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Goniolimon dalmaticum Rchb. f. and *G. tataricum* (L.) Boiss. (Plumbaginaceae) in the Croatian flora and their distribution in the Balkan Peninsula

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Abstract – *Goniolimon tataricum* (L.) Boiss. is recognized as a new species for the Croatian flora. Besides *G. dalmaticum* Rchb. f., *G. tataricum* represents the second species of this genus in Croatia. To confirm the identity of *G. tataricum* as a new species, morphometric study and multivariate statistical analysis were performed on the data from four Croatian populations of *G. dalmaticum* and *G. tataricum*. Based on results of morphometric analysis, an identification key for these two species is provided. Data about distribution in the Balkan Peninsula, habitat and ecology of the newly-recorded species are also presented. Typification of *G. dalmaticum* was performed for the first time.

Keywords: Balkan Peninsula, distribution, *Goniolimon*, morphology, morphometry, nomenclature, taxonomy, typification

Introduction

According to the current literature sources the genus *Goniolimon* Boiss. (Plumbaginaceae) is represented with six species in the Balkan countries: *G. besserianum* (Schult. ex Rchb.) Kusn. is distributed in Bulgaria and Romania, *G. dalmaticum* Rchb. f. in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece and Republic of Macedonia, *G. heldreichii* Halácsy in Greece, *G. incanum* (L.) Hepper (=*G. collinum* (Griseb.) Boiss.) in Bulgaria, Greece, Romania and Turkey, *G. sartorii* Boiss. in Greece and *G. tataricum* (L.) Boiss. in Bulgaria, Greece, Republic of Macedonia, Romania and Serbia (Răvăruț 1960, Bjelčić 1967, Trinajstić 1981, Ančev 1982, Bokhari and Edmondson 1982, Demiri 1983, Hepper 1988, Micevski and Matevski 1995, Paparisto et al. 1996, Buzurović et al. 2013, Dimopoulos et al. 2013, Vangjeli 2015). Interestingly, only in Montenegro none of *Goniolimon* species have been recorded (Rohlena 1942, Pulević 2005).

It should be mentioned, that there were confusions about the presence and distribution of a certain *Goniolimon* species in the Balkan Peninsula. Namely, *G. incanum* was reported under the name *G. collinum* for the flora of Serbia (Gajić 1972) but the most recent revision of the genus *Goniolimon* in Serbia (Buzurović et al. 2013) definitely resolved this problem and denied its presence in this country. Also, *G. dalmaticum* was recorded in six above mentioned countries, which could not be completely confirmed by field and herbarium investigations.

Additionally, during a field study in the surroundings of Grabovac and Zadvarje in Croatia, we observed that known populations of *G. dalmaticum* from Croatian subcontinental sites morphologically differ from other coastal populations, and that the plants from these populations actually resemble to closely related species *G. tataricum* (L.) Boiss. Concerning the nomenclature of the name *G. dalmaticum*, literature sources cited the authors of this name in different ways. Greuter et al. (1989) considered that Reichenbach (1854–1855) was the first one who validly described this taxon, while Euro+Med (Domina 2011) and The Plant List cited Carl Presl (Presl 1845) as an author of the basionym *Statice dalmatica*.

The aim of the present study was to conduct a comparative morphological analysis of two *Goniolimon* populations from continental part of Croatia (Grabovac and Zadvarje) with two insular populations (Vir and Pag islands) of *G. dalmaticum*, in order to determine to which species the

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populations from two Croatian subcontinental sites actually belong. Additional aims of this study were to revise and accomplish distribution of the species *G. dalmaticum* and *G. tataricum* in the Balkan Peninsula and to perform the typification of the name *G. dalmaticum*.

Material and methods

In this study we included 70 individuals from four populations collected during July 2015 in Croatia on Vir and Pag islands, Grabovac and Zadvarje (Tab. 1). For comparative study of morphological characters of *Goniolimon* species five spikelets per plant were collected. Collection permit was obtained from the Croatian Ministry of Environmental and Nature Protection. Vouchers are deposited in herbaria BEO, BEOU, CAT and ZAGR.

Thirteen quantitative characters (Tab. 2) were measured on alcohol-fixed material (mixture of 96% ethanol and 85% glycerol, 1:1) by using Digimizer Image Analysis software (MedCalc Software, Belgium). Statistical analyses were performed using the package Statistica 5.1 (StatSoft, Inc.). Analysis of variance (ANOVA) showed that calyx width was not statistically significant, so it was excluded from further analyses – canonical discriminant analysis (CDA) and unweighted pair group method with arithmetic mean (UPGMA) cluster analysis based on Mahalanobis distances – defining populations as groups. The identification key is based on the interquartile range, while minimum and maximum values are given in brackets. Qualitative characters were observed using a stereomicroscope.

The distribution data were plotted on a 10 × 10 km grid map based on the military grid reference system (MGRS) projection (Lampinen 2001). New records comprised findings that had not been registered in the literature for individual UTM squares so far. Imprecise records (rough position) relate to wider localities which included two or more UTM 10 × 10 squares. The chorological analyses included herbarium specimens of *G. dalmaticum* and *G. tataricum* from the following herbaria collections: CAT, CNHM, BEO, BEOU, BP, MKNH, P, PAD, SOA, SO, SOM, W, ZA, ZAGR, ZAHO (abbreviations according to Thiers 2015), and various literature data.

Results

Analysis of variance (ANOVA) showed that twelve of thirteen morphological characters were statistically significant ($p < 0.05$) for delimitation between costal populations

Tab. 1. Localities of the *Goniolimon* specimens used in the morphometric analysis.

