

THE SAXICOLOUS MOSS FLORA OF THE MIDDLE URALS  
ФЛОРА МХОВ СКАЛЬНЫХ ОБНАЖЕНИЙ СРЕДНЕГО УРАЛА

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Summary

The saxicolous moss flora of the Middle Urals, the lowest part of the Ural Mts extending from 55°54' N to 59°15' N, is studied. It is found to be quite specific, comprising 110 species inhabiting exclusively or predominantly rock outcrops. Number of their localities in the Middle Urals, types of bedrock, altitudinal, regional and general distribution are analyzed. Annotated list of moss species with comments on morphology and anatomy of some taxa is provided.

Резюме

Изучена флора мхов скальных обнажений Среднего Урала – самой низкой части Уральских гор, простирающейся от 55°54' до 59°15' с.ш. Она является довольно специфичной, включающей 110 видов, произрастающих исключительно или преимущественно на скально-каменистых субстратах. Проанализирована частота их встречаемости, распределение по высотным поясам и горным породам на Среднем Урале, региональное и общее распространение. Приведен аннотированный список видов; для некоторых рассмотрены анатомо-морфологические особенности.

Rocks on top of hills and mountains, cliffs along river banks are widespread in mountainous regions. Rock outcrops are characterized by extremely fragmented and variable microenvironment providing for the highest diversity of habitats for bryophytes. Besides, rock outcrops are known to be places where lots of rare, endemic and relic plant species occur. The flora of vascular plants growing on various rock outcrops in the Middle Urals, and their geographic distribution have been well studied, while the knowledge of saxicolous mosses of the area have remained very poor.

The Ural Mountains is a long range located along the boundary between Europe and Asia. It is divided into five parts: the Polar, Sub-Polar, Northern, Middle and Southern. The Middle Urals extends from 55°54' N to 59°15' N (Borisevich, 1968) (Fig. 1). It is the lowest part of the Ural Mts., with its western slope on the territory of Perm Province, and the eastern one in Sverdlovsk Province. The relief is rather gentle, with average heights of 300-600 m a.s.l. The highest point is Middle Baseg Mt. (994.8 m) – the main peak of the Basegi range situated in the north-western part of the area.

The climate is temperate, more continental on the eastern slope. The coldest month is January with a mean air temperature of –16-17°C, while the warmest month is July with a mean of +16-17°C. The annual amount of precipitation is 400-500 mm (Kuvshinova, 1968).

Most of the territory is covered with boreal forests. Dark coniferous woods of *Picea obovata* and *Abies sibirica* predominate on the western slope, while pine (*Pinus sylvestris*) forests prevail on the eastern slope. The very south of the Middle Urals is covered with forest-steppe plant communities (Krasnoufimsky district) and birch-aspen (*Betula verrucosa*, *Populus tremula*) forests (Kamensky district). Areas above 650-700 m a.s.l. belong to the subalpine belt with fir and spruce open stands, sometimes with birch (*Betula tortuosa*), meadows and rock fields. Tundra vegetation is formed on the most windy slopes (Igoshina, 1952; Ignatova et al., 1995).

Wide spectrum of rock types is presented in the Middle Urals. According to the concentration of SiO<sub>2</sub> these are divided into acidic (65-80% of SiO<sub>2</sub> – granite, quartzite), medium (52-65% of SiO<sub>2</sub> – diorite, andesite), basic (about

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50% of SiO<sub>2</sub> – basalt, diabase, gabbro, pyroxenite, chlorite and talc schists), and ultrabasic (less than 45% of SiO<sub>2</sub> – dunite, serpentine). They are all characterized by rather low concentrations of Ca. Most of these rocks (granite, andesite, diorite, basalt, diabase, gabbro, pyroxenite, dunite) are volcanic, and some (quartzite, serpentine, schists) are metamorphic. Sedimentary rocks are also common – these are limestones consisting mostly of CaCO<sub>3</sub>.

In 1996-2000, I collected saxicolous mosses in Sverdlovsk Province: on the granite outcrops close to Yekaterinburg, limestone cliffs in the valleys of the Ufa, Serga, Chusovaya, Iset, Rezh rivers and their tributaries, basic and ultrabasic rock outcrops along the Sysert and Iset rivers, and on tops of a few hills. The specimens are placed in the Herbarium of Institute of Plant and Animal Ecology (SVER) in Yekaterinburg. I also examined other collections of mosses from the Middle Urals housed there and in the herbaria of the Ural Teachers' Training State University in Yekaterinburg (which still has no official acronym and called below as UTTSU), Perm State University (PERM), Moscow State University (MW), Main Botanical Garden (MHA) in Moscow, and of the Botanical Institute (LE) in St. Petersburg. Additional data were obtained from Krylov (1885), Navashin (1888), Syuzev (1899,1909), Gorchakovskiy & Arkhipova (1964), Sitnikova (1976), Dyachenko (1987, 1990, 1996, 1997a, b), Trotsenko (1990), Ignatov & Maslovskiy (1991), Ignatova et al. (1995), Dyachenko et al. (1996), and Bezgodov (2002).

The saxicolous moss flora is known from 85 localities in the Middle Urals (Fig. 1, Appendix 1), most of them are situated in the central part of the eastern slope. The saxicolous flora comprises 190 species and 5 varieties. 80 taxa facultatively grow on rock substrates (Table 2), and I am not sure that the list is complete. Most of these species are widespread in boreal forests, where they inhabit soil and decaying wood or grow as epiphytes. Some are typical of disturbed habitats: open soil in woods and fields, sides of roads and ditches, pits under roots of fallen trees. Hygrophytes from wet habitats (flood-plains, bogs, meadows, and boggy forests) can inhabit boulders in river valleys. Some facultative saxicolous taxa are rare in the Middle Urals: *Amblystegium varium*, *Brachythecium erythrorrhizon*, *Buxbaumia aphylla*,

*Campylium hispidulum*, *Schistostega pennata*.

11 moss species (*Cynodontium strumiferum*, *Dichodontium pellucidum*, *Dicranum spadicum*, *Homalia trichomanoides*, *Hygrohypnum ochraceum*, *Oxystegus tenuirostris*, *Plagiothecium cavifolium*, *Platydictya jungermannioides*, *Platygyrium repens*, *Pohlia cruda*, *Racomitrium canescens*) have been found predominantly on rock outcrops, with a few collections on other substrates. 99 species and 5 varieties belonging to 62 genera of mosses are known to grow exclusively on rock substrates in the Middle Urals. These are obligate saxicolous species, and I would like to underline that they grow not only on bare rock surfaces (as one could think), but also on humus and soil accumulating in crevices and niches, and on cliff ledges.

The rest of this article will be devoted to the diversity and distribution patterns of moss species found in the Middle Urals exclusively or predominantly on rock substrates.

#### Number of localities in the Middle Urals.

For each species I counted the number of sites where it was recorded. Species found at 1-10 localities were regarded as rare, at 11-20 localities – common, at more than 20 localities – frequent. Only 16 species of saxicolous mosses (*Anomodon viticulosus*, *Cynodontium strumiferum*, *Distichium capillaceum*, *Hedwigia ciliata* and others) are frequent, and 9 (*Anomodon longifolius*, *Cynodontium tenellum*, *Grimmia affinis*, *Encalypta raptocarpa*, *Hypnum vaucheri*, *Pseudoleskeella tectorum*, *Taxiphyllum wisgrillii*, *Tortella tortuosa*) are common on rock outcrops in the Middle Urals; that makes a bit more than 20 percent of the flora. All of them are known from both Perm and Sverdlovsk Provinces. Other taxa (85) are rare. Of them, 16 species have been found only in Sverdlovsk Province, and 26 taxa only in Perm Province. A very high percent of rare species in the saxicolous moss flora of the Middle Urals can be explained by their ecological features, such as altitudinal distribution in the Middle Urals and types of rock they inhabit, as well as geographic distribution – in the Ural Mts. and Eurasia.

Altitudinal distribution. Although highlands do not cover vast areas in the Middle Urals, there are 9 rare taxa (*Andreaea rupestris* var. *papillosa*, *Anomodon rugelii*, *Dicranowesia crispula*, *Grimmia elatior*, *Hygrohypnum alpestre*, *Iwatsukiella*

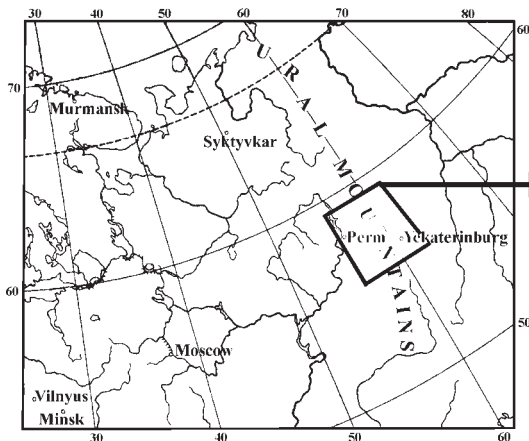
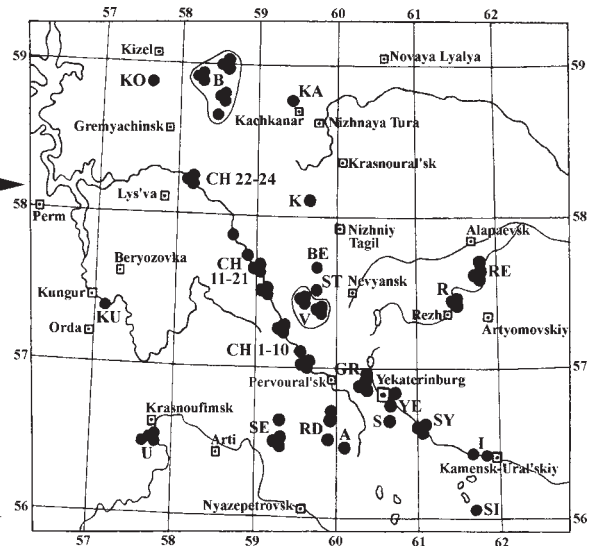


Fig. 1. The study area.

*leucotricha*, *Lescuraea saxicola*, *Pseudoleskea radicata*, *Racomitrium sudeticum*) reported only from the subalpine belt. 35 species (*Amphidium lapponicum*, *Bartramia ithyphylla*, *B. pomiformis*, *Cynodontium strumiferum*, *C. tenellum*, *Grimmia muehlenbeckii*, *Paraleucobryum longifolium*, *Pohlia cruda* and others) are known from both forest and subalpine belts. Among them, *Andreaea rupestris* var. *rupestris*, *Racomitrium microcarpon* and *Polytrichastrum alpinum* are very common in the subalpine belt and rare at low elevations. Only one collection of *Anomodon attenuatus* has been made above the timberline, while in the forest zone it is more frequent. The rest of species have been found only on rock outcrops in the forest belt.

**Type of bedrock.** Most of publications and specimens collected by other researches do not carry this information. The results of my own study and data available from other authors show that many rare saxicolous species (*Campylium calcareum*, *Didymodon fallax* var. *reflexus*, *Ditrichum flexicaule*, *Homalia besseri*, *Hygrohypnum luridum*, *Molendoa sendtneriana*, *Plagiommium confertidens*, *Plagiopus oederiana*, *Seligeria campylopoda*, *S. donniana*, *S. pusilla*, *Tortella fragilis*, *Tortula muralis* var. *aestiva*, and some other taxa) have been found only on limestone cliffs, and only some of them on other rock types: ultrabasic (*Funaria pulchella*, *Homomallium incurvatum*, as well as *Fabronia ciliaris*, *Dicranum viride*, *Encalypta vulgaris*, *Tortula mucronifolia* that have been collected also on limestone); acidic (*Rhabdoweisia crispata*, *Ulota curvifolia*). Only a few rare species inhabit wide spectrum of rock types, from granite to limestone (*Bryum subelegans*, *Dichodontium pellucidum*, *Grimmia*



*muehlenbeckii*). In general, moss species diversity is the highest on limestone, and the lowest on granite.

