

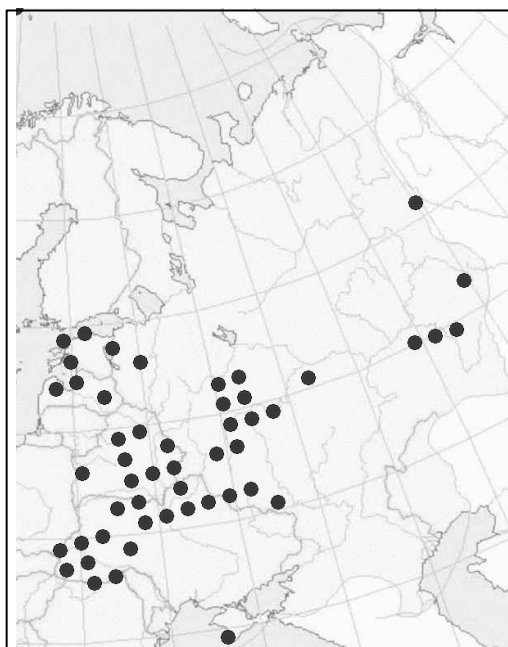
## RARE AND THREATENED BRYOPHYTES AND A PROPOSAL FOR AN EASTERN EUROPEAN RED BOOK

Oleg Maslovsky

Institute of Experimental Botany, Minsk, Belarus. E-mail: oleg@biobel.bas-net.by

**Abstract:** The bryoflora of Eastern Europe includes around 1300 species. Analysis of their distribution has revealed about 250 rare species. Many European threatened species have their main distribution in Eastern Europe. Results of Eastern European bryological investigations are not widely known in Western Europe and some of the threatened Eastern European species are not protected on a European level. The experience of bryophyte protection activity in Belarus and the creation of an Eastern European Bryophyte Red Book will be useful for the real protection of species in countries in both this region and in all the continent. The Eastern European Red Book will include: 1) European protected species; 2) very rare species (1-5 sites) in Eastern Europe; 3) declining species of threatened specific habitats; 4) regionally protected species in different Eastern European countries. A draft checklist of species to be included in the proposed Eastern European Red Book is presented.

The conservation of rare and threatened bryophytes in continental Europe is an important but very difficult and complex task, depending on the protection and conservation activities in the different regions and countries. The publication of the Red Data Book of European Bryophytes (1995) was a very important step in this direction, It was particularly as this was the first Red Book among different systematic group of plants. However, Eastern European bryophytes are represented very incompletely in the Red Book, but this territory occupies half of Europe. For example, *Dicranum viride* (Sull. & Lesq.) Lindb. has only 3 points in Eastern Europe in this Red Data Book. According our data (fig. 1) there are more than 50 localities of *D. viride* in this region. The bulk of former Soviet Union bryological literature is not available to «western»

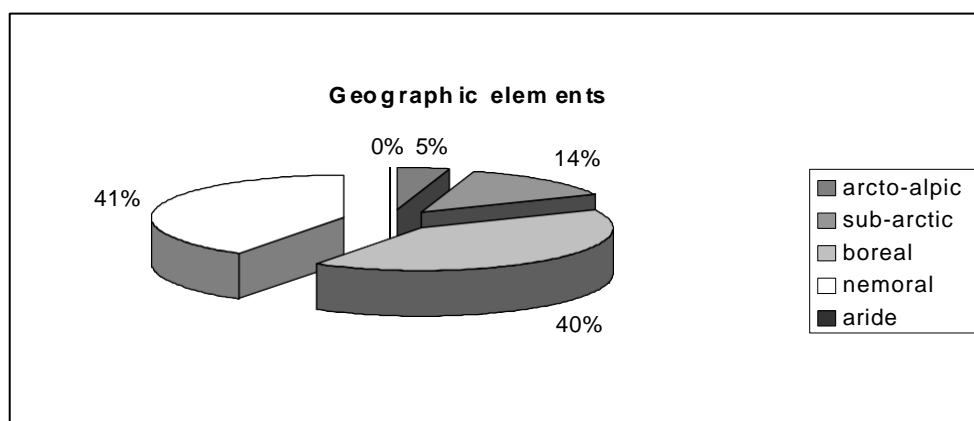


**Figure 1.** Distribution of *Dicranum viride* in Eastern Europe.

bryologists. Furthermore, large parts of some European threatened species are concentrated in this region alongside centres of high diversity. Effective bryophyte protection on the European continent depends on the integration of data from the Eastern part of Europe. Our experience of

bryophyte protection in Belarus and our proposed Eastern European Red Book should be a valuable contribution to bryophyte conservation in all of Europe.

