

# Bryophyte diversity along the Northern Black Sea Coast in Bulgaria

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**Abstract.** Here we examine the bryophyte flora of the Northern Black Sea Coast in Bulgaria. The total number of recorded species is 153. Five species are new to the bryophyte flora of Bulgaria. One hundred and sixteen species are new to the Black Sea Coast floristic region. Eighteen species are red-listed at national level. At European level, 10 species are red-list candidates. This study highlights the importance of the studied region for conservation of the bryophyte diversity in Bulgaria.

**Key words:** Black Sea coast, bryophyte flora, Bulgaria, liverworts, mosses, threatened bryophytes

## Introduction

Bryophyte flora of the Bulgarian part of the Black Sea Coast has never been subject to systematic studies. There are accidental reports on some species made by Velenovsky (1902), Simon & Vajda (1959), Petrov (1963, 1970), Šmarda (1970), Ganeva & Sopotlieva (2007), Natcheva (2007), and Papp & al. (2012). Prior to our study, the total number of bryophytes known for the Black Sea Coast were 55, with 25 species known from its northern part and 35 species from the southern part (Ganeva & Natcheva 2003, Natcheva & Ganeva 2005).

Biodiversity of the Black Sea Coast region is severely threatened by the heavy anthropogenic pressure, intensive infrastructure development and touristic resorts. There is a system of protected areas along the coast (seven nature reserves, 30 protected sites, 13 Nature monuments, and two nature parks). It is important to study all aspects of biodiversity, including bryophytes, in order to identify further areas of special

species richness that need to be protected. The aim of this study was to reveal bryophyte diversity along the Bulgarian Northern Black Sea Coast.

## Material and methods

The Black Sea Coast of Bulgaria is a strip with varying width: from 5–10 km to 40–50 km. Its total length is 378 km. The relief is heterogeneous, including sandy beaches and dunes, wetlands, limestone cliffs, and limestone plateaus. Cape Emine (the easternmost part of the Balkan Range) serves as a geographical and phytogeographical boundary, dividing the Bulgarian Black Sea Coast into a southern and a northern part.

The study area belongs to the Continental-Mediterranean Climatic Province (Velev 2002). The influence of the Black Sea creates a milder climate at the shoreline than in the corresponding inland parts. The shoreline is mainly low and flat. Lack of mountain

barriers leaves the coastal area open to the strong winds. In the cold months, western winds predominate in the south, while in the north, northern winds prevail. Breeze circulation is characteristic during summer. There are considerable differences in temperature and precipitation in the northern and southern part of the region. In the north, mean temperature in January is 0.6°C and mean precipitation is 411 mm, while in the south, they are 4°C and 700 mm, respectively (Velev 2002). Precipitation maximum is in November–December and its minimum is in August–September (Mateeva 2002).

The study sites were selected so as to cover as much as possible of the habitats diversity of bryophytes (Fig. 1). A list of the study sites is presented in Appendix 1. Nomenclature follows Hodgetts (2015). The red-list categories are according to the *Red List of Bulgarian Bryophytes* (Natcheva & al. 2006).

## Results and discussion

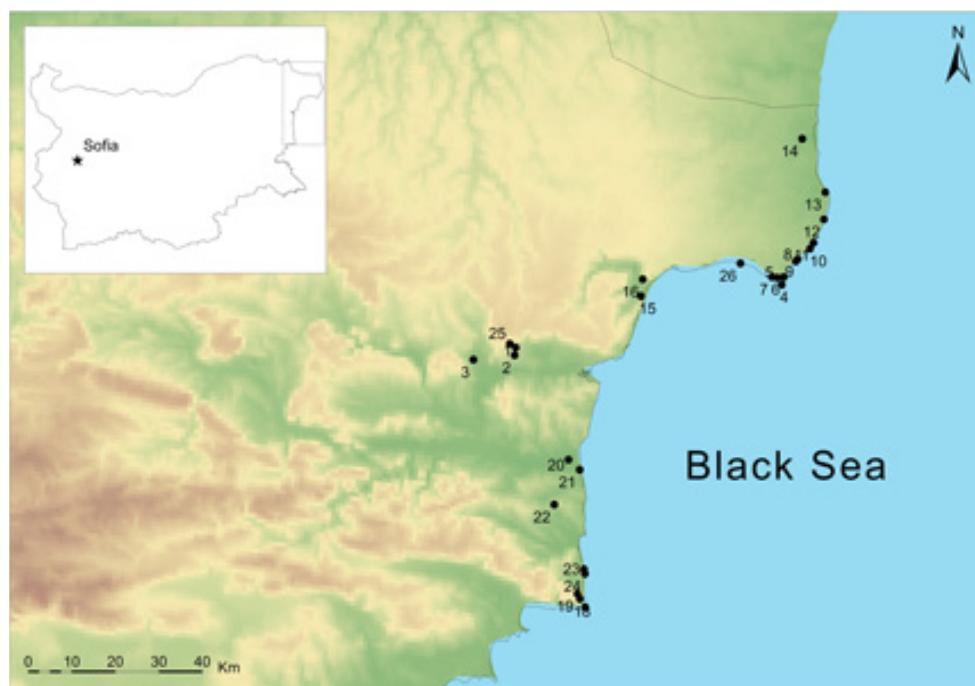
**Floristic diversity.** The total number of species recorded in this study is 153 (Table 1). Of them, 147 are mosses and six are liverworts. The low number of liverworts is noteworthy. This is probably due to the low rainfalls and humidity in the study area, and the strong winds contributing to further desiccation. Five species are new to the bryophyte flora of Bulgaria:

*Enthostodon hungaricus* (Boros) Loeske. In the Balkans, it is known also from Romania, Serbia (EN) and Greece, as well as from S and C Europe, and SE Russia. It is red-listed or Data Deficient in most countries of its occurrence: Canary Islands (DD), Malta (DD), Spain (NT), Austria (2), Germany (R), Slovakia (CR), and Hungary (NT) (Hodgetts 2015).

