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## Bryophytes of the Nature Park »Bol'šoj Thač« and adjacent territories

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### Abstract

Data on species composition and on ecological and biogeographical peculiarities of the bryophyte flora of the Nature Park »Bol'šoj Thač« and its neighbouring areas in the NW Caucasus Mts are given.

The annotated species list contains 171 taxa of mosses; 80 of which are documented for the first time for this area. A list of hepatics was published earlier elsewhere, but more detailed data regarding the occurrence of *Frullania parvistipula* are given here.

17 species have a ± oceanic distribution and are situated at the eastern border of their European distribution; in Russia many of them are known only from the Caucasus (e.g. *Barbula crocea*, *Neckera pumila*, *Ptychodium plicatum*, *Ulota coarctata*). Only one species – *Orthotrichum vladikavkanum* – is situated at the western border of its distribution in the Caucasus. The Western Palaeartic endemic *Ptychodium plicatum* represents a monotypic genus. It occurs preferably on limestone in the high-mountain belt.

A number of the species are very rare and endangered in Europe and have therefore been included into the Red Data Book of European Bryophytes: *Buxbaumia viridis*, *Dicranum viride*, *Neckera pennata*, *Orthotrichum vladikavkanum*, *Frullania parvistipula*. In Europe, these species are endangered mainly by destruction of their habitats by forestry and by air pollution.

Because of its comparatively low anthropogenic damage, the area of study can serve as a model of bryophyte vegetation of natural European forest ecosystems, the functionality of which has to be studied further.

### Zusammenfassung

**Moose des Naturparks »Bol'šoj Thač« und angrenzender Gebiete** – Es werden Angaben zum Artenbestand sowie zu ökologischen und biogeographischen Besonderheiten der Moosflora im Gebiet des Naturparks Bol'šoj Thač und angrenzenden Gebieten des NW-Kaukasus gemacht.

Die kommentierte Artenliste enthält 171 Taxa von Laubmoosen, von denen 80 erstmals für das Gebiet dokumentiert werden. Eine Liste der Lebermoose wurde bereits an anderer Stelle veröffentlicht, doch werden hier ausführlichere Angaben zum Vorkommen von *Frullania parvistipula* gemacht.

17 Arten besitzen eine ± ozeanische Verbreitung und befinden sich an der Ostgrenze ihres europäischen Areals; viele von ihnen sind aus Rußland nur vom Kaukasus bekannt (z.B.

*Barbula crocea*, *Neckera pumila*, *Ptychodium plicatum*, *Ulota coarctata*). Nur eine Art – *Orthotrichum vladikavkanum* – befindet sich im Kaukasus an der Westgrenze ihrer Verbreitung. Das in der Westpaläarktis endemische *Ptychodium plicatum* vertritt eine monotypische Gattung. Es gedeiht hauptsächlich auf Kalkgestein in der Hochgebirgszone.

Eine Reihe der nachgewiesenen Arten ist in Europa sehr selten und gefährdet und hat deshalb Aufnahme in das Rote Buch der europäischen Moose gefunden: *Buxbaumia viridis*, *Dicranum viride*, *Neckera pennata*, *Orthotrichum vladikavkanum*, *Frullania parvistipula*. Diese Arten sind in Europa hauptsächlich durch die Zerstörung ihrer Habitate durch die Forstwirtschaft sowie durch Luftverschmutzung gefährdet.

Aufgrund seiner vergleichsweise geringen anthropogenen Beeinträchtigung kann das Gebiet als Modell für die Moosvegetation naturnaher europäischer Waldökosysteme dienen, deren Funktionalität weiter zu erforschen ist.

### Резюме

**Мхи Природного Парка «Большой Тхач» и сопредельных территорий** – В публикации представлены обобщенные сведения по видовому составу, экологическим и биогеографическим особенностям флоры мхов части территории Западного Кавказа, ядром которой является природный парк «Большой Тхач». Район исследований охватывает природный парк «Большой Тхач» и прилегающие территории в бассейнах рек Большой и Малый Сахрай, Куна, Ходзь, Тхач, Афонка.

Представлен аннотированный список листостебельных мхов данного района, включающий 171 таксон мхов, из них 80 таксонов указаны для этой территории впервые. Список печеночных мхов приводился ранее в другом месте. Однако в данной статье подробно описываются местонахождения *Frullania parvistipula*.

17 видов имеют ± океаническое распространение и находятся на восточной границе европейского ареала, многие из них для флоры России известны только с Кавказа (например, *Barbula crocea*, *Neckera pumila*, *Ptychodium plicatum*, *Ulota coarctata*). При этом лишь один вид – *Orthotrichum vladikavkanum* – находится на Кавказе на западном пределе распространения. В районе исследований отмечен также эндемичный для Западной Палеарктики вид, являющийся единственным представителем эндемичного европейского рода – *Ptychodium plicatum*. Основными местообитаниями этого вида являются известняковые породы в высокогорной зоне.

На территории природного парка «Большой Тхач» и в прилегающих районах произрастает ряд очень редких для Европы видов мхов, которые занесены в Красную книгу европейских бриофитов: *Buxbaumia viridis*, *Dicranum viride*, *Neckera pennata*, *Orthotrichum vladikavkanum*, *Frullania parvistipula*. Основной угрозой существованию этих видов в Европе является разрушение местообитаний в результате интенсивных лесоразработок и загрязнение воздуха.

В настоящее время необходимо продолжить изучение распространения и состояния популяций видов мхов, редких или исчезающих на большей части своего ареала. Регион Б. Тхача в этом отношении может явиться своеобразной моделью для сравнительно мало нарушенной растительности мхов лесных экосистем европейского типа.

Keywords: biogeography, conservation value, Red Data Book species

## 1. Introduction

Notwithstanding the comparatively good knowledge of its species composition, the bryophyte flora of Caucasia is rather unevenly known. Until quite recent times the limestone massif of the Bol'šoj Thač and its surroundings had practically not been visited by bryologists. In the Herbarium of the Caucasian Reserve there are a few specimens collected in this region in 1941 (R. A. Elenevskij) and in 1951 (A. P. Seničeva). Data on bryological findings from this territory in the literature had been lacking until recent times. First lists of bryophytes of this area were published by OTTE (2001, 2004). Some information regarding mosses of Mount Bol'šoj Thač are included in the publications of AKATOVA (2002, 2004), dealing predominantly with the bryophytes of the Caucasian Biosphere Reserve.

The aim of the paper presented here is to bring together all information presently available regarding species composition as well as ecological and biogeographical peculiarities of the moss flora of that part of the Western Caucasus, the core of which is the Nature Park »Bol'šoj Thač«.

## 2. Materials and methods

The work is based on material obtained during field work in the area around Mount Bol'šoj Thač in July/August 1995 as well as in June/July 2003 by T. V. Akatova and in June/July 1997, August/September 1998, August/September 1999, July/August 2001, June/July 2002, August/September 2003 and May 2004 by V. Otte. However, in V. Otte's collections the bryophytes are only of secondary importance, as his studies were focused on lichens. In 2001 – 2003, V. Otte's investigations were supported by J. Fürstenow, who dealt in particular with the genus *Orthotrichum* Hedw.

The collected specimens were deposited in GLM, in the personal herbaria of V. Otte and J. Fürstenow, and in CSR (the herbarium of the Caucasian Reserve), as indicated in the species list; duplicates of a part of the latter material were given to MNA.

The nomenclature mostly follows IGNATOV & AFONINA (1992); as far as that is not the case, the name used there is named as a synonym.

The study area contains the Nature Park »Bol'šoj Thač« and adjacent areas in the catchment area of the rivers Bol'šoj Sahraj, Malyj Sahraj, Kuna, Hodz', Thač and Afonka (43°59' – 44°06'N, 40°20' – 40°28'E), and some data originate from the Malyj Bambak ridge 15 km ESE of Mt Bol Thač. For general characteristics of the vegetation and natural conditions see OTTE (2007b) in this volume. The main collection sites are:

1. Polâna Knâžeskaâ, 44°04'N, 40°25'E, 1700 m;
2. headwaters of the river Hodz', 44°03'N, 40°25'E, 1400 m;
3. Mount Bol'šoj Thač, 44°04'N, 40°24'E, 1900 – 2300 m;
4. Mount Ačešbok (Čertovy Vorota), 43°59'N, 40°28'E, 2100 m;
5. Mount Koryto, 44°04'N, 40°20'E, 1600 m;
6. headwaters of the river Bol'šoj Sahraj, 44°03'N, 40°22'E, 1200 – 1500 m;
7. valley of the river Bol'šoj Sahraj, 44°05'N, 40°23'E, 1050 m;
8. confluence of the rivers Bol'šoj Sahraj and Malyj Sahraj, 44°06'N, 40°22'E, 900 m;
9. valley of the river Kuna, 44°04'N, 40°19'E, 800 m;
10. valley of the river Malyj Sahraj, 44°06'N, 40°24'E, 950 m;
11. headwaters of the river Thač, 44°02'N, 40°27'E, 1500 – 1700 m;
12. Polâna Firsova, 44°05'N, 40°25'E, 1400 m;

13. valley of the river Afonka, 44°01'N, 40°25'30"E, 1400 – 1700 m;
  14. massif Malyj Bambak east of the immediate Thač region, 43°57'N, 40°38'E, 1600 m;
  15. ridge between Mt Malyj Thač and Mt Afonka, GPS (Potsdam) 44°01'22"N, 40°25'48"E, 1950 m;
  16. Mt Malyj Thač, 44°01'30"N, 40°26'E, 2000 – 2200 m;
  17. refuge »Vetrennyj« below 3, GPS (Potsdam) 44°02'29"N, 40°25'23"E, 1900 m;
  18. valley of the river Sahraj, 44°06'N, 40°22'E, 850 m;
  19. village Novoprohladnoe, 44°08'N, 40°17'E, 650 m;
  20. abandoned settlement Brilevo, 44°07'N, 40°20'30"E, 750 m;
  21. meadow Polána Šestakova, 44°01'40"N, 40°23'20"E, 1850 m;
  22. cascade »Man'kin Šum« E of 19, GPS (Potsdam) 44°08'11.5"N, 40°19'4.5"E, 650 m;
  23. slope of the massiv Bol'soj Thač into 7, 44°03'30"N, 40°24'E, 1650 – 1950 m.
- The collection sites of V. Otte are described in detail in OTTE (2001, 2004, 2007a).

