

# Current state of knowledge of the liverwort and hornwort flora of the Vologda Region, Russia

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**Abstract:** An annotated checklist of liverworts and hornworts is presented for the Vologda Region, Russia, based on the authors' collections and those of their colleagues, as well as the literature. The paper presents the first published checklist for the region and includes 84 species from 42 genera and 22 families. Three species are reported for the first time for the region: *Conocephalum salebrosum* Szweykowski et al., *Scapania subalpina* (Nees ex Lindenb.) Dumort., and *Trichocolea tomentella* (Ehrh.) Dumort.

**Kokkuvõte:** Helvik- ja kõdersamblad Vologda regioonis (Venemaa)

Autorite kollektsioonide ja kirjanduse põhjal on koostatud Venemaa Vologda oblasti helvik- ja kõdersamblade kommenteeritud nimestik. See on esimene selle piirkonna trükitud liiginimestik ning sisaldab kokku 84 liiki 42 perekonnast ja 22 sugukonnast. Esmakordselt registreeriti piirkonnast järgmised liigid: *Conocephalum salebrosum* Szweykowski et al., *Scapania subalpina* (Nees ex Lindenb.) Dumort. ja *Trichocolea tomentella* (Ehrh.) Dumort.

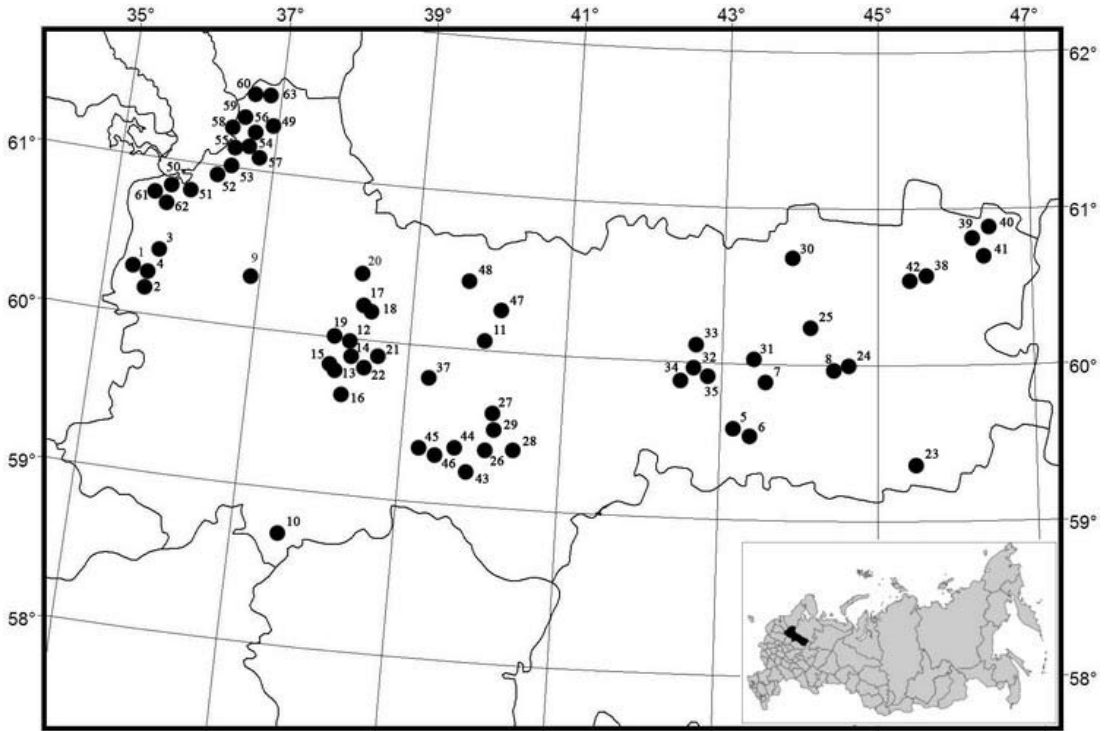
## INTRODUCTION

Bryophytes, including mosses, liverworts, and hornworts, form a conspicuous and important component in many ecosystems throughout the world. Their biological, ecological, and phylogenetic significance is well documented (e.g., Pócs, 1980; Frahm, 1990; Coxson et al., 1992; Hallingbäck & Hodgetts, 2000; O'Neill, 2000; Gignac, 2001; Gradstein et al., 2001; Wellman et al., 2003). Yet, compared to vascular plants, liverworts remain a significantly understudied group, possibly due to their generally small plant size coupled with difficulties of identification. This concerns both the knowledge of their ecological and biological features and their taxonomic diversity. The importance of the present paper is in summarizing the results of long-term research in compiling an inventory of the species of liverworts in the Vologda Region, one of the largest areas of the Northern European Russia (Fig. 1).

The Vologda Region is situated within the East-European Plain and divided into 26 administrative districts. The Region has an area of 145 700 km<sup>2</sup> and is of hilly relief, with alternating depressions, ridges and elevations, with

the Northern Ridge at the east of the area. The climate is moderately continental with a cold winter (mean temperature of January is -14 °C) and warm summer (mean temperature of July is +18 °C) (Skupinova, 2007). The combination of the relatively high mean precipitation, 500 mm per year, and low evaporation, contributes to the region abounding in rivers, lakes and bogs. Vegetation is typical for middle and southern taiga. The forests are mostly spruce woods and occupy two-thirds of the area. Soils are podzolic and soddy-podzolic, with boggy soils in some areas (Vorob'ev, 2007).

Mosses of the Vologda Region were first mentioned in 1780 (Lepyokhin, 1780). Studies devoted to liverworts of the Vologda Region have been fragmentary and conducted in various times in the 1890's, 1950's and 1960's, the late 1980's, as well as more recently in the present decade. Significant works in the last 200 years include: Zickendrath (1900); Warnstorf (1913); Perfil'ev (1914, 1915), Abramova & Abramov, 1961; Akhminova & Zhukova, 1971; Volkova et al., 1994; Andreeva, 2002. There are also scattered papers that include notes on the liv-



**Fig. 1.** The main collecting sites of liverworts in the Vologda Region.

erwort flora of Vologda Region (e.g., Karmazina & Andreeva, 2004; Bakalin, 2005; Bobrov & Chemeris, 2004, 2005; Bobrov, 2005; Ahti & Boychuk, 2006; Philippov & Dulin, 2008). From these references, 80 liverwort and 1 hornwort species have been reliably reported for the region up to the present time.