Type of bedrock the species is restricted to can partly explain its altitudinal distribution. For example, there are no limestone outcrops above the timberline in the Middle Urals, and all calcicole moss taxa are known only from the forest belt.

**Distribution in the Ural Mountains** have been analyzed using the results of my own investigations in the Northern (Goldberg, 2002) and Southern Urals (yet unpublished) and data by other researches (Kildyushevsky, 1956; Selivanova-Gorodkova & Shljakov, 1956; Ignatova & Ignatov, 1993; Zheleznova, 1994; Chernyadjeva, 1994; Ignatova et al., 1996; Dyachenko, 1997b, 1999; Zheleznova & Shubina, 1997). The saxicolous mosses of the Middle Urals have been grouped into eight distribution patterns according to their occurrence in different parts of the Ural Mts. (Table 1):

1. Species spread throughout the Urals. This is the biggest group, comprising 61 saxicolous taxa. All frequent species and 7 common taxa belong to this group. They grow in both forest and subalpine belts of the Middle Urals. Some taxa rare in the Middle Urals (*Andreaea rupestris*, *Ditrichum flexicaule*, *Polytrichastrum alpinum*, *Racomitrium canescens*, *R. microcarpon*) are common and abundant in the highlands of the southern and northern parts of the Urals, where they inhabit not only rock substrates, but also soil in mountain tundras (Fig. 2). Others are rare or sporadic throughout the Ural Mts. (e.g. *Plagiommium con-*

Table 1. Distribution of the saxicolous species in the Ural Mts: SU – Southern Urals, MU – Middle Urals, NU – Northern Urals, SPU – Sub-Polar+Polar Urals; Perm – Perm Province, Sverd – Sverdlovsk Province; SA – subalpine belt, F- forest belt. Species frequent in the Middle Urals are marked with two asterisks (\*\*), common taxa with one (\*).

| Group | Species   | SU | MU       |         |        | NU | SPU |
|-------|---|----|----------|---------|--------|----|-----|
|       |   |    | Perm(SA) | Perm(F) | SverdF |    |     |
| 1     | <i>Andreaea rupestris</i> var. <i>rupestris</i> | •  | •        | •       | •      | •  | •   |
|       | ** <i>Cynodontium strumiferum</i>               | •  | •        | •       | •      | •  | •   |
|       | * <i>Cynodontium tenellum</i>                   | •  | •        | •       | •      | •  | •   |
|       | ** <i>Distichium capillaceum</i>                | •  | •        | •       | •      | •  | •   |
|       | ** <i>Encalypta streptocarpa</i>                | •  | •        | •       | •      | •  | •   |
|       | <i>Grimmia muehlenbeckii</i>                    | •  | •        | •       | •      | •  | •   |
|       | ** <i>Hedwigia ciliata</i>                      | •  | •        | •       | •      | •  | •   |
|       | ** <i>Paraleucobryum longifolium</i>            | •  | •        | •       | •      | •  | •   |
|       | ** <i>Pohlia cruda</i>                          | •  | •        | •       | •      | •  | •   |
|       | <i>Polytrichastrum alpinum</i>                  | •  | •        | •       | •      | •  | •   |
|       | ** <i>Rhytidium rugosum</i>                     | •  | •        | •       | •      | •  | •   |
|       | * <i>Tortella tortuosa</i>                      | •  | •        | •       | •      | •  | •   |
|       | ** <i>Tortula ruralis</i>                       | •  | •        | •       | •      | •  | •   |
|       | <i>Bartramia ithyphylla</i>                     | •  | •        | •       | •      | •  | •   |
|       | <i>Plagiothecium cavifolium</i>                 | •  | •        | •       | •      | •  | •   |
|       | <i>Pohlia longicollis</i>                       | •  | •        | •       | •      | •  | •   |
|       | <i>Pterigynandrum filiforme</i>                 | •  | •        | •       | •      | •  | •   |
|       | <i>Bartramia pomiformis</i>                     | •  | •        | •       | •      | •  | •   |
|       | <i>Dicranum spadiceum</i>                       | •  | •        | •       | •      | •  | •   |
|       | <i>Ditrichum flexicaule</i>                     | •  | •        | •       | •      | •  | •   |
|       | * <i>Grimmia affinis</i>                        | •  | •        | •       | •      | •  | •   |
|       | <i>Grimmia incurva</i>                          | •  | •        | •       | •      | •  | •   |
|       | <i>Pseudoleskea incurvata</i>                   | •  | •        | •       | •      | •  | •   |
|       | <i>Racomitrium microcarpum</i>                  | •  | •        | •       | •      | •  | •   |
|       | <i>Dicranoweisia crispula</i>                   | •  | •        | •       | •      | •  | •   |
|       | <i>Lescuraea saxicola</i>                       | •  | •        | •       | •      | •  | •   |
|       | ** <i>Anomodon viticulosus</i>                  | •  | •        | •       | •      | •  | •   |
|       | ** <i>Bryoerythrophyllum recurvirostrum</i>     | •  | •        | •       | •      | •  | •   |
|       | ** <i>Campylium chrysophyllum</i>               | •  | •        | •       | •      | •  | •   |
|       | <i>Dichodontium pellucidum</i>                  | •  | •        | •       | •      | •  | •   |
|       | ** <i>Didymodon rigidulus</i>                   | •  | •        | •       | •      | •  | •   |
|       | <i>Encalypta ciliata</i>                        | •  | •        | •       | •      | •  | •   |
|       | * <i>Encalypta rhaptocarpa</i>                  | •  | •        | •       | •      | •  | •   |
|       | <i>Encalypta vulgaris</i>                       | •  | •        | •       | •      | •  | •   |
|       | * <i>Gymnostomum aeruginosum</i>                | •  | •        | •       | •      | •  | •   |
|       | <i>Hygrohypnum luridum</i>                      | •  | •        | •       | •      | •  | •   |
|       | <i>Hygrohypnum ochraceum</i>                    | •  | •        | •       | •      | •  | •   |
|       | <i>Hypnum recurvatum</i>                        | •  | •        | •       | •      | •  | •   |
|       | * <i>Hypnum vaucheri</i>                        | •  | •        | •       | •      | •  | •   |
|       | ** <i>Leucodon sciuroides</i>                   | •  | •        | •       | •      | •  | •   |
|       | ** <i>Orthotrichum anomalum</i>                 | •  | •        | •       | •      | •  | •   |
|       | ** <i>Pseudoleskeella catenulata</i>            | •  | •        | •       | •      | •  | •   |
|       | * <i>Pseudoleskeella tectorum</i>               | •  | •        | •       | •      | •  | •   |
|       | <i>Plagiomnium confertidens</i>                 | •  | •        | •       | •      | •  | •   |
|       | <i>Plagiopus oederiana</i>                      | •  | •        | •       | •      | •  | •   |
|       | <i>Racomitrium canescens</i>                    | •  | •        | •       | •      | •  | •   |
|       | <i>Saelania glaucescens</i>                     | •  | •        | •       | •      | •  | •   |
|       | ** <i>Schistidium apocarpum</i>                 | •  | •        | •       | •      | •  | •   |
|       | <i>Schistidium strictum</i>                     | •  | •        | •       | •      | •  | •   |
|       | <i>Tortula mucronifolia</i>                     | •  | •        | •       | •      | •  | •   |
|       | <i>Hygrohypnum duriusculum</i>                  | •  | •        | •       | •      | •  | •   |
|       | <i>Pohlia elongata</i>                          | •  | •        | •       | •      | •  | •   |
|       | <i>Schistidium rivulare</i>                     | •  | •        | •       | •      | •  | •   |
|       | <i>Bryum pallescens</i>                         | •  | •        | •       | •      | •  | •   |
|       | <i>Cnestrum schistii</i>                        | •  | •        | •       | •      | •  | •   |
|       | <i>Didymodon fallax</i>                         | •  | •        | •       | •      | •  | •   |

| Group | Species   | SU | MU       |         |        | NU | SPU |
|-------|---|----|----------|---------|--------|----|-----|
|       |   |    | Perm(SA) | Perm(F) | SverdF |    |     |
|       | <i>Grimmia ovalis</i>                           | •  |          |         | •      | •  | •   |
|       | <i>Molendoa sendtneriana</i>                    | •  |          |         | •      | •  | •   |
|       | <i>Timmia austriaca</i>                         | •  |          |         | •      | •  | •   |
|       | <i>Timmia norvegica</i> var. <i>excurrens</i>   | •  |          |         | •      | •  | •   |
|       | <i>Ulota curvifolia</i>                         | •  |          |         | •      | •  | •   |
| 2     | <i>Anomodon attenuatus</i>                      | •  | •        | •       | •      | •  |     |
|       | <i>Homalia trichomanoides</i>                   | •  | •        | •       | •      | •  |     |
|       | <i>Rhabdoweisia crispata</i>                    | •  | •        | •       | •      | •  |     |
|       | <i>Grimmia elatior</i>                          | •  | •        |         |        | •  |     |
|       | <i>Iwatsukiella leucotricha</i>                 | •  | •        |         |        | •  |     |
|       | * <i>Anomodon longifolius</i>                   | •  |          | •       | •      | •  |     |
|       | <i>Homalia besseri</i>                          | •  |          | •       | •      | •  |     |
|       | * <i>Taxiphyllum wissgrillii</i>                | •  |          | •       | •      | •  |     |
|       | <i>Bryum subelegans</i>                         | •  |          | •       | •      | •  |     |
|       | <i>Brachythecium plumosum</i>                   | •  |          | •       |        | •  |     |
|       | <i>Campylium halleri</i>                        | •  |          | •       |        | •  |     |
|       | <i>Oxystegus tenuirostris</i>                   | •  |          | •       |        | •  |     |
|       | <i>Didymodon fallax</i> var. <i>reflexus</i>    | •  |          |         | •      | •  |     |
|       | <i>Timmia megapolitana</i> var. <i>bavarica</i> | •  |          |         | •      | •  |     |
| 3     | <i>Anomodon rugelii</i>                         | •  | •        |         |        |    |     |
|       | <i>Cynodontium asperifolium</i>                 | •  |          | •       | •      |    |     |
|       | <i>Fabronia ciliaris</i>                        | •  |          | •       | •      |    |     |
|       | <i>Homomallium incurvatum</i>                   | •  |          | •       | •      |    |     |
|       | <i>Fissidens minutulus</i>                      | •  |          | •       |        |    |     |
|       | <i>Dicranum viride</i>                          | •  |          |         | •      |    |     |
|       | <i>Weissia</i> sp.                              | •  |          |         | •      |    |     |
|       | <i>Tortula obtusifolia</i>                      | •  |          |         | •      | ?  | ?   |
| 4     | <i>Bryum algovicum</i>                          | •  |          | •       | •      |    | •   |
|       | <i>Platygyrium repens</i>                       | •  |          | •       | •      |    | •   |
|       | <i>Orthotrichum alpestre</i>                    | •  |          | •       |        |    | •   |
| 5     | <i>Bryum elegans</i>                            |    | •        | •       | •      | •  |     |
|       | <i>Neckera complanata</i>                       |    | •        | •       |        | •  |     |
|       | <i>Tortula muralis</i> var. <i>aestiva</i>      |    |          | •       | •      | •  |     |
|       | <i>Racomitrium aciculare</i>                    |    |          | •       |        | •  |     |
|       | <i>Seligeria campylopoda</i>                    |    |          | •       |        | •  |     |
|       | <i>Campylium calcareum</i>                      |    |          |         | •      | •  |     |
|       | <i>Dicranodontium denudatum</i>                 |    |          |         | •      | •  |     |
|       | <i>Orthotrichum cupulatum</i>                   |    |          |         | •      | •  |     |
| 6     | <i>Myurella julacea</i>                         |    | •        | •       | •      | •  | •   |
|       | <i>Tortella fragilis</i>                        |    | •        | •       | •      | •  | •   |
|       | <i>Amphidium lapponicum</i>                     |    | •        | •       |        | •  | •   |
|       | <i>Cyrtomnium hymenophylloides</i>              |    | •        | •       |        | •  | •   |
|       | <i>Schistidium agassizii</i>                    |    | •        | •       |        | •  | •   |
|       | <i>Tortula norvegica</i>                        |    | •        |         | •      | •  | •   |
|       | <i>Hygrohypnum alpestre</i>                     |    | •        |         |        | •  | •   |
|       | <i>Pseudoleskea radicata</i>                    |    | •        |         |        | •  | •   |
|       | <i>Racomitrium sudeticum</i>                    |    | •        |         |        | •  | •   |
|       | <i>Mnium ambiguum</i>                           |    |          | •       | •      | •  | •   |
|       | <i>Platydictya jungermannioides</i>             |    |          | •       | •      | •  | •   |
|       | <i>Pseudoleskeella papillosa</i>                |    |          | •       | •      | •  | •   |
|       | <i>Myurella sibirica</i>                        |    |          | •       |        | •  | •   |
|       | <i>Orthothecium intricatum</i>                  |    |          | •       |        | •  | •   |
| 7     | <i>Andreaea rupestris</i> var. <i>papillosa</i> |    | •        |         |        |    | •   |
| 8     | <i>Seligeria donniana</i>                       |    |          | •       | •      |    |     |
|       | <i>Seligeria pusilla</i>                        |    |          | •       | •      |    |     |
|       | <i>Funaria pulchella</i>                        |    |          |         | •      |    |     |

