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Distribution and variability of the Balkan endemic *Geum bulgaricum* (Rosaceae) - a species of European concern

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ABSTRACT: As a European endemic restricted to a few European countries, *Geum bulgaricum* is here treated as a "target species" or "species of European concern". Although of great international significance, its distribution is insufficiently known. Based on several years of field studies and analyses of herbarium and literature data, we have determined that *G. bulgaricum* is a Balkan endemic plant distributed in Albania, Bosnia and Herzegovina, Bulgaria, Montenegro, and Serbia. Although the range of its distribution is divided into two main parts - "eastern" (the Rila Mountains in the Rhodope-Rila mountain system) and "western" (several mountains in the Dinaric system and one isolated population in the northeastern part of the Scardo-Pindic system) - in fact all populations are grouped into four disjunctions. Based on our studies of extensive chorological data and estimation of the number of individuals and condition of the populations, we have now defined *G. bulgaricum* as IUCN NT in Albania and Montenegro, and VU D2 E in Serbia. Also, we have confirmed its status as NT in Bulgaria, and changed its status from LR to VU D2 E in Bosnia and Herzegovina. The species is most often found in alpine and subalpine acidophilous (*Juncetea trifidi*) and calcicolous (*Elyno-Seslerietea*) grasslands and swards, as well as in the vegetation of scree habitats (*Thlaspietea rotundifolii*), rocky crevices (*Asplenietea trichomanis*), subalpine belts of krummholz pine (*Roso pendulinae-Pinetea mugo*), and very localised serpentine outcrops. Its ecological optimum is in the subalpine and alpine vegetation belt. Furthermore, we here provide the first insight into the differentiation of its populations. We found that the Rhodope-Rila and Dinaric populations are slightly differentiated on the morphological level and well differentiated with respect to genome size. The name *Geum bulgaricum* is lectotypified.

Keywords: Balkan Peninsula, endangered species, genome size, *Geum*, lectotype, morphology

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INTRODUCTION

The species *Geum bulgaricum* was described by Josif Pančić (1814–1888) on the basis of material collected in August of 1882 in the Rila Mountains of Bulgaria (Pančić 1883). This is a European endemic (Gajewski 1968; Ozinga & Schaminée 2005; Kurtto 2009) distributed in the central part of the Balkan Peninsula (Gajewski 1957; Kurtto *et al*. 2004). Although the species was declared to be a "target species" or "species of European concern" (Ozinga & Schaminée 2005), its distribution is insufficiently known. To be specific, Ozinga & Schaminée (2005) stated that the species has been registered in three countries, Kurtto (2009) in four countries, but in fact it is distributed in five Balkan countries with two disjoint parts of its range. One group of populations inhabits subalpine and alpine habitats on the siliceous bedrock of the Rila Mountains in the Rhodope-Rila mountain system, while the other group inhabits high mountain carbonate habitats of the Dinaric mountain system (mountain systems according to Stevanović *et al*. 2009).

After the last consolidation of the list of strictly protected plant species, *G. bulgaricum* was included in Annex I of the Bern Convention (Heywood 2009). According to national legislations, *G. bulgaricum* is a protected species in Bulgaria (BDA 2007), Montenegro (Sl RCG 76/2006), and Serbia (Sl RS 5/2010), and it is included in the red lists of the floras of Bosnia and Herzegovina (as LR in Đug *et al*. 2013) and Bulgaria (as NT in Peev & Tsoneva 2009).

Although it is of great international importance, data on the distribution of this species are scattered in numerous papers and herbarium collections, and precise or georeferenced records are lacking. Also, there are no data regarding its inclusion in any known recovery program (Heywood 2009).

Recent findings of *Geum bulgaricum* at several localities in Montenegro and Albania, as well as the availability of a number of herbarium specimens collected on different sites in Bulgaria, Serbia, Montenegro, Albania, and Bosnia and Herzegovina, have provided new insights into the distribution and the need to protect this internationally significant species. Hence, the main aim of this contribution was to gather all known data about distribution of the species and its ecological affinities in order to provide detailed information for efficient conservation planning. Given that up to now *G. bulgaricum* was not the object of any detailed studies, our second aim was to provide preliminary insight into morphological variability, variability of genome size, and the presumed differentiation between the Rhodope-Rila and the Dinaric populations.

MATERIALS AND METHODS

Distribution and estimation of threatened status. Our investigations are based on recent field studies, analysis of herbarium material deposited at BEO, BEOU, BP, BREM, P, SARA, SO, and SOM (acronyms according to Thiers 2017), and literature data. Data on occurrence of the species in the field were recorded using a GPS device (Garmin eTrex Legend HCx and Garmin eTrex Vista C). All other data on the distribution were georeferenced in the OziExplorer 3.95 4s program. The chorological data are presented using a grid map with squares of c. 10 km × 10 km based on the universal transverse Mercator (UTM) projection (Lampinen 2001), grid zone 34T. Latitudes and longitudes are given in terms of the World Geodetic System 84 (WGS84).

Estimation of the threatened status of *G. bulgaricum* on the territories of Europe, Bulgaria, Serbia, Montenegro, Albania, and Bosnia and Herzegovina was based on IUCN (2001) criteria and categories.

Morphometric analyses. Morphological study and morphometric analyses were carried out on herbarium specimens from the Rila Mountains in Bulgaria, Mt. Čvrsnica in Bosnia and Hercegovina, and the Prokletije Mountains in Montenegro deposited in BEOU and SOM. The 16 morphological character states measured in this study are listed in Table 1. Descriptive statistics were calculated for each character state. A principal component analysis (PCA) was performed on the complete dataset to show the overall morphological variation and the relationships between individuals. The hypothesis of morphological separation of the three analysed populations was tested by a canonical discriminant analysis (CDA). Tukey's HSD post-hoc test of homogenous groups for unequal N was used to check the significance of morphological differences. All measurements were performed using Digimizer Image Analysis software, Version 4.6.1 (MedCalc Software 2005–2016). Statistical analyses were performed using the Statistica 7.0 package (StatSoft 1996).

Flow cytometry for genome size assessment. For genome size measurements, 15 individuals were analysed from three populations of *G. bulgaricum* (five individuals from each of the three populations, viz., those of the Mt. Rila, Mt. Čvrsnica, and the Prokletije Mountains). DNA amounts were determined by flow cytometry following Marie & Brown (1993). Cell nuclei were isolated from young leaves of at least five individuals per population. Tomato [*Solanum lycopersicum* Montfavet '63-5' (2C = 1.99 pg, Lepers-Andrzejewski *et al*. 2011)] was used as an internal standard. The standard and investigated species leaf tissues were simultaneously chopped with a razor blade in a Petri dish in 600 µl of cold buffer (Gif

Nuclear Buffer) of the following composition: 45 mM $MgCl_2$, 30 mM sodium citrate, 60 mM 4-morpholinepropane sulphonate (pH 7), 0.1 % (w/v) Triton X-100, 1% polyvinylpyrrolidone (~10,000M_r, Sigma P6755), 5 mM sodium metabisulphite, and 10 µg/ml RNase (Sigma Aldrich, Saint Quentin, France). The suspension of nuclei was filtered through nylon mesh (pore size 30 µm) and kept at 4°C. Nuclei were stained with 50 µg/ml propidium iodide (Sigma), a specific DNA fluorochrome-intercalating dye. For each sample, at least 5 000 to 10 000 nuclei were measured. The 2C DNA value was calculated using the linear relationship between the fluorescent signals from stained nuclei of unknown *Geum* species and the known *Solanum lycopersicum* internal standard. Tukey's HSD post-hoc test of homogenous groups was used to analyse the differences in genome size of the three populations.

RESULTS

Distribution and ecology. *Geum bulgaricum* is a Balkan endemic plant distributed in Albania, Bosnia and Herzegovina, Bulgaria, Montenegro, and Serbia. Although the range of its distribution is divided into two main parts - "Eastern" (the Rila Mountains in the Rhodope -Rila mountain system) and "Western" (several mountains in the Dinaric mountain system and one isolated population in the northeast part of the Scardo-Pindic system) - in fact all populations are grouped into four disjunctions: "Bulgarian", "Herzegovinian", "Montenegrin-Albanian", and "E Albanian". The average distance is c. 450 km between the"Bulgarian" and "Herzegovinian" disjunctions, c. 300 km between the"Bulgarian" and "Montenegrin-Albanian" disjunctions, c. 260 km between the"Bulgarian" and "E Albanian" disjunctions, c. 200 km between the "Herzegovinian" and "Montenegrin-Albanian" disjunctions, and c. 50 km between the "Montenegrin-Albanian" and "E Albanian" disjunctions (Fig. 1). The existence of *G. bulgaricum* in mountains of the Scardo-Pindic system (Kunora e Lurës) in E Albania is confirmed here for the first time.

