Galium sect. Leiogalium (Rubiaceae) in the Bulgarian flora

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Abstract. The work contains the results from the investigation of morphological variation, chromosome numbers and ploidy levels, distribution, phytogeographic and phylogenetic relationships of the species of genus Galium sect. Leiogalium, occurring on the territory of Bulgaria. The section includes 18 species and two non-nominal subspecies. Morphologically, phytogeographically and supposedly phylogenetically related species are divided into five species groups. The species are cross-pollinated entomophilous plants, which reproduce sexually and vegetatively by underground runners. The mesophilous species with white flowers, G. album, G. intermedium, G. lucidum, G. pashale, and G. procurrens, are pollinated chiefly by flies of Syrphidae, Muscidae and Larvivoridae. The xerophilous G. aegeum, G. mirum, G. asparagifolium, G. flavescens, G. rhodopeum with pale yellowish to greenish corolla are visited mostly by small coleopterans of the genera Strangalia, Agriotes, Mordelis, etc. Six species are Balkan endemics: G. mirum, G. macedonicum, G. rigidifolium, G. rhodopeum, G. aegeum and G. procurrens. Galium velenovskyi is a local endemic, restricted in its occurrence to the calcareous slopes of E Rhodopi Mts. The chromosome numbers and the ploidy levels of 18 species and two subspecies studied in 95 populations are reported in the article. Eight species are diploid, nine are tetraploid, and one is hexaploid, all with $x = 11$, the most common and probably original basic chromosome number in the genus. G. ×pomeranicum (G. album × G. verum) is polyploid with $2n = 44$.

Key words: Bulgaria, chromosome numbers, endemics, flora, Galium, hybridization, Leiogalium, phylogenetic relationships, polyploidy, reproductive biology

Introduction

Genus Galium in the Bulgarian botanical literature was treated with different taxonomic content. Velenovský (1891, 1898) reported 26 species in his Flora Bulation and Supplementum I to it. Stojanov & Stefanov (1925) included 21 species and six non-nominal subspecies in the first edition of the Flora of Bulgaria. That taxonomic structure remained almost unchanged in the following three editions of the Flora of Bulgaria (Stojanov & Stefanov 1933, 1948; Stojanov & al. 1967). In the next twenty years, the progress of cytotaxonomic investigations in systematic botany in Bulgaria had influenced the taxonomic studies of Galium. This resulted in taxonomic revisions published in a few papers (Ančev 1971, 1975, 1978; Anchev 1982; Ehrendorfer 1975) and subsequently included in Flora RP Bulgaricae (Ančev 1989). The accepted taxonomic structure followed Flora Europaea (Ehrendorfer & al. 1976), with morphologically well differentiated species and species groups, which included closely related taxa.

Galium is now represented in the Bulgarian flora by 38 species, four nothospecies, two non-nominal subspecies, six varieties, and seven forms. Thirty-one species are perennial plants, and seven are annuals, all classified into six sections: Platigalium Koch (3 spp.), Apari-
**Systematic treatment**

**Conspectus of *Galium* sect. *Leiogalium* species and subspecies in the Bulgarian flora**

(with reference to the ploidy levels based on chromosome counts in Bulgarian populations, in square brackets; see also Appendix 2)

**Sect. *Leiogalium* Ledeb.**

1–2. *G. mollugo* group

1. *G. lovocene* Urum. (incl. *G. protopycnotrichum* Ehrend. & Krendl) [2x]

2. *G. album* Mill. [4x]

   subsp. *album*
   subsp. *pycnotrichum* (Heinr. Braun) Krendl
   subsp. *prusense* (K. Koch) Ehrend. & Krendl

3. *G. lucidum* All. [4x]

4–8. *G. asparagifolium* group


5. *G. macedonicum* Krendl [2x]

6. *G. rigidifolium* Krendl [4x]

7. *G. flavescens* Borbás [4x]

8. *G. asparagifolium* Boiss. [4x]

9–11. *G. rhodopeum* group

9. *G. rhodopeum* Velen. [2x, ?4x]

10. *G. velenovskyi* Ančev [4x]

11. *G. aegeum* (Stoj. & Kitan.) Ančev [4x]

12–14. *G. glaucum* group

12. *G. octonarium* (Klokov) Pobed. [2x]

13. *G. glaucum* L. [4x]

14. *G. volhynicum* Pobed. [?2n]

15–18. *G. sylvaticum* group

15. *G. pseudoaristatum* Schur [2x]

16. *G. paschale* Forsskål [2x]

17. *G. procurrens* Ehrend. [2x]

18. *G. intermedium* Schult. (*G. schultesii* Vest) [6x]

**Variation and diagnostic characters**

The morphological variation of the species members of sect. *Leiogalium* concerns the root system, size and position of the stem, number, size and form of the leaves, position of the leaf margins toward the midrib, form and branching of the inflorescence, length of the flower/ fruit pedicel, form and diameter of the corolla, form of the corolla lobes. For a correct identification one needs plants with well preserved flowers.
The woody stock with a branched taproot without subterranean runners are characters differentiating *G. lovcense* (2x) from the related to it *G. lucidum* (4x) and narrow-leafy forms of *G. album* (4x). The well developed taproot differentiates *G. mirum* (2x) from *G. flavescens* (4x), as well as *G. octonarium* (2x) from *G. glaucum* (4x), and *G. paschale* (2x) from *G. procurrens* (2x).

The wide-leafy species, members of *mollugo* group and *sylvaticum* group, are mesophylo and xeromesophylo plants with oblancoaleate to oblong-oblancoaleate leaves. Their leaf size is a rather variable character, more or less related to the ecological characteristics of the habitat. The leaf form and the position of the leaf margin, together with the form of the corolla and corolla lobes, are important characters for the differentiation of the mesophilous and xeromesophilous species of *G. mollugo* and *asparagifolium*. The members of the *rhodopeum* group (*G. rhodopeum*, *G. velenovskyi* and *G. aegeum*) develop basal dense leafy shoots forming lax tufts. This feature, together with the narrow pyramidal inflorescence with short branches, differentiates *G. rhodopeum* group from *G. asparagifolium* group and the related *G. mirum*, *G. macedonicum*, *G. rigidifolium* and *G. flavescens*, which do not form basal tufts and have wide pyramidal inflorescences with long branches. The corolla form and diameter are diagnostic characters also of *G. octonarium*, *G. glaucum*, *G. procurrens* and *G. intermedium*.

Along with morphology, karyotype data and phyto-geographical characteristics, some secondary plant substances, and above all iridoid glycosides, were used in the biosystematic investigations into sect. *Leiogalium* in Bulgaria. In these studies, the phylogenetic relationships among species and species groups were analyzed on the basis of iridoid glycosides and iridoid patterns (Mitova & al. 2002). The results from these analyses supported the close relationships among the species members of *mollugo* group, as well as the differentiation of *G. lovcense* from *G. album*. The obtained phytocochemical evidence supported the close relationships among *G. rhodopeum*, *G. aegeum* and *asparagifolium*, on the one hand, and *G. mirum*, *G. macedonicum* and *G. rigidifolium*, on the other (Handjieva & al. 1996; Mitova & al. 1996a, b, 2002; Mitova 1999).

Ehrlich & Raven (1965: 601) emphasized that "secondary plant substances play the leading role in determining patterns of utilization. This seems true not only for butterflies, but for all phytophagous groups and also for those parasitic on plants". The results of our field observations in plant populations of *Galium* in the entire country demonstrate that, with two exceptions, there were no plants (leaves or flowers) damaged by insects. During more than four decades of field studies into the Bulgarian flora, only in two cases the junior author [here the first author] found plants of *G. album* subsp. *album* with heavily damaged leaves – in localities along the Black Sea Coast (north of the town of Varna) and in the Rhodopi Mts (Eastern – south of Kardzhali). Caterpillars of the moth *Macroglossa stellatarum* (Sphingidae) obviously fed on the leaves of these plants. This supported the known information about the members of *Rubiaeae* differentiated by Merz (1959, after Ehrlich & Raven 1965: 600) together with other families into the group "Sphingidpflanzen": plants fed on by moths of the family *Sphingidae*. We suppose that in *Galium* chemical compounds of the secoiridoil glycosides and triterpene saponins probably play the role of protection against phytophagous insects.

It is remarkable that in the herbarium materials of broad-leaved species of *Galium*, most of the members of sect. *Leiogalium*, observed in the Bulgarian herbaria (SO, SOA, SOM), as well as in 12 other European herbaria, no plants damaged by insects were found. Traces of damages to plants of other genera and families were found accidentally, particularly in older herbarium collections, the insects being most often larvae of small herbarium beetles of the genera *Stegobium*, *Ptinus* and *Anthrenus* (cf. Skvortsov 1977). Personal collections of voucher specimens of *Galium*, occasionally left for a few years without chemical or temperature treatment, were never damaged by insects, which was impossible with plants of *Cruciferae* or *Campanulaeae*, the families the junior author works with.

**Distribution and phyto-geographical relations**

The Bulgarian taxa of sect. *Leiogalium* pertain morphologically to two large groups – the first of them including wide-leaf, more or less mesophilous species, South-Central-European, East-Mediterranean and Balkan-Anatolian floral elements, related to *mollugo* group, with the diploid *G. lovcense* and polyploid *G. album*, and *sylvaticum* group, including the diploids *G. pseudoaristatum*, *G. paschale*, *G. procurrens* and the polyploid *intermedium* (*G. schultesii*).
The second, narrow-leaf group of species comprises narrow-leaf mesoxerophyous and xerophyous plants, Balkan-Anatolian, East-Mediterranean and Pontic-Balkan floral elements, related to the species groups of \textit{G. asparagifolium}, \textit{G. rhodopeum} and \textit{G. glaucum}. The \textit{G. asparagifolium} group includes the diploid \textit{G. mirum} and \textit{G. macedonicum} and the polyploid (tetraploid) \textit{G. rigidifolium}, \textit{G. flavescens} and \textit{G. asparagifolium}. Three of these species, two diploid and one polyploid, are Balkan endemics, and \textit{G. asparagifolium} has its area of distribution in the southeastern part of the Balkan Peninsula and W Anatolia. Members of the species group of \textit{G. rhodopeum} are three Balkan endemics, one diploid and two polyploids, with areas of distribution in the southeastern part of the Balkan Peninsula.

All three members of the \textit{G. glaucum} group (\textit{G. octonarium}, \textit{G. glaucum} and \textit{G. volhynicum}) are European forest-steppe elements. \textit{Galium octonarium} (2x) and \textit{G. volhynicum} (4x) occur in SE Europe, and \textit{G. glaucum} (4x) is distributed in the hilly plains and mountain foothills of W, C and S Europe.

The geographical distribution, species endemism and distribution of the diploids in the species groups suggest that the origin and the irradiation of the species members of sect. \textit{Leiogalium} are related to the phytogeographical area of Southwest and West Anatolia, the primary center of origin and diversification of genus \textit{Galium}. From that region, the species irradiated westwards and north-westwards to the Eastern Mediterranean, Balkan Peninsula and South Europe, where secondary centers of speciation and diversification arose (Ehrendorfer 1971; Ehrendorfer & Krendl 1976; Ehrendorfer & Shönbeck-Temesy 1982). The irradiation of species from the centers of speciation was most probably variably active in the different periods of their evolution. The species irradiated from South and Southeast through the Aegean pathway, where the Balkan-Anatolian exchange of floristic elements took place, closely connected to the East Mediterranean – a secondary center of speciation and species irradiation.

Formation of the contemporary species structure of section \textit{Leiogalium} in the Bulgarian flora resulted from processes closely related in time – genesis and distribution of the Balkan endemic (autochthonous) element, and irradiation of species from adjacent floras. In these processes, species of pre-glacial origin were involved, as well as species that had arisen from Pleistocene and post-Pleistocene form differentiation in the flora of the Balkan Peninsula and South Europe.