Pop. no.	Taxon name	Locality	No. of individuals	Voucher	Coordinates	Elevation (m)
1	*G. tataricum*	Grabovac	12	BEO-82735	43.43044N 16.98615E	327
2		Zadvarje	18	BEO-82734	43.42929N 16.88801E	207
3	*G. dalmaticum*	Vir island	20	BEO-82732	44.32667N 15.02562E	4
4		Pag island	20	BEO-82733	44.45538N 15.02653E	60

Tab. 2. Descriptive statistics of morphological characters of *G. dalmaticum* Rchb. f. (n = 40) and *G. tataricum* (L.) Boiss. (n = 30) from Croatia. Max – maximum value, Min – minimum value, LQ – lower quartiles, UQ – upper quartiles. Statistically significant characters ($p < 0.05$) are bolded.

Morphological characters (measurements in mm)	*Goniolimon tataricum*				*Goniolimon dalmaticum*				ANOVA	
	Min	Max	LQ	UQ	Min	Max	LQ	UQ	F	p
Calyx length	7.9	10.0	8.7	9.4	7.3	9.2	8.0	8.6	35.13	**0.0000**
Calyx width	2.6	3.5	2.8	3.2	2.3	3.7	2.9	3.2	1.51	0.2213
Calyx limb length	1.9	2.9	2.4	2.5	1.7	2.1	1.8	1.9	91.54	**0.0000**
Calyx nerve length	5.3	7.2	5.8	6.7	5.3	7.2	6.0	6.3	18.48	**0.0000**
Inner bract length	5.8	7.4	6.5	7.1	4.7	6.6	5.3	5.7	59.38	**0.0000**
Inner bract width	2.1	3.0	2.5	2.8	2.5	3.9	2.8	3.3	31.16	**0.0000**
Middle mucro of inner bract length	2.3	3.0	2.6	2.8	1.5	2.7	1.8	2.1	76.69	**0.0000**
Lateral mucro of inner bract length	1.6	2.1	1.7	1.9	0.9	2.2	1.3	1.6	30.04	0.0000
Outer bract length	6.0	7.4	6.4	6.8	4.5	6.4	5.2	5.9	50.64	**0.0000**
Outer bract width	1.3	2.1	1.6	1.8	1.6	2.8	1.9	2.3	39.91	**0.0000**
Outer bract mucro length	2.0	2.7	2.1	2.5	1.3	2.2	1.7	2.0	42.32	**0.0000**
No. of spikes per cm	1	1.5	1.25	1.5	1.25	2	1.5	1.75	33.43	**0.0000**
No. of spikelets per cm	4	7	5	6	6	9	7	8	38.61	**0.0000**

of *G. dalmaticum* and subcontinental population of *G. tataricum* (Tab. 2). A single character, calyx width, is not statistically significant and it was excluded from the further analysis.

Results of CDA of twelve selected morphological characters of the investigated populations showed that there are two main groups of populations which are separated along the first axis and can be attributed to two different species: *G. dalmaticum* (two populations on the right side of the figure) and *G. tataricum* (Fig. 1). The first discriminant function (CD1) explained 84.93% of the total discrimination, while the second (CD2) accounted 8.56%. Characters which mostly contributed to separation of the two groups on the first axis are: middle mucro of the inner bract length, outer bract length, calyx nerve length, calyx limb length and number of spikes per cm.

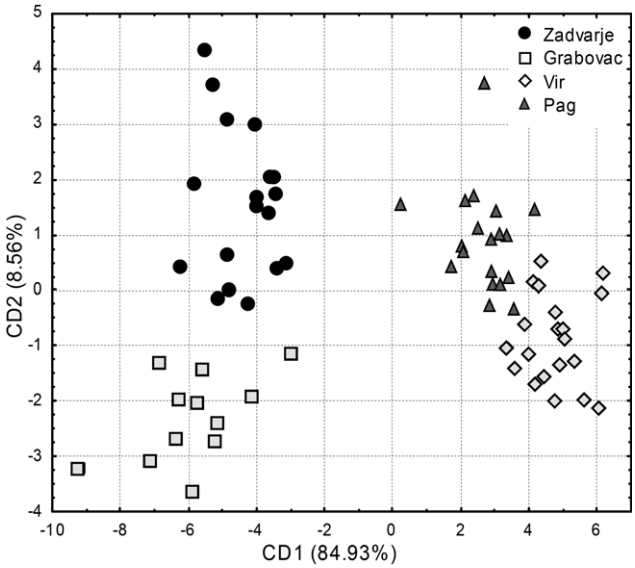

Fig.1. Canonical discriminant analysis (CDA) of morphometric data for four investigated *Goniolimon* populations on the first (CD1) and second (CD2) axis. Populations are indicated with different symbols.

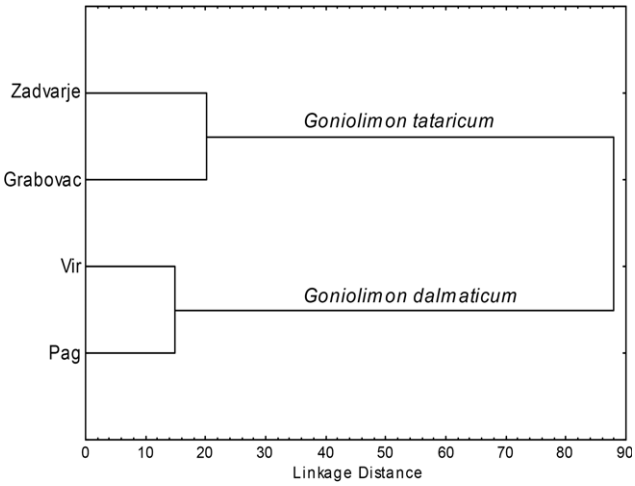

Fig. 2. Unweighted pair group method with arithmetic mean (UPGMA) cluster analysis of four *Goniolimon* populations based on Mahalanobis distances.