## MATERIALS AND METHODS

Collections made by E.V. Karmazina and D.A. Philippov during field seasons from 2001 to 2008 throughout 10 municipal districts of the Vologda Region formed the primary basis for the present list. The studies were conducted using a traditional route-based method, with subsequent processing and identification of the collections mainly by M.V. Dulin. Altogether ca. 350 samples were collected and studied, the majority of which are kept in the herbaria of the Department of Botany of the Vologda State Pedagogical University and I.D. Papanin Institute for Biology of Inland Waters of the RAS (IBIW); duplicates are deposited in the herbarium of the

Institute of Biology of the Komi Science Center UB RAS (SYKO) and Lomonosov Moscow State University (MW). In addition, we were also able to study selected specimens from the Tsitsin Main Botanical Garden of the RAS (MHA, collections of M.S. Ignatov and E.A. Ignatova in the basins of the Sukhona and the Yug rivers, 2001) and from IBIW (collections of E.V. Chemeris and A.A. Bobrov, 1996–2007).

The taxa in the checklist are arranged in alphabetic order. Nomenclature follows Konstantinova, Potemkin & Schlyakov (1992) with some updates from the recent literature (Konstantinova & Vasiljev, 1994; Konstantinova & Potemkin, 1996; Grolle & Long, 2000; Damsholt, 2002). Taxonomy of *Lophozia* (Dumort.) Dumort. follows Bakalin (2005). We share the ideas of Schlyakov (1980, 1981), who followed the narrow generic concepts suggested by Scandinavian researchers (Buch, 1933; Arnell, 1956). Modern analysis of molecular data have provided more precise definition of the systematic position of a number of taxa (Vilnet et al., 2007). Synonyms from regional papers are given in parenthesis

after the accepted names of species. Because only limited numbers of liverworts have been collected in the Vologda Region, all known habitats and localities are listed, by administrative division. We include the geographical location of the collection, collection dates, and the surnames and initials of the collectors. Further information on ecotopes and substrate types of the species is presented in the checklist. Frequency of occurrence is estimated according to a 5-point scale: very rare (1 find), rare (2–5), sporadic (6–10), frequent (11–15), very frequent (over 15). The conservation status (category) is indicated for rare endangered species registered in the Red Data Book of the Vologda Region (Konechnaya & Suslova, 2004). Species included in the Red Data Book of the Vologda Region are marked with #. Species recorded in Vologda Region for the first time are marked with \*.

### The main collecting sites of liverworts in the Vologda Region

(Fig. 1; abbreviations: distr. – district; vill. – village; coll. – collector)

Babaevo distr.: 1) the Koloshma river near Koloshma vill.; 2) the Nozhema river near Pyazhelka vill.; 3) the Parans river; 4) the Pyazhelka river in the vicinity of the Pyazhelka vill., coll. E.V. Chemeris & A.A. Bobrov in 2000–2008 (station 1–4 by Bobrov & Chemeris, 2004, 2005).

Babushkin distr.: 5) valley of the Zyablikha river, coll. Mironova in 1957 (Akhminova & Zhukova, 1971); 6) valley of the Mokrusha river, coll. Mironova in 1957 (Akhminova & Zhukova, 1971); 7) left bank of the Staraya Tot'ma river at Bol'shoy Dvor vill., coll. M.S. Ignatov & E.A. Ignatova in 2001; 8) mire Mikhalyovo, vicinity of Logduz and Pleshkino vill., coll. D.A. Philippov in 2006.

Belozersk distr.: 9) vicinity of. Mishino vill, coll. Metel'kova in 1956 (Akhimova & Zhukova, 1971).

Cherepovets distr.: 10) Darvinskiy State Natural Biospheric Reserve, coll. N.D. Nemtceva in 1987, 1991; A.L. Zhukova & A.D. Potemkin in 1988, 1990 (Volkova et al., 1994) & A.A. Bobrov in 1996 (Bobrov, 2005).

Kharovsk distr.: 11) slope of riverbank of the Sit' river near Kharovsk settlement, coll. 1965 (Akhminova & Zhukova, 1971).

Kirillov distr. (all localities within the National Park "Russkiy Sever"): 12) near Okulovskoe

Lake, vicinity of Okulovo vill., coll. T.A. Suslova in 1987, E.N. Andreeva in 2002, E.V. Karmazina in 2003; 13) near Gora Maura, coll. E.V. Karmazina in 2003; 14) near Tcypina Gora, vicinity of Oden'evo vill., coll. E.V. Karmazina in 2003; 15) vicinity of Goritcy vill., coll. E.V. Karmazina in 2003; 16) near the Topornya river, nature monument «Sokol'skiy Pinewood», coll. E.V. Karmazina in 2003 & 2004; 17) vicinity of Kovarzino vill., coll. E.V. Karmazina in 2003 & 2004; 18) vicinity of Rusanovo vill., coll. E.V. Karmazina in 2004; 19) vicinity of Vognema vill., coll. E.V. Karmazina in 2004; 20) vicinity of Gorka vill., landscape reserve «Shalgo-Bodunovskiy Forest», coll. E.V. Karmazina in 2003 & 2004, D.A. Philippov in 2006; 21) along the Kishemskiy Channel, coll. D.A. Philippov in 2007; 22) Nikol'skoe Lake, vicinity of Schidorovo vill., coll. D.A. Philippov in 2008.

Nicol'sk distr.: 23) southwards from Nicol'sk town, left bank of the Yug river near Permas vill., coll. M.S. Ignatov & E.A. Ignatova in 2001; 24) mires on the slope of the Borovoy Kachug river, near Kachug vill., coll. D.A. Philippov in 2006.

Nyuksenitca distr.: 25) bank of the Sukhona river near Nyuksenitca settlement, coll. M.S. Ignatov & E.A. Ignatova in 2001.

Sokol distr.: 26) no exact site specified, probably near town of Sokol, coll. M.S. Ignatov in 1990 (Bakalin, 2005); 27) mire Sludka, coll. D.A. Philippov in 2007; 28) mire Alekseevskoe-1, vicinity of Kadnikov town, coll. D.A. Philippov in 2007; 29) mire Durkovskoe northwards from railway st. Morzhenga, coll. D.A. Philippov in 2007.