**Reproductive biology, chromosome numbers and hybridization**

The species of sect. \textit{Leiogalium} are entomophilous plants with protandrous flowers. The species with white flowers – \textit{G. album}, \textit{G. intermedium} (=\textit{G. schulteri}), \textit{G. pseudoaristatum}, \textit{G. paschale} (=\textit{G. bulgaricum}), \textit{G. procurrens}, and \textit{G. octonarium}, are pollinated mostly by flies of the families \textit{Syrphidae}, \textit{Muscidae} and \textit{Larvivoridae}. The xerophilous species with yellowish or pale-yellowish corolla, members of the species groups of \textit{G. asparagifolium} and \textit{G. rhodopeum}, are visited chiefly by small coleopterans. This was the reason to speculate that there is a connection between pollinators and plants, related to habitats and distribution of mesophilous and xerophilous plant populations, on the one hand, and of dipteran and coleopteran insects, on the other (Ančev 1982).

Karyological studies of the chromosome number and ploidy level include all 18 Bulgarian species of sect. \textit{Leiogalium}. Eight of them (44.4 %) are diploid (2n = 22), nine species (50 %) are tetraploid (2n = 44), and one (5.6 %) is hexaploid (2n = 66), all with x = 11 (Appendix 2), the most common and probably the original basic number in the genus. It is notable that all species which form ryzomes and reproduce sexually and vegetatively are polyploids. Such are \textit{G. album}, \textit{G. lucidum}, \textit{G. asparagifolium}, \textit{G. rigidifolium}, \textit{G. flavescens}, \textit{G. velenovskyi}, \textit{G. aeguenum}, \textit{G. intermedium}, and \textit{G. glaucum}. The three diploids \textit{G. macedonicum}, \textit{G. rhodopeum} and \textit{G. procurrens} also form ryzomes with underground runners. The diploids \textit{G. lovcense}, \textit{G. mirum}, \textit{G. pseudoaristatum}, and \textit{G. octonarium} form taproot without runners and reproduce only by seeds.

The pattern of morphological variability in \textit{Galium} is complicated by the interspecific, probably mostly introgressive hybridization. Because of the simple flower morphology, non-specialized insect pollination, partial reproductive compatibility even between morphologically distinct species taxonomically referred to different sections, combined with vegetative reproduction, hybridization is more or less common, where species grow in common habitats. In Bulgaria, \textit{G. x pomeranicum} Retz. (\textit{G. album} × \textit{G. verum}) occurs in the Forebalkan, Balkan Range (Central), Mt Vitosha Region, Rhodopi Mts (Western) and Mt Strandzha (Appendix 2). In Balkan Range (Central), \textit{G. x pomer-
Leaves 10–15(20) mm long; inflorescence with 2–5 patent branches; corolla 3–4 mm in diameter. ................ 6. *G. rigidifolium*

8 Leaves (20)25–40 mm long. ................ 7. *G. flavescens*

8* Leaves 5–15(20) mm long. ................ 9

9 Plant virgate; inflorescence with relatively long branches ................ 8. *G. asparagifolium*

9* Plant not virgate; inflorescence with short branches. ................ 10

10 Leaves linear, curved near the apex .... 11. *G. aegyptiaca*

10* Leaves acicular, straight, not curved near the apex ................ 11

11 Leaves 0.5–0.7 mm wide; corolla pale-yellowish, 3.5–4.5 mm in diameter ................ 9. *G. rhodopeum*

11* Leaves 0.7–1.0 mm wide; corolla white, 4–5 mm in diameter ................ 10. *G. velenoskyi*

12 (1*) Leaves 0.5–2 (3) mm wide; plant glaucous-pruinose ................ 13

12* Leaves (2)3–12 mm wide; plants green (*G. pseudoaristatum*) or glaucous-pruinose ............. 15

13 Plants with woody stock; leave margin with several rows of teeth ................ 12. *G. octonarium*

13* Plants with rootstock with subterranean runners; leave margin with 1–2 rows of teeth. .. 14

14 Corolla 3.5–4.5(6) mm in diameter; stem glabrous or occasionally hairy near the base .... 13. *G. glaucum*

14* Corolla 3–3.5(4) mm in diameter; stem hairy near the base ................ 14. *G. volhynicum*

15 Leaves green, linear lanceolate; stock without runners ................ 16

15* Leaves glaucous-pruinose, broadly lanceolate; rootstock with runners ................ 17

16 Stem quadrangular, mostly pilose ................ 15. *G. pseudoaristatum*

16* Stem rounded at the base, slightly quadrangular above, glabrous ................ 16. *G. paschale*

17 Corolla cup-shaped, mostly less than 3 mm in diameter; petals acute, not apiculate .... 17. *G. procurrens*

17* Corolla more or less rotate, seldom flowers cup-shaped, mostly more than 4 mm in diameter; petals shortly apiculate ............ 18. *G. intermedium*

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*p. lucidum* occurs together with the parental species and forms populations above the timberline. The hybrid *G. humifusum × G. verum*, sect. *Galium*, known from the steppes of E Europe, occurs in Bulgaria in the northeastern part of the country, near Silistra, where it is distributed together with the parental species. It was also reported for the vicinity of Obraztsov Chiflik, Ruse district (Stojanov & al. 1967).

Besides these species, hybrid plants, result from hybridization between members of different sections and species groups, also occur. Probably they have a short life, being represented by small populations with few individuals only growing in habitats transitional to the typical ones for the parental species. Such are the hybrids *G. octonarium × G. rhodopeum* (Thracian Lowland, 500 m) and *G. pseudoaristatum × G. verum* (Mt Vitosha, 950 m) (Ančev 1989). We believe that in common habitats *G. album* subsp. *album* hybridises with *G. lucidum*.

**Key to the species of *Galium* sect. *Leiogalium***

1 Corolla rotate. ...................... 2

1* Corolla cup-shaped .................. 12

2 Leaves (2)–6 mm broad, oblong to broadly oblanceolate ................ 3

2* Leaves 0.5–2 mm broad, narrowly lanceolate, linear to acicular ................ 5

3 Plants with woody stock, without subterranean runners ................ 1. *G. lovicense*

3* Plants with rootstock with subterranean runners. .... 4

4 Leaves oblong to broadly oblanceolate. 2. *G. album*

4* Leaves narrow oblanceolate or linear lanceolate ................ 3. *G. lucidum*

5 Stems 60–150 cm; corolla pale-yellowish .... 6

5* Stems 10–50(100) cm; corolla pale-yellowish to greenish, seldom white (*G. velenoskyi*) .... 8

6 Stems densely villous at base, hairs 1–2 mm long; partial inflorescence to 250 mm long. 4. *G. mirum*

6* Stems with hairs 0.1–0.7 mm at the base; partial inflorescence 30–80 mm long ........... 7

7 Leaves 10–15(20) mm long; inflorescence with 6–9 patent branches; corolla 2–3(4) mm in diameter ................ 5. *G. macedonicum*
**Sect. Leiogalium** Ledeb.

Perennial herbs with woody stock, more or less branched taproot or root ing stolons. Stems 4-angled or terete, glabrous or hairy, never retrorsely aculeate. Leaves in whorls of (4)6–10, with antrorsely directed papilliform teeth along the more or less revolute margins, inciscopious or prominent midrib and hyaline apiculum. Inflorescence mostly manyflowered, oblong, ovate, conoid or corymbiform; flowers on short or long pedicels; corolla rotate or cup-shaped, white, whitish, pale-yellowish, occasionally greenish, seldom yellow, lobes acute to apiculate. Pollen grains staphano-colpate, elliptic to spheroidal, (5)6–10(11) colpate. Fruit dry, ovoid, glabrous.

1–2. *G. mollugo* group

Plants green (not pruinose). Stock with, or without subterranean runners. Stems (10)20–60(80) cm. Leaves in whorls of 6–8, 10–20(30) × 1.5(5) mm, narrow oblanceolate or mostly on the lower part pale-violet. Leaves in whorls of 6–8, 10–20(30) × 1.5(5) mm, narrow oblanceolate or oblong elliptic, gradually narrowed towards the apex, margin slightly incurved, midrib narrow. Inflorescence elongate ovoid, branches patent; partial inflorescences narrow to broad conoid; pedicels 1–4 mm. Corolla (2)3–5 mm in diameter, whitish or yellowish-white, lobes with short, 0.3–0.4(0.5) mm long apiculus. 2n = 22*.

**Distribution and ecology**

In scattered localities along Black Sea Coast (Northern), Northeast Bulgaria, Forebalkan, Balkan Range, Znepole Region, West Frontier Mts, Valley of River Struma, Mt Belasitsa, Mt Slavyanka, Valley of River Mesta, Pirin Mts, Rhodopi Mts, Thracian Lowland, from 200 m up to about 1900 (2200) m a.s.l. In dry, open, gravely, mostly limestone habitats and rocky terrains, on the slopes of foothills and mountains (Appendix 1). SE Europe (Balkan Peninsula: Albania, Bosnia and Herzegovina, Crete, Greece, Croatia, Macedonia, Montenegro, Serbia), SW Asia (W Anatolia).

Flowering June to July.

**Note.** 1. The problem with differentiation of *G. lov­cense* from *G. protopycnotrichum* both diploids, is open to discussion. *Galium protopycnotrichum* was known mostly as a mesophyous plant with larger leaves, longer stems with more internodes, with pyramidal loose inflorescences, distributed mostly at the mountain foothills and mountains, on temperate wet and dry silicate and calcareous terrains. *Galium lov­cense* is a spe­cies comprising more xeromorphic plants, growing mostly on dry calcareous terrains with a wide range of variation of the stem length, branching, leaf size, pedicel length, and corolla diameter demonstrated in ecologically different habitats on the slopes of the mountain foothills and low mountains. Because the extreme morphotypes, mesomorphic and xeromorphic plants, are not clearly differentiated geographically, and there is no morphological basis for their taxonomic differentiation, *G. protopycnotrichum* here is treated in the synonymy of the earlier described *G. lov­cense*.

2. Low plants with short stem, obovate small leaves and short narrow pyramidal inflorescence found in three localities in rocky calcareous habitats in NE Bulgaria (near Tabachka vill., Ruse district, and in the vicinity of Madara and Kyulevcha, Shumen district) were taxonomically differentiated and described as...


**Type:** England, London „common in Chelsea“ (ex descr.). **Holotype:** BM?

Plants with branched rhizome with long rooting subterranean runners. Stems 50–150 cm, erect or ascending, branches ascending to spreading, short or long ramificate, glabrous or pilose, hairs 0.3–2 mm. Leaves in whorls of 6–8, 10–40 × 1.5–7 mm, oblong, oblanceolate, cuspidate acuminate or rounded and mucronate, scarcely scabrid along the flat to slightly incurved margin. Inflorescence broad, ovoid or oblong; partial inflorescences broad or narrow conoid; pedicels 1–5 mm. Corolla 3–5 mm in diameter, white or greenish-white (young flowers). 2n = 44, 44*.

**Distribution and ecology**

Scattered all over the country, from the sea level up to about 1900(2000) m. Occurs at road sides and in fields, on river banks, in mountain glades and meadows, in shrubby communities, in clearings and seldom mixed deciduous forests, on limestone, marble, gneiss, sandstone, crystalline, (Appendix 1). Widespread in Europe, Caucasus, SW and C Asia, W Siberia, Atlantic N America (adventive).

Flowering June to July (early August).

**Key to the subspecies**

1 Corolla whitish to yellowish; inflorescence oblong pyramidal with short branches; plants up to 60 (80) cm ................................. subsp. prusense

1* Corolla whitish; inflorescence broadly ovoid with long branches; plants often more than 80 cm . . . . . . . . . . . . . . . . . . . 2

2 Leaves oblanceolate, gradually narrowed towards the apex; plants often slender, predominantly glabrous .......................... subsp. album

2* Leaves oblong to broadly oblanceolate, abruptly narrowed towards the apex; plants robust, usually pilose .......................... subsp. pycnotrichum

G. album subsp. album


= G. mollugo var. angustifolium Leers, Fl. Helv. 52 (1789).


= G. mollugo subsp. mollugo sensu Hayek, in Hegi, Ill. Fl. Mitteleurop. 6/1, 212 (1914).