*fertidens*, *Hygrohypnum luridum*; Figs 3, 4).

2. Species absent in the Sub-Polar and Polar Urals (*Didymodon fallax* var. *reflexus*, *Homalia besseri*; Figs 5, 6). The group comprises 12 rare and two common (*Anomodon longifolius*, *Taxiphyllum wissgrillii*) species. Most of them grow only in the forest belt of the Middle Urals.

3. Species known only from Southern and Middle Urals (*Fabronia ciliaris*; Fig. 7).

4. Species absent in the Northern Urals.

5. Species known only from the Middle and Northern Urals (*Seligeria campylopora*; Fig. 7).

6. Species absent in the Southern Urals.

7. Species known only from the Middle and Sub-Polar+Polar Urals.

8. Species known only from the Middle Urals.

Groups 3-8 comprise only rare taxa. The knowledge of their regional distribution is still poor, and further investigations are necessary to improve it. A good example is *Taxiphyllum wissgrillii* that was known by the beginning of my investigations from only one locality in Perm Province (Ignatov & Maslovsky, 1991). I found it to be a common calcicole species growing in deep crevices and grottos in limestone cliffs.

General distribution. I also made an attempt to explain the fact that certain species are restricted to some parts of the Urals, analyzing their general distribution. It did not give impressive results. The majority of species have Holarctic ranges and grow in temperate and cold regions of Eurasia. There are only some taxa located in the Middle Urals near the limits of their geographic ranges:

1. Northern (*Anomodon attenuatus*, *Fabronia ciliaris*, *Homalia trichomanoides*, *Homomallium incurvatum*, *Tortula obtusifolia*) – all of them belong to distribution groups 2 and 3.

2. Western (*Plagiomnium confertidens*).

3. Eastern (*Neckera complanata*, *Tortula muralis* var. *aestiva*).

Thus, the saxicolous moss flora of the Middle Urals belongs to the boreal type. It comprises some southern elements common in broad-leaved forests (*Fabronia ciliaris*, *Homalia trichomanoides*, *Homomallium incurvatum*) and steppes (*Tortula obtusifolia*, *Weissia* sp.) of Eurasia, as well as species with predominantly northern – high altitude distribution (*Andreaea rupestris* var. *papillosa*, *Cyrtomnium hymenophylloides*, *Polytrichastrum alpinum*, *Timmia norvegica* var. *excurrens*).

#### ANNOTATED LIST OF MOSS SPECIES FOUND IN THE MIDDLE URALS EXCLUSIVELY OR PREDOMINANTLY ON ROCK OUTCROPS

Names of taxa are arranged alphabetically, the nomenclature is according Ignatov & Afonina (1992). After the name of each species, information about its altitudinal distribution in the Middle Urals, and rock types on which it has been found (when it is available), is given. It is followed by the data on the species distribution in other parts of the Ural Mts.: SU – Southern, NU – Northern, SPU – Sub-Polar & Polar Urals. These are given in square brackets.

For common and rare species, all localities in the Middle Urals from which they are known are listed (see Fig.1). Each locality abbreviation is followed by dates of collections in italics (which are mine and housed in SVER unless otherwise preceded by a collector's name and followed by an acronym of herbarium where they are housed). A published report based on specimens that I have been unable to study is referred as a literature citation in parentheses. For each frequent species, only one specimen from herbarium SVER is listed as an example.

I have also included comments on morphology, anatomy and regional distribution of some species.

The list comprises 62 genera, 110 species and 5 varieties of Musci. Species new to the Middle Urals are marked with an asterisk (\*), and to the Ural Mts. – with two asterisks (\*\*).

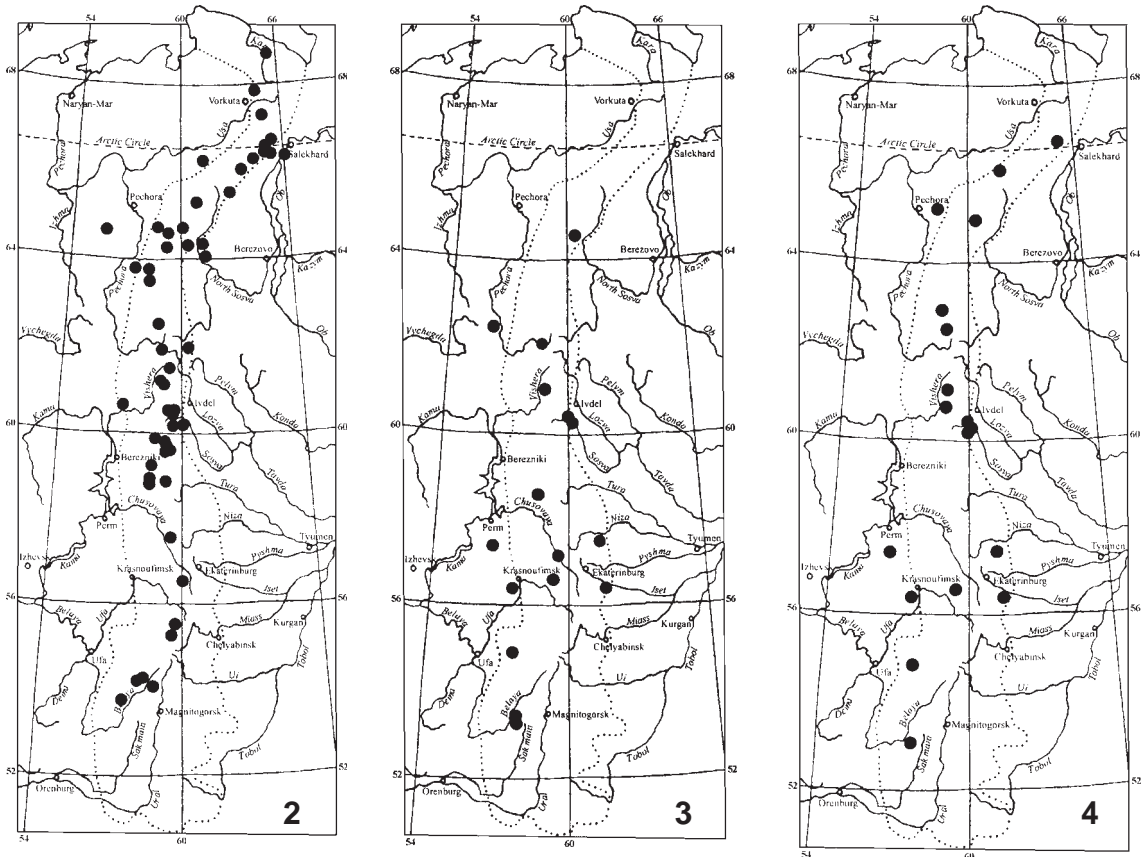
*Amphidium lapponicum* (Hedw.) Schimp. Rare. In both forest and subalpine belts. [NU, SPU]. – B1, B3 (Ignatova et al., 1995).

*Andreaea rupestris* Hedw. In both forest and subalpine belts; in the latter it is particularly common. On the outcrops of basic rocks with low Ca. [SU, NU, SPU]. – A, 26.VI.1996; V1, 4.IX.1998; V2 (Dyachenko et al., 1996); ST, *Sitnikova* 26.IX.1970, SVER; BE (Sitnikova, 1976); RE4 (Dyachenko, 1987, 1990); B1, B3, B4, B5 (Ignatova et al., 1995).

*A. rupestris* var. *papillosa* (Lindb.) Podp. Only one record in the subalpine belt. [SPU]. – B3 (Ignatova et al., 1995).

