

## *Inventory of Bryophytes in the "Bulgarka" Nature Park*

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**Abstract.** This study reports data on the diversity of bryophytes in the Bulgarka Nature Park. The registered 55 species belonged to 23 families and 46 genera. Six species were with conservation status; 2 were assessed as Not Evaluated. The main threats were assessed and measures towards bryophyte conservation were proposed.

**Key words:** Bulgarka Nature Park, bryophytes, conservation status, threats.

### **Introduction**

Recently, conservation biologists alarm about mass extinction of biodiversity caused by human influences (GOOD & RODRÍGUEZ, 2009). However, preserved territories still protect habitats, species and genotypes. Among them is Bulgarka Nature Park, located on the ridges and northern slopes of Shipka and Trevnenska mountains and partly of the adjacent Pre-Balkan region (Bulgaria) with total area 21 772.2 ha. The territory includes the Yantra River springs and its main tributaries in the upper reaches. The park covers settlements located within the municipalities of Gabrovo, Tryavna and Muglitzh. Hristo Smirnenski dam also belongs to the territory of the park.

Bryophytes are among the best-adapted plants in habitats with extreme conditions, such as Arctic and Alpine Tundra, marshes

and bare rocks, etc. (DIERSSEN, 2001). Bryophytes have an important role in natural ecosystems. Their most important contribution is related to the water cycle, primary production and carbon fixation (HALLINGBÄCK & HODGETTS, 2000). Some moss species are valuable for their medicinal properties and contain chemical components that are active against certain cell lines of cancer cells. Others have antibacterial, antimicrobial and antifungal action (RAYMUNDO *et al.*, 1989; ASAKAWA, 1995; ASAKAWA *et al.*, 2003; NAGASHIMA *et al.*, 2003). Because of their small size, they largely reflect micro-conditions of the environment, especially the microclimate, soil development and its chemical composition.

About 754 bryophyte species were registered in Bulgaria (PETROV, 1975;

NATCHEVA & GANEVA, 2009). At present the Red List of bryophytes in Bulgaria includes 251 species, 228 of them being Threatened (28 Critically Endangered, 42 Endangered and 158 Vulnerable) (NATCHEVA *et al.*, 2006). Four species are included in Annex 2 of the Biological Diversity Act (2002): *Buxbaumia viridis*, *Dicranum viride*, *Hamatocaulis vernicosus* and *Mannia triandra*.

Nowadays it is obvious that the landscape in most of the world has changed to such an extent that the environment is already unfavorable for the existence and development of a number of plant and animal species (VIÉ *et al.*, 2009). Bryophytes particularly suffer from various threats, but they have received significantly less conservation attention in comparison with vascular plants (SABOVLJEVIĆ *et al.*, 2014). Reduction of biodiversity may be caused directly by deforestation, urbanization, road construction, construction of dams, mining, production of peat and many other human activities. Changes of habitats caused by the humans entail changes in the conditions of the abiotic environment, thus creating additional negative effects to bryophytes. Habitat loss is the fastest growing threat to the survival of the species and this will probably continue to be the dominant risk factor in the coming decades (BROOKS *et al.*, 2002; FAHRIG, 2002).

Bulgarka Nature Park aims to secure habitats and species, thus species that are under threat must first be registered. This is the first study describing the bryophyte flora in Bulgarka Nature Park with a focus on threaten species.

### Materials and Methods

Inventorization of bryophytes was done in the period May-October 2012 and in the spring of 2013 on the territory of Bulgarka Nature Park (Figure 1). The route transect method was used. Samples of bryophyte species were collected from different substrates: rocks, stones of different sizes, trunks of beech trees, dead wood, soil, mostly in rocky ridges, grasslands, and beech forests. Portable GPS receiver GARMIN 530 was used for studying the localities of the species.

Taxonomic composition was determined by microscopic identification following PETROV (1975) and SMITH (2004). Herbarium samples were used to confirm the species identification.

HILL *et al.* (2006) were followed for moss nomenclature and GROLLE & LONG (2000) for liverworts. The threat status was assessed according to NATCHEVA *et al.* (2006) and European working list of mosses (2014).

