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ECOLOGY AND DISTRIBUTION OF *DICRANUM VIRIDE* (SULL. & LESQ.) LINDB. (BRYOPHYTA) IN THE SOUTHERN URAL MTS.

ЭКОЛОГИЯ И РАСПРОСТРАНЕНИЕ *DICRANUM VIRIDE* (SULL. & LESQ.) LINDB. (BRYOPHYTA) НА ЮЖНОМ УРАЛЕ

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Abstract

Distribution and ecology of a rare red-listed bryophyte *Dicranum viride* were studied in nemoral and dark coniferous-nemoral forests of the western part of the Southern Urals. In total, data from 63 sample plots (20×20 m) which were made in forests with different age structures were analyzed. Populations of *Dicranum viride* in the Southern Urals showed high vitality and were abundant on suitable substrates and habitats. The distribution of *Dicranum viride* was related to forest type, environmental factors and history of land management. Ecological scaling showed that *Dicranum viride* in the Southern Urals had a narrow ecological amplitude, especially in relation to the factor of continentality. Characteristic features for South Ural regions with *Dicranum viride* are diverse topography and mountain river valleys which represent refugia of a nemoral flora. This likely explains the occurrence of relict nemoral species (*Dicranum viride, Eurhynchium angustirete, Brachythecium geheebii, Frullania bolanderi, Anomodon spp., Metzgeria furcata, Lejeunea cavifolia*) with limited dispersal ability and sporadic distribution in the European part of Russia. Besides, good preservation of *Dicranum viride* populations in the Southern Urals is due to historical factors related to specific forest management practices in this region during the 18th-20th centuries.

Резюме

Обсуждаются распространение и экология редкого краснокнижного вида *Dicranum viride* в неморальных и темнохвойно-широколиственных лесах западной части Южного Урала. В основу работы положены данные анализа 63 пробных площадей (20×20м), заложенных в лесах разного возраста. Южно-уральские популяции *Dicranum viride* имеют высокий виталитет и обилие в подходящих для вида местообитаниях. Выявлена зависимость распространения *Dicranum viride* от типа леса, условий окружающей среды и истории хозяйственного освоения территории. Использование метода экологических шкал показало, что *Dicranum viride* имеет узкую экологическую амплитуду, особенно в отношении фактора континентальности. Характерными местообитаниями вида являются долины горных рек, которые на Южном Урале являются рефугиумами неморальной флоры. Вероятно, именно в этих местах сохранились реликтовые неморальные виды (*Dicranum viride, Eurhynchium angustirete, Brachythecium geheebii, Frullania bolanderi, Anomodon spp., Metzgeria furcata, Lejeunea cavifolia*), которые имеют ограниченную способность к расселению и рассеянное распространение в Европейской части России. Существование хорошо сохранившихся популяций *Dicranum viride* на Южном Урале также связано со спецификой лесопользования в регионе в течении XVIII-XX вв.

KEYWORDS**:** *Dicranum viride*, bryophytes, rare species, nature conservation, nemoral forests, old-growth forests

INTRODUCTION

The Ural Mountains represent the natural border between Europe and Asia and show drastic differences in climate (wet versus dry), biomes, and resulting species distribution between the Western and Eastern sides of the Ural Mts. (Shklyaev, 1964; Atlas…, 2005). The South Urals not only represent the geographical border between Europe and Asia, but also the natural eastern limit of the nemoral forest distribution including species associated with these forests. This refers to rare species from different organism groups (bryophytes, invertebrates, vertebrates) in Bashkortostan (Gorchakovsky, 1972; Martynenko *et al.*, 2005; Mirkin, 2010). Broad-leaved forests in the Southern Urals were noted as refugia (Krasheninnikov, 1939), as broad-leaved-Abies-Picea forests developed from pliocene nemoral vegetation (Ermakov *et al*., 2000).

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Dicranum viride is a rare nemoral species decreasing in abundance and it may be classified as an 'amphi-atlantic disjunct'. Disjunct distribution might be explained by the population history, as relicts from earlier times when species could show different distribution patterns could migrate under ecological conditions different from today (Dahl, 2007). This species is known from Central Europe, Norway, Baltic States, the Caucasus, European Russia, the southern part of the Far East, eastern parts of the USA and Canada.

Dicranum viride is a key bryophyte species with international conservation importance (Council Directive..., 1992). It has a scattered distribution in European Russia, except for the Southern Urals, and in southern part of West Siberia (Red Data Book…, 1995; Ignatov & Ignatova, 2003; Ignatova & Fedosov, 2008). The species is listed under the Bern Convention (Annex 2), in the European Bryophyte red-list noted as vulnerable (Red Data Book…, 1995) and in Annex 2 of the European Habitat Directive (Council Directive..., 1992). In regional Russian Red Books, it is listed as vulnerable in Krasnodar Territory (Ignatova, 2007), Republic of Komi (Zheleznova & Shubina, 2010), Voronezh region (Red Data book…, 2011), Kursk region (Zolotukhin *et al*., 2001), Tver region (Zykov *et al*., 2002) and listed as a rare species in Belgorod region (Red Data Book…, 2004), Moscow region (Ignatov, 1998), Tula region (Red Data Book…, 2010),) and the Republic of Bashkortostan (Baisheva, 2011).

