



A CONTRIBUTION TO THE MOSS AND LIVERWORT FLORA OF THE REBERCE NATURE RESERVE AT THE PRZEMYŚL FOOTHILLS (WESTERN CARPATHIANS, POLAND)

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ABSTRACT. The paper presents the results of studies on bryophyte flora of the Reberce forest reserve located in the Przemyśl foothills. Thirty-three species of liverworts, 70 species and two varieties of mosses were found. Terrestrial (66 species) and epixylic (58) bryophytes formed the largest ecological groups in the reserve. Twenty-four protected species were also recorded, eight endangered bryophytes and six taxa considered as primeval forest species. The most interesting finds are: *Bazzania trilobata*, *Buxbaumia viridis*, *Calypogeia suecica*, *Cephalozia catenulata*, *Frullania dilatata*, *Metzgeria conjugata*, *Nowellia curvifolia*, *Orthotrichum lyellii*, *O. stramineum*, *Trichocolea tomentella* and *Ulota crispa*.

KEY WORDS: epixylic species, protected species, primeval forest species, endangered bryophytes, *Dentario glandulosae-Fagetum*

INTRODUCTION

Reberce is one of nine nature reserves located within the Przemyśl Foothills Landscape Park (PFLP) (Fig. 1.1). It was established in 1996 in order to protect the fragments of primeval fir forest with natural characteristics (JANICKI 2005, RAKOWSKI et al. 2007). The reserve is located in the Bircza Municipality of the Przemyśl District in the Bircza Forest District. The forest covers 190.96 ha and is one of the largest in that Landscape Park. The study area is adjacent to the disused small airport (JANICKI 2005).

The Przemyśl Foothills, which lay in the foreland of the Bieszczady Mountains, are relatively poorly known in respect of bryology. Most of the data is very fragmentary (REHMANN 1879, SZAFRAN 1968, KARZMARZ 1975, DZWONKO 1977, SZWEYKOWSKI & KOZŁIĆKA 1977, KOZŁOWSKA 2000, BEDNAREK-OCHYRA et al. 2011, STEBEL 2011, STEBEL et al. 2011, ZUBEL et al. 2011, ZARZECKI 2012, BARABASZ-KRASNY & SOŁTYS-LELEK 2014). The aim of this study was to recognise the diversity of bryophyte species of the Reberce reserve. This study is one of three (Chwaniów reserve – Stebel et al., Na Opalonym reserve – Fojcik et al.,

