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Morphological differentiation and conservation status of *Cardamine pancicii* (Brassicaceae), a stenoendemic of Mt. Kopaonik in Serbia

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ABSTRACT: *Cardamine pancicii* Hayek has recently been reaffirmed as a "good species", and distributed only in Mt. Kopaonik in Serbia. Based on several years of field ivestigation, analyses of herbarium and literature data, as well as a formal morphometric study, detailed analyses of morphological differentiation, distribution, population size and conservation status of the species *C. pancicii* in Mt Kopaonik were carried out. The population from mires of Pajino Preslo is described as a new variety *Cardamine pancicii* var. *palustris* var. nova, 19 records were georeferenced with maximal accuracy, total population size of *C. pancicii* in Mt. Kopaonik was estimated to be approximately 1.7 million individuals, and the conservation status of species was defined as IUCN CR-B3c.

Key words: *Cardamine*, endemic species, critically endangered species, distribution, Balkan Peninsula

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INTRODUCTION

Cardamine pancicii was described by Hayek (1918) on the basis of the Herbarium specimen collected by Josif Pančić on Mt Kopaonik (Serbia) in 1874. In the most relevant contemporary botanical literature (Greuter *et al.* 1986; Jones & Akeroyd 1993; Jalas & Suominen 1994; Kit Tan 2002) the name *C. pancicii* has been used as a synonym for *C. glauca* Spreng. ex DC. On the basis of multivariate morphometrics and an amplified fragment length polymorphism (AFLP) study of taxa from the subsect. *Cryptopterum* Griseb. from the Balkan and Apennine Peninsula, Lakušić *et al.* (2006) have shown that despite previous taxonomic confusions, populations from Mt Kopaonik represent a well-distinct group, which should be treated as a separate species *C. pancicii* Hayek. This opinion is accepted in Euro+Med Plantbase (Marhold 2011).

C. pancicii is usually treated in the *Cardamine* sect. *Pteroneurum* DC. subsect. *Cryptopterum* Griseb. together with the Balkan-Apennine *C. glauca* Spreng. ex DC., Balkan *C. carnosa* Waldst. et Kit. and south-European *C. plumierii* Vill. This is a stenoendemic species of Mt Kopaonik in Serbia. Records from the Prokletije (Jovanović-Dunjić 1972: 254; Jalas & Suominen 1994: 167) and Šar-planina Mts (Jalas & Suominen 1994: 167) from the Balkan Peninsula and south Italian mountains (Schulz 1903: 572) were not confirmed (Lakušić *et al.* 2006).

C. pancicii primarily inhabits alpine and subalpine rocky grounds and pastures (*Juncetea trifidi* Hadač 1944), mire ribs (*Scheuchzerio-Caricetea fuscae* (Nordhagen 1936) R. Tx. 1937) and strands of alpine streams (*Montio-Cardaminetea* Br.-Bl. et Tx. 1943). Rarely, it inhabits ribs of alpine heaths (*Vaccinion uliginosi* Lakušić 1974) and subalpine shrub vegetation (*Juniperion sibiricae* Br.-Bl. 1939). In the region of Mt. Kopaonik this species has been

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noticed at altitudes between 1400 and 2000 m, exclusively on acidic siliceous (granodiorite and cornite) rocks on iron-rich soils, or on wet peat which is wetted by iron-rich water.

The aim of this paper was to present detailed results of the morphological differentiation and conservation status of the species *C. pancicii* on Mt Kopaonik.

MATERIAL AND METHODS

Study Area and Plant Sampling. Five coenopopulations of *C. pancicii* (180 specimens) from Mt Kopaonik in C. Serbia were sampled for morphometric analysis. The study area covered the highest part of Mt. Kopaonik (from 1300 to 2018 m a.s.l.), including the habitat of alpine and subalpine rocky grounds and pastures (*Juncetea trifidi* Hadač 1944), peatbog ribs (*Scheuchzerio-Caricetea fuscae* (Nordhagen 1936) R. Tx. 1937) and strands of alpine streams (*Montio-Cardaminetea* Br.-Bl. et Tx. 1943), all developed on acidic siliceous (granodiorite and cornite) rocks on the iron-rich soils.

Flowers were fixed in an ethanol-glycerol mixture (50 : 50), and dry plants and voucher specimens were deposited in the Herbarium of the Institute of Botany and Botanical Garden "Jevremovac", Faculty of Biology, University of Belgrade – BEOU (Thiers 2012).

Voucher specimens:

SERBIA: Kopaonik Suvo Rudište, 43.27301 N, 20.81943 E, 1950 m a.s.l., Ass. *Minuartietum recurvae*, cornite (*Lakušić, D. 17161*, 25.06.2003, BEOU).

SERBIA: Kopaonik Suvo Rudište, 43.27477 N, 20.82042 E, 1850 m a.s.l., open rocky ground with domination of *Anthemis carpatica*, cornite (*Lakušić, D. 17164*, 26.06.2003, BEOU).

SERBIA: Kopaonik, Pojilo Greben, 43.27861 N, 20.81418 E, 1800 m a.s.l., grassland with moist peat substrate (*Lakušić, D. 17159*, 25.06.2003, BEOU).

SERBIA: Kopaonik Pajino Preslo, 43.28136 N, 20.81627 E, 1770 m a.s.l., peatboog - *Hygronardion*, silicate (*Lakušić, D. 17160* , 27.06.2003, BEOU).

SERBIA: Kopaonik, Krst-Rudničke ravni, 43.27963 N, 20.80581 E, 1770 m a.s.l., Ass. *Sclerantho-Cardaminetum pancicii*, moist gravel substrate (*Lakušić, D. 17162*, 25.06.2003, BEOU).

