



Gagea vanensis, a new species and *G. chomutovae*, a new record from Southeastern Anatolia, Turkey (Liliaceae)

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Abstract

Gagea vanensis sp. nov. (Liliaceae) is described and illustrated as a new species from Van province in Eastern Anatolia, Turkey. *G. chomutovae* is reported as a new record for the Turkish flora. Both species belong to the section *Stipitatae*, based on morphological features. The taxonomic relationships of *G. vanensis* with other taxa, such as *G. ova*, *G. stipitata*, *G. absurda*, *G. kunawurensis*, and *G. chomutovae*, are given.

Key words: *Stipitatae*, taxonomy, Van

Introduction

Gagea Salisbury (1806: 555) is represented by approximately 280 (Peruzzi 2012) to 300 species worldwide (Peterson *et al.* 2008, 2011, Zarrei *et al.* 2011a, 2011b, Tison *et al.* 2013, Kayıkçı *et al.* 2014). The distribution of the genus is restricted to the temperate and subtropical regions of Eurasia and does not extend into any areas with either a tropical climate or permafrost (Levichev 1999, Peterson *et al.* 2008). The highest species diversity is reported for the Western Pamir-Alai (97 species) and the Western Tien-Shan (65 species), representing the modern centres of species diversity (Levichev 1999; Peterson *et al.* 2009). In Turkey, this genus has 27 species and one subspecies, three of which are endemic (Rix 1984, Hamzaoğlu *et al.* 2008, Tison *et al.* 2013, Kayıkçı *et al.* 2014).

Gagea includes 15 sections, mainly separated by the morpho-anatomic and ontogenetic features of the basal and cauline leaves, peduncle, pedicels, tepals, and seeds (Peterson *et al.* 2008, Peruzzi 2003, 2012, Peruzzi *et al.* 2008a, 2008b, 2011; Levichev 2011).

The taxa of the genus *Gagea* belong to the following sections in Turkey: sect. *Anthericoides* Terracciano (1905: 24), sect. *Bulbiferae* Levichev in Peterson *et al.* (2008: 448), sect. *Didymobulbos* (Koch 1849: 229) Boissier (1882: 203), sect. *Gagea*, sect. *Minimae* (Pascher 1907: 357) Davlianidze (1973: 62), sect. *Persicae* (Levichev 1990: 230) Peruzzi (2012: 24), sect. *Platyspermum* Boissier (1882: 204), sect. *Plecostigma* (Turczaninov 1844: 8) Pascher (1904: 116). During this research, we discovered two species clearly belonging to the section *Stipitatae* (Pascher 1904: 118) Davlianidze (1972: 71), never recorded before for Turkey.

The section *Stipitatae* has a paniculate inflorescence, often wide ramified, with alternate phyllotaxis, peduncle more frequent with 1–2 leaves below the inflorescence, peduncle in cross section roundish or complex longitudinal grooved, basal leaf mostly 1 or less frequent in certain species always 2 (if so, the second is reduced), basal leaves in cross section roundish or roundishly grooved, rarely fistular, from filiform up to narrow linear, always of unifacial type, tepal apex obtuse or widely rounded, capsule oblong, roundish triangular, often borne on a short shaft, seeds in lobule-form and flat (Peterson *et al.* 2008). This section, including about 60 species, is one of the largest in *Gagea* (Peterson *et al.* 2008). The species of sect. *Stipitatae* are very closely related, so that their taxonomical separation is in most cases very difficult (Zarrei & Zarre 2005). They are all similar in basal leaf anatomy, except for *G. chomutovae* (Zarrei *et al.* 2009, 2010). The capsule borne on a short shaft is a unique morphological character for most species (Peterson *et al.* 2008).

In this study, *G. vanensis* was compared with *G. ova* Stapf (1885: 16), *G. stipitata* Merckl. ex Bunge (1851: 512),

Distribution, Habitat, and Ecology:—*G. chomutovae* is distributed in Turkey, Transcaucasus, Kazakhstan, Kyrgyzstan, Tadjikistan, Turkmenistan, Uzbekistan, Afghanistan, Iran, and now South Eastern Anatolia (WCSP 2014). The flowering time is late April and May. This species grows on calcareous soils, steppes, and stony places at 1950–2255 m altitude, sharing its habitat with *Fritillaria crassifolia* Boiss. & Huet subsp. *kurdica* (Boiss & Noë) Rix, *Iris reticulata* M.Bieb. var. *reticulata*, *Iris sari* Schott ex Baker, *Allium scabriscapum* Boiss. & Kotschy, *Gagea bulbifera* and *G. reticulata*.

