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THE DISTRIBUTION AND SOME ECOLOGICAL CHARACTERISTICS OF ESTONIAN RARE BRYOPHYTES

РАСПРОСТРАНЕНИЕ И НЕКОТОРЫЕ ЭКОЛОГИЧЕСКИЕ ОСОБЕННОСТИ РЕДКИХ ВИДОВ МОХООБРАЗНЫХ ЭСТОНИИ

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Abstract

Bryophyte flora of Estonia includes 512 species and 189 of these are known from up to 7 localities and considered as rare. Their frequency within Estonia is mapped. Some ecological factors influencing the distribution of rare species are studied by the comparison of ecological indexes of rare and common species, separately for mosses and liverworts. The majority of rare species are more hygrophilous than common species. Many rare species grow in Estonia close to their ecological limits. There are no rare bryophytes that can inhabit several different substrata. The percentage of species growing on stones and in water is much higher in rare bryophytes.

Резюме

Бриофлора Эстонии включает 512 видов, из которых 189 известны из 1-7 местонахождений и отнесены к редким видам. Дан их список и представлена карта частоты встречаемости редких видов на территории Эстонии. Влияние некоторых экологических факторов на распространение редких видов изучено с помощью сравнения распределений экологических индексов редких и нередких видов, особо для мхов и для печеночников. В целом редкие виды мохообразных Эстонии более гигрофильны, заметно выше процент эпилитных и водных видов (по сравнению со всей бриофлорой). Большинство редких видов растут в Эстонии на пределе своих экологических возможностей (крайние значения индексов). В числе редких отсутствуют виды, способные расти на нескольких субстратах.

INTRODUCTION

The Estonian bryoflora consists of 512 species, 398 mosses and 114 liverworts (Anthocerotopsida & Marchantiopsida). The number of species is quite high for the relatively small area of Estonia (ca. 45 000 km^2). This could be explained by the great diversity in habitats arising from the nature of the bedrock and the relatively extensive seminatural areas. Along the coast of northern Estonia and the island of Saaremaa runs a glint where the Cambrian and Ordovician calcareous rocks are exposed. The bedrock in southern Estonia consists mainly of Devonian sandstone and clay. A large number of erratic boulders were deposited across Estonia during the last glacial period, and they are found more densely in its northern part. Due to the influence of the Baltic Sea the climate in northern and western Estonia is milder and moister than in the South and East. About 22% of the territory of Estonia is covered with mires and ca. 40% with forests.

MATERIAL AND METHODS

We have delimited as rare the species which have up to 7 localities in Estonia. The total number of such species is 189 (128 mosses and 51 liverworts). The list of rare species (see Appendix) was compiled using the list of Estonian bryophytes (Ingerpuu & al., 1994). Two additional rare species (*Aloina rigida* (Horn.) Kindb. and *Dicranella humile* Ruthe) have been found by L. Kannukene later. The percentage of rare bryophytes in Estonia is 37%, 34% among mosses and 46% among liverworts.

The map of frequency of Estonian rare bryophytes (Fig. 1) has been compiled on a UTM 10×10 km grid using the program DMAP by Alan Morton (1992 version).

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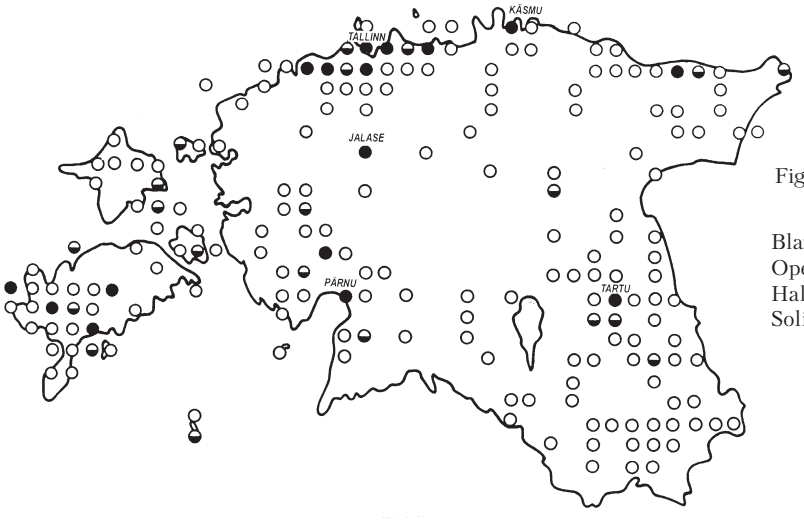

