geophyte (ephemeroid) growing on dry slopes and foothills. Flowering time begins in mid-March and lasts 2-3 weeks. In Turkmenistan, on the Big Balkhans, flowering is shifted to April, early

May. In Iran, habitats are intensively grazing in spring. In addition, the populations are surrounded by agricultural land, so the use of pesticides definitely affects the habitat, which poses a threat to the species.

### Basal leaf anatomy

The basal leaf of *G. iranshahrii* in cross section is rounded, without a cavity in the center (Figs. 1F-I; Figs. 2G-K), at the base with 5 vascular bundles located in the form of a ring. This type of leaves is called unifacial - having one surface (without expanding into a flat, bifacial, plate). The annular arrangement of the bundles is confirmed by the orientation of the xylem (Göbel 1913: 273, 278) in each bundle, the xylem is oriented towards the leaf center (Fig. 1F, xy). From the base to the top of the sheet, its cross-sectional shape naturally changes. The abaxial surface has a groove at the very base (Fig. 1F; Fig. 2G), but above the groove disappears (Figs. 1G-I; Figs. 2H-K) and the leaf takes on rounded shapes. As a result of successive anastomoses (fusions), the number of bundles in the upper part of the leaf decreases to 4, 3, 2, and up to 1. The epidermis is 1-layer. The outer surface of its cells covers with a thick cuticle. Below the epidermis are 4-5 layers of photosynthetic parenchyma. The inner part of the leaf is filled with larger and rounded mesophilic cells.

### Features of the root system

The ageotropic sclerified roots mentioned in the description are a systematically important but variable feature. For all representatives of the genus *Gagea*, even for seedlings (Levichev 1999a, Fig. 3, 4), the annual formation of 2 types of annual roots is mandatory. These are thin feeding and, usually, thickened, with a pronounced ageotropic (horizontally and upwards) orientation and sclerified (Pascher 1942). The last type of roots, after dying off, performs the function of an underground velamen (Levichev and Kurbaniyazova 2022, Fig. 1). In *G. iranshahrii*, both types of roots differ little. The sclerified roots are slightly thicker and loosely entwine the bulb horizontally (Figs. 1, B-B’’’).

### Spreading .

*G. iranshahrii* (sect. *Stipitatae*, ser. *Stipitatae*) occupies a compact area in easternmost hyrcanian area within the catchment area of the Atrak River (Fig. 3).

*G. subtilis* (sect. *Stipitatae*, ser. *Stipitatae*) is a local endemic of Mogoltau and the Turkestan Ranges.

*G. vanensis* (sect. *Stipitatae*, ser. *Stipitatae*) was recently described from Eastern Anatolia (Turkey), where it lives among steppe vegetation at altitudes of about 2000 m above sea level.

*G. namanganica* (sect. *Stipitatae*, ser. *Stipitatae*) was found in the northern foothills of the Fergana valley (Levichev et al., in press). The taxon grows on dry foothills (800 - 900 m a.s.l) in the pasture, above farming zone.

*G. tenera* (sect. *Didymobolbos* (K. Koch) Boiss., sect. *tenerae* Levichev) is distributed in Turkey, Iran, Afghanistan, and Central Asia. It lives in the middle belt of mountains, reaching 2000 or more meters above sea level.

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**Table 1.** Morphological features of *Gagea iranshahrii* , *G. subtilis* , *G. vanensis* , *G. namanganica* and *G. tenera* .

	<i>G. iranshahrii</i>	<i>G. subtilis</i>	<i>G. vanensis</i>	<i>G. namanganica</i>	<i>G. tenera</i>
Habit	single, very thin	single	single, widely branched	single , multiflorous	single and in groups, few-flowered
Height (cm)	9-15	5-15	9-15	7-14	6-17
Ageotropic roots	thin, loosely braided	thickened, few	not expressed	not expressed	not expressed
Bulb shape, diameter (mm)	ovoid pear-shaped, 2-4	obliquely drop, 2-4	ovoid-globose, 4-8	obliquely drop, 5-6	obliquely drop, 4-8
Vegetative bulbils number, shape, diameter × height (mm)	1, spherical, hanging, 2×2-2.5	1, semi-drop, pressed, 1.5×3-4	5-8 (group), ovoid or pear-shaped, 1-4×1.5-2.5	1, semi-drop, pressed, 1-2.5×1-2	1, semi-drop, 1,5×3-6 or absent, in immature age the crowded group on peduncle among filamentous leaves, 1×1,5
Number of basal leaves, cross-sectional shape, number of vascular bundles	1, rounded, 5	1, rounded, 5-6	1, rounded, 5	1, semicircular, the upper part is hollow, 6	2, at the end of ontogenesis 1, triangular-canaliculate, 3
Lower stem leaf width (mm)	1-2.5	2-3	1-2	1-1.5	3-4
The shape of the anther before opening	oblong	oblong	oblong	oblong, pointed at the top	narrow-ovoid
Ovary and base shapes	obovate, narrowed into a short leg	obovate, narrowed into a short leg	obovate, narrowed into a short leg	obovate, narrowed to the base	obovate, sessile

## Figure legends

**Figure 1 .** a) *G. iranshahrii* , general view. b, b', b'', b''') Bulb and vegetative bulbil are freely entwined with ageotropically oriented thin sclerified roots. b'') Longitudinal section of bulb and bulbil. c) Flower at the beginning of flowering, part of the anthers (large) have not yet been opened. c') Flower discolored in alcohol, all anthers opened. d) Mature box. e) Seeds. Cross-section of the basal leaf: (f) at the base, (g) below the middle, (h) upper the middle, (i) under the apical point. Scale bars: b-e) 5mm, f-h) 200  $\mu$ m, i) 100  $\mu$ m.

**Figure 2.** *G. iranshahrii* , line art. a) General view of a mature plant. B-b') Bulb and bulbil with and without tunic. b'') Longitudinal section of bulb and bulbil. c) Flower. c') Ovary, style, stamen, closed anther. d) Perianth after flowering. e) Mature capsule and style. f) Seed. g-k) Successive cross-sections of the basal leaf. Scale bars: a-b'') 10 mm, c-f) 5 mm, g-k) 200  $\mu$ m.

**Figure 3.** Distribution of *G. iranshahrii* .





