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BRYOPHYTES IN THE SOUTHERN PART OF LIELIE KANGARI NATURE RESERVE, CENTRAL LATVIA

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The first study about bryophytes in Lielie Kangari was published by Austra Āboliņa in 1982, where 144 species were found. The present study was conducted in the southern part of Lielie Kangari Nature Reserve in spring of 2016, where 148 bryophyte species and one bryophyte variety were found. In total 19 bryophyte species had conservation status in Latvia and 29 species were found for the first time in the Reserve. Bryophytes were found mostly on soil, peat, and dead wood substrates.

Key words: bryophytes, Lielie Kangari Nature Reserve, conservation, substrates.

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INTRODUCTION

Besides their fundamental ecological, biogeochemical functions in different ecosystems (Glime 2017), bryophytes play also significant role in nature conservation helping protect the whole ecosystem. Inventory and monitoring studies contribute to our knowledge about bryophyte distribution patterns in different regions. In total 565 bryophyte species, nine subspecies, 22 varieties, and one bryophyte form were published recently from Latvia (Āboliņa et al. 2015). In total 87 bryophyte species are red-listed in Latvia (Āboliņa 1994). Under legal Latvian governmental protection are 126 specially protected bryophyte species (LRMK 2000) and 26 microhabitat species (LRMK 2012). European Union Habitat Directive includes nine of Latvian bryophyte species (EU 1992). Bryophytes are also used as one of the best

groups in the estimation of forest naturalness. For that reason, 14 woodland key habitat bryophyte specialist species and 16 WKH bryophyte indicator species were defined in Latvia (Ek et al. 2002, Lārmanis et al. 2013).

However, more detailed bryophyte inventories (Āboliņa 1982 a, b, 1985, 1991, 1994, 2001, 2004, 2007, Āboliņa & Bambe 2001, Āboliņa & Rēriha 2004, Bambe 1988, 1989, 2002 a,b, Bambe & Lārmanis 2001, Bambe et al. 2017, Mežaka et al. 2009, Salmiņa 2002, Tabaka et al. 1991) are missing in the most of Nature Reserves in Latvia. In spite of bryophyte importance in nature conservation, bryophytes were not included in many nature conservation planning projects or their importance was underevaluated.

Aim of the present study was to compile the bryophyte species checklist in relation to substrate and conservation status in the southern part of Lielie Kangari Nature Reserve.

MATERIALS AND METHODS

The present study was conducted in the southern part of Lielie Kangari Nature Reserve (Fig. 1). The area of Lielie Kangari Nature Reserve is 1972.4 ha (Latvijas dabas fonds 2007). It is protected area since 1957, and is included in the Nature 2000 site network. The study area is located in Viduslatvija geobotanical region. The specific geological form as glaciofluvial esker is typical in the southern part of Reserve representing the longest glaciofluvial esker in Latvia (Ramans 1975, Latvijas dabas fonds 2007). Annual rainfall varies 400-700 mm, the average temperature in January varies from – 6° to – 5°C, in July around +17°C (Ramans 1975).

Lielie Kangari Nature Reserve presents different habitats – bogs, transitional mires, forests, and freshwater habitats. Raised bogs and bog woodlands cover the largest part of the Reserve. *Pinus sylvestris* dominating forests are the most common forests in Reserve, while deciduous forests cover only small part mostly on slopes of the southern part of Reserve (Latvijas dabas fonds 2007).

Bryophyte records were registered during the Latvian bryological group 1st expedition in 7th of May 2016 in the southern part of Lielie Kangari Nature Reserve (N56°55'53'', E24°44'46''). All bryophytes on all substrates (soil and/or peat, dead wood, living tree, water, litter, excrements) were registered in natural and man-made habitats with route method. Bryophyte species names after Āboliņa et al. 2015.

