

## *Cardamine amara* (Brassicaceae) in Serbia and Republic of Macedonia

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**Abstract:** Distribution data on *Cardamine amara* L. in Serbia and Republic of Macedonia are presented, together with a short review of the history of taxonomic treatment of *C. amara* in this area. *C. amara* subsp. *balcanica* Marhold, Ančev & Kit Tan is reported as a new taxon both for the flora of Serbia and flora of Republic of Macedonia and the occurrence of *C. amara* subsp. *amara* in Serbia was confirmed.

**Key words:** Brassicaceae; *Cardamine amara*; taxonomy; Republic of Macedonia; Serbia

### Introduction

*Cardamine amara* L. is a species which shows a considerable amount of morphological and karyological variability. According to the most recent studies (Jalas & Suominen 1994; Marhold 1998; Marhold et al. 1996; Lihová et al. 2000; Tan 2002; Perný et al. 2005) it is divided in Europe into four diploid and one tetraploid subspecies. Diploids include *C. amara* subsp. *amara* distributed throughout most of Europe except its most northern parts (Jalas & Suominen 1994) and southwards extending to N Italy and Stara planina Mts in Bulgaria (Marhold et al. 1996); *C. amara* subsp. *opicii* (J. Presl & C. Presl) Čelak. distributed in the Sudety Mts and Carpathians (Hrouda & Marhold 1993; Marhold 1995); *C. amara* subsp. *pyrenaica* Sennen restricted to the Eastern Pyrenees (Lihová et al. 2000); and finally, *C. amara* subsp. *balcanica* Marhold, Ančev & Kit Tan described only recently from the Pirin Mts. in Bulgaria, and recorded also in several other localities in Bulgaria and Greece (Marhold et al. 1996). The only tetraploid subspecies *C. amara* subsp. *austriaca* Marhold (Marhold 1999) is distributed mainly in the Eastern Alps in Austria, extending to the neighbouring areas of Switzerland, Germany, Czech Republic, Slovenia, Croatia and Italy. A closely related tetraploid species, *C. amporitana* Sennen & Pau (previously treated mostly as *C. amara* subsp. *olotensis* O. Bolós) has a disjunct distribution, and occurs in Catalonia (NE Spain) and Central Italy (Lihová et al. 2000, 2004).

The aim of this paper is to present distribution

data on *C. amara* in Serbia and Republic of Macedonia together with a short review of the history of taxonomic treatment of this species in the studied area.

The first record on *C. amara* for the territory of Serbia was by Pančić (1856: 508, as *C. amara* var. *hirta* W. D. J. Koch), who reported it as occurring on Mt. Kopaonik. In “Flora Principatus Serbiae”, Pančić (1874: 139) mentioned that this plant grew in the mountains and he also stated that the whole plant was densely hairy. Later, Pančić (1883: 175) and Velenovský (1891: 29) reported this species from the locality Kopren in the Stara planina Mts. Hayek (1925: 392–393) referred to two taxa, namely *C. amara* β [var.] *hirta* Wimm. & Grab. and *C. barbaraeoides* Halácsy for the territory of Serbia. Jovanović-Dunjić (1972: 247–250), following Hayek’s statement, also reported two species for Serbia: *C. amara* L. (including two formas f. *amara* and f. *hirta* “Wimm. & Grab.”) and *C. barbaraeoides* Halácsy. According to her, *C. amara* f. *amara* is distributed on Mt. Kopaonik and in the Stara planina Mts. (Kopren, Krvave Bare ponds, Midžor), while f. *hirta* is present in Vlasina plateau; *C. barbaraeoides* was reported to grow in the mountains in Serbia proper, as well as in Kosovo province, but considered to be a rare plant.

Micevski (1995: 623–624) mentioned only *C. barbaraeoides* for the flora of the Republic of Macedonia. He considered *C. amara* as absent from this territory, and data of its occurrence from Mt. Osogovo (Carev Vrv) and Gostivarsko treated as erroneous (Micevski 1995: 630).

Marhold et al. (1996) revealed that all previous records of *C. barbaraeoides* (or *C. amara* subsp. *barbareoides* (Halácsy) “Stojanov & Stefanov”) from Bulgaria unequivocally refer to *C. amara*, most of them (if not all) to the taxon described as *C. amara* subsp. *balcanica*. *C. barbaraeoides* was excluded from the flora of Bulgaria.