SERBIA: Kopaonik, Krst, 43.2821 N, 20.79958 E, 1740 m a.s.l., Ass. *Sclerantho-Cardaminetum pancicii*, moist peat substrate (*Lakušić, D., 17163* , 25.06.2003, BEOU).

Morphometric analyses. The measurements were performed on 180 selected specimens collected in the field. In the first step a total of 45 characters were measured (for details, see Lakušić *et al.* 2006). Further character reduction was envisaged by computing pairwise Spearman correlations and retaining only one from character pairs with absolute values of correlation coefficients exceeding 0.6. The hypothesis of morphological separation of five coenopopulations inhabiting different altitudes and vegetation was tested using canonical discriminant analysis (CDA) conducted on the resulting data matrix comprising 33 characters after standardisation to zero mean and unit variance. The CDA was performed with five *a priori* defined groups ′ 180 individuals ′ 33 characters. Canonical scores for each case were calculated with the aim to measure distances between individuals, and a scatterplot of canonical scores (Fig. 2) was made to visualise the relationship between *a priori* defined groups. Statistical analyses were performed using Statistica 5.1 (StatSoft, 1996).

Analyzed coenopopulations:

A - "non-mire coenopopulation":

1. Krst (*Sclerantho-Cardaminetum pancicii* - 1680 m)
2. Pojilo (*Sclerantho-Cardaminetum pancicii* - 1800 m)
3. Suvo Rudište (*Sclerantho-Cardaminetum pancicii* - 1850 m)
4. Suvo Rudište (*Minuartietum recurvae* - 1950 m)

B - "mire coenopopulation"

5. Pajino Preslo (*Hygronardion* - 1770 m)

Conservation status. Estimation of the threatened status of *C. pancicii* for the territory of Mt. Kopaonik was based on data on the distribution and population size, and was made according to the criteria and categories of IUCN (2001).

Distribution data were based on recent field studies, analysis of herbarium material deposited at BEOU, G, W and WU (Thiers 2012), as well as literature data (Fig. 1, Table 1, Appendix 1). The locations of occurrences of the species in the field were recorded with GPS (Garmin eTrex Legend HCx and Garmin eTrex Vista C). All other data on the distribution were georeferenced in OziExplorer 3.95 4s program. Chorological data are presented according to the 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 the World Geodetic System 84 (WGS84).

Population size was determined on the basis of counting the individuals in 50 plots with an area of 1 m^2. Plots were randomly distributed in different habitats at altitudes between 1700 and 2000 m a.s.l. The total number of individuals of *C. pancicii* in the investigated area was estimated as the ratio between average number of individuals per m^2 and estimated habitat areas in m^2.

Table 1. Georeferenced data on the distribution of *C. pancicii* (coordinates in WGS84). Number in the first column corresponds to numbered points on the map of distribition in Fig. 1.

No.	Location	Latitude	Longitude	Altitude (m a.s.l.)	Collector	Voucher
1	Suvo Rudište	43.2720	20.8176	1900	Lakušić, D.	field obs.
2	Suvo Rudište	43.2728	20.8190	2000	Stevanović, V.	BEOU-1623/94
3	Suvo Rudište	43.2730	20.8194	1950	Lakušić, D.	BEOU-17161
4	Suvo Rudište	43.2748	20.8204	1850	Lakušić, D.	BEOU-17164
5	Suvo Rudište	43.2767	20.8184	1850	Stevanović, V. *et al.*	BEOU-5382
6	Pojilo-Greben	43.2786	20.8142	1800	Lakušić, D.	BEOU-17159
7	Pajino Preslo	43.2814	20.8163	1770	Lakušić, D.	BEOU-17160
8	Pajino Preslo	43.2822	20.8135	1750	Lakušić, D.	BEOU
9	Pajino Preslo	43.2829	20.8114	1700	Lakušić, D.	BEOU-8626
10	Krst-Rudnička ravna	43.2796	20.8058	1770	Lakušić, D.	BEOU-17162
11	Krst	43.2805	20.8037	1750	Lakušić, D. *et al.*	BEOU-15157
12	Krst	43.2819	20.8029	1740	Lakušić, D.	BEOU-17163
13	Repuška reka	43.2819	20.7964	1600	Lakušić, D. *et al.*	BEOU-15156
14	Suvi Jelak, Hotel Putnik	43.2868	20.7979	1700	Lakušić, D. *et al.*	BEOU-13893
15	Suvi Jelak, Murska reka	43.2912	20.7968	1600	Lakušić, D.	BEOU
16	Crni Jelak	43.2917	20.8154	1720	Lakušić, D.	field obs.
17	Crni Jelak	43.3019	20.8147	1700	Lakušić, D.	field obs.
18	Bećirovac	43.2775	20.8447	1750	Lakušić, D.	field obs.
19	Metalica	43.3489	20.8465	1450	Novčić, R.	BEOU-17087

RESULTS

Morphometric analyses. The canonical discriminant analysis (CDA) based on individuals from five coenopopulations of C. *pancicii*, resulted in two morphologically differentiated entities, which were completely separated along the first axis – "mire populations" from Pajino Preslo as one group, and all other "non-mire populations" as the other group (Fig. 2). Furthermore, within the group of "non-mire populations", there was a trend of separation along the second discriminant axis between populations that inhabited alpine (above 1900 m a.s.l.), and subalpine open grassland habitats (belowe 1900 m a.s.l.)..

Morphological differences between the "mire populations" and "non-mire populations" are summarized in Table 2, showing standard statistical parameters of the selected characters. The most pronounced differences between the two morphologically entities were number of stems, stem height, number of stem leaves, width of the terminal leaflets of the basal leaf, length of the basal leaflets of the middle-stem leaf, width of the basal leaflets of the middle-stem leaf, number of lobes of the terminal leaflet of the middle-stem leaf, number of leaflets of the largest leaf, length of the basal leaflets of the largest leaf, width of the basal leaflets of the largest leaf and length of stylus.