Taxonomic relationships:—The anatomy of *G. chomutovae* was studied by Zarrei *et al.* (2010): the cross section of the pedicel is circular to circular–sinuate in outline; there is no clear boundary between the derm and the pith; the hypoderm is three to four layers thick; the basal leaf is fistulose without collenchyma and sclerenchyma; the palisade parenchyma consists of two or three layers; the pith disappears during the ontogeny of the basal leaf unlike the other members of sect. *Stipitatae* including *G. vanensis*. Zarrei & Zarre (2005) studied the pollen morphology of several members of section *Stipitatae*: the sculpture of the exine is reticulate in proximal face and perforate in distal face in *G. chomutovae*, but perforate in *G. ova* and *G. stipitata* aggregate; the muri of these species are compound and simpli-columellate as characteristics of sect. *Stipitatae* including *G. vanensis*. Unlike these species, the pollen of *G. vanensis* is conspicuous in its reticulate-cristate ornamentation. According to many researchers (Pascher 1907, Grossheim 1935, Levichev 1990, Levichev 2006, Ali and Levichev 2007, Zarrei *et al.* 2007, 2010, 2011b, Peterson *et al.* 2011) and the present study, the diagnostic morphological and anatomical characters useful for the distinction among *G. vanensis*, *G. ova*, *G. stipitata*, *G. absurda*, *G. kunawurensis*, and *G. chomutovae* are given in Table 1.

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References

- Ali, S.I. (2006) Two new species of *Gagea* Salisb. (Liliaceae) from Pakistan. *Pakistan Journal of Botany* 38: 43–46.
- Ali, S.I. & Levichev, I.G. (2007) *Gagea*. In: Ali, S.I. & Qaiser, M. (Eds.) *Flora of Pakistan: Liliaceae*. Missouri Botanical Press, USA, pp. 17–81.
- Boissier, E. (1882) *Flora Orientalis* 5(1). Basel, Geneva, 280 pp.
- Bunge, A.A. (1851) Beitrag zur Kenntniss der Flor Russlands und der Steppen Central-Asiens. *Mémoires des Savants Étrangers Academié. Saint Pétersbourg* 7: 1–512.
<http://dx.doi.org/10.5962/bhl.title.51048>
- Davlianidze, M.T. (1972) Conspectus of the Caucasian representatives of the genus *Gagea* Salisb. I. Notulae Systematicae ac Geographicae, *Instituti Botanici Thbilissiensis* 29: 1–71.
- Davlianidze, M.T. (1973) Conspectus of the Caucasian representatives of the genus *Gagea* Salisb. II. Notulae Systematicae ac Geographicae, *Instituti Botanici Thbilissiensis* 30: 1–62.
- Feinbrun-Dothan, N. (1986) *Flora Palaestina* 4. Jerusalem Academic Press, Jerusalem, 33 pp.
- Greuter, W. (1970) The taxonomic position of *Lloydia graeca* (Liliaceae) and related species. *Israel Journal of Botany* 19: 155–160.
- Grossheim, A.A. (1935) *Gagea* Salisb. In: Komarov, V.L. (Ed.) *Flora USSR* 4, Israel Program for Scientific Translation Ltd., pp. 61–112.
- Hamzaoğlu, E., Budak, Ü. & Aksoy, A. (2008). A new species of *Gagea* Salisb. (Liliaceae) from Sivas (Central Anatolia, Turkey). *Turkish Journal of Botany* 32: 61–64.
- Hesse, M., Halbroter, H., Zetter, R., Weber, M., Buchner, R., Frosch-Radovo, A. & Ulrich, S. (2009) *Pollen Terminology: An illustrated handbook*. Springer-Verlag/Wien, Austria, 270 pp.
- Heywood, V.H. (1980) *Lloydia* Salisb. ex Rchb. In: Tutin, T.G., Heywood, V.H., Burges, N.A. & Valentine, D.H. (Eds.) *Flora Europaea* 5. Cambridge University Press, Cambridge, UK, pp. 26–28.
- IUCN (2013) *IUCN red list of threatened species, version 2013.2*. IUCN Red List Unit, Cambridge U.K. Available from: <http://www.iucnredlist.org/> (accessed 5 June 2014).
- Kayıkçı, S., Ocağ, A., Tekşen, M. & Karaman Erkul, S. (2014) *Gagea antakiensis*, a new species from Southern Anatolia, Turkey and the