In Albania the presence of *G. bulgaricum* was confirmed for Mt. Škelsen (above Tropoja), Mt. Maja Hekuravë (near the village of Bunjaj), the Prokletije Mountains, the Mt. Bješka maze, Mt. Maja e Bërdashës, Mt. Maja e Boshit, Mt. Maja Strebishit, Qafa e Valbonës, Qafa e Pejës, Tarabosh, the vicinity of Thethi, and Shtegu i Dhenve (Hayek 1917, 1924, 1927; Jávorka 1926; Rohlena 1942; Pénzes 1954; Tutin *et al.* 1968; Demiri 1983; Qosja *et al.* 1992; Vangjeli 2003, 2015; Kurtto *et al.* 2004; Shuka *et al.* 2008; Ball 2011; Meyer 2011; Schütt s.d.). Also, a field observation for Mt. Kunora e Lurës in the most northwestern part of the Scardo-Pindic mountain system (Kunora e Lurës, 1850 m, 10.05.1975, *Vangjeli Tartari* - Shuka pers. com.) was confirmed during our own field investigations (herbarium specimen BP758300!). At the same time, the literature record for Mt. Korab (Shuka & Malo 2010), which is based on a field observation (Korabi Mt, 29.07.2009. *M. Mersinllari* - Shuka pers. com.), has to be treated as questionable, since it was not confirmed either during field investigations or in the herbarium material from the studied herbarium collections. In Bosnia and Herzegovina, *G. bulgaricum* was recorded on Mt. Prenj (Ortiš and Tisovica peaks), Mt. Čvrsnica (Plasa and Muharnica), and Mt. Čabulja (Protić 1908; Malý 1923; Beck 1927; Lubarda 2013). In Montenegro, it can be found in the following places: Mt. Sinjavina (Babji Zub peak), the Kučke Planine Mountains (Žijovo, the lake Rikavačko Jezero), the Prokletije Mountains (above Gusinje, Fuša Rudnices, the Karanfili-Kotlovi peaks, Mt. Maja Potkajs, Mt. Zeletin, Mt. Čakor, Mt. Hajla, Mt. Suha Planina, Sjenova) (Baldacci 1892; Rohlena 1904, 1942; Rechinger 1935; Lakušić 1964, 1968, 1991; Šmarda 1968; Markišić 1984; Vuksanović 2003, 2016; Stešević & Petrović 2004). In Serbia, it grows in the Prokletije Mountains (Mt. Koprivnik: Krš Čvrlje, Mt. Ljubenička Planina-Jelivi Sluzi; Mt. Lumbardska Planina: Žuti Kamen peak; above the lake Nedžinatsko Jezero; Mt. Prilepska Planina; Mt. Hajla; Mt. Žljeb: Maja Rusolija, Savine Vode) (Rechinger 1935; Rudski 1936, 1949; Grebenščikov 1943; Diklić & Nikolić 1961; Janković & Bogojević 1962-1964 (1967); Lakušić 1968, 1984; Šmarda 1968; Gajić 1972; Janković 1972, 1998; Markišić 1986; Rexhepi 1986, 1989-1990 (1991), 2013; Amidžić & Belij 1995; Amidžić 1997, 2003; Amidžić & Krivošej 1998; Jovović *et al.* 1998; Matović & Tatić 2002; Amidžić & Panjković 2003; Janković & Amidžić 2003; Tomović 2007). The literature record for Mt. Radočelo (Krivača) (Sigunov 1979; Nikolić *et al.* 1986) has not been confirmed in the field and remains questionable. The presence of the species in the Šar Planina Mountains (Mihajlov *et al.* 1998) has to be treated as erroneous. In Bulgaria, it can be found only in the Rila Mountains (*locus classicus*) (Assenov 1973; Markova 2006; Petrova & Vladimirov 2010). Subpopulations (mosaic with low to medium abundance) are recorded among alpine and subalpine rocks and on screes in the four parts of the mountain - East Rila or the Musala Ridge, Central Rila or the Skakavets Ridge, Northwest Rila, and Southwest Rila or the Kapatnik Ridge (Bondev 1959; Ganchev 1963; Tashev & Pavlov 1995; Dimitrov *et al.* 1996; Peev *et al.* 2000; Roussakova 2000, 2003; Roussakova & Georgieva 2003; Vladimirov *et al.* 2015). The species is represented in the National Ecological Network (BDA 2007) in four strict reserves (the Parangalitsa, Ibar, Central Rila, and Rila Monastery Forest Reserves) and the Rila Monastery Nature Park and Rila National Park (Peev *et al.* 2000; Roussakova & Valchev 2000; Roussakova & Georgieva 2003; Tsoneva & Peev 2003; Vladimirov *et al.*

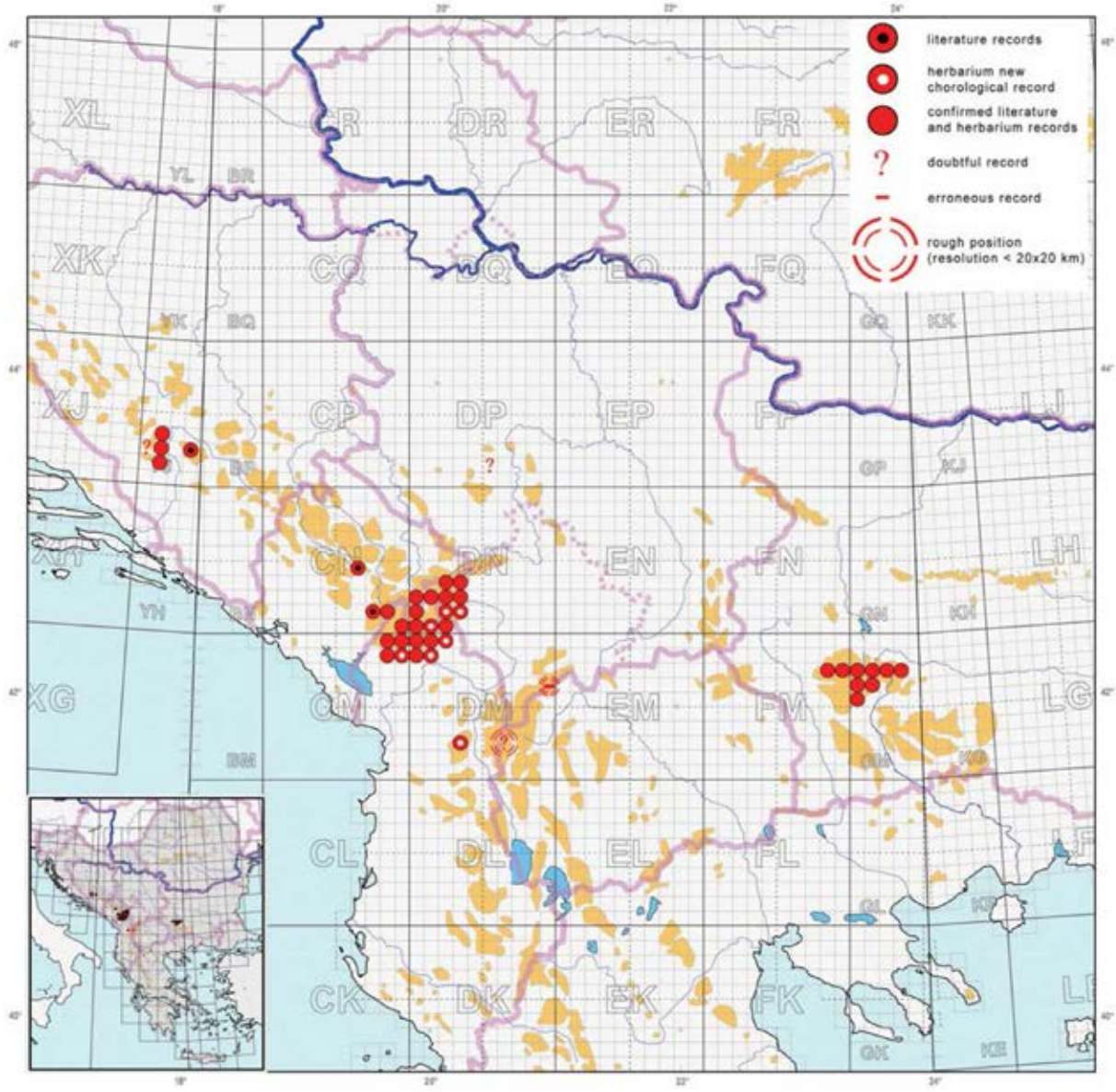

Fig. 1. Distribution of *Geum bulgaricum* (UTM grid zones 33T and 34T; dots correspond to basic MGRS squares of 10 × 10 km).

2015); in the BGIPA 096 Rila Important Plant Area (Spiridonov *et al*. 2012); and at the Natura BG 0000495 Rila site (Roussakova 2013, 2015; Roussakova & Gussev 2015). Detailed data on occurrence of the given species are given in the *Specimina Visa* and *Field Observations* sections below.

Geum bulgaricum is most often found in alpine and subalpine acidophilous (*Juncetea trifidi* Hadač in Klika et Hadač 1944) and calcicolous (*Elyno-Seslerietea* Br.-Bl. 1948) grasslands and swards, as well as in the vegetation of scree habitats (*Thlaspietea rotundifolii* Br.-Bl. 1948), rocky crevices [*Asplenietea trichomanis* (Br.-Bl. in Meier et Br.-Bl.1934) Oberd. 1977], subalpine belts of krummholz pine (*Roso pendulinae-Pinetea mugo* Theurillat in Theurillat et al. 1995), and very localised serpentine outcrops (Pavlova 2012). Although its total altitudinal range extends between 1200 m a.s.l in the Prokletije Mountains and 2700 m a.s.l in the Rila Mountains, the ecological optimum of this species is in the subalpine and alpine vegetation belt (1800–2600 m a.s.l.).

Morphology. Our preliminary morphometric investigations showed that *G. bulgaricum* is characterised by pronounced morphological variability, relating in particular to stem and pedicel height and thickness, the number of flowers, achene dimensions, and indumentum characteristics (Fig. 2, Table 1).

According to the position of individuals along the first two PCA axes, *G. bulgaricum* represents a morphologically relatively homogeneous group (Fig. 3A). On the first two axes, populations from the Dinarides and