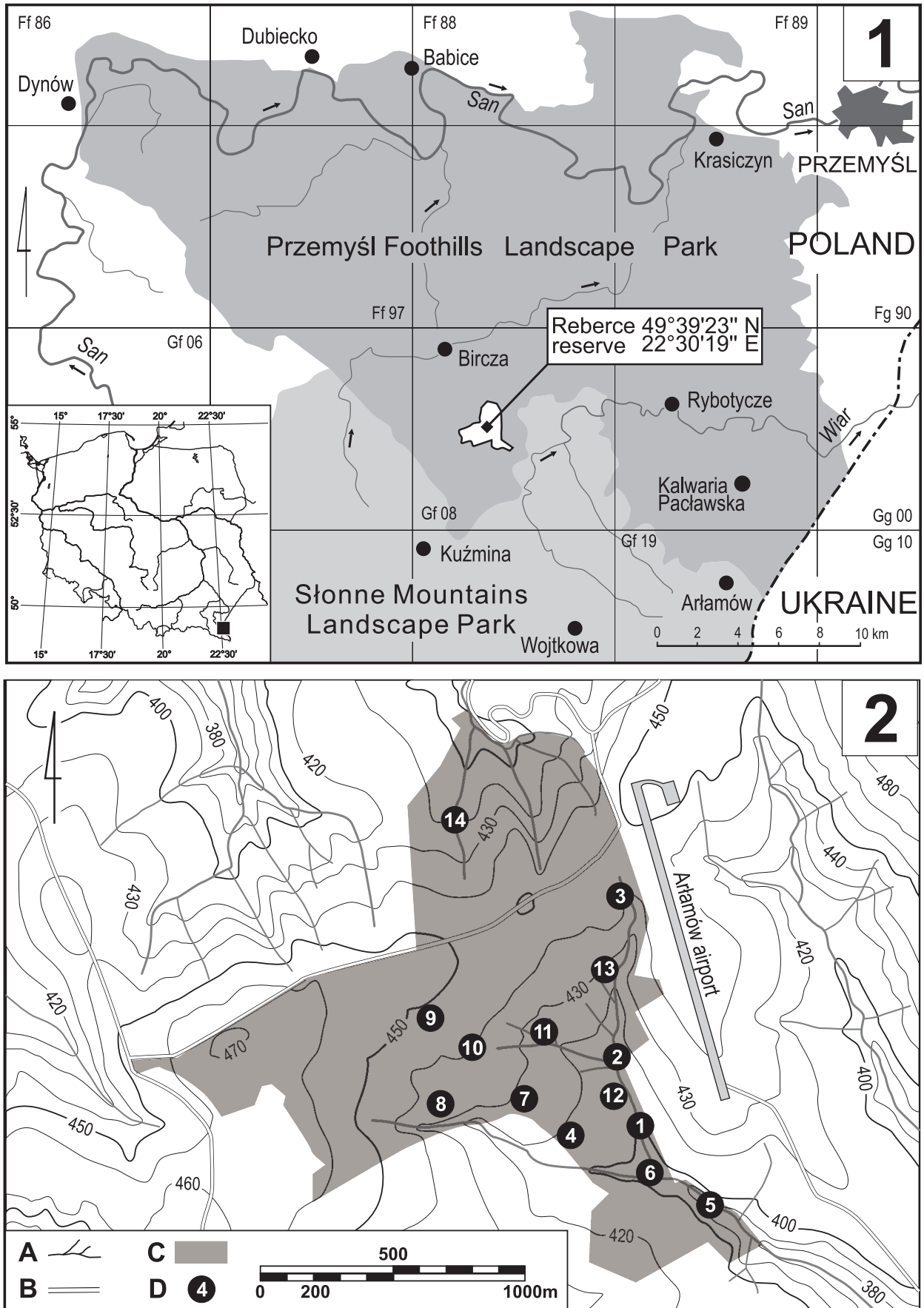


Fig. 1. 1 – Localization of the studied area in the Przemysł Foothills Landscape Park; 2 – Distribution of collecting sites in the Reberce nature reserve; A – rivers, B – roads, C – study area, D – collecting sites

both in preparation), that fill the gap in knowledge about the poorly described bryoflora of the Przemyśl Foothills and Sanocko-Turczańskie Mountains. Field study was conducted in September 2015 during the 13th Field Workshop organised by the Bryology Section of the Polish Botanical Society.

AREA CHARACTERISTICS

The Reberce nature reserve lies in the Kiczjerka range, a small group of hills in the southern part of the Przemyśl Foothills (the highest point is located at an altitude of 480 m a.s.l.), overgrown with forests administered by the Bircza Forest District. It includes six forest sections – 143, 144, 152, 153, 154 and 156. Several small streams, which are Wiar and Stupnica tributaries, flow through the reserve. The study area is dominated by floristically rich beech community *Dentario glandulosae-Fagetum* in its piedmont form. Tree stand, for the most part over 100 years old, is formed mainly by fir *Abies alba* mixed with beech *Fagus sylvatica*, elm *Ulmus glabra*, sycamore *Acer pseudoplatanus* and spruce *Picea abies* (JANICKI 2005). The entire reserve is located in Gf 08 ATMOS grid square (OCHYRA & SZMAJDA 1981).

MATERIALS AND METHODS

The bryophytes were studied at 14 localities (Fig. 1.2) of which most are situated in the central and eastern part of the reserve. Mosses and liverworts were noted on all available types of substrate (soil and humus, rocks, decaying wood and bark of living trees). Based on the number of localities, on which the species was identified, the frequency for each taxon was determined using a four-point scale: rare – 1–3 localities, fairly frequent – 4–6, frequent – 7–9, common – 10–14. Names for mosses and liverworts follow OCHYRA et al. (2003) and KLAMA (2006b) respectively.

Protected species are qualified according to the Regulation of the Minister of Environment from 9th October 2014 on the protection of plant species (Dz. U. 2014.1409). Endangered species in Poland and Polish part of Carpathians were determined on the basis of the current “Red lists” (ŻARNOWIEC et al. 2004, KLAMA 2006a). Bryophytes which are primeval forest relics were distinguished according to the studies of KLAMA (2002a, b) and STEBEL & ŻARNOWIEC (2014). Herbarium materials remain at the disposal of the individual authors.

All samples of bryophyte species were collected in accordance with Polish law and permission of The Regional Directorate for Environmental Protection; clearances no.: WPN.6205.51.2015.AKw-3 (20 July 2015) and WPN.6205.51.2015.AKw-4 (20 July 2015).

RESULTS

LIST OF SPECIES

Species on the list are arranged in systematic order. Following information was provided for each species: conservation status (before the names), threat category, frequency, list of localities, types of substrates on which it grew and the author of the collection initials at particular localities.

Abbreviations: ** – strictly protected species; * – partially protected species; threat categories: E – endangered, V – vulnerable, R – rare; loc. – locality; authors: AR – Anna Rusińska, AS – Adam Stebel, BCM – Beata Cykowska-Marzencka, BF – Barbara Fojcik, EF – Ewa Fudali, GV – Grzegorz Vončina, MSK – Monika Staniaszek-Kik, MSZ – Mirosław Szczepański, RZ – Robert Zubel. In the case of the most valuable species GPS coordinates are given.