Fig. 1. Frequency of rare bryophytes in Estonia

Blank area – no records of rare species
Open circle – 1-3 rare species
Half-open circle – 4-6 rare species
Solid circle – 7 or more rare species

The relative distribution of Estonian bryophytes according to ecological indexes (Duell, 1991) and substrata was studied using the statistical program package Statgraphics Vers. 5.0. The rare and common species of liverworts and mosses were analyzed separately. Comparisons were made between the rare and common species groups for liverworts and mosses. 14 rare mosses (marked with * in Appendix), twelve common mosses and one common hepatic were excluded from the comparison of ecological indexes and three rare hepatics and seven rare mosses (marked with ** in Appendix) were excluded from the comparison of substrata due to lack of data.

RESULTS AND DISCUSSION

As can be seen from the map (Fig. 1), the rare bryophytes are distributed over almost all of the Estonia. The white areas in the centre of the country are largely explained be the insufficient investigation; also there is much more arable land in these regions. Rare bryophytes are more frequent and abundant in the western and northern Estonia, also on the islands where there are numerous limestone outcrops and the climate is milder and moister. A great number of rare bryophytes are found on the Glint and in several nature reserves. These areas are less influenced by man, contain many different habitats and are better investigated. The large number of rare bryophytes near the Tallinn, Tartu and Paernu can be explained by more thorough investigations there since the middle of the last century. Unfortunately, it is likely that many rare species have disappeared from the vicinity of these towns due to the rising of human impact. The extent of investigation is one of the main factors determining the distribution pattern of rare bryophytes on the whole map. An example demonstrating this is the "discovery" of the Jalase Village Reserve by Estonian bryologists in 1992, where new localities for 20 rare species were found.

By comparison of the ecological indexes in groups of rare and common species several interesting tendencies were noted. No essential differences were found between the distribution curves of the rare and common groups according to the light and reaction indexes.

The percentage of species with a low temperature index (1) is about 5 times higher in the group of rare mosses as well as in the group of rare liverworts in comparison with the common species groups. The percentage of species with high temperature indexes is also several times greater in the group of rare mosses and in the group of rare liverworts (Fig. 2).

According to the continentality indexes the percentage of species of oceanic tendency (indexes 2-4) is higher in both rare groups and the percentage of continental species (indexes 7 & 8) higher in the group of rare mosses (Fig. 3).

The differences in humidity index curves show the tendency of rare species from both groups to require moister habitats (Fig. 4).

There are some interesting differences in the substrata preferences of rare and common bryo-