### 3. Results

The conspectus below contains records of taxa new to the study area (marked with an asterisk \*) as well as earlier communicated species accompanied by further data on distribution and frequency in the area.

CSR: Herbarium Caucasus State Nature Biosphere Reserve

GLM: Herbarium Staatliches Museum für Naturkunde Görlitz

Otte: Herbarium Otte

A list of hepatics was given earlier by OTTE (2001) and additional data recently by OTTE (2006) and OTTE (2007a). Therefore the paper presented here is widely confined to mosses. However, it is considered as indispensable to give additional information on *Frullania parvistipula*.

**Additional data on *Frullania parvistipula* Steph.** – This species was mentioned as »cf.« by OTTE (2001). In the meantime, this determination was confirmed by comparison with original material of this species from Caucasia and East Asia loaned from JE. *F. parvistipula* was found to be very common in the investigation area. Collections were made at the following places:

Between 1 and 12, in the forest on tree bark (Otte-B-2163); 6: 1725 m, on *Acer* (Otte-B-2518); 7: not far from 8, on the trunk of a young *Fraxinus*; 10: on *Alnus incana* (GLM); 11 (Otte-B-2162); 15: on *Acer trautvetteri*; 18: S-facing slope on the northern side of the valley, above the forest road, oak forest, on *Carpinus* (Otte-B-2707) and *Fagus* (Otte-B-2926); 19: pastured forest, on *Carpinus* (e.g. Otte-B-2771). Moreover, north of the study area: near Kamennomostski in the forest along the river Belaâ (Otte-B-2708).

#### **Bryopsida –**

*Abietinella abietina* (Hedw.) M. Fleisch. – on the ground of alpine shortgrass lands and lichen vegetation, subalpine grasslands, high mountainous meadows (under herbal cover, often together with other bryophyte species), on rocks, on sunny slopes, common throughout the whole study area, e.g. 23: *Abies* forest, on limestone rocks (Otte-B-604)

*Amblystegium subtile* (Hedw.) Schimp. – 13: on *Alnus* (OTTE 2007a, Otte-B-2716)

*Anomodon attenuatus* (Hedw.) Huebener – on the bases of deciduous trees, as *Fagus*, *Acer campestre*, common, e.g. 7: not far from 8, on *Fagus*, 920 m (GLM-B-23189)

*Anomodon longifolius* (Brid.) Hartm. – 7: not far from 8, on *Fagus*, 920 m (GLM-B-23180)  
10: on the base of a *Fraxinus* tree (OTTE 2001, GLM-B23175)

- Anomodon rugelii* (Müll. Hal.) Keissl. – 11: on limestone rock (Otte-B-560 & 2134); below 12: on *Acer platanoides* (GLM-B-23196); below 21: on *Acer* (Otte-B-3034); not as frequent as thought by OTTE (2001), much less common than *A. viticulosus*
- Anomodon viticulosus* (Hedw.) Hook. & Taylor – in the whole area on the trunks of deciduous trees, on dry rocks along rivers, on rotten trunks along brooks, common, e.g. 12: on *Acer platanoides* (GLM-B-23201)
- Atrichum flavisetum* Mitt. – 13: on a loamy slope (OTTE 2001, Otte-B-2304)
- Aulacomnium turgidum* (Wahlenb.) Schwägr. – 3: in alpine grassland (OTTE 2001, Otte-B-2140)
- \**Barbula convoluta* Hedw. – 3: on limestone rocks in the subalpine belt (CSR-228-95)
- Barbula crocea* (Brid.) F. Weber & D. Mohr – 13 (OTTE 2001, Otte-B-2302)
- \**Barbula sinuosa* (Mitt.) Garov. – 14: moist gorge on the edge of the plateau (Otte-B-2536)
- \**Barbula unguiculata* Hedw. – 3: NE slope, alpine belt, river bed, on limestone outcrops (CSR-177-95)
- \**Bartramia halleriana* Hedw. – 7: on rocks along the river bank (CSR-368-03)
- Bartramia ithyphylla* Brid. – 15: on soil over siliceous rock (OTTE 2001, Otte-B-2143)
- \**Brachythecium albicans* (Hedw.) Schimp. – 3: subalpine belt, *Calamagrostis-Festuca*-grassland, on the ground (CSR-256-03)
- \**Brachythecium rivulare* Schimp. – 2: gorge, on dry rocks in the river bed; 3: subalpine belt, on rocks near mouth of a cave (CSR)
- \**Brachythecium salebrosum* (F. Weber & D. Mohr) Schimp. – 14: moist gorge on the edge of the plateau (Otte-B-2535)
- Brachythecium velutinum* (Hedw.) Schimp. – widespread in the forest belt, growing on the ground, rotten wood, on the bases of tree trunks and root appendages of deciduous trees, e.g. below 12 (OTTE 2001, Otte-B-2142)
- Bryoerhythrophyllum recurvirostum* (Hedw.) P. C. Chen – 15 (OTTE 2001, Otte-B-2145)
- Bryum argenteum* Hedw. – 3: slope, on limestone; 16: southern slope, in subalpine pasture on bare ground (OTTE 2001); near 19: Mt Šibaba, open soil on a slope (Otte-B-2763)
- \**Bryum capillare* Hedw. – 7: on soil over rocks (Otte-B-2756)
- \**Bryum pseudotriquetrum* (Hedw.) P. Gärtner et al. – near 17 (Otte-B-3016)
- Bryum subelegans* Kindb. – 13: on *Acer* (Otte-B-2791); 14 (Otte-B-2534); 23: N of the rock Kolokol'nâ, on a tree trunk (OTTE 2001, Otte-B-2269)
- Buxbaumia viridis* (DC. in Lam. & DC.) Moug. & Nestl. – on rotten *Abies* trunks in *Abies* and mixed deciduous/*Abies* forests, scattered, e.g. 23 (Otte-B-2704)
- \**Calliargon stramineum* (Brid.) Kindb. – 1: swampy part amongst meadow associations (CSR-36-03)
- Camptothecium lutescens* (Hedw.) Schimp. [= *Homalothecium lutescens* (Hedw.) Robins.] – on limestone rocks up to the alpine belt, widespread, e.g. 3 (Otte-B-2173); 8 (Otte-B-615)
- Campylium halleri* (Hedw.) Lindb. – 23: on a limestone boulder (OTTE 2001, Otte-B-2292 & 2718)
- \**Campylium protensum* (Brid.) Kindb. – 3: northern slope, in subalpine grassland on the ground under herbal cover, on rocks (CSR)
- \**Campylium stellatum* (Hedw.) C. E. O. Jensen – 3: cave Kristal'nâ, near the mouth on rocks (CSR-303-95); 13: on soil (Otte-B-2795)

