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New data for Bulgarian endemic *Betonica bulgarica* Deg. et Neič. of Sinite Kamani Natural Park Sliven

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ABSTRACT

The distribution of *Betonica bulgarica* on the territory of Natural park Sinite kamani has been confirmed. Four localities of the species have been registered. An assessment of the status of populations and soil fertility of the territories occupied by them has been made. The factors with adverse effect have been pointed out and recommendations for their more efficient conservation have been made.

Key words: Natural park Sinite kamani, *Betonica bulgarica*, distribution

Introduction

Natural park Sinite kamani is located on the southern slopes of Eastern Stara planina above the town of Sliven. Regardless of its relatively small territory – 11,308.8 hectares, over 25% of the vascular plants in Bulgarian flora have found shelter in it, among it 42 protected species, 9 Bulgarian and 23 Balkan endemic ones (Grozeva et al., 2004; Georgieva & Petrova, 2009; Petrova et al., 2009, 2011; Tashev et al., 2010; Tashev, 2011).

The object of the present study is the Bulgarian endemic *Betonica bulgarica* Deg. et Neič. The species is protected under the Biological Diversity Act (2002) and is included in the Red Book of Bulgaria, vol.1. (Genova, 2011) Plants and fungi under the category „endangered“. It is known with localities in Stara planina (Middle and Eastern) and the Thracian plain (Koeva, 1970; Genova, 2011). According to data by Genova (2011) it has good renewable capacity and the populations are normal in number, their area being 0.3 - 0.5 hectares. For the first time *Betonica bulgarica* is reported for Eastern Stara planina by Grozeva et al. (2004) on the territory of Natural park Sinite kamani in Ablanovo area. According to data by the authors the population is small in number. In Bulgarian scientific herbaria (SOM, SOA, SO) there is one herbarium specimen of *Betonica bulgarica* from

Eastern Stara planina, Natural park Sinite kamani – a meadow in the area of Karandila (SOM 167749, 19.07.2010, A. Petrova). Data about the locality have not been published.

The objective of the present study is to establish the present-day distribution of *Betonica bulgarica* in Natural park Sinite kamani, to make an assessment about the status of its populations and soil fertility of the territories inhabited by them and to outline measures for their protection. The study is part of a project Restoration of habitats and preservation of biodiversity in Natiral park Sinite kamani funded by Agreement No. 5103020-C-002 on Priority axis 3 Preservation and restoration of biodiversity of Operational programme “Environment 2007 – 2013”.

Materials and Methods

The study was conducted during the vegetation period of 2013. To establish the distribution of species the routing method was applied. The tourist routes in the park were mainly used with more or less deviations in order to cover as much as possible of the habitats characteristic for each species.

Studies have been carried out mainly on the following routes:

Karandila area - Kushbunar area - Peschenik peak - Enyova bulka area - Kaloyanovi kuli area - Mollova kuria

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area, Karandila area - Chukata area - Enyova bulka area - TV Tower - Karandila Hotel complex, Mollova kuria area - Upper lift station - Karandila area, Town of Sliven - Plachidol area - Barmuka peak - Ablanovo area, Ablanovo area - Bobenishteto area - Asenovets Dam, Kushbunar - Karandila area - TV Tower - Maryova skala area, Ablanovo area - Dalgia rid area, Ablanovo area - Plochite area - Ovcharnitsite area - Karakyutyuk area - Kostova cheshma area - Balgarka peak - Daula area, Town of Sliven - Slancheva polyana area - Karandila area - Microdam, Mollova kuria area - Gornaka area - Karandila area - Mecha polyana area, Town of Sliven - Gagovets area, Town of Sliven - Novoselska River - Kuru Dere area, Ayazmoto area - Malka poyana area - Aremiyata area, Sliven - turnout to the village of Sotirya - Andreeva cheshma - Hisarlaka, Karandila area - Chukata area - Malkata chuka - Tunkata rutlina - Lokvata.

A Global positioning system (GPS) was used to determine the coordinates of the sampling points. The habitats of the species are presented on the map of Natural park Sinite kamani in scale 1:100 000.