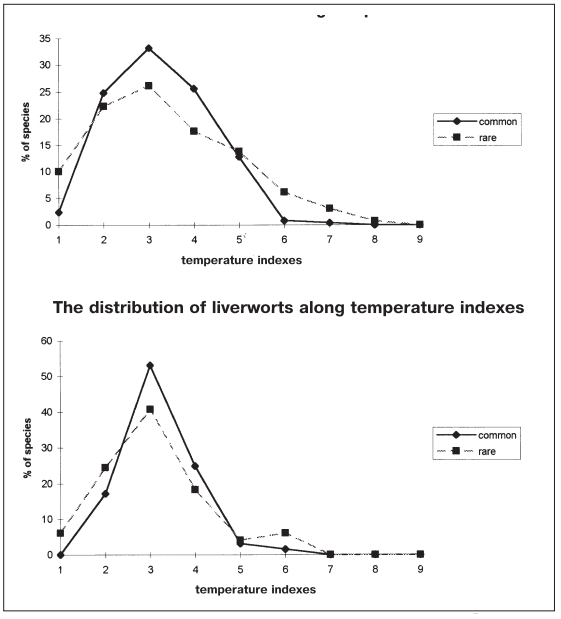

Fig. 2. Temperature indexes: 1 – cold; 2 – between 1 and 3; 3 – cool; 4 – between 3 and 5; 5 – temperate; 6 – between 5 and 7; 7 – warm; 8 – between7 and 9; 9 – extremely warm.

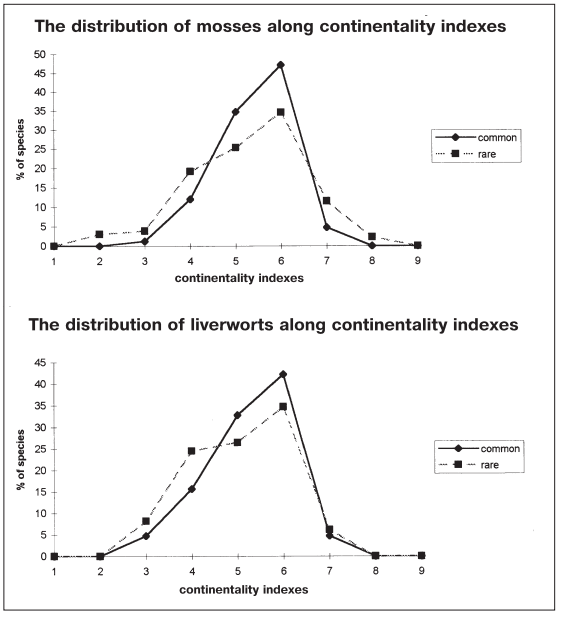

Fig. 3. Continentality indexes: 1 – euoceanic; 2 – oceanic; 3 – between 2 and 4; 4 – suboceanic; 5 – intermediate; 6 – subcontinental; 7 – between 6 and 8; 8 – continental; 9 – eucontinental.

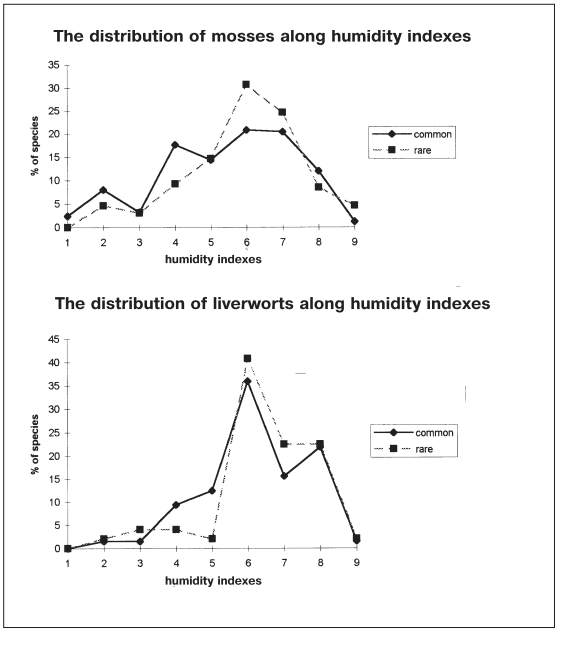

Fig. 4. Humidity indexes: 1 – extremely dry; 2 – between 1 and 3; 3 – dry; 4 – between 3 and 5; 5 – moderately moist; 6 – between 5 and 7; 7 – moist; 8 – between 7 and 9; 9 – prolonged wet period.

