Bryoflora of mountain mires of Sub-Polar Urals

Yu V Skuchas\textsuperscript{1,3}, E D Lapshina\textsuperscript{2,4}

\textsuperscript{1}Museum of Nature and Man, Mira str. 11, Khanty-Mansiysk, 628011, Russian Federation
\textsuperscript{2}Yugra State University, Chekhova str., 16, Khanty-Mansiysk, 628012, Russian Federation
\textsuperscript{3}jskuchas@umuseum.ru
\textsuperscript{4}e_lapshina@ugrasu.ru

Abstract. The Bryoflora of mountain mires of Sub-Polar Urals within the Khanty-Mansi Autonomous District was studied in 2013-2015. The field work was conducted at Mt. Ner-Oika and in the upper course of the Puiva River (64° 27' - 64° 35' N, 59°35' - 59° 46'E). In total, 76 species of mosses were identified in the 24 mires surveyed. Most mosses have specific habitat preferences to different mire types, 5 species were observed almost in all types of mires: Warnstorfia exannulata, Straminergon stramineum, Sanionia uncinata, Pohlia nutans, and Pleurozium schreberi. A significant number of rare moss species were identified among the mires bryoflora (Dicranum laevidens, D. leioneuron, Loeskypnum badium Paludella squarrosa, Philonotis tomentella and others). Two species, Tayloria lingulata and Philonotis serotina were observed in the Khanty-Mansi Autonomous District for the first time.

1. Introduction

Sub-Polar Urals (SPU) is the highest and most wide-stretching part of the Ural Mountains located between 65°40' and 64° N. SPU is the location of Urals’ highest peaks (incl. Mt. Narodnaya, 1894 m a.s.l.). In contrast with the rest of the Urals, SPU commonly features Alpine-type landscapes characterized by well-defined high mountain peaks, sharp ridges, steep slopes, and deep valleys. The axial part of the mountains in this area is adjoined by 360 – 600 m high foothills alternating with lower flats. The Urals stretch from north to south blocking movement of relatively warm humid Atlantic air masses and making their eastern slopes of SPU much drier and colder than the western ones. Precipitation does not exceed 800 mm per year in the uplands whereas it can be 1500 mm on the western slopes. The eastern slopes are in the area of influence of the Siberian anticyclone with clear sunny weather being access to the masses of Arctic air from the Barents and Kara seas. It leads to a mixture of Arctic and continental influences and a cold climate [1]. Climatic features of the area can be summarized as follows: the climate is continental with long winters and very short summers. The mean temperature of January is \(-19\text{-}23\text{oC}\), minimal values reach \(-50\text{-}55\text{oC}\). The mean temperature of July varies from 14-16°C in plains to 5° at height of 1300-1400 m. There are large permanent snowfields on the leeward eastern slopes of the highest peaks [2, 3].

Due to the difficulty of access, the SPU area is dominated by pristine natural landscapes, the biodiversity of which has been poorly characterized in terms of both species and biocenoses, including bryophytes. The moss flora of SPU has been investigated during more than 150 years. The previous reseach of this region was mainly conducted on the forested mountain slopes and on neighboring
lowlands, both on the west and east slopes [4, 5]. The data on moss flora from numerous publications [6-13] was summarized at the end of last century [14]. The aim of this paper is to present the results of our study on the moss species composition of mountain mires of SPU as a very specific type of habitat with a high concentration of species extremely rare in the plains of Western Siberia.

2. Material and methods
Here we report on the field work conducted in 2013-2015 at Mt. Ner-Oyka and in the upper course of the Puiva River (64° 27’ - 64° 35’ N, 59°35’ - 59° 46’E). Both sites are located in proximity to the drainage divide of the Urals on its eastern slope 380 to 1200 m a.s.l (figure 1). The research area covers the upper part of the forest zone, the mountain-forest-tundra zone, and a mountain tundra zone transitioning to rocky deserts dominated by loose rock screes (kurumniks). The upper limit of dark coniferous forest is situated at 400-500 m a.s.l. The mountain-forest-tundra zone is represented by larch-dominated open woodlands, secondary low birch forests, alder tickets and subalpine meadows. Since 500-600 m, mountain tundra forms the belt: draft shrub - green moss and moss lichen tundra in the lower part is replaced by dry debris-lichen-moss tundra, which is succeeded by rock fields with only scattered and fragmentary vegetation at the level above 900-1000 m a.s.l. However, due to the highly dissected relief, the location of the upper limit of the subalpine wood communities is quite variable in the SPU [3].