MARCHANTIOPHYTA

Conocephalaceae: *Conocephalum conicum* (L.) Dumort. – fairly frequent (loc.: 1, 2, 6, 7, 13, 14), on wet soil and stone near stream, rarely on rotten wood [AR, BF, EF, GV, MSZ, RZ].

Pelliaceae: *Pellia endiviifolia* (Dicks.) Dumort. – fairly frequent (loc.: 1, 4, 5, 7, 13), wet soil and stone near stream [EF, GV, MSZ, RZ]; *Pellia epiphylla* (L.) Corda – rare (loc.: 1, 10), soil in valley of the stream [AS, BF, RZ].

Aneuraceae: *Riccardia latifrons* (Lindb.) Lindb. – fairly frequent (loc.: 1, 6, 7, 9, 14), decaying wood, mainly logs [MSK, MSZ, RZ]; *Riccardia multifida* (L.) Gray – rare (loc.: 1, 2), soil near stream [RZ]; *Riccardia palmata* (Hedw.) Carruth. – fairly frequent (loc.: 1, 2, 3, 6, 7), decaying wood, mainly logs [AR, EF, MSK, RZ].

Metzgeriaceae: *Metzgeria conjugata* Lindb. – V, frequent (loc.: 1, 2, 3, 7, 8, 10, 13), bark of *Abies alba*, *Carpinus betulus*, *Fagus sylvatica*, *Salix caprea* and *Tilia* sp., rarely decaying wood and wet soil near stream [AR, AS, EF, GV, MSK, RZ]; *Metzgeria furcata* (L.) Dumort. – rare (loc.: 2, 7) on the bark of *Carpinus betulus* and *Salix caprea* [MSZ, RZ].

Trichocoleaceae: *Trichocolea tomentella* (Ehrh.) Dumort. – frequent (loc.: 1, 2, 6, 7, 8, 9, 11, 12, 14), moist soil near streams, rarely decaying wood [AR, AS, BF, EF, GV, MSK, MSZ, RZ].

Pseudolepicoleaceae: *Blepharostoma trichophyllum* (L.) Dumort. – fairly frequent (loc.: 1, 2, 5, 7, 10, 13), decaying wood, mainly logs, wet soil, stones and base of trees (*Salix caprea*, *Tilia* sp.) [AS, EF, GV, MSK, MSZ, RZ].

Geocalycaceae: *Chiloscyphus polyanthos* (L.) Corda – rare (loc.: 10), moist soil near stream [AS]; *Lo-phocolea bidentata* (L.) Dumort. – fairly frequent (loc.: 1, 2, 6, 8), moist soil near stream, wet soil