= G. mollugo var. pubescens Schrad., Spicil. Fl. Lips. 16 (1794).

Stems up to (60)80–150 cm, robust, mostly pilose. Leaves 10–40 × 3–7 mm, oblong or broadly oblanceolate, abruptly narrowed towards the apex. Inflorescence wide pyramidal with long branches. Corolla 3–4 mm in diameter, whitish or greenish-white. 2n = 44, 44*.

**Distribution and ecology**

Frequent in plains and lowlands, mostly in E and S Bulgaria. Occurs in steppe shrub forests, in dune areas, in rock reefs, from the sea level up to 900(1000) m a.s.l. S and C Europe (Pannonian area).

Flowering May to July.


≡ G. *prusense* C. Koch, Linnaea 24: 466 (1851).
≡ G. *erectum* auct. p.p., non Huds (1762).


Stems up to 60(80) cm, glabrous or pubescent with short flowering branches. Leaves 10–25 × 2–4(5) mm, oblongate to lanceolate, gradually narrowed towards apex, usually coriaceous. Inflorescence oblong, narrow, dense. Corolla 3.5–4.5 mm in diameter, white or yellowish-green. 2n = 44, 44*.

**Distribution and ecology**

In alpine grassland and pastures on gravelly, mostly limestone ground. Above the timberline, Mt Slavyanka, N Pirin Mts and Rila Mts, from (1700)1800 up to 2500 m a.s.l.

Flowering late June to early August.

**Note.** In Bulgaria (Black Sea Coast: Kranevo; Forebalkan; Balkan Range: Shipka Pass and Kaloferski Balkan; Mt Vitoshia and Rhodopi Mts-Western) occurs G. pomeranicum × lucidum (All.) Retz. (G. album × G. verum – 4x, Appendix 2). In Balkan Range (Central): above the timberline it grows together with the parental species and forms populations with numerous plants.


**Type:** „Hort. Reg. Taurinensis“ (ex descr.).
≡ G. *erectum* var. *lucidum* (All.) DC., Prodr. 4, 596 (1830).
≡ G. *gerardi* Vill., Prosp. 19 (1779).

≡ G. *erectum* var. *rigidum* (Vill.) Gren. & Godr., Fl. Fr. 223 (1850).

Stock with rhizome with rooting subterranean runners. Stems 25–70 cm, erect or ascending, glabrous or pilose (hairs 0.1–1.5 mm). Leaves in whorl of 3–5, linear-lanceolate, linear to filiform, more or less blackening when dried; midrib prominent; margin more or less incurved and scabrid. Inflorescence long, wide and lax with long patent branches. Corolla 3–5 mm in diameter, white or yellowish-green. 2n = 44, 44*.

**Distribution and ecology**

Forebalkan, Balkan Range, Znepole Region, West Frontier Mts, Mt Vitoshia Region, Mt Belasitsa, Mt Slavyanka, Pirin Mts, Rila Mts, W and C Rhodopi Mts (Chepelare, Pamporovo, Bachkovo, Assenovgrad), Thracian Lowland (Krichim, Plovdiv), Mt Strandzha (Gramatikovo, Brodilovo, Malko Tarnovo, Yasna Polyana). In deciduous and coniferous forests, along forest edges, in brook ravines, rockheaths and meadows; on limestone, sandstone, schist, gneiss, andesite, from 200 up to 1500 m. S and SC Europe.

Flowering from June to July.

**Note.** In localities where G. *lucidum* grows together with G. *album* subsp. *album*, occur plants with intermediate morphological characteristics, difficult to be determined and most probably of hybrid origin.

4–8. **G. asparagifolium** group

Stock woody, with or without subterranean runners. Stems 35–80(120) cm, shortly hairy, more seldom glabrous. Leaves in whorls of 6–11, linear-lanceolate, linear to filiform, more or less blackening when dried; midrib prominent; margin more or less incurved and scabrid. Inflorescence long, wide and lax with long patent branches. Corolla usually pale-yellowish to greenish, slightly cup-shaped; lobes incurved, usually strongly apiculate. Anthers more or less darker when dried. Fruit dark-brown to blackish.

Lectotype: Macedonia orientalis, District Drama, montes Boz Dagh, in favee infra pagum granitis (Jurcik, ca. 300 m); substr. calc., 01.06.1934, K.H. & H. Rechinger 6339 W! Isotypes: LD! W! Syntypes: Leilagebirge bei Serrai, Föhrenwald, ca. 1400 m (10749); Boz-Dagh bei Drama, Schluht unterhalb Granitis, ca. 500 m (6342); Granithügel bei Kavala (10111) (Krendl 1987: 111). Illustrations: Abb. 38 (Krendl 1987: 112), table XI, fig. 1 (Ančev 1989: 63).

Stock woody, without subterranean runners. Stems robust, (60)80–150 cm, strongly branched, densely pilose at base, with hairs more than 1 mm long. Leaves in whorls of (6)8–11, 15–5 × 1–2 mm, linear to aciculate, slightly falcate, gradually narrowed, with 0.2–0.3 mm long hyaline apiculum, margin slightly incurved, with 0.2–0.3 mm long apiculus; anthers 0.2–0.3 mm long, dark-brown. 2n = 22, 22*.

Note. Galium mirum differs from Galium macedonicum and Galium rigidifolium by its dense indumentum at the base of the stem (hairs 1–2 mm), short pedicels (0.5–3 mm) and small corolla (2–3 mm in diameter).

Distribution and ecology
SW Bulgaria. Mt Slavyanka, Pirin Mts (Northern), Rhodopi Mts (Eastern – Arda Valley near Kardzali), Thracian Lowland (Krichim). On stony slopes, rockheaths, sandstone, granite, seldom on marble, from 250 upwards to1000 m. SE part of the Balkan Peninsula: Greece (Drama, Kavala, east of Xanthi). A Balkan endemic.

Flowering from June to July.


=G. scabrifolium auct. bulg., non (Boiss.) Hausskn.

Stock woody, with long subterranean runners and many flowering shoots. Stems 40–60(90) cm, erect, dense pilose (hairs 0.1–0.6 mm), asperate. Leaves in whorls of 6 (seldom 7–9), 10–15(20) × 0.5–1 mm, linear to aciculate, gradually narrowed to a long hyaline apiculum (0.5–1 mm), midrib broad, margin slightly incurved, very scabrid, with two to several rows of teeth. Inflorescence broadly ovoid, partial inflorescences with erect spreading branches (30–0 mm). Pedicels 1–4 mm. Corolla 2–3(4) mm in diameter, yellow, lobes incurved, with long (0.4–0.8 mm) apiculus. 2n = 22, 22*.

Distribution and ecology
In scattered localities in S and SW Bulgaria. Znepole Region, Mt Vitosha Region, Valley of River Struma (northward to Mt Konyavska), Mt Belasitsa, Mt Slavyanka, Pirin Mts, Rhodopi Mts (Eastern). On open slopes and rockheath, on limestone or marble, seldom on silicate ground, from 400 up to about 1200 m. Macedonia, NE Greece. A Balkan endemic.

Flowering from June to July.


=G. flavescens auct. bulg., non Borbás, 1874.

=G. scabrifolium auct. bulg., non (Boiss.) Hausskn. 1893.

Plants darkening when dried, rootstock with long subterranean runners and many flowering shoots. Stems 60–80 cm, erect, dense pilose at base (hairs 0.1–0.7 mm), with prominent ridges. Leaves in whorls of 6–8(11), (10)15–25 × 0.5–1.5 mm, linear to aciculate, gradually narrowed into a long (0.2–1 mm) hyaline apiculum, midrib beneath broad, margin incurved, strongly scabrid, with two to several rows of teeth. Inflorescence broadly oval, densiflorous; partial inflorescences up to 80 mm long, mostly strongly ramificate; pedicels 1–3 mm. Corolla 3–4 mm in diameter, yellowish, lobes incurved, with long (0.4–0.8 mm) apiculus; anthers dark-brown. 2n = 44, 44*.

Note. 1. Galium rigidifolium is reported for Bulgaria for first time by Ančev (1999). In habit it is close to Galium flavescens and known for Bulgarian flora by earlier authors under this name.

2. Galium rigidifolium is a tetraploid, morphologically closely related to the diploid G. macedonicum. It
differs from *G. macedonicum* by some longer leaves and longer corolla lobes.

**Distribution and ecology**

In scattered localities along the Black Sea Coast (*Northern*), Northeast Bulgaria, Forebalkan, Balkan Range, Znepole Region, Mt Vitoshia Region, Valley of River Struma, Valley of River Mesta, Pirin Mts, Rila Mts, Rhodopi Mts, Thracian Lowland (*Kurtovo*). The occurrence near Sliven (direction Balgarka) is doubtful. In pinetis, bush- and ravine forest, on rubble and rocks, in pastures, along road margins, on silicate and serpentine; from 350 upwards 2000 m a.s.l. Serbia (Pirot), E Macedonia, NE Greece. A Balkan endemic. Flowering from June to July.


Rootstock with long subterranean runners and many flowering shoots. Stems 25–100 cm, virgate, fragile, glabrous or short pilose (hairs 0.1–0.7 mm), strongly branched. Leaves in whorls of 6–8(10), 20–40 × 0.5–1 mm, narrowly linear to aciculate, margin strongly incurved, sharply scabrid, gradually narrowed into a long (0.5–1 mm) hyaline apiculum, midrib more or less prominent. Inflorescence broad, ovoid, with numerous branches; partial inflorescences strongly ramifications. Pedicels 2–7 mm. Corolla 2–4 mm in diameter, pale-yellowish, with incurved strongly apiculate lobes. $2n = 22, 44, 44^*$.  


Plants darkening when dried. Rootstock with long subterranean runners and many flowering shoots. Stems 25–100 cm, virgate, fragile, glabrous or short pilose (hairs 0.1–0.7 mm), strongly branched. Leaves in whorls of 6(7)5–15(20) × 0.5–2 mm, linear to aciculate, gradually narrowed into a hyaline apiculum, margin incurved to the midrib, with 2–3 rows of antorse teeth. Inflorescence long oval, strong, ramificate, partial inflorescence narrow conoid. Pedicels 2–3(4) mm. Corolla 2–4 mm in diameter, yellowish, lobes incurved, strongly apiculate. $2n = 22, 44, 44^*$.  

**Distribution and ecology**

In scattered localities along the Black Sea Coast, Northeast Bulgaria, Forebalkan, Balkan Range (*Eastern & Central*), Znepole region, Sofia Region, Mt Vitoshia Region, Mt Slavyanka, Pirin Mts (*Sinanitsa*), Rila Mts, Rhodopi Mts (*Western & Central*), Thracian Lowland (south of Pazardzhik and Plovdiv), Mt Strandzha (east of Malko Tarnovo). In open terrains, on limestone and andesit, dry rockheaths and rubble, occasionally in ruderal habitats, from 300 to 1200 m a.s.l. Serbia (Vranje, Vršác), Kosovo, Montenegro (east of Kotor), Bosnia, C and E Romania. Flowering from June to July.
Pangeon, near Drama, Mt Athos, Lesbos and Samos islands), W Anatolia.
Flowering from mid-May to early-July.

**Note.** *Galium asparagifolium* was reported for Bulgaria for first time by Mitova & al. (2002).

9–11. **G. rhodopeum** group
Stock woody, with or without subterranean runners. Stems (3)10–35(40) cm shortly hairy, more seldom glabrous. Leaves narrowly linear-lanceolate to linear, acicular to filiform, more or less blackening when dried, midrib prominent, margin usually strongly incurved and scabrid. Inflorescence long and narrow, with short branches. Corolla yellowish to greenish, seldom pure white, slightly cup-shaped; lobes incurved, usually strongly apiculate. Anthers more or less darkening when dry. Fruit dark brown to blackish.


**Type:** In rupibus calcareis calidis supra Tekir ad radicem m. Rhodope detexi a. 1893. **Lectotype.** [Bulgaria]: In calcareis aridis supra Tekir, 1893, J. Velenovský, s.n., B!

Illustrations: abb. 6 (Krendl 1987: 18); table XII, fig. 1 (Ančev 1989: 67).