The bryoflora of Belarus consist of 440 species: 303 Bryidae (green mosses), 34 Sphagnum mosses, 101 Hepaticae and 2 Anthocerotae. At the end of 2004 the first volume of the *Flora of Belarus. Bryophytes (Andreaeaopsida-Bryopsida)*, was published (Rykovsky & Maslovsky, 2004). The second volume of the Flora (*Sphagnum*, Hepaticae, Anthocerotae) will be published in 2006. The Belarus bryoflora is not very rich because coastal and mountain habitats are absent in the territory, but 27 European protected species are found in Belarus: *Amblystegium saxatile* Schimp. (Rare, R), *Bryohaplocladium microphyllum* (Hedw.) R. Watan. & Iwats. (Regionally threatened taxon, RT), *Bryum neodamense* Itzigs. in C. Muell. (R), *B. uliginosum* (Brid.) Bruch & Schimp. in B.S.G. (RT), *B. warneuum* (Roehl.) Bland. ex Brid. (R), *Buxbaumia aphylla* Hedw. (RT), *Callicadium haldanianum* (Grev.) Crum (RT), *Campylium elodes* (Lindb.) Kindb. (RT), *Cephaloziella elachista* (Jack ex Gott. & Rabenh.) Schiffn. (Insufficiently known, K), *Dicranodontium asperulum* (Mitt.) Broth. (K), *Dicranum viride* (Vulnerable, V), *Drepanocladus lycopodioides* (Brid.) Warnst. (RT), *Dr. sendtneri* (Schimp. ex C. Muell.) Warnst. (RT), *Entodon cladorrhizans* (Hedw.) C. Muell., *Hamatocaulis vernicosus* (Mitt.) Hedenäs (K), *Hypnum fertile* Sendtn. (RT), *Massularia (Lophozia) laxa* (Lindb.) Shljak. (RT), *Meesia hexasticha* (Funck) Bruch (Endangered, E), *M. longiseta* Hedw. (R), *Neckera pennata* Hedw. (V), *Orthotrichum gymnostomum* Bruch ex Brid. (RT), *O. patens* Bruch ex Brid. (Taxa apparently threatened but presenting taxonomic problems, T), *Physcomitrium eurystomum* Sendtn. (RT), *P. sphaericum* (Ludw.) Brid. (R), *Pohlia atropurpurea* (Wahlenb. ex Fuernr.) Lindb. (K), *Pterygoneurum sessile* (Brid.) Jur. (RT), *Riccia huebeneriana* Lindenb. (R), and *Ulota coarctata* (P. Beauv.) Hammar (RT).



**Figure 2.** Geographical elements distribution of Belarus bryophytes in European Red Book in percentage (data of O. Maslovsky and E. Yaroshevich).

The species have different ecologies and strategies, but the majority of they are eutrophic and mesotrophic hygro- and mesophytes. The distribution of the geographical elements of European threatened species is represented in figure 2.

Fifteen bryophyte species are listed in the second edition of the Belarus Red Book (Maximovitch (ed.), 1993): *Andreaea rupestris* Hedw., *Bryum klinggraeffii* Schimp., *Cinclidium stigium* Sw., *Cinclidotus danubicus* Schiffn. & Baumg., *Gymnocolea inflata* (Huds.) Dum., *Moerkckia hibernica* (Hook.) Gott., *Orthotrichum lyellii* Hook. & Tayl., *Paraleucobrium longifolium* (Ehrh. ex Hedw.) Loeske, *Porella platyphylla* (L.) Preiff., *Pterigynandrum filiforme* Hedw., *Rhynchostegium murale* (Hedw.) B.S.G., *Scapania apiculata* Spruce, *Sphagnum lindbergii* Schimp., *S. molle* Sull., and *Tortella tortuosa* (Hedw.) Limpr. These species have statutory protection in Belarus.