UPGMA also showed two separated groups of *Goniolimon* populations: two insular populations of *G. dalmaticum* (from Vir and Pag) are grouped together, forming a separate cluster, while other two subcontinental populations belong to the second cluster of *G. tataricum* (from Grabovac and Zadvarje) (Fig. 2).

Based on morphometric analysis and qualitative characters, an identification key is proposed for Croatian *Goniolimon* taxa:

Terminal spikes laxer, often racemiform with 5–6 spikelets per cm; number of spikes per cm 1.25–1.5; spikelets 2-flowered, rarely 1-flowered. Bracts puberulent, rarely glabrous; middle mucro of the inner bract (2.3–) 2.6–2.8 (–3.0) mm, outer bract (6.0–)6.4–6.8(–7.4) mm. Calyx tube 1½–2 times as long as the limb; calyx limb 2.4–2.5 mm; calyx lobes subulate..... *G. tataricum*

Terminal spikes denser, often capituliform with 7–8 spikelets per cm; number of spikes per cm 1.5–1.75; spikelets 1–2-flowered. Bracts glabrous sometimes with stipitate glands; middle mucro of the inner bract (1.5–) 1.8–2.1(–2.7) mm, outer bract (4.5–)5.2–5.9(–6.4) mm. Calyx tube 2–2½ times as long as the limb; calyx limb 1.8–1.9 mm; calyx lobes rounded..... *G. dalmaticum*

Discussion

According to available records and current check-lists *G. dalmaticum* is widespread in the Balkan Peninsula (Albania, Bulgaria, Croatia, Greece, Serbia, Turkey) (Greuter et al. 1989, Euro+Med). However, our morphometric and chorological analysis have shown that the species' range is actually limited to a narrow costal zone of Dalmatia in Croatia. All inland records, even including those from the Submediterranean Croatia, refer to sub-Pontic species *G. tataricum*. The main source of misidentifications and chorological confusion came from diagnosis and illustrations in the Reichenbach's (1854–1855) protologue where in case of *G. dalmaticum* middle mucro of the inner bract [erroneously "exterioribus"] was presented as longer than the lateral, whereas in case of *G. tataricum* the mucros were treated as subequal. This claim was not denied even recently (Trinajstić 1981, Pignatti and Moore 1972, Ančev 1982, Micevski and Matevski 1995). However, the current morphometric study showed that the middle mucro is longer than the lateral one in both species, while in *G. tataricum* is slightly longer compared to *G. dalmaticum*. Also, cited differences in hairiness were shown as not significant, since both species have shortly appressed-hirsute calyx (sparsely or densely). Bogdanović (2015) also noticed morphological similarity between these two species. Besides that, the existence of clear morphological (see identification key) and ecological differences between *G. dalmaticum* and *G. tataricum* were revealed.

Although the given results are based on analyses performed only from Croatia, herbarium specimens of *G. tataricum* from CAT, CNHM, BEO, BEOU, BP, MKNH, P, PAD, SOA, SO, SOM, W, ZA, ZAGR, ZAHO covering the whole range of the species were also studied.

Goniolimon dalmaticum Rchb. f., Icon. Fl. Germ. Helv.: 61, 102, tab. 149 (1855).

Type locality: "Specimina nostra: S. Stefano Petter "Dalmatia" Clementi".

Lectotype (designated here) [icon.]: Reichenbach Heinrich Gustav (1854–1855), Icon. Fl. Germ. Helv. 17: tab. 149 [1200], figs. II, 2, 3.

Epitype (designated here): "368. Flora dalmatica exsiccata. / *Statice tatarica* L. / *St. incana* Spr. / Mai. Juni. / Litoral – Pflanze. Auf dem grasigen Platze / am Meere bei S. Stefano in Spalato. / Legit Fr. Petter." P05386681 P [on the same sheet with one sample of *G. tataricum*, but with a separate label].

– "*Statice tatarica*" sensu Rchb., Fl. Germ. Excurs. 1: 191; Host, Fl. Austriac. 1: 408 (1827).
– "*Statice incana*" sensu Petter, Bot. Wegw. Spalato: 125, n. 910 (1832); Alsch., Fl. Jadr.: 71 (1832); Vis., Fl. Dalmat. 2: 7 (1847).
– *Statice dalmatica* C. Presl, Abh. Königl. Böhm. Ges. Wiss. ser. 5, 3: 535 (1845), nom. inval. [nom. nudum].

Distribution of *G. dalmaticum* in the Balkan Peninsula is shown in the Fig. 3.

Almost all previously used names were correctly indicated in the protologue (Reichenbach 1854–1855) in which figure legends [p. 102] and table [149] were additionally inserted [in "Supplementum"]. Although the same elements were cited as in Visiani (1847), the original material ["Specimina nostra"] is indicated for the vicinity of Split ["Spalato"] near the small church on Marjan hill and collected by Franz Petter. It was also stated that a specimen comes from the collection of Giuseppe Clementi, but several Petter's specimens found in European herbaria are not a part of that collection. The lack of original material caused the selection of the original illustration from the protologue as the lectotype and one specimen from herbarium in Paris (P05386681) was designated as its epitype.

According to some recent database sources (Euro+Med, The Plant List) *Statice dalmatica* C. Presl (1845) is the basionym of *G. dalmaticum*. However, although this is the oldest name it is obviously invalid, representing a *nomen nudum* ('naked name'). Carl Presl did not give a description (or diagnosis) and bibliographic citation, but only mentioned a single herbarium specimen „*Statice incana* Petter pl. dalm.". The original material was found in PRC (455211) ["*Statice dalmatica* Presl. / In Dalmatia collegit Petter. / Com. 1832"] but it has no nomenclatural importance, which is confirmed in an additional label written by Patrik Mráz in 2015: „Bigger label was written by C.B. Presl. The name is probably only a nomen nudum". Therefore, the correct author citation of *G. dalmaticum* [Rchb. fil.] corresponds to Med-Checklist (Greuter et al. 1989).