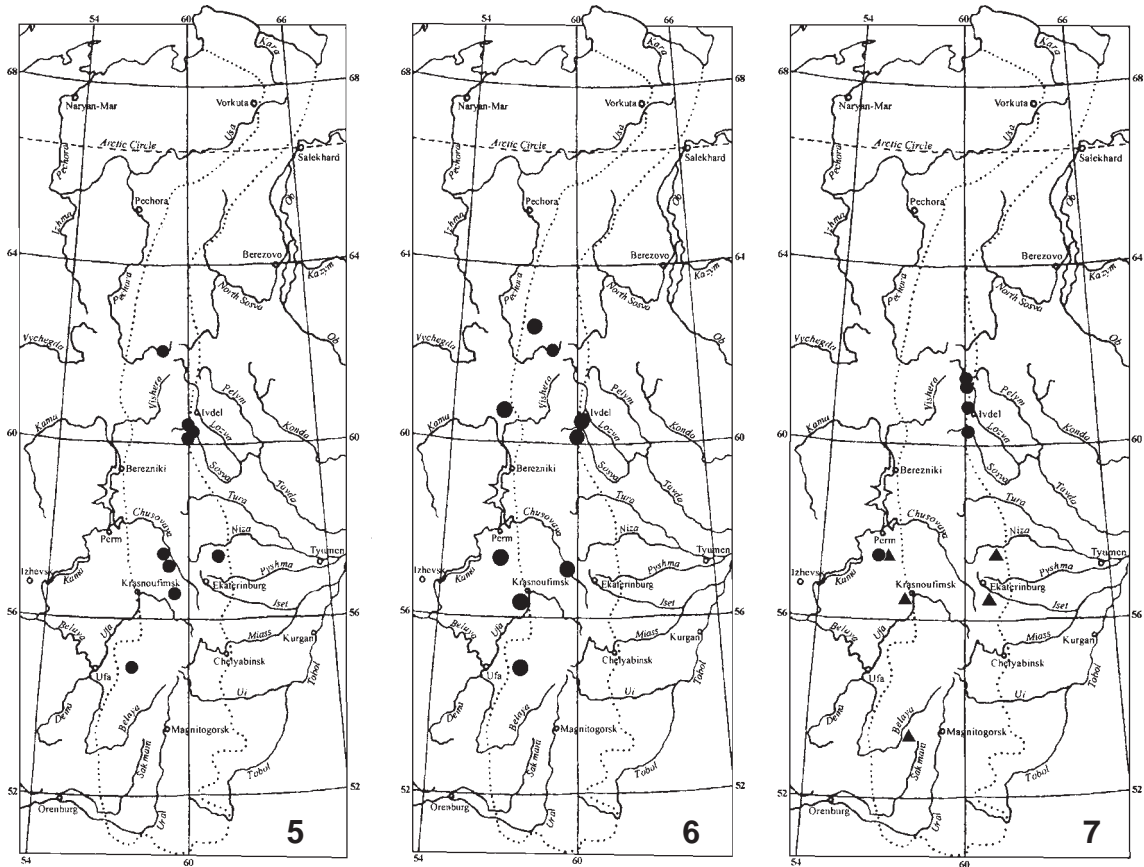
*Anomodon attenuatus* (Hedw.) Hueb. Rare. Mostly on limestone cliffs in the forest belt; there is only one collection on a boulder in a subalpine meadow (Ignatova et al., 1995). [SU, NU]. – U1, 31.VII.1996; U2, 29.VII.1996; CH5, 15.IX.1998; RE4, *Dyachenko* 24.VII.1982, LE; B1, B5 (Ignatova et al., 1995).

*A. longifolius* (Brid.) Hartm. Common. Only in the forest belt, on limestone and diorite (?) cliffs. [SU, NU]. – SI (Syuzev, 1909); I1, 2.VII.1999; U1, 31.VII.1996; SE1, 7.IX.1996; SE2, 7.IX.1996; SE4 (Syuzev, 1899); U2, 29.VII.1996; U3, 1.VIII.1996; U4, 30.VII.1996; CH4, 9.VIII.1998; CH21 (Dyachenko, 1997a); R1, 18.VII.1996; KU (Bezgodov, 2002);



Figs. 2-4. Distribution of (2) *Polytrichastrum alpinum*, (3) *Plagiomnium confertidens*, (4) *Hygrohypnum luridum*.

- B1 (Ignatova et al., 1995). The record on granite outcrops in Yekaterinburg (Trotsenko, 1990) is doubtful, and specimens collected by the author are absent in herbaria.
- A. rugelii* (C. Muell.) Keissl. Rare. Only in the subalpine belt. [SU]. – B3, B5 (Ignatova et al., 1995).
- A. viticulosus* (Hedw.) Hook. et Tayl. Frequent. Only in the forest belt. On limestone and diorite cliffs, one record on talc-carbonate schist (SY3). [SU, NU, SPU]. – CH3, 8.VII.1998.
- Bartramia ithyphylla* Brid. Rare. In both forest and subalpine belts. [SU, NU, SPU]. – B3, B5, B9 (Ignatova et al., 1995).
- B. pomiformis* Hedw. Rare. In both forest and subalpine belts. [SU, NU, SPU]. – RE4, *Dyachenko* 11.VIII.1982, UTTSU; B3 (Ignatova et al., 1995).
- Brachythecium plumosum* (Hedw.) B. S. G. Rare. Only in the forest belt. [SU, NU]. – B1, B2 (Ignatova et al., 1995); B5, *Bezgodov* 18.VI.1983, UTTSU.
- Bryoerythrophyllum recurvirostrum* (Hedw.) Chen. Frequent in the forest belt. On limestone cliffs; one record on talc-carbonate schist (SY3). – [SU, NU, SPU]. – CH3, 8.VII.1998.
- Bryum algovicum* Sendtn. ex C. Muell. Rare. Only in the forest belt. On limestone cliffs. [SU, SPU]. – CH3, *Dyachenko* 4.V.1981, UTTSU; CH20, *Soroka & Dyachenko* 5.V.1981, UTTSU; CH24, *Dyachenko & Soroka* 6.V.1981, UTTSU.
- B. elegans* Nees ex Brid. Rare. In both forest and subalpine belts. [NU]. – SY5, *Dyachenko* 10.VII.1987, UTTSU; B1 (Ignatova et al., 1995).
- B. pallescens* Schleich. ex Schwaegr. One record in the forest belt, on limestone cliffs. [SU, NU, SPU]. – U3 (Navashin, 1888). *Dyachenko* (1987, 1990) reported this species from rock outcrops along the Rezh river. The specimen (RE4, *Dyachenko* 28.VII.1982, UTTSU) has been revised by Valery Zolotov to *B. caespiticium*.
- B. subelegans* Kindb. Rare. Only in the forest belt. On the outcrops of various rocks: granite, basalt, limestone, pyroxenite, talc-carbonate schist. [SU, NU]. – I2, 1.VII.1999; SY1, 1.VIII.1996; SY2, 27.VI.1997; SY3, 3.VII.1997, 17.VII.1998; GR6, 13.X.1996; GR7, 27.VI.1996; CH3, 8.VII.1998; CH4, 9.VII.1998; B1 (Ignatova et al., 1995).
- \*\**Campylium calcareum* Crundw. et Nyh. One collection in the forest belt, on a limestone cliff. –



Figs. 5-7. Distribution of (5) *Didymodon fallax* var. *reflexus*, (6) *Homalia besseri*, (7) *Fabronia ciliaris* (triangle) and *Seligeria campylopoda* (circle).

- CH4, 9.VII.1998. I also found this species in NU.
- C. chrysophyllum* (Brid.) J. Lange. Frequent in the forest belt. Mostly on limestone cliffs; two records on various kinds of schist (SY3, B8), and one on a dunitic cliff (SY5). [SU, NU, SPU]. – CH4, 9.VII.1998.
- C. halleri* (Hedw.) Lindb. One collection in the forest belt, on a limestone cliff. [SU, NU]. – CH23, *Dyachenko* 6.V.1981, *UTTSU*.
- Cnestrum schistii* (Web. et Mohr) Hag. Two collections in the forest belt. [SU, NU, SPU]. – RE4, *Dyachenko* 12.VIII.1982, *UTTSU*.
- Cynodontium asperifolium* (H. Arnell) Par. Rare. Only in the forest belt, on granite and chlorite schist outcrops. [SU]. – S, *Yerokhin* 1.XII.1996, *SVER*; YE2 (Syuzev, 1909). B9, *Ignatov & Bezgodov* 4.VI.1994, *MHA*.
- C. strumiferum* (Hedw.) Lindb. Frequent. In both forest and subalpine belts. On rocks with low Ca. I also found it once on decaying wood in a pine forest (SY3). [SU, NU, SPU]. – RD2, *Yerokhin* 22.V.2000, *SVER*.
- C. tenellum* (B. S. G.) Limpr. Common. In both forest and subalpine belts. On rocks with low Ca: granite,

- basalt-andesite porphyry, diabase. [SU, NU, SPU]. – I2, 1.VII.1999; A, 26.VI.1996; YE2, GR1, GR7 (Gorchakovskiy & Arkhipova, 1964); V1, 4.IX.1998; RE4 (*Dyachenko*, 1987); B3, B4 (*Ignatova et al.*, 1995).
- Cyrtomnium hymenophylloides* (Hueb.) Nyh. et T. Kop. Rare. In both forest and subalpine belts. [NU, SPU]. – B3 (*Ignatova et al.*, 1995).
- Dichodontium pellucidum* (Hedw.) Schimp. Rare. Only in the forest belt. On boulders along rivers and creeks, on various rock types: limestone, granite. Also found on a brook bank in spruce forest (*Ignatova et al.*, 1995). [SU, NU, SPU]. – SE1, 7.IX.1996; SE2, 7.IX.1996; U1, 31.VII.1996; GR3, 24.XI.1996; CH4, 8.VII.1998; CH5, 15.IX.1998; KU (*Ignatov & Maslovskiy*, 1991).
- Dicranodontium denudatum* (Brid.) Britt. One collection in the forest belt. [NU]. – V1, *Dyachenko* 11.VII.1979, *UTTSU*.
- Dicranoweisia crispula* (Hedw.) Lindb. One collection in the subalpine belt. [SU, NU, SPU]. – B3 (*Ignatova et al.*, 1995). *Trotsenko* (1990) reported this species on the granite outcrops in Yekaterinburg; the specimens are absent in herbaria.