*Ephemerum crassinervium* subsp. *sessile* (Bruch) Holyoak. In the Balkans, it is reported from Greece and Montenegro (Hodgetts 2015). The species is also known from S, W, N, and C Europe, Israel, Turkey, and Morocco (Smith 2004). The species is red-listed in Germany (EN) (Hodgetts 2015).

*Grimmia dissimulata* E.Maier. In the Balkans, it is known from Albania, Croatia, Greece, Montenegro, and Serbia, as well as from W and C Europe. It is red-listed or Data Deficient in many European countries, e.g. Ireland (VU), Czech Republic (DD), Germany (D), Luxembourg (VU), and Switzerland (DD) (Hodgetts 2015).

*Syntrichia caninervis* var. *gypsophila* (J.J.Amann ex G.Roth) Ochyra. This is the first report of this variety from the Balkans. The species is known from Greece (var. *caninervis*), as well as from S and C Europe, C and SE Russia. *S. caninervis* var. *gypsophila* is a recently described taxon of unclear distribution. It is Data Deficient in the Czech Republic and Hungary



**Fig. 1.** Bryophyte sampling sites along the Northern Black Sea Coast of Bulgaria.

(but with recent records, Erzberger & al. 2015) (Hodgetts 2015).

*Syntrichia subpapilloissima* (Bizot & R.B.Pierrot ex W.A.Kramer) M.T.Gallego & J.Guerra. In the Balkans, it is found in Greece (Crete) (Gallego 2005) and Croatia (Papp & al. 2013). It is also known from Andorra, France, Portugal, Spain, Austria, and Germany, where it is Data-Deficient (Hodgetts 2015).

In the present study, 116 species are new to the Black Sea Coast floristic region and 132 are new to its northern subregion.

**Conservation.** At national level, 18 species are red-listed. Of them, three are Critically Endangered, five are Endangered, and 10 are Vulnerable. Another 16 species are Data Deficient and four are Near Threatened (Table 1.).

At European level, the following 10 species are red-list candidates (Hodgetts 2015): *Acaulon mediterraneum* Limpr., *Didymodon cordatus* Jur., *Enthosthodon hungaricus* (Boros) Loeske, *Ephemerum crassinervium* subsp. *sessile* (Bruch) Holyoak, *Fissidens fontanus* (Bach.Pyl.) Steud., *Grimmia crinita* Brid., *Microbryum floerkeanum* (F.Weber & D.Mohr) Schimp., *Orthotrichum patens* Bruch ex Brid., *Schistidium helveticum* (Schkuhr) Deguchi, and *Weissia levieri* (Limpr.) Kindb.

Eight of the sites in this study are protected areas, according to Bulgarian legislation. However, they did not always harbor especially high bryophyte diversity. The nationally red-listed species and those of European conservation importance occur mostly outside of protected areas.

### Comments on some rare and interesting species

*Acaulon mediterraneum*: The N Black Sea Coast is the second location of this species in Bulgaria. So far it has been known only from the Struma River Valley (Ellis & al. 2015). It is probably more widespread, but often overlooked, due to its small size and short-lived vegetative phase.

*Aloina ambigua*: This is the second report of this species in Bulgaria. So far it has been known only from the Struma River Valley (Petrov 1962).

*Fissidens fontanus*: This species was reported for Bulgaria at river Devnya by Velenovsky (1902) and has

never been collected afterwards. Our visit to the same site after more than 100 years confirmed the occurrence of *F. fontanus*, with numerous individuals/patches on suitable substrates (mostly concrete and tree roots).

*Grimmia crinita*: Like the previous species, *G. crinita* was collected for the first time by Velenovsky (1902) near the town of Nevsha and has never been found afterwards. Our finding is the second location of the species in Bulgaria.

*Microbryum floerkeanum*: A recently found member of the Bulgarian bryophyte flora, collected for the first time on loess cliffs along the Danube (Natcheva & Ganeva 2006). It is also known from one location along the Black Sea Coast (Natcheva 2007). This is the third report of the species for Bulgaria.

*Microbryum starckeana*: The taxonomic treatment of this taxon differs between various comprehensive floristic works (Ahrens & Nebel 2000, Ros & Werner 2006). Our specimens represent *Pottia mutica* Venturi, which is a synonym to *Pottia starckeana*, according to the Spanish authors (Ros & Werner 2006). Our specimens have smooth spores and the peristome is rudimentary or completely lacking, which is a feature of *P. mutica* and, according to the German authors, this is a separate species (Ahrens & Nebel 2000). *Pottia starckeana* (*sensu stricto*) has a well-developed peristome and the spores are verrucose with rounded protuberances, low ridges or vermiciform ornamentation.