Distribution in Croatia

Recent detailed field investigation and chorological analysis of *G. dalmaticum* in Croatia, showed that this species is distributed at several localities on the coastal area of the eastern Adriatic: islands of Vir [MGRS 33T WK00], Pag [MGRS 33T VK92, VK93, WK01, WK02], Rab [MGRS 33T VK75, rough position] and Silba [MGRS 33T VK71], surroundings of the cities Nin [MGRS 33T WJ19], Trogir [MGRS 33T XJ01], Split [MGRS 33T XJ11], as well as Seline village [MGRS 33T WK30] near the National Park Paklenica (Bogdanović et al. 2012, Bogdanović 2015).

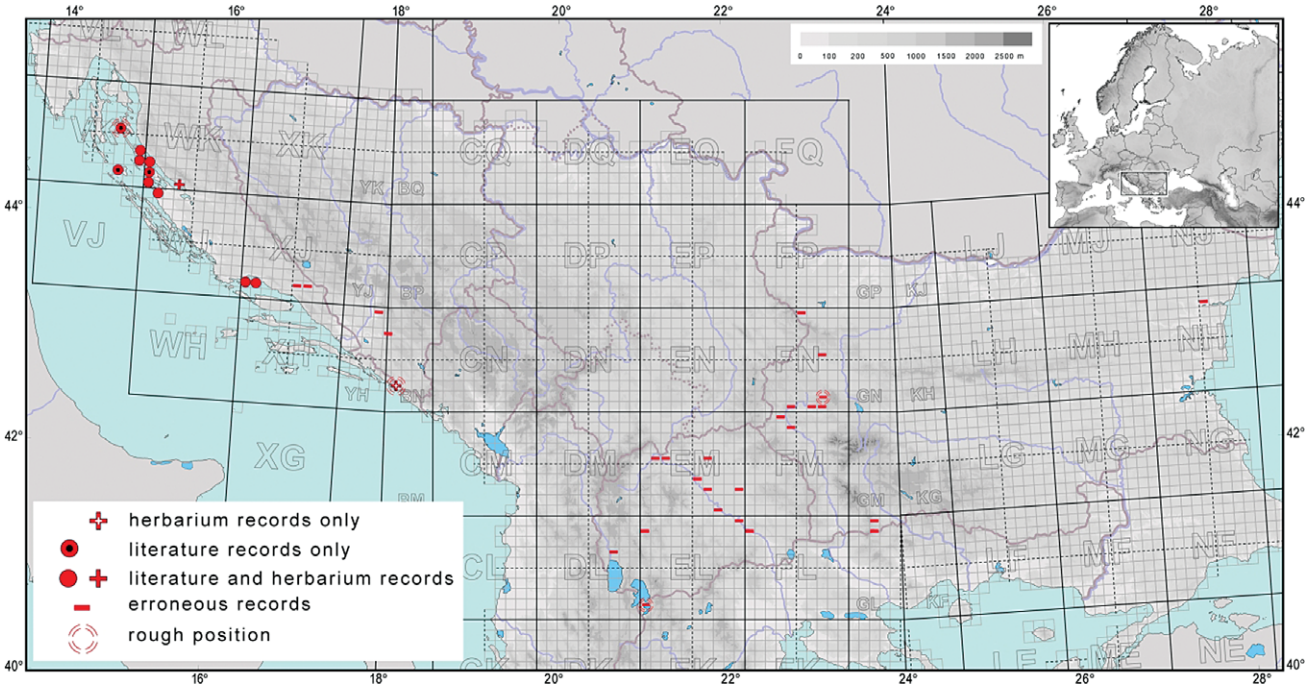

Fig. 3. Total distribution of *Goniolimon dalmaticum* Rchb. f. All erroneous records refer to *G. tataricum* (L.) Boiss. Records for recent populations are marked with a circle; extinct populations were marked with a plus (+) sign. Sign with small black circle in the middle – literature records only; sign with small white cross in the middle – herbarium records only; sigh without small circle/cross in the middle –literature and herbarium records.

Unpublished herbarium data for Croatia

Dubrovnik, "Ragusa" [MGRS 34T BN62], coll. B. de Welden, 1930, det. W. Wangerin, sub. *Statice incana*, rev. U. Buzurović (W s.*n.*). Recent field investigation in the surrounding of Dubrovnik city, proved that *G. dalmaticum* had disappeared from this locality.

Erroneous records for Croatia

The only known two subcontinental sites previously attributed to *G. dalmaticum* in the literature sources (Schlosser and Vukotinović 1869, Radić 1976, Rac and Lovrić 1987, Nikolić 1994, Bogdanović 2015, Nikolić 2015) are in the vicinity of the settlements Grabovac [MGRS 33T XJ51] and Zadvarje [MGRS 33T XJ51] in central Dalmatia. This study revealed that these two populations actually belong to *G. tataricum*.

Erroneous records for Bosnia and Herzegovina

Bjelčić (1967) wrongly cited taxon *G. tataricum* (L.) Boiss. subsp. *collinum* (Griseb.) var. *dalmaticum* Presl. f. *hercegovinicum* Novák for the surroundings of the city of Mostar [MGRS 33T YH39] and Stolac hill [MGRS 33T YH47]. However, the revision of herbarium material from the city of Mostar deposited in the herbarium W proved that in Bosnia and Herzegovina, only *G. tataricum* is present.