Dicranum viride is a dioicous species found to be mostly dispersed asexually by leaf fragments and rarely by spores (Ignatov & Ignatova, 2003). Therefore species with dominant dispersal by fragmentation have more limited dispersal, as leaf fragments cannot disperse as far as spores (Hallingbäck, 2002; Soderström *et al*., 2007). This species is susceptible to various threats (Ladle, Whittaker, 2011) such as forest cutting, and is therefore a good model organism to characterize the historical management and conservation in nemoral forests.

Several studies exist on distribution and taxonomy of *Dicranum viride* in Europe and in the United States of America (Erzberger, 1999; Hedenäs & Bisang, 2004; Maslovsky, 2005; Ignatova & Fedosov, 2008), but ecological studies (Sauer & Preußing, 2003), especially at the Eastern limits of this species, are lacking.

The aim of the present study was to characterize the environmental and historical factors affecting distribution of *Dicranum viride* in the Southern Urals and to evaluate the conservation significance in vegetation communities where this species was found.

MATERIALS AND METHODS

In 1991-2010, the vegetation sampling was performed in a mountain-forest zone of Southern Ural. Relevé sites were selected subjectively in order to represent the typical forests in the region. The 20×20 m plots were picked out to represent larger areas with homogeneous forest vegetation. In each plot, a list of all vascular plants and bryophytes was made, and the cover of each species growing on soil was evaluated according to Braun-Blanquet scale (Braun-Blanquet, 1964). For bryophytes, all substrates (tree trunks, dead wood, rocky substrate, *etc*.) were described.

The communities with *Dicranum viride* were revealed only in three regions: 1 – upper course of Rivers Bol'shoi and Malyj Inzer, 2 – valleys of Belaya and Nugush Rivers, 3 – Ufa plateau (Fig. 1). Regions 1 and 2 are located in the nemoral forest belt on the western slope of the Southern Urals, region 3 is located in the nemoral-coniferous forest belt of the Mountain forest region. Nemoral forests in the present study refer to broad-leaved forests. The data on location of relevés, tree stand composition, cover of layers, and forest age are given in Appendix 1.

The climate of the study area is continental with moderately warm, sometimes hot summer and long cold winter. The western part of the South Ural Mts. are the warmest and wettest regions in Bashkortostan. The average temperatures here are –15,5 - –16,0 °C in January, and +16,5 -+18,5 °C in July, the annual rainfall is 550-650 mm. The average snow cover is 50-70 mm (Atlas…, 2005).

A set of 63 phytosociological relevés of forest communities including *Dicranum viride* was placed into phytosociological database, managed in TURBOVEG (Hennekens & Schaminee, 2001). For each sample plot, the importance of ecological factors was evaluated using the Landolt Scale (Landolt, 1977) (Fig.2). All species of vascular plants and bryophytes found in th esample plots were included in data analysis. The ecological factors were F (Humidity) – characterizing average soil humidity during the vegetation period, R (Reaction) – acidity of soil, N (Nutrient) – the richness of soil with mineral elements, H (Humus) – humus saturation in soil. L (Light) – preference to light, T (Temperature) – the average temperature requirements in places during the vegetation period. K (Continentality) – the differences in temperature and air humidity during the day or year.

For comparison with *Dicranum viride,* the importance of ecological factors was evaluated for two widespread epiphytic species, *Dicranum montanum* (data from 734 sample plots) and *Pylaisia polyantha* (320 sample plots), and two nemoral species, *Neckera pennata* (53 sample plots) and *Homalia trichomanoides* (24 sample plots) (Fig.2).

Classification of vegetation into associations were conducted by the JUICE programme package (Tichý et al., 2011). Detrended Correspondence Analysis (DCA) was used for finding relationships among communities (63 sample plots) and environmental factors (humidity, continentality, light, temperature, nutrient). DCA was conducted in the CANOCO 4.5 (ter Braak & Šmilauer, 2002) programme package. All data (63 sample plots) relating to vascular plants and bryophytes, and ecological factors are included in Figure 3.