Tan (2002) included *C. barbaraeoides* as a subspecies within *C. amara* (*C. amara* subsp. *barbareoides* (Halácsy) Maire & Petitmengin) and considered it as restricted to central mountain ranges of mainland Greece, and probably extending into Albania along the serpentine belt. According to her, it is apparently absent from the former Yugoslavia (probably including Republic of Macedonia as well as Serbia) and Bulgaria. Nevertheless, Perný et al. (2005 and unpubl. data) recently revealed that *C. barbaraeoides* is closely related to *C. amara*, but still represents a distinct and well differentiated species, which is endemic to north-western Greece (Pindhos Mts. only), an area much more restricted than reported by Tan (2002).

On the basis of these findings, it can be concluded that all the literature data for *C. barbaraeoides* in Serbia and Republic of Macedonia almost certainly refer to *C. amara*. However, it is not known which subspecies are present in the flora of Serbia and Republic of Macedonia, and what are their distribution patterns in these two countries.

During the study of Balkan endemic plants in Serbia, it was revealed that herbarium specimens of *C. amara* from Mt. Kopaonik and the Stara planina Mts. in Serbia belong to *C. amara* subsp. *balcanica* (PhD thesis by Tomović 2007: 85).

## Material and methods

The study is based on the herbarium material deposited in the herbarium of the University of Belgrade – BEOU, herbarium of the Natural History Museum Belgrade – BEO (Holmgren et al. 1990) and Herbarium Moesiacum Niš. The chorological data of *C. amara* subsp. *balcanica* in Serbia and Republic of Macedonia are collected according to the grid map with squares of c. 10 km × 10 km, based on the Universal Transverse Mercator (UTM) projection (Lampinen 2001). Names of plant communities are given as they appeared in original publications or on herbarium labels.

## Results and discussion

### *Distribution of C. amara* subsp. *balcanica* in Serbia and Republic of Macedonia based on herbarium specimens (Fig. 1)

Serbia (East): Stara planina Mts.: Arbinje (FN49), 27.07.1998, leg. G. Tomović & B. Zlatković 11692 as *C. amara* L. (BEOU), rev. J. Kučera 09.2004 as *C. amara* subsp. *balcanica* Marhold, Ančev & Kit Tan; Stara planina Mts.: Mala Poljana (FN58), 06.1912, leg. M. Radojević 6689, det. Ž. J. Jurišić as *C. amara* L. (BEO).

Serbia (Central): Mt. Kopaonik 08.1852, leg. J. Pančić 14584 as *C. amara* β *hirta* W. D. J. Koch (BEOU

– Herb. Panc.), rev. K. Marhold, 09.09.2004 as *C. amara* subsp. *balcanica* Marhold, Ančev & Kit Tan; Mt. Kopaonik: Suvo Rudište, towards Nebeske stolice (43°16.484 N, 20°49.492 E, DN89), *Calthion*, silicate, 1800 m, 16.06.2007, leg. D. Lakušić 24646 (BEOU); Mt. Kopaonik: Suvo Rudište (DN89), *Cardaminetum barbaraeoides*, along stream, granite, 1700 m, 05.07.1991, leg. D. Lakušić 598/91 as *C. barbaraeoides* Halácsy (BEOU), rev. K. Marhold, 09.09.2004 as *C. amara* subsp. *balcanica* Marhold, Ančev & Kit Tan; Mt. Kopaonik: Suvo Rudište (DN89), peatbog in spruce fir forest, NW exp., 1650 m, 11.07.1987, leg. D. Lakušić as *C. barbaraeoides* Halácsy (BEOU), rev. K. Marhold, 09.09.2004 as *C. amara* subsp. *balcanica* Marhold, Ančev & Kit Tan; Mt. Kopaonik: Mali Karaman (DN89), peatbog, granite, 1800 m, 11.07.1987, leg. D. Lakušić as *C. barbaraeoides* Halácsy (BEOU), rev. K. Marhold 09.09.2004 as *C. amara* subsp. *balcanica* Marhold, Ančev & Kit Tan; Mt. Kopaonik: Crni Jelak (DN89), *Piceetum abietis moesiicum*, granite, 1700 m, 20.07.1987, leg. D. Lakušić as *C. amara* L. f. *hirta* (BEOU), rev. V. Stevanović as *C. barbaraeoides* Halácsy, rev. K. Marhold, 09.09.2004 as *C. amara* subsp. *balcanica* Marhold, Ančev & Kit Tan; Mt. Kopaonik: Lisine, near the path to mountain chalet (DN89), forest, 16.07.1938, leg. I. Rudski, det. V. Stevanović as *C. barbaraeoides* Halácsy (BEO); Mt. Kopaonik: near camping place, forest, 16.07.1938, leg. I. Rudski 6692 as *C. amara* L. (BEO); Mt. Kopaonik: Krčmar (DN89), 09.07.1938, leg. Rudski 6691, det. Th. Soška as *C. amara* L. (BEO). Serbia (Southeast): Vlasina plateau: Mt. Vardenik (Ravnište), (FN01), 1700 m, springs 09.06.1996, leg. V. Radelović & D. Jović as *C. amara* f. *hirta* (Herbarium Moesiacum Niš). Republic of Macedonia: Mt. Belasica: 22–23 state border military watch-tower (FL57), stream, 08.06.1928, leg. P. Černjavski 6690 as *C. amara* L. (BEO)