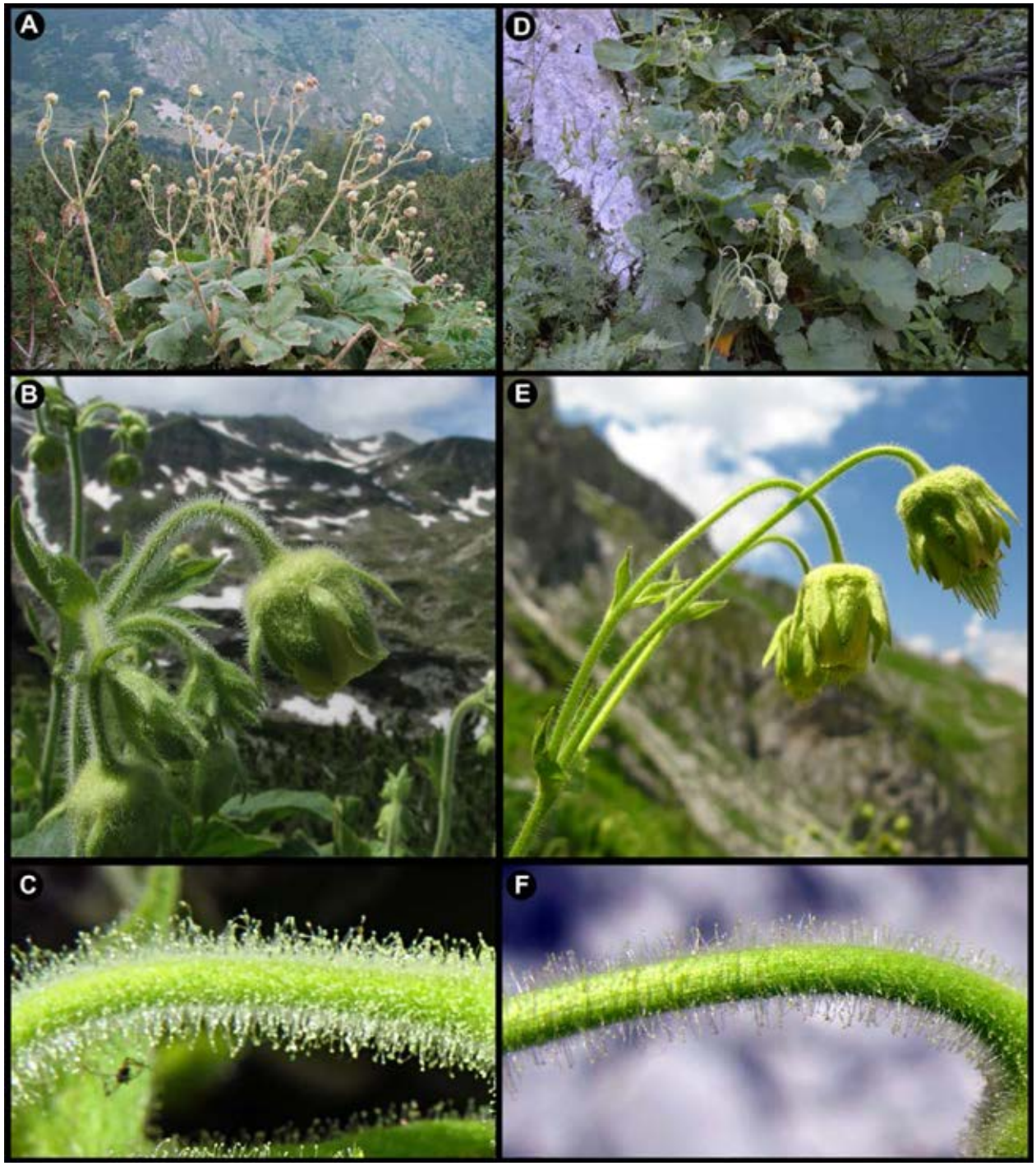

Fig. 2. A–C. *Geum bulgaricum* from the Rila Mountains [A—habit (photo Y. Bosseva), B—capitulum (26 June 2015, photo S. Tsoneva), C—indumentum (date and photographer, same as for B)]; D–F. *Geum bulgaricum* from Ljubokuč in the Prokletije Mountains [D—habit (13 July 2016, photo D. Lakušić), E—capitulum (date and photographer, same as for D), F—indumentum(date and photographer, same as for D)].

the Rila Mountains broadly overlap in the central part of the PCA1–PCA2 space and are just partially separated on the ends of the positive and negative parts of the first axis (Fig. 3A). Canonical discriminant analysis (CDA) conducted on three *a priori* defined groups showed that all three groups just barely overlap (Fig. 3B). Plotted along the first and the second discriminant axes, all three groups were positioned in distinct parts of the DA1–DA2 space. Scores of the population from the Prokletije Mountains are grouped on the positive part of the first axis, scores of the population from Mt. Čvrsnica are grouped on the negative part of the first

Table 1. Basic statistics for morphological characters of *Geum bulgaricum* (all measured values are in millimetres).

		RHODOPES						DINARIDES						TOTAL					
		Valid N	Mean	Min	Max	St.Dev.	St.Error	Valid N	Mean	Min	Max	St.Dev.	St.Error	Valid N	Mean	Min	Max	St.Dev.	St.Error
stem - height	St_h	18	422,20	296,96	554,29	71,67	16,89	17	495,54	383,77	604,29	75,08	18,21	35	457,82	296,96	604,29	81,27	13,74
stem - width at the base	St_w	18	3,39	1,91	4,67	0,77	0,18	17	3,11	2,00	4,05	0,55	0,13	35	3,26	1,91	4,67	0,68	0,11
flower pedicel - length	Pd_l	26	92,18	36,79	188,02	33,51	6,57	28	110,22	71,87	193,65	31,30	5,91	54	101,53	36,79	193,65	33,34	4,54
flower pedicel - width	Pd_w	8	1,36	1,08	2,06	0,33	0,12	28	0,90	0,48	1,27	0,20	0,04	36	1,00	0,48	2,06	0,30	0,05
indumentum of flower peidcel - thick	Pd_ind	8	1,20	0,87	1,80	0,30	0,11	28	0,71	0,34	1,04	0,18	0,03	36	0,82	0,34	1,80	0,29	0,05
number of flowers in inflorescences	Fl_no	16	5,38	2,00	9,00	2,06	0,52	14	3,79	2,00	6,00	1,12	0,30	30	4,63	2,00	9,00	1,85	0,34
leaf petiole - width of the base	Lb_pt_w	18	12,90	9,44	18,39	2,64	0,62	14	12,20	7,55	17,42	3,23	0,86	32	12,59	7,55	18,39	2,88	0,51
leaf petiole - length	Lb_pt_l	18	182,82	107,74	236,53	34,34	8,09	14	188,10	99,41	250,58	43,93	11,74	32	185,13	99,41	250,58	38,25	6,76
terminal leaflet - length	Lb_tl_l	18	84,04	59,13	117,91	18,40	4,34	15	78,23	55,06	99,10	14,79	3,82	33	81,40	55,06	117,91	16,86	2,93
terminal leaflet - width	Lb_tl_w	18	128,74	98,50	175,32	24,82	5,85	15	120,52	75,87	153,35	25,96	6,70	33	125,00	75,87	175,32	25,29	4,40
calyx toth - length	Ca_In_l	23	10,06	6,64	13,26	1,69	0,35	27	10,70	8,87	13,62	1,15	0,22	50	10,40	6,64	13,62	1,44	0,20
calyx toth - width	Ca_In_w	23	6,19	3,96	9,47	1,15	0,24	27	6,14	4,67	8,19	0,90	0,17	50	6,16	3,96	9,47	1,02	0,14
epicalyx toth - length	Ca_Ou_l	21	6,02	3,99	8,45	1,12	0,24	26	7,29	4,94	9,47	1,28	0,25	47	6,72	3,99	9,47	1,36	0,20
epicalyx toth - width	Ca_Ou_w	21	2,66	1,76	3,74	0,57	0,12	26	2,13	1,36	3,37	0,47	0,09	47	2,37	1,36	3,74	0,58	0,08
achenes - height	Ah_l	8	3,35	2,86	3,53	0,21	0,07	21	3,87	2,95	4,88	0,53	0,11	29	3,73	2,86	4,88	0,52	0,10
achenes - width	Ah_w	8	1,03	0,77	1,27	0,15	0,05	21	1,24	0,90	1,50	0,14	0,03	29	1,18	0,77	1,50	0,17	0,03
style - length	St_l	8	16,49	12,01	18,51	1,95	0,69	21	16,47	12,11	19,91	2,13	0,46	29	16,48	12,01	19,91	2,05	0,38
hair on style - length	St_H_L	8	2,78	2,27	3,68	0,49	0,17	21	3,03	1,98	3,90	0,43	0,09	29	2,96	1,98	3,90	0,45	0,08

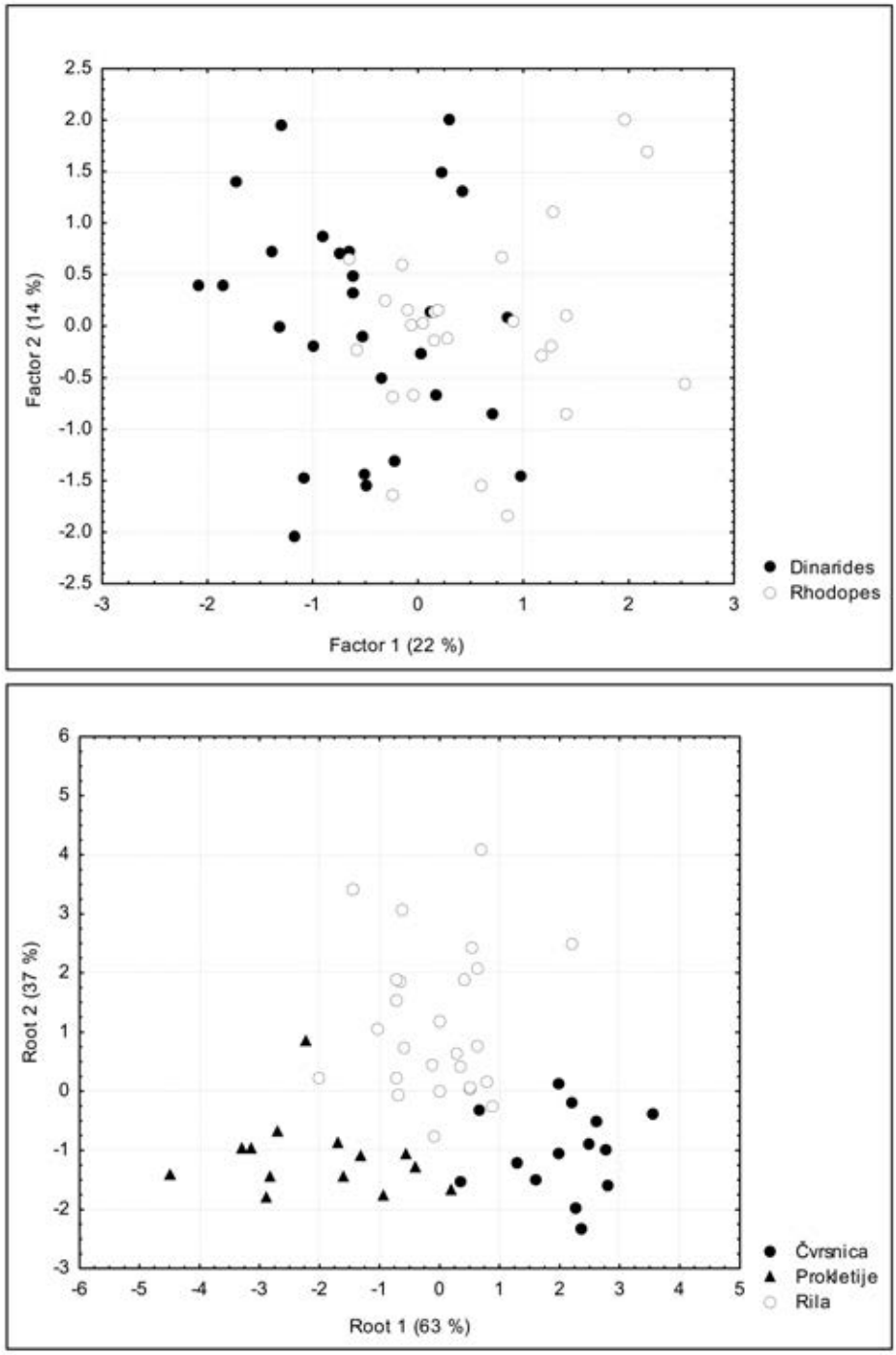

Fig. 3. A — Principal component analysis (PCA) of individuals of *Geum bulgaricum* from the Rila Mountains and the Dinarides; B — Canonical discriminant analysis (CDA) of individuals of *Geum bulgaricum* from the Rila Mountains, the Prokletije Mountains, and Mt. Čvrsnica based on all morphological characters.

axis, while scores of the population from the Rila Mountains are grouped on the positive part of the second axis. Unexpectedly, scores of the population from the Rila Mountains on the first axis are positioned between the two Dinaric populations. Despite that, in CDA we recognised three separate groups, but Tukey's HSD posthoc test for all characters showed that these differences are not statistically significant (Table 2).