- in herb community with *Chaerophyllum hirsutum*, rarely decaying logs [BF, GV, MSK]; *Lophocolea heterophylla* (Schrad.) Dumort. – fairly frequent (loc.: 1, 3, 6, 10), decaying wood [AS, EF, GV, MSK, RZ].
- Plagiochilaceae: **Plagiochila asplenioides* (L. emend. Taylor) Dumort. – frequent (loc.: 1, 2, 6, 7, 8, 11, 12, 14), bare soil (mainly near stream) and humus, decaying logs, stones in the stream and base of trunks of *Tilia* sp. [AR, AS, BF, EF, GV, MSK, RZ]; *Plagiochila porelloides* (Torrey ex Nees) Lindenb. – fairly frequent (loc.: 1, 2, 6, 7, 12, 13), decaying stumps and logs, base of trunks *Abies alba*, *Fagus sylvatica*, *Salix caprea* [AR, AS, BF, EF, GV, MSK, RZ].
- Calypogeaceae: *Calypogeia azurea* Stotler & Crotz – fairly frequent (loc.: 1, 2, 4, 6, 7), moist soil and stones near stream as well as rotten wood [AR, GV, MSK, RZ]; *Calypogeia integristipula* Steph. – rare (loc.: 8), decaying stump [AR]; *Calypogeia muelleriana* (Schiffn.) Müll. Frib. – fairly frequent (loc.: 1, 2, 3, 4, 9, 14), rotten wood and mineral soil in the forest and near the stream [EF, MSK, RZ]; *Calypogeia suecica* (Arnell & J. Perss.) Müll. Frib. – V; rare (loc.: 1, 6), decaying logs [GV, MSK, RZ].
- Lepidoziaceae: **Bazzania trilobata* (L.) Gray – fairly frequent (loc.: 1, 9, 10, 14), moist soil and rotten wood [AR, AS, MSK, MSZ, RZ]; *Lepidozia reptans* (L.) Dumort. – frequent (loc.: 1, 2, 3, 6, 7, 9, 12, 13, 14), decaying logs and stumps, rarely base of trunks *Abies alba* and mineral soil [AR, BF, EF, GV, MSK, MSZ, RZ].
- Cephaloziaceae: *Cephalozia bicuspidata* (L.) Dumort. – frequent (loc.: 1, 2, 3, 4, 5, 6, 10), rotten wood and moist soil near the stream, rarely humus and stones in the stream [AS, EF, GV, MSK, RZ]; ***Cephalozia catenulata* (Huebener) Lindb. – V, fairly frequent (loc.: 1, 2, 5, 6, 9), moist, rotten wood, especially large *Abies alba* logs [MSK, RZ]; *Cephalozia lunulifolia* (Dumort.) Dumort. – rare (loc.: 1, 2, 6), rotten wood [MSK, RZ]; **Nowellia curvifolia* (Dicks.) Mitt. – V, fairly frequent (loc.: 1, 5, 9, 10, 14), rotten wood, mainly logs [AS, GV, MSK, MSZ, RZ].
- Jungermanniaceae: *Jungermannia atrovirens* Dumort. – rare (loc.: 1, 7), sandstone stones in the stream [GV, MSK]; *Jungermannia leiantha* Grolle – fairly frequent (1, 2, 5, 6, 7), rotten wood and moist soil by the stream [GV, MSK, RZ]; *Jungermannia pumila* With. – rare (loc.: 1, 2, 5), soil and stones in the stream bed [RZ].
- Lophoziaceae: *Jamesoniella autumnalis* (DC.) Steph. – fairly frequent (loc.: 1, 2, 3, 13), trunks of *Salix caprea*, rotten wood, humus and stone in stream bed [EF, GV, RZ].
- Scapaniaceae: *Scapania undulata* (L.) Dumort. – rare (loc.: 13), moist soil [EF].
- Jubulaceae: **Frullania dilatata* (L.) Dumort. – rare (loc.: 3), decaying log [EF].
- Lejeuneaceae: *Lejeunea cavifolia* (Ehrh.) Lindb. – rare (loc.: 14), trunk of *Fagus sylvatica* (near the stream) [RZ].
- Radulaceae: *Radula complanata* (L.) Dumort. – fairly frequent (loc.: 1, 2, 3, 13), trunks of trees (*Abies alba*, *Salix caprea*) and rotten wood [EF, GV, RZ].
- BRYOPHYTA
- Sphagnaceae: **Sphagnum capillifolium* (Ehrh.) Hedw. – rare (loc.: 3), soil [EF]; **Sphagnum girgensohnii* Russow – rare (loc.: 9), soil [AR, MSK, MSZ]; **Sphagnum palustre* L. – rare (loc.: 3, 10), soil and wet humus [AS, EF, MSK]; **Sphagnum squarrosum* Crome – rare (loc.: 8, 9), soil [AR, MSK, MSZ].
- Polytrichaceae: *Atrichum undulatum* (Hedw.) P. Beauv. – common (loc.: 1, 2, 3, 4, 7, 8, 9, 10, 12, 13), exposed soil and humus in the forest and near the stream, root plate of uprooting trees, decaying logs [AR, AS, EF, GV, MSK, RZ]; *Polytrichastrum formosum* (Hedw.) G.L. Sm. – common (loc.: 1, 2, 3, 4, 6, 7, 8, 9, 10, 12, 13), soil, humus, root plate of uprooting trees and decaying logs [AR, AS, BF, EF, GV, MSK, MSZ, RZ]; **Polytrichum commune* Hedw. – rare (loc.: 1), rotten wood near the stream [RZ].
- Tetraphidaceae: *Tetraphis pellucida* Hedw. – frequent (loc.: 1, 2, 3, 6, 7, 10, 13), decaying logs and stumps, base of trees of *Abies alba* and root plates of uprooting trees [AR, AS, BF, EF, GV, MSK, MSZ, RZ].
- Buxbaumiaceae: ***Buxbaumia viridis* (Moug. ex Lam. & DC.) Brid. ex Moug. & Nestl. – E, rare (loc.: 6 – N 49°39'01.4", E 22°30'45.2"), moist, decaying logs of *Abies alba* [AR, BCM, MSK, MSZ].
- Fissidentaceae: *Fissidens bryoides* Hedw. – fairly frequent (loc.: 1, 2, 3, 8), moist soil and boulders in the stream [BF, GV, MSZ, RZ]; *Fissidens pusillus* (Wilson) Milde – rare (loc.: 5, 7, 11), boulders and moist soil in the stream [AS, MSK, RZ]; *Fissidens taxifolius* Hedw. – fairly frequent (loc.: 1, 2, 6, 12), steep slopes soil, moist soil and boulders in the stream bed, root plate of uprooting trees [BF, EF, GV, MSK, MSZ].
- Dicranaceae: *Dichodontium pellucidum* (Hedw.) Schimp. – frequent (loc.: 1, 2, 5, 6, 7, 8, 11, 12), stones, moist soil and gravel in the stream bed [AR, AS, BF, EF, GV, MSK, MSZ, RZ]; *Dicranella heteromalla* (Hedw.) Schimp. – frequent (loc.: 1, 2, 3, 7, 8, 9, 10, 13), mineral soil, decaying logs, root plates of uprooting trees, base of trees [AR, AS, BF, EF, MSK, MSZ, RZ]; *Dicranella varia* (Hedw.) Schimp. – rare (loc.: 7), moist, loamy soil in the stream bed [AR, MSK]; *Dicranodontium denudatum* (Brid.) E. Britton – common (loc.: 1,