*Orthotrichum patens*: So far it has been known from only three localities in Bulgaria: Varna, Vitosha and the Forebalkan (Stefanoff & Petrov 1962, Mickiewicz & al. 1966, Natcheva & Gyocheva 2016).

*Weissia levieri*: This species was collected in Bulgaria for the first time by Ganeva & Ros-Espin (2002). Afterwards, it proved to be relatively common in dry grasslands in the warmer parts of the country (Natcheva, unpubl.). Therefore, its status as DD at national level needs to be revised and no threat category will be assigned to this species.

**Conclusions:** The northern part of the Black Sea Coast is characterized by a rich and diverse bryophyte flora. This study highlights the importance of the studied region for the conservation of bryophytes in Bulgaria and the need for designation of further small-size protected areas so as to ensure the conservation of this diversity.

**Table 1.** List of species recorded in the Northern Black Sea Coast floristic subregion. Locality numbers correspond to Appendix 1. Abbreviations: BSC – Black Sea Coast floristic region, NBSC – Northern Black Sea Coast floristic subregion, DD – Data Deficient, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened.

Nr.	Taxon	Locality	National conservation status	European conservation status	New to Bulgaria	New to BSC	New to NBSC
<b>Marchantiophyta</b>							
1.	<i>Cephaloziella baumgartneri</i> Schiffn.	6				×	×
2.	<i>Frullania dilatata</i> (L.) Dumort.	8, 12, 15, 16, 19, 20, 22, 23, 25					×
3.	<i>Lophocolea heterophylla</i> (Schrad.) Dumort.	15, 20				×	×
4.	<i>Porella platyphylla</i> (L.) Pfeiff.	2, 6, 8, 16, 20, 22					
5.	<i>Radula complanata</i> (L.) Dumort.	8, 15, 16, 19, 20, 22, 23, 25					×
6.	<i>Riccia sorocarpa</i> Bisch.	9, 11				×	×
<b>Bryophyta</b>							
1.	<i>Acaulon mediterraneum</i> Limpr.	22	DD	×		×	×
2.	<i>Alleniella besseri</i> (Lobarz.) S.Olsson, Enroth & D.Quandt	20				×	×
3.	<i>Alleniella complanata</i> (Hedw.) S.Olsson, Enroth & D.Quandt	8, 20				×	×
4.	<i>Aloina ambigua</i> (Bruch & Schimp.) Limpr.	14				×	×
5.	<i>Amblystegium serpens</i> (Hedw.) Schimp.	4, 6, 14, 15, 16, 20, 25					×
6.	<i>Anomodon attenuatus</i> (Hedw.) Huebener	22				×	×
7.	<i>Anomodon viticulosus</i> (Hedw.) Hook. & Taylor	8, 15, 20, 22					
8.	<i>Atrichum undulatum</i> (Hedw.) P.Beauv.	22					
9.	<i>Barbula convoluta</i> Hedw.	8					
10.	<i>Barbula unguiculata</i> Hedw.	4, 5, 6, 10, 12, 13, 14, 15, 17, 20, 21, 22, 25, 26					
11.	<i>Brachytheciastrum velutinum</i> (Hedw.) Ignatov & Huttunen	6, 19, 22				×	×
12.	<i>Brachythecium albicans</i> (Hedw.) Schimp.	1, 8, 19					×
13.	<i>Brachythecium mildeanum</i> (Schimp.) Schimp.	20	DD			×	×
14.	<i>Brachythecium rivulare</i> Schimp.	15					×
15.	<i>Brachythecium rutabulum</i> (Hedw.) Schimp.	6, 15, 20, 22					×
16.	<i>Bryoerythrophyllum recurvirostrum</i> (Hedw.) P.C.Chen	6				×	×
17.	<i>Bryum argenteum</i> Hedw.	1, 21, 25, 26					
18.	<i>Bryum dichotomum</i> Hedw.	1, 4, 5, 9, 11, 12, 17, 21, 23					
19.	<i>Bryum klinggraeffii</i> Schimp.	20	DD			×	×
20.	<i>Bryum radiculosum</i> Brid.	5, 14	VU			×	×
21.	<i>Bryum ruderale</i> Crundw. & Nyholm	4, 6, 13	DD			×	×
22.	<i>Campylidium calcareum</i> (Crundw. & Nyholm) Ochyra	6, 22				×	×
23.	<i>Ceratodon purpureus</i> (Hedw.) Brid.	2, 21, 22, 25				×	×
24.	<i>Cirriphyllum crassinervium</i> (Taylor) Loeske & M.Fleisch.	8, 22				×	×
25.	<i>Cratoneuron filicinum</i> (Hedw.) Spruce	7				×	×
26.	<i>Crossidium squamiferum</i> (Viv.) Jur.	4				×	×
27.	<i>Ctenidium molluscum</i> (Hedw.) Mitt.	6, 8				×	×
28.	<i>Dicranella heteromalla</i> (Hedw.) Schimp.	22				×	×
29.	<i>Dicranella varia</i> (Hedw.) Schimp.	7, 20, 26				×	×
30.	<i>Didymodon acutus</i> (Brid.) K.Saito	1, 2, 4, 5, 6, 9, 10, 11, 12, 17, 18, 25				×	×
31.	<i>Didymodon cordatus</i> Jur.	5	VU	×			
32.	<i>Didymodon fallax</i> (Hedw.) R.H.Zander	26				×	×
33.	<i>Didymodon insulanus</i> (De Not.) M.O.Hill	26				×	×