The third edition of the Belarus Red Book is in preparation and will be published in the second part of this year (Bryophytes, by O. Maslovsky and G. Rykovsky). This book will include 72 bryophytes: 14 species probably extended in Belarus, 27 species are base part of book (5 critically endangered, 10 endangered, 12 vulnerable), also 31 species are included in an addition list: species needed of special attention.

Base part of the Belarus Red Book ( species included in the second edition of the book): are *Lophozia ascendens* (Warnst.) Schust., *Massularia laxa* (Lindb.) Shljak., *Cephalozia catenulata* (Hueb.) Lindb., *Riccia canaliculata* Hoffm., *Dicranum viride*, *Bryum schleicheri* Schwägr., *Pseudobryum cinclidioides* (Hueb.) T. Kop., *Meesia triquetra* (Richter) Ångstr., *Bryohaplocladium microphyllum* (Hedw.) Wat. & Iwats., *Cryo-hypnum minutulum* (Hedw.) Buck & Crum, *Pseudocalliergon lycopodioides* (Brid.) Hedenäs.

Some species probably extended outside Belarus: *Bryum warneum*, *Meesia hexasticha*, *Riccia huebeneriana*, *Physcomitrium sphaericum*, and *Cephaloziella elachista*; other species are: *Acaulon muticum* (Hedw.) C. Muell., *Amblyodon dealbatus* (Hedw.) Bruch & Schimp. in B.S.G., *Bryum neodamense* Itzigs. in C. Muell., *Campylium radicale* (P.Beauv.) Grout., *Catascopium nigratum* (Hedw.) Brid., *Dicranodontium asperulum* (Mitt.) Broth., *Frullania tamarisci* (L.) Dum., *Schistostega pennata* Hedw.

The Institute of Experimental Botany has a long history of working with the Ministry of Environmental resources and nature protection of Republic of Belarus and such a partnership enables us to achieve effective statutory protection of these species. One of results of this cooperation was the creation of a special computer data bank ('Flora') for rare species. This data bank has a flexible structure, wide analyzing system and mapping block (fig. 3). All populations of protected species (including bryophytes) were descrybedd and mapped. This data is used regularly by the Ministry. Also, tp prepare an inventory of our collections we created a computer system termed 'Herbarium' (fig. 4). This computer system can be used for the whole of Europe because the mapping block includes different scale maps of the continent.