- Ceratodon purpureus* (Hedw.) Brid. – 1: southern slope, on soil; 5: high-mountain meadow, open patch (probably saline soil), on soil; 15: on siliceous rock (OTTE 2001, Otte-B-2146)
- \**Cirriphyllum cirrosus* (Schwägr. in Schultes) Grout – 5: high-mountain meadow, swampy patch (CSR-310-03)
- \**Climacium dendroides* (Hedw.) F. Weber & D. Mohr – above 1: limestone rocks (Otte-B-2866); 3: western slope, subalpine grassland, on the ground; subalpine belt, doline, on dry rocks on fine-grit soil; alpine belt, lichen-covered waste ground, on soil amongst other bryophytes (CSR)
- \**Cratoneuron commutatum* (Hedw.) G. Roth – 6 (Otte-B-2747)
- \**Cratoneuron filicinum* (Hedw.) Spruce – 3: northern slope, krummholz of *Betula*, river bed of a dry brook, on rocks; subalpine belt, doline, on dry rocks on fine-grit soil; alpine belt, cave Kristal'naâ, on rocks near the mouth; 6: on rocks by a cascade (CSR)
- Ctenidium molluscum* (Hedw.) Mitt. – Mount Slesarnâ, on rock; 2: ravine, on dry rocks in the river bed; 3: alpine belt, cave Kristal'naâ, on rocks near the mouth; 9: 1000 m, near the way (OTTE 2001, Otte-B-2148)
- \**Cynodontium polycarpum* (Hedw.) Schimp. – E of 17: on *Pinus* (GLM-B-23179)
- \**Dichodontium pellucidum* (Hedw.) Schimp. – 3: north-eastern slope, alpine belt, river bed of a gorge, on rock outcrops; 6: in rock fissure in the river bed (periodically submerged zone), on rocks along the river bank (CSR)
- \**Dicranella heteromalla* (Hedw.) Schimp. – 14 (Otte-B-2523)
- \**Dicranella palustris* (Dicks.) Crundw. ex E. F. Warb. – 3: high-mountain meadow, on soil (CSR-220-03)
- \**Dicranodontium denudatum* (Brid.) E. Britton in Williams – 6: slope of a gorge, on a rotten tree trunk in the forest; Mount Slesarnâ, on wood remnants (CSR)
- \**Dicranum bonjeanii* De Not. – 3: north-eastern slope, in subalpine grassland on the ground (CSR-254-03)
- \**Dicranum muehlenbeckii* Bruch & Schimp. – 23: subalpine belt (Otte-B-2309)
- Dicranum scoparium* Hedw. – on the ground in low alpine grasslands and lichen-covered waste grounds, in coppices of *Rhododendron caucasicum* in the subalpine belt and the zone of the upper forest line, in the forest zone on the ground, rotten wood, widespread in the whole area, e.g. near 17 (Otte-B-597)
- \**Dicranum viride* (Sull. & Lesq.) Lindb. – on old *Fagus* trees, scattered, as e.g. 7: crotch of thick branches of a fallen *Fagus* (CSR-357-03); 10: on *Fagus* trunk and on branches of a fallen *Fagus* (GLM-B-23195, 23197)
- \**Didymodon fallax* (Hedw.) R. H. Zander – 3: northern slope, alpine belt, on limestone rocks, det. Ignatova (CSR-234-95); near 17 (Otte-B-2832)
- \**Didymodon rigidulus* Hedw. – 3: north-eastern slope, alpine belt, on limestone rocks, det. Ignatova (CSR-170-95)
- \**Distichium capillaceum* (Hedw.) Bruch & Schimp. – in the alpine and subalpine belts on limestone outcrops, in the upper forest border belt (*Betula* krummholz); in low alpine grasslands and lichen-covered wastelands (often together with other bryophytes)
- \**Distichium inclinatum* (Hedw.) Bruch & Schimp. – 3: north-eastern slope, subalpine belt, on stones (c. spg.) (CSR-220-95)

*Ditrichum flexicaule* (Schwägr) Hampe – in the alpine, subalpine and upper montane belts on limestone rocks and stones; in low alpine grasslands and lichen-covered wastelands on soil, e.g. 13 (Otte-B-2803), near 17 (Otte-B-3014)

\**Encalypta streptocarpa* Hedw. – 3: northern slope, alpine belt, on limestone rocks; above the forest line under *Rhododendron caucasicum* on soil; 7: on limestone outcrops along the river bank (all CSR); 13 (Otte-B-2794)

Note: the material of »*E. procera*« mentioned by OTTE (2001) also belongs here; the orange colour of the basal cells mentioned by FREY et al. (1995) is not a distinguishing feature of *E. procera*

*Encalypta vulgaris* Hedw. – 3: north-eastern slope, lichen-covered waste ground, on soil; 16: southern slope (OTTE 2001); near 17 (Otte-B-2830)

*Entodon concinnus* (De Not.) Paris – 3: in alpine grasslands and lichen-covered waste grounds on soil (with *Pleurozium schreberi*, *Hylocomium splendens*, *Rhytidiadelphus triquetrus* and others); 13: *Abies* forest (OTTE 2001, Otte-B-2305)

\**Entodon schleicheri* (Schimp.) Demet. – 14: moist gorge at the edge of the plateau (Otte-B-2528)

*Eurhynchium angustirete* (Broth.) T. J. Kop. – in the forest belt on the ground, rotten wood, roots of the trees, common, e.g. near 12 (Otte-B-2157)

\**Eurhynchium hians* (Hedw.) Sande Lac. – 3: alpine belt, cave Kristal'naâ, under arches on dry limestone; 6, 7, 8: in the forest on the ground, on eroded slopes along the banks, on a loamy landslide by the bank (with *Pohlia wahlenbergii*); feeder river of 7, on stones in the water and in the spray zone (all CSR)

\**Eurhynchium striatum* (Hedw.) Schimp. – 2: gorge, on dry rocks in the river bed; 6: on rocks along the river bank (CSR)

*Fissidens dubius* P. Beauv. – in the alpine, subalpine and forest belts on limestone rocks, widespread, e.g. 16: southern slope, on limestone (Otte-B-653)

\**Fissidens gracilifolius* Bruggemann-Nannenga & Nyh. (*F. minutulus* auct.) – 13: on limestone rock (Otte-B-2797)

*Fissidens osmundoides* Hedw. – 3: alpine belt, at the edge of an erosion channel (gorge long covered by snow), on limestone (OTTE 2001, Otte-B-2159)

*Fissidens taxifolius* Hedw. – sporadically throughout the area: on open, loamy stands; along the forest roads on bare soil; along the banks of streams and brooks in the forests, e.g. 7 near 8 (Otte-B-573)

*Fissidens viridulus* (Sw.) Wahlenb. – 14: moist gorge at the edge of the plateau (OTTE 2001, Otte-B-588)

\**Funaria hygrometrica* Hedw. – 4 (Otte-B-2783, leg. A. Kučerâvij); 6: in rock fissures on sand (in the periodically submerged zone) (CSR); 7: on a sandbank at the river bank; 9: anthropogenically transformed stand at the bank of the river, on a fireplace

*Grimmia affinis* Hoppe & Hornsch. ex Hornsch. – 15: on siliceous rocks (OTTE 2001); near 17: on siliceous debris (OTTE 2001, Otte-B-598)

\**Gymnostomum aeruginosum* Sm. – 3: alpine belt, cave Kristal'naâ, near the mouth on limestone rocks (CSR); 23: on limestone (Otte-B-2703)

\**Gyroweisia tenuis* (Hedw.) Schimp. – 16 (Otte-B-2814)

- \**Hedwigia ciliata* (Hedw.) P. Beauv. – 3: subalpine *Festuca* grassland, on the ground; alpine meadow, on the ground (CSR)  
– var. *leucophaea* Bruch & Schimp. – ridge above 13, on siliceous rocks; conf. Erzberger (OTTE 2001, Otte-B-2167)
- Herzogiella seligeri* (Brid.) Z. Iwats. – in the mountain forests on rotten trunks, common, e.g. 8 (Otte-B-2826)
- Homalia besseri* Lobarz. – widespread on the trunks of deciduous trees, e.g. *Acer trautvetteri*; e.g. 7 near 8: on *Fagus* (Otte-B-566); one collection on stone (Mount Slesarná, 27.07.1951, leg. Seničeva, CSR)
- Homalia trichomanoides* (Hedw.) Schimp. – rather frequent on the bases of trunks of deciduous trees, e.g. 7 near 8: on *Fagus* (Otte-B-565); sometimes on rock outcrops along the banks of brooks in the forest belt
- Homalothecium philippeanum* (Spruce) Schimp. in B. S. G. – on limestone rocks, frequent, e.g. 7: on a rotten trunk on the bank of a brook; 11 (Otte-B-2174); 23 (Otte-B-607)
- \**Hygroamblystegium tenax* (Hedw.) Jenn. – 6: on rocks by a cascade (CSR-345-03)
- Hygrohypnum luridum* (Hedw.) Jenn. – 3: *Betula* coppice, on rocks in the stream bed of a dry rivulet; 6: on rocks by the river bank; 13: in the stream bed on rocks (OTTE 2001, det. Benkert)
- Hylocomium splendens* (Hedw.) Schimp. in B. S. G. – 1: on limestone (Otte-B-2863); 3: alpine belt, in a doline on dry ground; in low alpine grasslands and lichen-covered wastelands on the ground (with *Pleurozium schreberi*); in the forest belt on rocks, soil and rotten wood, widespread
- \**Hypnum cupressiforme* Hedw. – on limestone outcrops in *Betula* krummholz; on the bases of deciduous trees, particularly on *Fagus*; in crotches of thick branches in the crowns of trees (fallen trunks); taking part in epixylic bryophyte associations on rotten trunks and stumps; common throughout the area (CSR)  
\*– var. *filiforme* Brid. – 7: in the crown of a fallen *Fagus* (CSR-360-03)
- \**Hypnum vaucheri* Lesq. – 3: alpine belt, on limestone rocks (CSR-208-03)
- \**Isopterygiopsis pulchella* (Hedw.) Z. Iwats. – 3: subalpine belt, rock outcrops, on dry, fine-grid soil (CSR-207-95)
- Isothecium alopecuroides* (Dubois) Isov. – on tree trunk bases, in crotches of thick branches in the crowns of deciduous trees, on rotten trunks, stones in forests, common in the forest belt, e.g. 6: on *Acer* (Otte-B-2541)
- Leskeella nervosa* (Brid.) Loeske – very widespread throughout the whole area, in deciduous and mixed deciduous-*Abies* forests, on trunk bases and on trunks of deciduous trees (often with *Hypnum cupressiforme*, *Isothecium alopecuroides*, *Pterigynandrum filiforme*), e.g. near 12 (Otte-B-2181)
- \**Leucobryum glaucum* (Hedw.) Ångstr. – 23: 1900 m, *Pinus* forest (Otte-B-2471)
- Leucodon immersus* Lindb. – widespread in the forest belt, on trunks and trunk bases of deciduous trees, on dry twigs fallen from tree crowns, e.g. 9: on *Ulmus* (OTTE 2004, Otte-B-2355); sporogonia not always present, identification of the species therefore sometimes difficult
- Leucodon sciuroides* (Hedw.) Schwägr. – frequent on trunks of deciduous trees, throughout the whole forest belt; certain identification often hindered by absence of sporogonia; with sporogonia: 6: in the crown of a fallen *Fagus*; near 12 (Otte-B-2182)



