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RARE LIVERWORTS OF THE RUSSIAN ARCTIC – A PRELIMINARY LIST AND DIRECTIONS FOR FUTURE RESEARCH

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SUMMARY—A preliminary list of rare hepatics of the Russian arctic includes 77 species which is about one quarter of the hepatic flora for this region. Forty-three percent of the rare species are known from the few nature reserves in the Russian arctic. The status of rare arctic hepatics will be elucidated by taxonomic revision of problematic groups, and inventories of poorly investigated regions and reserves.

KEY WORDS—Arctic, bryophytes, liverworts, rare species, Russia

ZUSAMMENFASSUNG—Seltene Lebermoose der russischen Arktis – Eine vorläufige Liste und Hinweise für künftige Forschung

Eine vorläufige Liste seltener Lebermoose der russischen Arktis umfasst 77 Arten, was ungefähr einem Viertel der Lebermoosflora dieses Gebietes entspricht. Dreiundvierzig Prozent der seltenen Arten kommen in den wenigen Naturschutzgebieten der russischen Arktis vor. Der Status seltener arktischer Lebermoose soll durch taxonomische Revision schwieriger Gruppen und Inventare schlecht untersuchter Gebiete und Reservate abgeklärt werden.

Introduction

The small size and vulnerability of populations of many rare arctic hepatics together with the considerable disturbance that has occurred in many Russian arctic ecosystems, lend urgency to the need to prepare a list of rare liverworts. Disturbance of Russian tundra landscapes has been considerably greater than in other arctic countries (Khitun & Rebristaya 1995; Archegova, in press), the main factors being widespread use of heavy military caterpillar transport, as well as gas and oil mining. In view of the slow recovery rate characteristic of disturbed tundra ecosystems (Druzhinina 1985, Matveyeva 1988, Sumina 1992), extinction of some rare species with small local populations is a real possibility.

Methods

A database of Russian arctic hepatics has been established and includes the following fields: genus, species, authority name(s), occurrence and frequency in Russian arctic phytogeographic sectors (Map), and confirmation of identification (Table). It is based upon literature records and unpublished data, resulting from studies on recent and old collections deposited in LE, H, S, and UPS. Concerning the phytogeographic division of the Arctic we follow mainly Yurtsev & al. (1978). The main difference from this is the inclusion of the alpine belt and lowland tundra of the Murmansk Region into the Arctic. In this we follow the 'Conservation of Arctic Flora and Fauna Project' (CAFF) recommendations for southern delimitation of the Arctic (Yurtsev, pers. comm.).

The criteria for identifying species as rare were the following: frequency (number of localities) and abundance in each phytogeographic sector (based on the personal experience of the authors, as well as on literature information); total range (Schljakov 1976-1982; Schuster 1969, 1974, 1980, 1992a, 1992b); biological and ecological peculiarities. It was considered almost impossible to numerically weight each of these characteristics, so we also incorporated judgements based on our broad floristic and taxonomic experience. Initially, hepatics recorded from five or fewer phytogeographic sectors were selected. Then, we subjectively determined the status of species

within each phytogeographic sector, taking into account the number of localities (mostly 1-5 for 'rare', 5-10 for 'sporadic', and over 10 for 'common'), its abundance, biological and ecological peculiarities, and whether the taxon can be subject to overlook. Subsequently, we took into account the total range, and degree of investigation of different areas to evaluate known data on distribution. For that purpose, we used a literature database on Hepaticae of the Russian Arctic (171 publications), which will be published soon as 'Bibliography on the liverworts of the Russian Arctic'. Most important sources of literature information are Afonina & Duda (1993), Konstantinova & al. (1993), Konstantinova & al. (1992), Potemkin (1993), Schljakov & Konstantinova (1982), Schljakov (1976-1982). In addition, we included all arctic endemics in the list in view of their restriction to this region and, in some cases, their isolated taxonomic position.

Thus, the following species are considered as rare for the Russian arctic: 1) species known from five or fewer phytogeographic sectors mostly with low frequency (rare worldwide and disjunct species, as well as species at the northern limit of their distribution), 2) species known from 1-3 phytogeographic sectors with low to high frequency (oceanic and disjunct mountain hepatics, relicts); 3) arctic endemics.