### *Distribution of C. amara* subsp. *amara* in Serbia based on herbarium specimens (Fig. 1)

Serbia (Northwest): Loznica: Borinska river gorge (CQ52), near river, limestone, 150–200 m, 26.04.2008, leg. M. Niketić & G. Tomović 26786 (BEOU).

### *Distribution of C. amara* in Serbia and Republic of Macedonia based on literature data

Serbia (Northeast): Majdanpečka Domena region: Felješana river (EQ71), in association *Chrysosplenio-Carpinetum betuli* (Dinić 1972: 143); Homolje area: Mt. Crni Vrh (EP78) (Nikolić et al. 1986: 274 as *C. amara* f. *hirta*).

Serbia (East): Stara planina Mts.: Kopren (FN46), stream (Pančić 1883: 175; Velenovský 1891: 29); Stara planina Mts.: Midžor (FP30), Kopren (FN46), Belan (FN39), Bata (FN49), Krvave Bare ponds (FN49), near mountain streams (Adamović 1909: 132); Stara planina Mts.: spring of Dojkinačka river (FN49), between the village of Gradište and Nišava river (FN28), in association *Salicetum albae*; valley of Dojkinačka river (FN49),

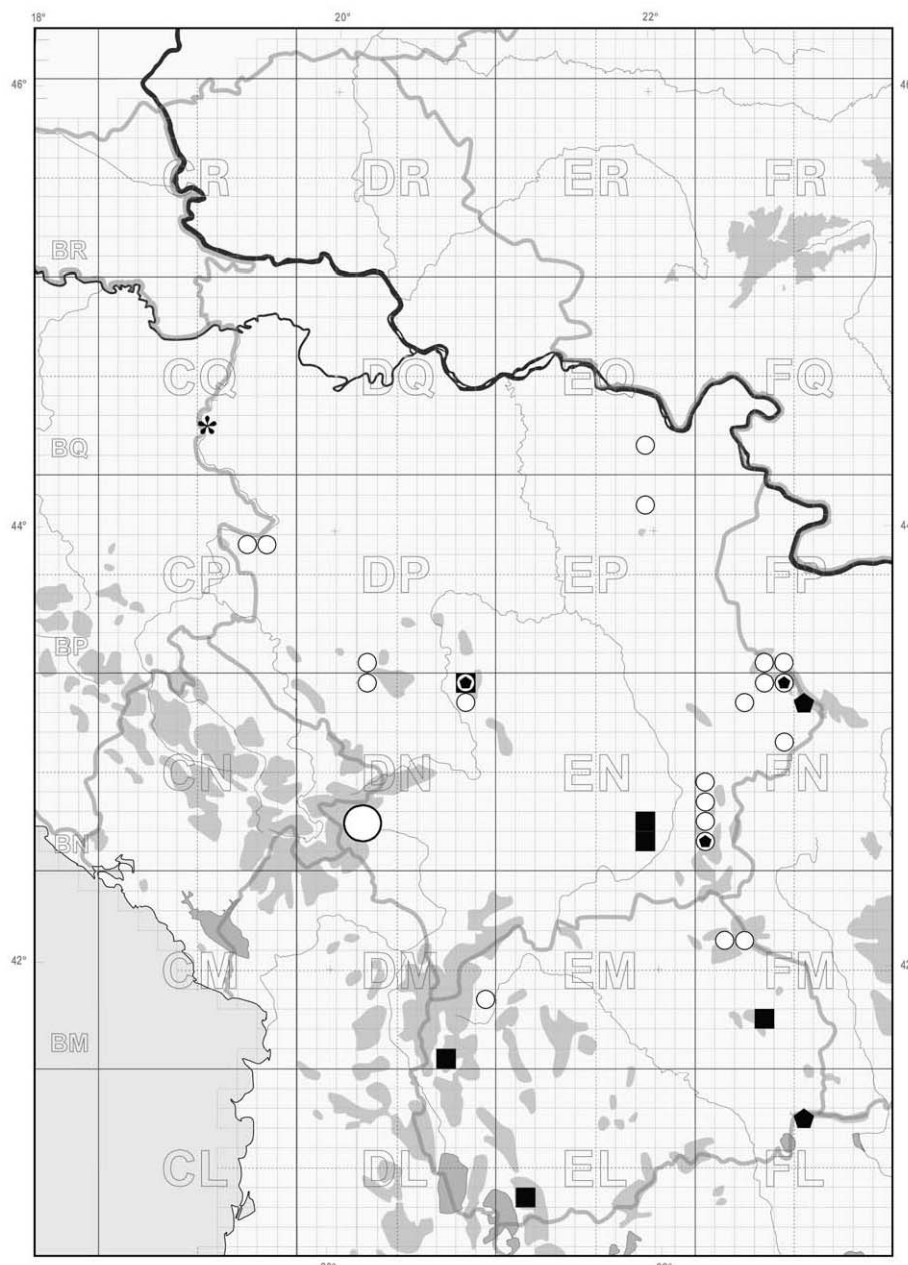


Fig. 1. Distribution of *Cardamine amara* in Serbia and Republic of Macedonia (UTM Grid zone 34T; basic square 10 × 10 km). Locality symbols: ● – *Cardamine amara* subsp. *balcanica* (herbarium data); \* – *Cardamine amara* subsp. *amara* (herbarium data); ○ – *Cardamine amara* (literature data – accurate localities); ○ – *Cardamine amara* (literature data – inaccurate localities); ■ – *Cardamine barbaraoides* (literature data, based on misidentifications).