- \**Meesia uliginosa* Hedw. – 3: north-eastern slope, alpine belt, in lichen-covered wasteland on soil (CSR-240-95)
- \**Mnium ambiguum* H. Müll. – 7: on a rotten trunk at the bank of a brook (CSR-350-03)
- Mnium marginatum* (Dicks.) P. Beauv. – 3: alpine belt, doline, on dry soil; 6: along the river bank on rocks and argillaceous slates of the river bank; 23: beneath rock Kolokol'nâ, in the forest belt (OTTE 2001, Otte-B-2188)
- Mnium spinulosum* Bruch & Schimp. in B. S. G. – 6 (Otte-B-2744); 11 (Otte-B-2481); 23: *Abies* forest (OTTE 2001, Otte-B-2310 & 2730)
- \**Mnium stellare* Hedw. – 2: gorge, on dry rocks in the river bed; 3: northern slope, cave Kristal'naâ, on dry limestone under the arches; (CSR); 6 (Otte-B-2746)
- \**Molendoa sendtneriana* (Bruch & Schimp.) Limpr. – 3: subalpine belt, near mouth of the cave on dry limestone rocks, det. Ignatova (CSR-296-95)
- \**Myurella julacea* (Schwägr.) Schimp. – 3: 2100 m, alpine meadow, leg. Ermolaeva; 4: northern exposition, *Dryas-Kobresia*-association, on the ground mixed with other bryophytes, leg. Elenevskij (CSR)
- Neckera complanata* (Hedw.) Huebener – on trunks of deciduous trees in the mountain forest belt throughout the area, e.g. 7 near 8: on *Fagus* (Otte-B-567)
- Neckera crispa* Hedw. – in the forest belt, on trunks of deciduous trees, on rotten wood, limestone rocks, common throughout the area, e.g. 23: on limestone (OTTE 2001, Otte-B-2191)
- Neckera pennata* Hedw. – in the mountain forests on *Fagus*, e.g. 7 (Otte-B-2437)
- Neckera pumila* Hedw. – in the mountain forests on *Fagus* and other trees, e.g. 13: on *Acer trautvetteri* (Otte-B-2195)
- \**Oncophorus virens* (Hedw.) Brid. – 3: north-eastern slope, subalpine belt, doline in a gorge, on dry rocks; northern slope, *Betula* krummholz, river bed, on rocks; alpine belt, on limestone rocks in a gorge (CSR)
- \**Orthodicranum flagellare* (Hedw.) Loeske – near 19: on rotten wood (Otte-B-2750 & 2780)
- \**Orthodicranum montanum* (Hedw.) Loeske – throughout the mountain forest belt, e.g. forest between 1 and 12: on rotten wood (Otte-B-2677)
- \**Orthothecium intricatum* (C. Hartm.) Schimp. – 3: northern slope, alpine belt, cave Kristal'naâ, on the walls of the cave near its mouth under the arches (CSR-321-95)
- \**Orthothecium rufescens* (Brid.) Schimp. – 3: subalpine belt, on limestone rocks (CSR-302-95)
- \**Orthotrichum anomalum* Hedw. – near 17: on calcareous rock (Otte-B-2834)
- Orthotrichum cupulatum* Brid. – 3: above the forest line, on limestone rocks (OTTE 2001)
- \**Orthotrichum lyellii* Hook. & Taylor – 12: on *Salix*; 19: on *Malus* (Fürstenow in litt.)
- Orthotrichum obtusifolium* Brid. – 20: on *Fraxinus* (OTTE 2001, Otte-B-2790); 23: on *Acer trautvetteri* (OTTE 2001, Otte-B-2285)
- \**Orthotrichum pallens* Bruch ex Brid. – frequent, from 19 up to the upper forest line, on deciduous trees [according to Fürstenow (in litt.), herb. Fürstenow, herb. Otte & GLM]; e.g. 22: on *Salix* branches (GLM-B-23184)
- Orthotrichum rupestre* Schleich. ex Schwägr. – 15: on siliceous rocks (OTTE 2001)
- \**Orthotrichum sordidum* Sull. & Lesq. – 1: on *Acer trautvetteri*; 19: on *Salix alba*; (Fürstenow in litt.)

- Orthotrichum speciosum* Nees in Sturm – on deciduous trees, common (OTTE 2001)
- Orthotrichum stramineum* Hornsch. ex Brid. – scattered, e.g. 15: on *Betula* (OTTE 2001)
- Orthotrichum striatum* Hedw. – frequent in deciduous stands up to subalpine *Betula* krummholz; e.g. 7: on *Fagus* trunk (with *Ulotia crispa*); 15: on *Betula* (Otte-B-629)
- Orthotrichum vladikavkanum* Vent. – slope of 1 into 2: 1600 m, mixed forest of mainly *Carpinus*, *Ostrya*, *Betula* and *Pinus*, on *Carpinus* (OTTE 2004, GLM-B-23185); 14: on *Salix* (OTTE 2004, Otte-B-2522); 23: on *Acer* (OTTE 2004, Otte-B-606)
- Note: records of *O. affine* by OTTE (2001) are erroneous
- \**Palamocladium euchloron* (Müll. Hal.) Wijk & Marg. – 2: gorge, on dry rocks along the bank (CSR-256-95)
- \**Palustriella commutata* (Hedw.) Ochyra – 3: subalpine belt, on dry stones (CSR-250-03)
- \**Palustriella decipiens* (De Not.) Ochyra – 3: subalpine belt, doline, on dry rocks on fine-grit soil; 7: on rocks along the river bank (CSR)
- Paraleucobryum longifolium* (Hedw.) Loeske – on the base of the trunks of deciduous trees, scattered, also on branches, e.g. 7: on branches of a fallen *Fagus*, 950 m (GLM-B-23366)
- \**Philonotis fontana* (Hedw.) Brid. – 5: high-mountain meadow, in mire (CSR-317-03)
- \**Plagiobryum zierii* (Hedw.) Lindb. – 14: moist gorge at the edge of the plateau (Otte-B-2530)
- Plagiomnium cuspidatum* (Hedw.) T. J. Kop. – 18: on a rotten *Quercus* stump in a lower montane *Fagus-Quercus-Carpinus* forest (OTTE 2001, Otte-B-2559); 19: pastured place in the village (Otte-B-2786); 20: on old *Fraxinus* (Otte-B-2731)
- \**Plagiomnium ellipticum* (Brid.) T. J. Kop. – 6: on rocks along the river bank (CSR-347-03)
- \**Plagiomnium rostratum* (Schrad.) T. J. Kop. – 3: cave Kristal'naâ, on rocks near the mouth of the cave; 6: on rocks along the river bank (CSR)
- \**Plagiomnium undulatum* (Hedw.) T. J. Kop. – 6: on rocks along the river bank; 7: on schist under spring water (with sporogonia) (CSR)
- Plagiopus oederianus* (Sw.) A. H. Crum & L. E. Anderson – up to the upper forest belt, on dry rocks; e.g. limestone rocks beneath 1; 4: northern slope, *Dryas-Kobresia*-association, on the ground mixed with other bryophytes, leg. Elenevskiy (CSR); near the way from 5 to 19 at about 1000 m (Otte-B-2213); 23: valley N of the rock Kolokol'nâ (Otte-B-2214)
- Plagiothecium denticulatum* (Hedw.) Schimp. – 6: mixed deciduous/*Abies* forest, on rotten wood, 15: on soil (OTTE 2001, Otte-B-3023)
- \**Plagiothecium laetum* Schimp. – 6: on a rotten trunk in the forest (CSR-341-03)
- Plagiothecium nemorale* (Mitt.) A. Jaeger [incl. *P. succulentum* (Wilson) Lindb.] – 6: on a rotten trunk at the bank of a brook; 11: mixed forest (OTTE 2001, Otte-B-2215)
- \**Platydictya jungermannioides* (Brid.) H A. Crum – 3: north-eastern slope, cave Kristal'naâ, on rocks near the mouth (CSR-278-95)
- \**Pleurochaete squarrosa* (Brid.) Lindb. – surroundings of 19: Mount Šibaba (Otte-B-2587).
- \**Pleurozium schreberi* (Brid.) Mitt. – widespread in the high-mountain belt, particularly on the ground of alpine grasslands and waste lands, subalpine grasslands, high-mountain meadows (under herbal cover together with other bryophytes) (CSR); 13 (Otte-B-2799)