Erroneous records for the Republic of Macedonia

G. dalmaticum was erroneously cited for the following localities: Struga, Dobovjani [MGRS 34T DL76], Kičevo, Demir Hisar (Strmnica pl.) [MGRS 34T EL08], Negotino [MGRS 34T EL99], Skoplje, Žeden (Raduša) [MGRS 34T EM15], Skoplje, Žeden (Rašče) [MGRS 34T EM25], Katlanovo [MGRS 34T EM53], Veles, Bašino selo [MGRS 34T EM62], Kumanovo, Bislim [MGRS 34T EM65], Gradsko, Ulanci [MGRS 34T EM70], Štip, Hisar [MGRS 34T EM92], Štip, Kumlak [MGRS 34T EM92], Demir Kapija [MGRS 34T FL08] (Beck 1904, Vandas 1909, Micevski and Matevski 1995, Ranđelović et al. 2008).

Erroneous records for Bulgaria

In the flora of Bulgaria, there are many erroneous records about the presence and distribution of *G. dalmaticum*: Kyustendil, Polska-Skakavica [MGRS 34T FM39], Kjustendil, Konjavo [MGRS 34T FM48], Kjustendil, Izvor [MGRS 34T FN59], Pernik, Zemen (Žabljano) [MGRS 34T FN40], Pernik, Provalenitsa [MGRS 34T FN60], Pernik, Radomir (Dolna Dikanja) [MGRS 34T FN70], Pernik, Radomir (Golo Brdo) [MGRS 34T FN71], Sofija, Kostinbrod (Beledie Han) [MGRS 34T FN75], Mt Slavyanka [MGRS 34T GL28, 34T GL29], Varna, Beloslav ("Kebedže") [MGRS 35T NH58] (Velenovský 1891, Urumov 1935, Ančev 1982, Goranova and Anchev 2011, Aneva et al. 2015).

Erroneous records for Greece

Pavlides (1997) reported species *G. dalmaticum* in Prespa National Park [MGRS 34T EL01, rough position], but this literature record is erroneous and most probably refers to *G. tataricum*. Other literature and herbarium data from this area were not found.

Erroneous records for Albania

Beck (1904) misinterpreted species *G. dalmaticum* in Albania for Struga, "Ohrid", Dobovjani [MGRS 34T DL76], but this locality is actually in the Republic of Macedonia and belongs to *G. tataricum*.

Erroneous report for Serbia

G. dalmaticum was erroneously published for Serbia, because Domina (2011) and Euro+Med misinterpreted data from Trinajstić (1981). The only species that is present in Serbia is *G. tataricum* (Buzurović 2013).

Erroneous report for European Turkey

Reviewing of the herbarium specimens from European part of Turkey showed that all examined specimens belong to *G. incanum*, hence we can conclude that *G. dalmaticum* was erroneously cited for the European part of Turkey (Greuter et al. 1989, Euro+Med).

Goniolimon tataricum (L.) Boiss. in DC., Prodr. 12: 632 (1848).

≡ *Statice tatarica* L., Sp. Pl.: 275 (1753).

Type locality: "Habitat in Tataria".

Lectotype (designated by Edmondson in Jarvis 2007: 874): leg. "Amman s.n., Herb Linn. No. 395.12 (LINN)".

= *G. serbicum* Vis. in Vis. & Pančić, Mem. Reale Ist. Veneto Sci. 10: 440 (1861).

Syntype localities: Western Serbia: "Raška", "Kremna", "Brdjane". "Klekovi" [Mt Vujan].

Lectotype (designated by Clementi et al. 2015: 126): "Illustration in Visiani & Pančić (1862: 450)"; epitype (designated by Buzurović in Clementi et al. 2015: 126): "Serbia, Vujan, 26 June 2012, U. Buzurović s.n. (BEOU 34923)" ≡ *G. collinum* var. *serbicum* (Vis.) Hayek, Repert. Spec. Nov. Regni Veg. Beih. 30(2): 3 (1931) [Prodr. Fl. Penins. Balc. 2].

– "*G. collinum*", "*S. collina*" auct. balc., p.p.
– "*G. besserianum*" auct. bulg., p.p. min.

Buzurović et al. (2013) were the first who treated Visiani's *G. serbicum* conspecific with *G. tataricum*. In the protologue of *G. serbicum* Visiani argues that scarious, truncate and reduced lateral 'mucros' of the inner bract represent one of the main diagnostic character (Visiani and Pančić 1862). However, particular individuals with increased frequency of reduced lateral mucros in the synflorescence can be sporadically found in several *Goniolimon* species, also including syntype populations of *G. tataricum*. Most probably, these morphotypes were presented in yet undiscovered original material of Visiani. Individuals with reduced lateral mucros can also be sporadically found in two Croatian populations of *G. tataricum*.

Distribution of *G. tataricum* in the Balkan Peninsula is shown in the Fig. 4.

First records for Croatia

Grabovac [MGRS 33T XJ51], coll./det. A. Grubišić, coll. no. 27.565, sub. *Statice tatarica*, rev. A. Lovrić, sub. *G. dalmaticum* (ZA 6174); Grabovac, 43.43107N, 16.98092E [MGRS 33T XJ61], limestone, 327 m, coll. U.