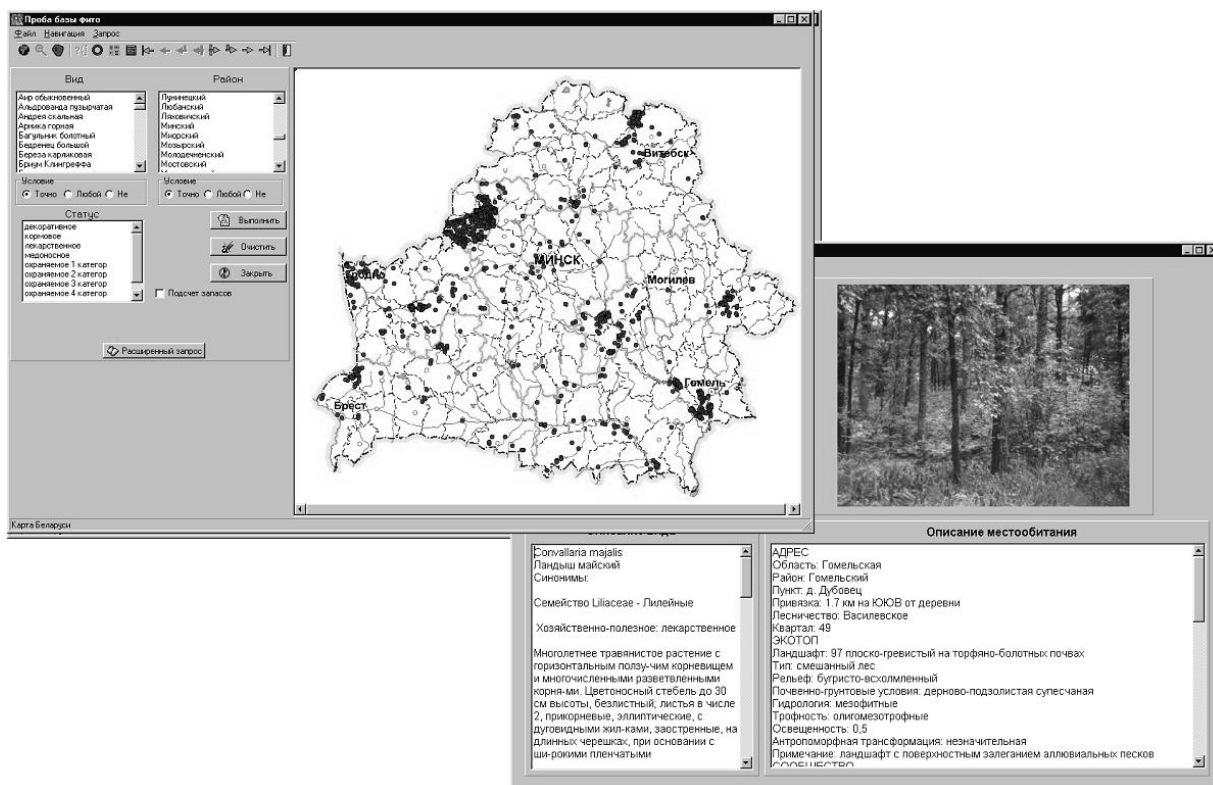


Figure 3. Information system *Flora*: map information and description of concrete habitat and population (70 parameters).

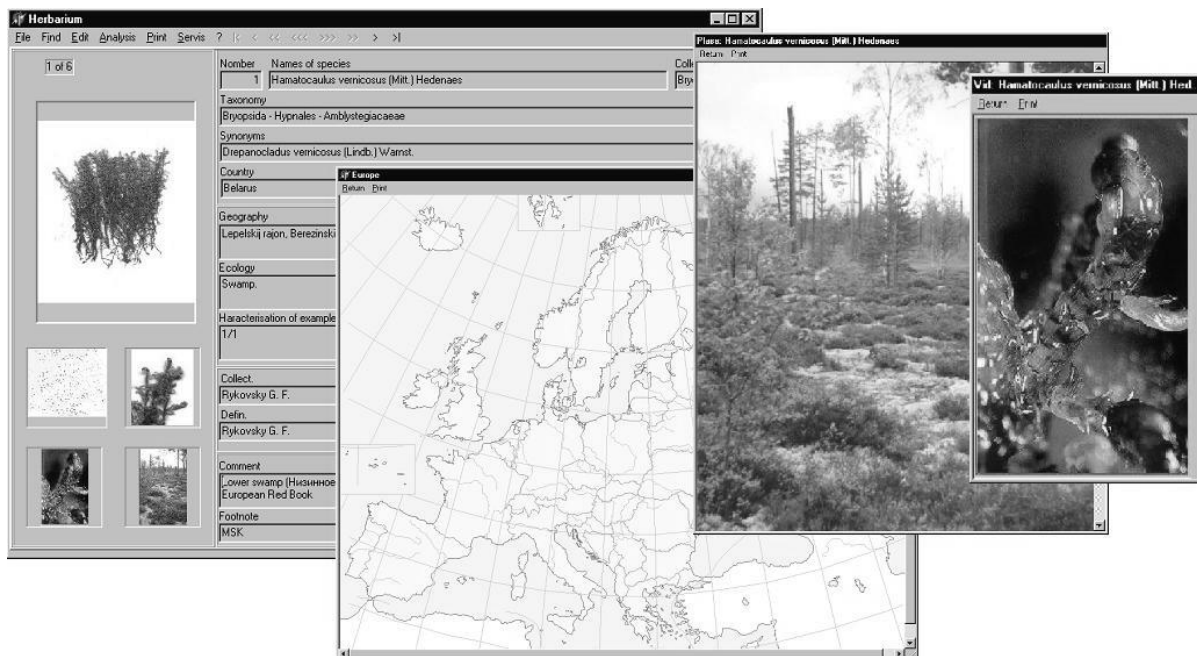
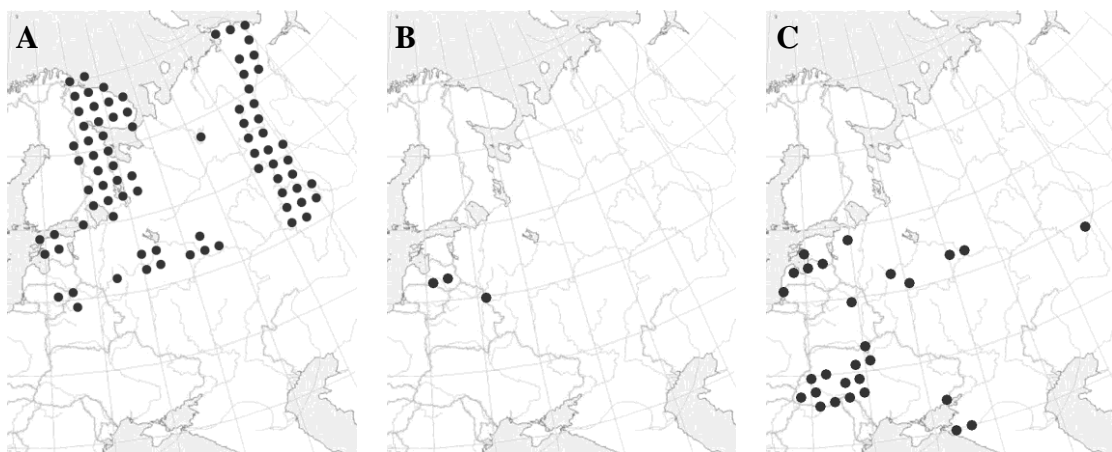