Results

The basic results are listed in the table. The rare species included in the list can be divided into several groups: arctic species; rare worldwide and disjunct, often relict species; recently described and poorly known species; species of which the distribution is limited by specific phytogeographic factors: mountain and/or oceanic species, as well as species at the northern limit of their range. The species composition of every group is preliminary because many taxonomic problems remain unsolved and data on distribution are in need of revision, particularly given the lack of investigation of extensive territories of the Russian arctic.

1. Species at the Northern Limit of their Range. This is the largest group (21 species) of mostly common boreal species such as *Ptilidium pulcherrimum*, *Lepidozia reptans*, *Lophozia bicrenata*, *Barbilophozia attenuata*, *Pellia endiviifolia*, *Radula complanata*, and most of *Riccia* species, which are very rare in the arctic. From this group, only the nemoral species *Lejeunea cavifolia*, which is known from a single isolated locality in Yakutia (Kharaulakh), is considered of interest.

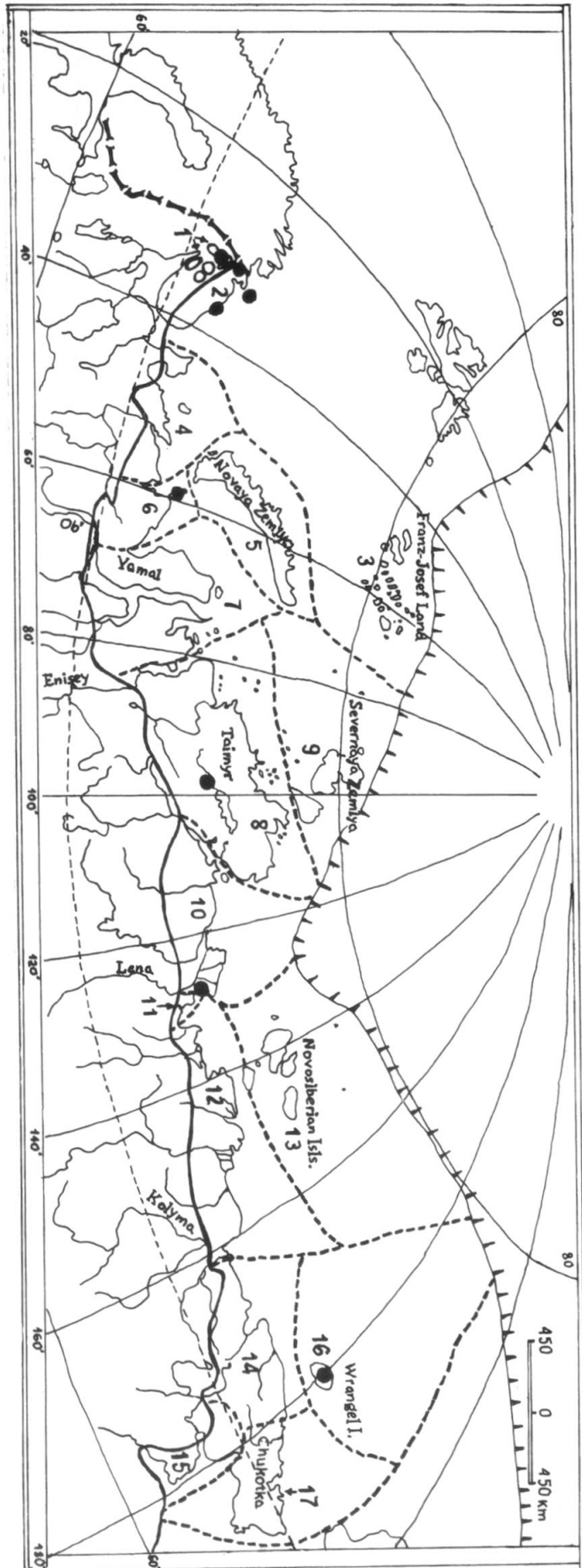
2. Species Rare Worldwide and Disjunct. This, the most interesting group includes 19 species with relicts such as *Apotreubia nana*, *Bucegia romanica*, *Jamesoniella undulifolia*, *Marsupella commutata*, *Metacalypogeia schusterana*, *Scapania brevicaulis*, and *Sphenolobopsis pearsonii*.