Figure 1. Position of Ner-Oyka and Puiva sites and collecting localities.
In two chosen key sites, 24 relevés were done, attempting to cover different types of mires and to reveal species diversity. The relevés were accompanied by collecting moss samples. In total, 242 specimens were collected: 127 at Mt. Ner-Oika and 115 at the upper course of the Puiva River.

A preliminary list of species and their abundance have been drafted in field. The identifications of the specimens were checked later in the laboratory. All herbarium samples collected during the field work are stored in the herbarium of the Yugra State University (YSU) and duplicates are in the Museum of Nature and Man in Khanty-Mansiysk.

3. Results and Discussion

The mires in the study area are rather small (from several square meters to one-two hectares) and totally occupy not more than 1% of the land area [4, 5]. Nevertheless, a significant species diversity is present due to the favorable combination of water and mineral nutrition, humidity conditions, the presence of peat or peat-mineral soils. Three types of mires were distinguished: mountain dwarf shrubs-sedge-sphagnum bogs predominantly with rain water-supply, rich fens with groundwater water-supply, and transitional sedge-sphagnum mires. 76 species of mosses were identified in the 24 mires surveyed (30% of the total bryoflora in the study area).

Mountain dwarf shrubs-sedge-sphagnum bogs feature high diversity of moss species (41 species, representing 54% of the total moss species identified for all types of mires). Sphagnum mosses predominate and cover up to 95% of the surface, including various combinations in different plant communities of Sphagnum russowii, S. angustifolium, S. capillifolium, S. balticum, S. girgensohni, S. warnstorfii, and S. lindbergii. Sphagnum fuscum, S. teres, and S. aongstroemii are less common. Green mosses are well-represented (up to 20%), most commonly Polytrichum strictum, Aulacomnium turgidum, Dicranum elongatum, and D. laevidens (table 1).

Transitional sedge-sphagnum mires of the upper part of the forest zone lack a distinctive species diversity (20 species or 26%). Their species composition is similar to the bogs of the first group (table 1), however several notable differences exist. Sphagnum mosses cover almost all the surface, dominated by Sphagnum riparium and S. fallax with either minor or co-dominant presence of Sphagnum jensenii, S. flexuosus, and S. fimbriatum.

Rich fens with groundwater water-supply feature the similar diversity of species (42 species, representing 55% of the total moss species identified). Sphagnum mosses are poorly represented, the only constantly encountered species being Sphagnum warnstorfii, occasionally accompanied by small numbers of S. squarrosum and S. girgensohni. Rich fens biodiversity is characterized by such species as Calliergon richardsonii, Bryum pseudotriquetrum, Paludella squarrosa, Aulacomnium palustre, Tomentypnum nitens, Helodium blandowii, Campylium stellatum, Plagioonmium ellipticum, and Rhizomnium pseudopunctatum (table 1). Such species as Tayloria lingulata and Philonotis serotina were exclusive to this type of mires.

The following 5 species were observed in all types of the mires: Warnstorfia exannulata, Straminergon stramineum, Sanionia uncinata, Pohlia nutans, and Pleurozium schreberi (table 1).

