

**FOUR NEW SPECIES OF THE GENUS *GAGEA* SALISB.
(LILIACEAE) FROM WESTERN HIMALAYAS
AND THE ADJOINING REGIONS**

IGOR G. LEVICHEV

*Herbarium, Komarov Botanical Institute of the Russian Academy of Sciences,
Prof. Popov str. 2, Saint Petersburg 197376, Russia.
E-mail: ilevichev@yandex.ru*

Abstract

The importance of various characters for the taxonomic discrimination of taxa in the genus *Gagea* is discussed. Four new species of the genus *Gagea* from Western Himalayas and the adjoining regions are described. Two species, *G. alii* Levichev and *G. utriculosa* Levichev belong to section *Plectostigma* whereas *G. bowes-lyonii* Levichev and *G. spumosa* Levichev are attributed to section *Stipitatae*.

Introduction

As a result of reviewing representatives of the genus *Gagea* Salisb., within the limits of the Western Himalayas and adjoining regions, presence of new species has been established; some of the results are described below. Herbarium specimen collections from BM, BSD, E, G, K, KUH, LE, LIV, MW, RAW, UPS, W and WU were reviewed, alongwith the results of long-term research of living plants from different areas of distribution of the genus i.e., Eurasia and North Africa (Levichev, 1999a, 1999b, 2002). It is necessary to briefly specify some features of the genus, which have taxonomic value and are used in descriptions. Organs of vegetative propagation, the cross-section (T.S.) of the basal leaves and peduncle, color of the perianth and anthers are most important for differentiation of species. For this reason, along with the mature plant the juvenile specimens of different ages growing side by side are also important in addition to the characters referred to above.

The obligatory generic attribute of *Gagea* is the presence of two basal leaves. However, these leaves demonstrate different features in diverse species, as well as very ambiguous behaviour during their ontogeny. Leaves may be free, but only the first leaf may be visible, and the second leaf may be either reduced or fuses with the peduncle and is separated from it in the form of the bottom leaf in an inflorescence. However, the true leaf of an inflorescence - the fourth leaf on a shoot - is located always above on the one side with first i.e. the basal leaf. Finally, the basal leaves may be absent: when both are reduced, or the first leaf fuses with a peduncle and the second is reduced. This variability is limited strictly to species by laws of ontogeny. This information is used for taxonomic purposes. The reduction of the leaf is a good indicator of the rudiment. Accretion with a peduncle is testified by the position at the subinflorescence leaf concerning the first basal leaf. This is also substantiated by the presence of two circles of vascular bundles in a peduncle, or presence of 1 or 2 vertical channels in the peduncle, or axile bulbils, or the character of the surface of the peduncle (Levichev, 2001c).

Localization, color and the texture of the surface of vegetative bulbils is related to the number of very reliable attributes. However, it is necessary to consider, that during an annual cycle these features regularly change. Coloring and the texture of ripened bulbils are of taxonomic importance (especially, generated in the previous cycle of growth). Originally the bulbils are smooth and milky-white. During development, white color is consistently replaced by yellowish, reddish, brown and almost black. Simultaneously, the surface gets pumiceform, either cellular, or wrinkled, or uneven, or warty in texture. However, a light color or a smooth surface on mature bulbils are also characteristic of some species. In contrast, the formation of the texture and color can "stop" at early stages of morphogenesis. Such juvenilization or natural evolutionary results also have taxonomic value (Levichev, 2005c).

In bulbous plants the true stem is the disk (lecus). The aerial axis is presented by the axial and appendicular organs associated with the peduncle (pedicel, flower stalk) or pseudostems sensu K. Kubitzki (1998: 7). For this reason in descriptions the term "pedunculus" is used.