Table 1. Continuation

Nr.	Taxon	Locality	National conservation status	European conservation status	New to Bulgaria	New to BSC	New to NBSC
34.	<i>Didymodon luridus</i> Hornsch.	4, 8, 9, 10, 22, 25					
35.	<i>Didymodon rigidulus</i> Hedw.	1					×
36.	<i>Didymodon sinuosus</i> (Mitt.) Delogne	6, 8					
37.	<i>Didymodon tophaceus</i> (Brid.) Lisa	6, 7, 14, 15					
38.	<i>Didymodon vinealis</i> (Brid.) R.H.Zander	2, 4, 6, 8, 10, 11, 25				×	×
39.	<i>Ditrichum flexicaule</i> (Schwägr.) Hampe	1, 2, 25				×	×
40.	<i>Drepanocladus aduncus</i> (Hedw.) Warnst.	20					
41.	<i>Encalypta streptocarpa</i> Hedw.	2, 6				×	×
42.	<i>Encalypta vulgaris</i> Hedw.	1, 2, 5, 6, 9, 11, 25				×	×
43.	<i>Enthosthodon hungaricus</i> (Boros) Loeske	4		×	×	×	×
44.	<i>Ephemerum crassinervium</i> subsp. <i>sessile</i> (Bruch) Holyoak	17		×	×	×	×
45.	<i>Ephemerum minutissimum</i> Lindb.	22	DD			×	×
46.	<i>Eucladium verticillatum</i> (With.) Bruch & Schimp.	4, 7					
47.	<i>Fissidens dubius</i> P.Beauv.	22				×	×
48.	<i>Fissidens fontanii</i> (Bach.Pyl.) Steud.	3	CR	×			
49.	<i>Fissidens pusillus</i> (Wilson) Milde	8, 22				×	×
50.	<i>Fissidens taxifolius</i> Hedw.	17, 18, 20, 22, 23, 24				×	×
51.	<i>Funaria hygrometrica</i> Hedw.	14				×	×
52.	<i>Grimmia crinita</i> Brid.	1	VU	×			
53.	<i>Grimmia dissimulata</i> E.Maier	1, 2, 6, 9, 25			×	×	×
54.	<i>Grimmia laevigata</i> (Brid.) Brid.	1, 2					×
55.	<i>Grimmia orbicularis</i> Bruch ex Wilson	1, 4, 6				×	×
56.	<i>Grimmia pulvinata</i> (Hedw.) Sm.	1, 2, 4, 5, 6, 8, 9, 25					×
57.	<i>Grimmia tergestina</i> Tomm. ex Bruch & Schimp.	1, 2, 25	VU			×	×
58.	<i>Gymnostomum viridulum</i> Brid.	6	VU			×	×
59.	<i>Gyroweisia tenuis</i> (Hedw.) Schimp.	7	DD			×	×
60.	<i>Herzogiella seligeri</i> (Brid.) Z.Iwats.	15				×	×
61.	<i>Homalothecium lutescens</i> (Hedw.) H.Rob.	1, 5, 6, 17, 18, 19, 23, 24, 25, 26				×	×
62.	<i>Homalothecium sericeum</i> (Hedw.) Schimp.	1, 2, 4, 6, 8, 10, 16, 19, 21, 22, 24					
63.	<i>Homomallium incurvatum</i> (Schrad. ex Brid.) Loeske	22				×	×
64.	<i>Hygroamblystegium varium</i> (Hedw.) Mönk.	15				×	×
65.	<i>Hypnum cupressiforme</i> Hedw.	1, 2, 6, 15, 16, 18, 19, 20, 21, 22, 23, 25				×	×
66.	<i>Hypnum vaucheri</i> Lesq.	1, 2, 25	NT			×	×
67.	<i>Imbribryum alpinum</i> (Huds. ex With.) N.Pedersen	19				×	×
68.	<i>Leptobryum pyriforme</i> (Hedw.) Wilson	4					×
69.	<i>Leptodictyum riparium</i> (Hedw.) Warnst.	3, 6, 14, 20					×
70.	<i>Leskeia polycarpa</i> Hedw.	15, 20					
71.	<i>Leucodon sciuroides</i> (Hedw.) Schwägr.	16, 20, 22, 23, 25					
72.	<i>Microbryum curvicollum</i> (Hedw.) R.H.Zander	5, 10, 11, 17, 25, 26	DD			×	×
73.	<i>Microbryum davallianum</i> (Sm.) R.H.Zander	5, 11				×	×
74.	<i>Microbryum floerkeanum</i> (F.Weber & D.Mohr) Schimp.	13, 22	DD	×			
75.	<i>Microbryum starkeanum</i> (Hedw.) R.H.Zander	5, 9	EN			×	×
76.	<i>Microeurhynchium pumilum</i> (Wilson) Ignatov & Vanderp.	8, 22	EN			×	×
77.	<i>Mnium stellare</i> Hedw.	22				×	×
78.	<i>Orthotrichum affine</i> Schrad. ex Brid.	16, 20, 22, 25				×	×