As the morphometric data support the specificity of "mire populations" from Pajino Preslo, we have consequently transferred this coenopopulation from the typical *C. pancicii* to the new variety *C. pancicii* var. *palustris* D. Lakušić & Novčić, and publish it here (Fig. 3).

Conservation status. Based on the detailed systematic and chorological study we can conclude that *Cardamine pancicii* is a stenoendemic species of Mt. Kopaonik in Serbia. All known populations are located in UTM square 34TDN 98. The main part of the population is spread on open rocky habitats of the central massif of Suvo Rudište,

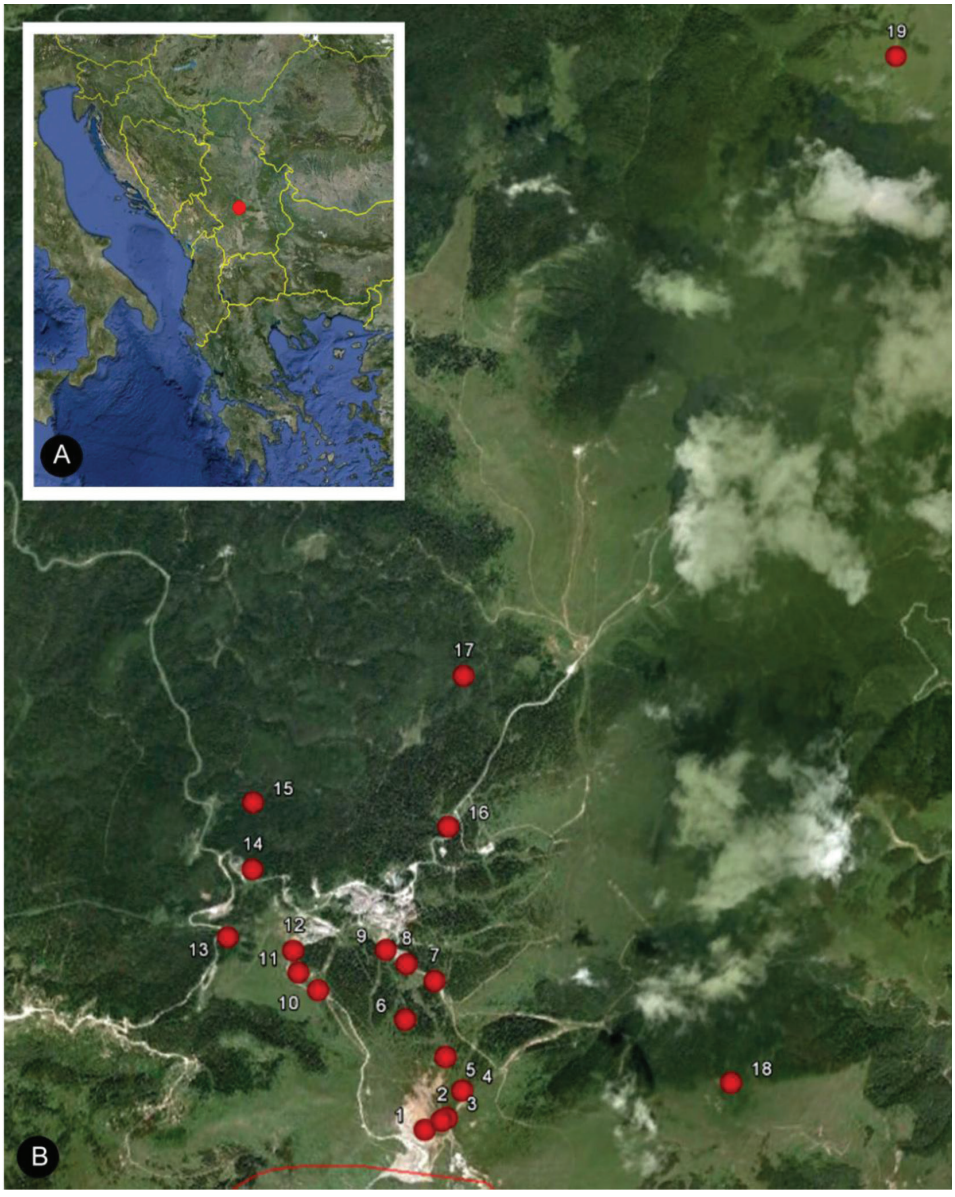

Fig. 1. Distribution of *Cardamine pancicii*. A – General distribution. B – Distribution on Mt. Kopaonik (Numbers on map 1B correspond to numbers in the first colum of Tab. 1.)

from its highest peak (1976 m) to the base at an altitude of 1600 m, both on the north and on its southern slopes. A few subpopulations, adjacent to the central one, appeared at peat-bog edges of Pajino Preslo, Vrelo and Krst, and the banks of the river Repuška reka. In addition to this relatively compact part of its range, we found four isolated subpopulations. Subpopulation Bećirovac had a significant number of indivudals inhabiting similar vegetation to that occurring at the top of Suvo Rudište. Two isolated subpopulations with few individuals were recorded on the Ravni Kopaonik, on open rocky habitats on or near the trail in the spruce forests in Suvi Jelak (Murska reakr) and Crni Jelak. The most isolated subpopulations were recorded on the Metalica near Bela Reka (Fig. 1). The record of the presence of *C. glauca* on southern Kopaonik, on silicate massive Šatorica, at an altitude of about 1700 m (Randjelović *et al.* 1982: 41) may refer to a *C pancicii*. Unfortunately, we could not check this record, so the question of the southern limit of distribution ot this species remains unresolved.