Tarnoga distr.: 30) the Ajga river vicinity of Ilezskiy Pogost vill., coll. D.A. Philippov in 2007;

Tot'ma distr.: 31) bank of the Kamchuga river, near Kamchuga vill., coll. A.A. Korchagin in 1969 (Akhminova & Zhukova, 1971); 32) bank of the Sukhona river, vicinity of Tot'ma town, coll. 1965, 1969 (Akhminova & Zhukova, 1971); 33) vicinity of Bryukhachikha vill., coll. A.A. Korchagin & O.F. Hase in 1926 (Akhminova & Zhukova, 1971); 34) vicinity of Sovetskiy settlement, coll. 1969 (Akhminova & Zhukova, 1971); 35) vicinity of Chernyakovo vill., coll. 1969 (Akhminova & Zhukova, 1971); 36) vicinity of Ponomaryovo settlement, coll. 1969 (Akhminova & Zhukova, 1971).

Ust'-Kubenskoe distr.: 37) north-eastern bank of the Kubenskoe Lake, coll. E. Zickendrath in 1890 (Zickendrath, 1900).

Velikiy-Ustyug distr.: 38) slope of riverbank of the river Sukhona near Opoki vill., coll. 1895 (Zickendrath, 1900); coll. 1968 (Akhminova & Zhukova, 1971); 39) vicinity of Gorka settlement, coll. E. Zickendrath in 1895 (Zickendrath, 1900); 40) mire near the Sinega settlement, coll. 1895 (Zickendrath, 1900); 41) bank of the Luza river, coll. A.G. Kolmovskiy in 1895 (Zickendrath, 1900); 42) vicinity of Poldars settlement, on the slope of river Sukhona, coll. 1968 (Akhminova & Zhukova, 1971).

Vologda distr.: 43) vicinity of Vologda city, coll. E. Zickendrath, 1891 (Zickendrath, 1900), A.A. Snyatkov in 1896 (Zickendrath, 1900), I.A. Perfil'ev, G.I. Shiryaev & A.A. Snyatkov (Perfil'ev, 1915), A.A. Korchagin (Akhminova & Zhukova, 1971); 44) vicinity of Nikolaevskoe-Vosimskoe settlement, coll. E. Zickendrath in 1893 (Zickendrath, 1900); 45) vicinity of Severnaya Ferma vill., coll. A.A. Snyatkov in 1895 (Zickendrath, 1900); 46) western bank of the Kubenskoe Lake, near Kubenskoe settlement, coll. M.S. Ignatov & E.A. Ignatova in 2001.

Vozhega distr.: 47) vicinity of railway st. of Kadnikovskiy vill., coll. 1958, 1963, 1965, 1966 (Akhminova & Zhukova, 1971); 48) vicinity of Kuklinskaya vill., coll. D.A. Philippov in 2007.

Vytegra distr.: 49) vicinity of Andomskiy Pogost vill., near Kivruchey, coll. A.K. Cajander in 1899 (Ahti & Boychuk, 2006); 50) mire Zhabinskoe, vicinity Oshtinskiy Pogost settlement, coll. L.S. Korotkevich in 1949 (Konechnaya & Suslova, 2004); 51) mire near the Panskoe Lake, vicinity of Kedra vill., coll. D.A. Philippov in 2006; 52) mire Vytegorskoe, vicinity Vytegra town, coll. D.A. Philippov in 2006; 53) mire Gladkoe near Vytegra town, coll. D.A. Philippov in 2006; 54) Tuzozero Lake, near Ostrov & Panovo vill., coll. D.A. Philippov in 2005 & 2007; 55) mire in the Palaya river valley, coll. D.A. Philippov in 2006; 56) mire Shidry, vicinity of Pustosh' & Nasonova vill., coll. D.A. Philippov in 2006; 57) mire Sorozhskoe-Dol'noe, left bank of the Povreka valley, near Tuzozerskiy Pogost vill., coll. D.A. Philippov in 2006; 58) slope of Onezhskoe Lake, vicinity of Ol'kovo vill., coll. D.A. Philippov in 2006; 59) mire Krestenskoe, vicinity of Ol'kovo vill., coll. D.A. Philippov in 2006; 60) mire Desyatochnoe, vicinity of Oktyabr'skiy settlement, coll. D.A. Philippov in 2007; 61) the Oshta river, vicinity of Kurvoskiy Pogost vill., coll. E.V. Chemeris & D.A. Philippov in 2007; 62) the Vodlica river near Gornruchey vill., coll. D.A. Philippov in 2007; 63)

the Kurzhekksa river, near Tikachyovo vill., coll. E.V. Chemeris & D.A. Philippov in 2007.

## CHECK-LIST OF THE LIVERWORTS AND HORNWORTS OF THE VOLOGDA REGION

In the following list 'small-leaved forest' refers to woodland of birch (*Betula*), aspen (*Populus*) and alder (*Alnus*) trees.

### MARCHANTIOPHYTA

ANEURA PINGUIS (L.) Dumort. (*Riccardia pinguis* (L.) Gray). – 10, 24, 38, 47, 48. Among the mosses on sedge-moss spring bogs, in humid sites in boggy spruce woods, on silty soil along the banks of watercourses. Sporadic.

#APOMETZGERIA PUBESCENS (Schrank) Kuwah. (*Metzgeria pubescens* (Schrank) Raddi) – 47. Among beds of leafy forest mosses in a boggy spruce forest. Very rare. Critically Endangered.

BARBILOPHOZIA BARBATA (Schmidel ex Shreb.) Loeske – 7, 18, 37, 47, 48. On rotten stumps and spruce trunks mainly in boggy spruce woods, less frequent in pine forests on sandy sloping riverbanks. Sporadic.

#BARBILOPHOZIA LYCOPODIODES (Wallr.) Loeske – 12, 47. On forest litter in blueberry and humid mixed spruce forests. Rare. Least Concern.

BLASIA PUSILLA L. – 10, 16, 32, 35, 47, 58. On sandy, less frequent on clay soil, on stream banks, in various types of pine forests, once in a swampy forest. Sporadic.

BLEPHAROSTOMA TRICHOPHYLLUM (L.) Dumort. var. TRICHOPHYLLUM – 10, 16, 20, 21, 25, 34, 35, 40, 43, 45, 47. In small-leaved, mixed and coniferous forests of various degrees of humidity, on rotten wood, stumps and at the foot of birch and spruce trunks. Very frequent.

CALYPOGEIA AZUREA Stotler et Crotz (*Calypogeia trichomanis* auct.; *Kantia trichomanes* auct.) – 32, 43, 47. Boggy spruce forests, on wet soil and on rotten fallen trees, less frequently in bogs. Rare.