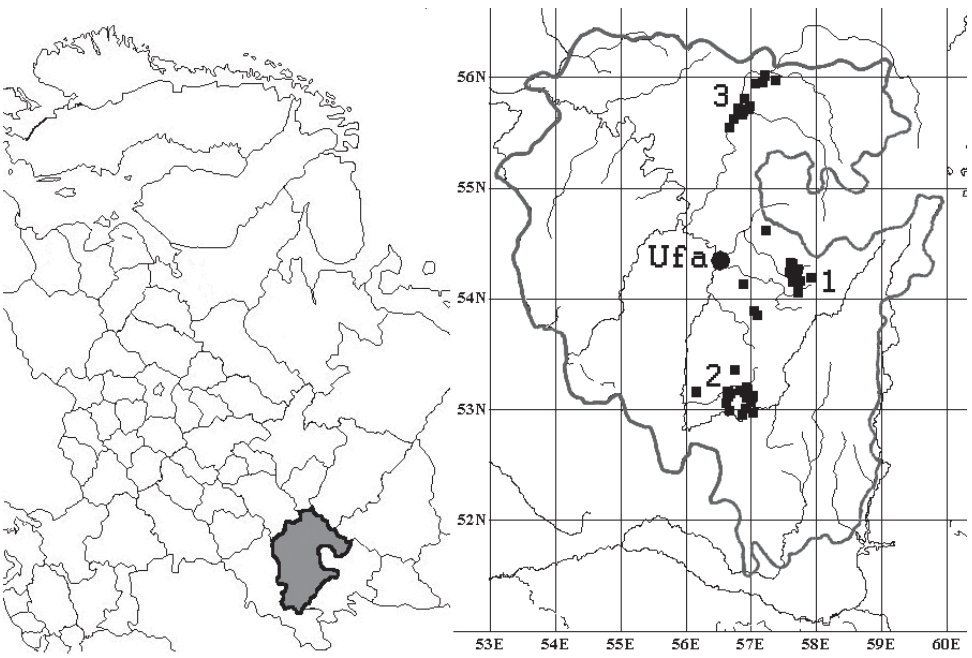

Fig. 1. Study sites in Bashkortostan (Southern Ural): 1 – upper-course of Rivers Bol'shoi and Malyj Inzer; 2 – valleys of Rivers Belaia and Nugush; 3 – Ufa Plateau.

Determination of communities important for *Dicranum viride* conservation was based on expert evaluation. At first, the community received expert evaluation according to six basic criteria. Based on this evaluation, integral rates were identified – category of conservation and threat of dissappearence. Methods for plant communities evaluationwere developed during the preparation of the 'Green Book' (a summary of plant communities which are rare and in need of conservation) (Didukh, 2009; Bulokhov, 2012).

Species names follow the list of vascular plants of the former USSR (Cherepanov, 1995), the check-list of mosses of Eastern Europe and Northern Asia (Ignatov, Afonina, Ignatova *et al.*, 2006) and the check-list of liverworts (Marchantiophyta) of Russia (Konstantinova, Bakalin *et al.*, 2009).

Results

In Bashkortostan *Dicranum viride* was found in nine forest vegetation associations (Appendix 1). The dominant tree species in the studied forests were *Tilia cordata*, *Acer platanoides*, *Ulmus glabra*, *U. laevis*, *Quercus robur*, *Abies sibirica*, *Picea abies*, *P. obovata*, *Betula pendula*, *Populus tremula,* and *Padus avium*; the shrub layer was represented by *Rubus idaeus*, *Rosa majalis*, *Lonicera xylosteum* and *Euonymus verrucosa*; the herb layer was composed mainly of *Asarum europaeum*, *Galium odoratum*, *Calamagrostis arundinacea*, *Lathyrus vernus, Rubus saxatilis* and *Stellaria holostea*. A fragment of the synoptic table of investigated communities is given in Appendix 2.

Most of the study plots (>70%) were made in forests of uneven age structure, about 17% of studied forest communities were mature (forest age > 70 years) and overmature (forest age >100 years).The forests were characterized with high tree canopy cover (60-85%). The cover of epigeic bryophytes was up to 15% in nemoral forests and 10-15(-60)% in nemoral-coniferous forests (see Supplement 1, http://arctoa.ru/ru/Archive-ru/19/Baisheva-supplement1.php).

The results of DCA showed that *Dicranum viride* was found more often in mesophytic nemoral and coniferous-nemoral forests (alliances ***Aconito-Tilion*** and ***Aconito-Piceion***), sometimes the species was found in xeromesophytic *Quercus robur* forests as well as on separate broad-leaved trees in coniferous forests. The species was found in shady places with increased air humidity (Fig. 3). The main factor explaining axis 1 in relation to *Dicranum viride* communities is a complex gradient with increasing continentality and decreasing nutrient. Axis 2 is explained by decreasing light and increasing humidity in forest communities.

The analysis of ecological factors in the studied communities with *Dicranum viride* showed that *D. viride* has a narrow ecological amplitude (0.5-1.1 units of Landolt scale). Similar results were obtained for other nemoral species *Homalia trichomanoides* and *Neckera pennata*. In comparison with widespread epiphytic species *Dicranum montanum* and *Pylaisia polyantha,* the nemoral species were particularly sensitive to continentality (Fig. 2).

A system of criteria, consisting of community rarity, characteristics of floristic composition (species richness, presence of rare species), succession stage, a tendency towards decreasing distribution was used for evaluation of forest community conservation significance, where *Dicranum viride* was found (Tab. 1). The system of criteria presented below was originally prepared in the Geobotanical and Vegetation Protection Laboratory, Institute of Biology of Ufa Research Centre of RAS (Martynenko, 2009).

