Conference Paper

Bryophyte Diversity of Calcareous Fens in the Bashkir Cis-Urals (Republic of Bashkortostan, the Southern Urals)

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Abstract

The bryophyte diversity of base-rich fens was studied in 16 calcareous mires of the Bashkir Cis-Urals (the Southern Ural region). Thirty-seven moss species and nine liverworts were recorded in treeless communities dominated by *Schoenus ferrugineus, Molinia caerulea*, small sedges and mosses. The annotated species list with precise locations is provided. Most of the surveyed mires are located in the northeastern part of the Bashkir Cis-Urals, that is, in the Mesyagutovo forest-steppe bordering with the western foothills of the Southern Ural Mountains. In the plain areas of the western part of the Bashkir Cis-Urals, calcareous mires are very rare and characterized by the low number of habitat specialists. Arctic-boreo-alpine species (*Cinclidium stygium*, *Paludella squarrosa*, *Palustriella decipiens*, *Pseudocalliergon trifarium*, etc.) make up approximately 30% of the total bryophyte diversity of the surveyed fens. In the study area, these species grow in small isolated populations at the southern limit of the species range. Currently, only half of the surveyed calcareous mires are located within protected areas. It is essential to improve the protection of these unique habitats in the study area.

Keywords: calcareous mires, base-rich fens, bryophytes, the Southern Urals

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1. Introduction

Base-rich fens are locally rare wetlands that have a high conservation status in many countries. The conditions for the appearance of these habitats are the presence of calcareous bedrock, usually limestone or marble, and a constant supply of mineralized groundwater from subsurface seeps or surface springs. Places where this combination

of environmental factors occurs are rare. Therefore, calcareous mires support a well-defined group of specialized plant communities that are small size and vulnerable to human impact.

In Europe, base-rich fens have been destroyed to a large extent by drainage as a result of which they turned into low fertile pasture and hay fields. Local extinctions of specialists have been related to anthropogenic changes on a landscape scale, and future losses of species are expected due global warming. According to the European Nature Information System habitat classification, base-rich fens are assigned to the type 'D4 – Base-rich fens and calcareous spring mires' and are protected by the Habitats Directive (92/43/EEC of May 21, 1992) under code 7230 (alkaline fens) [1, 2].

The eastern part of the main distribution range of European calcareous mires (alliance *Caricion davallianae* Klika 1934) runs through Northwestern Russia, that is, the Leningrad and Pskov provinces and the Republic of Karelia. Isolated calcareous mires were found in the Kola Peninsula [3, 4]. In the Southern Urals, these communities are relicts, as evidenced by the presence of *Schoenus ferrugineus* remains in the lower layers of the peat deposits [5]. Base-rich fens are particularly rich in vascular plant and bryophyte species, including habitat specialists which need highly mineralized of water and cannot tolerate excessive nitrogen and eutrophication. Among the habitat specialists recognized for European base-rich fens, there are many rare species with low competitiveness, including orchids [6].

There is little information relating to vascular plant diversity of calcareous mires in the study area [4, 7]: nor has targeted research of bryophytes been conducted. This study aimed to record bryophyte diversity of base-rich fens in the Bashkir Cis-Urals.

2. Methods

In 1992–2016, about 400 specimens of bryophytes were collected in base-fen communities dominated by *Schoenus ferrugineus, Molinia caerulea*, small sedges and mosses in sixteen calcareous mires located in the Bashkir Cis-Urals. The specimens were identified with the microscopes Olympus CX31 and Altami SPM 0880 using the traditional anatomical-morphological method. The geographic distribution of bryophytes was analyzed according to the botanical-geographical method. The nomenclature of bryophytes follows 'An annotated checklist of the mosses of Europe and Macaronesia' [8] and the 'World checklist of hornworts and liverworts' [9]. Specimens were kept in the Herbarium of the Ufa Institute of Biology (UFA) and in MHA and MW.

The study area is the southeastern part of the East European Plain bordering with western foothills of Southern Ural Mountains. The terrain is a gently sloping and hilly plain with an elevation between 60 and 80 Asl (an average elevation of about 200–300 Asl). The Bashkir Cis-Urals has a continental climate characterized by short warm summers and long and moderately cold winters. The average temperature varies from +2.5 to +3.5°C, while the sum of effective temperatures during the growing period ranges from 1900 to 2350°C. The average annual precipitation is 450–500 mm, while Selyaninov's geothermal coefficient is 0.8–1.4 [10].