Plants with branched rhizome with rooting subterranean runners. Stems 10–40 cm, the lower half pubescent, with small coarse hairs (0.1–0.2 mm), seldom glabrous, rigid and erect, fragile with prominent white ridges. Leaves in whorls of 6–7(8), 5–10(12) × 0.5–1 mm, linear to acicular, with 0.5–0.8 mm long hyaline apiculum, beneath with broad prominent midrib, margin scabrid, with 3–5 rows of teeth. Inflorescence narrow pyramidal, little ramificate, with short, rigid and erect branches. Pedicels 2–6 mm. Corolla 4–4.5(5) mm in diameter, white; lobes mostly incurved, apiculate. 2n = 44*.

**Distribution and ecology**
S Bulgaria. Rhodopi Mts (*Central & Eastern* – south of Kardzhali and Momchilgrad), Thracic Lowland (Sladun vill., Svilengrad district). On open rocky and gravelly slopes, in glades and shrub communities of *Quercus pubescens*, *Carpinus orientalis*, *Paliurus spina-christi*, *Colutea arborscens*, etc., on limestone substrate, from 250 up to about 600 m a.s.l. A local endemic.
Flowering from May to June.


**Holotype:** In rupestribus apricis solo calcareo, Strâmni rid, Rhodopae orientalis, 04.06. 1970, M. Ančev (SOM 70235a ! ). **Illustrations:** table XII, fig. 3 (Ančev 1989: 67).

Stock with branched rhizome with rooting subterranean runners. Stems few, 10–30 cm with prominent whitish edges, glabrous or lower half minutely hispid (hairs 0.1 mm). Leaves in whorls of 6(7)6–12(15) × 0.7–1 mm, linear to acicular, with 0.7–1 mm long hyaline apiculum, beneath with broad prominent midrib, margin scabrid, with 1–2 rows of teeth. Inflorescence narrow pyramidal, little ramificate, with short, rigid and erect branches. Pedicels 2–6 mm. Corolla 4–4.5(5) mm in diameter, white; lobes mostly incurred, apiculate. 2n = 44*.

**Distribution and ecology**
S Bulgaria. Rhodopi Mts (*Central & Eastern* – south of Kardzhali and Momchilgrad), Thracic Lowland (Sladun vill., Svilengrad district). On open rocky and gravelly slopes, in glades and shrub communities of *Quercus pubescens*, *Carpinus orientalis*, *Paliurus spina-christi*, *Colutea arborscens*, etc., on limestone substrate, from 250 up to about 600 m a.s.l. A local endemic.
Flowering from May to June.


**Lectotype:** Ins. Tasos, in rupibus marmoreis jugo saxoso inter cacuminos Ipsarion et Kamenovrhacos, ca. 1000–1100 m s. m., 14.07.1943, N. Stojanov, B. Kitanov (SOM 71171!) (Ančev 1975: 1535). **Illustrations:** Abb. 48 (Krendl 1987: 137); table XII, fig. 2 (Ančev 1989: 67).


Facing stony and grassy slopes in glades and patchy shrub communities of *Carpinus orientalis* and *Fraxinus ornus*, on shallow and eroded soils, on limestone, marble and dolomite, from 300 m to about 1450 m a.s.l. The Balkan Peninsula (R Macedonia: southeast of Titov Veles, south of Gradsko; NE Greece). A Balkan endemic.
Flowering from May to June.
Ančev, M. & Krendl, F. • *Galium* sect. *Leiogalium* in Bulgaria

Plants blackening when dried. Rhizome thick, with short or long rooting subterranean runners. Stems (3)10–35(40) cm, ascending to erect, pubescent at the base (hairs 0.1–0.4 mm), seldom glabrous; basal vegetative shoots numerous. Leaves in whorls of 6(8), (3.5)4–10 × 0.7–1 mm, linear to acicular, falcate, mucronate, thick, midrib broad and prominent, margin scabrid, with 1–2 rows of teeth. Inflorescence narrowly conoid, sparcely branched; pedicels 2–3.5(4) mm. Corolla 3.5–4.5 mm in diameter, white or greenish-yellow, lobes incurved, apiculate, with 0.2–0.4 mm long apiculum. 2n = 44, 44*.

**Note.** 1. *Galium aegeum* differs from *G. rhodopeum* by darkening when dried, stem base with many short lateral shoots, falcate leaves, and 2n = 44.


**Distribution and ecology**

Frequent along the Black Sea Coast to Mt Strandzha, scattered in Northeast Bulgaria, Danubian Plain, Forebalkan, Balkan Range, Znepeol Region, and Thracian Lowland (Plovdiv, Dimitrovgrad, Haskovo). In xerophilous plant communities in dry meadows, in forest-steppe and related grassland, on limestone, seldom on sandstone or granite, from 160 up to 1100 m. SE Europe (E Romania, Euroean Turkey, Ukraine, S Russia to the Ural (near Ufa), SW Asia.

Flowering from May to June.

**12–14. *G. glaucum* group**

Plants glaucous-pruinose. Stock with or without subterranean runners. Stems glabrous or pilose. Leaves in whorls of 6–12, linear to acicular, gradually narrowed into hyaline apiculum; margin revolute, scabrid with several rows of teeth. Inflorescence broadly ovoid to pyramidal, with long lower branches. Pedicels stout, not divaricate after anthesis. Corolla white, infundibuliform to cup-shaped; lobes acute, seldom shortly apiculate.

**12. *G. octonarium*** (Klokov) Soó × *G. rhodopeum* Velen.

Stock with subterranean runners. Stem 25–40 cm, erect, shortly hairy at the base. Leaves in whorls of 6–7, 10–15 × 0.5–0.7 mm, linear with prominent midrib; margin revolute. Inflorescence narrow pyramidal; pedicels 1.5–2.5 mm. Corolla 2–3.5 mm in diameter, white, infundibuliform, lobes shortly apiculate.

**Distribution.** Thracian Lowland: in limestone glades on open slopes of the mountain foothills of Besaparski Ridove, above Ognyanovo vill. Occurs together with the parental species.


≡ *Asperula glauca* (L.) Besser, Enum. Pl. Volhyn. 7 (1822).

**Type:** Linn. Herb. 1, n. 129. 20 (BM-LINN).

Plants glaucous-pruinose. Stock with long subterranean runners. Stems 40–100 cm, erect, usually rounded with four ridges, glabrous or pilose. Leaves in whorls of 8–9(12), 20–45 × 1–3(4) mm, linear to aciculate, seldom narrow-oblancoelate to oblancoelate, apex 0.2–0.3 mm long, mucronate, mostly spreading, midrib narrow, margin weakly scabrid, with 1–2 rows of teeth. Inflorescence conoid to broad oval; partial inflorescence conoid. Pedicels 0.5–3 mm. Corolla 3.5–4.5(6) mm in diameter, white, broadly cup-shaped; lobes with short apex; anthers 0.2–0.4 mm long, brown to dark brown. 2n = 44, 44*.
Distribution and ecology
NW Bulgaria. In scattered localities in the Danubin Plain (Pleven, Nikopol), Forebalkan (Shiroka Planina, the upland Veslets, the vicinity of Lukovit and Lovech), Sofia Region, Znepole Region, West Frontier Mts (Mt Vlahina), and Valley of River Struma, from 200 m up to 900 m. Along bushy forest margins, in dry meadows, on limestone, dolomite, seldom basalt. W, C and S Europe (from Belgium and France eastwards to Austria, Slovakia, Roumania and Russia, southwards to Portugal and Italy).

Flowering from May to June.


**Type:** Ad Tyram in Podolia australis, Herbar Besser (Holotype LE!)


Plants darkening when dried. Stock with subterranean runners. Stems 20–100 cm, erect, rounded in the lower part, with four ridges, stout, usually densely pilose at the base, glabrous above. Leaves in whorls of 6-8, 20–40 × 0.5–1.5 mm, linear to acicular, margin scabrid, with 1–2(3) rows of teeth. Inflorescence ovoid to broadly conoid paniculate; partial inflorescences pyramidal. Pedicels 1–3 mm. Corolla 3–4 mm in diameter, cup-shaped, lobes +/− incurved. 2n = 44.

**Distribution and ecology**
In scattered localities along the Black Sea Coast, from the area of Balchik southwards to Mt Strandzha (Malko Tarnovo), Northeast Bulgaria (Shumen Plateau, Provadiya Plateau), Forebalkan (Lovech). On stony and gravelly terrains, on rocky slopes, in steppe regions along dry forests and bushes, usually on limestone substrates, from 150 m to 500 m. SE Europe (R Macedonia, Moldova, Roumania, and the Ukraine).

Flowering from May to June.

15–18. *G. sylvaticum* group
Young shoots green or glaucous and pruinose. Stock with or without runners. Stems terete to 4-angled, glabrous or hairy. Leaves elliptical to linear-lanceolate, lower surface paler-green than the upper, often bluish. Inflorescence broadly ovoid-pyramidal; pedicels usually capillary, not divaricate after anthesis. Corolla white, cup-shaped to rotate; tube shorter than acute to shortly apiculate lobes.


**Type:** Zwischen Gebüschi, auf kräuterreichen Abhängen am Zoodfluß bei Talmats mit *G. capillipes*; Alluvium. Jul. 1846.


≡ *G. sylvaticum* var. *turcicum* (Velen.) Stoj. et Stef., op. c. 1050 (1925).


≡ *G. aristatum* auct. Bulg. p. p. min., non L.


≡ *G. papillosum*, Heuff., Flora No. 36: 563 (1853), non Lapeyr.

Root short, branched, stock without subterranean runners. Stem usually 70–100 cm, erect, 4-angled, glabrous or densely pilose below. Leaves (25)30–60 × 2–4(6) mm, narrow to linear-lanceolate, often falcate, bright-green, margin scabrid with several rows of teeth. Inflorescence ovoid to broadly pyramidal, flowers crowded towards the end of the branches. Pedicels 0.5–3 mm. Corolla 2–3 mm in diameter, cup-shaped, lobes acute. 2n = 22, 22*.

**Distribution and ecology**
Across the country, in scattered localities in the hilly plains and on the south-facing mountain slopes, frequent in xerophilous plant communities in the oak vegetation belt, on limestone and sandstone ground, from 150 m to 1300 m a.s.l. C and SE Europe (Slovakia, Albania, Greece, R Macedonia, Serbia, Romania,). Flowering from June to July.

16. *G. paschale* Forssk., Fl. Aeg.-Arab. 203 (1775);
Ančev, Fl. RP Bulg. 9: 82 (1989), table XIV, fig. 2.

**Holotype:** [Turkey A2 (E) Istanbul] ad Constantopolēm, VIII 1761 (Forsskål) (C – Forssk.!).
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40–80(110) cm, stout, erect, rounded at the lower part, upwards with four weak ridges, usually glabrous; young shoots pruinose. Leaves in whorls of (6)8–10(11), 25–60 × (3)4–8(12) mm, linear-oblanceolate to elliptical, narrowing abruptly towards the acute apex; margin with 1–2 rows of small papilose teeth. Inflorescence ovoid pyramidate, rather loose; pedicels 0.7–2.5 mm. Corolla (2)2.2–3 mm in diameter, cup-shaped, lobes acute to shortly apiculate. Mericarps dark-brown to black, more or less pruinose. 2n = 22*

Distribution and ecology

SW Bulgaria: Mt Vitosha Region (Mt Plana above river Vedena) and Mt Slavyanka (on the west slopes of Parilski Dol – Ambar Dere), from 650 m up to about 1400 m a.s.l. In bushy and shadowy grassy places along mixed deciduous forests of Fagus orientalis, F. sylvatica, Carpinus betulus, Tilia tomentosa, T. platyphylos, and Acer platanoides. The Balkan Peninsula (Montenegro, N Albania). A Balkan endemic.

Flowering from mid-June to August.