### Results and Discussion

Fifty-five species belonging to four classes were described after the field inventory in Bulgarka Nature Park: Marchantiopsida, Jungermanniopsida, Polytrichopsida and Bryopsida (Table 1). They usually develop on rock substrate and on the trunks of trees in beech forest communities. The analysis of the described species shows that class Marchantiopsida was represented by two species belonging to genus *Conocephalum* and *Conocephalum conicum* (L.) Dumort being among the most common. Class Jungermanniopsida is represented by only two species. Class Polytrichopsida was also represented by two species and several localities of *Polytrichum juniperinum* Hedw. were found. Class Bryopsida comprised 49 species, grouped in 42 genera of 20 families referring to 7 orders. Order Hypnales was represented by the highest diversity of species (30 species) and the most common species belonging to class Bryopsida were: *Hypnum cupressiforme* Hedw., *Homalothecium lutescens* (Hedw.) H. Rob., *Plagiomnium undulatum* (Hedw.) T. J. Kop., *Platyhypnidium riparioides* (Hedw.) Dixon and *Rhytidiadelphus loreus* (Hedw.) Warnst.

Table 2 presents identified species, their conservation status according to NATCHEVA *et al.* (2006) and European working list of mosses (2014). Six of the registered moss species have a conservation value. The species *Dicranum viride* var. *papillosum* (Sull. et Lesq.) Lindb. is endangered (EN) and *Anomodon rugelii* (Müll. Hal.) Keissl., *Grimmia torquata* Drum., *Lescuraea mutabilis* (Brid.) Lindb. ex I. Hagen, *Philonotis caespitosa* Jur., *Sciuro-hypnum glaciale* (Schimp.) Ignatov & Huttunen are vulnerable (VU). *Pseudoleskea*

*radicosa* (Mitt.) Macoun & Kindb. belongs to the category near threatened (NT). *Conocephalum salebrosum* Szweykowski et al. and *Dichelyma falcatum* (Hedw.) Myrin are underexplored and respectively, not

evaluated (NE). Finding and registering new habitats of the latter species in Bulgarka Nature Park, in the region of Kozyata River in particular, will help future evaluation of their conservation status.



**Fig. 1.** Topographic map of the study area.

**Table 1.** Distribution (in number) by taxonomic categories of the moss taxa identified in Bulgarka Nature Park.

Class	Order	Family	Genus	Species
Marchantiopsida	1	1	1	2
Jungermanniopsida	1	1	1	2
Polytrichopsida	1	1	2	2
Bryopsida	7	20	42	49

The major threats to the bryophytes were related to the habitat loss and fragmentation in the studied territory, mainly from construction works. In recent years grassland habitats are really endangered by the growing interest in renewable energy sources (wind generators and photovoltaics). A wind farm has been constructed at the park's border in the regions of Buzludzha peak, Atovo padalo (Atovo fal) peak, Karadzhova kula (Karadzhova tower) peak, and Bedek peak. The construction of the ski slope from

Ispolin peak down to Uzana locality, situated to the northwest of the peak, also has a negative effect on the vegetation.

Recent review of peer-reviewed studies on the effects of construction of structures by humans, stated that the alteration of a landscape through the removal of vegetation changes the characteristics of the environment in a way that affects wildlife (LOVICH & ENNEN, 2011). Increasing habitat fragmentation and land-use changes in surrounding areas form nature preserves as habitat "islands" (GOOD & RODRÍGUEZ,

2009). In addition, activities leading to fragmentation within the nature park itself, may cause its decrease in size and increases isolation between threaten species.

Few actions, taken in order to fight the decline in bryophyte diversity in the last 30 years were documented (SABOVLJEVIĆ et al., 2014). Due to the limited experience worldwide and based on the highlighted threats within the studied protected area, the following measures should be taken for protecting threaten species' habitats. Of high importance are further studies on the so-called 'hot spots' of distribution. In parallel, activities dedicated to the popularization and conservation of these bryophyte species should be taken also.

### Conclusion

Predominantly high abundance of bryophytes was registered in all studied sites, which confirms their important environmental role. Thus their conservation worldwide and particularly in Bulgaria, is crucial. Based on the data obtained, bryophyte diversity on the territory of Bulgarka Nature Park can be considered high. The list of bryophytes found in the protected area includes 55 species, 6 of them being of conservation importance. Two of the species are underexplored in the studied region.