Population size of *C. pancici* varied widely in different habitat types (Table 3). In alpine and subalpine opened siliceous rocky grasslands (*Juncetea trifidii* - ass. *Scleranthо-Cardaminetum pancicii typicum* and *Minuartietum recurvae*) the number of individuals per m^2 varied between one and 32. The median number of individuals per square meter was seven. A slightly larger population size was recorded on the banks of alpine streams (*Montio-Cardaminetea*), where the number of individuals per m^2 varied between three and 15. The median number of individuals per square meter was nine. The highest number was recorded in community-*Sclerantho Cardaminetum*

Table 2. The main diagnostic features to distinguish the "non-mire" and "mire" populations of *C. pancicii* from Mt. Kopaonik. Legend: N: number of measurments, Avg: average, Min: minimum, Max: maximum, SD: standard deviation

	"non-mire population"					**"mire population"**				
	N	**Avg**	**Min**	**Max**	**SD**	**N**	**Avg**	**Min**	**Max**	**SD**
Number of stems	94	4.8	1.0	20.0	3.3	30	1.7	1.0	6.0	1.4
Stem height	94	99.4	51.0	199.0	23.8	30	198.0	106.0	320.0	45.1
Number of stem leaves	94	6.2	3.0	26.0	3.4	30	15.2	4.0	53.0	9.1
Number of flowers per stem	94	16.0	5.0	49.0	8.2	30	24.1	4.0	89.0	18.0
Lenght of the middle-stem leaf	140	7.0	2.4	14.7	2.5	30	14.0	6.0	24.0	4.3
Length of the terminal leaflet of the middle-stem leaf	140	2.2	0.9	5.0	0.7	30	4.8	2.0	7.5	1.6
Width of the terminal leaflet of the middle-stem leaf	140	2.1	0.3	5.6	1.0	30	6.0	3.0	9.1	1.6
Length of the basal leaflets of the largest leaf	94	2.6	1.1	5.0	0.7	30	5.4	2.9	9.0	1.6
Width of the basal leaflets of the largest leaf	94	3.0	0.6	5.6	0.9	30	6.5	3.1	11.5	1.8
Length of the terminal leaflet of the largest leaf	94	2.5	1.2	4.1	0.7	29	5.3	2.9	10.5	1.6
Width of the terminal leaflet of the largest leaf	94	3.0	1.0	5.4	0.9	30	7.7	3.0	66.3	11.2

Table 3. The populations size of *Cardamine pancicii* in different habitat types

Habitat	**No of plots**	**The average number of individuals per m²**	**Minimum number of individuals per m²**	**Maximum number of individuals per m²**	**Estimated habitat areas in m²**	**Estimated total number of individuals**
Ass. *Sclerantho-Cardaminetum pancicii typicum* and *Ass. Minuartietum recurvae*	32	7	1	32	170,000	1,190,000
Ass. *Sclerantho-Cardaminetum pancicii musicetosum*	8	57	35	70	7,500	427,500
Montio-Cardaminetea (strands of subalpine streams)	10	9	3	15	7,500	67,500
TOTAL	50				185,000	1,685,000

pancicii muscietosum developed on wet peat which was wetted by the iron-rich water coming from the mining shaft. At this site the number of individuals per m² varied between 35 and 70. The median number of individuals per square meter was 57. Based on the determined population size in different habitat types, and based on estimation of the surface that affects these habitat types, we estimated that the total population size of *C. pancicii* on Mt. Kopaonik was approximately 1.7 million individuals (Table 3).

Finally, on the basis of chorological data and estimation of the population size, we can define *C. pancicii* as IUCN **CR-B3c**.

TAXONOMICAL TREATMENTS

C. pancicii Hayek, Akad. Wiss. Wien, Math.-Naturwiss. Kl., Denkschr. 94: 149 (1918) var. ***palustris*** D. Lakušić & Novčić var. nova (Fig. 3).