Note. Galium procurrens is morphologically close to the hexaploid G. intermedium, from which it differs by narrower, oblong oblanceolate to elliptical leaves and smaller, cup-shaped corolla with non-apiculate lobes. After the first finding of G. procurrens in Mt Slavyanka (Ehrendorfer & Ančev 1975), we report now a new site in the plant communities of deciduous Carpinus-Quercus forest in Mt Plana (Mt Vitosha Region). The new finding of G. procurrens in Mt Plana extends the known distribution area of this Balkan endemic species from Mt Slavyanka northwards to the Mt Vitosha Region. It is likely that G. procurrens, a species listed in the Red Data Book of R Bulgaria as threatened by extinction, has a wider distribution in the mountains of SW Bulgaria.


= G. schultesii Vest, Flora (Regensb.) 4(6): 530 (1821); Ehrend. & Krendl, Fl. Eur. 4: 28 (1976); Ančev, Fl. RP Bulg. 9: 84 (1989), table XIV, fig. 3.

Holotype. (Montenegro) Cattaro (= Kotor), Vermač, 2.VII.1905, J. Schneider. Det.: F. Ehrendorfer (W!).

Stock with long subterranean rooting runners. Stems 40–80(110) cm, stout, erect, rounded at the lower

part, upwards with four weak ridges, usually glabrous; young shoots pruinose. Leaves in whorls of (6)8–10(11), 25–60 × (3)4–8(12) mm, linear-oblanceolate to elliptical, narrowing abruptly towards the acute apex; margin with 1–2 rows of small papilose teeth. Inflorescence ovoid pyramidate, rather loose; pedicels 0.7–2.5 mm. Corolla (2)2.2–3 mm in diameter, cup-shaped, lobes acute to shortly apiculate. Mericarps dark-brown to black, more or less pruinose. 2n = 22*

Distribution and ecology

SW Bulgaria: Mt Vitosha Region (Mt Plana above river Vedena) and Mt Slavyanka (on the west slopes of Parilski Dol – Ambar Dere), from 650 m up to about 1400 m a.s.l. In bushy and shadowy grassy places along mixed deciduous forests of Fagus orientalis, F. sylvatica, Carpinus betulus, Tilia tomentosa, T. platyphylos, and Acer platanoides. The Balkan Peninsula (Montenegro, N Albania). A Balkan endemic.

Flowering from mid-June to August.

Note. Galium procurrens is morphologically close to the hexaploid G. intermedium, from which it differs by narrower, oblong oblanceolate to elliptical leaves and smaller, cup-shaped corolla with non-apiculate lobes. After the first finding of G. procurrens in Mt Slavyanka (Ehrendorfer & Ančev 1975), we report now a new site in the plant communities of deciduous Carpinus-Quercus forest in Mt Plana (Mt Vitosha Region). The new finding of G. procurrens in Mt Plana extends the known distribution area of this Balkan endemic species from Mt Slavyanka northwards to the Mt Vitosha Region. It is likely that G. procurrens, a species listed in the Red Data Book of R Bulgaria as threatened by extinction, has a wider distribution in the mountains of SW Bulgaria.


= G. schultesii Vest, Flora (Regensb.) 4(6): 530 (1821); Ehrend. & Krendl, Fl. Eur. 4: 28 (1976); Ančev, Fl. RP Bulg. 9: 84 (1989), table XIV, fig. 3.

Holotype. (Montenegro) Cattaro (= Kotor), Vermač, 2.VII.1905, J. Schneider. Det.: F. Ehrendorfer (W!).

Stock with long subterranean rooting runners. Stems 40–80(110) cm, stout, erect, rounded at the lower part, upwards with four weak ridges, usually glabrous; young shoots pruinose. Leaves in whorls of (6)8–10(11), 25–60 × (3)4–8(12) mm, linear-oblanceolate to elliptical, narrowing abruptly towards the acute apex; margin with 1–2 rows of small papilose teeth. Inflorescence ovoid pyramidate, rather loose; pedicels 0.7–2.5 mm. Corolla (2)2.2–3 mm in diameter, cup-shaped, lobes acute to shortly apiculate. Mericarps dark-brown to black, more or less pruinose. 2n = 22*.
Appendix 1. List of examined herbarium specimens

=G. sylvaticum subsp. schultesii (Vest) Stoj. et Stef., op. c. ed. 2: 955 (1933); G. sylvaticum auct. Fl. Bulg. non L.
=G. aristatum auct. Fl. Bulg. p. max. p., non L.
=G. sylvaticum subsp. aristatum auct. Stoj. et Stef., op. c. 1050 (1925) et auct. Fl. Bulg., non. L.

Plants glaucous-pruinose. Rootstock with long subterranean runners. Stems 30–120 cm long, stout, erect, terete at the base with four weak ridges, otherwise 4-angled, usually glabrous. Leaves 25–60 × (3)4–8(12) mm, broadly oblanceolate to elliptical, narrow-ing abruptly at the apex, margin with one or two rows of teeth. Inflorescence usually dense, broadly ovoid, strongly ramified. Pedicels 4–7 mm long. Corolla 3(4.5) mm in diameter, mostly rotate; lobes distinctly apiculate. 2ν = 66, 66*.

Distribution and ecology

Forebalkan, Balkan Range, Sofia Region, Znepole Region, West Frontier Mts (Mt Osogovska), Mt Vitosha Region, Rila Mts, Mt Sredna Gora. Frequent in mixed deciduous forests, on ravine woodland slopes in the mountains and mountain foothills, mostly on granite and sandstone ground, with Fagus sylvatica, Quercus deleschampi, Carpinus orientalis, etc., along forest margins, bushes, rocky slopes, from 800 m to 1700 m. C and SE Europe.

Flowering from June to July.

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Appendix 1. List of examined herbarium specimens

G. aegueum

Bulgaria. Mt Slavyanka (Ali-Botush): 1650 m, 10.07.1934, A. Drenovski as G. rhodopeum (SOM); peak Gotsev, limestone terrain, 16.07.1957, V. Velchev & al. as G. asperum Schreb. (SOM); Ambar Dere above Paril, calcareous rocky habitats, 10.07.1934, A. Drenovski as G. rhodopeum (SOM); Ambar Dere, 28.09.1969, M. Anchev A3175 (SOM); 26.07.1971, M. Anchev 71691a (SOM); Ambar Dere, limestone rocky slopes, 27.05.1976, N. Andreev (SOM); 25.06.1979, M. Anchev (SOM); Paradzhi Dol (Ambar Dere), 29.06.1980, B. Kuzmanov & M. Anchev (SOM); 17.08.1987, I. Pashaliev (SOM); 1400 m, 04.08.1994, M. Anchev (SOM); Mt Stargach, rocky places, 29.07.1977, M. Anchev (SOM); Pirin Mts: near Lova-chiya, 23°19’E, 41°29’N, 15.06.1995, M. Anchev (SOM); gravelly habitats on peak Sveshtnik, 23°34’E, 41°33’N, 19.09.1969; 05.07.19709, M. Anchev (SOM).


G. album subsp. album

Black Sea Coast: 5 km NE of Nesebar, near Elenite Resort, Kozlushko Dere, 27°48’32”E, 42°42’36”N, 31.05.1999, Gussev & Rutherford 30-4-391 (W); of the Dyuni Resort, 27°43’15”E, 42°21’1”N, 10 m, 24.05.1999, Gussev & Rutherford 16-4-137 (W); NE of Burgas, Slanchev Briyag, 27°30’E, 42°33’N, 18.05.1962, Ehrendorfer 62-1/8-3 (W); Northeast Bulgaria: Deli-Orman, circa urbem Dobrich, 02.06.1902, B. Davidoff (SOM); Balkan Range: north of Sliven, at Dik Tepe, 500–750 m, 06.07.1970, Krendl (W); Vitinya, 750 m, 02.07.1995, Anchev (SOM); 15 km W-SW of Dalgopol, N of Dobromir, Chudnite Skali, 27°17’23”E, 42°58’1”N, 100 m, 01.06.1999, Gussev, Rutherford 33-4-305 (W); Rila Mts: Kurt Dere, 23°30’E, 41°50’N, 1050 m, 15.08.1912, B. Davidoff (SOM); Valley of River Struma: south of Rila town, 27.09.2003, D. Stoyanova (SOM); Thracian Lowland: ad pag. Dervent, 26°44’E, 42°0’N, 20.07.1914, Urumov (SOM); east of Dimitrovgrad, 400 m, 14.06.1980, Malicky (W); Mt Strandzha: along the road Burgas–Sredets, 20 km off Burgas, 11. 06.1998, Uzunov & Vitek (SOM, W); NW of Malko Tarnovo, along the river near Brashlyan, 27°25’6”E, 42°24’4”N, 250 m, 21.05.1999, Gussev & Rutherford 2-4-19 (W); Malko Tarnovo, northwestern edge of the town, 350 m, 10. 06. 1998, Uzunov, Gussev & Vitek (W); along the road from Sredets to Bolyaro-vo, 300 m, 11. 06. 1998, Uzunov & Vitek (W).
**G. album** subsp. *pycnotrichum*

**Black Sea Coast:** ca. 1 km S of the border to Romania, 03.06.1998, Uzunov, Gussev & Vitek (W); S of Shablja, along road from Gorun to Tyulenovo, 100 m, 04.06.1998, Uzunov, Gussev & Vitek (W); NE of Nesebar, Kozlушкиa rive Valley N of Elenite Resort, 27°48'39"E, 43°10'16"N, 150 m, 07.06.1998, Uzunov, Gussev & Vitek 98-477 (W); Cape Emine, 10 km E–NE of Nesebar, 27°53'53"E, 42°42'14"N, 50 m, 30.05.1999, Gussev & Rutherford, (W); 15 km W–SW of Varna, S of Beloslav, Provadiya Plateau, 27°41'50"E, 43°10'16"N, 150 m, 02.06.1999, Gussev & Rutherford 34-4-409 (W); Velika Faka (Pogprigorovo), 17.06.1905, B. Davidoff (SOM!); Ad urbem Kavarna, 28°20'E, 43°26'N, 15.07.1902, B. Davidoff (SOM); Dubrudzha, ad Gebедзе, 27°42'E, 43°12'N, 06.06.1904, B. Davidoff (SOM); ca. Varna, Gebедze–Aladin, 27°46'E, 43°12'N, 06.06.1904, B. Davidoff (SOM); circa Varna, ad Pontum, 27°54'E, 43°12'N, 02.07.1904, B. Davidoff (SOM); ca. 6 km S–SE of Obzor, 06.06.1998, Uzunov, Gussev & Vitek (W); NW of Nesebar, 5 km W of Vlas, Kalinatca loc., 27°41'30"E, 42°58'1"N, 100 m, 07.07.1907, Gussev, & Rutherford 25,1-98-394 (W); Cape Emine, 10 km E–NE of Nesebar, 41°29'41"N, 06.06.1894, B. Davidoff (SOM); near Tarnovo, ad stadiumem, Urumov 1896 (W); Kaspičan, 27°9'4', 43°18'N, 20.08.1905, B. Davidoff (SOM); **Balkan Range:** Mt Kamchiyska, Balban Dere, 05.06.1998, Uzunov, Gussev & Vitek (W); 15 km W–SW Dalgopol, N of Dobromir, 27°17'23"E, 42°58'1"N, 100 m, 01.06.1999, Gussev & Rutherford 33-4-307 (W); **Rhodopi Mts:** (Eastern): Stramni Rid south of Momchilgrad, 25°25'E, 41°42'N, 04.06.1970, M. Ančev 70236a (SOM); **Thracian Lowland:** Bunartschik bei Philippol (Plovdiv), 05.1890, Pichler (W); Ocvi Halmove, in grassy and stony places, 30.06.1977 (SOM).

**G. glaucum**

**Danubian Plain:** the valley of river Studena near vill. Studena, Pleven district, 13.05.2007, S. Stoyanov (SOM); Jasen vill., Pleven district, 26.06.1924, I. Urumov (SOM); in graminosis ad Lukovit, 1924, I. Urumov (SOM); in collinis siccis prope Lovech, 1889, I. Urumov (SOM); **Sofia Region:** Gradets, Sofia district, in grassy places, on limestone ground, V. Velchev, 27.06.1956 (SOM).