RESULTS AND DISCUSSION

In total 148 bryophyte species (113 moss and 35 hepatic species) and one variety were recorded at the present study in Lielie Kangari Nature Reserve. From all, 19 species are especially protected or rare in Latvia. In total 29 bryophyte species were found for the first time in Reserve (Appendix). The first study about bryophytes in Lielie Kangari was published by Austra Āboliņa in 1982b, where 144 species were found. As we studied only part of the Reserve, we expect that more species could be found including also other parts of the Reserve. However, the studied part of the Reserve is the most diverse in terms of habitats and may be representative of the whole Reserve. Āboliņa (1982b) noted, that variety of soil types and specific hydrological regimes found in Lielie Kangari Nature Reserve are among the major prerequisites for high bryophyte diversity.

The highest all bryophyte and moss species richness was found on soil and/or peat substrates (Fig. 2). The highest liverwort species richness was found on dead wood. Dead wood has properties for ensuring more constant humidity (dead logs on the ground) and microhabitats than other substrates and thus being favorable for liverwort species richness (Ódor et al. 2005, Kushnevskaya & Shorohova 2018) in the Reserve.

The increase of the species richness from 1982 to 2016 might be explained by the increased

Fig. 1. The studied area in the southern part (marked) of Lielie Kangari Nature Reserve (delimited with a black line). Black point is studied area in Latvian map (upper left).

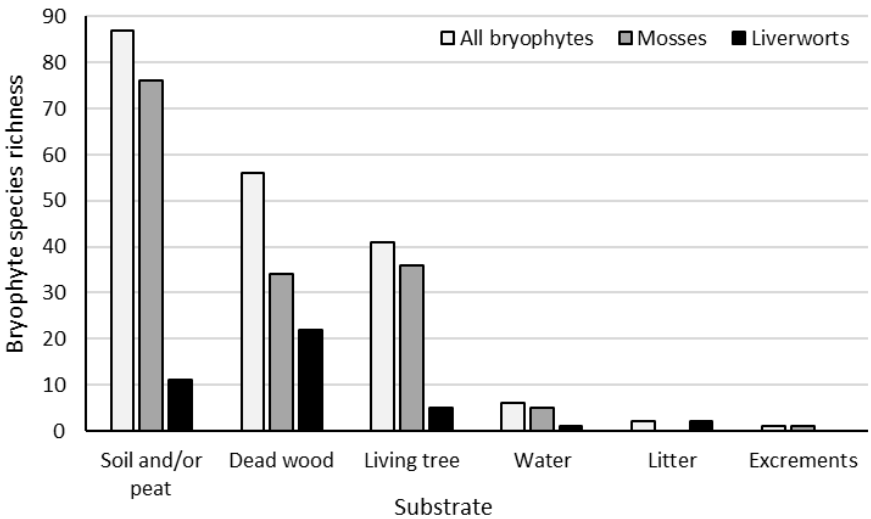

Fig. 2. Bryophyte species richness on different substrates.

number of bryologists. Future bryological studies are needed to explore the whole Lielie Kangari Nature Reserve.

CONCLUSIONS

Lielie Kangari Nature Reserve offers high bryophyte diversity due to the habitat and substrate diversity. We investigated only one part of the Reserve and future bryophyte inventories are needed to include all Lielie Kangari Nature Reserve.

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APPENDIX

Bryophyte species checklist of Lielie Kangari Nature Reserve found in 2016.