- new finding of *Gagea lojaconoi* (Liliaceae). *Phytotaxa* 170: 269–277.
<http://dx.doi.org/10.11646/phytotaxa.170.4.4>
- Koch, C. (1849) Beiträge zu einer Flora des Orientes (Fortsetzung). *Linnaea*, 22: 1–229.
- Kosenko, V.N. (1991a) Pollen morphology of the genus *Fritillaria* (Liliaceae). *Botanicheskii Zhurnal* 76: 1201–1210.
- Kosenko, V.N. (1991b) Palynomorphology of the family Liliaceae s. str. *Botanicheskii Zhurnal* 76: 1696–1706.
- Kosenko, V.N. (1992) Pollen morphology and systematic problems of the Liliaceae family. *Botanicheskii Zhurnal* 77: 1–15.
- Kosenko, V.N. (1999) Contribution to the pollen morphology and taxonomy of Liliaceae. *Grana* 38: 20–30.
- Levichev, I.G. (1990) On age variation and hybridization of some representatives of *Gagea* (Liliaceae). *Botanicheskii Zhurnal* 75: 656–667.
- Levichev, I.G. (1999) Phytogeographical analysis of the genus *Gagea* Salisb. (Liliaceae). *Komarovia* 1: 47–59.
- Levichev, I.G. (2006) A review of the *Gagea* (Liliaceae) species in the flora of Caucasus. *Botanicheskii Zhurnal* 91: 917–951.
- Levichev, I.G. (2011) Neotenic divergence in genus *Gagea* (Liliaceae). *Takhtajania* 1: 133–137.
- Moore, P.D., Webb, J.A. & Collinson, M.E. (1991) *Pollen Analysis*. Blackwell, London, 216 pp.
- Pascher, A.A. (1904) Übersicht über die Arten der Gattung *Gagea*. *Sitzungsberichte des Deutschen naturwissenschaftlich-medizischen Vereins für Böhmen 'Lotos'* 24: 116–118.
- Pascher, A.A. (1905) Neue Arten und Varietäten der Gattung *Gagea*. *Feddes Repertorium* 1: 1–194.
<http://dx.doi.org/10.1002/fedr.4870011302>
- Pascher, A.A. (1907) Conspectus Gagearum Asiae. *Bulletin of the de la Societe Imperiale des Naturalistes de Moscou* 19: 1–372.
- Peruzzi, L. (2003) Contribution to the cytotaxonomical knowledge of *Gagea* Salisb. (Liliaceae) sect. *Foliatae* A. Terracc. and synthesis of karyological data. *Caryologia* 56: 115–128.
<http://dx.doi.org/10.1080/00087114.2003.10589314>
- Peruzzi, L. (2012) Nomenclatural novelties at sectional level in *Gagea* (Liliaceae). *Atti della Società Toscana di Scienze Naturali, Memorie, serie B* 118 (2011): 23–24.
- Peruzzi, L., Peterson, A., Tison, J.M. & Harpke, D. (2011) New light on phylogeny and taxonomy of the Eurasian *Gagea villosa*–*G. fragifera* group (Liliaceae). *Nordic Journal of Botany* 29: 722–733.
<http://dx.doi.org/10.1111/j.1756-1051.2011.01187.x>
- Peruzzi, L., Peterson, A., Tison, J.M. & Peterson, J. (2008a) Phylogenetic relationships of *Gagea* Salisb. (Liliaceae) in Italy, inferred from molecular and morphological data matrices. *Plant Systematics and Evolution* 276: 219–234.