The major threat assessed to the bryophytes in the studied territory was habitat loss and fragmentation.

This is the first bryophyte study within the protected area, and it could be a basis for further conservation measures to ensure the long-term threaten species survival. Phytocenological studies including species composition and their quantitative assessment should be carried out with the aim of determine detailed environmental characteristics of the areas, especially with species of conservation significance.

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**Table 2.** Taxonomic composition, conservation status and GPS coordinates of the localities of the identified bryophytes on the territory Bulgarka Nature Park. Legend: EN - Endangered; VU - Vulnerable; NT - Near Threatened; LC - Least Concern; NE - Not Evaluated.

Class MARCHANTIOPSIDA					
Order	Familia	Genus	Species	Conservation value	GPS coordinates
Marchantiales	Conocephalaceae	<i>Conocephalum</i>	<i>Conocephalum conicum</i> (L.) Dumort	LC	N 42°48'30.0" E 25°18'15.4"
					N 42°46'89.3" E 25°15'31.0"
					N 42°46'13.3" E 25°18'02.6"
					N 42°49'57.1" E 25°12'85.0"
					N 42°48'16.5" E 25°15'39.6"
					N 42°48'07.8" E 25°15'28.7"
					N 42°46'07.0" E 25°23'07.1"
			<i>Conocephalum salebrosum</i> Szweykowski et al.	NE	N 42°46'13.3" E 25°18'02.6"
Class JUNGERMANNIOPSIDA					
Order	Familia	Genus	Species	Conservation value	GPS coordinates
Porellales	Porellaceae	<i>Porella</i>	<i>Porella laevigata</i> (Schrad.) Pfeiff.	Unknown	N 42°48'23.2" E 25°34'49.0"
			<i>Porella platyphylla</i> (L.) Pfeiff.	Unknown	N 42°48'23.2" E 25°34'49.0"
Class POLYTRICHOPSIDA					
Order	Familia	Genus	Species	Conservation value	GPS coordinates
Polytrichales	Polytrichaceae	<i>Polytrichastrum</i>	<i>Polytrichastrum formosum</i> (Hedw.) G.L.Sm.	LC	N 42°48'23.2" E 25°34'49.0"
			<i>Polytrichum</i>	LC	N 42°45'98.9" E 25°14'45.9"
					N 42°45'00.6" E 25°25'59.5"
					N 42°45'51.8" E 25°28'28.8"
					N 42°46'05.8" E 25°29'06.2"
Class BRYOPSIDA					
Order	Familia	Genus	Species	Conservation value	GPS coordinates
Encalyptales	Encalyptaceae	<i>Encalypta</i>	<i>Encalypta streptocarpa</i> Hedw.	LC/status unknown	N 42°48'23.2" E 25°34'49.0"
Grimmiales	Grimmiaceae	<i>Schistidium</i>	<i>Schistidium agassizii</i> Sull. & Lesq.	LC	N 42°45'08.4" E 25°14'20.7"
		<i>Grimmia</i>	<i>Grimmia hartmanii</i> Schimp.	LC/status unknown	N 42°45'98.6" E 25°14'38.0"