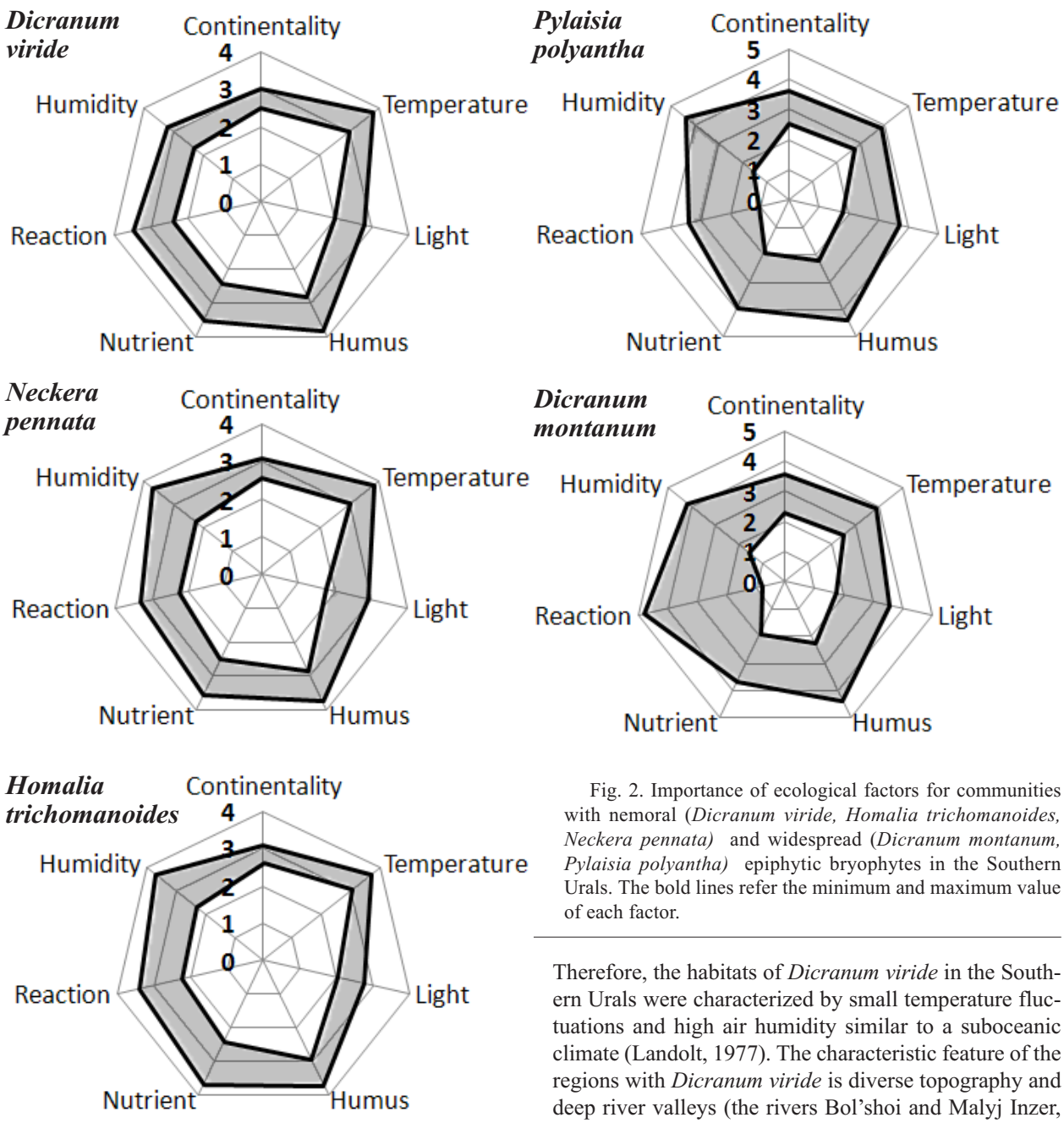

Fig. 2. Importance of ecological factors for communities with nemoral (*Dicranum viride, Homalia trichomanoides, Neckera pennata)* and widespread (*Dicranum montanum, Pylaisia polyantha)* epiphytic bryophytes in the Southern Urals. The bold lines refer the minimum and maximum value of each factor.

DISCUSSION

In spite of the poor nemoral flora of the Southern Urals in comparison with that of Central Europe (Chytrý *et al.*, 2010), populations of the rare species *Dicranum viride* in Bashkortostan are abundant on suitable substrates and habitats. Conservation of luxurious *Dicranum viride* populations in the Southern Urals is dependent on several environmental and historical factors discussed below.

In Bashkortostan, *Dicranum viride* was found in nine forest vegetation associations (Martynenko, 2009) (Table 1). Analysis of ecological factors shows that *Dicranum viride* in the Southern Urals has a narrow ecological amplitude, especially in relation to continentality (Fig. 2). Therefore, the habitats of *Dicranum viride* in the Southern Urals were characterized by small temperature fluctuations and high air humidity similar to a suboceanic climate (Landolt, 1977). The characteristic feature of the regions with *Dicranum viride* is diverse topography and deep river valleys (the rivers Bol'shoi and Malyj Inzer, Belaya, Nugush, Kuzha), having a stable microclimate.

Danukalova *et al.* (2009) noted that the main causes of flora development in the Southern Urals were absence of ice caps in different glacial periods of the Quaternary and changes of paleoenvironment as these were not as strong as in North Western European territories. In periods of regression phases and climate continentalization the plains underwent changes favouring development of steppe, but forest vegetation was preserved in river valleys during the Pleistocene (Smirnova, 2004). Therefore, valleys of mountain rivers in the Southern Urals contained the refugia of the nemoral flora. In our opinion, this is the reason for the occurrence of relict nemoral species (*Dicranum viride, Eurhynchium angustirete, Brachythecium geheebii, Anomodon* spp., *Frullania bolanderi, Pylaisia selwynii*, *Metz-*

