Botanica Pacifica. A journal of plant science and conservation. 2024.
DOI: 10.17581/bp.2024.13103

BIODIVERSITY STUDIES

Family Collemataceae in the lichen flora of the Magadan Region, Russia

Tatiana V. Makryi[1]*, Elena V. Zheludeva[2]

Tatiana V. Makryi [1]*
e-mail: tatiana.makryi@gmail.com

Elena V. Zheludeva [2]
e-mail: elena.zheludeva.88@mail.ru

[1] Central Siberian Botanical Garden SB RAS, Novosibirsk, Russia

[2] Institute of Biological Problems of the North FEB RAS, Magadan, Russia

* corresponding author

Manuscript received: 05.02.2023
Review completed: 25.10.2023
Accepted for publication: 02.11.2023
Published online: 11.11.2023

ABSTRACT

The localities of sixteen species of cyanolichens of the family Collemataceae Zenker discovered in the Magadan Region are provided. *Collema glebulentum* (Cromb.) Degel. is recorded for the first time in the Russian Far East. Fourteen species are new for the Magadan Region. *Collema furfuraceum* (Arn.) DR., *C. subflaccidum* Degel., *Leptogium saturninum* (Dicks.) Nyl., *Rostania occultata* (Bagl.) Otálora, P.M. Jørg. et Wedin, *Scytinium teretiusculum* (Wallr.) Otálora, P.M. Jørg. et Wedin live as epiphytes in poplar-chosenia forests along the valleys of large rivers. *Collema pulcellum* Ach., *C. flaccidum* (Ach.) Ach., *Leptogium* cf. *hirsutum* Sierk occur in habitats unusual for them – in the subalpine mountain belt. *Leptogium cyanescens* (Ach.) Körb. was found only on the coast of the Sea of Okhotsk. All lichens are rare and occur in special habitats, manly refugia. Most species were found on the Olskoye Basalt Plateau and the Atargan Peninsula. The localities of *Collema pulcellum*, *Leptogium cyanesces*, *L.* cf. *hirsutum* are outside their ranges; these lichens are relics of the Miocene-Pliocene mesophilous flora.

Keywords: cyanolichens, Collemataceae, new records, special habitats, refugia, mesophilous relics, Magadan Region, Russia

РЕЗЮМЕ

Макрый Т.В., Желудева Е.В. Семейство Collemataceae в лихенофлоре Магаданской области (Россия). Приведены местонахождения 16 видов цианолишайников семейства Collemataceae Zenker, обнаруженных в Магаданской области. *Collema glebulentum* (Cromb.) Degel. впервые указывается для российского Дальнего Востока. Четырнадцать видов являются новыми для Магаданской области. *Collema furfuraceum* (Arn.) DR., *C. subflaccidum* Degel., *Leptogium saturninum* (Dicks.) Nyl., *Rostania occultata* (Bagl.) Otálora, P.M. Jörg. et Wedin, *Scytinium teretiusculum* (Wallr.) Otálora, P.M. Jørg. et Wedin обитают как эпифиты в тополево-чозениевых лесах по долинам крупных рек. *Collema pulcellum* Ach., *C. flaccidum* (Ach.) Ach., *Leptogium* cf. *hirsutum* Sierk встречаются в несвойственных им местообитаниях – в субальпийском поясе гор. *Leptogium cyanescens* (Ach.) Körb. обнаружен только на побережье Охотского моря. Все лишайники редки и встречаются в особых местообитаниях, в основном в рефугиумах. Больше всего видов обнаружено на Ольском базальтовом плато и полуострове Атарган. Местонахождения *Collema pulcellum*, *Leptogium cyanesce*, *L.* cf. *hirsutum* находятся за пределами их ареалов; эти лишайники являются реликтами миоцен-плиоценовой мезофильной флоры.

Ключевые слова: цианолишайники, Collemataceae, новинки, особые местообитания, рефугиумы, мезофильные реликты, Магаданская область, Россия

The family Collemataceae Zenker (order Peltigerales) is the largest among the families of jelly cyanobiont lichens. It includes ten genera and about 300 species. The genera *Leptogium* (Ach.) Grey, *Scytinium* (Ach.) Grey, and *Collema* Weber ex F.H. Wigg. are the richest in number of species.