Species	Cons.	Habitat, substrate
Abietinella abietina (Hedw.) M. Fleisch.		Roadside, on sandy soil
Amblystegium serpens (Hedw.) Schimp.		In forests on tree stems, on *Pinus sylvestris* root
Amblystegium subtile (Hedw.) Schimp.		In forests on deciduous tree stems
***Anastrophyllum hellerianum* (Nees ex Lindenb.) R. M. Schust.**	MIC, SP, WKHs	In the coniferous forest on dead logs, in swamp forest on dead *Picea abies*
***Aneura pinguis* (L.) Dumort.**		In transitional mire understory
Anomodon longifolius (Schleich. ex Brid.) Hartm.	WKHi	In slope forest on deciduous tree stem, root
Atrichum undulatum (Hedw.) P. Beauv.		In forest understory, on open mineral soil
Aulacomnium palustre (Hedw.) Schwägr.		In bog woodland understory, in bogs among hummocks
***Barbilophozia attenuata* (Mart.) Loeske**	RL1, SP, MIC	In old coniferous forests on dead logs (three records)
Blepharostoma trichophyllum (L.) Dumort.		In the forest on dead logs and coarse woody debris
***Brachytheciastrum velutinum* (Hedw.) Ignatov & Huttunen**		In the forest on *Tilia cordata* stem, in slope forest on the stump, in swamp forest on *Picea abies* root
Brachythecium albicans (Hedw.) Schimp.		In roadsides on sandy mineral soil
Brachythecium campestre (Müll. Hal.) Schimp.		In the mixed forest on *Populus tremula* stem
Brachythecium glareosum (Bruch ex Spruce) Schimp.		In dry roadside slope facing south, on sandy mineral soil
Brachythecium rivulare Schimp.		Swamp forest, in the overstory
Brachythecium rutabulum (Hedw.) Schimp.		In forests on dead logs, coarse woody debris, trees and on nutrient-rich mineral soil
Brachythecium salebrosum (Hoffm. ex F. Weber & D. Mohr) Schimp.		On trees on coarse woody debris and on tree stems
***Breidleria pratensis* (W. D. J. Koch ex Spruce) Loeske**		In swamp forest on *Ulmus glabra* root
Bryum moravicum Podp.		In deciduous forest on dead logs, in swamp forest on peat, on tree stems, in dry roadside on soil
Bryum pseudotriquetrum (Hedw.) P. Gaertn et al.		In spring forest on soil, dead logs, understory
***Buxbaumia aphylla* Hedw.**		In dry roadside on mineral soil
Calliergon cordifolium (Hedw.) Kindb.		In swamp forest overstory, in depressions with water
***Calliergon giganteum* (Schimp.) Kindb.**		In swamp forest understory, in bog lake
***Calliergon megalophyllum* Mikut.**		In lake
Calliergonella cuspidata (Hedw.) Loeske		In swamp forest overstory, on dead logs, tree stems
Calypogeia muelleriana (Schiffn.) Müll. Frib.		In coniferous and bog woodlands on dead logs, ditches, on mineral soil of fallen tree uproot
Calypogeia neesiana (C. Massal. & Carestia) Müll. Frib.		In dried bog woodland on peat

Species	Cons.	Habitat, substrate
Calypogeia sphagnicola (Arnell & J. Perss.) Warnst. & Loeske	SP	In raised bog on old tree root between hummocks and *Sphagnum* sp.
***Calypogeia suecica* (Arnell & J.Perss.) Müll.Frib.**	SP, WKHs	In swamp woodland on dead coniferous stem
Campyliadelphus chrysophyllus (Brid.) R. S. Chopra		In the mixed forest on calcareous soil and on tree branches
Campylium proteins (Brid.) Kindb.		In swamp forest on a tree root
Campylophyllum sommerfeltii (Myrin) Hedenäs		In the coniferous forest, on a dead log, in swamp forest on large *Populus tremula* basal part
Cephalozia bicuspidata (L.) Dumort.		In coniferous and swamp forest on dead log and litter
Cephalozia connivens (Dicks.) Lindb.		In raised bog overstory
Cephalozia lunulifolia (Dumort.) Dumort.		In bog woodland understory
***Cephaloziella rubella* (Nees) Warnst.**		In bog woodland on dead *Picea abies* stem
Ceratodon purpureus (Hedw.) Brid.		In roadside on soil, in the old fire place
Chiloscyphus pallescens (Ehrh. ex Hoffm.) Dumort.		In the coniferous forest, ditch wall, on soil, on dead logs
***Chiloscyphus pallescens* var. *fragilis* (Roth) Müll. Frib.**		In lake coast, on dead plant debris
Cirriphyllum piliferum (Hedw.) Grout		In the coniferous forest, on a slope on a dead log, in nutrient-rich wet and dried forest overstory
Cladopodiella fluitans (Nees) H. Buch		In raised bog among Sphagnum sp., in swamp forest water depression
Climacium dendroides (Hedw.) F. Weber & D. Mohr		In the coniferous forest on a dead log, in bog woodland understory, in nutrient-rich wet and dried forest overstory, in roadsides on dead logs
Cratoneuron filicinum (Hedw.) Spruce		In spring forest, understory
Dicranella heteromalla (Hedw.) Schimp.		In coniferous forest uproot on mineral soil
Dicranum flagellare Hedw.		On the path, on soil, on a dead stump
Dicranum majus Sm.		In coniferous and mixed forest overstory
Dicranum montanum Hedw.		In forests on tree bases, on dead logs
Dicranum polysetum Sw. ex anon.		In coniferous forest and raised bog overstory
Dicranum scoparium Hedw.		In the coniferous forest, understory, basal part of a tree stem, on dead logs
Dicranum undulatum Schrad. ex Brid.		The understory of bog, on hummocks among Sphagnum spp in the bog
***Didymodon fallax* (Hedw.) R. H. Zander**		In roadside on soil
Encalypta streptocarpa Hedw.		In roadside on the soil of glaciofluvial esker on mineral soil, on basal part of *Populus tremula* stem, on Juniperus commune snag
Eurhynchium angustirete (Broth.) T. J. Kop.		In forest understory, on tree stem, on coarse woody debris
Fissidens adianthoides Hedw.		In swamp forest on the root, spring sites on soil and on coarse woody debris
Frullania dilatata (L.) Dumort.		In slope forest and mixed forest on Populus tremula
Funaria hygrometrica Hedw.		In fireplace