- Pogonatum aloides* (Hedw.) P. Beauv. – 7 (Otte-B-2755); 13: on loamy slope (OTTE 2001, Otte-B-2303); 14: moist gorge at the edge of the plateau, on open, loamy soil (OTTE 2001, Otte-B-589)
- Pogonatum urnigerum* (Hedw.) P. Beauv. – above 1 on open soil among rocks (Otte-B-2869); 15: western slope (OTTE 2001, Otte-B-2299); 17 (Otte-B-2585); near 21: on open soil by the trail (OTTE 2001, Otte-B-2216)
- Pohlia cruda* (Hedw.) Lindb. – 3: alpine belt, cave Kristal'naâ, near the mouth on limestone rocks; 15: on siliceous rocks (OTTE 2001, Otte-B-2217)
- \**Pohlia wahlenbergii* (F. Weber & D. Mohr) A. L. Andrews – 6: on an eroded river bank (with *Eurhynchium hians*) (CSR-346-03); 7 near 8 (Otte-B-2722)
- Polytrichastrum alpinum* (Hedw.) G. L. Sm. – 3: alpine belt, stand with long snow cover (OTTE 2001, Otte-B-2218); 4: northern slope, *Dryas-Kobresia*-association, on soil; 14: moist gorge at the edge of the plateau (Otte-B-2520)
- Polytrichum formosum* Hedw. – 3: south-western slope, 2000 m, at the edge of a pine forest; 3: north-eastern slope, gorge above the forest line, under *Rhododendron* on the ground; near 17 (OTTE 2001, Otte-B-596)
- \**Polytrichum juniperinum* Hedw. – 3: northern slope, *Betula krummholz*, in a river bed on rocks; near 17 (Otte-B-2584)
- Polytrichum sexangulare* Brid. – 3: alpine belt, stand with long snow cover (OTTE 2001, Otte-B-2219); subalpine belt, on dry rocks covered with fine-grit soil
- \**Pseudoleskeella catenulata* (Schrad.) Kindb. – 16 (Otte-B-2816); near 17 (Otte-B-2831)
- Pterigynandrum filiforme* Hedw. – widespread in the forest belt on trunks and in the crowns of trees; sometimes on rotten wood; in the area of siliceous rock outcrops also on rocks; e.g. between 1 and 12: in the forest on *Acer* (Otte-B-2678)
- \**Ptychodium plicatum* (F. Weber & D. Mohr.) Schimp. – 3: north-eastern slope, subalpine belt, in a doline on dry rocks (CSR-178-95)
- Ptilium crista-castrensis* (Hedw.) De Not. – on rotten *Abies* trunks, frequent, e.g. W of 1 (Otte-B-2228)
- Pylaisia polyantha* (Hedw.) De Not. – 7: 1000 m, in the crown of a fallen *Ulmus* in the river bed; 7 near 8: on *Alnus incana* (Otte-B-2519); 18: on *Crataegus* (OTTE 2001, Otte-B-3024); 20: on *Fraxinus* (Otte-B-2824)
- Racomitrium canescens* (Hedw.) Brid. – 3: alpine belt, on limestone rocks (OTTE 2001, Otte-B-2233)
- \**Rhizomnium pseudopunctatum* (Bruch. & Schimp.) T. J. Kop. – 2: on dry rocks in the river bed; 3: north-eastern slope, subalpine and alpine belt, in a doline on dry rocks (CSR)
- Rhizomnium punctatum* (Hedw.) T. J. Kop. – up to the upper forest belt on the ground; 2: gorge, on dry rocks in the river bed; 3: on the ground (Otte-B-2235); 6: 1200 m, along the river bank on rocks; 11 (Otte-B-2234); 13 (Otte-B-2802); 14: moist gorge at the edge of the plateau (Otte-B-2521); 16: 1900 m, eastern slope, *Betula krummholz*, in a brook on rocks
- Rhodobryum roseum* (Hedw.) Limpr. – 14: moist gorge at the edge of the plateau (OTTE 2001).
- \**Rhynchostegium murale* (Hedw.) Schimp. – 3: alpine belt, on limestone outcrops; 7: rock outcrops at the bank of the stream (CSR)

- Rhynchostegium riparioides* (Hedw.) Cardot – 2: gorge, on moist rocks in the river bed; 6: on limestone in the river bed; 7: bank of the river, on rocks under spring water, on rocks in the river bed under a cascade; 13 (Otte-B-2798)
- Rhytidiadelphus triquetrus* (Hedw.) Warnst. – on the ground in alpine grasslands and lichen-covered waste lands, subalpine grasslands, high-mountain meadows (under herbal cover together with other bryophytes); e.g. above 1: alpine meadow (Otte-B-2236); 2: on dry rocks; in *Betula* krummholz on rocks; on wood remnants; widespread
- Rhytidium rugosum* (Hedw.) Kindb. – in low alpine grasslands and lichen-covered waste lands, in subalpine grasslands of middle growth, Festuceta, frequent, e.g. above 1: among limestone rocks (Otte-B-2862)
- Sanionia uncinata* (Hedw.) Loeske – widespread on the ground and on rotten wood, rarer on dry rocks along the banks of rivers and brooks, e.g. 15 (Otte-B-2240)
- Schistidium apocarpum* (Hedw.) Bruch & Schimper s. l. – 7: near the rock Kolokol'nâ, on limestone rocks; 3: subalpine belt, near the mouth of the cave on limestone rocks; above the forest line in *Rhododendron* coppices on the ground; 15: on siliceous rocks
- Seligeria donniana* (Sm.) Müll. Hal. – 23: on a limestone boulder (OTTE 2001, Otte-B-2243)
- Seligeria pusilla* (Hedw.) Bruch & Schimp. – 13: on limestone rocks (OTTE 2004, Otte-B-2468)
- \**Sphagnum subsecundum* Nees – 1: at a boggy stand amongst meadow associations (CSR-41-03)
- Tetraphis pellucida* Hedw. – on rotten trunks and stumps in the forests, e.g. between 1 and 12 (Otte-B-2676)
- Thamnobryum alopecurum* (Hedw.) Gangulee – 7: on a rotten trunk at the bank of the river; 7 near 8 (OTTE 2001, Otte-B-2282); 8: in the forest
- \**Thuidium delicatulum* (Hedw.) Mitt. – 8: on rotten wood (Otte-B-2825)
- Thuidium philibertii* Limpr. – up to the upper forest belt on the ground; 3: subalpine belt, on the ground; 6: river terrace, on the base of a *Fagus* tree (with *Isothecium alopecuroides*); 7: on a rotten trunk at the bank of a brook; 11 (Otte-B-2247); 13 (Otte-B-2807); 14: moist gorge at the edge of the plateau (Otte-B-591); 23 (Otte-B-2245)
- Thuidium recognitum* (Hedw.) Lindb. – 23: near the rock Kolokol'nâ (OTTE 2001, Otte-B-2248)
- Timmia austriaca* Hedw. –3: alpine belt, northern slope, cave Kristal'naâ, on dry walls near the mouth of the cave under arches. The species is not as frequent as thought by OTTE (2001) (confusion with the following taxon).
- \**Timmia megapolitana* Hedw. var. *bavarica* (Hessl.) Brid. – 3: alpine belt, northern slope, cave Kristal'naâ, on dry limestone under arches (CSR-317-95); between 5 and 19: at about 1000 m near the way (Otte-B-2251); 23: on soil (Otte-B-2250)
- Tortella tortuosa* (Hedw.) Limpr. – on bare soil and on limestone rocks up to the alpine belt, very frequent, e.g. above 1: on and amongst limestone rocks (Otte-B-2467)
- \**Tortula mucronifolia* Schwägr. – near 17 (Otte-B-461)
- Tortula norvegica* (F. Weber) Wahlenb. ex Lindb. – 13: in the forest (OTTE 2001); 3: alpine belt, on limestone near the mouth of the cave

\**Tortula ruralis* (Hedw.) P. Gaertn. et al. – 14: on *Acer trautvetteri* (Otte-B-2524); near 17 (Otte-B-599)

*Tortula subulata* Hedw. – 15 (OTTE 2001, Otte-B-2255)

\**Trichostomum crispulum* Bruch – on calcareous rocks, e.g. 11 (Otte-B-2811); 13 (Otte-B-2806); near 19: Mt Šibaba (Otte-B-2766)

*Ulotia coarctata* (P. Beauv.) Hammar – 2: 1550 m, on *Acer trautvetteri* (OTTE 2004, Otte-B-2391); 7: 950 m, on *Salix* (OTTE 2004, GLM-B-23203); 13: on *Alnus* (Otte-B-2709); 19: orchard, on *Malus* (OTTE 2004, Otte-B-2433)

*Ulotia crispa* (Hedw.) Brid. – in deciduous forests up to subalpine *Betula* coppice, common, e.g. 7: on *Fagus* (Otte-B-2392)

*Weissia controversa* Hedw. – 15: soil over siliceous rock (OTTE 2001, Otte-B-2266)

*Zygodon rupestris* Schimp. ex Lorentz – between 1 and 12: in the forest on tree trunks (OTTE 2001, Otte-B-2267)

#### 4. Discussion

The massif Bol'šoj Thač and its surrounding ridges is the watershed between the catchment areas of the rivers Belaâ and Laba. It is characterised by a number of climatic and biogeographical parameters. In the western part of the catchment area of the river Belaâ the influence of the Black Sea on climate and vegetation is well perceivable. In the forest belt of this area *Fagus* and *Fagus-Abies* forests with the so called Colchic underbrush, represented by *Rhododendron ponticum* L., *Laurocerasus officinalis* M. Roem., *Ilex colchica* Pojark., are widespread. The bryophyte flora of the headwaters of river Belaâ holds many species common with the flora of the southern, Black-Sea-facing slope of the Great Caucasus (AKATOVA 2002, 2004). Simultaneously, many nemoral species with a West-European distribution are very abundant. In the vicinity of Mount Bol'šoj Thač *Laurocerasus officinalis* and *Ilex colchica* are already rarer, and *Rhododendron ponticum* was found by us only very rarely. The catchment area of the river Laba is characterised by an increasing continentality of the climate and the corresponding changes in the vegetation. The proportion of the prevailing tree species changes, *Abies* becomes the predominating species, *Picea orientalis* (L.) Peterm. appears and plays an important role. Mesophilic Colchic shrubs are practically absent from the undergrowth (GOLGOFSKAÂ 1967). Also the number and abundance of nemoral bryophyte species with a restricted distribution considerably decline. According to ELENEVSKIJ (1939), the turning point in the general change of the vegetation is observed from the watershed that separates the catchment area of the river Malaâ Laba from the catchment area of the river Urušten.