Figure 4. Computer system *Herbarium*: main base, mapping block and representation of graphic information in db.

From 2004 we began work on a Governmental Register of plants and vegetation of the Belarus Republic. This is an all-encompassing system of identification, analysis, legal protection and use of plant resources and different botanical aspects (protected, useful, invasive species, and rare communities, habitats etc.) in Belarus. Bryophytes and their habitats are objects in the register. It is very important that all populations of rare species are registered and will have a special register passports for legal protection with financial sanctions for their protection.

The computer databases and cooperation with the Ministry has created an opportunity for the effective protection of rare bryophytes. However, Belarus is comparatively small and the areas occupied by bryophytes are often very large, necessitating consideration of their status in neighbouring countries. For example, 3 species have only one point on territory of Belarus, and their Eastern Europe distribution is shown in Fig. 5. *Andreaea rupestris* in Belarus is situated on the southern boundary of its range, *Cinclidotus danubicus* is a very rare species and has only 3 points in all Eastern Europe and *Atrichum angustatum*, whilst not rare in Eastern Europe, has possibly been overlooked in Belarus. It is essential that in Belarus a different focus is adopted and strategies for the protection of species are based on their wider distribution in the region. The production of an Eastern European Bryophyte Red Book will not only be invaluable for conservation activities in the various countries of Eastern Europe, but will also encourage cooperation between bryologists throughout Europe.



**Figure 5.** Distribution of 3 species in Eastern Europe, which has only one point in Belarus. A: *Andreaea rupestris*, B: *Cinclidotus danubicus*, C: *Atrichum angustatum*.

The rationale for a Red List book was born when I studied the ecology-geographical relationships of the Belarus bryoflora in the context of Eastern Europe (Maslovsky, 2002). The idea was subsequently supported by post-Soviet Union bryologists as a joint project. The proposed Eastern European Bryophyte Red Book will cover 4 main topics:

1. Inclusion of European protected species.

2. Inclusion of very rare species in region (1-5 sites).
3. Inclusion of rapidly declining species in threatened specific habitats.
4. Inclusion of regionally protected species in neighbouring countries.