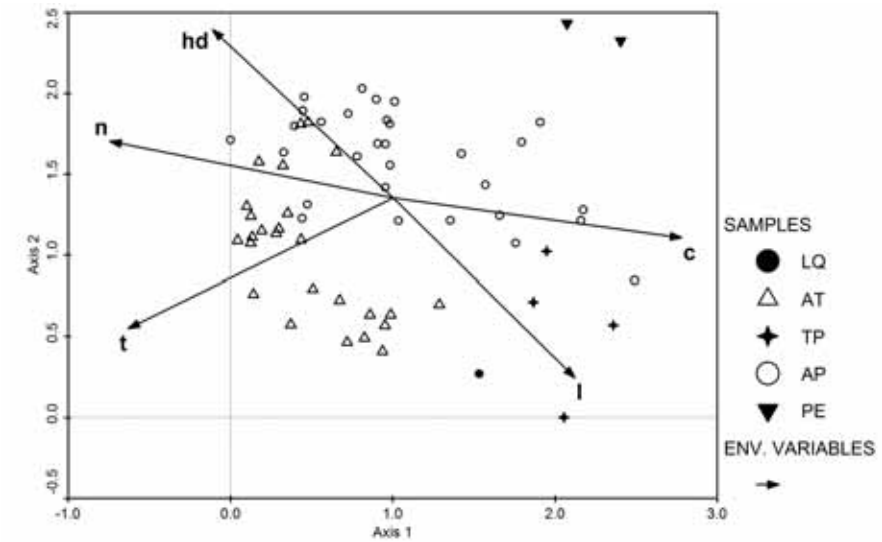

Fig. 3. DCA of forest communities including *Dicranum viride* in relation to ecological factors. Axis 1 explains 35% variation, 22 % variation is explained by Axis 2. Community types - **LQ** – xeromesophytic, mostley grass *Quercus robur* forests (alliance ***Lathyro-Quercion***), **AT** – mesophytic nemoral forests (suballiance ***Aconito-Tilienion***), **TP** – mesophytic *Pinus sylvestris* – nemoral forests (suballiance ***Tilio-Pinenion***), **AP** – mesophytic coniferous-nemoral forests (alliance ***Aconito-Piceion***), **PE** – mesophytic coniferous herbaceous-green moss forests (alliance ***Piceion excelsae***). Ecological factors: hd – humidity, c – continentality, l – light, t – temperature, n – nutrients.

geria furcata, and *Lejeunea cavifolia* in mountain river valleys. These species have limited dispersal ability and sporadic distribution in the European part of Russia.

Dicranum viride prefers specific forest types as it is related to particular substrate trees. It grows mostly on *Tilia cordata* trunks, sometimes is found also on other broad-leaved trees and recent dead-wood (Baisheva, 2011, 2012). It was more often found in mesophytic nemoral and coniferous-nemoral forests (Fig.3) and rarely in much drier habitats (*Pinus sylvestris*-nemoral or *Quercus robur* forests), indicating that relict nemoral plant communities (including substrate tree) are more important for it then just humidity. Communities with *Dicranum viride* in the Southern Urals represent the climax old-growth nemoral and coniferous-nemoral forests which have been highly influenced by man (decreasing area) and preserved only in small territories at a local scale. For stabilization of these communities at least 100 years are necessary.

Vegetative reproduction characteristic of *Dicranum viride* is more effective in stable conditions, when gene cloning is typical for plants with better adaptation ability (Longton, 2006). The survival and successful existence of *Dicranum viride* is possible only in habitats, where habitat disturbance (anthropogenic) was not long-term, ensuring habitat continuity (Norden & Appelqvist, 2001). The basic threat to *Dicranum viride* populations existence is wide clear-cutting, limiting potential substrate tree occurrence and aeration (Baisheva, 2011).

The management history of Southern Ural forests is connected with traditions of the Bashkir people, who until the 17–19 th centuries were managed cattle, removing dead wood, practicing wild beekeeping (in trees) and collecting edible and medical plants (Portal, 1946). Only in the second half of the 18th century the Bashkir forests started to be cut down in the lowlands, while mountain nemoral forests along the river valleys were less affected (Rekhenberg, 1852) due to the poor transport. In such regions the logging could be carried out only in the winter time. Some largest trees were selected for chopping and transported across the ice on the rivers. For bryophytes, the winter logging is less harmful then the summer one, because the ground layer and the bases of tree trunks are protected by snow cover. Moreover, the broad-leaved trees in the South Ural mountain forests have small annual increment with small productivity (Gorchakovsky, 1968; Martynenko *et al.*, 2005; Mirkin, 2010) and are of no interest for timber enterprises in contrast to coniferous forests.

The tradition of beekeeping was strong among the Bashkir people also during the Soviet time. More than 30 % of Russian nemoral *Tilia cordata* forests are concentrated in Bashkortostan (Khairetdinov, 2004). *Tilia cordata* is the most common tree species in the Southern Ural nemoral forests and is also important for beekeeping (Gorchakovsky, 1968). At 1970-1980 a lot of South Ural *Tilia cordata* forests were classified as "nectar lime-tree forests" – the forests of high value for beekeeping. Clear-cutting is prohibited there and the age of selective logging exceeds 80-90 years. Therefore, large areas (39.7%) of modern *Tilia cordata* forests in Bashkortostan are mature and overmature (Sultanova, 2006).