As our investigations show, a number of species with European or western-Palaeartic distribution and abundant development on the southern Caucasian slope and in the western part of the catchment area of river Belaâ occur in the flora of the study area, such as e.g. *Neckera complanata*, *N. crispa*, *Plagiomnium undulatum*, *Isoetecium alopecuroides* and others. However, eastwardly, their abundance and frequency decline considerably. Many of them are rather rare in the study area. For example, species that are widespread in the more western areas of the Caucasus, such as *Thamnobryum alopecurum* and *Palamocladium euchlorum* have only single occurrences in the Bol'šoj Thač region.

Among the species found in the investigation area 17 have a  $\pm$  oceanic distribution and are situated here at the eastern border of their European distribution. Many of them are only known within Russia from the Caucasus (e.g. *Barbula crocea*, *Neckera pumila*, *Ptychodium plicatum*, *Ulotia coarctata* and the liverworts *Metzgeria fruticulosa* and *Porella arboris-vitae*). Only one species – *Orthotrichum vladikavkanum* – is situated at its western border in the Caucasus.

One has also to mention the western Palaearctic endemite *Ptychodium plicatum*; the only representative of an endemic European genus. This species occurs in oceanic regions of Europe. In the western Caucasus it mainly grows on outcrops of carbonatic rocks in the alpine zone: dolines, rocks, talus. In addition to its occurrence in the investigation area it is known from limestone massifs of the Caucasian Reserve: Trû-Âtyrgvarta (catchment area of the river Malaâ Laba) and Pšeho-su (catchment area of the river Belaâ) (AKATOVA 2002).

In the mountain forests of the western Caucasus a number of species occur that are very rare in Europe and therefore have been included into the Red Data Book of European Bryophytes (1995). Of these, the following occur on the territory of the Nature Park Bol'soj Tač:

*Buxbaumia viridis* – status in Europe: V (vulnerable). This is an obligately epixylic species, growing on rotten trunks of coniferous trees. In Europe a fragmentation of its distribution range has taken place due to forestry. In the Caucasus the species is mentioned from Georgia (ČIKOVANI 1986), from the Teberda Reserve (IGNATOVA et al. 1990) and the Caucasian Reserve (AKATOVA 2002, 2003, 2004). Occurs sporadically.

*Dicranum viride* – status in Europe: V. Epiphyte on old beeches under sufficiently moist conditions. In Europe threatening factors are forestry and pollution (Red Data Book of European Bryophytes 1995).

*Neckera pennata* – status in Europe: V. Threats are particularly clearcuts, which take away the phorophytes and destroy the habitat of the species. Furthermore, the species suffers from pollution (Red Data Book of European Bryophytes 1995). In the Caucasus it is mentioned from Georgia (ČIKOVANI 1986), Armenia (MANAKÂN 1995), the Teberda Reserve (IGNATOVA et al. 1990) and the Caucasian Reserve (AKATOVA 2002, 2004).

*Orthotrichum vladikavkanum* – status in Europe: V. The limiting factors are not known. These are probably clearcuts and pollution; the more as pollution is the main threatening factor for the majority of the members of the genus *Orthotrichum* (Red Data Book of European Bryophytes 1995). This species was first described by Venturi from the vicinity of Vladikavkaz. In the last few years it was found on some further locations in the Caucasus (AKATOVA 2002, 2004, OTTE 2004). Besides the Caucasus only one occurrence area of this species is known: Altaj Mts, 440 – 1100 m, where it is frequent (IGNATOV & LEWINSKY-HAAPASAARI 1994).

*Frullania parvistipula* – status in Europe: E (endangered). In Europe, including the Caucasus, this species was known only from 4 – 5 occurrences, 2 of them in the Caucasus, of which one is believed to be extinct (Red Data Book of European Bryophytes 1995). Moreover, this species was recently found in Romania (ȘTEFĂNUȚ 2004). In Europe, forestry that changes the microclimate is considered to be the main threatening factor (Red Data Book of European Bryophytes 1995). In East Asia *F. parvistipula* is evidently a widespread species (e.g. according to specimens in JE). In the Altaj Mts it is the most common species of *Frullania* (VÁŇA & IGNATOV 1995). Judging from this, *F. parvistipula* probably belongs to the group of species with an »eastern affinity« that is rare in Europe due to natural causes, but

more frequent in the Caucasus (JÄGER 1968, OTTE 2004). However, nothing is known regarding its current occurrence in the Caucasian Reserve (Red Data Book of European Bryophytes 1995). Our records from the territory of the Bol'šoj Thač Nature Park confirm the existence of this species in Caucasia. Stands are trunks of deciduous trees. In the lower mountain belt in the surroundings of Mount Bol'šoj Thač *F. parvistipula* is probably widespread, as are also other species with an »eastern« distribution character (see OTTE 2004, 2007a). Unfortunately, the protected areas of the Northern Caucasus are predominantly situated in the high mountains (AMIRHANOV et al. 2002). The forest massifs of the lower mountain zone have experienced a considerable transformation and are being intensively further exploited.

In the EU, *Buxbaumia viridis* and *Dicranum viride* belong to the prior-ranking species according to appendix II of RL 92/43/EWG (1992), for which the EU countries are obliged to organise a network of specially protected areas.

## 5. Conclusion

At present it is indispensable to continue the investigation of the distribution and the situation of the populations of those species of bryophytes that are rare or endangered in large parts of their distribution range.

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## 7. References

- AKATOVA, T. V. (2002): Listostebel'nye mhi Kavkazskogo zapovednika (Zapadnyj Kavkaz, Rossiâ) – Arctoa **11**: 179 – 204
- (2003): K vosprosu ohrany redkih vidov listostebel'nyh mhov Zapadnogo Kavkaza. – Materialy III Meždunarodnoj naučno-praktičeskoj konferencii. Majkop, MGTI: 15 – 16
- (2004): Listostebelnye mhi Kavkazskogo zapovednika (Zapadnyj Kavkaz). – Avtoreferat dissertacii na kandidata biologičeskikh nauk. Moskva, 20 pp.
- AMIRHANOV, A. M., A. A. TIŠKOV & E. A. BELONOVSKAÂ (2002): Sohranenie biologičeskogo raznoobraziâ gor Rossii. – Ministerstvo prirodnyh resursov RF, Institut geografii RAN, Proekt GEF »Sohranenie biorasnoobraziâ«, Moskva, 78 pp.
- ČIKOVANI, N. V. (1986): Bryophyta. – In: NAČUZRIŠVILI, I. J. (ed.) Flora sporovyh rastenij Gruzii. – Tbilisi, Mecniereba: 786 – 852
- ELENEVSKIJ, R. A. (1939): Gorno-lugovye etûdy Kavkazskogo zapovednika. – Trudy Kavkazskogo Zapovednika **2**: 127 – 161
- FREY, W., J.-P. FRAHM, E. FISCHER & W. LOBIN (1995): Die Moos- und Farnpflanzen Europas. Kleine Kryptogamenflora, begründet von Helmut Gams, Band IV. – Stuttgart/Jena/New York, 426 pp.
- GOLGOFSKAÂ, K. Ū. (1967): K drobnomu geobotaničeskomu rajonirovaniû Kavkazskogo zapovednika. – Trudy Kavkazskogo gosudarstvennogo zapovednika **9**: 119 – 156
- IGNATOVA, E. A., Y. VANÂ & F. M. VOROB'EV (1990): Brioflora Teberdinskogo zapovednika. – Trudy Teberdinskogo Zapovednika **12**: 1 – 39
- IGNATOV, M. S. & O. M. AFONINA (1992): Check list of mosses of the former USSR. – Arctoa **1**: 1 – 85