**Table 1.** Continuation

Nr.	Taxon	Locality	National conservation status	European conservation status	New to Bulgaria	New to BSC	New to NBSC
79.	<i>Orthotrichum anomalum</i> Hedw.	1, 2, 6, 8, 10, 19, 25				×	×
80.	<i>Orthotrichum cupulatum</i> Hoffm. ex Brid.	1, 4, 19				×	×
81.	<i>Orthotrichum diaphanum</i> Schrad. ex Brid.	12, 14, 16, 20				×	×
82.	<i>Orthotrichum pallens</i> Bruch ex Brid.	16, 20, 22				×	×
83.	<i>Orthotrichum patens</i> Bruch ex Brid.	22	NT	×		×	×
84.	<i>Orthotrichum speciosum</i> Nees	22				×	×
85.	<i>Orthotrichum stramineum</i> Hornsch. ex Brid.	22, 25				×	×
86.	<i>Orthotrichum striatum</i> Hedw.	22, 25				×	×
87.	<i>Oxyrrhynchium hians</i> (Hedw.) Loeske	15, 17, 18, 20, 22, 23				×	×
88.	<i>Oxyrrhynchium schleicheri</i> (R.Hedw.) Röll	22	CR			×	×
89.	<i>Oxyrrhynchium speciosum</i> (Brid.) Warnst.	3, 15				×	×
90.	<i>Oxystegus tenuirostris</i> (Hook. & Taylor) A.J.E.Sm.	22				×	×
91.	<i>Physcomitrium eurystomum</i> Sendtn.	15, 22				×	×
92.	<i>Plagiomnium affine</i> (Blandow ex Funck) T.J.Kop.	22				×	×
93.	<i>Plagiomnium undulatum</i> (Hedw.) T.J.Kop.	8				×	×
94.	<i>Plagiothecium cavifolium</i> (Brid.) Z.Iwats.	22				×	×
95.	<i>Platygyrium repens</i> (Brid.) Schimp.	25	DD			×	×
96.	<i>Pleuridium acuminatum</i> Lindb.	22				×	×
97.	<i>Pleuridium subulatum</i> (Hedw.) Rabenb.	22					×
98.	<i>Pohlia melanodon</i> (Brid.) A.J.Shaw	7, 20				×	×
99.	<i>Pseudocrossidium hornschuchianum</i> (Schultz) R.H.Zander	1, 2, 5, 9				×	×
100.	<i>Pseudocrossidium revolutum</i> (Brid.) R.H.Zander	1, 2, 4, 8, 25				×	×
101.	<i>Pterigynandrum filiforme</i> Hedw.	16				×	×
102.	<i>Pterygoneurum ovatum</i> (Hedw.) Dixon	5, 6, 9, 10, 13, 17				×	×
103.	<i>Ptychostomum boreale</i> (F.Weber & D.Mohr) Ochyra & Bednarek-Ochyra	14				×	×
104.	<i>Ptychostomum capillare</i> (Hedw.) Holyoak & N.Pedersen	4, 5, 9, 10, 21, 26				×	×
105.	<i>Ptychostomum imbricatulum</i> (Müll.Hal.) Holyoak & N.Pedersen	1, 2, 4, 5, 8, 9, 11, 12, 25				×	×
106.	<i>Ptychostomum moravicum</i> (Podp.) Ros & Mazimpaka	10, 20, 22, 24, 25				×	×
107.	<i>Ptychostomum pseudotriquetrum</i> (Hedw.) J.R.Spence & H.P.Ramsay	14				×	×
108.	<i>Ptychostomum rubens</i> (Mitt.) Holyoak & N.Pedersen	13, 22, 23	DD			×	×
109.	<i>Ptychostomum torquescens</i> (Bruch & Schimp.) Ros & Mazimpaka	17	VU			×	×
110.	<i>Pylaisia polyantha</i> (Hedw.) Schimp.	16, 20, 25				×	×
111.	<i>Rhynchostegiella curviseta</i> (Brid.) Limpr.	22	DD			×	×
112.	<i>Rhynchostegiella tenella</i> (Dicks.) Limpr.	8	VU			×	×
113.	<i>Rhynchostegium megapolitanum</i> (Blandow ex F.Weber & D.Mohr) Schimp.	4, 5, 6, 10, 17, 22, 26				×	×
114.	<i>Schistidium apocarpum</i> (Hedw.) Bruch & Schimp.	1				×	×
115.	<i>Schistidium brunnescens</i> Limpr. ssp. <i>brunnescens</i> <i>Schistidium brunnescens</i> ssp. <i>griseum</i> (Nees & Hornschr.) H.H.Bлом	1, 2, 25	NT			×	×
116.	<i>Schistidium confusum</i> H.H.Bлом	19				×	×
117.	<i>Schistidium crassipilum</i> H.H.Bлом	1, 6, 22, 25	DD			×	×
118.	<i>Schistidium helveticum</i> (Schkuhr) Deguchi	1, 6, 25	DD	×		×	×
119.	<i>Scleropodium touretii</i> (Brid.) L.F.Koch	22, 23	EN			×	×