CALYPOGEIA INTEGRISTIPULA Steph. – 10, 12, 17, 48. In boggy coniferous and mixed forests, on rotten timber, trunk buttresses and less frequent on soil. Frequent.

CALYPOGEIA MUELLERIANA (Schiffn.) Müll.Frib. – 10, 18, 20. In spruce and aspen woods, on rotten wood and fallen trees. Sporadic.

CALYPOGEIA NEESIANA (C.Massal. et Carestia) Müll. Frib. – 6, 10, 12, 14, 27, 32, 47. In spruce woods (mainly boggy), less frequently pine forests, at the edges of *Sphagnum* mires,

- on rotten wood, at the foot of aspen trunks, sometimes on soil and litter, and also on stumps and bare roots, among *Dicranum* sp. and *Tetraphis pellucida* Hedw. Sporadic.
- CALYPOGEIA SPHAGNICOLA (Arnell et J.Perss.) Warnst. et Loeske – 10, 28, 29, 52, 60. In meso- and oligotrophic pine and dwarf-shrub *Sphagnum* mires, on dwarf shrub/moss hummocks and pine trunk burls, between beds of *Sphagnum* ssp. Rare.
- CALYPOGEIA SUECICA (Arnell et J.Perss.) Müll.Frib. – 10, 16, 20. In a blueberry/monkshood (*Aconitum*) pine forest, in a mossy pine forest, on rotten wood, stumps, once on peaty soil. Rare.
- CEPHALOZIA AFFINIS Lindb. ex Steph. – 10. On birch bark at base of trunks at the edges of mire. Very rare.
- CEPHALOZIA BICUSPIDATA (L.) Dumort. var. BICUSPIDATA – 10, 16, 20, 32, 47. In coniferous forests (mainly spruce woods) of various degrees of humidification, in brook valleys, on rotten wood, fallen trees and bare sandy soil. Sporadic.
- CEPHALOZIA CONNIVENS (Dicks.) Lindb. – 10, 27, 32, 47, 59, 60. Between *Sphagnum* mosses in boggy forests and on (mainly oligotrophic) forest mires, on bare peat, at the foot of trees, less frequent on sandy soil in dry woods and at sloping riverbanks, sometimes on rotten wood. Frequent.
- CEPHALOZIA LOITLESBERGERI Schiffn. – 10, 28. On trunk buttresses on pine/dwarf shrub *Sphagnum* bogs and in boggy pine forests. Rare.
- CEPHALOZIA LUNULIFOLIA (Dumort.) Dumort. (*Cephalozia media* Lindb.) – 10, 16, 18, 20, 21, 32, 43. In small-leaved and coniferous forests of various types, on rotten timber and forest soil, less frequent on peat, fallen trees or sandy soil. Frequent.
- CEPHALOZIA PLENICEPS (Austin) Lindb. – 12, 17, 21, 40, 41, 43, 48, 53. Mainly on mires, on hummocks, at the foot of trees and on bark of pine stumps, among several *Sphagnum* species (including *Sphagnum centrale* C.E.O. Jensen et al.). Sporadic.
- CEPHALOZIELLA DIVARICATA (Sm.) Schiffn. (*Cephalozia byssacea* (A. Roth.) Warnst.) – 10, 43. On sandy soil, in relatively dry pine forests. Growing mixed with *Buxbaumia apophylla* Hedw. Rare.
- #CEPHALOZIELLA ELACHISTA (J.B.Jack ex Gottsche et Rabenh.) Schiffn. – 50. On mesotrophic mire, among *Sphagnum* and *Hypnum* mosses, frequently mixed with other liverworts. Very rare. Data Deficient.
- CEPHALOZIELLA HAMPEANA (Nees) Schiffn. – 10, 32, 44. At sides of forest paths, on soil among *Ceratodon purpureus* (Hedw.) Brid., *Polytrichum* sp., on a hummock near tree trunk in a wet grassy birch forest. Rare.
- CEPHALOZIELLA RUBELLA (Nees) Warnst. – 10. On soil in relatively dry pine forests, at edges of ditches, on rotten timber. Sporadic.
- CEPHALOZIELLA SPINIGERA (Lindb.) Warnst. – 29, 48, 60. On meso- and oligotrophic pine/dwarf shrub *Sphagnum* mires, on tussocks, among *Sphagnum*. Rare.
- CHILOSCYPHUS PALLESCENS (Ehrh. ex Hoffm.) Dumort. – 10, 12, 16, 17, 20, 47. In wet forests (mainly spruce and birch woods) and stream gullies, on soil, fallen trees, less frequently on fallen leaves and rotten timber. Sporadic.
- CHILOSCYPHUS POLYANTHOS (L.) Corda – 10, 16, 18, 19, 20, 21, 43, 49, 55, 56. In wet and boggy, less frequent in dry spruce woods and small-leaved forests, at shrubby and mesotrophic mires and their edges, on rotten timber, fallen trees, less frequently on bark and on soil among fallen leaves. Frequent.
- CHILOSCYPHUS RIVULARIS (Schrad.) Hazsl. – 1. On banks and rapids of a rapid dark-water stream with sandy-rocky ground. Rare.
- CLADOPODIELLA FLUITANS (Nees) H.Buch – 10, 28, 59, 60. In wet hollows and between tussocks of mesotrophic and oligotrophic mires, and also at edges of small lakes on bare peat between and on *Sphagnum* mosses. Sporadic.
- CONOCEPHALUM CONICUM (L.) Dumort. – 9, 11, 12, 17, 20, 25, 30, 34, 48. On shrubby and forest-covered banks of brooks and on stones in beds of small streams, in boggy small-leaved forests, on wet soil, less frequently on fallen trees. Frequent.
- \*CONOCEPHALUM SALEBROSUM Szweykowski et al. – 61. On forest-covered river bank on wet soil. Very rare.
- CROSSOCALYX HELLERIANUS (Nees ex Lindenb.) Meyl. (*Anastrophyllum hellerianum* Schust.) – 34. On rotten timber in a wood-sorrel (*Oxalis*) spruce forest. Very rare.
- CROSSOGYNA AUTUMNALIS (DC.) Schljakov (*Jamesoniella autumnalis* (DC.) Steph.) – 43. Mire. Very rare.
- #FRULLANIA BOLANDERI Austin – 34. On spruce and stumps of elms and rowans in mixed broad-leaved forest. Very rare. Critically Endangered.