Membes of the Collemataceae are mostly mesophilous and hygro-mesophilous lichens that live on trunks of deciduous trees, as well as mossy rocks in shady humid broad-leaved and mixed (with dark coniferous tree species) forests, usually in mountain valleys. A minority of the species are epilithic (saxicolous) or epigeic (terricolous) lichens, which inhabit predominantly calciferous soil and stones in more or less dry ecotopes, and occur manly in mountains and in arid regions. A very small group includes the species growing on stones with thin soil layer, mosses and plant debris, found in the mountains from the lower belts to the highlands and also in the Arctic.

In the Russian Far East, the members of the Collemataceae is poorly studied. The most complete information about these lichens refers to the southern part of the Russian Far East; for this territory, a partial revision of herbarium materials of the genera *Collema* s. l. and *Leptogium* was carried out. At present, thirty-four species of the Collemataceae are known in the south of the Russian Far East, while eighteen and sixteen species, respectively, are known in the north of the Far East and the Far Eastern sector of the Arctic. For the Magadan Region, only one species was reported – *Leptogium saturninum* (Dicks.) Nyl. (Zheludeva 2015, 2018).

This study focuses on the distribution and habitat features of representatives of the family Collemataceae in the Magadan region.

MATERIAL AND METHODS

The paper was prepared on the basis of the results of handling of herbarium lichen specimens collected during 2008–2017 years by E.V. Zheludeva on the territory of the Magadan Region of Russia. The identification of lichens was carried out in the Central Siberian Botanical Garden SB RAS.

Lichen thalli and their sections were examined by methods of stereoscopic and light microscopy. The names of species and genera are given in accordance with the modern taxonomy of the Collemataceae, revised based on the results of molecular genetic analysis (Otalora et al. 2013, Index Fungorum). Synonyms and names under which the lichens were identified and under which they are listed in the papers (Degelius 1954, 1974, Jørgensen, 2007, etc.) are given in square brackets. Herbarium specimens are kept in the Herbarium of the Institute of Biological Problems of the North FEB RAS (MAG) and the M.G. Popov Herbarium of the Central Siberian Botanical Garden SB RAS (NSK).

RESULTS

On the territory of the Magadan Region, sixteen members of the family Collemataceae, belonging to seven genera, have been discovered.

Blennothallia Trevis.

The genus contains four species worldwide. In Russia, only one species is known.

Blennothallia crispa (Huds.) Otálora, P.M. Jørg. et Wedin [*Collema crispum* (Huds.) Weber ex F.H. Wigg. var. *crispum*]

This is a terricolous (or epilithic) calcephilous species with a multiregional range. In Russia, it occurs in the European part, the Caucasus, the Urals, South Siberia, the Siberian and Far Eastern sectors of the Arctic (Urbanavichus, 2010), also in Yakutia (Masaryk University).

Specimens examined: Ola District, Ola firth, Atargan Peninsula, 59°33'41.68"N 151°28'13.35"E, 88 m a.s.l., stony hillside, rock outcrops with scree (calciferous rocks), on thin soil layer, 31.03.2016, E. Zheludeva, (MAG).

Collema Weber ex F.H. Wigg.

The genus includes about seventy species worldwide, most of which are epiphytes. In Russia, nineteen species are known.

Collema flaccidum (Ach.) Ach.

This is the eurytopic species (living as an epiphytic, epilithic, or epigeic lichen), which has a Eurasian-North American range. In Russia, it was reported for the European part, the Caucasus, the Urals, Siberia, the Far East (northern and southern parts), and also for the European and Siberian sectors of the Arctic (Urbanavichus 2010).

Specimens examined: Khasynsky District, Ola Plateau, 60°37'41.01"N 151°15'16.29"E, 1164 m a.s.l., stony *Dryas* tundra, on *Dryas* twigs, 12.07.2017, E. Zheludeva, (MAG, doublet in NSK).