The registered populations of *Betonica bulgarica* were visited during phenophase reaching normal size of leaves, beginning of flowering, flowering, fruit formation, fruit bearing, falling of mature seeds and period after falling of leaves. To assess the status of each population Methodology for monitoring vascular plants in Bulgaria has been used. The voucher specimens are deposited in the herbarium of the Institute for Biodiversity and ecosystem research Bulgarian Academy of Sciences (SOM). Soil samples from 0-20 cm layer were collected from every studied area. The samples were air-dried, and plant residues and stones were removed, after which the samples were crushed and sieved with particle size less than 2 mm. All samples were analyzed for: pH with 1:2,5 soil:water ratio; mineral nitrogen ($\text{NH}_4^+\text{-N} + \text{NO}_3^-\text{-N}$) content using spectrophotometer JENWAY 6705 UV/VIS; available potassium and available phosphorus content by the Egner-Riem method. The concentration of available potassium was determined by AAS using AAnalyst 800 Atomic Absorption Spectrometer, Perkin Elmer. Visual soil assessment of soil texture and soil structure in the field was performed (Houšková, 2005).

Results

As a result of the terrain studies four populations of *Betonica bulgarica* were found on the park territory (Figure 1). The two registered localities in Ablanovo area and

Karandila area have been confirmed and two new ones have been registered – in Slancheva polyana area and near Upper lift station.

The population in Ablanovo area (Figure 1 – 1.1) is on an open meadow on the edge of a mixed deciduous forest comprising *Carpinus betulus* L., *Quercus robur* L., *Ulmus minor* Mill., *Fraxinus ornus* L. and *Crataegus monogyna* Jacq. The terrain is very slightly sloped ($3^\circ\text{-}4^\circ$), non-eroded, facing south-east and altitude of 540 m a.s.l. The bedrock is limestone, the soil type –Chromic Luvisols (WRBSR, 2006). The studied soil is characterized with moderate soil structure, with crumb structure in the upper surface horizon, the soil texture is sandy clay loam, no carbonates detected. The reaction of the soil is slightly acidic, with pH values between 6,6 and 6,7 (Figure 2). The results from the chemical analyses for available nitrogen, phosphorus and potassium content characterize the soil as poorly stocked with total mineral nitrogen with values Total N = 16,28 mg.kg⁻¹ (Figure 3), moderately stocked with available forms of phosphorus, $\text{P}_2\text{O}_5 = 13,55 \text{ mg.}100\text{g}^{-1}$ and good level of available potassium, $\text{K}_2\text{O} = 20,28 \text{ mg.}100\text{g}^{-1}$ (Figure 4). The area of the population is 1600 m² and it numbers 289 specimens, incl. 239 flowering and 50 juvenile ones. The geographical coordinates in its central part are N 42° 42.638', E 26° 17.262'. The plant community is dominated by *Betonica bulgarica*. Humidity during flowering and fruit bearing is moderate. Invasive and competing plant species have not been found. The specimens are in good condition, but due to the proximity of the population to forest road and to the main road to the town of Sliven, there is real threat of trampling and collection of plants for medicinal purposes.

The population of Upper lift station (Figure 1 – 1.2) is located on an open meadow on the edge of a forest consisting of *Fagus sylvatica* L. ssp. *moesiaca* (K. Maly) Hjelmquist, *Picea abies* (L.) Karst. and *Pinus sylvestris* L. The terrain has a slope of 7°, slightly eroded, dry, facing west and altitude of 1015 m. The bedrock is limestone, the soil type is Rendzinas (WRBSR, 2006). The studied soil is characterized with moderate structure, the soil texture is silty clay loam. The soil reaction is neutral, with pH (H₂O) = 7,04 and presence of carbonates in the soil surface layer (Figure 2). The results of the chemical analyses for the studied soil parameters content characterize the soil as poorly stocked with a total mineral nitrogen, with values Total N = 22,24 mg.kg⁻¹ (Figure 3) and good level of available phosphorus, $\text{P}_2\text{O}_5 = 29.10 \text{ mg.}100\text{g}^{-1}$ and potassium, $\text{K}_2\text{O} = 53.45 \text{ mg.}100\text{g}^{-1}$ (Figure 4).