Shoots in *Gagea* are of cryptodicyclic type (Levichev, 2001b, 2005a). Each shoot develops within two years. In the first cycle the replacing bulb is formed only with one of the reserving bottom-scales and a bud of the future overground shoot. In the second cycle the overground field of the shoot develops. Shoots of the first and second cycles possess their own annual roots. In very large number of species in the first cycle the special type of roots - sclerificatous roots (Mordak, 1982; Levichev, 1982, 1999) develop. These are short-cut, incrassate up to 1-1.5 mm in diameter; very rigid and ageotropic (upwards and in the parties) the focussed roots which more or less loosely surround their own bulb. Such roots can be kept and collected for several years. Sclerificatous roots effectively feed a bulb for 1-2 months, then die off. However, in the dead condition the sclerificatous roots can use their capillary properties for mechanical support and concentrate around the bulb during water scarcity throughout the years. In empty, very large cells of these roots, there is condensation of air moisture also (Levichev, 1999a). In the individual species these roots are thickened only on the proximal end and in the distal direction thin roots are present. In the first cycle ageotropic or geotropic thin roots are also known. In the second cycle of each dicyclic shoot only thin, soft, long, geotropic roots develop.

Wide range of neotenical structures of basal leaves is met with in the genus *Gagea* (Levichev, 1999b). In the generative stages in different species, the form of a leaf from flat (with a horizontal line of numerous vascular bundles), typically bifacial plate narrowed in similarity to the base (the type of the leaf qualified as exhibiting the least degree of a neotenization within the limits of the given genus), up to a filiform cotyledon-similar plate of unifacial type with unique vascular bundles in the center (one of the greatest degrees of a neotenization). The sheet plate can combine the unifacial and bifacial structure along the axis. The parity of length of unifacial and bifacial fields varies variously according to the laws, and also allows to judge a degree of neotenization of the given taxon. Prevalence of a unifacial field testifies to an increase in the degree of neotenization, down to a leaf of especially unifacial structure (Levichev, 2003), and then, up to a small fragment of such unifacial leaf (up to its rudiment), with the subsequent transition of the given neotenized basal phytomer in the most neotenical condition - in a "silent" category (Levichev, 2005a; Levichev & Krasovskaya, 2005).

Similar variability is present in other modern representatives of some lilies s. str., onions, iris, amaryllis and other monocotyledons as well as in some dicotyledons (Vasil'chenko, 1965). Neotenical transformation of the leaf plates at a radical level of a shoot of definite age (Helikomorphie sensu Diels, 1906) bears specific information regarding the differentiation of species. The genera and species differ from each other in the degree of neotenical transformation (Levichev, 2001a). The analysis of such variability in *Gagea*, has led to the conclusion about neotenical divergence in phylogenesis of the genus (Levichev, 2005a; Levichev, 2005, Levichev & Krasovskaya 2005, Levichev, 2006).

In bulbous plants neotenical evidences are most appreciable at the basal level that allows us to assume the reasons of the occurrence of this phenomenon (Levichev, 2001a). In cross-section of a basal leaf it is not complex to define a degree of a neotenization of a concrete taxon within the limits of a genus (or on the basis of leaf cross-sections - a degree of neotenization of taxonomic groups). For this purpose an empirical line of a neotenization is used in the form of the certain sequence from generalisation of forms of cross-section of a leaf plate (Levichev, 2003). Such "empirical line" reflects simultaneously: age changeability of a leaf in ontogeny (at the left - to the right), a degree of neotenization of a taxon (on the right - to the left), dependence of the structure of a leaf on its position on the axis of a shoot (on the left - to the right) and sequence of an individual morphogenesis (from old to young tissues) of the basipetally developing leaf (at the left - to the right).

Neotenical species of *Gagea* grow in the most extreme habitats: the driest, cold or on the grounds used by a person. It is a parameter of evolutionary specialization to adverse conditions. Taxa with an insignificant degree of a neotenization are widespread in optimum conditions for obligatory mesophytes.

1. *Gagea alii* Levichev, sp. nov. (sect. *Plecostigma* (Turcz.) Pasch.) Affinitas. A *G. chlorantha* (Bieb.) Schult. et Schult.f. magnitudine, folio radicali solitario, inflorescentia multiflora differt.