Collema furfuraceum (Arn.) DR.

It is an epiphytic lichen with a wide range covering the Northern Hemisphere. In Russia, it occurs in the European part, the Caucasus, the Urals, Siberia (Urbanavichus 2010), Yakutia (Poryadina 2005) and the Russian Far East, where it was reported for the southern part (Chabanenko 2002), for Kamchatka and Koryakia (Himelbrant et al. 2014, 2019).

Specimens examined: Ola District, valley of Uglikanka River (tributary of the Ola River), 59°36'38.00"N 151°18'30.74"E, 12 m a.s.l., *Larix cajanderi* forest with rare *Populus suaveolens*, on *Populus*, 07.04.2016, E. Zheludeva, O-2378 (MAG); Taui River valley, 59°46'11.66"N 148°45'12.95"E, 17 m a.s.l., *Alnus hirsuta–Populus suaveolens–Chosenia arbutifolia* forest with rare *Larix cajanderi* and *Betula platyphylla*, on *Chosenia*, *Populus*, 08.07.2015, E. Zheludeva, O-2378 (MAG, doublet in NSK); Chelomdzha River walley, Nevta Brook, hillside, 59°47'29.81"N 148°12'57.83"E, 36 m a.s.l., *Chosenia* forest with *Alnus hirsuta*, shrub and horsetail-high-grass cover, on *Chosenia*, 12.07.2012, E. Zheludeva, (MAG); Severo-Evensky District, vicinity of Evensk, 5-6th km upriver Bolshaya Garmanda, 61°57'37.23"N 159°15'33.73"E, 13 m a.s.l., old *Chosenia arbutifolia* forest with *Populus suaveolens*, shrub and forbs-green moss cover, on *Chosenia*,12.07.2015, E. Zheludeva, (MAG, doublet in NSK).

Notes. Degelius (1974: 179) pointed out that "in the American population, the rides and pustules of the thallus are less distinct [then in the European population], and such specimens may be confused with *C. subflaccidum*". This remark fully applies to the Magadan population.

Collema glebulentum (Cromb.) Degel.

It is an epilithic lichen (on siliceous rocks) that has a Eurasian-North American range. In Russia, the species is known from the north of the European part – Murmansk Region, Karelia (Fadeeva et al. 2007, Urbanavichus et al. 2008, Urbanavichus 2010), the Northern and Polar Urals – Komi, Yamalo-Nenets Autonomous Area (Ryabkova 1998, Hermansson et al. 2006), also from Central Siberia – Krasnoyarsk Territory: Evenkiysky District (Natural History Museum 2022) and South Siberia – Transbaikal Territory: Kodar Range (Makryi 2013). The lichen is not listed for Japan and China.

Specimens examined: Omsukchan District, Kilgan Mountains, vicinity of Juliet mine, 61°11'40.05"N 153°56'34.05"E, subalpine belt, 952 m a.s.l., stony hillside, rocks along the stream, on rock, 08.08.2012, E. Zheludeva, (MAG, doublet in NSK).

Collema pulcellum Ach.

This is a typical epiphytic lichen (very rare living on boulders), which has a narrow East Asian-North American range. In Russia, it is distributed in the mountainous regions of South Siberia and the south of the Russian Far East – from Altai to the Pacific Ocean. The nearest locality is in the Khabarovsk Territory, 10 km NW of Okhotsk, the mountains Lanzhinskiye Gory [about 59°19.3'–59°33.3"N 143°18.7'–143°37.6'E] in the floodplain forest, on *Chosenia* (Makryi & Skirina 2009).

Specimens examined: Khasynsky District, Ola Plateau, the upper Ola River, stony dwarf shrub-lichen tundra, on plant debris, 28.06.2015, O.N. Vokhmina, (MAG); ibid., 60°37'41.01"N 151°15'16.29"E, 1164 m a.s.l., stony *Dryas* tundra, on small stones, 12.07.2017, E. Zheludeva, X3-692 (MAG, doublet in NSK).

Notes. Thallus is clearly pustulate but without apothecia. According to the anatomical structure, it corresponds to *Collema pulcellum*.