According to our preliminary data, there are 186 species in the territory of Eastern Europe, which were included in European Bryophyte Red Book (1995): 8 endangered (E) species, 44 vulnerable (V), 77 rare (R), 30 insufficiently known (K), 20 regionally threatened taxa (RT), and 6 threatened but with taxonomical problems (T).

Threatened (E and V category) European protected species in Eastern Europe include: *Anacamptodon splachnoides* (Brid.) Brid., E (present in 5 100x100 km squares), *Anoetangium handelii* Schiffn., V (1), *Asterella saccata* (Wahlenb.) Evans, V (?1), *Barbula enderesii* Garov., V, endemic of Europe (1), *Bartramia subulata* B.S.G., V (1), *Bryohaplocladium virginianum* (Brid.) R. Watan. & Iwats., V (1), *Bryum savicziae* Schljak., V (1), *Buxbaumia viridis* (Moug.) Moug. & Nestl., V, (Bern convention, 13), *Cephalozia lacinulata* Jack, V (3), *Cynodontium suecicum* (H. Arn. & C. Jens.) I. Hag., V, (Bern convention, 2), *Desmatodon systylius* Schimp., V (1), *Dichelyma capillaceum*, V (1), *Dicranum viride*, V, (Bern convention, 50), *Distichium hagenii* Ryan ex Philib., V (?1), *Encalypta brevipes* Schljak., V (1), *Encalypta longicollis* Bruch, V (1), *Entodon cladorrhizans*, V (1), *Frullania bolanderi* Aust., E (?1), *Frullania parvistipula* Steph., E, (Bern convention, 1), *Funaria aeguidens* Lindb. ex Broth., V (1), *Gymnostomum boreale* Nyh. & Hedenäs, V (?1), *Hamatocaulis lapponicus* (Norrlin) Hedenäs, V (2), *Haplohymenium triste* (De Not.) Kindb., V (1), *Heterophyllum affine* (Hook. ex Kunth) Fleisch., E (2), *Iwatzukiella leucotricha* (Mitt.) Buck & H. Crum., V (2), *Jubula hutchinsiae* (Hook.) Dum. subsp. *javanica* (Steph.) Verd., V (1), *Leucodon flagellaris* Broth., V (1), *Lindbergia brachyptera* (Mitt.) Kindb., V (1), *Meesia hexasticha*, E (1), *Mielichhoferia himalayana* Mitt., V (1), *Mnium heterophyllum* (Hook.) Schwägr., V (1), *Molendoa homschuchiana* (Hook.) Lindb. ex Limpr., V (1), *Myurella sibirica* (C. Muell.) Reimers, E (3), *Neckera pennata*, V (85), *Orthotrichum limprichtii* I. Hag., V (1), *O. rogeri* Brid., V (1), *O. scanicum* Gronv., E (1), *O. vladikavkanum* Vent. in Husn., V (1), *Pallavicinia lyellii* (Hook.) Carruth., V (2), *Pterygoneurum kozlovii* Lazarenko, V (2), *P. lamellatum* (Lindb.) Jur., V (2), *Pylasiella selwynii* Kindb., V (9), *Pyramidula tetragona* (Brid.) Brid., V, (Bern convention, 4), *Scapania sphaerifera* Buch & Tuomikoski, V (1), *Splachnum melanocaulon* (Wahlenb.) Schwägr., V (1), *Splachnum pensylvanicum* (Brid.) Grout ex Crum, E (?1), *Tayloria splachnoides* (Schwägr.) Hook., V (1), *Tetraplodon ureolatus* (Hedw.) B. & S., V (1), *Tortula handelii* Schiffn., V (2), *Trachycystis ussuriense* (Maack & Regel in Regel) T. Kop., V (1), *Ulota rehmannii* Jur., E (3), *Voitia hyperborea* Grev. & Arnott, V (?1).