in association *Salici-Alnetum viridis*; Krvave Bare ponds (FN49), Babin Zub (FP30), Vražja Glava (FP40) and Goveško Lice (FN49), in association *Coccineo-Deschampsietum*; Babin Zub (FP30), in association *Deschampsietum subalpinum*; Babin Zub (FP30) and Dojčino Vrelo spring (FP30), in association *Scirpetum silvaticii*; Krvave Bare ponds (FN49), Govedarnik (FN49), Babin Zub (FP30), Dojčino Vrelo spring (FP30), Arbinje (FN49) and Ivankovica (FP40), in association *Carici-Sphagno-Eriophoretum*; Babin Zub (FP30), Dojčino Vrelo spring (FP30) and Gornje Lise (FN49), in association *Cardamino-Rumici-Calthetum* (Mišić et al. 1978).  
 Serbia (Southeast): Vlasina plateau: near Vlasina river

(near Karapandža bridge) (FN03), plant communities with diverse *Salix* species (Košanin 1910: 110); Vlasina plateau: Mt. Vardenik (along mountain streams) (FN01, FN02), in association *Calliargon cordifolii-Fontinaletum antipyreticae*; Mt. Plana (FN04), in association *Rumicetum balcanici*; Mt. Čemernik (FN03) and Mt. Vardenik (FN01, FN02), along mountain streams, in association *Stellario alsinae-Cardaminetum amarae* (Randelović 2002).  
 Serbia (South): vicinity of Vranje (Mt. Grot (EN71) and Mt. Oblik (EN72)) (Nikolić et al. 1986: 274 as *C. barbaraoides*).  
 Serbia (Central): Mt. Kopaonik (Pančić 1856: 6 as *C. amara* var. *hirta*; Lakušić 1993: 45 as *C. barbaraoides*;