- Dicranum spadiceum* Zett. Rare. In both forest and subalpine belts. I found the species on limestone boulders. It was also recorded on soil in mountain tundra (Ignatova et al., 1995). [SU, NU, SPU]. – U1, 31.VII.1996; B3, B5 (Ignatova et al., 1995).
- \**D. viride* (Sull. et Lesq.) Lindb. Rare. Only in the forest belt. On limestone and talc-carbonate schist boulders on forested slopes. [SU]. – SY3, 19.VII.1997; U1, 31.VII.1996.
- Didymodon fallax* (Hedw.) Zander. Rare. In the forest belt, on limestone cliffs. [SU, NU, SPU]. – SE1, 7.IX.1996; KU (Bezgodov, 2002); CH10, CH14 (Dyachenko, 1999).
- D. fallax* var. *reflexus* (Brid.) Zander. Rare. In the forest belt, on limestone cliffs. [SU, NU]. – SE1, 7.IX.1996; SE2, 7.IX.1996; CH10, CH14 (Dyachenko, 1997a); R2, 19.VII.1996.
- D. rigidulus* Hedw. Frequent in the forest belt. On limestones and ultrabasic and basic rocks. [SU, NU, SPU]. – CH4, 8.VII.1998.
- Distichium capillaceum* (Hedw.) B. S. G. Frequent in both forest and subalpine belts. Most common on limestone cliffs. [SU, NU, SPU]. – SE1, 7.IX.1996.
- Ditrichum flexicaule* (Schwaegr.) Hampe. Rare. In the forest belt grows only on limestone cliffs. One finding in the subalpine belt. [SU, NU, SPU]. – U1, 31.VII.1996; U2, 29.VII.1996; U3, 1.VIII.1996; U4, 30.VII.1996; CH9 (Dyachenko, 1997a); R3, 21.VII.1996; RE2, *Dyachenko* 31.VII.1981, *UTTSU*, KU (Bezgodov, 2002); B3 (Dyachenko, 1996).
- Encalypta ciliata* Hedw. Rare. Only in the forest belt. On diorite, basalt-andesite porphyry, chlorite schist outcrops. [SU, NU, SPU]. – I2, 1.VII.1999; RD3, *Chairkin* 23.V.2000, *SVER*; RE4 (Dyachenko, 1987); B1 (Ignatova et al., 1995).
- E. raptocarpa* Schwaegr. Common. In the forest belt on limestone cliffs. [SU, NU, SPU]. – I1, 3.VII.1999; U3 (Navashin, 1888); SE1, 7.IX.1996; CH4, 9.VII.1998; CH11, CH12, CH13, CH15, CH18, CH19 (Dyachenko, 1997b); KU (Ignatov & Maslovsky, 1991); R2, 19.VII.1996; RE2, *Chernogorodova & Dyachenko* 31.VII.1981, *UTTSU*.
- I would like to call readers' attention to the specimens that remind *E. raptocarpa* in prominent striation of capsules and leaves with long hair point, but their capsules are gymnostomous, like in *E. vulgaris*. They can't be called *E. spathulata*, because the calyptrae are not translucent or transparent, have erose, rather than fringe bases; plants are usually small, up to 4(8) mm tall, but sometimes bigger, up to 1.0-1.2 mm (compare with the description of *E. spathulata* by Horton (1979)). Such specimens are quite many, and were identified (e.g. by Dyachenko, 1987, 1997a) as *E. raptocarpa* or *E. vulgaris*: I1, 3.VII.1999; SY1, 20.VI.1997, 24.VI.1997; SY2, 11.VII.1997; SY3, 1.VII.1997; 28.VI.1998, 17.VII.1998; 27.VIII.1998; U2, 29.VII.1996; U4, 30.VII.1996; CH2, 8.VII.1998, *Dyachenko* 26.VIII.1983, *UTTSU*; CH3, 8.VII.1998; CH4, 9.VII.1998; CH5, 15.IX.1998; R1, 18.VII.1996; R3, 21.VII.1996; RE2, *Chernogorodova & Dyachenko* 31.VII.1981, *UTTSU*; RE3, 23.VI.2000; RE4, *Chernogorodova & Dyachenko* 31.VII.1981, *UTTSU*, *Dyachenko* 28.VII.1982, *UTTSU*.
- E. streptocarpa* Hedw. Frequent in both forest and subalpine belts. On limestone cliffs, diorite and talc-carbonate schist outcrops. [SU, NU, SPU]. – CH2, 8.VII.1998. All specimens are sterile, and therefore it's impossible to distinguish them from *E. procera*.
- E. vulgaris* Hedw. Rare. In the forest belt. On limestone and serpentine cliffs. [SU, NU, SPU]. – SY3, 2.VII.1997; SY5, 19.VII.1998; CH10 (Dyachenko, 1997a); KU (Ignatov & Maslovsky, 1991); RE2 (Dyachenko, 1987); RE4, *Dyachenko* 28.VII.1982, *UTTSU*.
- \**Fabronia ciliaris* (Brid.) Brid. Rare. In the forest belt on limestone, pyroxenite, talc-carbonate schist outcrops. [SU]. – U4, 30.VII.1996; SY1, 29.VI.1998; SY3, 7.VII.1996, 10.VII.1996; KU (Bezgodov, 2002); RE3, 23.VI.2000.
- Fissidens minutulus* Sull. One collection in the forest belt, on a limestone cliff. [SU]. – KU, *Ignatov* 24.IX.1988, *MHA*.
- \*\**Funaria pulchella* Philib. One collection in the forest belt, on a talc-carbonate schist outcrop. Unknown from other parts of the Urals. – SY3, 24.VI.1997.
- Grimmia affinis* Hoppe et Hornsch. ex Hornsch. Common. In both forest and subalpine belts. On granite, basalt-andesite porphyry, serpentine (?), and talc-carbonate schist. [SU, NU, SPU]. – I2, 1.VII.1999; YE2, 3.X.1996, *Navashin* 23.VIII.1887, *LE*; GR2, *Gorchakovsky* 12.V.1958, *SVER*; CH3, 8.VII.1998; SY1, 6.VII.1997; SY2, 27.VI.1997; SY3, 10.VII.1997, 26.VIII.1998, 29.VIII.1998; SY4, *Dyakonov* 19.VIII.1998, *SVER*; SY5, 18.VII.1995, 19.VII.1995; R7, 23.VII.1996; RE1, *Chernogorodova & Dyachenko* 31.VII.81, *UTTSU*; RE4, *Dyachenko* 24.VII.1982, *UTTSU*; B3 (Ignatova et al., 1995).
- G. elatior* Bruch ex Bals. et De Not. Rare. Only in the subalpine belt. [SU, NU]. – B3, B4 (Ignatova et al., 1995).
- G. incurva* Schwaegr. Rare. In both forest and subalpine belts. I found this species on a limestone cliff. [SU, NU, SPU]. – R7, 23.VII.1996; B3, B4 (Ignatova et al., 1995).
- G. muehlenbeckii* Schimp. Rare. In both forest and

- subalpine belts. On the outcrops of various rocks – from granite to limestone. [SU, NU, SPU]. – SY3, 10.VII.1995; YE2, 3.X.1996; A, 26.VI.1996; CH8, *Soroka & Dyachenko* 30.IV.1981, *UTTSU*; K (Krylov, 1885); B1 (Ignatova et al., 1995); B3, *Ignatov & Bezgodov* 9.VI.1994, *MW*; B5, *Balandin* 10.VIII.1986, *UTTSU*.
- G. ovalis* (Hedw.) Lindb. Rare. In the forest belt; I found the species on a limestone cliff. [SU, NU, SPU]. – RE3, 23.VI.2000; K (Krylov, 1885). Navashin (1988) erroneously reported this species from the environs of Yekaterinburg (YE2). The specimen collected by him proved to be *G. affinis*.
- Gymnostomum aeruginosum* Sm. Common in the forest belt on limestone cliffs. [SU, NU, SPU]. – I1, 3.VII.1999; SE1, 7.IX.1996; SE2, 7.IX.1996; U1, 31.VII.1996; U3, 1.VIII.1996; CH1, 1.XI.1998; CH23 (Dyachenko, 1997a); KU (Bezgodov, 2002); R1, 18.VII.1996; R2, 19.VII.1996; R3, 21.VII.1996. The specimens I collected differ from the description of the species (Savicz-Ljubitzkaja & Smirnova, 1970; Nyholm, 1989) in weaker and narrower costa with reduced ventral stereid band.
- Hedwigia ciliata* (Hedw.) P. Beauv. Frequent in both forest and subalpine belts on rocks with low Ca. [SU, NU, SPU]. – I2, 1.VII.1999.
- Homalia besseri* Lob. Rare. In the forest belt on limestone cliffs. [SU, NU]. – U1, 31.VII.1996; U3, 1.VIII.1996; CH4, 9.VII.1998; CH5, 15.IX.1998; KU, *Ignatov* 23.IX.1988, *MHA*, *Ignatov* 24.IX.1988, *MHA*.
- Homalia trichomanoides* (Hedw.) B. S. G. Rare. In both forest and subalpine belts. I collected this species on basalt-andesite porphyry. There are also two findings on tree trunks in Perm Province (Abramova & Abramov, 1983). [SU, NU]. – I2, 1.VII.1999; RE4 (Dyachenko, 1987, 1990); B1, B3 (Ignatova et al., 1995).
- Homomallium incurvatum* (Brid.) Loeske. Rare. In the forest belt on talc-carbonate schist and limestone outcrops. [SU]. – SY3, 7.VIII.1995, 28.VIII.1998; SY5 (Dyachenko, 1997b); KU (Bezgodov, 2002).
- Hygrohypnum alpestre* (Hedw.) Loeske. One finding in the subalpine belt. [NU, SPU]. – B5 (Dyachenko, 1996).
- H. duriusculum* (De Not.) Jamieson. Rare. In the forest belt on boulders in small brooks and creeks. [SU, NU, SPU]. – B2, B5 (Ignatova et al., 1995); B8 (Dyachenko, 1996).
- H. luridum* (Hedw.) Jenn. Rare. In the forest belt, on limestone boulders along rivers and creeks. [SU, NU, SPU]. – I1, 2.VII.1999; SE1, 7.IX.1996; SE2, 7.IX.1996; U2, 29.VII.1996; KU (Ignatov & Maslovsky, 1991); R2, 19.VII.1996.
- H. ochraceum* (Turn. ex Wils.) Loeske. Rare. In the forest belt, on boulders in brooks, creeks and rivers. Also found on submerged wood (Ignatova et al., 1995). [SU, NU, SPU]. – V (Dyachenko, 1990; Dyachenko et al., 1996); B2, B3, B5, B8, B9 (Ignatova et al., 1995).
- Hypnum recurvatum* (Lindb. et H. Arnell) Kindb. Rare. In the forest belt, on limestone cliffs. [SU, NU, SPU]. – SE2 (Dyachenko, 1990); SE4 (Syuzev, 1899); CH3, *Dyachenko* 29.IV.1981, *UTTSU*; KU (Bezgodov, 2002); RE2, *Dyachenko* 31.VII.1981, *UTTSU*.
- H. vaucheri* Lesq. Common in the forest belt. On limestone cliffs; one record on talc-carbonate schist outcrops. [SU, NU, SPU]. – I1, 3.VII.1999; I3, 31.VII.1996; SY3, 26.VI.1997; U2, 29.VII.1996; U3, 1.VIII.1996; U4, 30.VII.1996; CH2, 8.VII.1998; CH3, 8.VII.1998; CH4 (Dyachenko, 1997a); CH5, 15.IX.1998; CH6, CH17 (Dyachenko, 1997a); KU, *Ignatov* 23.IX.1988, *MHA*; R2, 19.VII.1996; R4, 22.VII.1996; R6, 24.VII.1997.
- Iwatsukiella leucotricha* (Mitt.) Buck et Crum. Rare. Only in the subalpine belt. [SU, NU]. – B3 (Ignatova et al., 1995).
- Lescurea saxicola* (B.S.G.) Milde. Rare. Only in the subalpine belt. [SU, NU, SPU]. – B3, B5 (Ignatova et al., 1995). – One collection also on a *Sorbus* trunk (Ignatova et al., 1995).
- Leucodon sciuroides* (Hedw.) Schwaegr. Frequent in the forest belt, on limestones and ultrabasic rocks. One record on granite outcrops (Syuzev, 1909). [SU, NU, SPU]. – SE1, 7.IX.1996.
- Mnium ambiguum* H. Muell. Rare. In the forest belt, on granite and diorite outcrops. [NU, SPU]. – GR5 (Gorchakovskiy & Arkhipova, 1964); B3 (Ignatova et al., 1995).
- \**Molendia sendtneriana* (B. S. G.) Limpr. One collection in the forest belt on a limestone cliff. [SU, NU, SPU]. – SE1, 7.IX.1996. I collected this species also in SU and NU. Most of material is sterile, and only a few specimens from NU bear no sporophytes but have archegonia on short lateral branches. Nevertheless, such characters as small sized upper leaf cells covered with simple broad papillae, smooth pellucid basal cells forming distinctive group, presence of ventral stereid band which is occasionally reduced, and glaucous colour of plants (Zander, 1994) enabled me to ascribe all specimens to *M. sendtneriana*.
- Myurella julacea* (Schwaegr.) B. S. G. Rare. In both forest and subalpine belts. Mostly on limestone cliffs. [NU, SPU]. – SE1, 7.IX.1996; SE2, 7.IX.1996; U1, 31.VII.1996; CH23 (Dyachenko, 1997a); KU (Bezgodov, 2002); R2, 23.VII.1997; RE4 (Dyachenko,