- 2, 3, 6, 7, 8, 9, 10, 12, 13), decaying stumps and logs, humus [AR, AS, BF, EF, GV, MSK, MSZ, RZ]; **Dicranum polysetum* Sw. – rare (loc.: 1), mineral soil near the stream [RZ]; **Dicranum scoparium* Hedw. – frequent (loc.: 1, 2, 6, 7, 8, 10, 12, 13), decaying logs, bark of trees (*Abies alba*, *Corylus avellana*, *Salix caprea*), soil and humus in forest [AR, AS, BF, EF, GV, MSK, MSZ, RZ]; *Orthodicranum montanum* (Hedw.) Loeske – frequent (loc.: 1, 3, 6, 7, 8, 9, 10, 12, 13), bark of trees (*Abies alba*, *Corylus avellana*, rotten wood [AR, AS, BF, EF, GV, MSK, MSZ]).
- Orthotrichaceae: **Orthotrichum lyellii* Hook. & Taylor – R, rare (loc.: 3), bark of *Abies alba* [EF]; *Orthotrichum pumilum* Sw. – rare (loc.: 1), bark of *Acer pseudoplatanus* [GV]; *Orthotrichum speciosum* Nees – rare (loc.: 13), decaying log [EF]; *Orthotrichum stramineum* Hornsch. ex Brid. – V, rare (loc.: 1), bark of *Acer pseudoplatanus* [GV]; **Ulota crispa* (Hedw.) Brid. – V, rare (loc.: 1), bark of *Corylus avellana* [GV].
- Bryaceae: *Pohlia melanodon* (Brid.) A.J. Shaw – rare (loc.: 1, 3), wet soil near the stream [BF]; *Pohlia nutans* (Hedw.) Lindb. – rare (loc.: 1, 2), mineral soil near the stream [RZ]; *Pohlia wahlenbergii* (F. Weber & D. Mohr) A.L. Andrews – rare (loc.: 1, 3, 7), moist soil and stone near the stream [AR, BF, GV, MSK, MSZ]; *Rosulabryum moravicum* (Podp.) Ochyra & Stebel – rare (loc.: 10), bark of tree [AS].
- Cinclidiaceae: *Rhizomnium punctatum* (Hedw.) T.J. Kop. – frequent (loc.: 1, 2, 3, 6, 7, 8, 10, 12, 13), decaying logs, wet stone and mineral soil [AR, AS, BF, EF, GV, MSK, MSZ, RZ].
- Plagiomniaceae: *Plagiomnium affine* (Blandow ex Funck) T.J. Kop. – frequent (loc.: 1, 2, 3, 6, 7, 8, 9, 10, 13), soil and humus on the slopes along the stream and decaying logs in the forest [AR, AS, BF, EF, GV, MSK, MSZ, RZ]; *Plagiomnium elatum* (Bruch & Schimp.) T.J. Kop. – rare (loc.: 1), moist soil in communities of tall herb near the stream [BF, GV]; *Plagiomnium undulatum* (Hedw.) T.J. Kop. – frequent (loc.: 1, 2, 3, 6, 7, 8, 13), moist soil and humus along streams and springs [AR, BF, EF, GV, MSK, MSZ, RZ].
- Echinodiaceae: *Isothecium alopecuroides* (Lam. ex Dubois) Isov. – frequent (loc.: 1, 2, 6, 7, 8, 10, 12, 13), trunks and bases of deciduous trees (*Carpinus betulus*, *Populus tremula*) and coniferous trees (*Abies alba*), stones and rotting logs [AR, AS, BF, EF, GV, MSZ].
- Pterigynandraceae: *Pterigynandrum filiforme* Hedw. – rare (loc.: 1), rotten wood of *Abies alba* [GV].
- Thuidiaceae: **Thuidium tamariscinum* (Hedw.) Schimp. – common (loc.: 1, 2, 3, 4, 6, 7, 8, 9, 10, 12, 13), mineral soil, humus, rotten wood, tree bases of *Abies alba* [AR, AS, BF, EF, GV, MSK, MSZ, RZ].