Although no general differentiation in regard to all morphological character states was established, significant differences between the Rhodope-Rila and the Dinaric populations were observed when we analysed separate groups of individual characters. Thus, statistically significant differences were established with respect to characters of the indumentum, seeds, and epicalyx (Table 2). In all three groups of characters, *G. bulgaricum*

from the Rila Mountains represents a homogenous group significantly different from the Dinaric populations. As in canonical discriminant analysis (CDA), Tukey's HSD posthoc test showed that regarding some morphometric characters, the population from the Rila Mountains, quite unexpectedly, has an intermediate position between the two Dinaric populations. In fact, regarding seed (Ah_l + Ah_w + St_l + St_H_L) and stem (St_h + St_w) features, populations from the Rila Mountains and Mt. Čvrsnica form a homogenous group (Table 3).

Genome size. Our studies showed that the nuclear DNA amount (2C value) ranged from 4.79 in the population from the Prokletije Mountains to 6.58 in that from the Rila Mountains. The mean value of all investigated populations was 5.72 pg. Furthermore, the populations from the Rhodope-Rila system (the Rila Mountains) and the Dinaric system (Mt. Čvrsnica and the Prokletije Mountains) have statistically significant different genome sizes (Fig. 4). The 2C value in the population from the Rila Mountains ranged from 6.24 to 6.58 with a mean value of 6.39 pg, while this index in the Dinaric population ranged from 4.79 to 5.83 with a mean value of 5.39 pg. It is noteworthy that in the population from the Prokletije Mountains, two individuals are recorded with significantly smaller 2C values (4.80 and 4.90 pg) than the average value (5.39 pg) for the Dinaric population.

Tukey's HSD posthoc test for 2C values showed that the differences in genome sizes between Rhodope-Rila and Dinaric individuals are statistically significant (Tables 2, 3).

Threatened status. On the basis of the obtained new chorological data and estimation of the number of individuals and condition of the populations, we can define *G. bulgaricum* as IUCN NT in Bulgaria, Albania, and Montenegro; and as VU D2 E in Serbia and Bosnia and Herzegovina.

DISCUSSION

Although data on the presence of *G. bulgaricum* outside the territory of Bulgaria were published soon after Pančić's discovery of this species in 1882 in the Rila Mountains (Baldacci 1892 - Montenegro; Protić 1908 - Bosnia and Herzegovina; Hayek 1917 - Albania; Rechinger 1935 - Serbia), the distribution of this "species of European concern" remained insufficiently known and in some aspects controversial. In most of the relevant botanical literature, there are different data about the distribution of *G. bulgaricum*, both in regard to the number of states (Gajewski 1968; Ozinga & Schaminée 2005; Kurtto 2009) and in regard to the position of the populations within geographical regions (Gajewski 1957; Kurtto *et al*. 2004).

While Gajewski (1968) correctly stated that *G. bulgaricum* is distributed on "mountains of S Yugoslavia, Albania, and SW Bulgaria (Ju Al Bu)", on his map of the distribution there are no data about the occurrence of *G. bulgaricum* in Albania and Montenegro. At the same time, one large part of the species' range is located in the Šar Planina Mountains and the mountains Skopska Crna Gora and Rujan on the border between Macedonia and Serbia (Gajewski 1957). This error on the map was probably taken by later authors to indicate that the species *G. bulgaricum* is also present in the Republic of Macedonia and the Šar Planina Mountains in the south of Serbia. Additionally, although Kurtto *et al*. (2004) provided a completely correct map with clear indication that the species is present in Montenegro, in the last relevant source (Kurtto 2009) it was stated that the species is distributed only in Albania, Bosnia and Herzegovina, Bulgaria, and Serbia (Al BH Bu Sr). Finally, Ozinga & Schaminée (2005) stated that the species is registered only in three European countries, without indicating which countries.

As a result of our research, the occurrence of *G. bulgaricum* was confirmed in five Balkan countries: Albania, Bosnia and Herzegovina, Bulgaria, Montenegro, and Serbia. Its range of distribution is divided into two main parts. The first part is in the Rila Mountains, the second in the central and southeastern Dinarides and northwest corner of the Scardo-Pindic mountain system. Furthermore, all populations are grouped into four clearly separated disjunctions: "Bulgarian", "Herzegovinian", "Montenegrin-Albanian" and "East Albanian". At the same time, all literature records for the presence of the species in the Šar Planina Mountains and at other localities in the Republic of Macedonia have to be treated as erroneous, which is in accordance with the opinion of Micevski (1998). Several localities were newly discovered in Albania and Montenegro, and it appears to be a relatively common species in the vegetation of subalpine -alpine silicious and calcareous grasslands, screes, and stands of krummholz pine.

As an endemic with a very restricted range of distribution in Europe, *G. bulgaricum* is defined as a species of great international (Ozinga & Schaminée 2005; Heywood 2009) and national (Sl RCG 76/2006; BDA 2007; Peev & Tsoneva 2009; Sl RS 5/2010; Đug *et al*. 2013) significance. However, except for Bulgaria and Bosnia and Herzegovina, previous assessments of the status and vulnerability of this species at national or regional levels is completely missing. We therefore here define *G. bulgaricum* as IUCN NT in Albania and Montenegro, and as VU D2 E in Serbia and Bosnia and Herzegovina, based on our extensive chorological data and estimation of the number of individuals and condition of the populations.

It is well documented that the Balkan Peninsula represents one of the European centres of diversity (Turrill 1929; Hewitt 2011; Nieto Feliner 2014) and endemism (Turrill 1929; Stevanović *et al*. 2003, 2007; Stevanović 2005; Tan *et al*. 2007; Tomović *et al*. 2014).

Table 2. Tukey's HSD post-hoc test for morphometric and genome size characters of *Geum bulgaricum* of two groups, viz. the population of the Rila Mountains vs. that of the Dinarides. The full names of morphometric characters and the corresponding acronyms are given in Table 1. Values given in bold are statistically significant.

		Homogenous Groups		Populations	
all characters		**1**	**2**	**Dinarides**	**Rila Mts.**
	Dinarides	****			0.084
	Rila Mts.	****		0.084	
indumentum (Pd_w + Pd_ind)		**1**	**2**	**Dinarides**	**Rila Mts.**
	Dinarides	****			**0.000**
	Rila Mts.		****	**0.000**	
seed (Ah_l + Ah_w + St_l + St_H_L)		**1**	**2**	**Dinarides**	**Rila Mts.**
	Dinarides	****			**0.032**
	Rila Mts.		****	**0.032**	
epicalyx (Ca_In_l + Ca_In_w)		**1**	**2**	**Dinarides**	**Rila Mts.**
	Dinarides	****			**0.002**
	Rila Mts.		****	**0.002**	
stem (St_h + St_w)		**1**	**2**	**Dinarides**	**Rila Mts.**
	Dinarides	****			**0.006**
	Rila Mts.		****	**0.006**	
genome size (2C)		**1**	**2**	**Dinarides**	**Rila Mts.**
	Dinarides	****			**0.000768**
	Rila Mts.		****	**0.000768**	

It is estimated that its vascular flora comprises *ca* 8000 native taxa, including 2600–2700 endemics. The highly structured topography, extremely different recent climatic conditions, refugial character, and very involved geological history of the Balkan Peninsula have resulted in its becoming a very complex territory in the phytogeographical sense. With respect to its phytogeography, the Balkan Peninsula is differentiated into many phytochoria of subregion and province rank (Horvat *et al*. 1974; Jäger & Welk 2003). The Dinaric and Rhodope-Rila mountain systems have very different geographical, geological, and historical features, and these two mountain systems belong to different phytochoria of subregion rank (the Illyrian vs. the Balkan subregion). Accordingly, many well-known endemic plants (Illyrian vs. Balkan endemics) are geographically restricted to one of these two areas (Horvat *et al*. 1974; Tomović *et al*. 2014). At the same time, the recent discovery of several new or neglected cryptic species, as in *Campanula* (Lakušić *et al*. 2013a; Janković *et al*. 2016), *Edraianthus* (Surina *et al*. 2009; Lakušić *et al*. 2013b, 2016), and *Sesleria* (Kuzmanović *et al*. 2013), indicates that crypto speciation is very common in this area. It is important to note that this kind of speciation, which is noticeable in genetic structure but not readily apparent in morphological characters, exhibits a strong phytogeographical pattern in the spatial sense. To be specific, all these recently discovered cryptic taxa are defined as local or stenoendemics, which are characteristic of phytochoria at the level of a single floristic province or district. With this in mind, as well as the fact that *G. bulgaricum* is not only geographically but also ecologically strongly differentiated into the siliciphilous Balkan (Rhodope-Rila) and calciphilous Illyrian (Dinaric) populations, it was expected that differentiation would be found on both the morphological and the cytogenetic levels, which could have implications for the taxonomic treatment of this species.

Given that up to now, *G. bulgaricum* has not been the object of any detailed studies, we are here providing the first insight into the differentiation of its populations. We found that the Rhodope-Rila and Dinaric populations are slightly differentiated on the morphological level and well differentiated with respect to genome size.

With respect to qualitative features, the Rhodope-Rila and Dinaric populations showed clear morphological differences (Fig. 2). The plants from the Rila Mountains

Table 3. Tukey's HSD post-hoc test for morphometric and genome size characters of *Geum bulgaricum* of three groups, viz., the population of the Rila Mountains vs. that of the Prokletije Mountains vs. that of Mt. Čvrsnica. The full names of morphometric characters and the corresponding acronyms are given in Table 1. Values given in bold are statistically significant.