Plantae solitariae et perpaucae gregariae, plerumque magnae, 7-25 cm alt. Bulbus 9-11 mm in diam., guttiformis, tunicis firme coriaceis, fissis, griseolo-fuscis, in collum breve (ad 1.2 cm lg.) continuatis tectus, in plantis juvenilibus radicibus sclerificatis crassis (in plantis vetustis nullis) circumcinctus. Bulbillus vegetativus solitarius, semiguttiformis, radicibus sclerificatis crassis, sursum directis, paucis circumcinctus. Pedunculus 3-10 cm lg., sectione rotundatus, ca 2 mm in diam. Folium radicale solitarium, inflorescentia sublongius, gradatim attenuescens, ad 1 mm lt. Folia pedunculo alterna inferius inflorescentiae subaequilongum, lineare, ad basin vix dilatatum, ad 2 mm lt. Inflorescentia ramosa, 6-14-flora, flores congesti. Perianthii phylla lanceolata, apice rotundata et calyptrata, 9-12 mm lg., sub anthesi elongata, 2-2.5 mm lt., intus flava, extus virescentia, interiora paleimarginata, exterioribus vix breviora et angustiora. Antherae flavae, dehiscentes lineares, ad 2.8 mm lg. Ovarium oblongum, sessile.

Species in honorem exploratoris et peritissimi florum Pakistanicae cl. S. I. Ali nominata est.

Differs from *G. chlorantha* (Bieb.) Schult. et Schult.f. in the large sizes, in having a single basal leaf and a multiflorous inflorescence.

Plant single and not in groups of numerous plants, 7-25 cm in height. Bulb 9-11 mm in diameter, ovate covered by densely-coriaceous, greyish-brown tunic, continued in a short neck (up to 1.2 cm) in young plants the bulb is surrounded by thick (c. 0.8 mm in diameter) sclerificatous roots (absent in old plants). Vegetative bulbil single, semi-ovate, surrounded by few upwards directed, thick sclerificatous roots. Peduncle 3-10 cm long, in section roundish, nearby 2 mm in diameter. Basal leaf single, longer than the inflorescence, c. 1 mm broad. Leaves on the peduncle linear, at the base c. 2 mm broad. Inflorescence branched, 6-14-flowered, flowers dense. Tepals lanceolate, tip rotund and bearing a cap-like covering, 9 mm long, enlarging during flowering, 2-2.5 mm broad, yellow inside, greenish outside. Anthers yellow, dehiscence linear, up to 2.8 mm long. Ovary oblong, sessile.

Species is named in honour of the researcher and the expert of the flora of Pakistan S.I. Ali.

Holotype: India, British Beluchistan [Pakistan]: secundum viam e Sorob ad Khuzdar, 11 Martii, 1943, V.I. Ulijaniszczew (LE!). Latin translation of the Russian label.

2. *Gagea bowes-lyonii* Levichev, *sp. nov.* (sect. Stipitatae (Pascher) Davlianidze) Affinitas. A *G. kunawurensis* (Royle) Greuter minutie, *G. capillifolia* Vved. folio radicali unico, a *G. paedophila* Vved. folio pedunculi infimo angusto et folio radicali longo, a *G. exilis* Vved. perianthii phyllis acutiusculis, a *G. toktogulii* bulbillis vegetativis aggregatis (nec bulbillo solitario, radicibus sclerificatis perplexo) differt.