3. Recently Described and Poorly Known Species. This group includes recently described taxa such as *Fossombronina alaskana*, *Barbilophozia rubescens*, *Gymnocolea fasciniifera*, *Lophozia debiliformis*, *Prasanthus jamalicus*, *Riccia sorocarpha* subsp. *arctica*; species that are not sharply delimited morphologically, for example, *Anastrophyllum sphenoloboides*, *Lophozia heteromorpha*, *L. kateninii*, *L. rubrigemma*, *Marchantia polymorpha* s.str. (= *M. aquatica*), *Nardia insecta* (according to our experience); and species which tend to be overlooked as do *Cephaloziella aspericaulis*, *Cladopodiella francisci*, *Lophozia alboviridis*, *Nardia japonica*, and *Scapania zemliae* according to our experience.

4. Arctic Species. The seven arctic endemics included in this group are *Calycularia laxa*, *Cryptocolea imbricata*, *Marsupella arctica*, *Mesoptychia sahlbergii*, *Pseudolepicolea fryei*, *Radula prolifera*, and *Scapania simmonsii*.

5. Oceanic and/or Montane Species. The ten hepatics included in this group are *Calypogeia neesiana*, *Cephalozia bicuspidata* subsp. *otaruensis*, *Gymnomitrium pacificum*, *Macrodiplophyllum plicatum*, *M. microdontum*, *Mannia fragrans*, *Marsupella boeckii*, *M. condensata*, *Mylia taylorii*, *Scapania paludosa*.

A significant proportion of the rare species are known from the Asian sector of the Russian arctic, what presumably reflects the fact that large parts of the Beringian arctic were unglaciated and support an ancient, rich flora with numerous relicts. Thirty-nine of the rare species are



MAP. Phytogeographic sectors and nature reserves of the Russian Arctic (modified from Silimark 1984).

- 1 = Alpine belt of the Murmansk Region; 2 = Lowland tundra of the Murmansk Region; 3 = Franz-Josef Land;
- 4 = Tundra of Eastern Europe; 5 = Novaya Zemlya;
- 6 = Polar Ural; 7 = Western Siberia; 8 = Taimyr Peninsula; 9 = Severnaya Zemlya; 10 = Western Yakutia; 11 = Kharaulakh; 12 = Eastern Yakutia; 13 = Novosibirsk Islands; 14 = Continental Chukotka; 15 = Southern Chukotka; 16 = Wrangel Island; 17 = Beringian Chukotka; ● = State Nature Reserves;
- ▴▴▴▴▴ = continental slope; — = southern limit of the Russian arctic; - - - - - = boundaries of the phytogeographic sectors.

TABLE. Rare liverworts of the Russian Arctic. Frequency abbreviations: r - rare; s - sporadic; c - more or less common. The following abbreviations are used for the sectors of the Russian Arctic: Alp. Murman - alpine belt of the Murmansk Region (1), Murman. Tundra - lowland tundra of the Murmansk Region (2), Franz-Josef - Franz-Josef Land (3), Nov. Zemlya - Novaya Zemlya (5), E. Europe Tundra - Kanino-Pechyorskyy (4), Pol. Ural - Polar Ural (6), Sev. Zemlya - Severnaya Zemlya (9), W. Siberia - Yamal-Gydansky (7), Taimyr - Taimyr Peninsula (8), W. Yakutia - Anabaro-Olenyok (10), E. Yakutia - Yano-Kolymsky (12), Novosib. Isls - Novosiberian Islands (13), Cont. Chukotka - Continental Chukotka (14), S. Chukotka - Southern Chukotka (15), Wrangel - Wrangel Island (16), Bering. Chukotka - Beringian Chukotka (17) (figures in brackets refer to the map).

'!' is the authors' confirmation of species presence in the territory of the mentioned phytogeographic sector.

'?' before frequency abbreviation means doubtful frequency; '?' before name of sector means doubtful presence in mentioned sector.