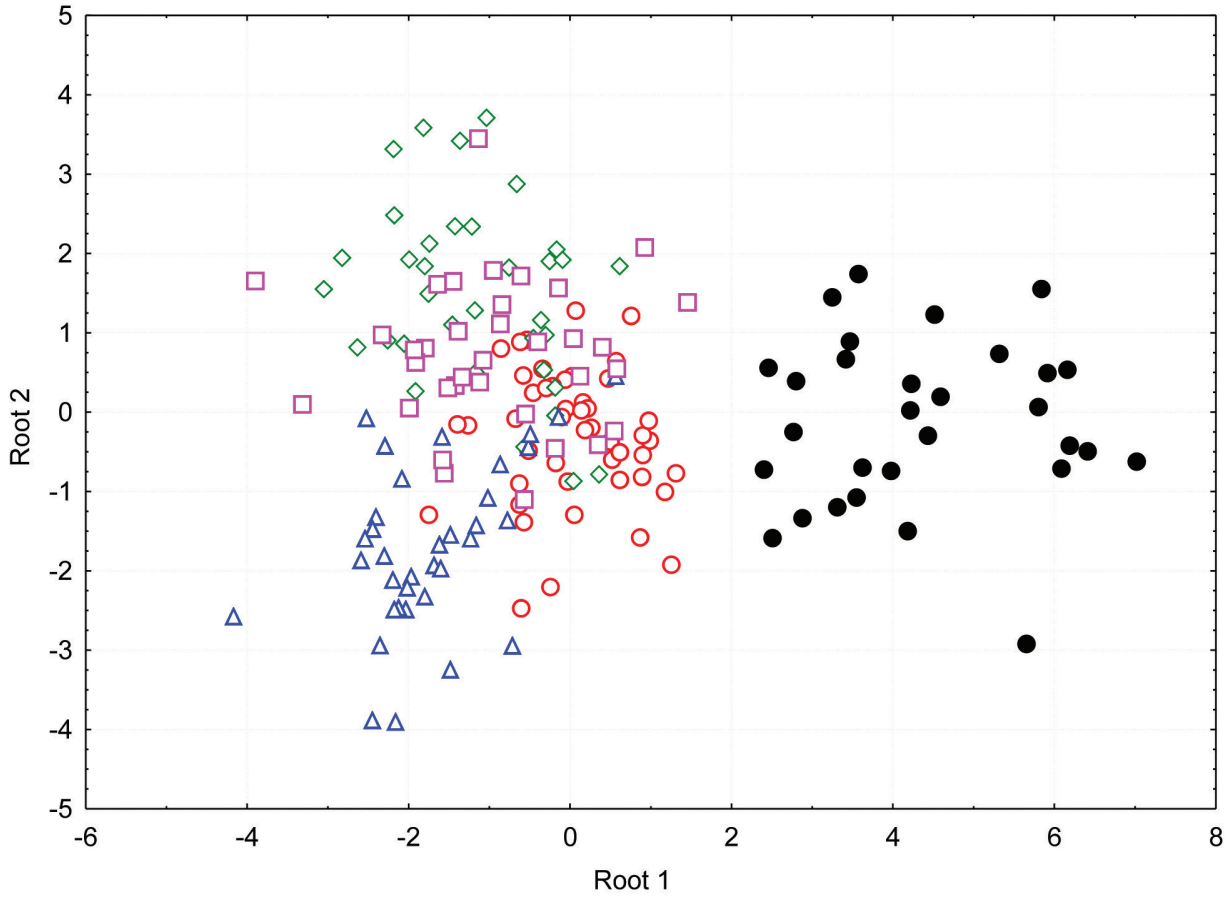

Fig. 2. Discriminant analysis of basic components of coenopopulations of species *C. pancicii* on Mt Kopaonik. Legend: ○ Pojilo (*Sclerantho-Cardaminetum pancicii*, 1800 m), ◇ Suvo Rudište (*Minuartietum recurvae*, 1950 m), △ Krst (*Sclerantho-Cardaminetum pancicii*, 1680 m), □ Suvo Rudište (*Sclerantho-Cardaminetum pancicii*, 1850 m), ˜ Pajino Preslo (*Hygronardion*, 1770 m)

Type: Serbia, Mt. Kopaonik, Pajino Preslo, 43.28136 N, 20.81627 E, *Hygronardion*, silicate, 1770 m.a.s.l., 27.06.2003, *Lakušić, D. 17160* (Holotype: BEOU).

Diagnosis: *Affinis* ***C. pancicii var. pancicii*** *sed* ***caulis*** *1–3(–6), flexuosus (non 1–8 (–20), caespitosus), alteoribus (10–) 15–25 (–32) cm (non (5–) 7–12 (–20) cm), cum 4–25 (–53) (non (3–10 (–26) folis;* ***folia caulina*** *(6–) 9.7–18.3 (–24) mm (non (2.4–) 4.5–9.5 (–14.7) mm) longa;* ***foliola terminalia*** *(2–) 3.2–6.4 (–7.5) mm (non (0.9–) 1.5–2.9 (–5) mm) longa, (3–) 4.4–7.6 (–9.1) mm (non (0.3–) 1.1–3.1 (5.6) mm) lata;* ***inflorescentia*** *racemosa cum 4–40 (–90) (non 5–25 (–50) florets, recedit.*

Description. — Perennial, entirely glabrous, not or rarely glaucous. Short vertical rhizome present. Mature plant with 1–3(–6) stems with evergreen leaf rosettes. Stems (10–) 15–25 (–32) cm, ascending, weakly flexuose, with several stem branches at base. Leaves imparipinnate with 3–7 (–11) pairs of entire, obovate to suborbicular lateral leaflets and an entire or shallowly 3–lobed, larger elliptic to obovate terminal leaflet (terminal leaflets of the basal leaf (1.1–) 2-4 (–4.4) Î (1.6–) 2–3.6 (–4.2) mm). Infructescence secund, mature siliquae vertically or ± horizontally spread. Mature siliquae (1.2–) 6.1–18.5 (–24) Î (0.2–) 0.5–1.1 (–1.2) mm, with beak (0.1–) 0.6–1.8 (–3.1) Î 0.1–0.3 (–0.6) mm.

DISCUSSION

Detailed morphometric analysis has shown that on Mt Kopaonik there are two morphologically well-defined entities which inhabit substentially different habitats. Coenopopulations from vegetation of siliceous alpine pastures, silicate streamsides and few coenopopulations that can be found on the ribs of alpine heaths and associations of dwarf juniper belong to one morphological type, which is considered as *C. pancicii* var. *pancicii*. The specific coenopopulation which inhabits ribs of mountain mires, is considered as a new variety *C. pancicii* var. *palustris*. Basic differences between these two varieties