Plantae minutae tenues, flexiles, 5-8(13) cm altae, solitariae vel perpaucae gregarie. Bulbus 4-6 mm in diam., oblique guttiformis, tunicis brunneis tenuiter coriaceis fissis, in collum breve (0.5 cm lg.) productis tectus, radicibus sclerificatis tenuibus paucis circumcinctus. Bulbilli gregarii brunnescenti-fusci, lobuliformes, ad 0.9-1.4 mm alt. et circa 0.7 mm in diam., minutissime alveolati, latere et apice affixi, quorum basalis non prominens. Pedunculus 2-6 cm alt., ca 0.5 mm in diam. Folium radicale soitarium, capilliforme, ca 0.3-0.4 mm in diam. flexuosum, inflorescentiam superans. Folia pedunculo alterna, quorum infimus anguste lanceolato-lineare, in cuspidem longam cylindricam attenuatum, inflorescentiae dimidium non attingens, 2-2.5 mm lt. Flores in inflorescentiam laxam 2-4(6)-floram dispositi, pedicellis tenuibus flexibilibus. Perianthii phylla 4.8-6.3 mm lg., ad 1 mm lt., oblanceolata, basi angustata, acutiuscula, intus aurea, extus virescentia, interiora exterioribus breviora et apice rotundata. Antherae flavae, oblongae, 0.8 mm lg., dehiscentes subglobosae, 0.5 mm in diam. Capsula obovoidea, in stipitem longum angustata, perianthio plus quam duplo brevior.

Species in honorem florum Himalaicae investigatoris cl. S.A. Bowes Lyon nominata est.

Differs from *G. kunawurensis* (Royle) Greuter in the reduced sizes, from *G. capillifolia* Vved., in having one basal leaf, from *G. paedophila* Vved. in having a narrow leaf of the peduncle and a long basal leaf, from *G. exilis* Vved., in not having the pointed tepals, from *G. toktogulii* Levichev in having a group of vegetative bulbils (instead of single, with braiding from sclerificatous roots).

Plants single and not growing in groups, tiny, thin, bending, 5-8 (13) cm in height. Bulb 4-6 mm in diameter, obliquely-ovate, covered by thin coriaceous, brown tunic, continued in short (0.5 cm) neck not attached to numerous thin sclerificatous roots.

Bulbils many, brownish-brown, lobuleform, 0.9-1.4 mm in height, and about 0.7 mm in diameter, very finely-cellular, with a lateral and top attachment, basal it is not allocated. Peduncle 2-6 cm in height, c. 0.5 mm in diameter. Basal leaf single, hair-like, c. 0.3-0.4 mm in diameter, bending, longer than the inflorescence. Peduncle leaves alternate narrowly lanceolate-linear, cuspidate, less than half the length of the inflorescence, 2-2.5 mm broad. Flowers in lax 2-4 (6)-flowered inflorescence, on thin bending pedicels. Tepals 4.8-6.3 mm long, nearly 1 mm broad, obovate, narrowed to the base, hardly pointed, golden-yellow inside, greenish outside, inner tepals a little bit longer, more broad and rounded on the end. Anthers yellow, oblong, 0.8 mm long, dehiscence by roundish pores 0.5 mm in diameter. Capsule obovate, narrowed in a long stipe, less than half the length of perianth.

Speices is named in honour of the researcher of the flora of Himalayas, S.A. Bowes Lyon.

Holotype: Chitral, Shishi Valley, Madaglash, 8000', between 35°35' N, 71°48' E and 35°45' N, 71°0' E., North slopes, beneath fir trees, golden yellow lucids, pale green outside, in fine black soil, 6.5.1958, S.A. Bowes Lyon 624 (BM!).

Other specimen seen: Thelle, Baltistan, yellow flos, 21.5.1981, *Saood Omer*, S. Nazimuddin, E.A. B Wahid 950 (KUH!). Pakistan: Kaschmir, inter Doarian et Shardi, silva humida, 1910-1975 m, 16-17.5.1954, F. Schmidt 1924 (RAW!, iso-G); Kaschmir: Doarian et Shardi, Kishenganga vy, 5900-6100', May 16-17 1954, Dr. F. Schmidt 1974 (RAW!).

3. *Gagea spumosa* Levichev, sp. nov. (sect. Stipitatae (Pascher) Davlianidze)

Affinitas. A *G. kunawurensis* (Royle) Greuter foliis radicalibus et pedicellis capilliformibus, a *G. capillifolia* Vved. et *G. bowes-lyonii* Levichev magnitudine et bulbillo basali tuberculato differt.