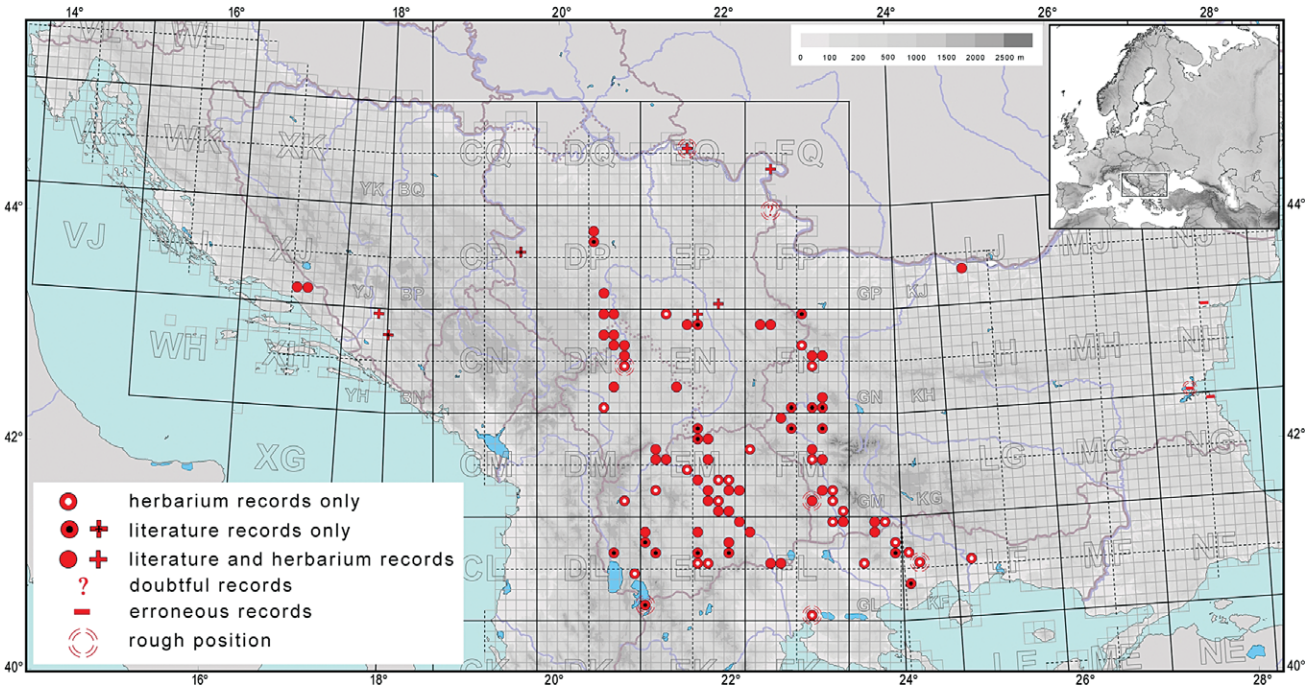

Fig. 4. Distribution of *Goniolimon tataricum* (L.) Boiss. in the Balkan Peninsula. All doubtful records refer to literature data only. Erroneous data refer to *G. besserianum* (Schult. ex Rchb.) Kusn. and/or to *G. incanum* (L.) Hepper. Records for recent populations are marked with a circle; extinct populations were marked with a plus (+) sign. Sign with small black circle/cross in the middle – literature records only; sing with small white circle in the middle – herbarium records only; sigh without small circle/cross in the middle – herbarium and literature records.

Buzurović & S. Bogdanović, 12-July-2015, det. U. Buzurović (BEO 82735, ZAGR 39895); Zadvarje, 43.42929N, 16.88801E [MGRS 33T XJ51], limestone, 207 m, 12-July-2015, coll. U. Buzurović & S. Bogdanović, det. U. Buzurović (BEO 82734, ZAGR 38864). One of the newly-recorded population in Croatia (Zadvarje) represents the western most point of *G. tataricum* distribution in the Balkan peninsula.

Distribution in Bosnia and Herzegovina

G. tataricum subsp. *collinum* var. *dalmaticum* f. *hercegovinicum* was reported by Bjelčić (1967) in two localities: city of Mostar [MGRS 33T YH39] and Stolac hill [MGRS 33T YH47] in Herzegovina. In 2015 we checked both localities and established that in these two sites *G. tataricum* had disappeared.

Distribution in Serbia

Detailed chorology of *G. tataricum* in Serbia was presented by Buzurović et al. (2013). On the basis of this paper, we checked several localities in Serbia: surrounding of city of Niš, Biljeg [MGRS 34T EN59] and Hum hills [MGRS 34T EP70], surrounding of city of Golubac, Braničevo [MGRS 34T EQ45], surrounding of city of Kladovo [MGRS 34T FQ23] and in Mt Tara, Kremna village [MGRS 34T CP85] and found out that in these five UTM squares *G. tataricum* does not grow any more. Also, the locality in the vicinity of Negotin [MGRS 34T FP29, rough position], which was published by Gajić (1972, sub. *G. collinum* (Gris.) Boiss. var. *serbicum* (Vis. & Pančić) Hayek) could not be checked, and remained questionable.

Unpublished herbarium data for Serbia

Kosovska Mitrovica [MGRS 34T DN84, rough position], coll./det. I. Trinajstić, 02-May-1974 (CNHM 33271); Koznik [MGRS 34T DN60], pašnjaci, serpentinit, coll./det. F. Rexhepi, 29-Jun-1977, sub. *G. collinum* var. *serbicum*, rev. U. Buzurović, 13-Dec-2013 (SO 97262); Blace, Brežani [MGRS 34T EN29], coll./det. J. Pančić, 1880, sub. *G. serbicum*, rev. U. Buzurović, 03-Dec-2013 (SO 57496). Population of *G. tataricum* in the vicinity of Brežani village could not be checked in the field and remains questionable whether it still grows in this locality.