- 1987, 1990); B3 (Ignatova et al., 1995).
- M. sibirica* (C. Muell.) Reim. One finding in the forest belt on a limestone cliff. [NU, SPU]. – CH23, *Dyachenko 6.V.1981, UTTSU*.
- Neckera complanata* (Hedw.) Hueb. Rare. In both forest and subalpine belts. [NU]. – B1, *Ignatov & Bezgodov 8.VI.1994, MHA*; B3, B9 (Ignatova et al., 1995).
- Orthothecium intricatum* (C. Hartm.) B. S. G. One finding in the forest belt on a limestone cliff. [SPU]. – CH23, *Dyachenko 6.V.1981, UTTSU*.
- Orthotrichum alpestre* Hornsch. Rare. In the forest belt, on diorite cliffs. [SU, SPU]. – B1 (Ignatova et al., 1995).
- O. anomalum* Hedw. Frequent in the forest belt, on limestone and ultrabasic rock outcrops. [SU, NU, SPU]. – CH3, 8.VII.1998.
- O. cupulatum* Brid. Rare. In the forest belt on limestone cliffs. [NU]. – CH2, *Igoshina 22.V.1943, SVER, Dyachenko 26.VIII.1983, UTTSU*.
- Oxystegus tenuirostris* (Hook. et Tayl.) A.J.E. Smith. Rare. On rock outcrops in the forest belt. One record also on inclined trunk of *Salix* covered with humus (Ignatova et al., 1995). [SU, NU]. – B1 (Ignatova et al., 1995).
- Paraleucobryum longifolium* (Hedw.) Loeske. Frequent in both forest and subalpine belts, on outcrops of rocks with low Ca. [SU, NU, SPU]. – SY3, 9.VII.1997.
- Plagiomnium confertidens* (Lindb. et H. Arnell) T. Kop. Rare. Only in the forest belt, on limestone cliffs. [SU, NU, SPU]. – I1, 3.VII.1999; SE1, 7.IX.1996; SE2, 7.IX.1996; SE3, 7.IX.1996; U1, 31.VII.1996; U3, 1.VIII.1996; CH5, 15.IX.1998; KU (Bezgodov, 2002); RE4 (Dyachenko, 1987, 1990); B1 (Ignatova et al., 1995).
- Plagiopus oederianus* (Sw.) Crum et Anderson. Rare. In the forest belt, on limestone cliffs. [SU, NU, SPU]. – SE1, 7.IX.1996; U1, 31.VII.1996; CH22 (Dyachenko, 1997a); CH23, *Dyachenko 6.V.1981, UTTSU*.
- Plagiothecium cavifolium* (Brid.) Iwats. Rare. In both forest and subalpine belts. Also found on soil at the Vilva river bank (Ignatova et al., 1995) and decaying wood in birch-spruce forest (Dyachenko et al., 1996). [SU, NU, SPU]. – B1, B2, B3, B5, B9 (Ignatova et al., 1995).
- Platydictya jungermannioides* (Brid.) Crum. Rare. Only in the forest belt, on limestone cliffs, on humus in shaded niches. Once found on talc-carbonate schist. One record on decaying wood in a forest in the Visimsky Nature Reserve (Dyachenko et al., 1996). [NU, SPU]. – SE1, 7.IX.1996; SE2, 7.IX.1996; SE3, 7.IX.1996; U1, 31.VII.1996; KU (Ignatov & Maslovsky, 1991); SY3, 2.VII.1997; R7, 23.VII.1996.
- Platygyrium repens* (Brid.) B. S. G. Rare. Only in the forest belt. On a wide spectrum of rock types with low Ca – from acidic to ultrabasic. Also found on tree trunks (Navashin, 1888; Syuzev, 1899, 1909). [SU, SPU]. – U3 (Navashin, 1888); RD1, *Yerokhin 21.V.2000, SVER*; RD2, *Yerokhin 22.V.2000, SVER*; SY2, 27.VII.1997; SY3, 27.VIII.1998; S, *Yerokhin 1.XII.1996, SVER*; V1, 1.IX.1998; RE4 (Dyachenko, 1987); B1 (Ignatova et al., 1995).
- Pohlia cruda* (Hedw.) Lindb. Frequent in both forest and subalpine belts. On outcrops of all rock types, on soil and humus. It was also found at a base of fallen trunk in spruce forest (Ignatova et al., 1995). [SU, NU, SPU]. – SY3, 3.VII.1997.
- P. elongata* Hedw. Rare. Only in the forest belt. [SU, NU, SPU]. – B1, B9 (Ignatova et al., 1995).
- P. longicollis* (Hedw.) Lindb. Rare. In both forest and subalpine belts. [SU, NU, SPU]. – B3, B9 (Ignatova et al., 1995).
- Polytrichastrum alpinum* (Hedw.) G.L. Sm. Common in mountain tundra, rare on rock outcrops in the forest belt. Grows on the outcrops of rocks with low Ca. [SU, NU, SPU]. – A, 26.VI.1996; ST (Sitnikova, 1976); KA (Krylov, 1885); B3, *Igoshina 19.VIII.1942, SVER*; B5, B9 (Ignatova et al., 1995).
- Pseudoleskea incurvata* (Hedw.) Loeske. Rare. In both forest and subalpine belts. [SU, NU, SPU]. – V2, *Dyachenko 11.VIII.1979, UTTSU*; B3, B5 (Ignatova et al., 1995).
- P. radicata* (Mitt.) Kindb. Rare. Only in the subalpine belt. [NU, SPU]. – B3, B5 (Ignatova et al., 1995).
- Pseudoleskeella catenulata* (Brid. ex Schrad.) Kindb. Frequent in the forest belt on limestone and ultrabasic rock outcrops. [SU, NU, SPU]. – CH3, 8.VII.1998.
- P. papillosa* (Lindb.) Kindb. Rare. In the forest belt. On diorite and various kinds of schist cliffs. [NU, SPU]. – SY3, 7.VIII.1998; RE4 (Dyachenko, 1987, 1990); B1, *Bezgodov 8.VI.1992, MW, Ignatov & Bezgodov 8.VI.1994, MW*; B9, *Ignatov & Bezgodov 4.VI.1994, MW*.
- P. tectorum* (Funck ex Brid.) Kindb. Common in the forest belt, mostly on limestone cliffs. [SU, NU, SPU]. – I1, 2.VII.1999; I3, 31.VII.1996; SY3, 18.VII.1998; U3, 1.VIII.1996; U4, 30.VII.1996; CH2, 8.VII.1998; CH3 (Dyachenko, 1997a); CH4, 9.VII.1998; CH7 (Dyachenko, 1997a); KU (Ignatov & Maslovsky, 1991); R2, 19.VII.1996; R3, 21.VII.1996; R4, 22.VII.1996; R5, 20.VII.1996; R6, 24.VII.1997; B1 (Ignatova et al., 1995); KO, *Igoshina & Smirnova 30.VIII.1925, LE*.
- Pterigynandrum filiforme* Hedw. Rare. In both forest and subalpine belts. [SU, NU, SPU]. – B1, B3, B9 (Ignatova et al., 1995).

- Racomitrium aciculare* (Hedw.) Brid. One collection in the forest belt, on a boulder on a creek bank. [NU]. – B2 (Ignatova et al., 1995).
- R. canescens* (Hedw.) Brid. Rare. In the forest belt on limestone (?). Also found in the Basegi Nature Reserve on a trail across a clear-cutting (Ignatova et al., 1995). [SU, NU, SPU]. – R7, 23.VII.1996.
- R. microcarpum* (Hedw.) Brid. Common in the subalpine, rare in the forest belt. [SU, NU, SPU]. – ST (Dyachenko, 1997b); R7, 23.VII.1996; KA (Krylov, 1885); B3, B5 (Ignatova et al., 1995).
- R. sudeticum* (Funck) B. S. G. Rare. Only in the subalpine belt. [NU, SPU]. – B3 (Dyachenko, 1996); B4, *Balandin* 10.VII.1986, *UTTSU*.
- Rhabdoweisia crispata* (Dicks.) Lindb. Rare. In both forest and subalpine belts. [SU, NU]. – V1, 4.IX.1998; V2 (Dyachenko, 1990; Dyachenko et al., 1996); B3, B5, B9 (Ignatova et al., 1995).
- Rhytidium rugosum* (Hedw.) Kindb. Frequent in both forest and subalpine belts, on limestone, ultrabasic and basic rock outcrops. [SU, NU, SPU]. – SY1, 5.VII.1997.
- Saelania glaucescens* (Hedw.) Broth. Rare. In the forest belt. [SU, NU, SPU]. – RD3, *Chairkin* 23.V.2000, *SVER*; RE4 (Dyachenko, 1987); B1, B8, B9 (Ignatova et al., 1995).
- Schistidium agassizii* Sull. et Lesq. Rare. In both forest and subalpine belts. [NU, SPU]. – B5, *Bezgodov* 18.VI.1983, *UTTSU*; B9, *Bezgodov* 19.VII.1985, *UTTSU*.
- S. apocarpum* (Hedw.) B.S.G. Frequent in the forest belt. On outcrops of various rocks. [SU, NU, SPU]. – CH3, 8.VII.1998. Material I have studied is extremely variable. I'm sure that further revision of the Ural specimens in the light of monograph by Blom (1996) is necessary.
- S. rivulare* (Brid.) Podp. Rare. Only in the forest belt. [SU, NU, SPU]. – B1, B2, B6, B7, B8 (Ignatova et al., 1995).
- S. strictum* (Turn.) Maort. s. l. Rare. Only in the forest belt. I collected this species on a diabase outcrop. Ural specimens, which belong to the *S. strictum*-subgroup of *S. apocarpum*-complex, need further studies. Blom (1996) considered *S. strictum* as an oceanic species, and recent revision of the material from the Basegi and Vishersky Nature Reserves has shown that it belongs to *S. papillosum* and *S. boreale* (Ignatova, pers. com.). [SU, NU, SPU]. – A, 26.VI.1996; B1, B8 (Ignatova et al., 1995).
- \**Seligeria campylopoda* Kindb. In the forest belt on limestone cliffs. [NU]. – KU, *Ignatov* 22.IX.1988, *MHA*, *Bezgodov* 6.VI.1998, *PERM*, *Bezgodov* 27.VI.1999, *PERM*.
- S. domniana* (Sm.) C. Muell. Rare. In the forest belt on limestone cliffs. – CH4, 9.VII.1998; KU, *Bezgodov* 5.VIII.2001, *PERM*. The species was reported from NU (Ignatova et al., 1996), but later the specimen was revised to a new species, *S. galinae* (Mogensen & Goldberg, 2003). Thus, present distribution of *S. domniana* is restricted to the Middle Urals.
- \*\**S. pusilla* (Hedw.) B. S. G. Rare. In the forest belt on limestone cliffs. Unknown from other parts of the Urals. – I1, 2.VII.1999; CH4, 9.VII.1998; KU, *Bezgodov* 5.VIII.2001, *PERM*.
- Taxiphyllum wissgrillii* (Garov.) Wijk et Marg. Common in the forest belt, on limestone cliffs. [SU, NU]. – I1, 2.VII.1999; SE1, 7.IX.1996; U1, 31.VII.1996; U2, 29.VII.1996; U3, 1.VIII.1996; CH3, 8.VII.1998; CH4, 9.VII.1998; CH5, 15.IX.1998; KU (Ignatov & Maslovsky, 1991); R1, 18.VII.1996; R2, 18.VII.1996, 19.VII.1996; R3, 21.VII.1996; R6, 24.VII.1997.
- Timmia austriaca* Hedw. Rare. In the forest belt on limestone cliffs. [SU, NU, SPU]. – SE2, 7.IX.1996; R2, 19.VII.1996; RE4 (Dyachenko, 1987, 1990).
- T. megalolitana* var. *bavarica* (Hessl.) Brid. Rare. Only in the forest belt. On limestone cliffs, one record on granite outcrops. [SU, NU]. – I1, 2.VII.1999; SE1, 7.IX.1996; U3 (Navashin, 1888); YE2 (Syuzev, 1909); R1, 18.VII.1996; R2, 19.VII.1996.
- \**T. norvegica* var. *excurrens* Bryhn. One collection in the forest belt on a limestone cliff. [SU, NU, SPU]. – SE1, 7.IX.1996.
- Tortella fragilis* (Hook. et Wils.) Limpr. Rare. In both forest and subalpine belts. In the forest zone it has been found on limestone cliffs. [NU, SPU]. – U1, 31.VII.1996; U2, 29.VII.1996; KU (Ignatov & Maslovsky, 1991); R6, 24.VII.1997; RE4 (Dyachenko, 1987, 1990); B1, B3 (Ignatova et al., 1995).
- T. tortuosa* (Hedw.) Limpr. Common in both forest and subalpine belts. Mostly on limestone cliffs. [SU, NU, SPU]. – U1, 31.VII.1996; U2, 29.VII.1996; U4, 30.VII.1996; CH2, 8.VII.1998; CH3, 8.VII.1998; CH4, 9.VII.1998; CH23 (Dyachenko, 1997a); R3, 21.VII.1996, 23.VII.1996; K (Krylov, 1885); KU (Bezgodov, 2002); B3, B5 (Ignatova et al., 1995). The record on granite outcrops in Yekaterinburg (Trotsenko, 1990) is doubtful, and specimens collected by the author are absent in herbaria.
- Tortula mucronifolia* Schwaegr. Rare. Only in the forest belt. On the outcrops of limestone, basic and ultrabasic rocks. [SU, NU, SPU]. – I2, 1.VII.1999; SY3, 25.VI.1997; U4, 30.VII.1996; KU (Bezgodov, 2002); RE4 (Dyachenko, 1987, 1990).
- T. muralis* var. *aestiva* Hedw. Rare. In the forest belt on limestone cliffs. [NU]. – I1, 2.VII.1999; U4, 30.VII.1996; CH2, 8.VII.1998; CH3, 8.VII.1998, *Dyachenko* 29.IV.1981, *UTTSU*; CH5, 15.IX.1998; KU, *Ignatov* 20.IX.1988, *MHA*; R1, 18.VII.1996,