**G. intermedium** (*G. schultesii*)

**Forebalkan:** S of Balgarski Isvor, Lovech district, 18.07.1971, M. Ančev (SOM); **Balkan Range:** prope urbem Karlovo, 24°48'E, 42°39'N, 1894, I. Urumov (SOM!); Prope urbem Kalofo, 24°58'E, 42°37'N, 1896, I. Urumov (SOM!); Near Gabrovo, 450 m, 25°19'E, 42°54'N, 07.07.1907, B. Davidoff (SOM!); Arman Kaja, 26.07.1902, I. Neiceff (SOM!); Troyan, Smesite, S Cherni Osam, along beech forest, 25°30'E, 42°52'N, 14.08.1970, M. Ančev (SO !); Kuru Dere, 11.08.1969, M. Ančev (SOM!); Troyanski Balkan, 1899, I. Urumov (SOM!); **Znepole Region:** Mt Rui, prope Tran, 25°38'E, 43°5'N, 1903, I. Urumov (SOM!); Mt Rudina, supra l. d. Borovski Dol prope pagum Treklyano, 22°35'E, 42°33'N, 1100 m,
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31.07.1939, B. Achtarov (SOM!); Tsarvendol, Krushkata loc., Kyustendil district, 23.07.1969, M. Anchev (SOM!); Tsarvendol, 03.09.1970, M. Anchev (SOM!); Mt Parmunmska, above vill. Paramun, 09.07.2008, S. Stoyanov (SOM). Mt Vitosha Region: Bosnek, 23°10'E, 42°29'N, B. Achtarov (SOM); deciduous forests aboveVladaya, 23°12'E, 42°38'N, 28.06.1970, M. Anchev (SOM!); Mt Vitosha, I. Urumov, 1924 (SOM!); Near Boyana water-fall, 23°15'E, 42°48'N, 10.06.1993, B. Achtarov (SOM!); ad radicem Mt Vitosha, 23°16'E, 42°33'N, 1904, M. Anchev (SOM); Dragalevtsi, 23°19'E, 42°38'N, 1200 m, 25.08.1933, B. Achtarov (SOM!); above Kniazhevo, 1300 m, 30.08.1970, M. Anchev (SOM!); SE of Sofia, Panchevarevo Water Reservoir, 19.05.2002, A. Polatschek (W); Rila Mts: Tsarska Rila ad riv. Malka Bistritsa, 1200 m, 03.06.1909, B. Davidoff (SOM!); Markudzhik, 2000 m, 07.08.1909, B. Davidoff (SOM!); Cherni Rila, 30.07.1911, B. Davidoff (SOM!); on a scree on the steep bank of river Bistritsa, above Borovets, 23°34'E, 42°20'N, 12.10.1970, N. Vichodcevski (SOM!); Mt. Cerna Rila: Beliya Uley supra coenobium, 1700 m, 30.07.1916, B. Davidoff (SOM!); Mt Malka Rila loc., 1200 m, 05.07.1911, B. Davidoff (SOM!); Mt Topla Rila, supra riv. Dumnishka Bistritsa, 1200 m, 29.07.1912, B. Davidoff (SOM!); Tsarska Rila, 1400 m, 06.09.1909, B. Davidoff (SOM!); Mt. Tsarska Rila, Malka Bistritsa, 1100 m, 23.07.1969, M. Anchev (SOM!); Mt Tsarska Rila, Sokolets ad riv. Malka Bistritsa, 23°11'E, 42°3'N, 1400 m, 23.07.1910, B. Davidoff (SOM!); Mt Tsarska Rila, 1250 m, 23.07.1910, B. Davidoff (SOM!); Tsarska Rila, ad riv. Lukovitsa, 1100 m, 14.06.1909, B. Davidoff (SOM!); Mt Malka Rila, peak Shismanov, 1100 m, 14.07.1910, B. Davidoff (SOM!); Mt Malka Rila, peak Shismanov, 1100 m, 10.07.1910, B. Davidoff (SOM!); near Tran, 18.05.2002, A. Polatschek (W); Rila Mts, in Monte Mussala, 1300 m, 19.08. 1907, Schneider & Bergmann (W); Mt Sredna Gora: 30.07.1911, B. Davidoff (SOM!); Manastirski Hills, northern slopes, Gradischteto, 30.05.1967, I. Ganchev (SOM).

G. lovicense

Black Sea Coast: Varna, 04.08.1886, Bornmüller (WU); Vailata at Kamen Briyag, 28°33'E, 43°27'N, 09.08.1998, A. Petrova (SOM); Kavarna, 16.05.1905, B. Davidoff (SOM); 15 km WSW of Varna, S of Beloslav, Provadiya Plateau, 27°41'50"E, 43°10'16"N, 150 m, 02.06.1999, Gussev & Rutherford 34-4-413 (W); mouth of river Kamchia, 06.06.1904, A. Javashov as G. verum (SOM);

Northeast Bulgaria: near vill. Tabachka, Ruse district, 25°2'E, 43°47'N, 16.07.1971, M. Anchev 71647a (SOM); valley of river Lom near Ruse, 12.07.1930, Ronniger (W); Shumen, 1902, A. Javashov (WU); Madara – Kaspchan, 07.06.1902, A. Javashov as G. saxatile (SOM); Gulitsa, 1902, A. Javashov (WU); ad urbem Lukovit, 24°10'E, 43°13'N, 1924, I. Urumov (SOM); near Kozludzha (Suvorovo), 27°36'E, 43°20'N, 22.07.1901, B. Davidoff (SOM); supra urbem Provadiya, 27°27'E, 43°11'N, 24.05.1903, B. Davidoff (SOM); Forebalkan: Vrashka Chuka, 19.06.1972, S. Kozhuharov (SOM); Bash Kulesi, south of Lovech, 1895, I. Urumov as G. erectum (WU); near Lovech, 1897, I. Urumov (WU); Bash Kulesi above Lovech, June 1971, M. Anchev (W); proper Lovech, 1899, I. Urumov (SOM); near Tarnovo, 1895, 1896, 1899, I. Urumov as G. aureum (SOM, WU); supra Tarnovo, 25°38'E, 43°5'N, 1210 m, 24.06.1933, B. Achtarov (SOM); Gabrovo, 0.1900, I. Neichev (SOM); above vill. Zdravkovets, Gabrovo district, 22.06.2008, A. Petrova (SOM); on limestone rocky slopes, Derventa loc. east of Tarnovo, 12.08.1970, M. Anchev (SOM); near Gabrovo, 1898, I. Urumov (WU); Balkan Range: Balkan Range, 20.07.1900, I. Neichev (SOM); Kuru Dere above Gabarevo, 09.08.1969, M. Anchev (SOM); Kozya Stena, 24°37'E, 42°49'N, 03.09.1995, T. Meshinev (SOM); S slopes of Kumanitsa hill, on limestone, 1770 m, 06.07.1996, I. Apostolova & T. Meshinev as G. heldreichii (SOM); Tvarditsa, 25°54'E, 42°42'N, 05.07.1969, S. Kozhuharov (SOM); near Karlovo, 1910, I. Urumov (SOM); 20.07.1900, I. Neichev (SOM); Mt Rishka, calcareus rocky places of Golyamia Ortilza, 850 m, 27.06.2002, D. Stoyanov (SOM); Troyanski Balkan, 22.07.1898, I. Urumov (WU); C Staraplana, Dobrila, 1896, I. Urumov (WU); E, prope Sliven, nörrdl. vom Barmuck, 16.07.1907, Schneider (W); 15 km WSW Dalgopol, N of Dobromir, Chudnite Skali loc., 27°17'23"E, 42°58'1"N, 100 m, Gussev & Rutherford 33-4-278 (W); Znepole Region: Mt Konyavska, north of Polska Skakavitsa, loc. Pazarliya, Ca, 03.06.1992, M. Anchev (SOM); Mt Konyavska, above vill. Konyavo, 22°47'E, 42°19'N, 03.70.1974, M. Anchev (SOM); Golo Bardo, on the south slopes along the road to Kula, 11.07.1969, M. Anchev (SOM); Berende Izvor, 23.07.2005, K. Vasiliev (SOM); Mt Belasitsa: along edges of chestnut forest east south of Petrich, 900 m, 12.07.1969, M. Anchev (SOM); Som Slavyanka (SOM); near Goleshevo, 23°35'E. Mt Belasitsa, south of Petrich, 900 m, 12.07.1969, M. Anchev (SOM); Som Slavyanka (SOM); near Goleshevo, 23°35'E. Mt Belasitsa, south of Petrich, 900 m, 12.07.1969, M. Anchev (SOM); Som Slavyanka (SOM); near Goleshevo, 23°35'E.
Massif, Kuru Dere, 24°50'E, 41°54'N, 07.1996, (SOM); Bachkovo, 41°55'N, 29.06.1991, 03.08.2003, A. Petrova (SOM); Dobrostan Massif, rocky slopes above the Marziganitsa–Bachkovo trail, 24°55'E, 41°55'N, 29.06.1991, A. Petrova (SOM); Bachkovo, 07.1914, V. Stríbrný as G. aureum (SOM); Dobrostan Massif, Kuru Dere, 24°50'E, 41°54'N, 07.1996, A. Petrova (SOM); E Rhodopi Mts, Stramni Rid, S of Momchilgrad, 10.06.1971, M. Anchev (SOM); Thracian Lowland: Haskovo district, 106 km E Plovdiv, 250 m, 14.06.1962, F. Ehrendorfer (WU).

G. lucidum
Balkan Range: C Balkan, 07.1903, I. Neichev (SOM); Stapatata, 1920, I. Neichev (SOM); rocky places above Karlovo, 24°48'E, 42°39'N, 08.1970, M. Anchev (SOM); Mt Vitosha Region: I. d. Kopitoto, 1400 m, 08.07.1951, Efremov & B. Achtarov (W); Znepole Region: ad Belovo (Zemen) prope Kyustendil, 22°46'E, 42°29'N, 1908, I. Uruman (SOM); Mt Slavyanka: south of Paril, Ambar Dere, 23°39'E, 41°2'N, 1300 m, 29.07.1988, I. Paschaliev (SOM); grassland above the timberline, ca. 2000 m, 23°39'E, 41°26'N, 29.07.1977, M. Anchev (SOM); Pirin Mts: Kamenitsa, Pogledets, 23°26'E, 41°42'N, 1980 m, 05.07.1981, N. Andreev (SOM); Banski Suhodol, 22.07.1980, B. Kuzmanov (SOM); alpine grasslands, Kazana, 20.07.1980, B. Kuzmanov (SOM); Orelova Skala supra pagum Pirin, 2000 m, 23°35'E, 41°34'N, 25.07.1938, B. Achtarov (SOM); Mt Baba, supra urb. Nevrokp (Gotse Delceh), 23°22'E, 48°8" N, 1850 m, B. Achtarov (SOM); Near Orelek, 2000 m, 23°36'E, 41°35'N, 28.07.1970, M. Anchev (SOM); ad Orelek supra Nevrokp, 23°35'E, 41°34'N, 2000 m, 21.07.1950, B. Achtarov (SOM); stony grassy places along the trail to Orelek, 19.07.1977, N. Andreev (SOM); Pirin, Kazana, 24.07.1980, 2000 m, B. Kuzmanov (SOM); Sandanska Bistritsa, near turisthaus Begovitsa, 23°24'32"E, 41°40'45"N, 1415 m, 09.07.2007, F. Krendl 44883 (W); S. Pirin Mts, between Ilinden and Paril, 23°36'34"E, 41°51'54"N, 746 m, 06.07.2007, F. Krendl 44861 (W); Rila Mts: NE of Urdini Ezerka, 700–1580 m, 22.07.1976, Vitek (W); Mt Tsarska Rila, 1450 m, 23.07.1920, B. Davidoff (SOM); Mt Bela Rila, sub Mala Cherkva, 1100 m, 12.06.1911, B. Davidoff (SOM); Rhodopi Mts: Prespa bei Bela Cerkva, 21.07.1930, Ronniger (W); vill. Kara Chumak, along the road of Karierata, 18.08.1971, Petrova (SOM); supra Bachkovski Monastery, 350–400 m, 12.06.1973, W. Greuter 11165 (W); ad Asenova Krepotst, inter Ase Novgrad et Bachkovo, 350 m, 12.06.1973, W. Greuter (W); Krichim, 24°26'E, 42°4'N, 350 m, 13.07.1970, F. Krendl (W); Beglika, 07.1976, B. Kuzmanov (SOM); Mt Strandzha: Malko Tarnovo, northern edge of city, 350 m, 10.06.1998, Uzunov, Gussev & Vitek (W); S of Gramatikovo, near the bridge of river Veleka, 64 m, 20.05.2000, A. Polatschek (W).