The collection sites are numbered as follow: 1. Belokatai District, 3.7 km southeast from Maygaza village. Emaza Mire. 55°34′12″ N, 58°53′58″ E; 2. Kigy District, 6 km northeast from Yunusovo village. Zilekly Mire. 55°23′26″ N, 58°41′28″ E; 3. Kigy District, 1 km north from Igenchelyar village. 55°31′17″ N, 58°33′56″ E; 4. Duvan District, vicinity of Ozero village. Ozerskoe Mire. 55°29′58″ N, 58°07′22″ E; 5. Salavatsky District, 1.5 km east from Yazgi-Yurt village. Lagerevskoe Mire. 55°16′52″ N, 58°24′35″ E; 6. Duvan District, 1 km west from Nizhnee Absalamovo village. Karakulevskoe (Arievskoe) Mire. 55°35′25″ N, 58°09′36″ E; 7. Duvan District, Chernosharskoe Mire. 55°44′59″ N, 57°58′06″ E; 8. Salavatsky District, 4 km northeast from Arkaulovo village. Arkaulovskoe Mire. 55°25′44″ N, 57°58′59″ E; 9. Salavatsky District, 1.4 km south from Novomikhailovka village. Nadezhdinskoe Mire. 55°09′44″ N, 58°05′17″ E; 10. Salavatsky District, 2 km east from Kropachevo railway station. Yakhinskoe Mire. 55°00′15″ N, 58°02′19″ E; 11. Mishkino District, 2 km northwest from Yanagushevo village. Narat–Saz Mire. 55°23′32″ N, 55°59′35″ E; 12. Ishimbay District, 0.5 km to southwest from Verkhneitkulovo village. Bol'shoe Mire. 53°21′51″ N, 56°19′25″ E; 13. Davlekanovo District, 1.7 km north from Burangulovo village. Igenchelar Mire. 54°18′50″ N, 54°30′37″ E; 14. Al'sheevsky District, 0.5 km west from Tashly village. 54°11′02″ N, 54°39′17″ E; 15. Miyaky District, 1.5 km south from Kurmanaybash village. 53°32′13″ N, 54°50′28″ E; 16. Tuimazy District, 4.5 km northwest from Sayranovo village. 54°29′49″ N, 54°07′49″ E.

3. Results

The bryophyte flora revealed in the surveyed base-rich fens includes 46 species (9 liverworts and 37 moss species). The list presents all species annotated with occurrence in the 16 collection sites cited earlier. Habitat specialists growing mostly in calcareous mires are marked with an asterisk.

Liverworts: **Aneura pinguis* (L.) Dumort – 5, 10, 11; *Fuscocephaloziopsis pleniceps* (Austin) Váňa et L.Söderstr. – 1, 11; *Chiloscyphus pallescens* (Ehrh.) Dumort – 5, 6, 11, 13; *C. polyanthos* (L.) Corda – 11, 13; *Marchantia polymorpha* L. – 4; **Pellia endiviifolia* (Dicks.) Dumort – 1, 2, 9, 13, 14; **Riccardia chamedryfolia* (With.) Grolle – 8; **R. incurvata* Lindb. – 11; *Riccia fluitans* L. – 2, 11.