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			<i>Grimmia pulvinata</i> (Hedw.) Sm.	LC/status unknown	N 42°48'23.2" E 25°34'49.0"	
			<i>Grimmia torquata</i> Drumm.	VU	N 42°45'89.2" E 25°15'13.6"	
Dicranales	Dicranaceae	<i>Racomitrium</i>	<i>Racomitrium canescens</i> (Hedw.) Brid.	LC	N 42°48'55.9" E 25°29'19.6"	
		<i>Dicranella</i>	<i>Dicranella heteromalla</i> (Hedw.) Schimp	LC/status unknown	N 42°45'98.9" E 25°14'45.9"	
		<i>Dicranum</i>	<i>Dicranum viride</i> var. <i>papillosum</i> (Sull. et Lesq.) Lindb.	EN	N 42°45'98.6" E 25°14'38.0"	
			<i>Dicranum flexicaule</i> Brid	LC	N 42°48'23.2" E 25°34'49.0"	
Pottiales	Pottiaceae	<i>Paraleucobryum</i>	<i>Paraleucobryum longifolium</i> (Hedw.) Loeske	LC/status unknown	N 42°48'23.2" E 25°34'49.0"	
		<i>Tortella</i>	<i>Tortella tortuosa</i> (Hedw.) Brid.	LC/status unknown	N 42°48'23.2" E 25°34'49.0"	
		<i>Weissia</i>	<i>Weissia</i> sp.		N 42°48'23.2" E 25°34'49.0"	
Orthotrichales	Orthotrichaceae	<i>Orthotrichum</i>	<i>Orthotrichum</i> sp.		N 42°48'23.2" E 25°34'49.0"	
	Bryales	Bartramiaceae	<i>Philonotis</i>	<i>Philonotis caespitosa</i> Jur.	VU	N 42°45'54.2" E 25°22'03.4"
		Bryaceae	<i>Bryum</i>	<i>Bryum turbinatum</i> (Hedw.) Turner	LC	N 42°45'54.2" E 25°22'03.4"
				<i>Bryum pseudotriquetrum</i> (Hedw.) P. Gaertn. et al.	LC	N 42°46'13.3" E 25°18'02.6"
			<i>Rhodobryum</i>	<i>Rhodobryum roseum</i> (Hedw.) Limpr.	LC	N 42°45'98.6" E 25°14'38.0"
	Cinclidiaceae	<i>Rhizomnium</i>	<i>Rhizomnium punctatum</i> (Hedw.) T. J. Kop.	LC	N 42°46'07.0" E 25°23'07.1"	
	Plagiomniaceae	<i>Plagiomnium</i>	<i>Plagiomnium affine</i> (Blandow ex Funck) T.J.Kop.	LC	N 42°48'23.2" E 25°34'49.0"	
			<i>Plagiomnium rostratum</i> (Schrad.) T.J.Kop.	LC	N 42°48'23.2" E 25°34'49.0"	
			<i>Plagiomnium undulatum</i> (Hedw.) T. J. Kop.	LC	N 42°48'39.6" E 25°16'06.0"	
					N 42°45'54.2" E 25°22'03.4"	
					N 42°46'07.0" E 25°23'07.1"	
					N 42°48'23.2" E 25°34'49.0"	
					N 42°48'23.2" E 25°34'49.0"	
Hypnales	Fontinalaceae	<i>Dichelyma</i>	<i>Dichelyma falcatum</i> (Hedw.) Myrin	NE	N 42°46'13.3" E 25°18'02.6"	
	Amblystegiaceae	<i>Cratoneuron</i>	<i>Cratoneuron filicinum</i> (Hedw.) Spruce	LC	N 42°48'23.2" E 25°34'49.0"	
		<i>Amblystegium</i>	<i>Amblystegium serpens</i> (Hedw.) Schimp.	LC	N 42°45'08.4" E 25°14'20.7"	
		<i>Hygroamblystegium</i>	<i>Hygroamblystegium varium</i> (Hedw.) Mönk.	LC	N 42°49'08.5" E 25°29'56.6"	
		<i>Palustriella</i>	<i>Palustriella commutata</i> (Hedw.) Ochyra	LC/status unknown	N 42°46'13.3" E 25°18'02.6"	
	Leskeaceae	<i>Leskea</i>	<i>Leskea polycarpa</i> Hedw.	LC	N 42°46'89.3" E 25°15'31.0"	
		<i>Pseudoleskeella</i>	<i>Pseudoleskeella catenulata</i> (Brid. ex Schrad.) Kindb.	LC	N 42°45'98.6" E 25°14'38.0"	
		<i>Pseudoleskea</i>	<i>Pseudoleskea radicata</i> (Mitt.) Macoun & Kindb.	NT	N 42°45'98.6" E 25°14'38.0"	
		Brachytheciaceae	<i>Lescurea</i>	<i>Lescurea mutabilis</i> (Brid.) Lindb. ex I.Hagen	VU	N 42°46'25.7" E 25°33'48.3"
			<i>Eurhynchium</i>	<i>Eurhynchium striatum</i> (Hedw.) Schimp	LC	N 42°48'55.9" E 25°29'19.6"
			<i>Platyhypnidium</i>	<i>Eurhynchium praelongum</i> (Hedw.) Schimp	LC	N 42°47'35.1" E 25°28'13.5"
			<i>Platyhypnidium riparioides</i> (Hedw.) Dixon	LC	N 42°48'30.0" E 25°18'15.4"	
					N 42°49'57.1" E 25°12'85.0"	