Collema subflaccidum Degel.

It is an epiphytic lichen, also found on mossy boulders. It has a wide multiregional range covering the Northern Hemisphere, South Africa, Australia and New Zeland (Jørgensen 2007). In Russia, the species is known in the European part, the Caucasus, the Urals, Siberia (Urbanavichus 2010) and the Far East, where it was recorded in the southern part and Kamchatka (Chabanenko 2002, Neshataeva et al. 2003).

Specimens examined: Ola District: Ola firth, Atargan Peninsula, 59°33'41.68"N 151°28'13.35"E, 88 m a.s.l., stony hillside, scree, on stone, 31.03.2016, E. Zheludeva, (MAG); Taui bay, Island Nedorazumenia, 59°34'57.07"N 150°24'46.54"E, 104 m a.s.l., over the cliff, on stone, 11.08.2016, E. Zheludeva, (MAG); Severo-Evensky District, vicinity of Evensk, 5-6th km upriver Bolshaya Garmanda, 61°57'01.51"N 159°14'52.48"E, 10 m a.s.l., old sparse *Chosenia arbutifolia* forest with *Duschekia fruticosa* and tall grass cover, on *Chosenia*, 03.07.2015, E. Zheludeva, (MAG).

Enchylium (Ach.) Gray

The genus include sixteen (eighteen) species worldwide. In Russia, nine species are known.

Enchylium tenax (Sw.) Gray [*Collema tenax* (Sw.) Ach. em. Degel. var. *vulgare*]

This is a calciphilous terricolous species with a vast Holarctic range. In Russia, the species is found in the European part, the Caucasus, the Urals, Siberia, all sectors of the Arctic and the north of the Far East (Urbanavichus 2010).

Specimens examined: Srednekansky District, Bolschoy Tuonnakh mountains, Mt. Aesop, 63°16'05.95"N 151°03'08.90"E, 980 m a.s.l., dwarf shrub tundra, on calcareous soil, 24.07.2011, E. Zheludeva, (MAG); Severo-Evensky District, road Evensk – Garmanda, 37th km, 62°09'45.27"N 159°07'10.99"E, 134 m a.s.l., top of little hill, stones covered with lichens, on layer of dense soil, 14.07.2015, E. Zheludeva, (MAG).

Lathagrium (Ach.) Gray

The genus includes ten species worldwide. In Russia, six species are known.

Lathagrium cristatum (L.) Otálora, P.M. Jørg. et Wedin [*Collema cristatum* (L.) F.H. Wigg. var. *marginale* (Huds.) Degel.]

It is a calcephilous saxicolous species with a wide Holarctic range. In Russia, it is known in the Arctic (all sectors), the European part, the Caucasus, the Urals, Siberia, and the north and south of the Russian Far East (Urbanavichus 2010).

Specimens examined: Ola District, Ola firth, Atargan Peninsula, 59°33'41.68"N 151°28'13.35"E, 88 m a.s.l., stony hillside, rock outcrops (calciferous rocks), on stony surface, 31.03.2016, E. Zheludeva, (MAG).

Lathagrium undulatum (Flot.) Otálora, P. M. Jørg. et Wedin [*Collema undulatum* Laurer ex Flot. var. *granulosum* Degel.]

This is an epilithic calcephilous species with a Holarctic range, found mainly in mountainous areas. In Russia, it was reported for the north of the European part, the Northern and Southern Urals, South Siberia and the Arctic (all sectors) (Urbanavichus 2010).

Specimens examined: Khasynsky District, Ola Plateau, 60°37'41.01"N 151°15'16.29"E, 1164 m a.s.l., stony *Dryas* tundra, on stone of rhinestone, in crevice with sand deposits between crystals,12.07.2017, E. Zheludeva, (MAG).

Leptogium (Ach.) Gray

It is the largest genus in the Collemataceae, including more than 150 species worldwide. In Russia, sixteen species are currently known.