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The area of the population is 150 m² and it numbers 32 specimens, incl. 17 flowering and 15 juvenile ones. The geographical coordinates in its central part are N 42° 43.100', E 26° 21.619'. The plant community is dominated by cereal species. Invasive plant species have not been established. The majority of specimens are in relatively good condition. Traces of trampling and the presence of boars have been recorded. There are 7 uprooted plants. Seed regeneration is hampered due to fouling with grass at the time of phenophase falling of mature seeds. Major threat to the population is anthropogenic pressure since it is located in close proximity to Upper lift station and near its territory there is a hiking trail to Karandila. Very close to the trail there are 11 plants.

The population from Karandila area (Figure 1-1.3) is located on an open meadow near the cliffs east of the dams. The grassland community is dominated by *Sesleria latifolia* Degen. The terrain is very sloped 11°-20°, highly eroded, dry, facing north and altitude of 945 m. The bedrock is quartz porphyry, the soil type – Eutric Cambisols. Due to the reported high level of soil erosion in Karandila area, east of the dam, the soil in the studied area was determined as Regosols, too (WRBSR, 2006). The soils in the studied area

are weak structured with granular structure, the soil texture is sandy clay loam. Total carbonates in the surface soil layer have not been found. The soil reaction is strongly acidic, with pH values (H₂O) = 4,23 (Figure 2).

The soil is characterized as poorly stocked with total mineral nitrogen =35.21 mg.kg⁻¹, moderately stocked with both available phosphorus, P₂O₅ =14,44 mg.100g⁻¹ and potassium, K₂O = 28.94 mg.100g⁻¹ (Figures 3 and 4). The population area is 950 m² and it numbers 127 specimens, incl. 96 flowering and 29 juvenile ones. The geographical coordinates in its central part are N 42° 42.852', E 26° 22.654'. Invasive and competing plants have not been found. Specimens are in relatively good condition, but traces of trampling have been noticed. Fouling with grass at the time of phenophase falling of mature hampers seed propagation. Additionally, due to the large slope of the terrain, some of the seeds are carried by air currents to places that are inappropriate for their development. A major threat to the population is anthropogenic pressure since the area around the dam is one of the most visited places in the park and there is a trail near the territory of the population. A serious threat to its existence are the registered erosion processes.