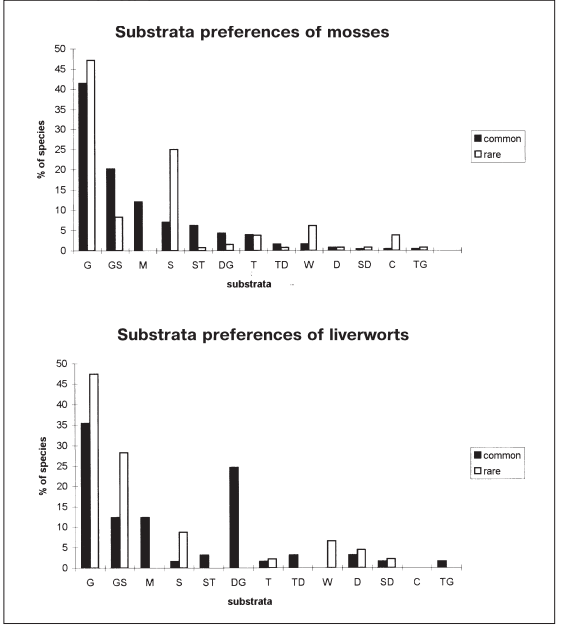

Fig. 5. Substrata: G – ground; GS – ground and stones; M – many substrata; S – stones; ST – stones and trunks; DG – decaying wood and ground; T – trunks; TD – trunks and decaying wood; W – in water; D – decaying woood; SD – stones and decaying wood; C – dung and carcasses; TG – trunks and ground.

phytes (Fig. 5). The percentage of species growing on stones (S) and in water (W) is much higher among all rare bryophytes. Only common species are able to grow on many (more than two) different substrata (M) and the percentage of those who grow on the ground and on decaying wood (DG) is much higher among common bryophytes. The difference between mosses and liverworts is that the percentage of species growing on the ground and on stones (GS) is higher among rare liverworts whereas for mosses the opposite is true. The moss species which grow on dung and carcasses are mostly rare, too.

CONCLUSIONS

Rare bryophytes are more common in northern and western Estonia due to climatic and bedrock conditions.

The majority of Estonian bryophytes are temperate-boreal (temperature index 3), subcontinental (continentality index 6) species preferring habitats which are moderately moist or with prolonged moisture periods and grow on the ground.

Many rare species have the extreme indexes of temperature and continentality, i. e. are close to their ecological limits.

The majority of rare species in Estonia are more hygrophilous than common species.

There are no rare bryophytes that can inhabit several different substrata.

The percentage of species growing on stones and in water is much higher among all rare bryophytes.

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APPENDIX: THE LIST OF ESTONIAN RARE BRYOPHYTES

BRYOPSIDA

Aloina rigida (Hedw.) Limpr.
Amblyodon dealbatus (Hedw.) B. & S.
* *Amblystegium compactum* (C.Muell.) Aust.
A. confervoides (Brid.) B.,S.& G.
A. humile (P.Beauv.) Crundw.
A. saxatile Schimp.
A. tenax (Hedw.) C.Jens.
Anomodon rugelii (C.Muell.) Keissl.
Aphanorhegma patens (Hedw.) Lindb.
* *Aplodon wormskioldii* (Hornem.) Kindb.
Atrichum angustatum (Brid.) B. & S.
Bartramia pomiformis Hedw.
Brachythecium campestre (C.Muell.) B.,S. & G.
B. plumosum (Hedw.) B.,S. & G.
B. starkei (Brid.) B.,S. & G.
B. turgidum (Hartm.) Kindb.
Bryum blindii B.,S. & G.
B. funckii Schwaegr.
B. knowltonii Barnes
B. mamillatum Lindb.
B. marratii Hook. f. & Wils.
B. neodamense Itzig. ex C.Muell.
B. salinum I.Hag. ex Limpr.
B. subapicatulum Hampe
B. warneum (Roehl.) Bland. ex Brid.
B. weigelii Spreng.
Buxbaumia viridis (Moug. ex Lam. & DC.) Brid. ex Moug. & Nestl.
Calliergon megalophyllum Mik.
C. richardsonii (Mitt.) Kindb.
C. trifarium (Web. & Mohr) Kindb.
Campylium calcareum Crundw. & Nyh.
C. halleri (Hedw.) Lindb.
Campylopus pyriformis (K.F.Schultz) Brid.
Cirriphyllum tenuinerve (Lindb.) Wijk & Marg.
* *Desmatodon randii* (Kenn.) Laz.
Dichelyma falcatum (Hedw.) Myr.
** *Dichodontium pellucidum* (Hedw.) Schimp.
Dicranella humilis Ruthe
D. rufescens (With.) Schimp.
D. subulata (Hedw.) Schimp.
Dicranum flexicaule Brid.
** *D. muehlenbeckii* B.,S. & G.
D. viride (Sull. & Lesq.) Lindb.
Didymodon insulanus (De Not.) M.Hill
D. tophaceus (Brid.) Lisa
D. vinealis (Brid.) Zander
Diphyscium foliosum (Hedw.) Mohr.
Discelium nudum (Dicks.) Brid.
** *Ditrichum heteromallum* (Hedw.) Britt.
D. lineare (Sw.) Lindb.
Drepanocladus capillifolius (Warnst.) Warnst.
* *D. tenuinervis* T.Kop.
Encalypta mutica I.Hag.
E. ciliata Hedw.
Ephemerum serratum (Hedw.) Hampe
Eucladium verticillatum (Brid.) B.,S. & G.