Species	Cons.	Habitat, substrate
***Geocalyx graveolens* (Schrad.) Nees**	RL4, SP, MIC, WKHs	In the coniferous forest on dead logs, in swamp forest on tiny dead branchlet, in the nemoral forest on old dead Alnus glutinosa stump
Herzogiella seligeri (Brid.) Z. Iwats.		In the coniferous forest on dead logs
Homalia trichomanoides (Hedw.) Brid.	WKHi	In mixed and slope forests on deciduous tree stems
Homalothecium sericeum (Hedw.) Schimp.		In slope forest on *Tilia cordata*
***Hygroamblystegium humile* (P. Beauv.) Vanderp., Goffinet & Hedenäs**		On lake morass
Hylocomium splendens (Hedw.) Schimp.		In coniferous and mixed forest understory
Hypnum cupressiforme Hedw.		In forests on slopes on dead logs, coarse woody debris
***Hypnum pallescens* (Hedw.) P. Beauv.**		In the coniferous forest on dead logs
Isothecium alopecuroides (Lam. ex Dubois) Isov.	WKHi	In the transition between slope forest with springs and swamp forest on *Alnus glutinosa* stem
***Jamesoniella autumnalis* (DC.) Steph.**	WKHi	In the coniferous forest on dead logs, in swamp forest and nemoral forest on coarse woody debris
Jungermannia leiantha Grolle	WKHi, SP, MIC	In Pinus sylvestris forest on a dead log in a ditch
Kurzia pauciflora (Dicks.) Grolle		In bog understory
Lepidozia reptans (L.) Dumort.		In forests on dead logs, on tree stems, coarse woody debris
Leptobryum pyriforme (Hedw.) Wilson		In the coniferous forest on fallen tree root, on mineral soil.
Leucobryum glaucum (Hedw.) Ångstr.	WKHi, HDV	In coniferous forest understory
Leucodon sciuroides (Hedw.) Schwägr.		In slope forest on tree stems
Lophocolea heterophylla (Schrad.) Dumort.		In forests on dead logs, coarse woody debris and tree stems
Lophozia ascendens (Warnst.) R. M. Schust.	SP, MIC, WKHs	In old *Pinus sylvestris* bog woodland on an old dead log
***Lophozia ventricosa* (Dicks.) Dumort.**	WKHs	In the old coniferous forest on a dead log
Marchantia polymorpha L.		In swamp forest on uproot with open peat soil
Mylia anomala (Hook.) Gray		In bog understory among Sphagnum sp., in the drained forest on peat
Neckera pennata Hedw.	RL2, WKHi	In mixed forest and in slope on Picea abies and deciduous tree stems
Nowellia curvifolia (Dicks.) Mitt.	WKHi	In forests on dead logs and coarse woody debris
***Odontoschisma denudatum* (Mart.) Dumort.**	SP, MIC, WKHi	In the coniferous forest on dead logs
***Orthotrichum affine* Schrad. ex Brid.**		In the mixed forest on *Betula* sp.
Orthotrichum pallens Bruch ex Brid.		In roadside Betula pendula forest on dead branches
***Orthotrichum pumilum* Sw. ex anon.**		In slope on Tilia cordata
Orthotrichum speciosum Nees		In mixed forest on Betula pendula and other trees, in roadside on dead branches
Oxyrrhynchium hians (Hedw.) Loeske		In nutrient rich forest on mineral soil