- Hylocomiaceae: **Pleurozium schreberi* (Willd. ex Brid.) Mitt. – frequent (loc.: 1, 2, 7, 8, 9, 10, 12, 13), mineral soil and humus, decaying logs [AR, BF, EF, GV, MSK, RZ]; **Rhytidiadelphus squarrosus* (Hedw.) Warnst. – rare (loc.: 1), mineral soil [GV]; *Rhytidiadelphus subpinnatus* (Lindb.) T.J. Kop. – fairly frequent (loc.: 1, 2, 3, 8, 9, 10), moist soil and humus, decaying logs [AR, AS, BF, EF, MSK, MSZ, RZ].
- Cratoneuraceae: *Cratoneuron filicinum* (Hedw.) Spruce – fairly frequent (loc.: 1, 2, 6, 7, 11, 12), moist soil and boulders in the streams [AR, AS, BF, EF, GV, MSK].
- Brachytheciaceae: *Brachytheciastrum velutinum* (Hedw.) Ignatov & Huttunen – frequent (loc.: 1, 2, 3, 6, 8, 10, 13), decaying logs, bark of deciduous trees *Carpinus betulus* and *Salix caprea*, mineral soil and boulders [AR, AS, BF, EF, GV, MSK, RZ]; *Brachythecium rivulare* Schimp. – fairly frequent (loc.: 3, 6, 7, 8, 11), wet logs and boulders in the stream, mineral soil in springs and marshes [AR, AS, EF, MSK]; *Brachythecium rutabulum* (Hedw.) Schimp. – fairly frequent (loc.: 1, 2, 8, 10, 13), rotten wood, mineral soil and base of trees (*Salix* sp.) [AR, AS, BF, EF, GV]; *Brachythecium salebrosum* (Hoffm. ex F. Weber & D. Mohr) Schimp. – fairly frequent (loc.: 2, 3, 7, 10), rotten wood (logs), tree trunks and boulders [AS, BF, EF, MSK]; *Cirriphyllum piliferum* (Hedw.) Grout – fairly frequent (loc.: 1, 2, 6, 8), mineral soil in communities of tall herbs near the stream, humus, rotting logs and base of trees (*Salix* sp.) [AR, BF, GV, MSK]; **Eurhynchium angustirete* (Broth.) T.J. Kop. – frequent (loc.: 1, 2, 3, 6, 7, 8, 10, 12, 13), soil, humus, rotting logs and bark of deciduous trees (*Fagus sylvatica*, *Tilia* sp.) [AR, AS, BF, EF, GV, MSK, MSZ, RZ]; *Kindbergia praelonga* (Hedw.) Ochyra – rare (loc.: 6), decaying log [MSK]; *Oxyrrhynchium hians* (Hedw.) Loeske – fairly frequent (loc.: 1, 2, 4, 11, 13), mineral soil in the forest and on steep slopes near the stream, decaying logs of *Abies alba* [AS, GV, RZ]; *Oxyrrhynchium speciosum* (Brid.) Warnst. – rare (loc.: 1, 2, 7), moist soil and rocks in the bed of the stream [BF, MSK]; *Torrentaria riparioides* (Hedw.) Ochyra (= *Platyhypnidium riparioides* (Hedw.) Dixon) – fairly frequent (loc.: 1, 7, 8, 11), boulders in the stream [AS, GV, MSZ]; **Pseudoscleropodium purum* (Hedw.) M. Fleisch. ex Broth. – rare (loc.: 1, 8), soil and humus in the fir forest [BF, GV, MSK]; *Rhynchostegium murale* (Hedw.) Schimp. – rare (loc.: 6), stone [MSZ]; *Sciuro-hypnum oedipodium* (Mitt.) Ignatov & Huttunen – rare (loc.: 8), soil and humus [MSK]; *Sciuro-hypnum populeum* (Hedw.) Ignatov & Huttunen – rare (loc.: 7, 10), base of trees and stone [AS, MSK]; *Sciuro-hypnum reflexum* (Starke) Ignatov & Huttunen – rare (loc.: 6), rotten wood [MSZ].