- GYMNOCOLEA INFLATA (Hads.) Dumort. – 10, 44. On peaty soil and rotten timber at the edges of boggy ditches and on mires. Rare.
- ISOPACHES BICRENATUS (Schmidel ex Hoffm.) H. Buch (*Lophozia bicrenata* (Hoffm.) Dum.) – 10. On sandy, less frequent loamy soil in dry woods and at the banks of the Rybinsk reservoir. Sporadic.
- LEIOCOLEA HETEROCOLPOS (Thed. ex Hartm.) H. Buch var. HETEROCOLPOS – 10. On soil at eroded sloping riverbank. Very rare.
- LEIOCOLEA RUTHEANA (Limpr.) Müll. Frib. – 57. Eutrophic mire site saturated by groundwater, in *Sphagnum* cover. Very rare.
- LEPIDOZIA REPTANS (L.) Dumort. – 6, 10, 16, 18, 20, 21, 23, 25, 43, 47, 56. In coniferous and small-leaved forests, on rotten stumps, rotten timber, at foot of birch trunks, on peaty soil in boggy forests and on eutrophic and mesotrophic forest mires. Very frequent.
- LIOCHLAENA LANCEOLATA Nees – 20, 21, 60. On bare peat at sedge tussocks and on super-humid semi-rotten stumps of *Salix aurita* L. at shrubby edges of eutrophic and mesotrophic mires. Rare.
- LOPHOCOLEA BIDENTATA (L.) Dumort. – This species has been indicated for the Vologda Region without geographical and ecological data (Andreeva, 2002). Rare.
- LOPHOCOLEA CUSPIDATA (Nees) Limpr. (*Lophocolea alata* Mitt. et Larter) – 36. In alder forest at the foot of a tree. Very rare.
- LOPHOCOLEA HETEROPHYLLA (Schrad.) Dumort. – 8, 10, 16, 20, 21, 27, 32, 34, 36, 47, 48, 52, 53. In forests of all types, streamside shrubs, on mesotrophic and oligotrophic mires, at the edges of eutrophic bogs, on rotten timber and on bark of the lower parts of birch, alder, willow, aspen, spruce, and lime trunks, frequent on fallen trees, on fine earth between roots of fallen trees, sometimes on soil and on fallen spruce trees covered with sandy-silty sediments. Also found on *Sphagnum centrale* and among *Plagiothecium* sp. Very frequent.
- LOPHOCOLEA MINOR Nees – 7, 10, 14, 20, 32. In aspen forests, on bark, roots and at foot of aspen trees, less frequent on decomposed timber and on soil at sloping stream banks. Sporadic.
- LOPHOZIA EXCISA (Dicks.) Dumort. var. EXCISA (*Jungermannia socia* Nees ab. Es.) – 10, 20, 37. On sandy and podzolic soils in dry leafy and mixed forests. Rare.
- LOPHOZIA LONGIDENS (Lindb.) Macoun – 17, 20, 42, 47. On rotten timber, less frequent at the foot of trees and on tree roots in coniferous (mainly spruce forests) and small-leaved forests. Rare.
- LOPHOZIA SILVICOLA H. Buch – 26, 60. On super-humidified semi-rotten stumps of *Salix aurita* in shrubby sedge-*Menyanthes-Sphagnum* bog edge, mainly on rotten timber in coniferous forests. Rare.
- LOPHOZIA VENTRICOSA (Dicks.) Dumort. var. VENTRICOSA – 18, 39, 40, 47. In spruce woods of various degrees of humidity, on mires, on bark and rotten timber. Sporadic.
- var. GUTTULATA (Lindb. et H.W. Arnell) Bakalin (*Lophozia longiflora* (Nees) Schiffn. var. *guttulata* (Lindb. et H. Arn.) Schljak.) – 10, 20. In spruce woods and aspen forests, on rotten timber and decomposed fallen trees.
- var. LONGIFLORA (Nees) Macoun (*Lophozia porphyroleuca* (Nees) Schiffner; *L. longiflora* (Nees) Schiffn. var. *longiflora* (Nees) Schiffn.) – 10, 43. On soil in forests.
- LOPHOZIA WENZELI (Nees) Bakalin var. GROENLANDICA (*Lophozia groenlandica* (Nees) Macoun.; *L. confertifolia* Schiffn.) – 10. On soil, trunk buttress, rotten timber in mixed and coniferous forests. Rare.
- MARCHANTIA POLYMORPHA L (*Marchantia aquatica* (Nees) Burgeff) – 6, 10, 34. On silty soil on banks of forest brooks and on shallow banks of the Rybinsk reservoir, less frequent in river valleys on soil among large sedge clumps. Rare.
- MARCHANTIA STELLATA Scop. (*Marchantia polymorpha* auct.) – Reliably known in over 50 sampling sites from Babaevo, Velikiy Ustug, Verkhovazh'e, Vozhega, Vologda, Vytegra, Kirillov, Sokol, Syamzha, Tot'ma, Cherepovets districts on bare wet soils in grassy forests, on stream banks, brooks, sites of old fires, on eutrophic grassy bogs, on soil between bricks of walls and paths of Kirillovo-Belozerskiy Monastery and Spaso-Prilutskiy Monastery. Very frequent.
- MARSUPELLA AQUATICA (Lindenb.) Schiffn. – 4. In rapid poorly-mineralized streams on siliceous boulders, usually together with *Scapania undulata* and *Fontinalis dalecarlica* Bruch et al. Rare.
- MYLIA ANOMALA (Hook.) Gray – 10, 12, 27, 28, 39, 43, 51, 52, 59. On mesotrophic and oligotrophic mires on hummocks and in hollows, less frequent on hummocks around trunks, on bare peat, sometimes among *Sphagnum* mosses. Frequent.