Species	Cons.	Habitat, substrate
Pellia epiphylla (L.) Corda		At ditch on peat, on soil
Plagiochila asplenioides (L. emend. Taylor) Dumort.		In nutrient-rich forest understory
Plagiomnium affine (Blandow ex Funck) T. J. Kop.		In wet and dry *Picea abies* forest understory
Plagiomnium cuspidatum (Hedw.) T. J. Kop.		In the coniferous forest on a dead log, on understory, on coarse woody debris
Plagiomnium elatum (Bruch & Schimp.) T. J. Kop.		In swamp and spring forest understory
Plagiomnium medium (Bruch & Schimp.) T. J. Kop.		In the transition between swamp forest and dry forest on glaciofluvial esker on old dead *Betula* sp.
Plagiomnium undulatum (Hedw.) T. J. Kop.		In coniferous forest nutrient rich understory
Plagiothecium denticulatum (Hedw.) Schimp.		In coniferous and mixed forest understory and on tree stems
Plagiothecium laetum Schimp.		In coniferous and mixed forests on stems on a fallen tree
***Plagiothecium latebricola* Schimp.**	WKHs, RL2, SP, MIC	In swamp forest on *Alnus glutinosa* stem
Plagiothecium succulentum (Wilson) Lindb.		Bog woodland understory
***Platygyrium repens* (Brid.) Schimp.**		In slope on tree
Pleurozium schreberi (Wild. ex Brid.) Mitt.		In forest understory, in glades, roadsides, on bog hummocks
Pohlia nutans (Hedw.) Lindb.		In the coniferous forest on uproot, in bog woodland on soil
***Pohlia sphagnicola* (Bruch & Schimp.) Broth.**		In bog understory among Sphagnum
Polytrichum commune Hedw.		In coniferous forest understory
Polytrichum juniperinum Hedw.		On dead logs
Polytrichum strictum Menzies ex Brid.		In bog and bog woodlands on hummocks
Pseudobryum cinclidioides (Huebener) T. J. Kop.		In the coniferous forest on ditch wall, in bog woodland understory
Ptilidium ciliare (L.) Hampe		On dead log
Ptilidium pulcherrimum (Weber) Vain.		In the forest on tree stems, on dead logs, on coarse woody debris
Ptilium crista-castrensis (Hedw.) De Not.		In the coniferous forest on forest pathway, on dead log and understory
Pylaisia polyantha (Hedw.) Schimp.		In forests on Tilia cordata and Betula pendula, in a roadside in Betula pendula forest on dead branches
Radula complanata (L.) Dumort.		In forests on *Populus tremula, Betula pendula* and on other tree species
Rhizomnium punctatum (Hedw.) T. J. Kop.		In swamp forest understory, on a dead log and coarse woody debris
Rhodobryum roseum (Hedw.) Limpr.		In coniferous forest understory, in nutrient-rich forest understory, glaciofluvial basement