Species	Frequency in recognized phytogeographic sectors	Notes
<i>Anastrophyllum sphenoloboides</i> Schust.	W. Siberia (s), Taimyr ! (r), Bering. Chukotka (r)	Arctic, poorly known species, local populations small
<i>Apometzgeria pubescens</i> (Schrank) Kuwah.	Wrangel (r), S. Chukotka (r), Bering. Chukotka (r)	Northern limit, local populations small
<i>Apotreubia nana</i> Hatt. & H. Inoue	Taimyr ! (r)	Poorly known, disjunct species at the northern limit of its range, the only locality in Russia
<i>Asterella saccata</i> (Wahlenb.) Evans	S. Chukotka ! (r)	Disjunct species, local populations small
<i>Athalamia hyalina</i> (Sommerf.) Hatt.	Alp. Murman ! (r), Taimyr (s), Bering. Chukotka (r)	Disjunct species
<i>Barbilophozia rubescens</i> (Schust. & Damsh.) Kartt. & Söderström	Murman. Tundra ! (r), Alp. Murman ! (r), E. Europe Tundra ! (?r), W. Siberia ! (s)	Rare, poorly known species, European and W. Siberian Arctic and Greenland only
<i>B. atlantica</i> (Kaal.) K. Müll.	Murman. Tundra ! (s), Alp. Murman ! (s), Pol. Ural (r), W. Siberia ! (r), Taimyr (r)	Northern limit, disjunct in central continental regions, local populations small
<i>B. attenuata</i> (Mart.) Loeske	Murman. Tundra ! (r), Alp. Murman ! (r), ? Nov. Zemlya (r)	Northern limit, local populations small
<i>Bucegia romanica</i> Radian	Kharaulakh (r), Wrangel (r), Bering. Chukotka (r)	Rare, disjunct, local populations small
<i>Calycularia laxa</i> Lindb. & H. Arnell	W. Siberia ! (c), Taimyr ! (?r), E. Yakutia (?r), Cont. Chukotka (c), Wrangel (c), S. Chukotka (c), Bering. Chukotka (c)	Siberian-W.-American species, known almost exclusively from the Arctic, local populations normally rather small
<i>Calypogeia neesiana</i> (Mass. & Car.) K. Müll.	Murman. Tundra ! (s), Alp. Murman ! (s), Taimyr (r), S. Chukotka (r), Bering. Chukotka (r)	Northern limit, mostly oceanic in the Arctic
<i>Cephalozia bicuspidata</i> (L.) Dum. subsp. <i>otarvensis</i> (Steph.) Hatt.	Bering. Chukotka only (r)	Pacific taxon, northern limit.
<i>C. connivens</i> (Dicks.) Lindb.	Alp. Murman ! (r), ? Pol. Ural (r), W. Siberia ! (r), ? Taimyr, ? Novosib. Isls	Northern limit, arctic populations very small
<i>C. loitlesbergeri</i> Schiffn.	Murman. Tundra ! (r), Alp. Murman ! (r), Pol. Ural (r), Taimyr (r)	Northern limit, disjunct, local populations small
<i>Cephaloziella aspericaulis</i> Jørg.	Cont. Chukotka (r), S. Chukotka ! (r), Bering. Chukotka ! (r)	Poorly known arctic species apparently of oceanic distribution
<i>C. elachista</i> (Gott. & Rabenh.) Schiffn.	Alp. Murman ! (r), ? Pol. Ural (r)	Northern limit, local populations small
<i>Chiloscyphus profundus</i> (Nees) Engel & Schust.	Pol. Ural (?r)	Northern limit