**Table 1.** Continuation

Nr.	Taxon	Locality	National conservation status	European conservation status	New to Bulgaria	New to BSC	New to NBSC
120.	<i>Scorpiurium circinatum</i> (Bruch) M.Fleisch. & Loeske	6, 8, 10	EN				×
121.	<i>Syntrichia calcicola</i> J.J.Amann	1, 2				×	×
122.	<i>Syntrichia caninervis</i> var. <i>gypsophila</i> (J.J.Amann ex G.Roth) Ochyra	1			×	×	×
123.	<i>Syntrichia laevipila</i> Brid.	21	VU				×
124.	<i>Syntrichia montana</i> Nees	2, 4, 6, 9, 10, 25				×	×
125.	<i>Syntrichia ruralis</i> (Hedw.) F.Weber & D.Mohr var. <i>ruralis</i>	1, 2, 4, 5, 6, 10, 13, 21, 25, 26					
	<i>Syntrichia ruralis</i> var. <i>ruraliformis</i> (Besch.) Delogne	2, 5, 9, 17	DD				×
126.	<i>Syntrichia subpilosissima</i> (Bizot & R.B.Pierrot ex W.A.Kramer) M.T.Gallego & J.Guerra	5, 21			×	×	×
127.	<i>Syntrichia virescens</i> (De Not.) Ochyra	25	VU			×	×
128.	<i>Thamnobryum alopecurum</i> (Hedw.) Gangulee	8					×
129.	<i>Tortella flavovirens</i> (Bruch) Broth.	12					×
130.	<i>Tortella inclinata</i> (R.Hedw.) Limpr.	1, 2, 5, 25				×	×
131.	<i>Tortella inflexa</i> (Bruch) Broth.	6	DD			×	×
132.	<i>Tortella nitida</i> (Lindb.) Broth.	1, 6, 8, 10	CR				
133.	<i>Tortella squarrosa</i> (Brid.) Limpr.	1, 2, 4, 5, 6, 8, 9, 17, 18, 21, 23, 25					×
134.	<i>Tortella tortuosa</i> (Hedw.) Limpr.	2, 6, 12, 25				×	×
135.	<i>Tortula acaulon</i> (With.) R.H.Zander var. <i>acaulon</i>	5, 6, 9, 12, 17, 20, 22					
	<i>Tortula acaulon</i> var. <i>pilifera</i> (Hedw.) R.H.Zander	10					
136.	<i>Tortula inermis</i> (Brid.) Mont.	6				×	×
137.	<i>Tortula lindbergii</i> Broth.	4, 5, 6, 9, 10, 13, 17, 26				×	×
138.	<i>Tortula muralis</i> Hedw.	1, 2, 4, 6, 10, 12, 14, 24, 25				×	×
139.	<i>Tortula protobryoides</i> R.H.Zander	6	EN			×	×
140.	<i>Tortula truncata</i> (Hedw.) Mitt.	4, 22				×	×
141.	<i>Trichostomum brachydontium</i> Bruch	6	VU			×	×
142.	<i>Trichostomum crispulum</i> Bruch	1				×	×
143.	<i>Weissia brachycarpa</i> (Nees & Hornsch.) Jur.	22				×	×
144.	<i>Weissia condensa</i> (Voit) Lindb.	2, 5, 6, 17, 22, 25				×	×
145.	<i>Weissia controversa</i> Hedw. var. <i>controversa</i>	22				×	×
	<i>Weissia controversa</i> var. <i>crispata</i> (Nees & Hornsch.) Nyholm	2				×	×
146.	<i>Weissia levieri</i> (Limpr.) Kindb.	5, 17, 23	DD	×		×	×
147.	<i>Weissia longifolia</i> Mitt.	18, 22				×	×

**Appendix 1.** List of studied localities along the Northern Black Sea Coast.

- Protected site Pobiti Kamani, a group SE of Slanchevo village, nummulite limestone rocks and sands, 135 m, N 43°14'39,8", E 27°42'34,3", 15.04.2007.
- Protected site Pobiti Kamani, the main group at the highway, SW of Slanchevo village, limestone rocks, quartz sands and sandstones, 115 m, N 43°13'42,2", E 27°42'23,0", 15.04.2007.
- Devnya river, south of Devnya town, limestone rocks in the river, 20 m, N 43°13'11,4", E 27°35'22,6", 15.04.2007.
- Cape Kaliakra at Bulgarevo village, limestone rock walls with intercalations of sands and clay, the soils are humus-calcareous rendzinas, 60 m, N 43°22'01,3", E 28°27'54,5", 16.04.2007.