Fissidens arnoldii Ruthe
F. exilis Hedw.
* *F. gracifolius* Brugg.-Nann. & Nyh.
F. pusillus (Wils.) Milde
Fontinalis dalecarlica B.,S. & G.
F. hypnoides Hartm.
F. squamosa Hedw.
Gymnostomum aeruginosum Sm.
G. calcareum Nees & Hornsch.
Gyroweisia tenuis (Hedw.) Schimp.
** *Herzogiella striatella* (Brid.) Iwats.
Hylocomium umbratum (Hedw.) B.,S. & G.
Hypnum pratense (Rabenh.) W. Koch ex Hartm.
Isopterygiopsis pulchella (Hedw.) Iwats.
Isothecium myosuroides Brid.
Kiaeria blyttii (B.,S. & G.) Broth.
* *Loeskypnum badium* (Hartm.) Paul
Meesia longiseta Hedw.
M. uliginosa Hedw.
* *Myrinia pulvinata* (Wahlenb.) Schimp.
Neckera crispa Hedw.
Octodiceras fontanum (B.Pyl.) Lindb.
Oncophorus wahlenbergii Brid.
Orthotrichum diaphanum Brid.
O. stramineum Hornsch. ex Brid.
O. tenellum Bruch ex Brid.
Palustriella decipiens (De Not.) Ochyra
Plagiopus oederiana (Sw.) Crum & Anderson
Plagiothecium latebricola B.,S. & G.
P. ruthei Limpr.
Platydictya jungermannioides (Brid.) Crum
** *Pogonatum aloides* (Hedw.) P.Beauv.
P.dentatum (Brid.) Brid.
P. nanum (Hedw.) P.Beauv.
Pohlia bulbifera (Warnst.) Warnst.
P. camptotrachela (Ren. & Card.) Broth.
P. elongata Hedw.
** *P. lescuriana* (Sull.) Grout
P.proligera (Lindb. ex Breidl.) Lindb. ex H.Arn.
Polytrichum pallidisetum Funck
Pottia bryoides (Dicks.) Mitt.
P. davalliana (Sm.) C.Jens.
Pseudephemerum nitidum (Hedw.) Reim.
Pseudocrossidium hornschuchianum (K.F.Schultz) Zander
Pseudoleskeella catenulata (Schrad.) Kindb.
Pterogonium gracile (Hedw.) Sm.
Racomitrium fasciculare (Hedw.) Brid.
Rhodobryum ontariense (Kindb.) Kindb.
Rhynchostegium murale (Hedw.) B.,S. & G.
Saelania glaucescens (Hedw.) Broth.
Schistidium agassizii Sull. & Lesq.
S. maritimum (Turn.) B. & S.
S. rivulare (Brid.) Podp.
S. calcarea (Hedw.) B.,S. & G.
* *Seligeria campylopoda* Kindb.
S. donniana (Sm.) C.Muell.
S. pusilla (Hedw.) B.,S. & G.
S. recurvata (Hedw.) B.,S. & G.
* *Sphagnum aongstroemii* Hartm. f.
* *S. jensenii* Lindb. f.
S. lindbergii Schimp. ex Lindb.
S. platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.
S. quinquefarium (Lindb. ex Braithw.) Warnst.
S. subfulvum Sjoers
* *Splachnum rubrum* Hedw.
S. sphaericum Hedw.
S. vasculosum Hedw.
Tayloria tenuis (With.) Schimp.
Thamnobryum alopecurum (Hedw.) Gang.
Thuidium minutulum (Hedw.) B.,S. & G.
Timmia bavarica Hessl.
Tortella rigens Alb.
Tortula lingulata Lindb.
** *Tortula norvegica* (Web.) Wahlenb. ex Lindb.
Trematodon ambiquus (Hedw.) Hornsch.
Trichostomum crispulum Bruch
Ulota coarctata (P.Beauv.) Hammar
U. curvifolia (Wahlenb.) Lilj.
U. drummondii (Hook. & Grev.) Brid.
* *Warnstorfia tundrae* (H.Arn.) Loeske
Weissia controversa Hedw.
W. squarrosa (Nees & Hornsch.) C.Muell.