Species	Frequency in recognized phytogeographic sectors	Notes
<i>Cladopodiella francisci</i> (Hook.) Jørg.	Murman. Tundra ! (?s), Alp. Murman ! (?s), Pol. Ural (r), W. Siberia ! (r)	Poorly known in Russia, disjunct
<i>Conocephalum conicum</i> (L.) Und.	Murman. Tundra ! (r), Alp. Murman ! (r), Pol. Ural (r), Kharaulakh (r)	Northern limit
<i>Cryptocolea imbricata</i> Schust.	W. Siberia ! (r), Taimyr ! (r), W. Yakutia ! (?r), Cont. Chukotka (r), S. Chukotka ! (r), Wrangel (r), Bering. Chukotka (r)	Known in Russia only from the Asian Arctic, local populations almost always very small
<i>Diplophyllum obtusifolium</i> (Hook.) Dum.	Alp. Murman ! (r), Pol. Ural ! (r), S. Chukotka ! (r)	Subject to overlook, known distribution disjunct
<i>Fossombronina alaskana</i> Steere & H. Inoue	W. Siberia ! (r), S. Chukotka ! (r)	Poorly known species with apparently disjunct distribution and small populations worldwide
<i>Frullania nisquallensis</i> Sull.	Taimyr (s), Novosib. Isls (r), S. Chukotka (r), Bering. Chukotka (r)	In the Russian Arctic known from Eastern Siberia and Chukotka only
<i>Gymnocolea fascinifera</i> Potemkin	W. Siberia ! (r)	Recently described
<i>Gymnomitrium pacificum</i> Grolle	Bering. Chukotka ! (r)	1 locality in the Russian Arctic, rare throughout the range
<i>Haplomitrium hookeri</i> (Sm.) Nees	Taimyr ! (r)	1 locality, very rare and disjunct, relict, populations exceedingly small in the Arctic
<i>Herbertus sakuraii</i> (Warnst.) Hatt.	Taimyr (r), Kharaulakh ! (r), Cont. Chukotka (s), Wrangel (s), S. Chukotka (s), Bering. Chukotka (s)	Northern limit for the genus, relict, never frequent everywhere
<i>Jamesoniella undulifolia</i> (Nees) K. Müll.	Pol. Ural ! (r), Wrangel (r), Bering. Chukotka (r)	Rare worldwide, disjunct
<i>Jungermannia caespiticia</i> Lindenb.	E. Yakutia ! (r), Bering. Chukotka (r)	Rather rare worldwide, northern limit
<i>J. exsertifolia</i> Steph. subsp. <i>cordifolia</i> (Dum.) Vána	Murman. Tundra ! (s), Alp. Murman ! (s), Bering. Chukotka ! (r)	Mountain oceanic
<i>J. exsertifolia</i> Steph. subsp. <i>exsertifolia</i>	S. Chukotka (r), Bering. Chukotka (r)	
<i>Lejeunea cavifolia</i> (Ehrh.) Lindb.	Kharaulakh ! (r)	Nemoral species, northernmost report, strongly isolated locality
<i>Lepidozia reptans</i> (L.) Dum.	Murman. Tundra ! (r), Alp. Murman ! (r), S. Chukotka ! (r)	Northern limit
<i>Lophozia alboviridis</i> Schust.	W. Siberia ! (s), S. Chukotka ! (r), Bering. Chukotka ! (r)	Poorly known, probably often overlooked
<i>L. bicrenata</i> (Hoffm.) Dum.	Murman. Tundra ! (s), Alp. Murman ! (s), Pol. Ural ! (r), W. Siberia ! (r)	Northern limit
<i>L. decolorans</i> (Limpr.) Steph.	Alp. Murman ! (r), W. Siberia ! (r)	Relict, disjunct, rare worldwide, populations small
<i>L. debiliformis</i> Schust.	Alp. Murman ! (r), Pol. Ural ! (r), W. Siberia ! (r)	Poorly known
<i>L. elongata</i> Steph.	Pol. Ural ! (r), S. Chukotka (r)	Rare worldwide, disjunct
<i>L. heteromorpha</i> Schust. & Damsh.	Alp. Murman ! (r), W. Siberia ! (r), Taimyr (r), Novosib. Isls (r)	Except the Russian Arctic only few localities in Greenland
<i>L. kateninii</i> (Schljak.) Duda	Bering. Chukotka (r)	Known only from the type locality
<i>L. pellucida</i> Schust. var. <i>pellucida</i>	Wrangel (r), Bering. Chukotka (r)	Type variety apparently very rare at least in Beringia
<i>L. rubrigemma</i> Schust.	Franz-Josef ! (r), Pol. Ural ! cf. (r), W. Siberia ! cf. (r)	Poorly known arctic taxon, few reports worldwide
<i>Macrodiplphyllum microdontum</i> (Mitt.) H. Perss.	S. Chukotka (r), Bering. Chukotka ! (s)	Rather rare species with almost amphipacific range
<i>M. plicatum</i> (Lindb.) H. Perss.	Bering. Chukotka ! (c)	Amphipacific only, local populations often large
<i>Mannia fragrans</i> (Balb.) Frye & Clark	Cont. Chukotka (r)	Disjunct, mountain distribution