Leptogium* cf. *hirsutum Sierk

This species belongs to the *L. saturninum* group. The group is very confusing; it represents a large complex of species that are currently being intensively studied. In recent years alone, six new species from North America and Asia have been described (Liu & Guan 2012, Stone et al. 2016, Lendemer & Stone 2022, Stone & McCune 2022).

Leptogium hirsutum was described from North America. Later this taxon has considered as a variation of *L. burnetiae* C.W. Dodge var. *hirsutum* (Sierk) P.M. Jørg. (Jørgensen 1973). It is a mesophilous lichen inhabiting tree trunks and mossy rocks. Its distribution is poorly studied; the range covers temperate areas of North America and East Asia (Jørgensen 1973). Stone et al. (2016) consider this species to be a North American endemic, although they have not studied Asian materials. In Russia, it is widespread in the south of the Russian Far East (Amur Region, Jewish Autonomous Region, Primorsky Territory) and also in the Western Pribaikalie (Makryi 2014). Reports of *L. burnetiae* from the south of the Russian Far East are erroneous.

Specimens examined: Khasynsky District, Ola Plateau, 60°37'41.01"N 151°15'16.29"E, 1164 m a.s.l., stony *Dryas* tundra, on dryad twigs, 12.07.2017, E. Zheludeva, X-3691c (MAG); ibid., slope of the Mt. Begemot, 60°37'28.30"N 151°15'35,69"E, 1082 m a.s.l., driad-lichen tundra, on dryad twigs, mosses and plant debris, 12.07.2017, E. Zheludeva, X-3694, X-3695, X-3701, X-3704, X-3705 (MAG, doublet in NSK).

Notes. The Magadan specimens differ from those of the South Far East. They have not yet been accurately identified.

Leptogium cyanescens (Ach.) Körb.

This is an epiphytic species inhabiting also the mossy rocks with a multiregional range. In Russia, it is known in the European part (north and center), the Caucasus, the Urals, Southern Siberia (Urbanavichus 2010), Yakutia (Vershinina et al. 2015), the southern part of the Russian Far East (Chabanenko 2002), and also in Kamchatka and in Koryakia (Neshataeva et al. 2003, Himelbrant et al. 2019).

Specimens examined: Ola District: Taui Bay, Island Nedorazumeniya, 59°34'34.67"N 150°23'47,57"E, 198 m a.s.l., *Larix cajanderi* forest with *Pinus pumila* and forbs-green moss cover, on mossy *Larix* roots, 11.08.2016, E. Zheludeva, O-3268 (MAG); Ola firth, Atargan Peninsula, 59°33'41.68"N 151°28'13.35"E, 88 m a.s.l., stony hillside, scree, on stone, 31.03.2016, E. Zheludeva, O-4472 (MAG); Atargan Peninsula, stony hillside, 59°32'48.93"N 151°29'43,20"E, 26 m a.s.l., on stones in dense grass, 15.08.2016, E. Zheludeva, O-3206 (MAG).

Leptogium saturninum (Dicks.) Nyl.

It is an epiphytic forest lichen with a wide range covering the Northern Hemisphere. In Russia the species is reported for the European part, the Caucasus, the Urals, Siberia, Yakutia, the Russian Far East, the European and Far Eastern sectors of the Arctic (Chabanenko 2002, Poryadina 2005, Urbanavichus 2010). In the Magadan Region, lichen was recorded in few localities (Zheludeva 2015, 2018). Nearest localities are know in Koryakia (Himelbrant et al. 2019), Kamchatka (Neshataeva et al. 2003), and Chukotka (Andreev et al. 1996).