Mosses: *Amblystegium serpens* (Hedw.) Schimp. – 5, 11, 13; *Aulacomnium palustre* (Hedw.) Schwägr. – 4–6, 8, 11; *Brachythecium mildeanum* (Schimp.) Schimp. – 5, 11, 13, 14; *B. rivulare* Schimp. – 11; *Breidleria pratensis* (W.D.J.Koch ex Spruce) Loeske – 1, 11; *Bryum pseudotriquetrum* (Hedw.) P.Gaertn. et al. – 1, 2, 4–6, 8–16; *Calliergon cordifolium* (Hedw.) Kindb. – 4; *Calliergonella cuspidata* (Hedw.) Loeske – 3, 5, 10, 11, 13, 14; *Campyliadelphus chrysophyllus* (Brid.) R.S.Chopra – 11, 13; **Campylium stellatum* (Hedw.) Lange & C.E.O.Jensen – 1–16; **Cinclidium stygium* Sw. – 2, 4; *Climacium dendroides* (Hedw.) F.Weber & D.Mohr – 1; *Cratoneuron filicinum* (Hedw.) Spruce – 14; *Dicranum bonjeanii* De Not – 1, 4, 11; *D. scoparium* Hedw. – 11; *Drepanocladus aduncus* (Hedw.) Warnst. – 11, 13; **D. polygamus* (Schimp.) Hedenäs – 2, 6, 10, 13; **Fissidens adianthoides* Hedw. – 1, 2, 4, 5, 8, 9, 11, 13; **Hamatocaulis vernicosus* (Mitt.) Hedenäs – 3; *Helodium blandowii* (F.Weber & D.Mohr) Warnst. – 11, 14; *Hygroamblystegium fluviatile* (Hedw.) Loeske – 11; *H. humile* (P.Beauv.) Vanderp., Goffinet & Hedenäs – 4, 13; **Paludella squarrosa* (Hedw.) Brid. – 8, 11; **Palustriella decipiens* (De Not.) Ochyra – 9; *Plagiomnium elatum* (Bruch & Schimp.) T.J.Kop. – 2, 11; *P. ellipticum* (Brid.) T.J.Kop. – 6, 11; *P. rostratum* (Schrad.) T.J.Kop. – 4; *Pleurozium schreberi* (Willd. ex Brid.) Mitt. – 1, 5, 6, 8, 11; *Pohlia nutans* (Hedw.) Lindb. – 4–6, 11; **Pseudocalliergon trifarium* (F.Weber & D.Mohr) Loeske – 10; **Scorpidium cossonii* (Schimp.) Hedenäs – 2, 4, 5, 7–11, 14; **S. scorpioides* (Hedw.) Limpr. – 5, 11; *Sphagnum capillifolium* (Ehrh.) Hedw. – 8; *S. squarrosum* Crome – 13; *S. teres (Schimp.) Ångstr.* – 11; *S. warnstorfii Russow* – 8, 11; **Tomentypnum nitens* (Hedw.) Loeske – 4, 6–8, 11, 12.

Most of the surveyed mires were found in the northeastern part of the Bashkir Cis-Urals, in the Mesyagutovo forest-steppe. In this area, the calcareous mires fed by spring water are located on hill slopes (for instance, Chernosharskoye Mire or Arkaulovskoe Mire) or may be related to the overgrowth of the lakes, such as Karakulevskoye Mire. The rare mosses *Paludella squarrosa, Cinclidium stygium, Pseudocalliergon trifarium* and *Palustriella decipiens* growing in the Southern Urals near the southern limit of species range were found only in this area. In the forest zone of the central Bashkir Cis-Urals, only two mires (sites 11 and 12) were found: of these, the Narat-Saz Mire in the floodplain of the Bir' River is most remarkable, characterized by its large size and high bryophyte diversity. In the forest-steppe zone of the western part of the Bashkir Cis-Urals (sites 13–16), the calcareous mires are very small and characterized by a low

diversity of habitat specialists: only *Campylium stellatum* and *Limprichtia cossonii* were found there.

Analyses of the geographic distribution of bryophytes revealed in the surveyed base-rich fens shown that 34.8% of species are arcto-boreo-alpine (*Cinclidium stygium, Limprichtia cossoni, Paludella squarrosa, Palustriella decipiens, Pseudocalliergon trifarium, Scorpidium scorpioides, Sphagnum warnstorfii, Tomentypnum nitens,* etc.), 13% of species have a boreo-nemoral range (*Chiloscyphus polyanthos, C. pallescens, Riccardia chamaedryfolia*, etc., and 52.2% of species are multizonal and related to wetland communities widely distributed across the world (*Brachythecium rivulare, B.mildeanum, Cratoneuron filicinum, Drepanocladus aduncus, Plagiomnium ellipticum, Calliergonella cuspidata*, etc.).

In the study area, species rare for the Southern Urals were found: *Cinclidium stygium, Pseudocalliergon trifarium, Paludella squarrosa, Palustriella decipiens* and *Hamatocaulis vernicosus.* The last three species are included into the Red Data Book of the Republic of Bashkortostan [11]. Currently, only half of the surveyed calcareous mires are under protection. The Arkaulovskoye, Lagerevskoye, Karakulevskoye, Chernosharskoye, Ozerskoe and Narat–Saz Mires are protected as natural monuments. Two mires (sites 13 and 16) are situated within the Asly–Kul and Kandry–Kul State Nature Parks [12]. Other calcareous mires are under risk and need protection.

4. Conclusion

In the Bashkir Cis-Urals, the base-rich fens are a rare type of vegetation characterized by a high diversity of bryophytes and an increased concentration of rare species with elevated conservation concern. Among 30% of revealed bryophytes are habitat specialists of calcareous mires. Only half of the calcareous mires in the study area are under protection. The protection of these mires should be improved to avoid the habitat loss of these unique plant communities.

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