An important component of nemoral forest conservation in the Southern Urals was the establishment of conservation areas, especially the "Shul'gan-Tash" Nature Reserve and "Bashkiria" National Park. Since 2012, these territories became UNESCO Biosphere Reserve – Bashkirskij Ural (MAB 2012). At the present time, conservation of 70 % of the studied plant communities with *Dicranum viride* is provided in Bashkortostan (Tab. 1).

In general we conclude, that the existence of well-preserved *Dicranum viride* populations in the Southern Urals is due to natural and historical factors related to specific forest management practices in Bashkortostan during the 18-20th centuries. Conservation of nemoral landscapes in

Table 1. Rarity criteria, significance and ensurance of plant community conservation with *Dicranum viride*

Associations\ Criteria	F	R	N	D	V	P	T	C
			Alliance ***Lathyro-Quercion roboris*** (LQ)					
Brachypodio-Quercetum	F3	R6	N2	D2	V1	P1	T2	C2
			Suballiance ***Aconito septentrionalis-Tilienion cordatae*** (AT)					
Brachypodio-Tilietum	F3	R4	N1	D2	V1	P2	T3	C3
Stachyo-Tilietum	F3	R4	N1	D2	V1	P2	T4	C3
			Suballiance ***Tilio cordatae-Pinenion sylvestris*** (TP)					
Tilio-Pinetum	F3	R5	N2	D2	V1	P2	T3	C3
			Alliance ***Aconito septentrionalis-Piceion obovatae*** (AP)					
Violo-Piceetum	F1	R7	N1	D3	V0	P2	T2	C1
Frangulo-Piceetum	F2	R6	N1	D2	V1	P0	T3	C2
Chrysosplenio-Piceetum	F2	R6	N1	D2	V1	P0	T3	C2
Brachypodio-Abietetum	F3	R6	N1	D2	V1	P0	T3	C2
			Alliance ***Piceion excelsae*** (PE)					
Equiseto-Piceetum	F1	R6	N1	D2	V0	P0	T2	C1

Explanations:

1. **Floristic-phytocenotic significance (F) –** indicator influenced by rare species (red-listed species, endemics, relicts, species on areal border), total species richness, unique plant communities (species from different taxonomical divisions, location close to areal). F1– very high, F2 – high, F3 – medium.

2. **Rarity (R) –** serves to characterise plant community distribution, being dependent on size of these plant areas and also occurrence in their area. For evaluation of rarity we used the scale made for plant species by Rabinowitz *et al*. (1986) and adapted for plant community rarity (Izco, 1998). R4 – area narrow, occurrence high, huge size of phytocenosis; R5 – area narrow, occurrence low, huge size of phytocenosis; R6 – area narrow, occurrence high, small size of phytocenosis; R7 – area narrow, occurrence low, small size of phytocenosis.

3. **Naturalness (N)** - indicator showing the level of community deviation from its original state, influenced by anthropogenic factors up to full degradation. N1 – climax communities, N2 – natural forest.

4. **Decrease of area in region (D)** – an important indicator in the current state of the community and future trends under the same level of anthropogenic influence. D2 – 50-79 %, D3– 30-49 %.

5. **Renovation ability (V)** – ability of plant communities to return to the original state after removal of the natural or anthropogenical influence. The lowest ability is shown by relict communities, where renovation is practically impossible due to lack of suitable climatical conditions. V0 – no ability of restoration, V1 – for restoration necessary 100 years.

6. **Conservation insurance (P)** – an important indicator, which evaluates the threat of community dissappearence. The evaluation is based on communities of present type, being under protection in the region. P0 – no conservation, P1 – < 20 % of area under conservation, P2 – 21-50 % area under conservation.

7. **Threat of dissappearence (T)** – an important integral indicator evaluated mostly on criteria 2, 4, 5, 6 and factors that are threating the community at the present time. T2 – dissappearing, T3 – vulnerable, T4 – small risk of dissappearence.

8. **Conservation category (C)** – an integral indicator, reflecting the status or need for plant community conservation. Evaluation based on criteria 1, 3, 7. C1 – the highest, C2 – high, C3 – medium.

the Southern Urals has international importance as they are hotspots for internationally rare species. Furthermore, *Dicranum viride* in Western Europe survives in few localities of small extent due to the intensive historical forestry (Erzberger, 1999). However, in the Southern Ural Mts, *Dicranum viride* may represent one of the largest population in Europe, similar to those found in Slovenian beech forests (Ódor & Dort, 2002) and therefore may serve as an important part of the conservation of this species internationally. Further investigations are necessary for comparison of *Dicranum viride* populations in different regions in Europe, as distribution of this species may be highly dependent on particular regional factors and historical habitat management.

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Figs. 4-7. Examples of *Dicranum viride* habitats in *Lathyro-Quercion* (4), *Tilio-Pinenion* (5), *Aconito-Tilienion* (6), *Aconito-Piceion* (7).