- NARDIA GEOSCYPHUS (De Not.) Lindb. – 10. On soil in a wet coniferous forest. Very rare.
- OBTUSIFOLIUM OBTUSUM (Lindb.) S.W.Arnell (*Lophozia obtusa* Evans) – 32. On soil at sloping riverbank. Very rare.
- ODONTOSCHISMA DENUDATUM (Mart.) Dumort. – 10. On peaty soil of a path at the edges of raised bogs. Very rare.
- #ORTHOCAULIS FLOERKEI (F.Weber et D.Mohr) H.Buch (*Barbilophozia floerkei* (F. Weber et D. Mohr) Loeske) – 50. On a mesotrophic mire, among leafy mosses and on trunk buttress. Very rare. Endangered.
- ORTHOCAULIS KUNZEANUS (Huebener) H.Buch (*Barbilophozia kunzeana* (Hübener) Buch) – 44, 53. On meso-olygotrophic pine/dwarf shrub *Sphagnum* mire, on bark and burls of pine, and also on *Sphagnum centrale*. Rare.
- PELLIA ENDIVIIFOLIA (Dicks.) Dumort. – 11, 30, 32. On wet soil at sloping stream bed, especially near the water (at bank-water interface). Together with other species of *Pellia* and *Marchantia*. Rare.
- PELLIA EPIPHYLLA (L.) Corda. – 1, 2, 3, 4, 10, 15. On soil in humid forests of various types, on steep banks of streams, forming Association *Pellio-Conocephaletum* Maas 1959 var. *Pellia epiphylla*. Sporadic.
- PELLIA NEESIANA (Gottsche) Limpr. – 10, 16, 20. On wet soil in spruce forest and in pine wood, on sandy soil of a fire-protection ditch. Rare.
- PLAGIOCHILA ASPLENIOIDES (L. emend. Taylor) Dumort. (*Plagiochila major* (Nees) S. W. Arnell) – 5, 20, 25, 31, 32, 43, 44, 45. In wood-sorrel (*Oxalis*) and wood-sorrel/blueberry spruce and spruce/aspens forests, and also at eroded banks of ravines and brooks, on soil. Sporadic.
- PLAGIOCHILA PORELLOIDES (Torr. ex Nees) Lindenb. – 10, 18, 19, 20, 30, 37, 43, 48. In boggy spruce woods, at the edges of eutrophic mires, in stream gullies, on wet almost bare soil, less frequently on rotten timber, fallen leaves and twigs, trunk buttress and at foot of aspens. Very frequent.
- PLECTOCOLEA HYALINA (Lyell) Mitt. (*Jungermannia hyalina* Lyell.) – 10. Sandy stream bank, on soil. Very rare.
- PREISSIA QUADRATA (Scop.) Nees – 11. On soil on sloping riverbank. Very rare.
- PTILIDIUM CILIARE (L.) Hampe – 10, 18, 45. On soil in dry moss-lichen pine forests, on bark and at foot of trees in boggy spruce woods. Rare.
- PTILIDIUM PULCHERRIMUM (Weber) Vain. – Widespread all over the region. It is reliably known (over 100 specimens in recent years) from Verkhovazh'e, Vozhega, Vytegra, Kirillov, Sokol, Syamzha, Tarnoga, Tot'ma, Cherepovets districts. In small-leaved, mixed and coniferous forests of various humidity levels, on bark, lower limbs, tree burls, at the foot of trees (frequent on birch, aspen, less frequent on alder, rowan tree, spruce, juniper, lime), rotten timber and fallen trees, seldom on rocks. Very frequent.
- RADULA COMPLANATA (L.) Dumort. – 12, 13, 14, 18, 20, 21, 38, 46, 47, 60. In mixed forests and at the edges of mires, on bark of deciduous trees (aspen, rowan, less frequently alder), sporadic on fallen leaves of *Populus suaveolens* Fisch. Very frequent.
- RICCARDIA LATIFRONS (Lindb.) Lindb. – 20, 32, 40, 47. On rotten timber in spruce and birch woods, on forest bogs. Sporadic.
- RICCARDIA PALMATA (Hedw.) Carruth. – 16, 43, 45. On rotten timber in mossy pine wood. Rare.
- #RICCIA CANALICULATA Hoffm. – 10. On the banks of water bodies on wet silty soil among grassy vegetation. Very rare. Critically Endangered.
- RICCIA CAVERNOSA Hoffm. – 10. On silty soil of banks in the flooded zone of Rybinsk reservoir. Rare.
- RICCIA FLUITANS L. – 10, 46. On lake banks, wet silt, or on exposed soil near water line of water bodies, and in open water of flooded sedge meadows and black alder wood around beaver ponds. Sporadic.
- RICCIA HUEBENERIANA Lindenb. – 4. In a very rapid stony stream, on siliceous boulders. Rare.
- RICCIA SOROCARPA Bisch. – 14. In a track rut on a path. Very rare.
- RICCIOCARPOS NATANS (L.) Corda – 10, 22, 54. In shallow slow-moving streams, bays of streams and lakes, at the edges of floodplain lakes, between sedge-reed beds. Rare.
- SCAPANIA CURTA (Mart.) Dumort. var. CURTA – 10, 32, 33, 47. On sandy soil on sloping stream banks, on forest edges and along paths in small-leaved forests. Sporadic.
- SCAPANIA IRRIGUA (Nees) Nees – 5, 16, 32, 47, 56, 60. On soil, less frequent on rotten wood in boggy birch and mixed forests, at the edges of *Sphagnum* mires, on wet soil of sloping stream banks and ditch edges, less frequent on tussock sides in bogs. Frequent.
- SCAPANIA PALUDICOLA Loeske et Müll.Frib. – 53. Mesotrophic margin of a raised bog, sedge-

*Hypnum-Sphagnum* willow wood, on trunk buttress of *Salix cinerea* L. and on sedge-*Hypnum-Sphagnum* carpet by shrubs. Rare.

\*SCAPANIA SUBALPINA (Nees ex Lindenb.) Dumort. – 62, 63. On a semi-submerged log and rocks near the stream bank. In pure patches or mixed with *Chiloscyphus polyanthos*. Rare.

SCAPANIA UNDULATA (L.) Dumort. – 1, 3, 4, 30. On soil at wet meadows, in beds of small streams, on stones, less frequently on wet timber. On siliceous boulders in rapid streams together with *Marsupella aquatica* (Association. *Scapanietum undulatae* Schwick. 1944; Bobrov & Chemeris, 2004). Sporadic.

SCHISTOCHILOPSIS INCISA (Schr.) Konstant. (*Lophozia incisa* (Schr.) Dum.) – 18, 20, 32, 40, 43, 47. In spruce woods (mainly boggy), on rotten wood, decomposed fallen trees and on soil. Sporadic.

SOLENOSTOMA CAESPITICUM (Lindenb.) Steph. (*Jungermannia caespiticia* Lindenb.) – 10. On soil at the edge and bottom of a dry ditch in a dry pine wood. Very rare.