Species	Cons.	Habitat, substrate
Rhytidiadelphus squarrosus (L. ex Hedw.) Warnst.		In roadside on soil, in Pinus sylvestris forest understory, in glades
Rhytidiadelphus subpinnatus (Lindb.) T. J. Kop.	WKHi	In bog woodland on soil
Rhytidiadelphus triquetrus (Hedw.) Warnst.		On coniferous and nutrient-rich forest understory, on coarse woody debris
Riccardia latifrons (Lindb.) Lindb.		In swamp forest on coarse woody debris
Sanionia uncinata (Hedw.) Loeske		In the deciduous forest on tree stems and dead logs
***Scapania apiculata* Spruce**	WKHs	In the coniferous forest on a dead log
Sciuro-hypnum curtum (Lindb.) Ignatov		In forest understory on coarse woody debris
Sciuro-hypnum populeum (Hedw.) Ignatov & Huttunen		On Alnus incana stem at Mazā Jugla river
Sphagnum angustifolium (C. E.O. Jensen ex Russow) C. E. O. Jensen		On bog and transitional mire understory, on hummocks
Sphagnum capillifolium (Ehrh.) Hedw.		In transition between forest and bog in bog woodland understory, in a bog on hummocks, on depressions of coniferous forests
Sphagnum centrale C. E. O. Jensen		In transitional mire at the lake, in Picea abies forest
Sphagnum contortum Schultz		In transitional mire
Sphagnum cuspidatum Ehrh. ex Hoffm.		In bog on understory
Sphagnum fallax (H. Klinggr.) H. Klinggr.		In bog understory, in bog woodland between hummocks
Sphagnum flexuosum Dozy & Molk		On bog woodland and transitional mire understory
Sphagnum fuscum (Schimp.) H. Klinggr.		On bog understory, on bog woodland hummocks
Sphagnum girgensohnii Russow		In coniferous and bog woodland understory
Sphagnum magellanicum Brid.		On bog, transitional mire, bog woodland understory, in swamp forest on hummocks
Sphagnum palustre L.		On bog and bog woodland understory
***Sphagnum riparium* Ångstr.**		In ditch, morass
***Sphagnum rubellum* Wilson**		In bog and bog woodland on hummocks
Sphagnum russowii Warnst.		On bog understory
Sphagnum squarrosum Crome		On coniferous forest, bog woodland and transition belt understory
Sphagnum tenellum (Brid.) Pers. ex Brid.		On bog understory
Sphagnum teres (Schimp.) Ångstr.		On transitional mire at the lake and swamp forest understory
Sphagnum warnstorfii Russow		On transitional mire understory
Sphagnum wulfianum Girg.		On swamp forest and coniferous forest understory
Splachnum ampullaceum Hedw.		In bog on animal excrements
Straminergon stramineum (Dicks. Ex Brid) Hedenäs		On bog understory
Syntrichia ruralis (Hedw.) F. Weber & D. Mohr		In dry roadside on south slope on sandy mineral soil
Tetraphis pellucida Hedw.		In forests on dead logs, coarse woody debris, rarely in cavities of tree stems

Species	Cons.	Habitat, substrate
Thuidium assimile (Mitt.) A. Jaeger		On soil, in forest glades and roadsides, in swamp forest and dry forest transition on dead *Betula* sp.
Thuidium delicatulum (Hedw.) Schimp.		In the mixed forest on *Betula* sp., in swamp forest at hummock on *Betula* sp. uproot
***Thuidium recognitum* (Hedw.) Lindb.**		On bog woodland understory
***Thuidium tamariscinum* (Hedw.) Schimp.**		On bog woodland understory
Ulota crispa (Hedw.) Brid.	WKHi	In the coniferous forest on Picea abies, in bog woodland on the tree, mostly in wet forests on tree stems and branches
Warnstorfia fluitans (Hedw.) Loeske		On transitional mire understory

Explanations: Cons. – conservation status; MIC – Microreserve species, SP – Specially protected species, WKHi – Woodland Key Habitat indicator species, WKHs – Woodland Key Habitat specialist species, RL –Red-listed species with the category as a number (1, 2, 4). Species in bold are new to Lielie Kangari Nature Reserve.