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APPENDIX 1

Syntaxonomical synopsis of forest communities with *Dicranum viride* in the Southern Urals

Class *QUERCO-FAGETEA* Br.-Bl. et Vlieger in Vlieger 1937
Order *FAGETALIA SYLVATICAE* Pawłowski, Sokołowski et Wallisch 1928
Alliance *LATHYRO-QUERCION ROBORIS* Solomeshch et al. 1989
Ass. *Brachypodio pinnati-Quercetum roboris* Grigorjev in Solomeshch et al. 1989
Alliance *ACONITO SEPTENTRIONALIS-TILION CORDATAE* Solomeshch et al. 1993
Suballiance *Aconito septentrionalis-Tilienion cordatae* Martynenko 2009
Ass. *Brachypodio pinnati-Tilietum cordatae* Grigorjev ex Martynenko et Zhigunov in Martynenko et al. 2005
Ass. *Stachyo sylvaticae-Tilietum cordatae* Martynenko et Zhigunov in Martynenko et al. 2005
Suballiance *Tilio cordatae-Pinenion sylvestris* Martynenko et Schirokikh 2009
Ass. *Tilio cordatae-Pinetum sylvestris* Martynenko 2009 prov.
Order *ABIETETALIA SIBIRICAE* (Ermakov in Ermakov et al. 2000) Ermakov 2006
Alliance *ACONITO SEPTENTRIONALIS-PICEION OBOVATAE* Solomeshch et al. ex Martynenko et al. 2008
Ass. *Chrysosplenio alternifolii-Piceetum obovatae* Martynenko et Zhigunova 2007
Ass. *Frangulo alni-Piceetum obovatae* Martynenko et Zhigunova 2007
Ass. *Violo collinae-Piceetum obovatae* Martynenko et Zhigunov in Martynenko et al. 2005
Ass. *Brachypodio sylvatici-Abietetum sibiricae* Martynenko et Zhigunova 2007
Class *VACCINIO-PICEETEA* Br.-Bl. in Br.-Bl., Siss. et Vlieger 1939
Order *PICEETALIA EXCELSAE* Pawłowski, Sokołowski et Wallisch 1928
Alliance *PICEION EXCELSAE* Pawłowski, Sokołowski et Wallisch 1928
Ass. *Equiseto scirpoidis-Piceetum obovatae* Martynenko et Zhigunova 2004

APPENDIX 2

Synoptic table of communities with *Dicranum viride* in the Southern Urals (species with low constancy are not shown)

Community		1	2	3	4	5	6	7	8	9
Number of releves		1	7	16	4	11	5	3	14	2
Cover of tree layer (%)		50	70	85	70	80	75	60	80	70
Cover of herb layer (%)		80	60	60	45	75	65	45	50	55
Cover of moss layer (%)		<1	15	3	5	3	10	35	10	60
Avg. DBH (cm)		16	20	25	30	25	20	30	30	25
Max DBH (cm)		36	56	60	65	85	45	80	50	40
Tree layer:										
Tilia cordata	t1	.	V^{1-3}	V^{2-4}	.	V^{1-3}	IV	.	IV	.
	t2	1	V^{+-2}	V^{+-3}	4^{1-2}	V^{+-3}	V^{+-2}	3	IV	1
	t3	1	V^{r-3}	V^{r-1}	4^{+-2}	V^{r-2}	V^{r-2}	3	V^{+-2}	2
Acer platanoides	t1		III	II	.	.	.	.	.	.
	t2	2	III	IV	.	III	I	1	III	.
	t3	1	V^{r-+}	V^{+-4}	2	V^{+-2}	IV	2	IV	2
Ulmus glabra	t1	.	I	I	.	I	.	.	.	.
	t2	.	II	IV	.	IV	I	2	IV	.
	t3	1	V^{r-1}	V	2	V^{+-2}	III	2	IV	.
Populus tremula	t1	.	III	I	.	IV	II	.	II	.
	t2	.	II	.	.	.	.	.	.	.
	t3	.	II	.	1	I	II	.	I	.
Betula pendula	t1	.	V	II	2	IV	IV	1	III	2
	t2	.	.	I	1	.	II	1	I	1
	t3	.	II	I	.	I	I	1	I	.
Picea obovata	t1	.	.	.	1	V^{2-3}	IV	3	IV	2
	t2	.	.	I	.	III	III	3	III	2
	t3	.	.	.	3	V^{+-2}	IV	3	IV	2
Abies sibirica	t1	.	.	I	1	IV	V	.	IV	1
	t2	.	.	I	2	III	III	.	III	1
	t3	.	.	I	2	V^{+-2}	IV	.	III	2
Pinus sylvestris	t1	1	.	.	4	I	II	.	II	.
Padus avium	t3	.	III	V^{r-+}	2	V^{r-1}	V^{r-+}	3	IV	1
Sorbus aucuparia	t3	1	III	III	3	IV	V^{r-1}	3	V^{r-+}	2
Shrub layer:										
Rubus idaeus		.	IV	III	1	IV	I	3	II	1
Rosa majalis		1	III	I	1	.	.	3	I	.
Lonicera xylosteum		.	I	I	3	V	IV	3	III	1
Euonymus verrucosa		.	I	I	1	III	IV	2	III	1
Sambucus sibirica		.	.	.	.	IV	I	.	II	1