Plagiotheciaceae: *Plagiothecium cavifolium* (Brid.) Z. Iwats. – rare (loc.: 1, 2, 8), soil on the steep and sandy slope [AR, BF]; *Plagiothecium curvifolium* Schlieph. ex Limpr. – fairly frequent (loc.: 1, 3, 10, 13), exposed soil on a slope, base of trees (*Abies alba*) and rotting logs [AS, BF, EF]; *Plagiothecium denticulatum* (Hedw.) Schimp. – rare (loc.: 7), soil on root plate of uprooting tree [MSK]; *Plagiothecium laetum* Schimp. – fairly frequent (loc.: 1, 2, 3, 9, 13), rotting logs and base of trees (*Abies alba*) [AR, BF, EF, GV]; *Plagiothecium nemorale* (Mitt.) A. Jaeger – fairly frequent (loc.: 1, 7, 8, 10, 13), mineral soil and humus on steep slopes and in the bed of the stream, bark of trees (*Corylus avellana*, *Salix caprea*) [AR, AS, BF, EF, GV, MSK, MSZ].

Amblystegiaceae: *Amblystegium serpens* (Hedw.) Schimp. – rare (loc.: 2), bark of *Acer pseudoplatanus* [BF]; *Campyllum stellatum* var. *protensum* (Brid.) Bryhn – rare (loc.: 1, 6, 7), soil and moist fir rotten logs [AR, GV, MSZ]; *Campylophyllopsis calcarea* (Crundwell & Nyholm) Ochyra – rare (loc.: 1), sandstone in the bed of the stream [GV]; *Hygrohypnum luridum* (Hedw.) Jenn. – rare (loc.: 1, 7, 11) boulders in the stream [AR, AS, BF, GV, MSK, MSZ]; *Sanionia uncinata* (Hedw.) Loeske – fairly frequent (loc.: 1, 2, 7, 10, 12, 13), rotting logs, boulders in the stream, mineral soil and bark of deciduous trees (*Corylus avellana*, *Populus tremula*, *Salix caprea*) [AS, BF, EF, GV, MSK, MSZ, RZ].

Hypnaceae: *Callicladium haldanianum* (Grev.) H.A. Crum – rare (loc.: 1, 3, 10), on rotting logs of *Abies alba* [AS, EF, GV]; **Calliergonella cuspidata* (Hedw.) Loeske – rare (loc.: 12), moist soil in the bed of the stream [EF]; **Ctenidium molluscum* (Hedw.) Mitt. – rare (loc.: 3, 7), decaying log and sandstone in the bed of the stream [EF, MSZ]; *Herzogiella seligeri* (Brid.) Z. Iwats. – frequent (loc.: 1, 2, 3, 6, 7, 8, 9, 10, 12), rotting logs, stones, humus and mineral soil on steep slopes near the stream [AR, AS, BF, EF, GV, MSK, MSZ, RZ]; *Hypnum cupressiforme* Hedw. var. *cupressiforme* – frequent (loc.: 1, 2, 3, 6, 7, 8, 10, 12, 13), trunks and bases of deciduous trees (*Abies alba*, *Alnus glutinosa*, *Carpinus betulus*, *Corylus avellana*, *Fagus sylvatica*), rotting logs and stumps and mineral soil and humus on steep slopes near the stream [AR, AS, BF, EF, GV, MSK, MSZ]; *Hypnum cupressiforme* var. *filiforme* Brid. – rare (loc.: 8), bark of withered *Salix caprea* [MSK]; *Hypnum pallescens* (Hedw.) P. Beauv. – rare (loc.: 1, 3, 10), bark of trees and rotting logs [AS, EF, GV]; *Platygyrium repens* (Brid.) Schimp. – rare (loc.: 10), bark of tree [AS].

GENERAL CHARACTERISTICS OF BRYOPHYTE FLORA

In the Reberce nature reserve, 33 species of liverworts and 72 taxa of mosses were found. Almost half of the species (49%) were classified as rare, 29% as fairly frequent, 18% as frequent, and only 4% as common taxa. *Atrichum undulatum*, *Dicranodontium denudatum*, *Polytrichastrum formosum* and *Thuidium tamariscinum* were the most common species. *Trichocolea tomentella*, a protected liverwort, known in Poland from scattered localities, was frequently found in the reserve.

HABITAT ANALYSIS

Among the species found during the research, terrestrial bryophytes were the largest group (66 species – 63%). They occur abundantly in the undergrowth, growing both on mineral soil and humus. Epigeal mosses are also a constant component overgrowing pits, mounds and root plates of uprooted trees. In this type of microhabitats were found, among others: *Atrichum undulatum*, *Dicranella heteromalla*, *Fissidens taxifolius*, *Polytrichastrum formosum* and *Plagiothecium denticulatum*. Moist, often steep escarpments of streams flowing through the reserve were characterised by significant species diversity. *Brachythecium rivulare*, *Dicranella heteromalla*, *Oxyrrhynchium hians*, *Plagiomnium undulatum*, *Plagiothecium nemorale* and liverworts *Calypogeia azurea*, *Conocephalum conicum*, *Plagiochila asplenioides*, *Trichocolea tomentella* were highly frequent in this type of habitat. Eroding escarpments along water courses are also an excellent habitat for small mosses of the genus *Pohlia* (*P. melanodon*, *P. wahlenbergii*). The Reberce nature reserve is distinguished by the development of diverse epixylic species communities. Specialised epixylic species occur on decaying wood, e.g.: *Nowellia curvifolia*, *Cephalozia catenulata*, liverworts of the genus *Riccardia* (*R. palmata* and *R. latifrons*), *Lepidozia reptans*, *Tetraphis pellucida* and *Buxbaumia viridis*. In total, 58 species (24 liverworts and 34 mosses), representing 55% of the whole bryophyte flora, were found on this type of substrate. Epiphytes flora of bryophytes was relatively poorly developed in the reserve. Epiphytic mosses and liverworts were recorded on eight phorophytes, but most taxa was found on firs, willows and hazels. In many cases, only root necks were covered, and only single turfs were observed in the higher parts of the trunks. The following multisubstrate bryophytes grew primarily here: *Brachythecium rutabulum*, *Dicranella heteromalla* and *Dicranum scoparium*; and occasionally typical epiphytes, e.g., *Metzgeria furcata*, *Radula complanata*, *Orthotrichum stramineum*, *O. lyellii* and *Ulota crispa*. In total, only 27 taxa were recorded on the bark of trees. On various types of rocks (mostly stones laying in the stream beds), 26 species of mosses and liverworts were found. *Campylophyllopsis calcarea*, *Hygrohypnum luridum*, *Jungermannia atrovirens*,

Torrentaria (= *Platyhypnidium*) *riparioides* and *Rhynchostegium murale* occurred solely in this habitat.