G. macedonicum
Valley of River Struma: open slopes north of Kresna, 250 m, 02.07.1992, M. Anchev (SOM); Mt Belasitsa: stony places in wood of Castanea sativa, 12.07.1969 (SOM); Pirin Mts: 2 km above vill. Vlahy, 22.07.1970, M. Anchev (SOM); Popina Laka, 1300–1350 m (BP); roadsides near Razlog, 06.06.1971, M. Anchev (SOM).

G. mirum
Pirin Mts: along the road G. Delchev-Papaz Chair, 1250 m, A. Petrova & M. Anchev (SOM); Gradevo, 06.06.1971, M. Anchev (SOM); Rhodopi Mts: Terasata loc., southwest of Kardzhali, 25°23'E, 41°38'N, 13.06.1953, N. Stojanov & B. Kitanov as G. angustifolium Leers. (SOM); Stramni Rid, south of Momchilgrad, 25.08.1971, M. Anchev (SOM); Thracian Lowland: Peshtera, V. Stríbrný (PRC); Besaparski Ridge, south of Sintevo, 311 m, 04.07.2007, M. Anchev & F. Krendl (SOM); Besaparski Hills near Ognyanovo, in bushes of Cotinus coggygria and Palirius spinachristi, 11.06.1992, M. Anchev (SOM); Besaparski Ridge above Ognyanovo, 09.06.2004, M. Anchev & V. Goranova (SOM).

G. octonarium
Black Sea Coast: Kavarna, valley between the town and the port, 14.07.1975, Manitz (JE); 5 km southwest of Kavarna, Balchishka Tuzla loc., 28°15'54"E, 43°24'42"N, 50 m, 03.06.1999, Gussev & Rutherford 36-4-445 (W); Cape Kaliakra, 28°27'37"E, 43°22'33"N, 120 m, 05.06.1999, Gussev & Rutherford 42-4-474 (W); ca. Varna, 27.05.1927, B. Davidoff (SOM); ad pagum Emirler (Povelenovo), 1885, I. Uruman (SOM); Northeast Bulgaria: prope Razgrad, 07.1885, J. Velenovsky (PR); Razgrad district, prope pag. Mikrovo, 18.06.1948, N. Stojanov (SOM); ca. 2 km nor-
teast of Byala, 160 m, 02.06.1998, Uzunov, Gussev & Vitek 98-87 (LI); Danubian Plain: ad urbem Pleven, 1924, I. Urumov (B); Forebalkan: between Brestritsa and Toros, near river Vit, south slopes, 24°15'1"E, 43°3'36"N, ca. 200 m, 05.70.2006, F. Krendl 44407 (W); Lovech, 1892, I. Urumov (BP); prope Lovech, 1882, I. Urumov (SOM); bei Lovech, Stratesh, 1893, I. Urumov (W); south of Lovech, Lapa, 10.07.1970, M. Anchev (SOM); Sevlievo, 05.1901, I. Neichev (SOM); ; Prope Tarnovo, 12.05.1896, I. Urumov (WU); Tarnovo, 1896, I. Urumov (SOM); Balkan Range: Troyansky Balkan, 1895, I. Urumov (WU) near Gabrovo, 1892, I. Urumov (WU); Sliven, under the saddle of the road to Balgarka, 800–1100 m, 06.1970, F. Krendl 39639 (W); Znepole Region: in the environs of Dragoman, 16 kms east of the Bulgarian-Serbian frontier, 18.05.1962, F. Ehrendorfer 62-1-999-2 (W); Thracian Lowland: hills near vill. Brestritvitsa, 19.6.1969, A. Petrova (SOM); Besaparski Ridove, 408 m, 14.07.1970, F. Krendl 39640 (W); Besaparski Ridove near Ognyanovo, 28.05.1970, M. Anchev (SOM); ad Sadovo, 18.06.1890, V. Střibrný (PR); near Papasly (Поповица), 06.1890, V. Střibrný (SOM); ad Sadovo, 18.06.1890, V. Střibrný (SOM); near Lovech, Stratesh, 1893, I. Urumov (BP); bei Lovech, Stratesh, 1893, I. Urumov (SOM); Sevlievo, 05.1901, I. Neichev (SOM); ; Prope Tarnovo, 12.05.1896, I. Urumov (WU); Tarnovo, 1896, I. Urumov (SOM); Balkan Range: Troyansky Balkan, 1895, I. Urumov (WU) near Gabrovo, 1892, I. Urumov (WU); Sliven, under the saddle of the road to Balgarka, 800–1100 m, 06.1970, F. Krendl 39639 (W); Znepole Region: in the environs of Dragoman, 16 kms east of the Bulgarian-Serbian frontier, 18.05.1962, F. Ehrendorfer 62-1-999-2 (W); Thracian Lowland: hills near vill. Brestritvitsa, 19.6.1969, A. Petrova (SOM); Besaparski Ridove, 408 m, 14.07.1970, F. Krendl 39640 (W); Besaparski Ridove near Ognyanovo, 28.05.1970, M. Anchev (SOM); ad Sadovo, 18.06.1890, V. Střibrný (PR); near Papasly (Поповица), 06.1890, V. Střibrný (SOM); ad Sadovo, 18.06.1890, V. Střibrný (SOM); near Lovech, Stratesh, 1893, I. Urumov (BP); bei Lovech, Stratesh, 1893, I. Urumov (SOM); Sevlievo, 05.1901, I. Neichev (SOM); ; Prope Tarnovo, 12.05.1896, I. Urumov (WU); Tarnovo, 1896, I. Urumov (SOM); Balkan Range: Troyansky Balkan, 1895, I. Urumov (WU) near Gabrovo, 1892, I. Urumov (WU); Sliven, under the saddle of the road to Balgarka, 800–1100 m, 06.1970, F. Krendl 39639 (W); Znepole Region: in the environs of Dragoman, 16 kms east of the Bulgarian-Serbian frontier, 18.05.1962, F. Ehrendorfer 62-1-999-2 (W); Thracian Lowland: hills near vill. Brestritvitsa, 19.6.1969, A. Petrova (SOM); Besaparski Ridove, 408 m, 14.07.1970, F. Krendl 39640 (W); Besaparski Ridove near Ognyanovo, 28.05.1970, M. Anchev (SOM); ad Sadovo, 18.06.1890, V. Střibrný (PR); near Papasly (Поповица), 06.1890, V. Střibrný (SOM); ad Papasly, 1890, J. Velenovský (PRC); Plovdiv, town hill, 07.07.1970, F. Krendl 33932 (W); 1–2 km south of Dimitrovgrad, 29.06.1972, F. Krendl 39637 (W); ad Haskovo, 06.1906, L. Adamović (WU).
Besaparski Ridove above Oglyyanovo, 24.08.1971, 11.06.1992, M. Ančev (SOM); Besaparski Ridove, Bababair, 1907, I. Urumov (SOM); Besaparski Ridove, Glavinishki Rid, 30.05.1991, I. Apostolova (SOM); Besaparski Ridove, ca. 30 km S of Plovdiv, 15.06.1970, O. Polunin (LTR); ad Pazardzhik, V. Střibrný 1987 (BP, FI, G, W); in submontanis ad Alikochovo (Kapitan Dimitrievo), 09.06.1895, V. Střibrný (W).

**G. rigidifolium**

Black Sea Coast: Balchik, Solnitsata, 30.07.1907, A. Javashov as G. ochroleucum (SOM); Kaliakra, 27.06.1903, B. Davidoff as G. ochroleucum (SOM); Kalajži–Dere (Tvarditsa), 10.07.1900, B. Davidoff as G. ochroleucum (SOM); Nevsha, 06.06.1902, B. Davidoff as G. aureum (SOM); Forebalkan: Tarnovo, 1896, I. Urumov (SOM); Balkan Range: Imitliysky Prohod, 30.07.1902, I. Neichev & B. Davidoff as G. lucidum (SOM); Mala Planina, Katinski Piramidi, 04.07.2005, V. Vutov & D. Dimitrov (SOM); Prope Karlovo, 24°48'E, 42°39'N, 1898, I. Urumov as G. ochroleucum (SOM); Znepole Region: Dolno Selo, 01.07.1913, B. Davidoff as G. lucidum (SOM); Mt Vitosha Region, Mt Lyulin, Gradishtet, 24.06.1951, I. Ganhev as G. mollugo subsp. lucidum (SOM); Mt Lyulin, above the railway, 28.06.1919, B. Achtarov (SOM); in graminosis petrosis apricis l.d. Kopitoto, 1400 m, 08.07.1951, N. Efremov & B. Achtarov as G. lucidum (SOM); Mt Plana, Prodanovski Rid, 25°27'E, 42°26'N, 1100 m, 25.06.1909, B. Davidoff as G. ochroleucum (SOM); Valley of River Struma: Pastuh vill. south of Nevestino, 500 m, 20.05.2005, A. Polatschek (W); Kresnenko Hanche, 23°11'E, 41°47'N, 350 m, 20.05.2005, A. Polatschek (W); Prope Gorna Džumaja (Blagoevgrad), 500 m, 15.10.1929, Fenensko (SOM); Valley of River Mesta: above the right riv-
er bank, in stony places along the road to G. Delchev, 23°44'E, 41°35'N, 30.06.2005, D. Dimitrov (SOM); Rila Mts: Topla Rila, Chiflika sub coenobium, 950 m, 02.08.1911, B. Davidoff as G. ochroleucum (SOM); Rhodopi Mts: Yundola, 23°52'E, 42°4'N, 1912, I. Urumov (SOM); W of riverKanina, Osikovo, 23°36'40'E, 41°33'14"N, 940 m, 07.07.2007, F. Krendl (W); Bachko-vo, 08.1914, V. Střibrný as G. ochroleucum (SOM); Ku-ru Dere above Asenovgrad, 30.06.1991, A. Petrova & M. Anchev (SOM); ad Lazene, 1912, I. Urumov as G. erectum (SOM); Thracian Lowland: pr. Kurtovo, 23°52'E, 42°2'N, 1898, I. Urumov (SOM).

**G. velenovskyi**

Rhodopi Mts: in limestone places on the west slope of the Zhelezni Vrata hill near Kardzhali, 25°23'E, 44°39'N, 600 m, 13.06.1953, N. Stojanov & B. Kitanov (SOM); near Studen Kladenets, 25°37'E, 41°37'N, 27.05.2001, A. Petrova (SOM); on rocks near the road Studen Kladenets–Krumovgrad, 25°41'E, 41°34'N, 25.05.2002, A. Petrova (SOM); south of Momchilgrad, Stramni Rid, 04.06.1970, M. Anchev (SOM); inter Plovdiv et Stanimaka (Assenovgrad), 1916, I. Urumov (SOM).