#SOLENOSTOMA SPHAEROCARPUM (Hook.) Steph. (*Jungermannia sphaerocarpa* Hook.) – 32, 40. On bare soil at sloping stream banks and on bare peat in bogs. Rare. Near threatened.

\*TRICHOCOLEA TOMENTELLA (Ehrh.) Dumort. – 48. In humid meadowsweet (*Filipendula*)/mossy spruce forest, on wet soil. Very rare.

#### ANTHOCEROTOPHYTA

PHAEOCEROS LAEVIS (L.) Prosk. – 10. On a channel bank, on sandy soil. Very rare.

## RESULTS AND DISCUSSION

We report a total of 84 species and two varieties of liverworts from 42 genera and 22 families for the Vologda Region. Most of the liverwort species belong to subclasses *Jungermanniiidae* and *Marchantiidae* of division *Marchantiophyta* and only one species *Phaeoceros laevis* to division *Anthocerotophyta*.

Three liverwort species, *Conocephalum salebrosum*, *Scapania subalpina* and *Trichocolea tomentella* are listed for the first time for the Vologda Region.

Seven liverwort species are included in the Red Data Book of the Vologda Region (Konechnaya & Suslova, 2004) (Table 1).

All red-listed species are known only from rare occurrences, except for *Barbilophozia lycopodioides* and *Solenostoma sphaerocarpum*, both found at two geographical sites. Three montane species, *Apometzgeria pubescens*, *Orthocaulis floerkei*, and *Frullania bolanderi*, can be considered objectively rare owing to the absence or extreme scarcity of available habitats. The latter species is a relic. In Europe it is known only from several localities in Norway and Sweden (Damsholt, 2002). In Russia it was found in the Caucasus, the Northern and the Southern Urals, the Altay, West Siberia, Yakutiya, and the Far East including Sakhalin and Kamchatka (Konstantinova et al., 1992). *Cephaloziella elachista*, a boreal Atlantic liverwort, is found further to the north in the Komi Republic and Karelia (Bakalin, 1999; Dulin, 2008) and most likely it

**Table 1.** Rare liverwort species in the flora of the Vologda Region. Localities in the list of collecting sites and Fig. 1. Each locality represents only one finding.

Taxa	Threat category	No of localities	Habitat	Substrate
<i>Apometzgeria pubescens</i>	Critically Endangered	47	Boggy spruce forest	Among forest mosses
<i>Barbilophozia lycopodioides</i>	Least Concern	12, 47	Blueberry and humid small-leaved/spruce forests	On forest litter
<i>Cephaloziella elachista</i>	Data Deficient	50	Mesotrophic mire	Among <i>Sphagnum</i> and <i>Hypnum</i> mosses
<i>Frullania bolanderi</i>	Critically Endangered	34	Coniferous/broad-leaved forest	On stumps of elm and rowan
<i>Orthocaulis floerkei</i>	Endangered	50	Mesotrophic mire	Among leafy mosses
<i>Riccia canaliculata</i>	Critically Endangered	10	Banks of a water body	On wet silty soil
<i>Solenostoma sphaerocarpum</i>	Near threatened	32, 40	Peat bog and sloping stream bank	On bare soil



is overlooked during collecting owing to its tiny size. The nemoral amphiatlantic liverwort *Riccia canaliculata* obviously has the north-eastern limit of its distribution in the region. The rarity of arctic-boreal circumpolar *Barbilophozia lycopodioides* and *Solenostoma sphaerocarpum* is presumably caused by insufficient study of regional bryoflora, and without any doubt future study will reveal new localities for these species. We recommend excluding *Barbilophozia lycopodioides* and *Solenostoma sphaerocarpum* from the threatened species list of the Red Data Book and propose including some rare species to it (*Crossocalyx hellerianus*, *Lophocolea cuspidata*, *Marsupella aquatica*, *Odontoschisma denudatum*, *Phaeoceros laevis*, *Riccia cavernosa*, *Trichocolea tomentella*).

Among the new discoveries, *Conocephalum salebrosum*, a recently described taxon (Szweykowski et al., 2005) is of interest. An insufficient knowledge coupled with considerable morphological similarity to the closely allied species, *C. conicum*, made it difficult to identify *C. salebrosum* both in the field and during processing of collections. However, a careful revision of our collections enabled us to detect *C. salebrosum* among samples previously identified by us as *C. conicum*. Although *C. salebrosum* is cited only from one locality, we predict that it has a wider distribution than currently reported.

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## REFERENCES

- Abramova, A.L. & Abramov, I.I. 1961. *Metzgeria pubescens* (Schrank) Raddi in the North East of Europe. (In Russian). *Bot. materials. Dept. of Spor. Plants of the Bot. Inst. AS USSR* 14: 279–281.
- Ahti, T. & Boychuk M. 2006. The botanical journeys of A.K. Cajander and J.I. Lindroth to Karelia and Onega River in 1898 and 1899, with a list of their bryophyte and lichen collections. *Norrinia* 14: 1–65.
- Akhminova, M.P. & Zhukova A.L. 1971. To the liverwort flora of the Vologda Region (In Russian). *News of lower plants systematics* 8: 345–354.
- Andreeva, E.N. 2002. Specific features of distribution of liverworts in the Vologda Region. (In Russian). *Problems of bryology on the boundary of centuries. Proceeding of the International conference devoted to 90-th anniversary of R.N. Shlyakov & I.I. Abramov (Saint Petersburg, November, 4–6, 2002)*: 13–15.
- Arnell, S. 1956. *Illustrated Moss Flora of Fennoscandia I. Hepaticae*. Lund. 308 pp.
- Bakalin, V.A. 1999. Liverworts of Karelia. (In Russian). *Arctoa* 8: 17–26.
- Bakalin, V.A. 2005. *Monograph of the genus Lophozia (Dumort.) Dumort. s. str.* (In Russian). Moscow: Nauka. 239 pp.
- Bobrov, A.A. & Chemeris E.V. 2004. Vegetation of rivers and brooks of the Vepsovskaya elevation, a unique area in the Upper Volga. (In Russian). *Environmental problems of the unique natural and man-created landscapes: Materials of All-Russia Pract. Conf. Yaroslavl*: 73–79.
- Bobrov, A.A. & Chemeris E.V. 2005. Specific feature of river vegetation of Vepsovskaya elevation (Vologda Region). (In Russian). *Biological Resources of the White Sea and inner reservoirs of the European North: Collected volume of works of IV (XXVII) Intern. Conf. dedicated to the memory of Prof. L.A. Zhakov (Vologda, Russia, 5–10 December 2005)*. Part 1: 56–59.
- Bobrov, A.A. 2005. Flora of beaver ponds of Darwin reserve. (In Russian). In: Abaturon, B.D. (ed.) *Impact of the European beaver on small river ecosystems*: 75–117.
- Buch, H. 1933. Vorarbeiten zu einer Lebermoosflora Fennoskandias: I. Ein Versuch zur Aufteilung Gattungen *Lophozia* Dum. und *Sphenobolus* Steph. *Mem. Soc. Fauna Flora Fenn.* 8: 282–297.
- Coxson, D.S., McIntyre, D.D. & Vogel, H.J. 1992. Pulse release of sugars and polyols from canopy bryophytes in tropical montane rainforest (Gadeloupe, French West Indies). *Biotropica* 24: 121–133.
- Damsholt, K. 2002. *Illustrated flora of Nordic liverworts and hornworts*. Lund: Nordic Bryological Society. 837 pp.
- Dulin, M.V. 2008. The preliminary check-list of liverworts of the Komi Republic. *Folia Cryptogam. Estonica* 44: 17–21.
- Frahm, J.-P. 1990. The altitudinal zonation of bryophytes on Mt. Kinabulu. *Nova Hedwigia* 51: 121–132.
- Gignac, L.D. 2001. Bryophytes as indicators of climate change. *The Bryologist* 104 (3): 410–420.