- & J. LEWINSKY–HAAPASAARI (1994): Bryophyte flora of Altai Mts. II. The genera *Amphidium* Schimp., *Orthotrichum* Hedw. and *Zygodon* Hook. & Tayl. (Orthotrichaceae, Musci). – *Arctoa* **3**: 29 – 57
- JÄGER, E. (1968): Die pflanzengeographische Ozeanitätsgliederung der Holarktis und die Ozeanitätsbindung der Pflanzenareale. – *Feddes Repert.* **79**: 157 – 335
- MANAKÂN, V. A. (1995): Itogi briologičeskikh issledovanij v Armenii. – *Arctoa* **5**: 15 – 33
- OTTE, V. (2001): Flechten und Moose im Gebiet des Bolschoi Tchatsch (NW-Kaukasus) – eine erste Übersicht, ergänzt durch einige von D. Benkert bestimmte Pezizales. – *Feddes Repert.* **112** (7 – 8): 565 – 582
- (2004): Flechten, Moose und lichenicole Pilze aus dem nordwestlichen Kaukasus – erster Nachtrag. – *Feddes Repert.* **115** (1 – 2): 155 – 163
- (2006): Erster Nachweis von *Frullania bolanderi* (Marchantiophyta: Jubulaceae) im Kaukasus. – *Herzogia* **19**: 353 – 355
- (2007a): Flechten, lichenicole Pilze und Moose aus dem Nordwest-Kaukasus – zweiter Nachtrag. – *Herzogia* **20**: 221 – 237
- (2007b): Vegetation and flora of vascular plants in the vicinity of Mt Bol'šoj Thač (NW Caucasus) and the effects of human interference. – *Abh. Ber. Naturkundemus. Görlitz* **79** (1): 85 – 95
- Red Data Book of European Bryophytes (1995): – Ed. by European Committee for Conservation of Bryophytes, Trondheim, 290 pp.
- RL 92/43/EWG (1992): Richtlinie 92/43/EWG des Rates vom 21. Mai 1992 (ABl. EG Nr. L 206 vom 22. 7. 1992, S. 7) zur Erhaltung der natürlichen Lebensräume sowie der wildlebenden Tiere und Pflanzen: 7
- ȘTEFĂNUȚ, S. (2004): *Frullania parvistipula* new to Romania. – *Lindbergia* **29**: 110 – 112
- VÁŇA, J. & M. S. IGNATOV (1995): Bryophytes of Altai Mountains V. Preliminary list of the Altaian Hepatics. – *Arctoa* **5**: 1 – 13

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**Bryophytes found so far in the vicinity of Mt Bol. Thač<sup>1</sup>, compiled from the available data by Volker Otte**

**Marchantiopsida**

*Aneura pinguis* (L.) Dumort.  
 (2: as *Riccardia p.* (L.) Gray)  
*Apometzgeria pubescens* (Schrank) Kuwah. (2)  
*Barbilophozia hatcheri* (A. Evans) Loeske (2)  
*Blepharostoma trichophyllum* (L.) Dumort. (2)  
*Cololejeunea calcarea* (Lib.) Schiffn. (5)  
*Frullania bolanderi* Aust. (4)  
*Frullania dilatata* (L.) Dumort. (2)  
*Frullania parvistipula* Steph. (1, 2)  
*Frullania tamarisci* (L.) Dumort. (2)  
*Jungermannia subulata* A. Evans (2)  
*Lepidozia reptans* (L.) Dumort. (2)  
*Marchantia polymorpha* L. (2)  
*Metzgeria conjugata* Lindb. (2)  
*Metzgeria fruticulosa* (Dicks.) A. Evans (2)  
*Metzgeria furcata* (L.) Dumort. (2)  
*Plagiochila asplenioides* (L.) Dumort. (2)  
*Porella arboris-vitae* (With.) Grolle (2)  
*Porella platyphylla* (L.) Pfeiff. (2)  
*Preissia quadrata* (Scop.) Nees (2)  
*Ptilidium pulcherrimum* (Weber) Vain. (2)  
*Radula complanata* (L.) Dumort. (2)  
*Radula lindenbergiana* Gottsche ex C. Hartm. (2)  
*Riccardia palmata* (Hedw.) Carruth. (2)  
*Scapania aequiloba* (Schwägr.) Dumort. (2)  
*Scapania calcicola* (Arnell & J. Perss.)  
 Ingham (2)  
*Tritomaria exsecta* (Schmidel) Loeske (2)

**Bryopsida**

*Abietinella abietina* (Hedw.) M. Fleisch. (2)  
*Amblystegium subtile* (Hedw.) Schimp. (1)  
*Anomodon attenuatus* (Hedw.) Huebener (2)  
*Anomodon longifolius* (Brid.) Hartm. (2)  
*Anomodon rugelii* (Müll. Hal.) Keissl. (2)  
*Anomodon viticulosus* (Hedw.)  
 Hook. & Taylor (2)  
*Atrichum flavisetum* Mitt. (2)  
*Aulacomnium turgidum* (Wahlenb.) Schwägr. (2)  
*Barbula convoluta* Hedw. (1)  
*Barbula crocea* (Brid.) F. Weber & D. Mohr (2)  
*Barbula unguiculata* Hedw. (1)  
*Bartramia halleriana* Hedw. (1)  
*Bartramia ithyphylla* Brid. (2)

*Brachythecium albicans* (Hedw.) Schimp. (1)  
*Brachythecium rivulare* Schimp. (1)  
*Brachythecium salebrosum* (F. Weber &  
 D. Mohr) Schimp. (1)  
*Brachythecium velutinum* (Hedw.) Schimp. (2)  
*Bryoerhythrophyllum recurvirostrum* (Hedw.)  
 P. C. Chen (1)  
*Bryum argenteum* Hedw. (1, 2)  
*Bryum capillare* Hedw. (1)  
*Bryum pseudotriquetrum*  
 (Hedw.) P. Gärtner et al. (1)  
*Bryum subelegans* Kindb. (2)  
*Buxbaumia viridis* (DC. in Lam. & DC.)  
 Moug. & Nestl. (2)  
*Calliergon stramineum* (Brid.) Kindb. (1)  
*Camptothecium lutescens* (Hedw.) Schimp. [syn.  
*Homalothecium l.* (Hedw.) Robins.] (2)  
*Campylium halleri* (Hedw.) Lindb. (2)  
*Campylium protensum* (Brid.) Kindb. (1)  
*Campylium stellatum* (Hedw.) C. E. O. Jensen (1)  
*Ceratodon purpureus* (Hedw.) Brid. (1, 2)  
*Cirriphyllum cirrosus* (Schwägr. in Schultes)  
 Grout (1)  
*Climacium dendroides* (Hedw.) F. Weber &  
 D. Mohr (1)  
*Cratoneuron commutatum* (Hedw.) G. Roth (1)  
*Cratoneuron filicinum* (Hedw.) Spruce (1)  
*Ctenidium molluscum* (Hedw.) Mitt. (1, 2)  
*Cynodontium polycarpum* (Hedw.) Schimp. (1)  
*Dichodontium pellucidum* (Hedw.) Schimp. (1)  
*Dicranella palustris* (Dicks.) Crundw.  
 ex E. F. Warb. (1)  
*Dicranodontium denudatum* (Brid.) E. Britton  
 in Williams (1)  
*Dicranum bonjeanii* De Not. (1)  
*Dicranum muehlenbeckii* Bruch & Schimp. (1)  
*Dicranum scoparium* Hedw. (2)  
*Dicranum viride* (Sull. & Lesq.) Lindb. (1)  
*Didymodon fallax* (Hedw.) R. H. Zander (1)  
*Didymodon rigidulus* Hedw. (1)  
*Distichium capillaceum* (Hedw.) Bruch &  
 Schimp. (1)  
*Distichium inclinatum* (Hedw.) Bruch & Schimp.  
 (1)  
*Ditrichum flexicaule* (Schwägr.) Hampe (1, 2)  
*Encalypta streptocarpa* Hedw. (1)