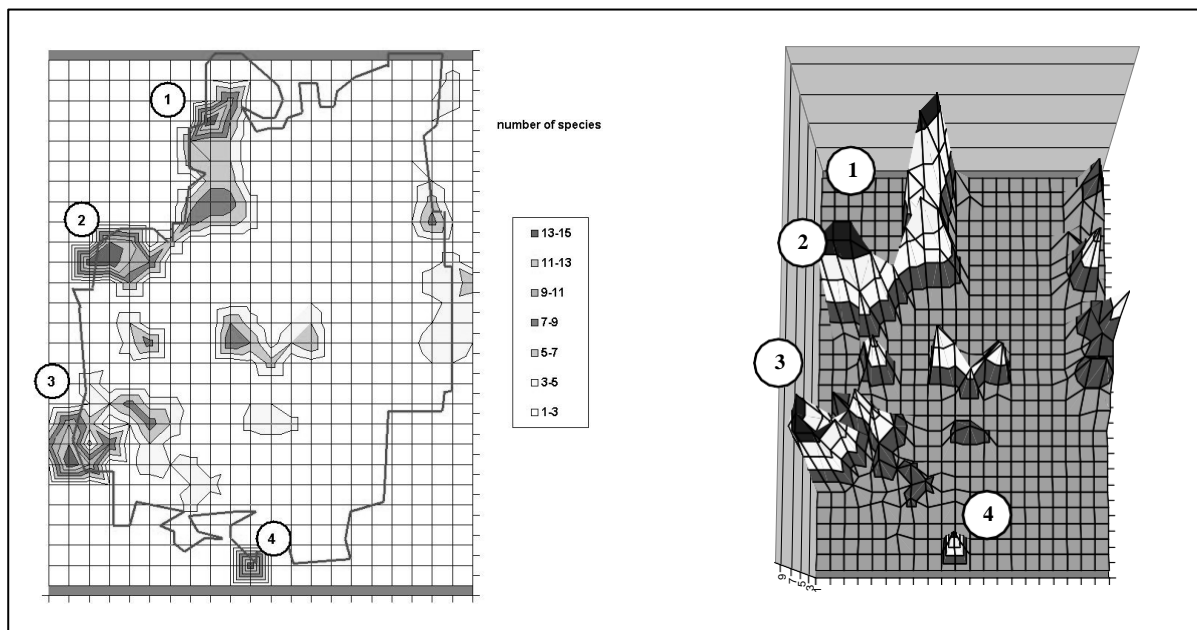
We propose that very rare regional species (1-5 sites) should be included in an Eastern European Red Book of Bryophytes. For example: *Bryhnia novae-angliae* (Sull. & Lesq. in Sull.) Grout, *Cyrtomnium hymenophylloides* (Hueb.) Nyh. ex T. Kop., *Entodon schleicheri* (Schimp.) Demet., and others.

Also, species that are not particularly rare but are declining rapidly and occur in threatened habitats should be included in the book, especially species from swamps, bogs, old growth broadleaf forests and so on. For example: *Timmia megapolitana* Hedw., *Philonotis marchica* (Hedw.) Brid., *Neckera crispa* Hedw., *Schistostega pennata* Hedw. and others.

The total number of species in an Eastern European Red Book of Bryophytes may be around 300 species. The average number of Red Book plant species is typically about 20-25% of the regional flora.

For an investigation of the geographical distribution of Eastern European bryophytes we created a customised computer atlas of 1280 species for mapping on 400 squares (100x100 km). This scale is optimal for such a large territory because this provides an opportunity for analysing geographical patterns of species diversity and minimizes errors associated with incomplete data. Examples of maps are shown in Figs. 1 and 5.

Analyses of the distribution of all European Red Book Bryophytes (ECCB, 1995) (129 species, 728 records) show that there are 4 centres where rare species are concentrated in Eastern Europe (fig. 6): Kola peninsula and Karelia, Estonia, Carpathians and North-Western Caucasus.



**Figure 6.** Distribution of European Red Book Bryophytes (species: 129, points: 728) in Eastern Europe (preliminary data). 1: Kola peninsula and Karelia, 2: Estonia, 3: Carpathians, 4: North-Western Caucasus.

I hope that our continuing investigations and the creation of an Eastern European Red Book of Bryophytes will be useful for the effective protection of bryophytes not only in this region, but in all of Europe.

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