Species	Frequency in recognized phytogeographic sectors	Notes
<i>M. pilosa</i> (Horn.) Frye & Clark	Pol. Ural (r), S. Chukotka (r), Bering. Chukotka (r)	Disjunct
<i>M. sibirica</i> (K. Müll.) Frye & Clark	Wrangel (r)	Northern limit, disjunct distribution
<i>Marchantia polymorpha</i> L. s.str. (= <i>Marchantia aquatica</i> (Nees) Burg.)	W. Siberia ! (r), Taimyr (r), Novosib. Isls (s)	Poorly known
<i>Marsupella arctica</i> (Berggr.) Bryhn & Kaal.	Novosib. Isls (s), Wrangel ! (c), S. Chukotka ! (c), Bering. Chukotka ! (c);	Arctic species
<i>M. boeckii</i> (Aust.) Kaal.	Alp. Murman ! (s), Wrangel ! (r), S. Chukotka ! (r), Bering. Chukotka ! (r)	Mainly alpine
<i>M. commutata</i> (Limpr.) H. Bern.	S. Chukotka ! (r)	Rare worldwide
<i>M. condensata</i> (C. Hartm.) Kaal.	Murman. Tundra (r), Alp. Murman ! (s), Pol. Ural (r), Wrangel (r), Bering. Chukotka ! (r)	Disjunct, mountain species
<i>Mesoptychia sahlbergii</i> (Lindb. & H. Arnell) Evans	W. Siberia ! (r), Taimyr ! (c), W. Yakutia ! (s), Kharaulakh (s), Novosib. Isls (r), Cont. Chukotka (c), Wrangel (c), S. Chukotka (c), Bering. Chukotka (c)	Arctic species
<i>Metacalypogeia schusterana</i> Hatt. & Mizut.	Wrangel ! (r), Bering. Chukotka (r)	Only two localities in Russia, rare worldwide, disjunct
<i>Moerckia blyttii</i> (Mørch) Brockm.	Murman. Tundra ! (r), Alp. Murman ! (s), E. Europe Tundra (r), Pol. Ural (r), W. Siberia ! (r), Taimyr (r)	Rare worldwide, disjunct
<i>M. hibernica</i> (Hook.) Gott.	Alp. Murman ! (r), Taimyr (r), S. Chukotka ! (r), Bering. Chukotka (r)	Northern limit
<i>Mylia taylorii</i> (Hook.) S. Gray	Murman. Tundra ! (s), Alp. Murman ! (s), S. Chukotka (r)	Mountain, oceanic, northern limit
<i>Nardia breidlerii</i> (Limpr.) Lindb.	Murman. Tundra ! (r), Alp. Murman ! (s), E. Europe Tundra (r), ? Taimyr (r)	Rare worldwide
<i>N. insecta</i> Lindb.	Murman. Tundra ! (r), W. Siberia ! (r), S. Chukotka ! (r)	Poorly known, apparently northern limit
<i>N. japonica</i> Steph.	Pol. Ural ! (r), W. Siberia ! (r), S. Chukotka ! (r), Bering. Chukotka ! (r)	Poorly known, but rather rare worldwide
<i>Pellia endiviifolia</i> (Dicks.) Dum.	S. Chukotka (r), Bering. Chukotka ! (r)	Northern limit
<i>Pseudolepicolea fryei</i> (H. Perss.) Grolle & Ando	W. Siberia ! (s), Taimyr ! (r), Novosib. Isls (r), Cont. Chukotka (s), Wrangel (s), S. Chukotka (s), Bering. Chukotka (s)	Arctic species
<i>Prasanthus jamalicus</i> Potemkin	W. Siberia ! (r)	Recently described, known only from two localities in Yamal
<i>Ptilidium pulcherrimum</i> (G. Web.) Vainio	Murman. Tundra ! (s), Alp. Murman ! (s), Pol. Ural ! (s)	Northern limit
<i>Radula complanata</i> (L.) Dum.	Alp. Murman ! (r), W. Yakutia ! (r), Cont. Chukotka (r), S. Chukotka (r), Bering. Chukotka (r)	Northern limit
<i>Radula prolifera</i> H. Arnell	Taimyr (s), Sev. Zemlya ! (r), Novosib. Isls (s), Cont. Chukotka (c), Wrangel ! (c), S. Chukotka ! (c), Bering. Chukotka ! (c)	Arctic species
<i>Riccia bifurca</i> Hoffm.	S. Chukotka (r)	Northern limit
<i>R. cavernosa</i> Hoffm.	S. Chukotka (r)	Northern limit
<i>R. glauca</i> L.	Bering. Chukotka (r)	Northern limit
<i>R. sorocarpa</i> Bisch. subsp. <i>arctica</i> Schust.	W. Siberia ! (r), Taimyr (r)	Recently described, local populations small
<i>Scapania brevicaulis</i> Tayl.	? Pol. Ural (r), Taimyr ! (?s), Cont. Chukotka ! (r), Wrangel (r)	Rare worldwide, disjunct, local populations small
<i>S. ligulifolia</i> Schust.	Franz-Josef ! (c), Taimyr (?r), Bering. Chukotka (r)	Poorly known, disjunct arctic species