5. Cape Kaliakra at Balgarevo village, steppe with humus-calcareous rendzina soils and limestone rock outcrops, 70 m, N 43°22'55,2", E 28°27'10,5", 16.04.2007.
6. Kaliakra Nature Reserve, Bolata Gorge at Balgarevo village, limestone rock cliffs and humus-calcareous rendzina soil, 2–20 m, N 43°22'59,2", E 28°28'16,8", 17.04.2007.
7. Wet limestone rock walls and thin layered clays at the shore at Balgarevo village, 2 m, N 43°23'00,5", E 28°26'16,1", 17.04.2007.
8. Rusalka Resort, around lake Nanevska Tuzla, limestone rocks with intercalations of sands and clay, and humus-calcareous rendzina soil, 10 m, N 43°24'54,4", E 28°30'22,4", 17.04.2007.
9. Protected site Stepite, Rusalka Resort, steppe with limestone rocks with intercalations of sands and clay, and humus-calcareous rendzina soil, 65 m, N 43°25'09,2", E 28°30'40,8", 17.04.2007.
10. Kamen Bryag village, Yaylata Archeological Site, limestone rocks with intercalations of sands and clay at the seashore and steppe with humus-calcareous rendzina soil, 40 m, N 43°26'26,0", E 28°32'49,8", 18.04.2007.
11. Kamen Bryag village, limestone rocks with intercalations of sands and clay, and steppe with humus-calcareous rendzina soil at the seashore, 40 m, N 43°27'10,3", E 28°33'26,6", 18.04.2007.
12. Tyulenovo village, limestone rocks with intercalations of sands and clay at the seashore, 11 m, N 43°30'02,3", E 28°35'16,9", 18.04.2007.
13. Shabla village, at lake Shablenska Tuzla, saline vegetation on heavy loamy leached chernozems, 5 m, N 43°33'25,0", E 28°35'36,8", 18.04.2007.
14. Protected site Durankulashko Lake, at the archeological site, on sands, clay and peat, 5 m, N 43°40'05,9", E 28°31'50,0", 18.04.2007.
15. Baltata Managed Reserve at Batova river delta, swamp forest near Kranevo village, 2 m, N 43°20'53,5", E 28°03'56,5", 19.04.2007.
16. Dyuzorman dry oak forest at Obrochishte village, humus-calcareous rendzina soils developed over carbonate clays, 220 m, N 43°22'57,6", E 28°04'17,4", 19.04.2007.
17. Cape Emine, Emona village, grassland at the seashore, on eroded cinnamon-podzolic (pseudopodzolic) soil developed over marls, siltstones, sandstones and limestones, 65 m, N 42°42'20,9", E 27°53'51,9", 20.04.2007.
18. Cape Emine, NE of Emona village, grassland and open forest along the road, on eroded cinnamon-podzolic (pseudopodzolic) soil developed over marls, siltstones, sandstones and limestones, 240 m, N 42°43'22,3", E 27°53'01,3", 20.04.2007.
19. Between Emona and Irakli villages, dry oak forest along the road, eroded cinnamon-podzolic (pseudopodzolic) soil developed over marls, siltstones, sandstones and limestones, 190 m, N 42°44'01,7", E 27°52'36,2", 20.04.2007.
20. Kamchia river delta, Kamchiiski Longoz Nature Reserve, swamp forest at Staro Oryahovo village, alluvial and alluvial-meadow, sandy and loamy soil, 9 m, N 43°00'40,6", E 27°51'19,8", 21.04.2007.
21. Kamchia Pyasici Nature Reserve, sand dunes at Novo Oryahovo village, 3 m, N 42°59'25,0", E 27°53'13,3", 21.04.2007.
22. N of Goritsa village, dry oak forest, eroded cinnamon-podzolic (pseudopodzolic) soil, stones and wet banks of shaded stream, 170 m, N 42°55'07,3", E 27°48'52,0", 22.04.2007.
23. N of Irakli village, dry oak forest, eroded cinnamon-podzolic (pseudopodzolic) soil, 20 m, N 42°47'04,0", E 27°53'44,8", 22.04.2007.
24. Protected site Smrikite, N of Irakli village, with *Juniperus oxycedrus*, eroded cinnamon-podzolic (pseudopodzolic) soil, 12 m, N 42°46'29,5", E 27°53'54,5", 22.04.2007.
25. Protected site Pobiti Kamani, a group NW of Slanchevo village, nummulite limestone rocks, and rocky grassland, heavy loamy leached chernozem soil, 210 m, N 43°15'07,9", E 27°41'34,3", 23.04.2007.
26. SE of Kavarna town, cape Chirakman, dry clayey-calcareous sparsely vegetated slope, shell limestones and humus-calcareous rendzina soil, 109 m, N 43°24'46,2", E 28°20'56,1", W-NW exposure, 16.04.2007.