Distribution in the Republic of Macedonia

According to several literature sources (Formánek 1900, Beck 1904, Vandas 1909, Jurišić 1923, Stojanoff 1928, Soška 1939, Micevski and Matevski 1995, Ranđelović et al. 2008) *G. tataricum* was found in the following areas: Demir Hisar, Demir Kapija, Gevgelija, Gradsko, Katlanovo, Kavadarci, Kičevo, Kratovo, Kumanovo, Makedonski Brod, Mariovo, Negotino, Petrina, Prilep, Skopje, Struga, Sveti Nikole, Štip, Taorska klisura Gorge and Veles. Micevski and Matevski (1995) presented the last detailed distribution of *G. tataricum* in the Republic of Macedonia. However, in this paper these two authors recognized also *G. dalmaticum* as a member of the flora of Macedonia, and denied presence of the species *G. incanum* and *G. heldreichii* in this country.

Unpublished herbarium data for the Republic of Macedonia

Petrina, Istok [MGRS 34T DL94], coll./det. Th. Soška, 01-Aug-1924, sub. *Statice collina*, rev. U. Buzurović, 22-

Mar-2016 (BEOU 38904); Kičevo, Bukovik [MGRS 34T DM81], coll./det. O. Grebenščikov, 25-Aug-1945, sub. *G. dalmaticum*, rev. U. Buzurović, 04-Mar-2013 (BEO 16604); Kičevo, Bukovik [MGRS 34T DM81], coll. I. Horvat, 17-Jul-1946, det. U. Buzurović (ZAHO, *s.n.*); Mariovo, Zović [MGRS 34T EL55], 700 m, coll./det. G. Tomović, B. Zlatković, 14-Apr-2012 (BEOU 34936); Mariovo, Zović [MGRS 34T EL55], dijatomit, 670 m, coll./det. M. Niketić, G. Tomović, 17-Jul-2012 (BEOU 36463); Mariovo, Bešište, između groblja i sela (vidikovac) [MGRS 34T EL65], krečnjak, 850 m, coll./det. G. Tomović, B. Zlatković, 15-Apr-2012 (BEOU 34937); Mariovo, Melnica, Melniška skrka [MGRS 34T EL65], mermer, krečnjak, 820 m, coll./det. G. Tomović, B. Zlatković, 15-Apr-2012 (BEOU 34935); Mariovo, Melnica, Melniška skrka [MGRS 34T EL65], mermer, krečnjak, 820 m, coll./det. G. Tomović, B. Zlatković, 16-Jun-2012 (BEOU 34934); Mariovo, Vitolište, 41.16959N, 21.78956E [MGRS 34T EL65], mermer, 707 m, coll./det. U. Buzurović, S. Đurović, G. Tomović, M. Niketić, 26-Jun-2013 (BEOU 38508); Mariovo, Sveti Ilija, desna obala Crne reke [MGRS 34T EL65], kamenjari, silikati, coll. I. Horvat, 18-Jul-1946, det. U. Buzurović (ZAHO *s.n.*); Makedonski Brod, Poreče, Breznica [MGRS 34T EM12], pašnjaci (sečena borovo-hrastova šuma), coll./det. P. Černjavski, 31-Jul-1929, sub. *G. collinum* (Gris.) Boiss., rev. U. Buzurović, 04-Mar-2013 (BEO 16582); Skopje, Dervenska klisura, Dvorce [MGRS 34T EM16], coll. K. Micevski, 17-Jun-1953, det. U. Buzurović (HMMNH, *s.n.*); Skopje, Dervenska klisura, Orašje [MGRS 34T EM16], coll./det. V. Lindtner, 10-Jul-1937, sub. *G. collinum* Boiss., rev. U. Buzurović, 04-Mar-2013 (BEO 16585); Skopje, Ljuboš [MGRS 34T EM44], coll. H. Oehm, Sep-1937, det. Th. Soška, sub. *G. collinum* (Gris.) Boiss., rev. U. Buzurović, 04-Mar-2013 (BEO 16597); Štip, Ovče pole, Bekirlija, 41.69339N, 21.95679E [MGRS 34T EM71], 205 m, coll./det. G. Tomović, S. Đurović, U. Buzurović, 06-Jul-2014, (BEOU 41826); Sveti Nikole, Gorobinci [MGRS 34T EM73], coll./det. Th. Soška, 13-Jun-1922, sub. *G. collinum*, rev. U. Buzurović, 22-Mar-2016 (BEOU 38917); Sveti Nikole, Erdželija [MGRS 34T EM73], coll./det. Th. Soška, 12-Jun-1922, sub. *G. collinum*, rev. U. Buzurović, 22-Mar-2016 (BEOU 38917); Kratovo, Lisec planina [MGRS 34T FM06], coll./det. Gradojević, 16-May-1914, sub. *G. collinum*, rev. U. Buzurović, 22-Mar-2016 (BEOU 38918).

Distribution in Bulgaria

G. tataricum grows in the following areas in Bulgaria: Blagoevgrad, Hadžhidimovo, Kresna, Petrich, Sandanski, Strumyani, Bobošević, Dupnica, Kyustendil, Pernik, Radomir, Zemen, Nikopol, Dragoman, Kostinbrod (Pančić 1883, Velenovský 1891, Stojanov 1921, Urumov 1935, Ančev 1982, Petrova et al. 1999).