Plantae graciles tenues ad 18 cm alt., flexiles, dense gregariae in caespites exemplaribus praecipue juvenilibus cum foliis capilliformibus. Bulbus 3-4 mm in diam., oblique guttiformis, tunicis griseo-fuscis tenuiter coriaceis fissis, in collum brevissimum (2-5 mm lg.) productis tectus. Bulbilli vegetativi in grege compacti, subnigri, quorum basalis anguste cochlearis, facie exteriori tuberculatus, minute alveolatus (spumosiformis), facie insertionis verticaliter regulariter alveolatus, bulbilli sororii hypobasalus, lobuliformes vel semilunati, saepe minute tuberculosi. Pedunculus 7-12 cm alt., 0.6-0.8 mm in diam. Folia radicalia duo, inflorescentiam superantia, flexuosa, capilliformia, ad 0.3 mm in diam. Folia pedunculo alterna, quorum infimum anguste lanceolato-lineare, in cuspidem longam sensim attenuatum, ad 3 mm lt., inflorescentiam fere attingens. Flores in inflorescentia laxa 2-4(6)-flora dispositi, pedicellis tenuibus flexibilibus. Perianthii phylla 7-9 mm long., 1-2 mm lt., intus flava, extus pallide viridia, interiora exterioribus sublatiora, sublongiora, apice magis rotundata, exteriora anguste lanceolata acutiuscula. Antherae flavae, dehiscentes subglobosae, 0.5 mm in diam. Ovarium elongatum, in stipitem angustatum. Capsula obovoidea, in stipitem longum angustata, perianthii phyllis subduplo brevior.

Differs from *G. kunawurensis* (Royle) Greuter in having hair-like basal leaves and pedicles, from *G. capillifolia* Vved., and *G. bowes-lyonii* Levichev in the increased sizes and tuberculate basal bulbils.

Plant slender up to 18 cm in height, bending, growing in patches with hair-like leaves in juvenile plants. Bulb 3-4 mm in diameter, obliquely-ovate, tunic thin coriaceous, gray-brown, continued in very short (2-5 mm) neck. Vegetative bulbils in dense group, blackish, basal narrowly cochleariform, external surface tuberculate, fine-meshed (foam-figurative), sisterous bulbils hypobasal, lobuleform or semilunar, often finely-tuberculate. Peduncle 7-12 cm in height, c. 0.6-0.8 mm in diameter. Basal leaves two, longer than the inflorescence, bending, hair-like, c. 0.3 mm in diameter. Peduncle leaves narrowly lanceolate-linear (cusp elongated) c. 3 mm broad, almost as long as the inflorescence. Flowers in a lax 2-4 (6)-flowered inflorescence, on thin, bending pedicels. Tepals 7-9 mm long, 1-2 mm broad, yellow inside, pale-green outside, inner tepals little bit more wide, longer and more rounded at the end, external narrowly-lanceolate, hardly pointed. Anthers yellow, dehiscence by roundish pore, 0.5 mm in diameter. Ovary elongated, stipe thin. Capsule obovate, stipe long and thin.

Holotypus: [Pamir] Tadzshikstan, GBAR, jugum Ruschanicum, angustiae Tang, in declivibus argillosis, 2700 m, 8.6.1984, *D. Navruzshoev* 1401 (LE!). Latin translation of the Russian label.

Other specimens seen: [Ishkoman] Karambar glacier, 11300-12000', flowers yellow, pale green reverse, on slope hillside with Juniper, on overhanging rock, 26. 6. 1976, S. A. Bowes Lyon 8221 (RAW!); [Pamir] Tajikistan, GBAR, Rushanski ridge, outskirts kishlak Sokhcharv, in cracks of rocks, 2100 m, 6.5.1984, *D. Navruzshoev* 1172 (LE!); Kirghizia, Central Tien Shan, a southern macroslope in east part of ridge Dzhamantau, stream Shorbulak, 4.8.1967, *M.G. Pimenov, E.V. Kljukov* (LE!) Alaiskii ridge, river basin Tap, a valley of the river Ojtal, a vicinity of settlement Ojtal, northern slope of mountain Karatuma, 22.7.1981, *M.G. Pimenov, E.V. Kljukov, M.G. Vasileva, T.V. Lavrova* (MW!)