<sup>1</sup> For a map of the study area see Fig. 2 on page 87 in this volume

- Encalypta vulgaris* Hedw. (1, 2)  
*Entodon concinnus* (De Not.) Paris (1, 2)  
*Entodon schleicheri* (Schimp.) Demet. (1)  
*Eurhynchium angustirete* (Broth.) T. J. Kop. (2)  
*Eurhynchium hians* (Hedw.) Sande Lac. (1)  
*Eurhynchium striatum* (Hedw.) Schimp. (1)  
*Fissidens dubius* P. Beauv. (2)  
*Fissidens gracilifolius*  
 Bruggemann-Nannenga & Nyh. (1)  
*Fissidens osmundoides* Hedw. (2)  
*Fissidens taxifolius* Hedw. (2)  
*Funaria hygrometrica* Hedw. (1)  
*Grimmia affinis* Hoppe & Hornsch.  
 ex Hornsch. (2)  
*Gymnostomum aeruginosum* Sm. (1)  
*Gyroweisia tenuis* (Hedw.) Schimp. (1)  
*Hedwigia ciliata* (Hedw.) P. Beauv. (1)  
 – var. *leucophaea* Bruch & Schimp. (2)  
*Herzogiella seligeri* (Brid.) Z. Iwats. (2)  
*Homalia besseri* Lobarz. (1, 2)  
*Homalia trichomanoides* (Hedw.) Schimp. (2)  
*Homalothecium philippeanum*  
 (Spruce) Schimp. (1, 2)  
*Homalothecium sericeum* (Hedw.) Schimp. (1)  
*Hygroamblystegium tenax* (Hedw.) Jenn. (1)  
*Hygrohypnum luridum* (Hedw.) Jenn. (1, 2)  
*Hylocomium splendens* (Hedw.) Schimp. (2)  
*Hypnum cupressiforme* Hedw. (1)  
 – var. *filiforme* Brid. (1)  
*Hypnum vaucheri* Lesq. (1)  
*Isopterigiopsis pulchella* (Hedw.) Z. Iwats. (1)  
*Isothecium alopecuroides* (Dubois) Isov. (2)  
*Leskeella nervosa* (Brid.) Loeske (2)  
*Leucobryum glaucum* (Hedw.) Ångstr. (1)  
*Leucodon immersus* Lindb. (3)  
*Leucodon sciuroides* (Hedw.) Schwägr. (1, 2)  
*Meesia uliginosa* Hedw. (1)  
*Mnium ambiguum* H. Müll. (1)  
*Mnium marginatum* (Dicks.) P. Beauv. (1, 2)  
*Mnium spinulosum* Bruch & Schimp. (2)  
*Mnium stellare* Hedw. (1)  
*Molendoa sendtneriana*  
 (Bruch & Schimp.) Limpr. (1)  
*Myurella julacea* (Schwägr.) Schimp. (1)  
*Neckera complanata* (Hedw.) Huebener (2)  
*Neckera crispa* Hedw. (2)  
*Neckera pennata* Hedw. (2)  
*Neckera pumila* Hedw. (2)  
*Oncophorus virens* (Hedw.) Brid. (1)  
*Orthodicranum flagellare* (Hedw.) Loeske (1)  
*Orthodicranum montanum* (Hedw.) Loeske (1)
- Orthotrichum anomalum* Hedw. (1)  
*Orthotrichum cupulatum* Brid. (2)  
*Orthothecium intricatum* (Hartm.) Schimp. (1)  
*Orthotrichum lyellii* Hook. & Taylor (1)  
*Orthotrichum obtusifolium* Brid. (1)  
*Orthotrichum pallens* Bruch ex Brid. (1)  
*Orthothecium rufescens* (Brid.) Schimp. (1)  
*Orthotrichum rupestre* Schleich. ex Schwägr. (2)  
*Orthotrichum sordidum* Sull. & Lesq. (1)  
*Orthotrichum speciosum* Nees in Sturm (2)  
*Orthotrichum stramineum* Hornsch. ex Brid. (2)  
*Orthotrichum striatum* Hedw. (2)  
*Orthotrichum vladikavkanum* Vent. (3)  
*Palamocladium euchloron*  
 (Müll. Hal.) Wijk & Marg. (1)  
*Palustriella commutata* (Hedw.) Ochyra (1)  
*Palustriella decipiens* (De Not.) Ochyra (1)  
*Paraleucobryum longifolium*  
 (Hedw.) Loeske (1, 2)  
*Philonotis fontana* (Hedw.) Brid. (1)  
*Plagiomnium cuspidatum* (Hedw.) T. J. Kop. (2)  
*Plagiomnium ellipticum* (Brid.) T. J. Kop. (1)  
*Plagiomnium rostratum* (Schrad.) T. J. Kop. (1)  
*Plagiomnium undulatum* (Hedw.) T. J. Kop. (1)  
*Plagiopus oederianus*  
 (Sw.) H. A. Crum & L. E. Anderson (1, 2)  
*Plagiothecium denticulatum*  
 (Hedw.) Schimp. (1, 2)  
*Plagiothecium laetum* Schimp. (1)  
*Plagiothecium nemorale* (Mitt.) A. Jaeger  
 [incl. *P. succulentum* (Wilson) Lindb.] (1, 2)  
*Platydictya jungermannioides*  
 (Brid.) H. A. Crum (1)  
*Pleurochaete squarrosa* (Brid.) Lindb. (1)  
*Pleurozium schreberi* (Brid.) Mitt. (1)  
*Pogonatum aloides* (Hedw.) P. Beauv. (2)  
*Pogonatum urnigerum* (Hedw.) P. Beauv. (2)  
*Pohlia cruda* (Hedw.) Lindb. (1, 2)  
*Pohlia wahlenbergii*  
 (F. Weber & D. Mohr) A. L. Andrews (1)  
*Polytrichastrum alpinum*  
 (Hedw.) G. L. Sm. (1, 2)  
*Polytrichum formosum* Hedw. (1, 2)  
*Polytrichum juniperinum* Hedw. (1)  
*Polytrichum sexangulare* Brid. (1, 2)  
*Pseudoleskeella catenulata* (Schrad.) Kindb. (1)  
*Pterigynandrum filiforme* Hedw. (2)  
*Ptilium crista-castrensis* (Hedw.) De Not. (2)  
*Ptychodium plicatum* (F. Weber & D. Mohr.)  
 Schimp. (1)  
*Pylaisia polyantha* (Hedw.) Schimp. (1, 2)

- Racomitrium canescens* (Hedw.) Brid. (2)  
*Rhizomnium pseudopunctatum*  
 (Bruch. & Schimp.) T. J. Kop. (1)  
*Rhizomnium punctatum* (Hedw.) T. J. Kop. (2)  
*Rhynchostegium murale* (Hedw.) Schimp. (1)  
*Rhynchostegium riparioides*  
 (Hedw.) Cardot (1, 2)  
*Rhytidiadelphus triquetrus*  
 (Hedw.) Warnst. (1, 2)  
*Rhytidium rugosum* (Hedw.) Kindb. (2)  
*Sanionia uncinata* (Hedw.) Loeske (2)  
*Schistidium apocarpum* (Hedw.) Bruch &  
 Schimper s. l. (1, 2)  
*Seligeria donniana* (Sm.) Müll. Hal. (2)  
*Seligeria pusilla* (Hedw.) Bruch & Schimp. (3)  
*Sphagnum subsecundum* Nees (1)  
*Tetraphis pellucida* Hedw. (2)  
*Thamnobryum alopecurum*  
 (Hedw.) Gangulee (1, 2)
- Thuidium delicatulum* (Hedw.) Mitt. (1)  
*Thuidium philibertii* Limpr. (1, 2)  
*Thuidium recognitum* (Hedw.) Lindb. (2)  
*Timmia austriaca* Hedw. (1, 2)  
*Timmia megapolitana* Hedw. var. *bavarica*  
 (Hessl.) Brid. (1)  
*Tortella tortuosa* (Hedw.) Limpr. (2)  
*Tortula mucronifolia* Schwägr. (1)  
*Tortula norvegica*  
 (F. Weber) Wahlenb. ex Lindb. (1, 2)  
*Tortula subulata* Hedw. (2)  
*Trichostomum crispulum* Bruch (1)  
*Ulota coarctata* (P. Beauv.) Hammar (3)  
*Ulota crispa* (Hedw.) Brid. (2)  
*Weissia controversa* Hedw. (2)  
*Zygodon rupestris* Schimp. ex Lorentz (2)

#### Data sources

- (1) AKATOVA, T. V. & V. OTTE (2007) in this volume: (as far as not mentioned in (2) or with additional stands here)
- (2) OTTE, V. (2001): Flechten und Moose im Gebiet des Bolschoi Tchatsch (NW-Kaukasus) – eine erste Übersicht, ergänzt durch einige von D. Benkert bestimmte Pezizales. – Feddes Repert. **112**: 565 – 582
- (3) OTTE, V. (2004): Flechten, Moose und lichenicole Pilze aus dem nordwestlichen Kaukasus – erster Nachtrag. – Feddes Repertorium **115** (1 – 2): 155 – 163
- (4) OTTE, V. (2006): Erster Nachweis von *Frullania bolanderi* (Marchantiophyta: Jubulaceae) im Kaukasus. – Herzogia **19**: 353 – 355
- (5) OTTE, V (ined.: Herb. Otte or GLM)



Fig. A2-51



Fig. A2-52



Fig. A2-53

- Fig. A2-51 In the oak belt old trees are often widely covered with the moss *Leucodon sciuroides* (at Mt Šibaba, May 2004, Photo: R. Berndt)
- Abb. A2-51 In der Eichenwaldstufe sind alte Bäume oft weithin mit dem Laubmoos *Leucodon sciuroides* bedeckt (am Berge Šibaba, Mai 2004, Foto: R. Berndt)
- Илл. A2-51 В поясе дубняка старые деревья часто широко покрыты мхом *Leucodon sciuroides* (г. Шибаба, май 2004 г., фото: Р. Берндт)
- Fig. A2-52 The European Red data book species *Frullania parvistipula* is rather widespread in the study area (herbarium specimen GLM-B-23187, collected by V. Otte at 950 m a.s.l. in the Maly Sahraj valley on *Alnus incana* in May 2004; Photo: V. Otte)
- Abb. A2-52 Die Art des Europäischen Roten Buches *Frullania parvistipula* ist im Untersuchungsgebiet ziemlich weit verbreitet (Herbarbeleg GLM-B-23187, gesammelt von V. Otte im Tal des Maly Sahraj auf 950 m ü. NN im Mai 2004 an *Alnus incana*; Foto: V. Otte)
- Илл. A2-52 Вид Европейской Красной Книги *Frullania parvistipula* достаточно распространен в области исследования (гербарный образец GLM-B-23187, собр. Ф. Отте в мае 2004 г. в долине р. Малый Сахрай на 950 м н. у. м. на *Alnus incana*; фото: Ф. Отте)
- Fig. A2-53 *Buxbaumia viridis* inhabits rotten trunks of conifers and has much declined in Europe (Afonka valley, August 2005, Photo: J. Fürstenow)
- Abb. A2-53 *Buxbaumia viridis* ist ein Bewohner morscher Nadelholzstämme und in Europa stark zurückgegangen (Afonkatal, August 2005, Foto: J. Fürstenow)
- Илл. A2-53 *Buxbaumia viridis* является обитателем гнилых стволов хвойных пород и значительно сократилась в Европе (долина р. Афонка, август 2005 г., фото: Й. Фюрстенов)

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