Unpublished herbarium data for Bulgaria

Petrich, Kožuh [MGRS 34T FL89], coll./det. B. Kuzmanov, 26-Jul-1977, sub. *Limonium gmelinii* (Willd.) O. Kuntze, rev. U. Buzurović, 2016 (SOM 135662); Petrich, Kožuh [MGRS 34T FL89], coll./det. B. Kuzmanov, 09-Jun-1980, sub. *Statice gmelinii*, rev. M. Ančev, Sep-1981 (SOM 139738); Petrich, Kožuh, 41.46075, 23.25825 [MGRS 34T FL89], silikat, 227 m, coll./det. U. Buzurović, S. Đurović, G. Tomović, M. Niketić, 23-Jun-2013 (BEOU 38498); Blagoevgrad-Kočerinovo, Golo Brdo, 42.07186, 23.03872 [MGRS 34T FM65], 403 m, coll./det. U. Buzurović, S. Đurović, G. Tomović, M. Niketić, 23-Jun-2013 (BEOU 38502); Sandanski, Ploski [MGRS 34T FM81], 260 m, trevisti-kamenisti mesta, coll./det. P. Stanimirova, 26-May-2004, sub. *G. collinum*, rev. M. Ančev, (SOM 161565); Strumyani, Ilindenci [MGRS 34T FM81], varoviti, trevisti mesta, coll./det. D. Stojanov, 29-Oct-2004 (SOM 161017); Strumyani, Mikrevo [MGRS 34T FM81], coll./det. V. Goranova, K. Vasilev, 24-May-2009 (SOM 165268); Kresna, Kresna defile [MGRS 34T FM82], coll./det. S. Vukojčić, G. Tomović, 26-Jun-2006, sub. *G. collinum*, rev. U. Buzurović, 24-Feb-2015 (BEOU 21290); Kresna, Vlahinska reka [MGRS 34T FM82], coll./det. C. Denčev, 30-Oct-1982 (SO 93871); Sandanski, Sveti Vrač [MGRS 34T FM90], coll./det. V. Kitanov, 24-Sep-1949 (SO 57531); Dragoman, Berende Izvor [MGRS 34T FN56], dry grasslands, coll./det. K. Vasilev, H. Pedashenko, 12-Aug-2005 (SOM 167615, 167618); Hadžhidimovo, Ilinden [MGRS 34T GL39], suhi trevisto-kamenisti mesta, coll. P. Stanimirova, 20-Jun-2004, det. M. Ančev (SOM 161563).

Erroneous records for Bulgaria

G. tataricum was wrongly cited by Velenovský (1886) for the region of Varna, Beloslav city „Kebedže" [MGRS 35T FM82] and by Ančev (1982) for the surroundings of cities Burgas [MGRS 35T NH30, rough position] and Sozopol [MGRS 35T NG59]. These localities refer on species *G. besserianum* and *G. incanum*.

Distribution in Greece

According to Dimopoulos et al. (2013) *G. tataricum* is present in north-eastern Greece and North Aegean islands. It was cited for Mt Menikion [MGRS 34T GL46] by Karagiannakidou and Kokkini (1987) and for Mt Pangeon, Iliokomi [MGRS 35T KF53] by Papanicolaou (1985). Pavlides (1997) reported species *G. dalmaticum* in Prespa National Park [MGRS 34T EL01, rough position], but according to the current distribution of this species, this literature record most probably refers to *G. tataricum*.

Unpublished herbarium data for Greece

Drama, c. 4 km u pravcu Kato Nevrokopi [MGRS 35T KF56], krečnjak, 650 m, coll. B. Zlatković & V. Ranđelović, Jun-2012, det. U. Buzurović (BEOU 34938); Drama [MGRS 35T KF65, rough position], coll./det. N. Stojanov, 28-May-1913, sub. *G. collinum*, rev. D. Jordanov (SO 57499); Drama [MGRS 35T KF65, rough position], coll./det. D. Stainson, 17-Jun-1959 (W 6768); Drama [MGRS 35T KF65, rough position], coll./det., 09-July (W 8327); Kato Nevrokopi-Granitis, 41.31585N, 23.87238E [MGRS 34T GL47], krečnjak, 596 m, coll./det. U. Buzurović, S. Đurović, G. Tomović, M. Niketić, 24-Jun-2013 (BEOU 38499); Serres, kod table Melenikiatika, 41.10008N, 23.53718E [MGRS 34T GL15], neogeni sedimenti, 163 m, coll./det. U. Buzurović & S. Bogdanović, 20-Jun-2015 (BEOU *s.n.*), Serres [MGRS 34T GL15], coll./det. F. K. H. Rechinger, 09-July, sub. *G. dalmaticum*, rev. U. Buzurović (W 2211); Serres

[MGRS 34T GL15], coll./det. F. K. H. Rechinger, 09-July, sub. *G. dalmaticum* var. *besserianum*, rev. U. Buzurović (W 2210); Thessaloniki [MGRS 34T FL60, rough position], coll. L. Adamović, 1900, det. W. Wangerin, sub. *G. collinum*, rev. U. Buzurović (W 11461); Xanthi, Paradisos [MGRS 35T LF15], coll./det. S. Brulo, P. Pavone, M. Signorelli, 02-Jul-1987, sub. *G. collinum*, rev. U. Buzurović, 16-Feb-2015 (CAT 013361); Xanthi, Paradisos [MGRS 35T LF15], coll. B. Stamatiadeu, 10-Jun-1970, det. U. Buzurović (W 6806).

In Croatia, *G. tataricum* grows on limestone geological substrate in the sub-Mediterranean zone of the alliance *Ostryo-Carpinion orientalis* Horvat (1954) 1959, on xerophilous pastures and grasslands, and within limestone rocky grounds of the alliance *Saturejon subspicatae* Horvatić (1975) between 200–350 m a.s.l. The vegetation of xerophilous pastures and grasslands of the Croatian habitats of *G. tataricum* are in the stadium of succession. Contrary to *G. tataricum*, *G. dalmaticum* grows in the eu-Mediterranean zone on saline sandy-gravelly substrate near the sea coast of the order *Sarcocornietalia fruticosae* Braun-Blanquet (1931) between 4–60 m a.s.l. and on the calcareous rocky coast within the alliance *Crithmo-Limonion* Molinier 1934.

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