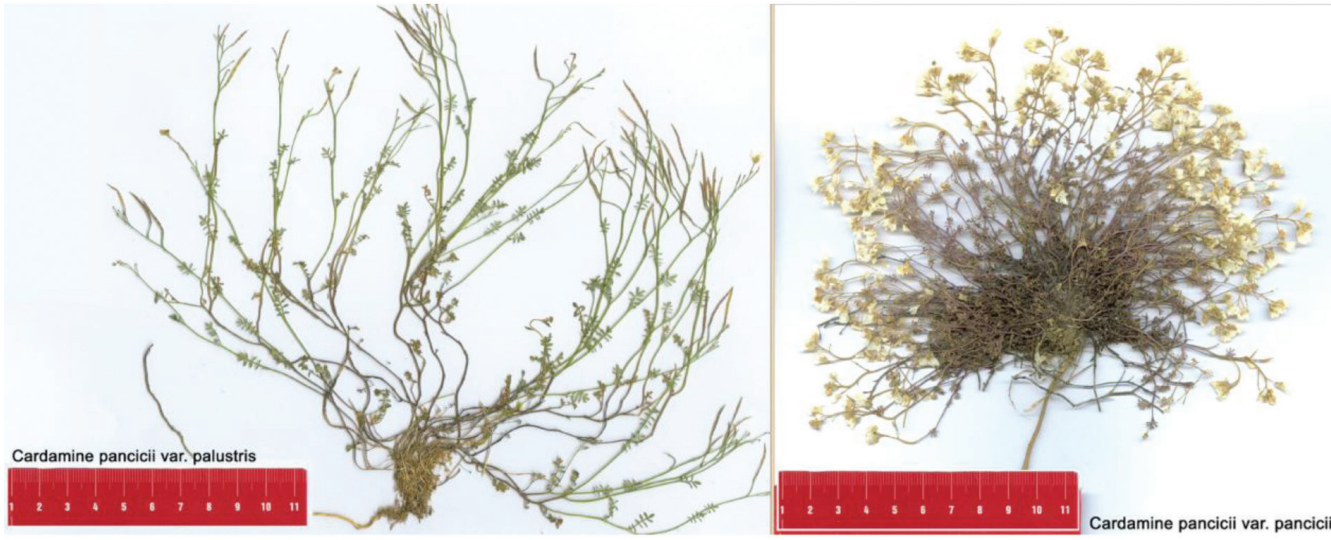

Fig.3. Varieties of the species *C. pancicii* on Mt Kopaonik

are in changed overall habitus of individuals, which is considered as a substantial overall enlargement of dimensions of vegetative parts at *C. pancicii* var. p*alustris*, especially the height of stem, length of internodes and dimensions of lateral and terminal leaves of cauline leaves. It is important that there are no morphological differences at the level of reproductive organs, taking out slight differences in dimensions of the siliqua and its beak that were recorded in *C. pancicii* var. *palustris*.

Given that *C. pancicii* in contemporary botanical literature was treated as a synonym for the widespread Apennine-Balkan species *Cardamine glauca*, it is not considered as protected or an important species for conservation in international legislation. According to national legislation, *C. pancicii* is a strictly protected species (Sl, RS 5/2010), and it is included in the List of internationally significant species (Stevanović *et al.* 1995). In addition, all known sites of this species are located in the National Park Kopaonik, so the legal protection of this area, indirectly protects the species itself.

On the basis of data on the distribution and population size, we can conclude that the populations which inhabit alpine and subalpine rocky grasslands, strands of alpine streams and ribs of alpine heaths and subalpine shrub vegetation (*C. pancicii* var. *pancicii*) are not directly affected. However, the population from mire ribs (*C. pancicii* var. *palustris*), was under extreme anthropogenic pressure. Due to the development of the tourism center and the building of a number of ski lifts and ski slopes, mountain peatbogs on Mt. Kopaonik are significantly reduced, which has a direct impact on reducing the population size of *C. pancicii* var. *palustris*.

Although *C. pancicii* on the main part of Mt. Kopaonik is not significantlly affected, the facts that the area of its occurrence is less than 100 km², and that its occupied territory is less than 10 km², as well as the fact that we found significant fluctuations in the size and quality of its habitat, lead us to conclude that according to new IUCN criteria *C. pancicii* belongs to a group of critically endangered species (CR-B3c), which means that at the global level it is in danger of disappearing from the wild in the near future. Furthermore, this is a European endemic species distributed in only one European country, and should be treated as a "target species", or "species of European concern" (Ozinga & Schaminée 2005).

Given the importance of this species and degree of its vulnerability at the global level, we can conclude that the current activity for its protection is not at a satisfactory level. In this sense, it would be necessary to implement the main recommendations of the "Action Plan for *Cardamine pancicii*" (Lakušić & Novčić 2006) which envisages a series of concrete actions in protection of areas, habitats, populations and individuals, and activities on reintroduction and monitoring.

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REFERENCES

Adamović L. 1909. Die Vegetationsverhältnisse der Balkanländer (Mösische Länder) umfassend Serbien, Altserbien, Bulgarien, Ostrumelien, Nordthrakien und Nordmazedonien. In: Engler A & Drude O (eds). Vegetation der Erde 11. Wilhelm Engelmann, Leipzig.

Fritsch K. 1895. Beiträge zur Flora der Balkanhalbinsel, mit besonderer Berücksichtigung von Serbien. II . *Verh. K. K. Zool.-Bot. Ges.* Wien **44**(3-4): 301-327.

Greuter W, Burdet HM & Long G. 1986. Med-Checklist 3. Conservatoire et Jardin Botanique, Geneva.

Hayek A. 1918. Beitrag zur Kenntnis der Flora des albanisch-montenegrinischen Grenzgebietes. *Akad. Wiss. Wien, Math.-Naturwiss. Kl., Denkschr*. **94**: 127-210.

IUCN 2001. World Commission on Protected Areas and Europark Federation 2001. Guidelines for Protected Area Management Categories. Grafenau, Brussels.

Jalas J & Suominen J (eds.). 1994. Atlas Florae Europaeae. Distribution of Vascular Plants in Europe. 10. Cruciferae (*Sysimbrium* to *Aubrieta*). The Committee for Mapping the Flora of Europe & Societas Biologica Fennica Vanamo, Helsinki.

Jones BMG & Akeroyd J. 1993. *Cardamine*. In: Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM & Webb DA (eds.). Flora Europaea 1 (ed. 2), pp. 346-351, Cambridge University Press, Cambridge.

Jovanović-Dunjić R. 1972. *Cardamine* L. In: Josifović M. (ed.), Flora SR Srbije 3, pp. 245-265, Srpska akademija nauka i umetnosti, Beograd.

Kit Tan. 2002. *Cardamine* L. In: Strid A & Tan K (ed.), Flora Hellenica 2**,** pp. 178-185, A.R.G. Gantner Verlag K.G.