		Homogenous Groups		Populations		
all characters		**1**	**2**	**Čvrsnica**	**Prokletije**	**Rila**
	Čvrsnica	****			0.730	0.112
	Prokletije	****		0.730		0.361
	Rila	****		0.112	0.361	
indumentum (Pd_w + Pd_ind)		**1**	**2**	**Čvrsnica**	**Prokletije**	**Rila**
	Čvrsnica	****			0.646	**0.003**
	Prokletije	****		0.646		**0.000**
	Rila		****	**0.003**	**0.000**	
seed (Ah_l + Ah_w + St_l + St_H_L)		**1**	**2**	**Čvrsnica**	**Prokletije**	**Rila**
	Čvrsnica	****			**0.001**	0.525
	Prokletije		****	**0.001**		**0.000**
	Rila	****		0.525	**0.000**	
epicalyx (Ca_In_l + Ca_In_w)		**1**	**2**	**Čvrsnica**	**Prokletije**	**Rila**
	Čvrsnica		****		0.726	**0.008**
	Prokletije	****	****	0.726		0.091
	Rila	****		**0.008**	0.091	
stem (St_h + St_w)		**1**	**2**	**Čvrsnica**	**Prokletije**	**Rila**
	Čvrsnica	****	****		0.704	0.275
	Prokletije		****	0.704		**0.044**
	Rila	****		0.275	**0.044**	
genome size (2C)		**1**	**2**	**Čvrsnica**	**Prokletije**	**Rila**
	Čvrsnica	****			0.999	**0.003**
	Prokletije	****		0.999		**0.003**
	Rila		****	**0.003**	**0.003**	

are more robust, with a thicker stem, a thicker and denser indumentum with many glandular hairs, a larger number of flowers, and more or less erect flowering branches. By way of contrast, the Dinaric plants are elongated, with a thinner and scattered indumentum on the stem (without or sometimes with just a few glandular hairs), and with a very characteristic downward bent of terminal parts of the flower stalk. However, these differences, which are noticeable at first glance, were not confirmed by our morphometric analysis, which showed that the level of variation of the analysed characters is very high and that overlapping occurs between the populations. Hence, it must be stated that we do not at the moment have enough arguments to conclude that the Dinaric and Rhodope-Rila populations are clearly differentiated at the morphological level.

Unlike the situation with morphology, we found strong statistical evidence indicating that the Rhodope -Rila and Dinaric populations are well differentiated with respect to genome size, most likely on the level of ploidy. From the results of a previous study of genome size in the hexaploid species *G. urbanum* (2C = 3,01 pg) (Pustahija *et al.* 2013), we can assume that *G. bulgaricum* from the Rila Mountains is dodecaploid (12x - 2C~6pg), while populations from the Dinarides are predominantly decaploids (10x - 2C~5pg), with a few octoploid individuals (8x - 2C~4pg) from the Prokletije Mountains.

As in the case of chorologic data, data on the chromosome number of this species are also very scarce and insufficiently clear. To be specific, we found only three published sources containing information about its chromosome number. In fact, all three chromosome numbers assumed by us on the basis of genome sizes have already been reported: 2n = 10x = 70 was reported in Gajewski (1957, 1958), 2n = 8x = 56 in Gajewski (1968), and finally 2n = 12x = 84 in Baltisberger (2006). Unfortunately,

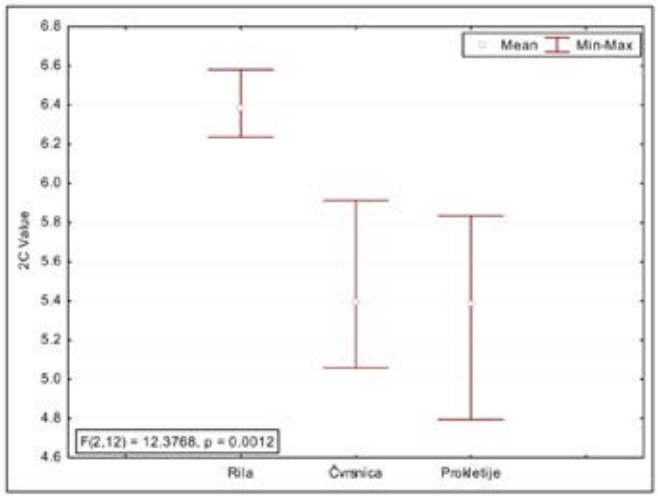

Fig. 4. Box plots of genome sizes for different populations of *Geum bulgaricum*.

only Baltisberger (2006) provided precise information on the origin of his material (Rila Mountains, northeast of Musala), so it remains unclear whether Gajewski counted chromosomes on plants from the Dinarides or on ones from the Rila Mountains.

CONCLUSIONS AND OUTLOOK

Given that our morphometric study was carried out on herbarium specimens that were not collected for formal morphometric analysis, and in view of the fact that the measured specimens were in different phenological phases, the morphometric results presented here should be considered as preliminary. For these reasons, additional morphological studies based on specimens collected specifically for morphometric analyses (an equal number of individuals for each population and individuals collected in the same phenological stage) are needed. Furthermore, molecular phylogeographical studies would be helpful in solving the taxonomic status of the Dinaric and Rhodope-Rila populations. We therefore decided for the time being to solve only the basic nomenclatural question related to the name *Geum bulgaricum*. We leave a more thorough taxonomic treatment to planned future detailed studies on the morphological, cytogenetic, and molecular levels.

Geum bulgaricum Pančić, *Elem. Fl. Bulg.* 26 (1883)

Lectotype (designated here): Bulg. bor. occid [Bulgaria borealis occidentalis], sub m. [monte] Rilo, ad rivulum montanum, Aug 882 [Augusto 1882], *J. Pančić s.n.* (BEOU 4541!) (Fig. 5).
Protologue citation: in elatioribus m. Rilo in ripa saxosa rivuli ad viam qua itur a coenobio Rila ad Samokov.
Other original material examined: Bulgaria bor. occid. [borealis occidentalis], m. [monte] Rilo, in saxosis rivularibus, Aug 882 [Augusto 1882], *J. Pančić s.n.* (BP 459167!)

Fig. 5. Lectotype of *Geum bulgaricum* Pančić (BEOU 4541).

Note: We found two herbarium specimens belonging to the original material collected by Pančić in August of 1882 in the Rila Mountains. The details on the labels match the information provided in the protologue. However, the specimen from BEOU is more representative than the one from the BP herbarium, having flowers and fruits which bear important diagnostic characters. We therefore here designate it as the lectotype.
Specimina Visa

ALBANIA (UTM Grid zone 34T). — Nordhange der "Prokletije", in der alpinen Region, c. 1700 m, 17.07.1914, *I. Dörfler No. 485* (WU!); "Prokletija"-Gebiet, in du alpinen Region am Nordhange der "Prokletija", c. 1700 m, 14.07.1914, *I. Dörfler 485* (BP168053!); distr. Scutari, Alpes alb. sept., m. Parun, [CM88], in rupestribus alpinis, *A. Baldacci 171* (P02567975!); P02567979!); Parun, Maja Strebiscit, [CM88], Kalk, 1700 m, 19.07.1933, *B. Schütt* (BREM03042!); Parun-Gebirge, [42.299191 N, 19.631539

E / CM88], 27.07.1928, *B. Schütt* (BREM03041!); distr. Scutari, Alpes alb. sept., m. Šala supra Abata, [CM98], in rupestribus alpinis, 23.07.1897, *A. Baldacci 171* (P02542171!); P02567984!); Q. e Pejs über Okol in Thethi, [42.44398353 N, 19.77268381 E / CM99], 07.1939, *B. Schütt* (BREM03046!); Q. e Pejës - Nikç, [42.44398353 N, 19.77268381 E / CM99], Kalk, 1800 m, 02.08.1933, *B. Schütt* (BREM03040!); Albania sep. Alpet, mt. Radohin, prope pagum Thethi, [CM99], in rupestribus declivibus, 1800 m.s.m., 23.07.1960, *P. Jakucs A22* (BP589851!); Сеси, изнад језера на седлу Пејаси код катуна [CM99], кречне стрме стене, 23.08.1938, *P. Černjavski*, det. P. Černjavski (BEO11413!); Bridashe b. Boga, [CM99], 30.07.1929, *B. Schütt* (BREM03039!); District of Shkodër (Rrethi i/Shkodrës), Prokletije Mountains: between Bogë and Okol, southern slope of Mount Shtegu (2081 m), 42.391110 N, 19.727710 E, [CM99], on limestone rocks, 1805 m.s.m., 29.05.2005, *Z. Barina, D. Pifkó* (BP183242!); distr. Klementi, Prokletije pl., supra Nikći (Scirta), [42.484761 N, 19.698662 E / CN90], in rupestribus, 04.08.1901, *A. Baldacci 26* (P02542169!); Distr. Klementi, Alpine Felsen du Fuša Rudnices, [CN90], c. 1800 m, 15.07.1914, *I. Dörfler No. 498* (WU!); District of Shkodër (Rrethi i Shkodrës), Prokletije Mountains: pass Pejes (qafa Pejes), 2,5 km north of Okol, near "Buni i Gropazt", 42.441920 N, 19.772620 E, [CN90], in rocky grassland on limestone, 1710 m.s.m., 31.05.2005, *Z. Barina, D. Pifkó* (BP182863!); from the camp to the tap in the cirque of Mount Ezertse [от лагера до чешмата в циркуса на връх езерце] [DM09], 29.07.1958, *B. Kitanov, S. Petrov* [*Б. Китанов, С. Петров*], det. D. Stoyanov [Д. Стоянов] (SO97884!); the cirque of Mount Ezertse [циркусът на връх езерце] [DM09], 29.07.1958, *B. Kitanov, S. Petrov* [*Б. Китанов, С. Петров*], det. B. Kitanov, S. Petrov [Б. Китанов, С. Петров] (SO101877!); Bertiscus, in jugo Qafa Valbons inter vallem Valbona et Theti, [DM09], in solo calcareo, 2000 m, 04.07.1955, *S. Jávorka & Ujhelyi* (BP273325!); District of Shkodër (Rrethi i Shkodrës), Prokletije Mountains: southeastern part of Mount Alis (2471 m), between pass Valbona (qafa Valbones) and Ragam, 42.409210 N 19.811760 E, [DM09], on limestone rocks, 1770 m.s.m., 02.06.2005, *Z. Barina, D. Pifkó* (BP182897!); Bertiscus, sub rupe Maja Drosks versus cacumen Maja Hekuravet, [DM19], in solo calcareo, 2600 m, 01.07.1955, *Ujhelyi* (BP273326!); Montes Albaniae borealis versus opp. Djakova extensi, Montes Hekurave, supra "Fune Hekurave" ad pagum. Bunjaj, [DM19], in saxosis in valle alpestri, c. 1800-2000 m, 24.08.1918, *S. Jávorka* (BP168847!); Hekuravë, [42.38428418, 19.97057579 / DM19], 07.1935, *B. Schütt* (BREM03045!); Curraj i Epërm, [DM19], 13.07.1929, *B. Schütt* (BREM03044!); District of Tropojë (Rrethi i Tropojës), Albanian Alps Mountains (Alpet Shqiptare, Bjeshkët e Nemuna, Prokletije), west of town Bajram Curri, west of the village of Dopsidol, on the northern slope of Mt. Marbicit (1855.0 m), 42.366760 N, 20.019000 E, [DM19], on limestone rocks, 1622 m.a.s.l., 30.05.2009, *Z. Barina, G. Lunk, D. Pifkó, D. Schmidt*, det. Z. Barina (BP748103!); county of Dibër (Rrethi i Dibrës), Mt. Ruja e Lura above the village of Fushë Lurë, 41.78203 N, 20.24341 E, [DM32], on limestone rocks, 1781 m.a.s.l., 21.06.2013, *Z. Barina, D. Pifkó*, det. Z. Barina (BP758300!); Montes Albaniae borealis ad occidentem opp. Djakova extensi, montes Škelsen supra pagum Tropoja, [DN20], in saxosis calcareis, c. 2100 m, 07.09.1918, *S. Jávorka* (BP168848!);