Herb layer:									
Aegopodium podagraria	1	V^{+-2}	V$^{1-3}$	4	V$^{1-3}$	V^{+-2}	2	V^{+-3}	2
Asarum europaeum	.	V^{r-2}	V$^{1-2}$	2	V$^{1-3}$	V^{+-2}	3	V^{+-3}	1
Galium odoratum	1	V^{+-2}	V^{+-3}	.	V^{r-1}	III	.	IV	.
Calamagrostis arundinacea	1	V^{+-1}	II	4	II	IV	3	III	2
Lathyrus vernus	1	V^{+}	V^{+}	4	V^{+}	V^{+}	3	V^{+}	2
Rubus saxatilis	1	V	II	4	II	V	3	IV	2
Stellaria holostea	1	V^{+}	V^{+}	4	V^{+-1}	V^{+}	3	V+	2
Aconitum lycoctonum	.	II	V^{+-3}	1	V^{+-2}	II	1	IV	.
Crepis sibirica	.	III	V^{+-3}	.	III	II	1	III	.
Cicerbita uralensis	.	I	V^{+-2}	.	V^{+-2}	II	.	III	.
Dryopteris filix-mas	.	II	V^{+-1}	2	V^{+-2}	V^{+-1}	1	V^{r-2}	2
Pulmonaria obscura	.	V^{+-1}	V^{+-1}	.	V^{+-1}	V^{+-1}	3	V^{+-2}	2
Milium effusum	.	IV	V^{+}	.	V^{+-1}	II	1	IV	.
Viola mirabilis	1	V^{+-1}	IV	4	IV	V^{+}	2	V^{+}	1
Bryophytes mainly growing on the bark of living trees:									
Dicranum viride	1	V	V	4	V	V	3	V	2
Pylaisia polyantha	1	IV	IV	2	I	II	1	III	1
Pseudoleskeella nervosa	1	IV	V	2	V	IV	2	III	.
Platygyrium repens	1	IV	II	2	II	III	2	II	1
Neckera pennata	.	I	I	2	III	III	1	I	2
Leucodon sciuroides	1	III	IV	.	.	I	.	.	.
Anomodon longifolius	.	II	II	.	.	.	.	II	.
Orthotrichum speciosum	.	.	II	.	.	.	.	.	.
Homalia trichomanoides	.	.	I	.	II	.	.	I	.
Bryophytes mainly growing on the base of living trees and on rotten wood:									
Brachythecium salebrosum	1	V	V	4	V	IV	1	IV	1
Sciuro-hypnum reflexum	1	IV	IV	2	V	III	1	IV	2
Dicranum montanum	1	III	III	4	V	V	3	III	2
Stereodon pallescens	1	III	III	1	III	III	2	IV	2
Radula complanata	.	II	III	2	II	III	2	III	.
Callicladium haldanianum.	II	III	2	V	IV	1	III	2	
Amblystegium serpens	1	I	I	1	II	IV	2	II	1
Lophocolea heterophylla	.	I	II	2	II	I	1	III	2
Sanionia uncinata	.	I	II	3	V	V	3	IV	2
Ptilidium pulcherrimum	.	.	I	3	II	IV	3	III	2
Bryophytes mainly growing on the soil:									
Plagiomnium cuspidatum	1	III	V	4	V	V	2	V	1
Eurhynchium hians	.	.	II	.	II	.	2	II	.
Fissidens taxifolius	.	I	II	.	I	.	1	II	.
Dicranum scoparium	.	I	I	1	II	I	2	II	2
Pleurozium schreberi	.	I	.	2	II	V	3	III	2
Rhytidiadelphustriquetrus	.	.	I	2	II	IV	3	II	2
Rhodobryum roseum	.	.	.	1	I	IV	2	I	.
Hylocomium splendens	.	.	.	2	I	III	3	II	2
Ptilium crista-castrensis	.	.	.	2	II	II	.	I	.
Bryophytes mainly growing on the rock outcrops:									
Paraleucobryum longifolium	.	II	.	1	.	.	.	I	.
Hypnum cupressiforme	.	I	I	.	.	.	2	I	.
Homomallium incurvatum	.	.	I	1	.	.	.	.	.
Tortella tortuosa	.	.	.	2	.	.	2	.	.
Eurhynchiastrum pulchellum	.	.	.	.	II	I	2	I	1
Campyliadelphus chrysophyllus	.	.	.	.	.	.	1	I	1

Explanations: 1: DBH – diameter of the trees at breast height.

2: t1, t2, t3 – tree layers (from high to low).

3: Community: 1 – ass. *Brachypodio pinnati-Quercetum roboris*, 2 – ass. *Brachypodio pinnati-Tilietum cordatae,* 3 – ass. *Stachyo sylvaticae-Tilietum cordatae,* 4 – ass. *Tilio cordatae-Pinetum sylvestris*, 5 – ass. *Chrysosplenio alternifolii-Piceetum obovatae*, 6 – ass. *Frangulo alni-Piceetum obovatae*, 7 – ass. *Violo collinae-Piceetum obovatae, 8 –* ass. *Brachypodio sylvatici-Abietetum sibiricae*, 9 – ass. *Equiseto scirpoidi-Piceetum obovatae*.

4: In the columns 2, 3, 5, 6, 8 the constancy of species have been evaluated according to the following scale: I – species presented in 1-20% relevés of the given association, II – 21-40%, III – 41-60%; IV – 61-80%, V – 81-100%. In the columns 1, 4, 7, 9 the constancy of species corresponds with the number of relevés in which the species was found.

5: For species with high constancy in the association the abundance in the sample plots have given: r – extremely rare, + – cover not more than 1 %, 1 – 1-5 %, 2 – 5-25 %, 3 – 25-50 %, 4 – 50-75 %, 5 – 75-100 %.