- Gradstein, R.S., Churchill, S. & Allen, S. 2001. Guide to the bryophytes of tropical America. *Memoirs of the New York Botanical Garden* 86: 1–577.
- Grolle, R. & Long, D.G. 2000. An annotated checklist of the Hepaticae and Anthocerotae of Europe and Macaronesia. *Journal of Bryology* 22(2): 103–140.
- Hallingbäck, T. & Hodgetts N. (eds.). 2000. *Status survey and conservation action plan for Bryophytes. Mosses, Liverworts and Hornworts*. 106 pp.
- Karmazina, E.V. & Andreeva, E.N. 2004. To the bryoflora of the National Park “Russkiy Sever”. (In Russian). *Material of VIII conference of young botanist in Saint-Petersburg (Saint-Petersburg, 17–21 May 2004)*: 100–101.
- Konechnaya, G.Yu. & Suslova, T.A. (eds.). 2004. *Red Data Book of the Vologda Region. Plant & Fungi*. (In Russian). Vologda. 359 pp.
- Konstantinova, N.A. & Potemkin, A.D. 1996. Liverworts of the Russian Arctic: an annotated checklist and bibliography. *Arctoa* 6: 125–150.
- Konstantinova, N.A. & Vasiljev, A.N. 1994. On the hepatic flora of Sayan Mountains (South Siberia). *Arctoa* 3: 123–132.
- Konstantinova, N.A., Potemkin, A.D. & Schlyakov, R.N. 1992. Check-list of the Hepaticae and Anthocerotae of the former USSR. *Arctoa* 1: 87–127.
- Lepyokhin, I.I. 1780. *Diary of travel of doctor and adjunct of the Academy of Science in various provinces of the Russian State*. (In Russian). Part 3. 376 pp.
- O'Neill, K.P. 2000. Bryophytes in the global carbon budget. In: Shaw, A.J. & Goffinet, B. (eds.) *Bryophyte Biology*: 344–368.
- Perfil'ev, I.A. 1914. List of mosses collected in the Vologda Guberniya and determined by Prof. Brotherus. (In Russian). *Works of Bot. Garden at Yuriev University* XIV (4): 295–300.
- Perfil'ev, I.A. 1915. Materials for the moss flora of the south-west part of the Vologda Guberniya (In Russian). *Izvestiya Vologodskogo obshchestva izucheniya Severnogo kraya* II: 87–88.
- Philippov, D.A. & Dulin, M.V. 2008. New species of liverworts to the flora of Vologda province. *Bulletin of Moscow society of naturalist. Biological series* 113 (6): 72–73.
- Pócs, T. 1980. The epiphytic biomass and its effect on the water balance of two rain forest types in the Uluguru mountains. *Acta Bot. Acad. Sci. Hung.* 26: 143–167.
- Schlyakov, R.N. 1980. *The Liverworts of the North of the Soviet Union, issue 3: Hepaticae: Lophozia-ceae – Mesoptychiaceae*. (In Russian). Leningrad: Nauka. 188 pp.
- Schlyakov, R.N. 1981. *The Liverworts of the North of the Soviet Union, issue 4: Hepaticae: Jungermanniaceae – Scapaniaceae*. (In Russian). Leningrad: Nauka. 221 pp.
- Skupinova, E.A. (eds.). 2007. *Atlas of the Vologda Region*. (In Russian). Saint-Petersburg. 107 pp.
- Szweykowski, J., Buczkowska, K. & Odrzykoski, I. 2005. *Conocephalum salebrosum* (Marchantiopsida, Conocephalaceae) – a new Holarctic liverwort species. *Plant Systematics & Evolution* 253 (1–4): 133–158.
- Vilnet, A.A., Milyutina, I.A., Konstantinova, N.A., Ignatov, M.S. & Troitsky, A.V. 2007. Phylogeny of the Genus *Lophozia* (Dumort.) Dumort. s. str. Inferred from Nuclear and Chloroplast Sequences ITS1-2 and TRNL-F. *Russian Journal of Genetics* 43 (11): 1306–1313.
- Volkova, L.A., Zhukova, A.L., Potemkin, A.D. & Nemtceva, N.D. 1994. Mosses of Darwin State Reserve. (In Russian). *Flora & vegetation of the Tver' Region. Collected volume of research papers*. P. 13–24.
- Vorob'ev G.A. (eds.). 2007. *Nature of the Vologda Region*. (In Russian). Vologda. 434 pp.
- Warnstorf, C. 1913. Bryogeographie des Russisches Reiches. *Hedwigia* 54: 53.
- Wellman, C.H., Osterloff, P. L. & Mohiuddin, U. 2003. Fragments of the earliest land plants. *Nature* 425: 282–285.
- Zickendrath, E. 1900. Beitrage zur Kenntniss der Moosflora Russlands. II. *Bulletin de la Société Imperiale des Naturalistes de Moscou* 14(3): 241–366.