**G. volhynicum**

Black Sea Coast: Rusalka Seaside Resort, 28°30'E, 43°25'N, 27.06.1999, A. Petrova & M. Anchev (SOM); the Kaliakra Reserve, 28°30'E, 43°25'N, 15.06.1999, A. Petrova & M. Anchev (SOM); the White Coast E. of Balchik, Cape Imeto, 50–70 m, Uzunov, Gussev & Vitek 98-185 (W); Kavarna, 13.07.1931, Häýrén (H); bezirk Varna: ca. 20 km W Varna on the street to Shumen, 17.08.1968, Mertzmüller & Zollitsch 24586 (M); Northeast Bulgaria: Provadiyska Trapeza, 27°27'E, 43°10'N, 27.06.1903, B. Davidoff (SOM); Forebalkan: near Tarnovo, 1896, I. Urumov (WU); Lovech, 1892, I. Urumov (BP).
Appendix 2. List of karyologically examined taxa, chromosome numbers and origin of the material

**G. aegeum – 2n = 44**
Mt Slavyanka: Ambar Dere, 23°48'E, 41°27'N, 19.09.1970, M. Anchev (SOM)

**Galium album subsp. album – 2n = 44**
Forebalkan: south of Malak Varshets, Lovech district (Anchev 1982).
Balkan Range: north of Karnare, on south slopes of Troyanski Balkan, 24°37'22"E, 42°44'8"N, ca. 1050 m, 07.07.2006 (K 44415); east of Sliven, near the road to the charnel-house, 10.07.1970, (K 1656+), 1657+); south of Momchilgrad, Stramni Rid, 300 m (Anchev 1982).

**G. album subsp. pycnotrichum – 2n = 44**
Black Sea Coast: NE of Burgas, Slanchev Bryag, 10.07.1970 (K 4699).

Forebalkan: Draganovo vill., Veliko Tarnovo district (Anchev 1982).
Balkan Range: Karnare, Troyan Divide. 24°37'22"E, 42°44'8"N, 1050 m, sparse deciduous forest, 07.07.2006, M. Anchev & F. Krendl (K 44415); east of Sliven, south foot of the Barmuka Hill, 06.07.1970 (K 45328).

Znepole Region: Strezimirovtsi vill., SE of Trun, 900 m, Ca, 18.05.2002, A. Polatschek (K 39039).

**G. asparagifolium – 2n = 44**

**G. flavescens – 2n = 22**
Balkan Range: north of Karnare, Troyanski Pass, 900 m, 25.06.1997, Polatschek & Anchev (K 32990).
Mt Vitosha Region: south of Pancharevo, the Dyavolkiya Most loc., 23°25'24"E, 42°33'37"N, 650 m, forest outskirts, rocks, Si, 02.70.2006, M. Anchev & F. Krendl (K 44400+).

**G. glaucum – 2n = 44**
**G. intermedium – 2n = 66**


Znepole Region: Tsarven Dol, Kyustendil district, 950 m (Ančev 1982 sub G. schultesii); Tsarven Dol, Kyustendil district, 22°42'E, 42°17'N, M. Ančev & F. Krendl (SOM A00863, W).

Mt Vitosha Region: above Knyazhevo, July 1970, M. Ančev (SOM A70621).

G. lovicense – 2n = 22

Northeast Bulgaria: Shumen Plateau, south of Madara vill., limestone slope, M. Ančev (SOM 70447); vill. Tabachka, Ruse district (Ančev 1982 sub G. heldreichii subsp. protopycnotrichum).


Balkan Range: Sinite Kamani above Sliven, open rocky slopes, 27.07.1999, M. Ančev (SOM A993); Troyansky Balkan, west of Troyan Pass, Kozyata Stena, 24°34'3"E, 42°47'28"N, 1200 m, Ca, 06.07.2006, M. Ančev & F. Krendl (K 44411); Kuru Dere above Gabarevo vill., 09.08.1969 (Ančev 1982 sub G. heldreichii subsp. protopycnotrichum).

Pirin Mts: peak Sveshtnik, 1900 m (Ančev 1982 sub G. heldreichii subsp. protopycnotrichum).

Rhodopi Mts: south of Asenovgrad, Kuru Dere, 24°52'E, 41°58'N, 1200 m, Ca, 06.07.2006, M. Ančev & F. Krendl (K 41808+). Along Vacha River near Krichim, 07.05.1971, F. Krendl (K 11944 as G. protopycnotrichum).

G. lucidum – 2n = 44

Balkan Range: above Karlovo (Ančev 1982).

Mt Vitosha Region: above Zheleznitsa vill., stony slope of the valley river Selskata, 23°21'23"E, 42°32'26"N, 1100 m, 01.07.2006, M. Ančev & F. Krendl (K 44396†); 23°20'37"E, 42°32'12"N, 1130 m, 01.07.2006 (K 44398†).


Rhodopi Mts: south of Chepelare, 09.07.1970 (K 1650); north of Pamporovo, 700–1580 m, gneiss, 09.07.1970 (K 1649†).

Mt Strandzha: ca. 1–2 km S of Yasna Polyana vill., 03.07.1970 (K 1662); near Malko Turnovo, 200 m, 14.06.1980, Malicky (K 4718); Gramatikovo vill., near to the bridge of river Veleka, 64 m, sandstone ground, 20.05.2000, A. Polatschek (K 36547†).

G. macedonicum – 2n = 22

Mt Vitosha Region: south of Pancharevo, bushy rock slopes with Lactuca perennis, silicate, 19.05.2002, A. Polatschek (K 39043).

Znepole Region: Mt Zemenska, 22°45'E, 42°28'N, 500 m, M. Ančev; gravelly places near the railway station Polska Skakavista, Ca, 22°40'E, 42°25'N.

Mt Slavyanka: north of Paril vill., ruderal roadsides, 18.05.2005, A. Polatschek (K 41811†).

Pirin Mts: near Vlahi vill., 900 m, M. Ančev (SOM A373); Rozhenski Monastery, bushy slopes at the foot of the sandstone pyramids, 20.05.2005, A. Polatschek (K 41808).

G. mirum – 2n = 22

Mt Slavyanka: Paril vill., meadow margin, sandstone, A. Polatschek (K 41808†).

Pirin Mts: Rozhenski Monastery, bushy slopes at the foot of the sandstone pyramids, 20.05.2005, A. Polatschek & M. Ančev (K 41806).

Rhodopi Mts: Terassata loc., south of Karadzhali, limestone ground, 03.06.1970, M. Ančev (SOM).

Thracian Lowland: ca. 1 km west of Krichim, 250–300 m, Si, 13.07.1970 (K1646, 1647); ca. 2 km west of Krichim, 250 m, deciduous forests, bushy margins, silicate, 13.07.1970 (K 2009); SE Pazardzhik, N slope, ca. 400 m, marble (K 1648, 2010, 2011, 2012).

G. octonarium – 2n = 22

Forebalkan: E-NE of Veliko Tarnovo, limestone gravelly glades above the St Troitsa Monastery, 320 m, brushwood of Carpinus orientalis, Tilia tomentosa, Staphyllea pinnata, Cotinus coggyria, Syringia vulgaris, 22.06.1997, A. Polatschek & M. Ančev (K 32991).

Balkan Range: east of Sliven, at souther foot of the Barmuka Hill, ravine wood of Quercus pubescens and Pinus stands, rockheath, rubble, sandstone, 06.07.1970 (K 5296†).

Thracian Lowland: SE of Popovitsa, dry glades with Quercus pubescens, Astragalus onobrychis, Filipendula vulgaris, Orchis purpurea, limestone ground, 12.05.2002, A. Polatschek (K 39022†); SE of Pazardzhik, 300–408 m; Quercus
pubescebs—bush, rockheath, limestone, 14.07.1970 (K 5295); 2–3 km SW of Dimitrovgrad, thin *Quercus cerris* wood, limestone rocks, 07.07.1970 (K 6609+); Besaparski Ridove, *M. Anchev* (SOM A4131) (Anchev 1982).

**G. paschale** – 2n = 22
Black Sea Coast: 1–2 km south of Primorsko, mixed oak woods, rocks, 03.07.1970 (K 10076+).
Balkan Range: NE of Sliven, ravine woods south of peak Balgarka, 800–1100 m, 06.07.1970 (K 10068, K 10130).
Rodopi Mts: Mt Chal, glades in oak-hornbeam forest (Ančev 1982).
Thracian Lowland: north of Peshtera, forest outskirts, Si, 11.07.1970 (K 10069); west of Krichim, bushy forest outskirts, Si, 13.07.1970 (K 10066+); Vurgarski Dol near Kosti vill. (Anchev 1982, sub *G. bulgaricum*).

**G. × pomeranicum** – 2n = 44
Forebalkan: Panega river valley, north of Petrevene vill., 24°9'12"E, 43°11'8"N, 05.07.2006 (K 44404).
Balkan Range: at the southern foot of Mt Shipchenska, near Skobelevo, 06.07.2006 (K 44416); near the peak Stoletov, 25°19'28"E, 42°44'47"N, ca. 1300 m, rocky glades, Ca, 07.07.2006 (K 44418).
Mt Strandzha: 1–2 km south of Yasna Polyanova vill., 03.07.1970 (K10071, K 10067+); 4–5 km south of Primorsko, mixed oak woods, rocks, 01.07.1970 (K 10066+); Vurgarski Dol near Kosti vill. (Anchev 1982, sub *G. bulgaricum*).

**G. procurrens**
Mt Vitosa Region: Forest outskirts above Knyazhevo (Anchev 1982).
Mt Strandzha: SW of Tsarevo (Michurin), Kosti, oak-hornbeam wood, Si, 20.05.2000, *A. Polatschek* & *M. Anchev* (K 36553+).

**G. rhodopeum** – 2n = 22
Rhodopi Mts: 5 km north of Shiroka Laka, 800 m, 22.06.1980, Malicky (K 4717+).
Thracian Lowland: SE of Pazardzhik, Besaparski Ridove, open limestone slopes, 500 m, *F. Krendl* (K 1645); Besaparski Ridove, SW of Tri Voditsi vill., Pazardzhik district (Ančev 1971).

**G. rigidifolium** – 2n = 44
Balkan Range: NE of Sliven, Dik Tepe, 500–750 m, 06.07.1970 (K 651); Sliven, the road to Balgarka, 800–1100 m; brook ravine wood, rockheath, rubble, silicate, 06.07.1970 (K 1652).
Valley of River Mesta: near Konovsko, SW of Cherna Mesta, 23°45'53"E, 42°2'20"N, 983 m; anthropogenic habitats in *Robinia pseudacacia* stand, Ca, 05.07.2007, *M. Anchev* & *F. Krendl* (K 44856).
Pirin Mts: ca. 2 km above Dobrotino, west of Gotse Delchev, 23°43'16"E, 41°25'49"N, 1057 m, road margins with *Pinus nigra*, 07.07.2007, *M. Anchev* & *F. Krendl* (K 44866).
Rila Mts: Forest road to Treshtenik, above Yakoruda, 23°40'26"E, 42°3'22"N, 1317 m; road margin, the slopes near *Pinus sylvestris*-wood, scree, 05.07.2007, *M. Anchev* & *F. Krendl* (K 44858, SOM, W).

**G. velenovskyi** – 2n = 44
Rhodopi Mts: Stramni Rid, south of Momchilgrad, rocky slopes, Ca, 23°25'25"E, 42°33'34"N, ca. 680 m, mixed deciduous forest, Si, 02.07.2006 (SOM A 00864; K 44401 W).

**G. velenovskyi** – 2n = 22
Mt Strandzha: SW of Tsarevo (Michurin), Kosti, oak-hornbeam wood, Si, 20.05.2000, *A. Polatschek* & *M. Anchev* (K 36553+).

**G. x pomeranicum** – 2n = 44
Forebalkan: Panega river valley, north of Petrevene vill., 24°9'12"E, 43°11'8"N, 05.07.2006 (K 44404).
Balkan Range: at the southern foot of Mt Shipchenska, near Skobelevo, 06.07.2006 (K 44416); near the peak Stoletov, 25°19'28"E, 42°44'47"N, ca. 1300 m, rocky glades, Ca, 07.07.2006 (K 44418).
Mt Strandzha: 1–2 km south of Yasna Polyanova vill., 27°37'E, 42°17'N, Si, 03.07.1970 (K 162+).

**G. procurrens**
Mt Vitosa Region: Mt Plana, on the slopes above river Vedena, 23°25'25"E, 42°33'34"N, ca. 680 m, mixed deciduous forest, Si, 02.07.2006 (SOM A 00864; K 44401 W).

**G. pseudoaristatum** – 2n = 22
Mt Sredna Gora: ca. 43 km SE of Sofia, near the highway to Plovdiv, 600 m, 18.05.1968, Habeler (W).