- 20.VII.1996; R3, 21.VII.1996; RE2, Chernogorodova & Dyachenko 31.VII.1981, UTTSU; RE3, 23.VI.2000. First I identified these specimens as *T. obtusifolia*, but due to longer and narrower leaves and less revolute margins becoming flat in leaf apices (Savicz-Ljubitzkaja & Smirnova, 1970; Nyholm, 1989) I ascribed them to this variety. The specimen of *T. obtusifolia* from RE2 on which the report by Dyachenko (1987) was based also belongs to *T. muralis* var. *aestiva*.
- T. norvegica* (Web. f.) Wahlenb. ex Lindb. Rare. In both forest and subalpine belts. Mostly on limestone cliffs. [NU, SPU]. – U4, 30.VII.1996; CH3, 8.VII.1998; CH4, 8.VII.1998; R3, 21.VII.1996; R4, 22.VII.1996; R6, 24.VII.1997; RE4 (Dyachenko, 1987, 1990); B3, B5 (Dyachenko, 1996).
- T. obtusifolia* (Schwaegr.) Mathieu. One finding in the forest belt on limestone cliffs. [SU]. – SI (Syuzev, 1909). The report should be based on the specimen found by Elena Ignatova in herbarium H. It was collected by the author in “the environs of Yekaterinburg” on 25.VI.1906. The species is also reported from NU and SPU. I doubt it occurs there. At least all my collections from NU are *T. muralis* var. *aestiva*.
- T. ruralis* (Hedw.) Gaertn. et al. Frequent in both forest and subalpine belts. On limestone, ultrabasic and basic rocks, mostly on soil in exposed habitats. [SU, NU, SPU]. – SY4, 18.VII.1996.
- Ulota curvifolia* (Wahlenb.) Lilj. One report from the forest belt, on granite outcrops. [SU, NU, SPU]. – GR1 (Gorchakovskiy & Arkhipova, 1964).
- Weissia* sp. was reported from the forest belt by Dyachenko (1997b) as *W. brachycarpa* from YE1, dunite outcrops, and *W. controversa* from SY5, serpentine outcrops. Each of three specimens I have studied was without sporophytes, and I didn't find it possible to identify the material to the species level.
- SPECIES EXCLUDED
- Ctenidium molluscum* (Hedw.) Mitt. was reported by Syuzev (1899) from Ochersky zavod, Okhansky district, Perm Province (57°53' N, 54°42' E), and from Yurma Mt (55°29' N, 59°59' E) located in the Southern Urals close to the geographical border of the Middle Urals. I found only the specimen collected on Yurma Mt.: Syuzev 3.VII.1894, LE. It proved to be *Ptilium crista-castrensis*.
- Grimmia montana* B. S. G. was reported by Dyachenko (1987, 1990) from the environs of the railway station Koptelovo (RE4). I would ascribe three specimens on which this report was based to *G. affinis* according to the cross section of costa. In upper half of leaf it is flat, with 3-6 cells on ventral surface. Identification by Dyachenko could be supported by more sharply keeled leaves, than in *G. affinis*, and shorter cells of the laminal bases. Specimens on which the reports from the Basegi Nature Reserve were based (B3, Ignatova et al., 1995) belong to *G. muehlenbeckii*.
- G. trichophylla* Grev. was reported by Dyachenko (1996) from the subalpine belt in the Basegi range. The specimen (B5, Balandin 10.VIII.1986, UTTSU) should be referred to *G. muehlenbeckii*, for the costa at back is irregularly angular, almost homogeneous in cross section vs. regularly rounded, with large ventral cells in *G. trichophylla* (Nyholm, 1998).
- Heterocladium dimorphum* (Brid.) B. S. G. was reported from the Basegi Nature Reserve (Ignatova et al., 1995). Ignatova and Ignatov recently revised the material to *Pseudoleskeella papillosa* (pers. comm.), and I share their opinion.
- Hypnum revolutum* (Mitt.) Lindb. Reported from the environs of Kungur (Ignatov & Maslovsky, 1991) proved to be *H. vaucheri*.
- Oligotrichum hercynicum* (Hedw.) DC. was published by Dyachenko (1997b) who revised the specimen on which the report was based. It was collected on a limestone cliff in the Chusovaya river valley (CH11) and published by Sitnikova (1976) under the name *O. parallelum*. I have been unable to study the specimen, and propose to exclude the species from the list of mosses of the Middle Urals till it is collected once again, or the specimen is found in a herbarium.
- Racomitrium lanuginosum* (Hedw.) Brid. was reported by Trotsenko (1990) on granite outcrops in Yekaterinburg. The specimens are absent in herbaria. In fact this is the only record from the Middle Urals, therefore I propose to exclude this species from the list of mosses of the area.
- Seligeria diversifolia* Lindb. was reported from the environs of Kungur (Ignatov & Maslovsky, 1991). The specimen on which this report was based (KU, Ignatov 22.IX.1988, MHA) was revised to *S. campylopoda* (Ignatov, pers. com.; Mogensen & Goldberg, 2003). Further collections by Bezgodov (2002) also confirm absence of *S. diversifolia* in the area.
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Table 2. Moss species facultatively growing on rock substrates, with their habitats in the Middle Urals. Rare species are marked with an asterisk (\*). LD=litter &amp; decaying wood; T=trunks; FP=flood-plains; B=bogs; M=meadows

| Species                               | Forest substrates |   | Wet habitats |   |   | Disturbed habitats |
|---------------------------------------|-------------------|---|--------------|---|---|--------------------|
|                                       | LD                | T | FP           | B | M |                    |
| <i>Abietinella abietina</i>           | +                 |   |              |   | + |                    |
| <i>Amblystegium serpens</i>           | +                 | + |              |   |   |                    |
| * <i>Brachythecium erythrorrhizon</i> | +                 |   | +            |   |   |                    |
| <i>Brachythecium oedipodium</i>       | +                 |   |              |   |   |                    |
| <i>Brachythecium populeum</i>         | +                 |   |              |   |   |                    |
| <i>Brachythecium reflexum</i>         | +                 | + | +            |   |   |                    |
| <i>Brachythecium salebrosum</i>       | +                 | + |              |   |   | +                  |
| <i>Brachythecium velutinum</i>        | +                 | + |              |   |   |                    |
| <i>Dicranum fragilifolium</i>         | +                 |   |              |   |   |                    |
| <i>Dicranum fuscescens</i>            | +                 | + |              |   |   |                    |
| <i>Dicranum muehlenbeckii</i>         | +                 |   |              |   |   |                    |
| <i>Dicranum polysetum</i>             | +                 |   |              |   |   |                    |
| <i>Dicranum scoparium</i>             | +                 | + |              |   |   |                    |
| <i>Eurhynchium pulchellum</i>         | +                 | + |              |   |   |                    |
| <i>Hylocomiastrum pyrenaicum</i>      | +                 |   | +            |   |   |                    |
| <i>Hylocomiastrum umbratum</i>        | +                 |   | +            |   |   | +                  |
| <i>Hylocomium splendens</i>           | +                 | + |              |   |   |                    |
| <i>Isopterygiopsis pulchella</i>      | +                 |   |              |   |   |                    |
| <i>Mnium marginatum</i>               | +                 | + |              |   |   |                    |
| <i>Mnium spinosum</i>                 | +                 | + |              |   |   |                    |
| <i>Mnium spinulosum</i>               | +                 |   |              |   |   |                    |
| <i>Mnium stellare</i>                 | +                 | + |              |   |   |                    |
| <i>Orthodicranum montanum</i>         | +                 | + |              |   |   |                    |
| <i>Plagiomnium cuspidatum</i>         | +                 | + |              |   |   |                    |
| <i>Plagiomnium medium</i>             | +                 |   |              |   |   |                    |
| <i>Plagiothecium denticulatum</i>     | +                 | + |              |   |   | +                  |
| <i>Plagiothecium laetum</i>           | +                 | + |              |   |   |                    |
| <i>Pleurozium schreberi</i>           | +                 |   |              |   |   |                    |
| <i>Pohlia nutans</i>                  | +                 |   |              |   |   | +                  |
| <i>Polytrichum juniperinum</i>        | +                 |   |              |   |   | +                  |
| <i>Polytrichum longisetum</i>         | +                 | + |              |   |   | +                  |
| <i>Polytrichum pallidisetum</i>       | +                 |   |              |   |   |                    |
| <i>Ptilium crista-castrensis</i>      | +                 |   |              |   |   |                    |
| <i>Rhodobryum roseum</i>              | +                 |   |              |   |   |                    |
| <i>Rhytiadelphus triquetrus</i>       | +                 |   | +            |   |   |                    |
| <i>Sanionia uncinata</i>              | +                 | + | +            |   |   |                    |
| <i>Tetraphis pellucida</i>            | +                 | + |              |   |   |                    |
| * <i>Campylium hispidulum</i>         |                   | + |              |   |   |                    |
| <i>Hypnum cupressiforme</i>           |                   | + |              |   |   |                    |
| <i>Hypnum pallescens</i>              |                   | + |              |   |   |                    |
| <i>Leskea polycarpa</i>               |                   | + |              |   |   |                    |
| <i>Leskeella nervosa</i>              |                   | + |              |   |   |                    |
| <i>Neckera pennata</i>                |                   | + |              |   |   |                    |
| <i>Pylaisiella polyantha</i>          |                   | + |              |   |   |                    |
| * <i>Amblystegium varium</i>          |                   |   | +            |   |   |                    |
| <i>Aulacomnium palustre</i>           | +                 |   |              | + | + |                    |
| <i>Brachythecium rivulare</i>         |                   |   | +            |   | + |                    |
| <i>Bryum pseudotriquetrum</i>         | +                 |   | +            | + | + | +                  |
| <i>Bryum weigelii</i>                 | +                 |   | +            |   | + | +                  |
| <i>Calliergon giganteum</i>           |                   |   | +            | + | + |                    |
| <i>Climacium dendroides</i>           | +                 |   | +            |   | + |                    |
| <i>Cratoneuron filicinum</i>          |                   |   | +            | + |   |                    |
| <i>Drepanocladus aduncus</i>          |                   |   | +            | + | + |                    |