				N 42°47'59.9" E 25°14'26.8"
				N 42°48'23.2" E 25°34'49.0"
				N 42°44'57.0" E 25°31'44.6"
				N 42°48'23.2"
				E 25°34'49.0"
	<i>Plasteurhynchium</i>	<i>Plasteurhynchium striatum</i> (Spruce) M.Fleisch.	LC	
	<i>Oxyrrhynchium</i>	<i>Oxyrrhynchium speciosum</i> (Brid.) Warnst.	LC	N 42°48'23.2" E 25°34'49.0"
	<i>Sciuro-hypnum</i>	<i>Sciuro-hypnum glaciale</i> (Schimp.) Ignatov & Huttunen	VU	N 42°46'13.3" E 25°18'02.6"
	<i>Brachythecium</i>	<i>Brachythecium rivulare</i> Schimp.	LC	N 42°47'35.1" E 25°28'13.5"
	<i>Homalothecium</i>	<i>Homalothecium lutescens</i> (Hedw.) H.Rob.	LC	N 42°46'89.3" E 25°15'31.0"
				N 42°48'16.5" E 25°15'39.6"
				N 42°48'07.8" E 25°15'28.7"
				N 42°46'00.5" E 25°29'19.0"
		<i>Homalothecium philippeanum</i> (Spruce) Schimp.	LC	N 42°48'23.2" E 25°34'49.0"
Hypnaceae	<i>Campylophyllum</i>	<i>Campylophyllum sommerfeltii</i> (Myrin) Hedenäs	Unknown	N 42°45'98.9" E 25°14'45.9"
	<i>Calliergonella</i>	<i>Calliergonella cuspidata</i> (Hedw.) Loeske	LC/status unknown	N 42°48'39.6" E 25°16'06.0"
	<i>Hypnum</i>	<i>Hypnum cupressiforme</i> Hedw.	LC	N 42°45'98.6" E 25°14'38.0"
				N 42°45'98.6" E 25°14'38.0"
				N 42°48'23.2" E 25°34'49.0"
Hylocomiaceae	<i>Pleurozium</i>	<i>Pleurozium schreberi</i> (Willd. ex Brid.) Mitt.	LC/status unknown	N 42°45'00.6" E 25°25'59.5"
	<i>Rhytidiadelphus</i>	<i>Rhytidiadelphus loreus</i> (Hedw.) Warnst.	LC/status unknown	N 42°45'74.4" E 25°15'14.6"
				N 42°46'89.3" E 25°15'31.0"
				N 42°46'03.7" E 25°29'12.0"
				N 42°44'57.0" E 25°31'44.6"
Lembophyllaceae	<i>Hylocomium</i>	<i>Hylocomium splendens</i> (Hedw.) Schimp.	LC/status unknown	N 42°45'98.9" E 25°14'45.9"
Leucodontaceae	<i>Isothecium</i>	<i>Isothecium alopecuroides</i> (Dubois) Isov.	LC/status unknown	N 42°48'23.2" E 25°34'49.0"
	<i>Leucodon</i>	<i>Leucodon sciuroides</i> (Hedw.) Schwägr.	LC	N 42°46'55.6" E 25°14'01.2"
				N 42°49'68.1" E 25°12'73.4"
Anomodontaceae	<i>Anomodon</i>	<i>Anomodon rugelii</i> (Müll.Hal.) Keissl.	VU	N 42°48'23.2" E 25°34'49.0"
		<i>Anomodon viticulosus</i> (Hedw.) Hook. & Taylor	LC	N 42°48'23.2" E 25°34'49.0"
Neckeraceae	<i>Neckera</i>	<i>Neckera complanata</i> (Hedw.) Huebener	Unknown	N 42°48'23.2" E 25°34'49.0"
Plagiotheciaceae	<i>Plagiothecium</i>	<i>Plagiothecium cavifolium</i> (Brid.) Z. Iwats.	LC	N 42°48'23.2" E 25°34'49.0"
				N 42°49'68.1" E 25°12'73.4"

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