BOSNIA AND HERZEGOVINA (UTM Grid zone 33T). — Čabulja planina, 1480 m, 09.08.1906, *K. Malỳ s.n.* (BEOU!); Felswände der Čabulja, Nordabhang des Sedlo, [YJ11, YJ12], ca. 1500 m, 09.07.1906, *K. Malỳ* (SARA17811!; SARA 17812!; SARA 17813!); Čvrsnica planina, montis Muharnica, [YJ13], in saxosis alpinis, solo calcareo, 10.08.1922, *K. Malỳ s.n.* (BEOU!); Čvrsnica, Muharnica, 43.63166 N, 17.63436 E, [YJ13], 1761 m, 09.07.2016, *D. Lakušić, N. Kuzmanović, I. Janković 46017* (BEOU!); Čvrsnica, Pešti-brda, iznad Bukove glave, [YJ12], u pukotinama krečnjačkih stijena, N exp., c. 1900 m, 17.09.1966, *Č. Šilić, Đ. Đaran*, det. Č. Šilić (SARA17809!); Čvrsnica planina, Drinača, [YJ13], c. 1950 m, 25.07.1933, *V. Loschingg* (SARA17808!); Čvrsnica planina, stijene ispod Ostrovače, [YJ13], 22.07.1933, *V. Loschingg* (SARA17807!).

BULGARIA (UTM Grid zone 34T). — Bulg. bor. occid, sub m. Rilo, ad rivulum montanum, 08.1882, *J. Pančić 4541* (BEOU!, *Herbarium Pancicianum*; Bulgaria bor. occid., m. Rilo, in saxosis rivularibus, 08.1882, *J. Pančić* (BP459167!); M. Rila, in alpinis, 1903, *O. Bierbach* (P02567983!); Rila, mezi kamenim, 08.1904, *J. Mrkvička* (SOM39840!, SOM39843); Rila [Рила], 08.1935, *K. Popov* [*K. Попов*,] det. K. Popov(SO37760!); alpine zone of Rila Mountains. [алписката зона на Рила], 05-07.09.1919, *B. Stefanoff* (SOM39834!); Rila Mts, prope l. d. Eli dere, [Chepinska reka], in saxosis, c. 2250 m, 21.07.1909, *B. Davidov*, det. B. Davidov (U185598!); mt. Topla Rila, "Polič" supra rivum Dupnička Bistritza, [FM87], in saxosis umbrosis, 2100 m, 27.07.1912, *B. Davidoff* (SOM39831!); Mt. Topla Rila, supra fontes rivi Otovitza, [FM87], in saxosis humidis, 2450 m, 28.07.1912, *B. Davidoff* (SOM39846!); Rila, kod jezera Kalin i brane, 42.17104 N, 23.251367 E, [FM87], silikat, 2327 m, 30.07.2014, *M. Niketić, G. Tomović, S. Đurović, U. Buzurović 41136* (BEOU!); Mt. Bela. Rila, inter locus Sedem ezera, [FM97], in rupestribus, 2300 m, 21.07.1909, *B. Davidoff* (SOM39850!); mt. Rila, Sedemte rilski ezera [Edi gjol /FM97], 22.07.1919, *B. Achtaroff* (SOM39823!); Rila Mts., Sedemte rilski ezera, [Edi gjol /FM97], in saxosis supra *Mugheto*, 2250 m, 21.07.1909, *B. Davidoff* (SOM39848!, 39849!, 39853); Rila Mts., ad Elenin Vrh, [FM97], in rivularibus, 1910, *Jv. K. Urumov* (SOM39824!); Rila Mts., Černi Iskar, [FM97], in saxosis graminosis,

2300 m, 05.08.1920, *B. Davidoff* (SOM39826!); Rila Mts., around the Malyovitsa lakes [Рила, край Мальовишките езера] [FM97], wet rocky places [влажни скалисти места], 2400 m [м.н.в.], 27.08.1969, *B. Kuzmanov* [*Б. Кузманов*] *БК-69890* (SOM119946!); Rila Mts., in Malyovitsa cirques [Рила, из Мальовишките циркуси] [FM97], on rocky meadows in abundance [по скалните поляни в изобилие], 23.07.1940, *A. Radoslavov* (SOM!, SOM39863!); Rila Mts., Malyovitsa [Рила, Мальовица] [FM97], 24.07. 1919, *B. Achtaroff* [*Б. Ахтаров*] (SOM39857!); in the region of Malyovitsa [в района на Мальовица] [FM97], around the *Pinus mugo* localities and rocky places at *ca.* [край клековите огнища и скални места на около] 2500 m [м надм. в.], 04.07.1978, *Docheva*, *Todorova*, *Peev* [*Дочева, Тодорова, Пеев*], det. D. Peev [Д. Пеев] (SOM136337!); to peak Malyovitsa [към вр. Мальовица] [FM97], rocky slopes between the lower and second terraces [скалисти склонове между долната и втората тераса], 16.06.1985, *S. Tsoneva* [*С. Цонева*], det. S. Tsoneva [С. Цонева] (SOM144761!); Rila mountain massif, Malyovitsa peak [Горн. масив "Рила", верш. "Мальовица"] [FM97], among wet rocks and on wet stony meadows [в влажных разелинах скал и на влажн. Каменист. лугах], 2300-2600 m [м над ур моря], 11.07.1948, *A. Yurkovski* [*А. Юрковский*] (SOM39861!); Rila, Malyovitsa, 42.169529 N, 23.36783 E, [FM97], alpine grasslands, *Juncetea trifidi*, granite, 2615 m, 11.07.2015, *D. Lakušić, N. Kuzmanović, I. Janković 42757* (BEOU!); Rila Mts., Urdina river [Рила, Урдина река] [FM97], 1500 m, 24.07.1919, *B. Achtaroff* (SOM39833!, SOM39855!, SOM39860!); Rila Mts., around the Makedonya hut, Blagoevgradska Bistritsa river [Рила пл. под х. "Македония" р. Благоевгр. Бистрица] [GM05], on steep slopes between *Pinus mugo* [по стръмните склонове между клека], 2225 m [м н.в.], 06.07.1955, *I. Penev* [*Ив. Пенев*], det. I. Penev [Ив. Пенев] (SO37766!); Rila Mts. Smradlivoto Lake [Рила Смрадливото езеро] [GM06], 2000', *B. Achtaroff* (SOM39835!); Central Rila Mts., along the road between the Ribni Lakes and the Partisanska Polyana [Централна Рила планина по пътя между Рибни езера и Партизанска поляна] [GM06], 07.1986, *S. Gheorghieff* [*С. Георгиев*], det. *S. Gheorghieff* [С. Георгиев] (SO94096!); Rila Mts., Kanarata, [GM06], in saxosis alpinis, 2600 m, 26.07.1909, *B. Davidoff* (SOM39862!); Montes Rila, infra opp. Samokov, in valle alpestri Levi Isker prope Mala Cerkva, [GM07], 20-21.06.1929, *S. Jávorka* (BP454135!); Mt. Bela Rila, supra rivum Dolna Leva Reka, [GM07], in saxosis, 2250 m, 17.07.1911, *B. Davidoff* (SOM39830!, SOM39854!); Rila Mts., decl. orient. "Sakan Dupka", [GM07], in saxosis umbrosis, 2400 m, 06.07.1909, *B. Davidoff* (SOM39864!, SOM39865!, SOM39867!, SO83837!); SE Rila Mts., NE of the mountain Suha vapa, S of the Grnčar chalet, [GM16], slopes with *Pinus mugo*, wet areas in scree, 1900 m, 24.07.1980, *P. Frost-Olsen 3467* (P00897993!); Sud-est du Massif Rila, au nord-est du Mt. Suha vapa, au sud de Grančar chalet, [GM16], pente couverte de *Pinus mugo* sur sol graveoleux humide, 1900 m, 24.07.1980, *P. Frost-Olsen 3467*, det. P. Frost-Olsen (P04198971!, L987251 660!); Rila Mts., [Рила], peak Mussala [Сталин], [GM17], eastern slope [източният склон], 2880-2900 m. 04.07.1957, *I. Bondev* [*Ив. Бондев*] (SOM109121!); around the Sara-Gyol, Chadur Tepe and Mussala [покрай Саръ Гьол Чадър Тепе и Мусала], [GM17], among rocks and on rocky meadows, in abundance [по скалите и скалните поляни, доста разпрстр.], 06.09.1919, *B. Achtarov* (SOM39836!); Rila pl., Musalensky masiv, [GM17], 07.1927, *J. Zolikoffer* (SOM39829!); Rila, Musala, [GM17], 2300 m, 25.07.1993, *Jovanović, S. 155/93* (BEOU!); Rila, pored staze od hiže Musala ka vrhu Musala, [GM17], silikat, 05.08.2013, *N. Kuzmanović, S. Đurović 39634* (BEOU!); Musalla, [GM17], 26.07.1892, *J. Wagner 51* (BP192810!); Musala, [GM17], 1906, *unknowun coll.* (SOM39839!); m. Musala, [GM17], in rivularibus, 17.07.1907, *Jv. K. Urumov* (BP168853!); m. Musala, [GM17], *J. K. Urumov 618* (BP168850!); m. Musala, [GM17], 04.08.1899, *V. Střibrný* (P02542172!); Mt. Musala, [GM17], in excelsis humidis summae regionis alpinae, 02.08.1920, *Jv. K. Urumov* (SOM39841!); Mt. Musala, [GM17], in rivularibus, 1906, *Jv. K. Urumov* (SOM39842!); Mt. Musala, [GM17], in rivularibus, 1908, *I. K. Urumoff* (SOM39837!); ad cuc. Musala, [GM17], in saxosis alpinis, 2600 m, 18.08.1913, *B. Achtaroff* (SOM39825!); Мусала, [GM17], 02.08.1912,-13.07.1903, (SOM39844!); Mussala [Мусала], [GM17], 2700 м, 26.06.1932, *B. Achtarov* [*Б. Ахтаров*], (SOM39828!); Mussala [Муссала], [GM17], Mussala [Муссала], [GM17], 08.1905, *V. Střibrný* (SOM39838!, 39845!, 39847!); South Rila, Suhoto Lake [Южна Рила, Сухото езеро], [GM17], 07.1980, *S. Tonkov* [*Сп. Тонков*], det. S. Tonkov [Сп. Тонков] (SO90328!); Rila Mts., the peak Deno [Рила, на в. Дено], [GM17], very humid grassy places, western slope, *ca.* [силно влажни тревисти места по западна склон, към] 2400 m [м.н.в.], 22.06.1968, *N. Vihodcevski* [*Н. Виходцевски*], det. N. Vihodcevski [Н. Виходцевски] (SO37767!); Rila Mts., cacumine Deno, [GM17], in saxosis declivibus, solo granitico, 2300 m, 23.07.1952, *B. Kitanov*, det: B. Kitanov (SO37768!, BP168070!); Rila Mts., Bistrtsa Lakes, near Mussala [Рила пл., Бистрични езера под Мусала], [GM17], 08.1897, *V. Střbrný* [*В. Стрибърни*], det. V. Střbrný [В. Стрибърни] (SO37762!); Rhodope centralis, montis Musala supra locus alpinos, i.c. supra fontes Maritzae fluvium, non procul ad urbe Samokov, [GM17], in rupestribus alpinis, 26.07.1892, *J. Wagner s.n.* (BEOU!); Montes Rhodope occidentales, in monte Musalla prope Čamkoria (Borovets), [GM17], in rupestribus, substr. silic., c. 2200-2600 m.s.m., 24.-26.07.1930. *K. H. Rechinger fil.* (BP168051!); Rhodope centralis, montis Musala supra locus alpinos, i.c. supra fontes Maritzae fluvium, non procul ad urbe Samokov, [GM17], in rupestribus alpinis, 26.07.1892, *J. Wagner* (BP192821!,