Lakušić 1996: 14); Mt. Kopaonik: village of Stanulovići (valley of Babin Potok) (DN88), in associations *Erico-Pinetum nigrae* and *Euphorbio glabriflorae-Pinetum nigrae* (Jovanović 1972: 18, 23); Mt. Kopaonik: Srebrnac (DN89) near road (Lakušić 1993: 46 as *C. barbaraeoides*); Mt. Kopaonik: Suvo Rudište (DN89), in associations *Hygronardeum strictae* and *Carici-Sphagno-Eriophoretum* (Jovanović-Dunjić 1981: 40). Serbia (West): Mt. Tara: Mitrovac plateau (Crveni Potok stream (CP76)), in associations *Omorikae-Piceeto-Abieto-Fageto-Pinetum mixtum* (Čolić 1957: 8) and *Alno glutinosae-Piceetum omorikae* (Čolić & Gigov 1958: 35); Mt. Tara: Mitrovac plateau (CP76) and in canyon of Rača river (CP86) (Gajić 1988: 182). Serbia (Southwest): Mt. Golija: Golijaska river (DN39, DP30), forest of *Picea excelsa* and *Alnus incana* (Gajić 1989: 180). Serbia (Metochia): Prokletije Mts. (Amidžić & Panjković 2003: 153). Republic of Macedonia: Mt. Bistra (Careva Češma) (DM70), Mt. Pelister (Nidže Pole) (EL13), Mt. Plačkovica (Blatačka river) (FM32) (Micevski 1995: 624 as *C. barbaraeoides*); Mt. Osogovo (Carev Vrv) (FM16, FM26 as *C. amara*); Gostivarsko (DM93 as *C. amara*) (Micevski 1995: 630).

The review of herbarium collections (BEO, BEOU and Herbarium Moesiacum Niš) and our field investigations in the territory of Serbia clearly confirmed that the available specimens of *C. amara* from the Stara planina Mts., Mt. Kopaonik and Vlasina plateau in Serbia, and on Mt. Bjelasica in the Republic of Macedonia are morphologically distinct from the typical subspecies *C. amara* subsp. *amara*. Specimens from these localities are characterized by more or less densely hairy stem and leaflet margins, 16–28 cauline leaves with (2–)3–4(–5) pairs of lateral leaflets, as well as by simple or branched stem. All these morphological features correspond to the recently described *C. amara* subsp. *balcanica* Marhold, Ančev & Kit Tan.

Typical subspecies, *C. amara* subsp. *amara* was confirmed as yet only from one locality in northwest Serbia, based on the recent collection by M. Niketić and G. Tomović.

On the basis of literature data from Serbia and Republic of Macedonia, it is obvious that *C. amara* is scarcely distributed in these two countries. However, the literature data alone do not provide sufficient information in respect of the subspecies identification and their distribution. For the areas, where herbarium specimens were available we were able to confirm the occurrence of *C. amara* subsp. *amara* and subsp. *balcanica*. Nevertheless, it still remains unresolved which subspecies grows in W and SW Serbia, and in the Metochia province.

The newly recorded locality of *C. amara* subsp. *balcanica* in Mt. Bjelasica in Republic of Macedonia confirms the literature data from the Bulgarian part of the same mountain range (Marhold et al. 1996: 203). Still, the literature data of *C. amara* from Mt. Osogovo and from the Gostivarsko region (Micevski 1995: 630),

as well as those of *C. barbaraeoides* from Mt. Bistra, Mt. Pelister and Mt. Plačkovica (Micevski 1995: 623–624) need to be checked in the field. It is likely that most of these data refer to *C. amara* subsp. *balcanica*.

#### Habitats

*Cardamine amara* subsp. *balcanica* in Serbia and Republic of Macedonia inhabits oligotrophic and eutrophic humid grasslands, alpine tall-herb communities, poor acidic fens, soft water spring mires, transition mires and peatbogs, acid oligotrophic vegetation of spring brooks and fast-flowing streams (according to EUNIS habitat terminology, Davies & Moss 2002). Data on coenotic affinities of this subspecies in Bulgaria were provided by Marhold & Valachovič (1998).

*Cardamine amara* subsp. *amara* in Serbia is an element of calcareous spring communities in lowland belt. More data on coenotic affinities of this subspecies in other parts of its distribution area were provided by Marhold & Valachovič (1998).

#### Threat

Considering the endemic distribution of *Cardamine amara* subsp. *balcanica* in the neighbouring areas of Bulgaria, Greece, Republic of Macedonia and Serbia, the fact that populations of this plant on Mt. Kopaonik and also in the Stara planina Mts. are restricted to small areas and to specific micro-habitats, and considerable population fragmentation, we suggest that its conservational status in Serbia and the Republic of Macedonia should be “Critically endangered” – CR B2a (Standards and Petitions Working Group 2006). Also the fact that the subsp. *balcanica* inhabits Transition mires (!54.5), Peri-Danubian black-white-star sedge fens (!54.426), Eutrophic humid grasslands (!37.2), Oligotrophic humid grasslands (!37.3), which are defined as endangered natural habitat types requiring specific conservation measures by Resolution no. 4 of Bern Convention (EEC 1996), stresses that this taxon should be protected by law.

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