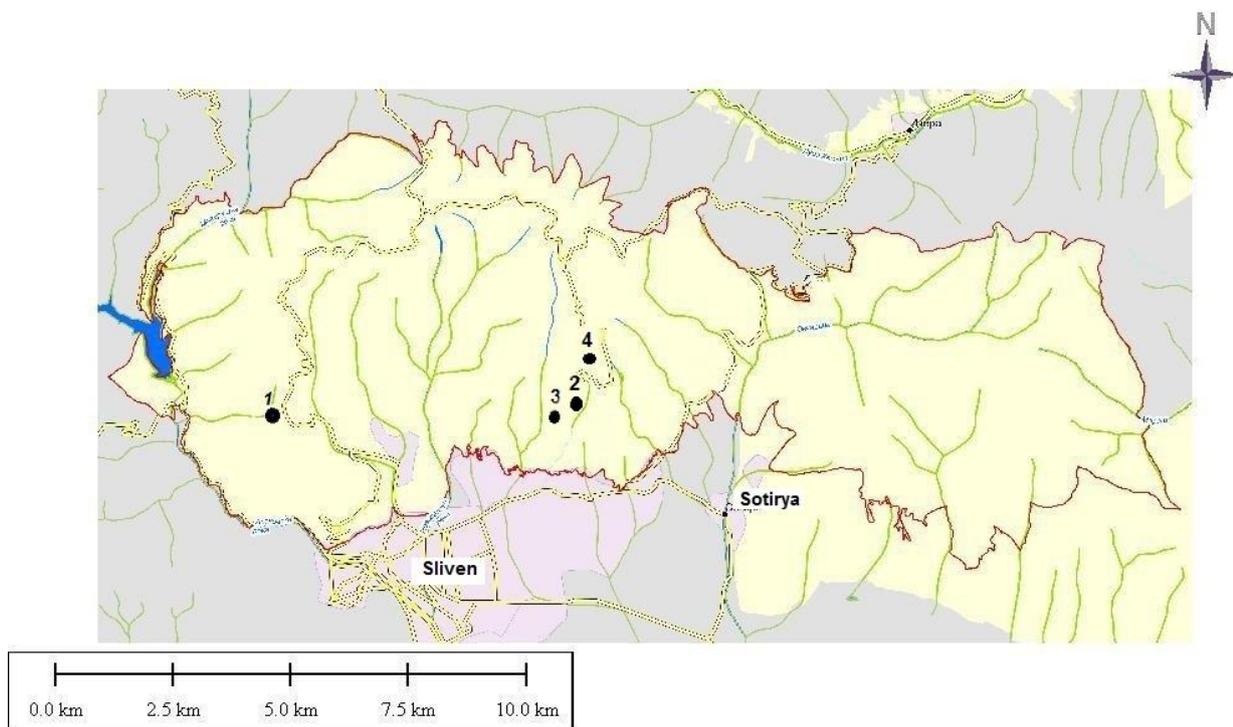


Figure 1. Distribution of *Betonica bulgarica* in Sinite kamani Natural park: 1.1. Ablanovo area; 1.2. Upper lift station; 1.3. Karandila area; 1.4. Slancheva polyana area.

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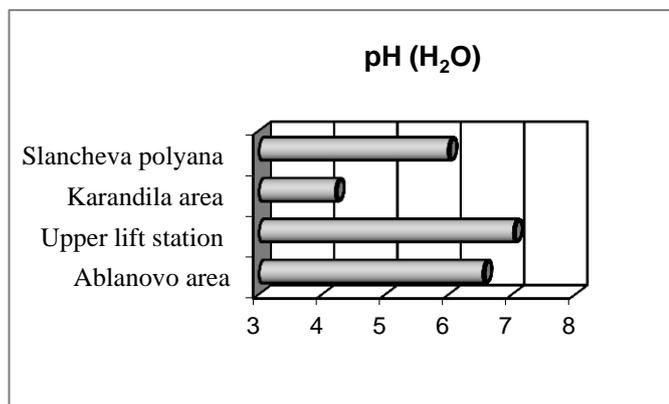


Figure 2. Values of pH in the studied soil samples.

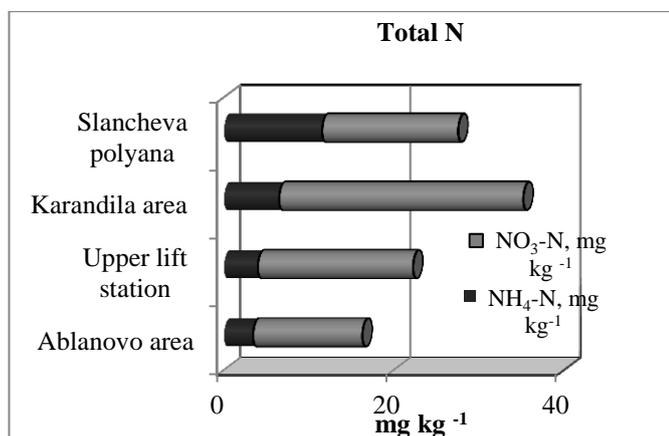


Figure 3. Values of mineral nitrogen ($\text{NH}_4^+\text{-N} + \text{NO}_3^-\text{-N}$) content, mg.kg^{-1} in the studied soil samples.

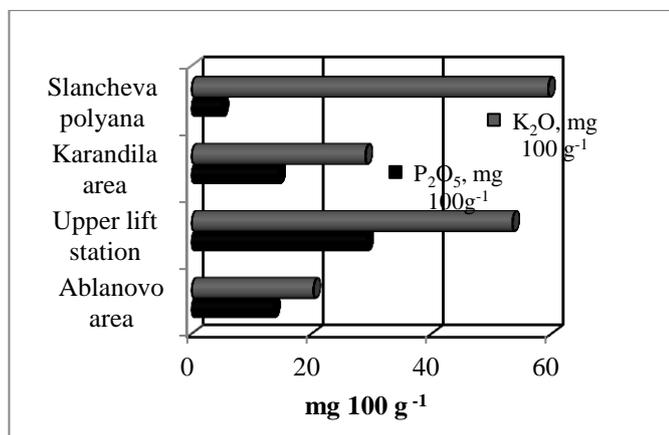


Figure 4. Values of available phosphorus and potassium content, mg.100 g^{-1} in the studied soil samples.