BP168851!); (P02567976!, P02542170!, P04202637!); Rhodopes centralis, montis Mušala, supra fontes fl. Maritzae non procul oppido Samokov, [GM17], in rupestribus alpinis, 26.07.1892, *J. Wagner 7703/2935* (BP688978!); *2935* (P02567974!, P04166218!, P02542168!); Rila Mts., Marichini springs near Mussala [Рила пл., Маричини извори под Мусала], [GM17], 11.08.1899, *V. Střbrný* [*B. Стрибърни*], det. *V. Střbrný* [В. Стрибърни] (SO37761!); Rila Mts., on the shores of the upper Marichino Lake [Рила планина, край брековете на горно Маричино езеро], [GM17], 14.07.1988, *D. Peev* [*Д. Пеев*], det. D. Peev [Д. Пеев] (SOM149660!); mt. Zelena Rila, ad rivum Desni Ibar, [GM27], in saxosis, 2200 m, 16.08.1911, *B. Davidof*, (SOM39832!); Rila Mts, the peak Ibar [Рила, на в. Ибър], [GM27], on steep rocks and rocky soils, northeastern slopes, [по стръмни скали и скални почви с. изт. склонове, на в.] 2600 m [м], 06.09.1919, *B. Achtaroff*, (SOM39827!); mt. Zelena Rila, Kotlinite, [GM37], in saxosis *mughetosis*, 2200 m, 13.08.1912, *B. Davidoff* (SOM39866!); Eastern Rila Mts., above the hut Belmeken, rocks on the path to the sprort base of Belmeken [Изт. Рила, над х. Белмекен, на скали до пътеката за спортната база Белмекен], [GM37], eastern exposure [източно изложение], 2350 m [м. надм. в.], 28.07.2007, *A. Tashev* [*Ал. Ташев*], det. A. Tashev [Ал. Ташев] (SOM165610!); Rila Mts, Belmeken [Рила пл., на Белмекен], [GM37], on rocky wet slopes [по скалисти влажни склонове], 12.08.1947, *A, Yanev* [*Ас. Янев*], det. A. Yanev [Ас. Янев] (SO37769!); Rila Mts., around the upper Belmeken Lake [Рила пл., около г. Белмекенско езеро], [GM37], on wet slopes [по влажните места на склоновете], 12.07.1889, *St. Gheorghieff* (SO37765!); mt. Zelena Rila, Sinžirli Čal, [GM37], in rupestribus, 12.07.1893, *B. Davidoff* (SOM39851!); mt. Zelena Rila, Sinžirli Čal, [GM37], in rupibus inter *Mugheto*, 12.07.1893, *B. Davidoff* (SOM39852!); Rila Mts. Sungurli Chal [Рила планина, Сунгурли чал], [GM37], on rocky places [по скалисти места], 12.07.1889, *St. Gheorghieff* (SO37763!); Rila Mts., Kostenetski Balkan, Kotlinite, [Рила пл., Костенецки балкан, Котлините] [GM37], 13.07.1889, *St. Gheorghieff* (SO37764!).

MONTENEGRO (UTM Grid zone 34T). — Gusinje, Brada Vezirik b. Gusinje, [DN00], 09.07.1939, *B. Schütt* (BREM03047!); Bertiscus, m. Bijelić supra Gusinje, [DN00], 07.1933, *V. Lindtner*, det. V. Lindtner (BEO11415!); m. Белић [Bjelič / DN00], кречњаци алписког појаса [krečnjaci alpiskog pojasa], 22.07.1933, *П. Черњавски, И. Рудски, В. Линдтнер*, det. V. Nikolić (BEO11410!); Prokletije, Bjelič, Borit katun, [DN00], krečnjak, 1900 m, 06.06.1988, *D. Lakušić 31/88* (BEOU!); Prokletije, Maja Kolata, [DN00], *Asplenietea rupestris*, krečnjak, 2400 m, 05.07.1995, *V. Stevanović, D. Lakušić, M. Niketić, Z. Bulić, S. Hadžiablahović 368/95* (BEOU!); Prokletije, Maja Karanfilit, Krošnja, [DN00], stene, 1300-2200 m, 26.07.2003, *M. Niketić, G. Tomović, S. Hadžiablahović 17682* (BEOU!); Prokletije, Ćafa Borit, [DN00], krečnjak, 07.07.2005, *M. Niketić, G. Tomović 19876* (BEOU!); Prokletije, Ropojana, 42.497000 N, 19.816660 E, [DN00], sipari, *Drypetea spinosae*, krečnjak, 1260 m, 28.07.2011, *D. Lakušić, S. Vukojičić, G. Tomović, N. Kuzmanović, B. Surina, R. Di Pietro, A. Radalj* 33657 (BEOU!); Prokletije, Karanfili, Kotlovi, 42 29.980 N, 19 47.853 E, [DN00], snežanici, *Salicetea herbaceae*, krečnjak, c. 1500 m, 17.07.2010, *D. Lakušić 31210* (BEOU!); Prokletije, Maja Karanfili, Ljubokuč, 42.51224 N, 19.79424 E, [DN00], 1635 m, 13.07.2016, *D. Lakušić, N. Kuzmanović, I. Janković, 46018* (BEOU!); Prokletia, Gebirge bei Gussinje, [42.56309696, 19.83769266 / DN01], 12.07.1927, *B. Schütt* (BREM03043!); Bertisci, Zeletin, Rogovi, [DN02], versus septentr., solo calcareo, 2000 m, 14.07.1924, *M. Šoškić s.n.* (BEOU!); Montenegro, ad fines arnautorum, in mte Zeletin, [DN02], c. 1700 m, rarissime, 06.1903, *J. Rohlena* (BP168854!); Prokletije, Čakor-Vaganica, [DN12], pašnjaci, 1850-2110 m, 24.07.1971, *V. Nikolić, N. Diklić*, det. N. Diklić (BEO46825!); distr. Kuči, Žijovo, m. Hat, [42.547185 N, 19.498693 E / CN71], in rupestribus, 02.09.1902, *A. Baldacci 42* (P02542167!, P02567977!, P02567978!); distr. Kuči, Čafa Velja supra Rikavac, [CN81], in rupestribus, 01.08.1900, *A. Baldacci 265* (BEOU!); (P02542173!, P02567980!, P02567982!); Prokletije, Kučke Prokletije, Velji vrh, [CN81], krečnjak, 19.07.2003, *D. Lakušić, F. Conti, Z. Bulić, M. Niketić, G. Chiasetti, G. Tomović 18511* (BEOU!); Prokletije, Kučke Prokletije, cirkovi ispod Pasjaka, 42.57964 N, 19.56673 E [CN81], 1749 mnv , sipari, krečnjak, 15.07.2017, *D. Lakušić, B. Surina, N. Kuzmanović, I. Janković, P. Glasnović, Balant, M.* (BEOU!); distr. Kuči, ad Mirčev do supra Rikavac, [42.572895 N, 19.599391 E / CN81], in rupestribus alpinis, 14.07.1898, *A. Baldacci 194* (P02542174!, P02567981!, P02567985!).