ANTHOCEROTOPSIDA & MARCHANTIOPSIDA

Anastrophyllum hellerianum (Nees ex Lindenb.) Schust.
A. minutum (Schreb.) Schust.
Barbilophozia floerkei (Web. & Mohr) Loeske
B. hatcheri (Evans) Loeske
B. kunzeana (Hueb.) K.Muell.
B. lycopodioides (Wallr.) Loeske
Bazzania trilobata (L.) S.Gray
Calypogeia sphagnicola (H.Arn. & J.Perss.) Warnst. & Loeske
** *Cephalozia catenulata* (Hueb.) Lindb.
C. loitlesbergi Schiffn.
Cephaloziella divaricata (Sm.) Schiffn.
C. hampeana (Nees) Schiffn.
C. integerrima (Lindb.) Warnst.
Fossombronia foveolata Lindb.
F. wondraczekii (Corda) Lindb.
Frullania tamarisci (L.) Dum.
Geocalyx graveolens (Schrad.) Nees
** *Harpantus scutatus* (Web. & Mohr) Spruce
Jungermannia atrovirens Dum.
J. caespitica Lindenb.
J. confertissima Nees
J. gracillima Sm.
J. hyalina Lyell
J. sphaerocarpa Hook.
Lejeunea cavifolia (Ehrh.) Lindb.

Lophozia bantriensis (Hook.) Steph.
L. heterocolpus (Thed. ex Hartm.) Howe
L. obtusa (Lindb.) Evans
L. opacifolia Culm. ex Meyl.
L. rutheana (Limpr.) Howe
L. sudetica (Nees ex Hueb.) Grolle
Metzgeria conjugata Lindb.
Moerckia hibernica (Hook.) Gott.
Nardia insecta Lindb.
Phaeocerus carolinianus (Michx.) Prosk.
Porella cordaeana (Hueb.) Moore
P. platyphylla (L.) Pfeiff.
Reboulia hemisphaerica (L.) Raddi
Riccardia chamaedryfolia (With.) Grolle
R. incurvata Lindb.
Riccia cavernosa Hoffm.
R. fluitans L.
R. warnstorfii Limpr.
Ricciocarpos natans (L.) Corda
Scapania apiculata Spruce
S. calcicola (H.Arn. & J.Perss.) Ingham
S. lingulata Buch
S. mucronata Buch
** *S. umbrosa* (Schrad.) Dum.
S. undulata (L.) Dum.
Tritomaria quinquedentata (Huds.) Buch