Species	Frequency in recognized phytogeographic sectors	Notes
<i>S. paludosa</i> (K. Müll.) K. Müll.	Murman. Tundra ! (s), Alp. Murman ! (s), Bering. Chukotka ! (r)	Mountain, disjunct
<i>S. rufidula</i> Warnst.	Bering. Chukotka ! (r)	Northern limit, Siberian species
<i>S. simmonsii</i> Bryhn & Kaal.	Murman. Tundra (r), Alp. Murman ! (r), Pol. Ural (r), W. Siberia ! (r), Taimyr ! (c), Sev. Zemlya ! (r), W. Yakutia ! (?r), Kharaulakh (c), Novosib. Isls (c), Cont. Chukotka ! (c), S. Chukotka ! (c), Bering. Chukotka ! (c)	Arctic species
<i>S. zemliae</i> S. Arnell	Franz-Josef (r), Nov. Zemlya ! (r), W. Siberia ! (s), Wrangel ! (r)	Poorly known arctic species
<i>Sphenolobopsis pearsonii</i> (Spruce) Schust.	Alp. Murman ! (r)	Rare worldwide, relict distribution, local populations small
<i>Tritomaria exsectiformis</i> (Breidl.) Loeske	W. Siberia ! (s), Taimyr (s), Bering. Chukotka (r)	Poorly known in the Arctic, northern limit, local populations small

known from Beringian Chukotka. Other areas with high numbers of rare species include Southern Chukotka (31 species), the alpine belt of Murmansk Region (28 species), Taimyr (25 species), Western Siberia (26 species), Polar Ural (20 species), Wrangel Island (17 species), and the lowland tundra of Murmansk Region (15 species). The remaining sectors, which have relatively few rare species, include Franz-Josef Land (3 species), Novaya Zemlya (1 or 2 species), the tundra of Eastern Europe (3 species), Severnaya Zemlya (2 species), Kharaulakh (6 species), Western Yakutia (4 species), Eastern Yakutia (2 species), Novosiberian Islands (8 species), and Continental Chukotka (11 species).

Presently there are only few nature reserves on the territory of the Russian arctic (Map). Most important of them are Wrangel Island, Taimyrsky reserve on the Taimyr Peninsula, and Ust'-Lensky reserve, situated in Lower Lena River, at the boundary of Kharaulakh and E. Yakutian phytogeographic sectors. Kandalakshsky, Laplandsky, and Pasvik reserves on the Kola Peninsula belong partly to the arctic territory of the peninsula. The total area of presently reserved territories is about 4 000 000 hectares (Stilmark 1984; M.S. Botch, pers. comm.). It is not comparable, however, with the vast territory of the Russian arctic. For the future, the establishment of state nature reserves is planned in Novaya Zemlya, Franz-Josef Land, and Chukotka. The latter seems to be most important for conservation of the rare arctic liverworts. At present 33 rare species, approximately 43% of the above list, are reported from the reserves; however, most of them have been insufficiently investigated with respect to hepatics.

Discussion and Conclusions

Evaluation and comparison of the floras of the phytogeographic sectors of the Russian arctic is hampered by unequal study of the territories. Only few regions in the Russian arctic were investigated by hepaticologists rather completely, for example, Murmansk Region (N. A. Konstantinova), Yamal Peninsula (A. D. Potemkin), Taimyr Peninsula (A. L. Zhukova), and Chukotka (collections of O. M. Afonina were identified by J. Duda mainly). Data on the other regions are based mostly on the study of collections made by geobotanists and are mainly insufficient. The most weakly studied territories are the North of Archangelsk Region, the Tazovsky Peninsula and the North of Yakutia. Frequent misdeterminations of problematic taxa in old collections are another source of confusion. Taxonomic revision of groups that are polymorphic in the Arctic as *Lophozia* s.l., *Scapania*, *Cephaloziella* s.l., and thorough inventories of the few Russian arctic nature reserves (Map) are crucial for evaluation of the status of Russian arctic hepatics.

On the basis of an analysis of the Russian arctic hepatic flora, approximately one quarter of the species are considered rare, and 43% of these occur in nature reserves. This list has to be considered preliminary in view of the need for detailed inventories of poorly investigated

regions and nature reserves, and for taxonomic revision of problematic groups. This work should be based on the study not only of old collections, but also and especially of fresh material.

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