| Species                            | Forest substrates |   | Wet habitats |   | M | Disturbed habitats |
|------------------------------------|-------------------|---|--------------|---|---|--------------------|
|                                    | LD                | T | FP           | B |   |                    |
| <i>Drepanocladus sendtneri</i>     |                   |   | +            | + |   |                    |
| <i>Hypnum lindbergii</i>           |                   |   | +            | + |   |                    |
| <i>Leptodictyum riparium</i>       |                   |   | +            |   |   |                    |
| <i>Philonotis fontana</i>          |                   |   | +            | + |   | +                  |
| <i>Plagiomnium ellipticum</i>      | +                 | + | +            | + | + |                    |
| <i>Plagiomnium rostratum</i>       |                   |   |              |   | + |                    |
| <i>Pohlia wahlenbergii</i>         |                   |   | +            |   |   |                    |
| <i>Polytrichum strictum</i>        | +                 |   |              | + | + |                    |
| <i>Pseudobryum cinclidioides</i>   | +                 |   |              | + | + |                    |
| <i>Rhizomnium punctatum</i>        | +                 |   | +            |   |   | +                  |
| <i>Rhytidiadelphus subpinnatus</i> |                   |   | +            |   | + | +                  |
| <i>Thuidium philibertii</i>        |                   |   |              |   | + |                    |
| <i>Thuidium recognitum</i>         |                   |   |              |   | + |                    |
| <i>Atrichum tenellum</i>           |                   |   |              |   |   | +                  |
| <i>Barbula unguiculata</i>         |                   |   |              |   |   | +                  |
| <i>Bryum argenteum</i>             |                   |   |              |   |   | +                  |
| <i>Bryum caespiticium</i>          |                   |   |              |   |   | +                  |
| <i>Bryum capillare</i>             |                   |   |              |   |   | +                  |
| * <i>Buxbaumia aphylla</i>         |                   |   |              |   |   | +                  |
| <i>Ceratodon purpureus</i>         | +                 |   |              |   |   | +                  |
| <i>Dicranella cerviculata</i>      |                   |   |              |   |   | +                  |
| <i>Funaria hygrometrica</i>        |                   |   |              |   |   | +                  |
| <i>Leptobryum pyriforme</i>        |                   |   |              |   |   | +                  |
| <i>Pogonatum urnigerum</i>         |                   |   |              |   |   | +                  |
| <i>Pohlia prolifera</i>            |                   |   |              |   |   | +                  |
| <i>Polytrichum piliferum</i>       |                   |   |              |   |   | +                  |
| * <i>Schistostega pennata</i>      |                   |   |              |   |   | +                  |

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## Appendix 1. List of localities

| Abbreviation   | N     | E     | Locality   |
|--|-------|-------|--|
| <b>Sverdlovsk Province</b>   |       |       |  |
| SI   | 56.03 | 61.41 | the Sinara river near Ust'-Karabolka   |
| A  | 56.28 | 60.05 | Azov Mt., diabase outcrops on the top  |
| S  | 56.40 | 60.37 | environs of the railway station Sysert, granite outcrops   |
| ST   | 57.31 | 59.42 | Starik-Kamen' Mt.  |
| BE   | 57.39 | 59.43 | Belaya Mt.   |
| K  | 58.07 | 59.38 | Kudryavy Kamen' Mt.  |
| KA   | 58.46 | 59.23 | Kachkanar Mt.  |
| Valley of the Iset river and its tributaries (I):                  |       |       |  |
| I1   | 56.25 | 61.39 | valley of the Smolyanka rivulet, limestone cliffs  |
| I2   | 56.25 | 61.39 | environs of Beklemischevo, the Iset' river, Revun rapids, basalt-andesite porfyr                                     |
| I3   | 56.25 | 61.51 | environs of Brod , left bank of the Iset' river, limestone cliffs  |
| Valley of the Sysert river (SY):                                   |       |       |  |
| SY1  | 56.35 | 61.03 | left bank of the river 1 km up of the artificial lake, pyroxenite  |
| SY2  | 56.36 | 60.57 | right bank of the river in the environs of Cherdantsevo, basalt cliff  |
| SY3  | 56.36 | 61.04 | right bank of the artificial lake and 1-2 km down, talc-carbonate schist   |
| SY4  | 56.36 | 61.05 | left bank of the river 3-4 km down of the artificial lake, serpentine outcrops                                       |
| SY5  | 56.36 | 61.06 | environs of Dvurechensk, left bank of the Iset river at the Sysert river mouth, dunite cliff and serpentine outcrops |
| Valley of the Revda river (RD):                                    |       |       |  |
| RD1  | 56.32 | 59.54 | right bank of the river 1.5 km up of the Kuzikha river mouth, chlorite schist outcrops                               |
| RD2  | 56.39 | 59.54 | Popovka Mt., gabbro  |
| RD3  | 56.43 | 59.55 | right bank of the river 1 km up of the Revdinskiy pond, chlorite schist outcrops                                     |
| Valley of the Serga river (SE), limestones:                        |       |       |  |
| SE1  | 56.30 | 59.16 | Dyrovaty cliff   |
| SE2  | 56.30 | 59.17 | Karts funnel "Bolshoy Proval"  |
| SE3  | 56.30 | 59.17 | Druzhba cave   |
| SE4  | 56.38 | 59.16 | environs of Nizhniye Sergi, Solonets cliff   |
| Valley of the Ufa river and its tributaries (U), limestone cliffs: |       |       |  |
| U1   | 56.28 | 57.47 | Seven Brothers   |
| U2   | 56.29 | 57.37 | Alikayev   |
| U3   | 56.30 | 57.42 | Sokoliny   |
| U4   | 56.32 | 57.44 | Zhelty   |
| Yekaterinburg (YE):  |       |       |  |
| YE1  | 56.46 | 60.40 | Uktus Mts, basic and ultrabasic rocks  |
| YE2  | 56.50 | 60.42 | Shartash granite outcrops  |
| Granite outcrops to the north-west of Yekaterinburg (GR):          |       |       |  |
| GR1  | 56.52 | 60.17 | Sokoliniye   |
| GR2  | 56.52 | 60.19 | Severskiye   |
| GR3  | 56.52 | 60.21 | environs of the railway station Peregón, the Reshetka river  |
| GR4  | 56.52 | 60.22 | Palkinskiye  |
| GR5  | 56.53 | 60.20 | near Peschanoye lake   |
| GR6  | 56.54 | 60.20 | Pshenichnaya Mt.   |
| GR7  | 56.57 | 60.21 | Chertovo Gorodische  |
| Valley of the Chusovaya river (CH), limestone cliffs:              |       |       |  |
| CH1  | 57.00 | 59.37 | Siniy  |
| CH2  | 57.01 | 59.34 | Slobodskoy   |
| CH3  | 57.02 | 59.33 | Sobachyi Rebra   |

|  |       |       |  |
|--|-------|-------|--|
| CH4  | 57.02 | 59.34 | Georgievskiy   |
| CH5  | 57.02 | 59.34 | Chasovoy   |
| CH6  | 57.05 | 59.34 | Shaitan  |
| CH7  | 57.06 | 59.32 | Sokol-1  |
| CH8  | 57.14 | 59.18 | Dyrovaty-1   |
| CH9  | 57.15 | 59.18 | Balaban  |
| CH10   | 57.16 | 59.17 | Sokol-2  |
| CH11   | 57.28 | 59.07 | Volegovskiy  |
| CH12   | 57.31 | 59.04 | Plenichny  |
| CH13   | 57.31 | 59.05 | Tyurik   |
| CH14   | 57.38 | 59.01 | Krasny   |
| CH15   | 57.39 | 58.57 | Dozhdevoy  |
| CH16   | 57.39 | 58.59 | Kharenskiy   |
| CH17   | 57.40 | 58.56 | Omutnoy  |
| CH18   | 57.43 | 58.51 | Stolby   |
| CH19   | 57.44 | 58.51 | Samarinskiy  |
| CH20   | 57.52 | 58.40 | Denezhny   |
| Visimsky Nature Reserve (V):                                     |       |       |  |
| V1   | 57.23 | 59.45 | Maly Sutuk Mt.   |
| V2   | 57.23 | 59.47 | Bol'shoy Sutuk Mt.   |
| V3   | 57.27 | 59.34 | slope of Kuliga Mt.  |
| V4   | 57.27 | 59.36 | top of Kuliga Mt.  |
| Valley of the Rezh River in Rezh district (R), limestone cliffs: |       |       |  |
| R1   | 57.25 | 61.28 | left bank of the river in the environs of Pershino village                     |
| R2   | 57.26 | 61.27 | left bank of the river 5 km down of Pershino                                   |
| R3   | 57.26 | 61.28 | right bank of the river, Pershinskiy cliff                                     |
| R4   | 57.27 | 61.27 | left bank of the river 7 km down of Pershino                                   |
| R5   | 57.27 | 61.27 | right bank of the river 1 km down of Pershinskiy cliff                         |
| R6   | 57.27 | 61.28 | right bank of the river in the environs of Golendukhino village, Bolshoy cliff |
| R7   | 57.27 | 61.29 | old quarry in the environs of Pershino village                                 |
| Valley of the Rezh river in Alapaevsk district (RE):             |       |       |  |
| RE1  | 57.35 | 61.46 | environs of "Samotsvety" resort  |
| RE2  | 57.37 | 61.44 | environs of Aromashevo village   |
| RE3  | 57.39 | 61.45 | left bank of the river at the Katyshka river mouth, limestone                  |
| RE4  | 57.41 | 61.45 | environs of the railway station Koptelovo                                      |
| <b>Perm Province</b>   |       |       |  |
| KU   | 57.22 | 57.10 | environs of Kungur, valley of the Sylva river, limestone cliffs                |
| KO   | 58.52 | 57.35 | valley of the Kosva river in the environs of Gubakha                           |
| Valley of the Chusovaya river (CH), limestone cliffs:            |       |       |  |
| CH21   | 57.53 | 58.42 | Ostryak  |
| CH22   | 58.13 | 58.09 | Ponysh   |
| CH23   | 58.14 | 58.03 | Plakun   |
| CH24   | 58.14 | 58.08 | Pechka   |
| Basegi Nature Reserve (B):                                       |       |       |  |
| B1   | 58.40 | 58.25 | valley of the Vilva river  |
| B2   | 58.45 | 58.31 | valley of the Korostelevka creek   |
| B3   | 58.49 | 58.28 | Southern Baseg Mt.   |
| B4   | 58.54 | 58.29 | Middle Baseg Mt.   |
| B5   | 58.57 | 58.30 | Northern Baseg Mt.   |
| B6   | 58.53 | 58.10 | valley of the Bolshoy Baseg river  |
| B7   | 58.55 | 58.20 | valley of the Maly Baseg river   |
| B8   | 58.59 | 58.34 | valley of the Porozhnaya creek   |
| B9   | 59.00 | 58.30 | valley of the Usva river   |