The population in Slancheva polyana area (Figure 1 – 1.4) is located on an open meadow on the edge of a mixed forest consisting of *Fagus sylvatica* ssp. *moesiaca*, *Pinus silvestris*, *Fraxinus ornus*, *Prunus cerasifera* Ehrh., *Acer campestre* L., with some bushes of *Juniperus communis* L., *Crataegus monogyna*, *Rosa canina* L., *Rubus canescens* DC. In the grass layer *Festuca valesiaca* Schleich. ex Gaudin is dominant. The terrain has a slope of up to 11°, non-eroded, dry, facing west and altitude of 1001 m. The bedrock is limestone, the soil type – Eutric Cambisols. The soils in the studied area are characterized by being of weak structure, the soil texture is sandy clay loam. Total carbonates in the surface soil layer have not been found. The soil reaction is slightly acidic, with pH values (H₂O) = 6,01 (Figure 2). It is poorly stocked with mineral nitrogen and phosphorus, with values of total mineral nitrogen = 27, 55 mg.kg^{-1} and P₂O₅ = 4,97 mg.100g^{-1} and well stocked with available potassium, K₂O = 59,79 mg.100g^{-1} (Figure 3 and 4). The area of the population is 654 m² and it numbers 171 specimens, incl. 146 flowering and 25 juvenile ones. The geographical coordinates in its central part are N 42° 43.252', E 026° 21.668'. Invasive and competing plants have not been found. Some of the specimens are in good condition, but in most of them anthropogenic impact has been observed (traces of trampling, uprooting, cutting). For all specimens due to fouling with grass at the time of phenophase falling of mature seeds, seed propagation is difficult. The population is subject to increasing anthropogenic pressure as Slancheva polyana is one the places frequently used for recreation in the park and there is a forest road passing through its territory. Another threat to its existence is the numerous population of *Pteridium aquilinum* (L.) Kuhn. located in close proximity.

Discussion

The Bulgarian endemic *Betonica bulgarica* exists on the territory of Natural park Sinite kamani in four areas – Ablanovo, Upper lift station, Karandila - east of the dam, Slancheva polyana. On the territory of the park the species forms populations on open meadows on the edges of deciduous forests and in grass communities dominated by *Sesleria latifolia* and *Festuca valesiaca* at an altitude from 540 to 1015 m on Chromic Luvisols, Eutric Cambisols and Rendzinas, moderate structured soils with crumb structural aggregates and on soil texture from sandy clay loam to silty clay loam. It grows successfully both in acidic soil reaction with pH values (H₂O) = 4,23, and in slightly acidic to neutral

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reaction with pH values (H₂O) of 6,01 to 7,04. It dwells on soils with low mineral nitrogen content, poorly to well stocked with available forms of phosphorus and with high available potassium content. The presence of carbonates in the soil does not affect negatively the development of the species. Its populations number from 32 to 289 specimens on an area of 150 to 1600 m². The basic threats to their existence are anthropogenic influence and hampered seed propagation. For the population in Slancheva polyana area a serious threat is also the nearby numerous population of *Pteridium aquilinum*. In order to prevent the penetration of *Pteridium aquilinum* on the territory of that population mechanical control has to be applied consisting of three-fold cutting (in May, July and beginning of September) at a strip 5 m wide and soil loosening once (beginning of July) till full disclosure of the roots of the aggressive weed. The cut plants should be promptly removed and the control is to continue till complete destruction of the species in the three-meter border strip. Due to the close proximity of all populations of *Betonica bulgarica* to a trail, forest and/or asphalt road, the full limitation of anthropogenic pressure is difficult to achieve. At this stage completely limited is only the collection of the species for medicinal purposes. Stabilization of populations and increasing their area and number is possible mainly by supporting their natural restoration – clearing the dead forest and grass mass, reseeding in appropriate areas with pre-collected mature seeds, transfer of vulnerable plants to better protected areas of the populations or to areas adjacent to them. For two of the populations – Upper lift station and in Slancheva polyana area, the transfer of some of the most endangered plants is compulsory. For the population at Upper lift station it is necessary the 11 plants located along the trail to be transferred to a remote location in the southeast corner of the lawn. For the population from Slancheva polyana the transfer of vulnerable plants and sowing of mature seeds within the population borders is impossible, due to the proximity to a forest road, recreation area and numerous population of *Pteridium aquilinum*. The data from field studies and soil analyses confirmed strong resemblance of the environmental conditions in Slancheva polyana area and Bozhurite area where human impact is not registered and possible transfer of the most vulnerable specimens of the population *Betonica bulgarica* from one area into the other could help stabilize its condition.