<http://dx.doi.org/10.1007/s00606-008-0081-4>
- Peruzzi, L., Tison, J.M., Peterson, A., & Peterson, J. (2008b) On the phylogenetic position and taxonomic value of *Gagea trinervia* (Viv.) Greuter and *Gagea* sect. *Anthericoides* A. Terracc. (Liliaceae). *Taxon* 57: 1201–1214.
- Peterson, A., Levichev, I.G. & Peterson, J. (2008) Systematics of *Gagea* and *Lloydia* (Liliaceae) and infrageneric classification of *Gagea* based on molecular and morphological data. *Molecular Phylogenetics and Evolution* 46: 446–465.
<http://dx.doi.org/10.1016/j.ympev.2007.11.016>
- Peterson, A., Harpke, D., Peruzzi, L., Levichev, I.G., Tison, J.M. & Peterson, J. (2009) Hybridization drives speciation in *Gagea* (Liliaceae). *Plant Systematics and Evolution* 278: 133–148.
<http://dx.doi.org/10.1007/s00606-008-0102-3>
- Peterson, A., Levichev, I.G., Peterson, J., Harpke, D. & Schnittler, M. (2011) New insights into the phylogeny and taxonomy of Chinese species of *Gagea* (Liliaceae) – speciation through hybridization. *Organism Diversity and Evolution* 11: 387–407.
<http://dx.doi.org/10.1007/s13127-011-0059-x>
- Post, G.E. (1932) *Flora of Syria, Palestine and Sinai* 2. American Press, Beirut, 624 pp.
- Punt, W., Hoen, P.P., Blackmore, S., Nilsson, S. & Le Thomas, A. (2007) Glossary of pollen and spore terminology. *Review of Palaeobotany and Palynology* 143: 1–81.
<http://dx.doi.org/10.1016/j.revpalbo.2006.06.008>
- Rix, E.M. (1984) *Gagea* Salisb. In: Davis, P.H. (Ed.) *Flora of Turkey and the East Aegean Islands* 8. Edinburgh University Press, Edinburgh, pp. 312–327.
- Royle, J.F. (1839) *Illustrations of the botany and other branches of natural history of the Himalayan mountains, and of the Flora of Cashmere*. London: W. H. Allen & Co., 388 pp.
- Salisbury, R.A. (1806) On the characters of a distinct genus hitherto confounded with *Ornithogalum*, and called *Gagea*; with some remarks on the importance of the inflorescence in distinguishing genera. *Annals of Botany (London)* 2: 553–557.
- Stapf, O. (1885) Beiträge zur Flora von Lycien, Carien und Mesopotamien. *Planta collectaea Dre Felix Luschan ann. 1881, 1882, 1883, 1. Denkschriften der Kaiserlichen Akademie der Wissenschaften, Wien. Mathematisch-Naturwissenschaftliche Klasse. Vienna.* 50: 1–16.
- Terracciano, A. (1905) Les espèces du genre *Gagea* dans la flore del l'Afrique boréale, *Bulletin de la Societe Botanique de France* 52:

1–24.

<http://dx.doi.org/10.1080/00378941.1905.10833362>

- Thiers, B. (2014) *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. Available from: <http://sweetgum.nybg.org/ih/> (accessed 25 May 2014).
- Tison, J.M., Peterson, A., Harpke, D. & Peruzzi, L. (2013) Reticulate evolution of the critical Mediterranean *Gagea* sect. *Didymobulbos* (Liliaceae) and its taxonomic implications. *Plant Systematics and Evolution* 299: 413–438.
<http://dx.doi.org/10.1007/s00606-012-0731-4>
- Townsend, C.C. & Guest, E. (1985) *Gagea* Salisb. In: Townsend, C.C. & Guest, E. (Eds.) *Flora of Iraq* 8. Ministry of Agriculture & Agrarian Reform Republic of Iraq, Baghdad, pp. 65–75.
- Turczaninow, N.S. (1844) *Plecostigma paucifolium* Turcz. In: Trautwetter, E.R. (Ed.) *Plantarum Imagines Descriptiones Floram Russicam*. Monachii, 8 pp.
<http://dx.doi.org/10.5962/bhl.title.6362>
- Wodehouse, R.P. (1935) *Pollen Grains*. Mc Graw-Hill, New York, 574 pp.
- WCSP (2014) *World Checklist of Selected Plant Families*. Facilitated by the Royal Botanic Gardens, Kew. Available from <http://apps.kew.org/wcsp/> (accessed 17 July 2014).
- Zarrei, M., Wilkin, P., Fay, M.F., Ingrouille, M.J., Zarre, S. & Chase, M.W. (2009) Molecular systematics of *Gagea* and *Lloydia* (Liliaceae; Liliales): implications of analyses of nuclear ribosomal and plastid DNA sequences for infrageneric classification. *Annals of Botany (London)* 104: 125–142.
<http://dx.doi.org/10.1093/aob/mcp103>
- Zarrei, M., Wilkin, P., Ingrouille, M.J., Zarre, S. & Chase, M.W. (2010) The systematic importance of anatomical data in *Gagea* (Liliaceae) from the Flora Iranica area. *Botanical Journal of the Linnean Society* 164: 155–177.
<http://dx.doi.org/10.1111/j.1095-8339.2010.01081.x>
- Zarrei, M., Wilkin, P., Noltie, H.J., Ingrouille, M.J. & Chase, M.W. (2011a) A revised infrageneric classification for *Gagea* Salisb. (Tulipeae; Liliaceae): insights from DNA sequence and morphological data. *Phytotaxa* 15: 44–56.
- Zarrei, M., Wilkin, P., Noltie, H.J., Ingrouille, M.J. & Chase, M.W. (2011b) Clarifying the nomenclature and taxonomy of *Gagea kunawurensis* (Royle) Greuter (Liliaceae) and allied taxa. *Edinburgh Journal of Botany* 68: 43–59.
<http://dx.doi.org/10.1017/s0960428610000296>
- Zarrei, M. & Zarre, S. (2005) Pollen morphology of the genus *Gagea* (Liliaceae) in Iran. *Flora* 200: 96–108.
<http://dx.doi.org/10.1016/j.flora.2004.04.001>
- Zarrei, M., Zarre, S., Wilkin, P. & Rix, E.M. (2007) Systematic revision of the genus *Gagea* Salisb. (Liliaceae) in Iran. *Botanical Journal of the Linnean Society* 154: 559–588.
<http://dx.doi.org/10.1111/j.1095-8339.2007.00678.x>

APPENDIX 1. Specimens investigated of *Gagea chomutovae*, *G. stipitata*, *G. ova*, *G. absurda* and *G.*

kunawurensis.

Gagea chomutovae:—UZBEKISTAN, Tashkent, Chomutova s.n. (lectotype, LE!); TURKEY: Van: Bahçesaray, Kızılköprü to Hizan, 57 km to Hizan, 2255 m, stony slopes, 11 May 2010, *M. Tekşen 2411* & *S. Karaman* (GAZI!); Güzelsu, Hoşap to Günbaşı village, 13. km, 1950 m, 15 May 2012, steppe, *M. Tekşen 2878* & *S. Karaman* (GAZI!); Güzelsu, Hoşap to Gürpınar, 7 km from Hoşap, 1971 m, 16 May 2012, steppe, *M. Tekşen 2880* & *S. Karaman* (GAZI!); *ibidem*, 18 May 2013, *M. Tekşen 2914* & *S. Karaman* (GAZI!).

G. stipitata:—TURKMENISTAN (?): Auf dem Dioritplateau zwischen Juss-Chuduk und Bakal, 25 April 1842 *Collector unknown* (syntype, LE!); AFGHANISTAN: Prov. Baghlan, N. Side of Salang pass, soil slopes, c.2100 m, 4 May 1969, *Hedge, Wendelbo 7759* & *Ekberg* (E!).

G. ova:—IRAN, Lorestan, in monte Karaghan (media), ad Schurab, 1882, *Pichler s.n.* (lectotype, K!).

G. absurda:—KIRGIZIA: Osh region, area Toktogulsky, river Niczke, locus Kotsch-Tectir, 21 June 1976, *R. Aidarova*, *A. Ubukeeva*, *R. Sultanova s.n.* (isotype, LE!); Pakistan, Chitral, Owir (Nichagh), 36°7'N, 71°55'E, 10000 ft, dry stony bank facing north, bright yellow, 11 June 1958, *S.A. Bowes Lyon 873* (BM!).

G. kunawurensis:—INDIA: Royle 1840, tab. 93 *Kunawur*. Herb Royle (lectotype, K!).