Lakušić D, Novčić R, Kučera J & Marhold K. 2006. *C. pancicii* (Brassicaceae) a neglected species of the Balkan Peninsula. *Willdenowia* **36** (Special Issue): 177-191.

Lakušić D. & Novčić R. 2006. Akcioni plan za kopaoničku režuhu *Cardamine pancicii* Hayek. Institut za botaniku i botanička bašta Jevremovac Biološki fakultet, Univerzitet u Beogradu, Nacionalni park Kopaonik, pp. 73.

Lampinen R. 2001. Universal Transverse Mercator (UTM) and Military Grid Reference System (MGRS). Downloadable from http://www.fmnh.helsinki.fi/english/botany/afe/map/utm.htm

Marhold K. 2011. Brassicaceae. In: Euro+Med Plantbase - the information resource for Euro-Mediterranean plant diversity. Published on the Internet http://ww2.bgbm.org/EuroPlusMed/ [accessed 01.28.2013].

Ozinga WA & Schaminée JHJ. (eds.) 2005. Target species – Species of European concern. Alterra-report 1119, Alterra, Wageningen.

Pančić J. 1856. Verzeichniss der in Serbien wildwachsenden Phanerogamen, nebst den Diagnosen einiger neuer Arten. *Verh. Zool. -Bot. Ges.* Wien **6**: 475-598.

Pančić J. 1867. Botanische Ergenbnisse einer i. J. 1866 unternommenen Reise in Serbien. *Österr. Bot. Z.* **17**: 166-173, 201-209.

Pančić J. 1874. Флора Кнежевине Србије – Flora Principatus Serbiae. Beograd.

Pančić J. 1884. Додатак флори Кнежевине Србије – Additamenta ad Floram Principatus Serbiae. Beograd.

Pavlović Z. 1955. O pašnjačkoj i livadskoj vegetaciji centralnog dela Kopaonika. *Glasnik Prirodnjačkog muzeja srpske zemlje* ser. B **7**(1): 47-76.

Pavlović Z. 1967. Sur une association végétale endémique des terrains serpentineux dans la vallée de la rivière Ibar (Serbie). *Glasnik Botaničkog zavoda i bašte Univerziteta u Beogradu* **2**(1-4): 189-195.

Ranđelović N, Rexhepi F & Jovanović V. 1982. Contributions to the study of the north-eastern Kosovo flora. *Acta Biologiae et Medicinae Experimentalis* **7**: 39-45.

Schultz OE. 1903: Monographie der Gattung *Cardamine*. *Bot. Jahrb. Syst*. **32**: 280-623.

Sl, RS 5/2010. Strogo zaštićene divlje vrste, Prilog I. Pravilnik o proglašenju i zaštiti strogo zaštićenih i zaštićenih divljih vrsta biljaka, životinja i gljiva *Službeni glasnik Republike Srbije* 5/2010.

Stevanović V, Jovanović S, Lakušić D & Niketić M. 1995. Diverzitet vaskularne flore Jugoslavije sa pregledom vrsta od međunarodnog značaja. In: Stevanović V & Vasić V (eds.). Biodiverzitet Jugoslavije sa pregledom vrsta od međunarodnog značaja, pp. 183-217, Ecolibri, Beograd, Biološki fakultet, Beograd.

Thiers B. 2012. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih/. [continuously updated]

Botanica SERBICA

REZIME

Morfološka diferencijacija i status ugroženosti vrste *Cardamine pancicii* (Brassicaceae), stenoendemita planine Kopaonik u Srbiji

Dmitar Lakušić, Radoslav Novčić

Cardamine pancicii Hayek je nedavno reafirmisana kao "dobra vrsta", koja je rasprostranjena isključivo na planini Kopaonik u Srbiji. Na osnovu višegodišnjih terenskih istraživanja, analize herbarijumskih i literaturnih podataka, kao i na osnovu formalne morfometrijske analize, u radu su prikazani detaljni rezultati o morfološkoj diferencijaciji, rasprostranjenju, veličini populacije i konzervacionom statusu ove stenoendemične vrste.

Morfološki veoma specifična populacija, koja naseljava rubove planinskih tresava Pajinog Presla, je opisana kao novi varijetet *Cardamine pancicii* var. *palustris* var. nova, 19 nalazišta je georeferencirano sa maksimalnom preciznošću, ukupna veličine populacije na Kopaoniku je procenjena na oko 1,7 miliona individua, a status ugroženosti vrste je definisana kao IUCN CR-B3c.

Ključne reči: *Cardamine*, endemične vrste, kritično ugrožene vrste, rasprostranjenje, Balkansko poluostrvo.

Appendix 1 – Chorological data of *C. pancicii*

Distribution of C. pancicii based on herbarium specimens:

1. Kopaonik (sub. *?, Dimitrijević, O.,* 1896, W - Herbarium Dr. A. Zahlbruckner, according Schultz 1903: 572);
2. Kopaonik (sub. *? Pančić, J.*, 1851, G - H. Boiss., according Schultz 1903: 572);
3. Kopaonik (sub. *? Pančić, J.*, 1851, W - Herbarium Dr. A. Zahlbruckner, according Schultz 1903: 572);
4. Kopaonik (sub. *? Pančić, J.*, 1851, Bresalu - Herbarium F. Pax, according Schultz 1903: 572);
5. Kopaonik (sub. *Cardamine glauca, Pančić, J.*, W, according Fritsch [Check spelling with reference list.] 1895: 323);
6. Kopaonik (sub. *Cardamine glauca var. microphylla, Pančić, J.*, WU - Herbarium A. Kerner, according Fritsch [Check spelling.] 1895: 323);
7. Kopaonik (sub. *Cardamine kopaonikensis spec. orig !, Pančić, J.*, Herbarium Halascy, according Fritsch [Check spelling.] 1895: 323);
8. Kopaonik (sub. *?, Petrović, D.*, Herbarium Halascy, according Fritsch [Check spelling with reference list.] 1895: 323);
9. Kopaonik, in glareosis, Serb. merid. (sub. *Cardamine glauca* Sprl. var. *microphyla, Pančić, J.*, Aug 1874, WU! - Herb. Kerner 000057);
10. Kopaonik, in saxosis magnetitici, Serb. merid. (*sub. Cardamine kopaonikensis* m., *Pančić, J.*, Aug., WU! - Herb. Kerner 000056);
11. Kopaonik, in glareosis magnetitici, S. merid. (*sub. Cardamine kopaonikensis* m., *Pančić, J.*, Aug.,G!- Herb. BOIS);
12. Kopaonik (*sub. Cardamine kopaonikensis* m., *Pančić, J.*, Jul 1864, BEOU! - Herb. Panč. No. 2693);
13. Kopaonik, Suho Rudište (*sub. Cardamine kopaonikensis* m., *Pančić, J.*, 31.7.1886, BEOU! - Herb. Panč. No. 2694);
14. Kopaonik (*sub. Cardamine sylvatica* L. b *microphylla* m., *Pančić, J.*, W!);
15. Kopaonik, SuviJelak, Hotel „Putnik", oko potoka (*Lakušić, D., Mitrović, V. 13893*, 25.05.2001, BEOU);
16. Suvo rudište, *Vaccinio-Juniperetum nanae*, silikat, 1850 m (*Stevanović, V., Jovanović, S., Lakušić, D. 5382, 2024*, 07.06.1997, BEOU);
17. Suvo Rudište, *Minuartietum recurvae*, kornit - jalovinište, 1950 m (*Lakušić, D. 17161*, 25.06.2003, BEOU);
18. Suvo Rudište, osuline sa dominacijom *Anthemis carpatica*, kornit - jalovinište, 1900 m (*Lakušić, D. 17164*, 26.06.2003, BEOU);
19. Suvo Rudište, silikat c. 2000 m (*Stevanović, V. 1623/94*, 16.10.1993, BEOU!);
20. Krst, *Sclerantho-Cardaminetum pancicii*, vlažna tresetna podloga, 1700 m (*Lakušić, D. 17158*, 25.06.2003, BEOU);
21. Krst, pored puta za Suvo Rudište, kamenjari, silikat, 1750 m (*Lakušić, D., Sabovljević, M., Mitrović, V. 15157*, 20.08.2000, BEOU);
22. Krst, *Sclerantho-Cardaminetum pancicii*, vlažna šljunkovita podloga 1800 m (*Lakušić, D. 17162*, 25.06.2003, BEOU);
23. Krst, *Sclerantho-Cardaminetum pancicii*, vlažna tresetna podloga, 1700 m (*Lakušić, D. 17163*, 25.06.2003, BEOU);
24. Pajino Preslo *Hygronardion*, silikat, 1700 m (*Lakušić, D. 17160*, 27.06.2003, BEOU);
25. Pajino Preslo, 1750 m, granit, *Caricion canescentis* (*Lakušić, D.*, 07.08.1986, BEOU);
26. Pajino Preslo, tresava, granit, 1700 (*Lakušić, D. 8626*, 03.07.1998, BEOU);
27. Pojilo Greben - Treska (lok. 5.1.) vlažna tresetna podloga, 1700 m (*Lakušić, D. 17159*, 25.06.2003, BEOU);
28. Repuška reka 1 km ispod hotela Bačište, oko potoka, silikat, 1600 m (*Lakušić, D., Sabovljević, M., Mitrović, V. 15156*, 27.05.2001, BEOU);
29. Suvi Jelak, Murska reka, 1600 m, granit (*Lakušić, D.*, 08.08.1986, BEOU);
30. Kriva Reka-Metalica, 1450 m, (*Novčić, R. 17087*, 25.06.2003, BEOU!);

Distribution of *C. pancicii* based on literature data:

31. Kopaonik (sub. *Cardamine glauca,* Adamović 1909: 419; Fritsh 1895: 323);
32. Kopaonik (sub. *Cardamine kopaonikensis* Pančić, Adamović 1909: 509);

33. Kopaonik (Hayek 1917: 23; Pavlović 1967: 193);
34. Kopaonik (sub. *Pteroneurum carnosum* DC. var. *polyphylla m.,* Pančić 1856: 508);
35. Kopaonik (sub. *Cardamine glauca* Spreng. var. *kopaonikensis* (Pančić) Pantoscek, Schultz. 1903: 572);
36. Bećirovac (sub. *Cardamine kopaonikensis,* Pančić 1867: 206);
37. Bećirovac (sub. *Cardamine glauca Spreng.* Pančić 1874: 140; 1884: 112);
38. Suvo Rudište (sub. *Cardamine kopaonikensis,* Pančić 1867: 173);
39. Suvo Rudište (sub. *Cardamine glauca Spreng.,* Pančić 1874: 140; Pančić 1884: 112);
40. Suvo Rudište (Pavlović 1955: 56);

Distribution of *C. pancicii* based on field observation:

41. Bećirovac, 1780 m, *Minuartietum recurvae*, cornite (*Lakušić, D.* 17.07.1987, field.obs.)
42. Suvo Rudište, 1900 m, abandoned pit mine (*Lakušić, D.* 27.05.2001, field.obs.);
43. Crni Jelak, rocky road in the spruce forest, c. 1700 m (*Lakušić, D.* 27.05.2001, field.obs.);
44. Crni Jelak, rocky road in the spruce forest, c. 1720 m (*Lakušić, D.* 25.07.2009, field.obs.).