In spite of the good regeneration ability of the species, the area of its populations in the park is far from the one

mentioned by Genova (2011) as an area normal for its populations of 0.3 - 0.5 hectares. To increase the surface area and the number of population on the territory of Natural park Sinite kamani, it is necessary to apply *ex-situ* conservation as well – seed and vegetative propagation of the species in the nursery that is under construction in the park and subsequent return of some of the plants grown in its natural habitats in the park. Collection of mature seeds with no risk for the natural seedling restoration of *Betonica bulgarica*, is possible for the population in Ablanovo area. Whole plants for vegetative propagation can be taken from the population in Slancheva polyana area and the selection shall include mainly plants from areas of the population subject to intensive anthropogenic pressure.

By implementing the above *in-situ* and *ex-situ* measures, stabilization of the populations of the Bulgaria endemic *Betonica bulgarica* on the territory of Natural park Sinite kamani will be achieved.

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References

- Biological Diversity Act. 2002. *Darzhaven Vestnik* no. 77 from 9 August 2002, pp. 9-42. Amended in *Darzhaven Vestnik* no. 94 from 16 November 2007 (Bg).
- Genova E. 2011. *Betonica bulgarica* Deg. et Neic. – In: Peev D (ed.), Red Data Book of the Republic of Bulgaria, vol. 1. Plants & Fungi, <http://e-ecodb.bas.bg/rdb/en/vol1/Betbulga.html> (12.01.2014).
- Georgieva M, Petrova A. 2009. Orchids in Sinite kamani Natural park. – Rodina, Sofia.
- Grozeva N, Georgieva M, Vulkova M. 2004. Flowering plants and ferns. – In: Stoeva M (ed.), Biological diversity of Sinite Kamani Nature Park. – Kontrast, Bogomilovo, p. 9-112 (Bg).
- Houškova B. 2005. Visual soil assessment. 3rd European Summer School on Soil Survey. Co-organized by TAIEX, JRC and SZIV.
- Koeva Y. 1970. Genus *Betonica* –In: Jordanov D (ed.), Flora Reipublicae Bulgariae, vol 9, Editio Acad. „Prof. Marin Drinov“, Serdicae, p. 412-416 (Bg).

RESEARCH ARTICLE

- Petrova A, Trifonov G, Venkova D, Ivanova M. 2009. Records 51-74. – In: Vladimirov V & al. (comps). New floristic records in the Balkans: 10. *Phytol. Balcan.*, 15(1): 128-132.
- Petrova AS, Getova N, Grozeva N, Venkova D. 2011. Reports 73-93. – In: Vladimirov, V. & al. (comps). New floristic records in the Balkans: 17. *Phytol. Balcan.*, 17(3): 361-384.
- Tashev A, Aleksandrova A, Dochshev D. 2010. New record of *Quercus coccifera* L. in Bulgaria. *Gora*, 8: 16-18 (Bg).
- Tashev A. 2011. Reports 108-113. – In: Vladimirov V & al. (comps). New floristic records in the Balkans: 17. *Phytol. Balcan.*, 17(3): 361-384.
- World referense base for soil resources. 2006. A framework for international classification, correlation and communication. Food and agriculture organization of the United Nations – Rome, Italy.