SERBIA (UTM Grid zone 34T). — Prokletije, Prilepske planine, [DN21], 21.06.1957, *M. Janković s.n.*, det. G. Tomović (BEOU!); Prokletije, Nedžinat, [DN22], osuline i kamenjari, 2200-2450 m, 15.07.1973, *V. Nikolić, N. Diklić, M. Bogdanović*, det. N. Diklić (BEO46828!); Prokletije, Nedžinat, [DN22], predeo oko jezera, mešovita četinarska šuma, krečnjak, N exp., c. 2000 m, 27.07.1971, *V. Nikolić, N. Diklić*, det. N. Diklić (BEO46826!); Mt. Нецинат, при врху изнад језера [Nedžinat, pri vrhu iznad jezera / DN22], кречњачке стене код *Mughetum*-а, 28.08.1933, *P. Černjavski, I. Rudski, V. Lindtner*, det. P. Černjavski (BEO11412!); Bertisci, m. Hajla, [DN23], 2200 m, 08.1922, *Gošović, St. s.n.* (BEOU!); m. Hajla ad Peć, [DN23], in pratis humidis, solo calcareo, c. 2200 m, 09.1957, *D. Mirić*, det. V. Lindtner (BEO46827!); Prokletije, Koprivnik, Belopoljski stanovi-Maja Ljubenić-Jelivi sluzi, [DN31], 09.07.1958, *M. Janković s.n.* (BEOU!); Prokletije, Koprivnik, [DN32], *Mugus* sa Wulfeniom, 10.07.1963, *M. Janković s.n.* (BEOU!); Проклетије, Крш

Чврље, [Prokletije, Krš Čvrlje] [DN32], 06.07.1963, *M. Janković s.n.* (BEOU!); Bertisci, m. Koprivnik, [DN32], in saxosis humidis regionis subalpine, 15.06.1923, *N. Košanin s.n.* (BEOU!); Bertisci, m. Koprivnik, [DN32], in saxosis humidis regionis subalpine, 15.06.1923, *Th. Soška s.n.* (BEOU!); Mt. Koprivnik, ca. urb. Peć, [DN32], in glareosis, in *Pinus mughi*, c. 2300 m, 07.07.1935, *O. Grebenščikov*, det. O. Grebenščikov (BEO11411!); Žljeb, Maja Rosulija, [DN33], 2000-2100 m, 25.06.1932, *I. Rudski*, det. V. Nikolić (BEO11414!);

Field observations

ALBANIA (UTM Grid zone 34T). — District of Malësi e Madhe (Rrethi i Malësisë së Madhe), Bjeshkët e Nemuna Mts. (Prokletije Mts.), above the village of Bogë, north of the peak Mt. Maja e Dragomirit (1901.6 m) and northeast of the peak Mt. Maja e Borës (1780 m), 42.40866 N, 19.61152 E, [CM89], in Bosnian pine forest, on limestone, 1618 m, 07.12.2010, *Barina, Z. et al.*; District of Malësi e Madhe (Rrethi i Malësisë së Madhe), Bjeshkët e Nemuna Mts. (Prokletije Mts.), above the village of Bogë, W of the bjeshkë (pasture) „Jaraku", towards Mt. Maja e Bridashes (2125.2 m), 42.41958 N, 19.65321 E, [CM89], on limestone rocks, 1866 m, 13.07.2010, *Barina, Z. et al.*; District of Malësi e Madhe (Rrethi i Malësisë së Madhe), Bjeshkët e Nemuna Mts. (Prokletije Mts), above the village of Bogë, Qafa e Mushkut Pass, 42.42995 N, 19.69161 E, [CM99], on limestone rocks, 2234 m, 13.07.2010, *Barina, Z. et al.*; District of Malësi e Madhe (Rrethi i Malësisë së Madhe), Bjeshkët e Nemuna Mts. (Prokletije Mts.), between the villages of Bogë and Nikç, north of the pasture Surta e Bogës, at Tarn Liqeni i Bogës, 42.45114 N, 19.71193 E, [CN90], in rocky grassland, on limestone, 1729 m, 14.07.2010, *Barina, Z. et al.*; District of Malësi e Madhe (Rrethi i Malësisë së Madhe), Bjeshkët e Nemuna Mts. (Prokletije Mts), above the village of Nikç, on the S slope of Mt maja e Shnikut (2552.2 m), 42.4674 N, 19.74484 E, [CN90], in limestone scree, 2259 m, 15.07.2010, *Barina, Z. et al.*; District of Malësi e Madhe (Rrethi i Malësisë së Madhe), Bjeshkët e Nemuna Mts. (Prokletije Mts.), above the village of Nikç, on the southern slope of Mt. Maja e Shnikut (2552.2 m), 42.46105 N, 19.74306 E, [CN90], in rocky grassland, on limestone, 1870 m, 15.07.2010, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), on the northern slope of Mt. Maja e Ershelit, above village Peraj, 42.3013 N, 19.8557 E, [DM08], in limestone scree, 1441 m, 15.07.2014, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), Mt. Maja e Shtrazës, above village Peraj, 42.30975 N, 19.84522 E, [DM08], on limestone rocks, 1907 m, 16.07.2014, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), Gropat e Shtarzes, above village Peraj, 42.31171 N, 19.85205 E, [DM08], in northrern exposed, closed grassland, on limestone, 1823 m, 17.07.2014, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), Gropat e Shtarzes, above village Peraj, 42.31284 N, 19.85601 E, [DM08], in northrern exposed, closed grassland, on limestone, 1620 m, 17.07.2014, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), Gropa e Grades, above village Peraj, 42.33474 N, 19.85024 E, [DM08], in rocky grassland, on limestone, 1630 m, 18.07.2014, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), Mts. Albanian Alps (Alpet Shqiptare, Bjeshkët e Nemuna, Prokletije), west of town Bajram Curri (Kolgecaj), on the northern slope of the 2026 m high mount south of mt maja e Dhive (2333 m), 42.34041 N, 19.98508 E, [DM18], in rocky grassland, on limestone, 2022 m, 02.06.2009, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), on the northern slope of Mt maja e Gavnit (2509 m) above homestead stanet e Droçës, above village Dragobi (Hajdaraj), 42.39832 N, 19.93963 E, [DM19], in rocky grassland, on limestone, 1654 m, 21.07.2012, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), on the slope of Mt Alshines (2211 m), above village Curraj i Epërm, 42.38067 N, 19.96711 E, [DM19], in rocky grassland, on limestone, 2331 m, 22.07.2012, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), on the southern slope of Mt maja e Gavnit (2509 m) above village Curraj i Epërm, 42.38557 N, 19.92471 E, [DM19], in rocky grassland, on limestone, 1985 m, 23.07.2012, *Barina, Z. et al.*; Kukës county, Shkëlzen Mts, Mt Maja e Radeshës above village Kërnajë, 42.433615 N, 20.086204 E, [DM29], on limestone rocks, 2050 m, 23.05.2016, *Barina, Z. et al.*; District of Dibër (Rrethi i Dibrës), Mt Ruja e Lura above village Fushë Lurë, 41.78441 N, 20.24803 E, [DM32], in rocky grassland, on limestone, 1846 m, 21.06.2013, *Barina, Z. et al.*; District of Dibër (Rrethi i Dibrës), Mt Ruja e Lura above village Fushë Lurë, 41.77728 N, 20.25961 E, [DM32], on limestone rocks in dolina, 1713 m, 21.06.2013, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), on Mt Maja a Gjytetit (2044 m), above village Çerem, 42.47773 N, 19.9852 E, [DN10], in limestone scree, 2128 m, 10.07.2011, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), between homesteads Gjarpnit e Siperme and Gjarpnit a Poshtme, above village Dragobi, 42.46473 N, 19.99193 E, [DN10], in limestone karst, 2043 m, 10.07.2011, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), Mts. Albanian Alps (Alpet Shqiptare, Bjeshkët e Nemuna, Prokletije), above town Tropojë, on the northern slope of mt. Shkëlzen (2404.4 m), 42.46181 N, 20.11676 E, [DN20], on limestone rocks, 2009 m, 06.06.2009, *Barina, Z. et al.*; District of Tropojë (Rrethi i Tropojës), Mts. Albanian Alps (Alpet Shqiptare, Bjeshkët e Nemuna, Prokletije), above town Tropojë, at the northern foot of cliffs of mt. Shkëlzen (2404.4 m), 42.46461 N, 20.12662 E, [DN20], in closed mountaine grassland, on limestone, 2041 m, 06.06.2009, *Barina, Z. et al.*

MONTENEGRO (UTM Grid zone 34T). — Prokletije, Plavsko-Gusinjske Prokletije, Planinica, [42.681458 N, 20.014671 E / DN12], 2000 m, sipari, krečnjak, 15.07.2015, *B. Surina, N. Kuzmanović*; Prokletije, Kučke Prokletije, cirkovi ispod Surdupa, [42.585924 N, 19.545372 E / CN81],

1750 m, sipari, krečnjak, 15.07.2017, *D. Lakušić, B. Surina, N. Kuzmanović, I. Janković, P. Glasnović, Balant, M.*; Prokletije, Kučke Prokletije, cirkovi ispod Štitana, [42.575852 N, 19.558760 E / CN81], 1850 m, sipari, krečnjak, 14.07.2017, *D. Lakušić, N. Kuzmanović, I. Janković.*

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Botanica SERBICA

REZIME

Rasprostranjenje i varijabilnost *Geum bulgaricum* (Rosaceae), vrste od evropskog interesa

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Kao evropski endemit, sa arealom ograničenim na nekoliko evropskih država, *Geum bulgaricum* Pančić je definisan kao "ciljna vrsta" ili "vrsta od evropskog interesa". Iako se radi o vrsti od velikog međunarodnog značaja, njeno rasprotranjenje je nedovoljno poznato. Na osnovu viešegodišnjih terenskih istraživanja, analize herbarskih i literaturnih podataka, potvrđeno je da je *G. bulgaricum* balkanska endemična vrsta rasprostanjena u Albaniji, Bosni i Hercegovini, Bugarskoj, Crnoj Gori i Srbiji. Njen areal je podeljen na dva glavna dela "istočni" (Rila u Rodopskom planinskom sistemu), i "zapadni" (nekoliko planina u Dinarskom i jedno izolovano nalazište u severoistočnom delu Skardo-Pindskog planinskog sistema), u okviru koga su sve populacije grupisane u četiri disjunkcije. Vrsta se najčešće nalazi u alpijskim i subalpisjkim acifofilnim (*Juncetea trifidi*) i kalcifilnim (*Elino-Seslerietea*) rudinama, a ređe i u vegetaciji sipara (*Thlaspietea rotundifolii*), pukotina stena (*Asplenietea trichomanis*), žbunjacima bora krivulja (*Roso pendulinae-Pinetea mugo*) i veoma lokalizovano na serpentinskim kamenjarima. Ukupan dijapazon nadmorskih visina se kreće između 1200 i 2700 m. Horološki podaci su su prikazani na UTM karti 10 × 10 km, a veliki broj nalaza je georeferenciran sa koordinatama u WGS84 sistemu. Na osnovu horoloških podataka i procene stanja poplacija *G. bulgaricum* je definisan kao IUCN NT u Bugarskoj, Albaniji i Crnoj Gori, i VU D2 E u Srbiji i Bosni i Hercegovini. S obzirom da do sada *G. bulgaricum* nije bio predmet bilo kakvih detaljnih studija, u radu je prikazan prvi uvid u diferencijacije populacije. Pokazano je da se Rodopske i Dinarske populacije neznatno razlikuju na morfološkom nivou, ali i das u veoma dobro izdiferencirane u pogledu veličine genoma. Na kraju je izvršena i lektotipifikacija imena *Geum bulgaricum*.

Ključne reči: Balkansko poluostrvo, ugrožene vrste, veličina genoma, *Geum*, lektotip, morfologija