PROTECTED SPECIES, ENDANGERED SPECIES
AND RELICS OF PRIMEVAL FORESTS

Fairly large number of protected species was found in the bryophyte flora of the Reberce reserve – 17 mosses and seven liverworts. Most of them are partly protected species (mosses – *Calliergonella cuspidata*, *Ctenidium molluscum*, *Dicranum polysetum*, *D. scoparium*, *Eurhynchium angustirete*, *Orthotrichum lyellii*, *Pleurozium schreberi*, *Polytrichum commune*, *Pseudoscleropodium purum*, *Rhytidiadelphus squarrosus*, *Sphagnum capillifolium*, *S. girgensohnii*, *S. palustre*, *S. squarrosus*, *Thuidium tamariscinum*, *Ulota crispa*; liverworts – *Bazzania trilobata*, *Frullania dilatata*, *Metzgeria conjugata*, *Nowellia curvifolia*, *Plagiochila asplenioides*, *Trichocolea tomentella*), except for two – *Buxbaumia viridis* and *Cephalozia catenulata* – which are under strict protection.

Eight species of mosses and liverworts found in the reserve were taxa present in the Red list of endangered species in Poland, including category E (Endangered) – one species: *Buxbaumia viridis*, V (Vulnerable) – six species: *Calypogeia suecica*, *Cephalozia catenulata*, *Metzgeria conjugata*, *Nowellia curvifolia*, *Orthotrichum stramineum*, *Ulota crispa*, R (Rare) – one species: *Orthotrichum lyellii*.

Noteworthy are also species considered as indicators of ancient forests (relics of primeval forests). These are: *Bazzania trilobata*, *Buxbaumia viridis*, *Cephalozia catenulata*, *Dicranodontium denudatum*, *Hypnum cupressiforme* var. *filiforme* and *Plagiochila asplenioides*. They were in almost all localities of the studied reserve.

DISCUSSION

Not only the type of forest phytocoenoses, but also the availability of suitable habitats and substrates are main factors determining the composition and species richness of bryophytes (ŻARNOWIEC 1995a, KLAMA 2002a, FOJCIK 2011). Terrestrial species were the most numerous group in the Reberce nature reserve bryophyte flora. The higher diversity of terrestrial bryophytes resulted from the complex structure of the forest floor, with numerous terrain microforms, such as uprooting trees and steep crumbling escarpments. Fresh soil exposures are particularly important for species with lower competing capacities, including small annual species (ŻARNOWIEC 1995b). A large group of epixylic bryophytes was also found in the reserve. The diversity and richness of this habitat group is caused both by a large amount of decaying wood, and favourable phytoclimatic conditions (high humidity) (CHLEBICKI et al. 1996, KLAMA 2002a). Species of trees of decaying trunks was also the factor determining the development of epixylic species (McALISTER 1997, JANSOVÁ & SOLDÁN 2006). Logs of

coniferous trees (including firs) were distinguished by the presence of a large group of liverworts and obligatory epixylic species (JANSOVÁ & SOLDÁN 2006, TÁBORSKÁ et al. 2015). On the other hand, the presence of fir trees in the stand makes epiphytic flora of rather average quality. Primarily terrestrial and epiphytic communities developed around the root necks. Fir, similarly as other coniferous species, is characterized by considerable poverty of arboreal bryophytes, especially obligatory epiphytes (LISOWSKI 1956, BARKMAN 1958, LÖBEL et al. 2006, MEŽAKA et al. 2012, FUDALI & WOLSKI 2015).

A high heterogeneity of habitats (the presence of decaying wood, uprooted trees and old tree specimens) is primarily characteristic of stands excluded from continuous forest management. Forests with such a complex structure create the possibility of providing appropriate microhabitats for spore-bearing plants (ŻARNOWIEC 1995a, b, KLAMA 2002a, b). In the Reberce nature reserve, despite relatively poorly diversified vegetation, 105 taxa of mosses and liverworts were found, of which 25% were endangered and protected species, and therefore the most valuable. The presence of specialised epixylic bryophytes, as well as the presence of a large group of species considered as indicators of primeval forests (CHLEBICKI et al. 1996, KLAMA 2002b, STEBEL & ŻARNOWIEC 2014), emphasised not only the naturalness of the stands of the reserve, but also the importance of this type of objects for the preservation of bryophyte species diversity.

The list of bryophytes presented in this paper, does not fully reflect the diversity of bryophyte flora. However, it indicates the high natural value of the reserve and fills the gap in the knowledge on bryophyte distribution in Poland.

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