4. *Gagea utriculosa* Levichev, sp. nov. (sect. Plecostigma (Turcz.) Pasch., ser. Vvedenskyiformes Levichev)

Affinitas. A *G. drummondii* Levichev et Ali plantae minutie et pedicellis brevibus, a *G. kuraiensis* Levichev et *G. neo-popovii* Golosk., inflorescentia 3-5-flora, a *G. jaeschkei* Pascher perianthii phyllis angustis et bulbillorum pedunculo quantitibus minutie, a speciebus quattuor capsulis majoribus differt.

Plantae solitariae, ad 7-10 cm alt. (folium radicale ad 17 cm lg.). Bulbus 8-10 mm in diam., elongatus, tunicis fuscidulo-griseis tenuiter coriaceis, in collum (1-2 cm lg.) fibrillosim continuatis tectus, sine radicibus sclerificatis. In statu immaturo et in statu generativo ineunte ex axillis unius-duorum foliorum infimorum pedunculi bulbilli pendentes. Folium radicale solitarium, lineare, inflorescentiam subduplo superans, 2-3 mm lt., sectione canaliculatum. Pedunculus 1-2 cm lg., alternifolius. Folium pedunculi infimum inflorescentiam fere attingens, ca 3 mm lt., anguste lanceolatum, sensim longe attenuatum, superiora decrescentia. Flores in inflorescentia anguste protracta 3-5-flora dispositi, pedicellis 3-4 cm lg. Perianthii phylla lineari-lanceolata, 10-17 mm longa, 1.4-2.2 mm lata, post anthesin elongata, apice rotundata, interiora exterioribus breviora et

angustiora. Antherae flavae, dehiscentes oblongae, ad 1.5 mm lg. Capsula perianthio subaequilonga, late elliptica (15-17 x 8.5-12mm), sessilis. Semina tenuiter plana. Differs from *G. drummondii* Levichev et Ali in the small sizes and short pedicels, from *G. kuraiensis* Levichev and *G. neo-popovii* Golosk. in having 3-5 flowered inflorescence, from *G. jaeschkei* Pascher in having narrow tepals and the reduced quantity of bulbils on a peduncle and from all four in having large capsules.

Plant single, not growing in groups, 7-10 cm (a basal leaf up to 17 cm) in height. Bulb 8-10 mm in diameter, tunic brownish-grey, thin, coriaceous, continued into a neck (1-2 cm long), without sclarificatous roots. In immature and in the early generative stages from the axils of 1-2 bottom leaves on the peduncle bulbils hang down. Basal leaf single, linear, almost twice the length of the inflorescence, 2-3 mm broad, grooved in section. Peduncle 1-2 cm long, leaves alternate. Bottom leaf of the peduncle almost as long as inflorescence, c. 3 mm broad, narrowly lanceolate, gradually elongated, upper smaller. Flowers in narrowly extended 3-5-flowered inflorescence, pedicels 3-4 cm long. Tepals linear-lanceolate, 10-17 mm long, 1.4-2.2 mm broad, increasing after flowering, tip rotund, internal tepals are shorter than the external. Anthers yellow, opening oblong, 1.5 mm long,. Capsule almost reaches the level of perianth, widely-elliptical (15-17 x 8.5-12 mm) sessile. Seeds thin, flat.

Holotype: Punjab, Mt. Sikisa, 3/1878, Doc. *Aitchison* (LE!)

Acknowledgements

The author is very grateful to S.I. Ali, J. Edmondson, S. Ghazanfar, A. Haigh, C. Jarvis, R. Kamelin, L. Klimes, D. Nicholson, S. Owens, E. Vitek, A. Smith and J.M. Tison for kind help with herbarium specimens and N.N. Nadel for correction of latin text. The financial support from Russian Foundation for Basic Research (05-04-48669) is gratefully acknowledged.

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(Received for publication 15 December 2005)