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## References

- Ahrens, M. & Nebel, M. 2000. Pottiaceae. – In: Nebel, M. & Philippi, G. (eds), Die Moose BadenWürttembergs. Band 1. Ulmer Verlag, Stuttgart.
- Ellis, L. T., Asthana, A.K., Srivastava, A., Bakalin, V.A., Bednarek-Ochyra, H., Cano, M.J., Jiménez, J.A., Alonso, M., Deme, J., Csiky, J., Dia, M.G., Campisi, P., Erzberger, P., Garilleti, R., Gorobets, K.V., Gremmen, N.J.M., Jimenez, M.S., Suárez, G.M., Jukoniene, I., Kiebacher, T., Kirmaci, M., Koczur, A., Kürschner, H., Lara, F., Mazimpaka, V., Larraín, J., Lebouvier, M., Medina, R., Natcheva, R., Newsham, K.K., Nobis, M., Nowak, A., Ören, M., Özçelik, A.D., Orgaz, J.D., Peralta, D.F., Plášek, V., Eíhal, L., Ristow, R., Sawicki, J., Schäfer-Verwimp, A., Smith, V.R., Stebel, A., Ştefanuț, S., Subkaitė, M., Sun, B.-Y., Uselienė, A., Uyar, G., Viñà, J., Yoon, Y.-J. & Park, S.J. 2015. New national and regional bryophyte records, 43. – J. Bryol., 37(2): 128-146.
- Erzberger, P., Németh, Cs., Papp, B., Mesterházy, A., Csiky, J. & Baráth, K. 2015. Revision of the red-list status of Hungarian bryophytes 1. New occurrences of species previously thought to be regionally extinct or without recent data. – Studia bot. hung., 46(2): 15-53.
- Gallego, M.T. 2005. A taxonomic study of the genus *Syntrichia* Brid. (Pottiaceae, Musci) in the Mediterranean region and Macaronesia. – J. Hattori Bot. Lab., 98: 47-122.
- Ganeva, A. & Natcheva, R. 2003. Check-list of the bryophytes of Bulgaria with data on their distribution. I. Hepaticae and Anthocerotae. – Cryptog. Bryol., 24(3): 229-239.
- Ganeva, A. & Ros-Espín, R.M. 2002. New data on Bulgarian bryo-flora. – Phytol. Balcan., 8(1): 35-36.
- Ganeva, A. & Sopotlieva, D. 2007. Reports 36-56. – In: Natcheva R. (compiler), New bryophyte records in the Balkans: 2. – Phytol. Balcan., 13(2): 277-289.
- Hodgetts, N.G. 2015. Checklist and country status of European bryophytes – towards a new Red List for Europe. – Irish Wildlife Manuals, No. 84. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Ireland.
- Mateeva, Z. 2002. Precipitation and snow cover. – In: Kopralev, I.E. (ed.), Geography of Bulgaria. Physical Geography. Socio-Economic Geography, pp. 152-154. ForComPublishers, Sofia.
- Mickiewicz, J., Rejment-Grochowska, I. & Sobotka, D. 1966. Résultats des recherches bryologiques en Bulgarie. – Acta Soc. Bot. Poloniae, 35: 111-127.
- Natcheva, R. 2007. Reports 57-70. – In: Natcheva R. (comp.), New bryophyte records in the Balkans: 2. – Phytol. Balcan., 13(2): 277-289.
- Natcheva, R. & Ganeva, A. 2005. Checklist of the bryophytes of Bulgaria with data on their distribution. II. Musci. – Cryptog. Bryol., 26(2): 209-232.
- Natcheva, R. & Ganeva, A. 2006. Bryophytes on loess cliffs in Bulgaria – a preliminary study. – Phytol. Balcan., 12(1): 47-50.
- Natcheva, R., Ganeva, A. & Spiridonov, G. 2006. Red List of the Bryophytes in Bulgaria. – Phytol. Balcan., 12(1): 55-62.
- Natcheva, R. & Gyosheva, M. 2016. Contribution to the bryophyte flora and mycota of Bulgaria: I. Bryophytes and larger fungi from Uchilishtna Gora Managed Reserve. – Phytol. Balcan., 22(3): 323-330.
- Papp, B., Alegro, A., Šegota, V., Šapić, I. & Vukelić, J. 2013. Additions to the bryophyte flora of Croatia. – J. Bryol., 35(2): 140-143.
- Papp, B., Natcheva, R., Erzberger, P. & Sabovljević, M. 2012. *Didymodon siccus*, new to Bulgaria and Serbia and notes on its ecology. – Nova Hedwigia, 95(1-2): 221-226.
- Petrov, S. 1962. Contribution à la flore bryologique de la Bulgarie. Bryophytes de la montagne Belasica. – Izv. Bot. Inst. (Sofia), 9: 191-199 (in Bulgarian).
- Petrov, S. 1963. Neuer Beitrag zur Kenntnis der Moosflora Bulgariens. – Izv. Bot. Inst. (Sofia), 11: 167-187 (in Bulgarian).
- Petrov, S. 1970. First representatives of the genera *Mlyia* Gray, *Scorpidium* Limpr. and *Scorpiurium* Schimp. in Bulgaria. – Izv. Bot. Inst. (Sofia), 20: 233-235 (in Bulgarian).
- Ros, R.M. & Werner, O. 2006. Microbryum. – In: Guerra, J., Cano, M.J. & Ros, R.M. (eds), Flora Briofítica Ibérica. Vol. III. Pottiales: Pottiaceae, Encalyptales: Encalyptaceae, pp. 197-208. Sociedad Española de Briología.
- Simon, T. & Vajda, L. 1959. Beiträge zur Moosflora Bulgariens. – Ann. Univ. Sci. Budapest. Rolando Eötvös, Sect. Biol., 2: 259-272.
- Šmarda, J. 1970. Complements à la flore muscinale de la Bulgarie. – Rev. Bryol. Lichénol., 37: 33-46.
- Smith, A.J.E. 2004. The Moss Flora of Britain and Ireland, ed. 2. Cambridge Univ. Press, Cambridge.
- Stefanoff, B. & Petrov, S. 1962. Über die Moose und die Moosflora Bulgariens. – Izv. Inst. Gorata, 11: 5-38 (in Bulgarian).
- Velenovsky, J. 1902. Neunter Nachtrag zur Flora von Bulgarien. – Österr. Bot. Z., 52: 115-121.
- Velev, S. 2002. Climatic regions. – In: Kopralev, I.E. (ed.), Geography of Bulgaria. Physical Geography. Socio-Economic Geography, pp. 155-156. ForComPublishers, Sofia