| Table 1. Frequency of moss species on studied mountain mires of Sub-Polar Urals. Mire types: 1 – Mountain dwarf shrubs-sedge-sphagnum bogs, 2 – Transitional sedge-sphagnum mires, 3 – Rich fens. Frequency: + – single, I – 1-20%, II – 1-40%, III – 41-60%, IV – > 60%. |
|-----------------|---|---|---|
| Moss species    | 1 | 2 | 3 |
| Sphagnum russowii | IV | III |
| Sphagnum angustifolium | III | IV |
| Sphagnum girgensohni | III | IV | I |
| Polytrichum strictum | IV | III |
| Polytrichum commune | III | III |
| Sphagnum lindbergii | III | II |
| Species                        | Bars |
|-------------------------------|------|
| Sphagnum teres               | II   |
| Sphagnum balticum            | III  |
| Aulacomnium turgidum         | III  |
| Dicranum laevigens           | III  |
| Dicranum elongatum           | III  |
| Dicranum leioneuron          | II   |
| Sphagnum capillifolium       | III  |
| Sphagnum fuscum              | II   |
| Polytrichastrum alpinum      | II   |
| Sphagnum aongstroemii        | III  |
| Loeskypnum badium            | II   |
| Polytrichum jenseni          | I    |
| Sphagnum compactum           | I    |
| Sphagnum contortum           | +    |
| Sphagnum majus               | +    |
| Sphagnum riparium            | IV   |
| Sphagnum fallax              | III  |
| Sphagnum jenseni             | III  |
| Sphagnum flexuosum           | II   |
| Sphagnum fimbriatum          | II   |
| Polytrichastrum longisetum   | II   |
| Sphagnum warnstorffii        | II   |
| Aulacomnium palustre         | V    |
| Bryum pseudotriquetrum       | III  |
| Callierгон richardsonii      | III  |
| Rhizomnium pseudopunctatum   | III  |
| Tomentypnum nitens           | III  |
| Hylocomiastrum pyrenaicum    | III  |
| Philonotis tomentella        | III  |
| Philonotis fontana           | II   |
| Sciuro-hypnum latifolium     | II   |
| Paludella squarrosa          | II   |
| Plagiomnium ellipticum       | II   |
| Bryum weigelii               | II   |
| Helodium blandowii           | II   |
| Campilium stellatum          | II   |
| Warnstorffia examulata       | II   |
| Straminergon stramineum      | III  |
| Pohlia nutans                | III  |
| Sanionia uncinata            | II   |
| Pleuroziium schreberi        | II   |
| Warnstorffia sarmentosa      | II   |
| Dicranum bonjeani            | I    |
| Oncophorus wahlenbergii      | II   |
| Scorpodium revolvens         | I    |
| Hylocomia splendens          | I    |

In addition, the following species were observed: 1 (mountain dwarf shrubs-sedge-sphagnum bogs)
- Conostomum tetragonum I, Dicranum angustum +, D. flexicaule +, D. majus +, D. spadiceum +,
Kiaeria blyttii +, Racomitrium lanuginosum +, Warnstorfia fluitans +; 2 (rich fens) - Calliergonella
lindbergii +; 3 (transitional sedge-sphagnum mires) - Brachythecium mildeanum I, B. rivulare I,
Campylium sommerfeltii I, Cinclidium dendroides I, Dicranella schreberiana I, Dicranum
fusescens +, Mnium stellare I, Philonotis seratina I, Plagiothecium denticulatum I, Pohlia cruda I, P.
wahlenbergii I, Pseudobryum cinclidioides I, Rhizomnium magnifolium I, Sciuro-hypnum starkei I,
Tayloria lingulata I.

While the transitional sedge-sphagnum mires are located at the upper part of the forest zone, two
other types of mires are not rare along a whole slope up from forest zone to the upper limit of tundra
(at 915-960 m a.s.l.). In addition to the typical bog species, Polytrichum commune, Polytrichastrum
alpinum are infrequently encountered in mountain dwarf shrubs-sedge-sphagnum bogs. Sphagnum
contortum, Loeskypnum badium, Dicranum leioneuron, and Polytrichum jensenii were exclusive to
this type of mires. Rich fens' bryoflora is additionally enriched by mountainous species such as
Hylocomiastrum pyrenaicum, and Sciuro-hypnum latifolium (at the level above 700 m a.s.l.), as well
as by the presence of Philonotis fontana, P. tomentella, and Bryum weigelii which indicates free-
flowing channel runoff in the area of their growth.

A significant number of rare moss species were identified among the mires bryoflora. Some of
them, Calliergon richardsonii, Paludella squarrosa, Dicranum laevidens, D. leioneuron, and
Loeskypnum badium, are quite common in SPU bogs and have a significant function in phytocenoses
formation there. Two species, Tayloria lingulata and Philonotis serotina were observed in the Khanty-
Mansi Autonomous District for the first time and deserve to be added to the regional Red List of
Threatened species.

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