Specimens examined: Ola district: valley of Uglikanka River (tributary of the Ola River), 59°36'38.04"N 151°18'30.74"E, 12 m a.s.l., *Laris cajanderi* forest with rare *Populus suaveolens*, on *Populus*, 07.04.2016, E. Zheludeva, (MAG); Yama River valley, 59°45'32.65 N 153°34'28.84"E, 70 m a.s.l., floodplain *Chosenia arbutifolia–Larix cajanderi* forest with grass-forbs cover, on *Chosenia*, 17.07.2010, E. Zheludeva, O-675 (MAG, doublet in NSK); Taui River valley, 59°46'11.66"N 148°45'12.95"E, 17 m a.s.l., *Alnus hirsuta–Populus suaveolens–Chosenia arbutifolia* forest with sparse *Larix cajanderi*, *Betula platyphylla*, on *Chosenia*, 08.07.2015, E. Zheludeva, O-2344, O-2563 (MAG, doublet in NSK); Kava River valley, 59°47'42.14"N 148°00'41.32"E, 67 m a.s.l., *Populus tremula* forest with sparse *Larix cajanderi*, *Betula platyphylla*, *Pinus pumila* and green moss cover, on stones, 09.07.2012, E. Zheludeva, O-484 (MAG); Kava River valley, 59°47'38.59"N 148°00'33.82"E, 41 m a.s.l., rocks along the river, on stones, 09.07.2012, E. Zheludeva, (MAG); Severo-Evensky District, vicinity of Evensk, 5–6th km upriver Bolshaya Garmanda, valley, 61°57'37.23"N 159°15'33.73"E, 13 m a.s.l., old *Chosenia arbutifolia* forest with *Populus suaveolens* and dwarf shrub–forbs–green moss cover, on *Populus* and *Chosenia*, 12.07.2015, E. Zheludeva, CƏ-2193 (MAG, doublet in NSK); 13th km upriver Bolshaya Garmanda, 62°01'14.34"N 159°17'29.96"E, 55 m a.s.l., *Populus suaveolens–Chosenia arbutifolia* forest with sparse *Pinus pumila* and green moss–lichen cover, on *Chosenia*, 13.07.2015, E. Zheludeva, CƏ-2426 (MAG, doublet in NSK).

Rostania Trevis.

The genus includes eight species worldwide. In Russia, three species are known.

Rostania occultata (Bagl.) Otálora, P.M. Jørg. et Wedin [*Collema occultatum* Bagl. var. *occultatum*]

This is an epiphytic lichen that inhabits mainly the bark of deciduous trees (*Populus*, *Salix*) and has a Holarctic range. In Russia it is reported for the north of the European part, the Northern Urals, the Caucasus, South Siberia and the north of the Russian Far East – Kamchatka (Urbanavichus 2010, Neshataeva et al. 2003).

Specimens examined: Ola District, Taui River valley, 59°46'11.66"N 148°45'12.95"E, 17 m a.s.l., *Alnus hirsuta–Populus suaveolens–Chosenia arbutifolia* forest with sparse *Larix cajanderi* and *Betula platyphylla*, on *Populus*, 15.07.2015, E. Zheludeva, (MAG, doublet in NSK); Severo-Evensky District, vicinity of Evensk, 5-6th km upriver Bolshaya Garmanda, valley, 61°57'37.23"N 159°15'33.73"E, 13 m a.s.l., old *Chosenia arbutifolia* forest with *Populus suaveolens* and dwarf shrub–forbs–green moss cover, on *Chosenia*, 12.07.2015, E. Zheludeva, (MAG).

Scytinium (Ach.) Gray

The genus currently includes forty nine species worldwide. In Russia, twenty three species are known.

Scytinium intermedium (Arnold) Otálora, P.M. Jørg. et Wedin [*Leptogium intermedium* (Arnold) Arnold]

It is a more or less calciphilous lichen, inhabiting mainly rocks with soil layers, and mosses. The species has a Eurasian–North American range. In Russia, it is known in the north of the European part, the Caucasus, the Urals, South Siberia, the north of the Russian Far East, and the European and Siberian sectors of the Arctic (Urbanavichus 2010).

Specimens examined: Ola District, Ola firth, Atargan Peninsula, 59°33'41.68"N 151°28'13.35"E, 88 m a.s.l., hillside, rock outcrops with scree, on thin layer of carbonated soil with plant debris, 31.03.2016, E. Zheludeva (MAG).

Scytinium tenuissimum (Dicks.) Otálora, P.M. Jørg. et Wedin [*Leptogium tenuissimum* (Dicks.) Körb.]

It is a calciphilous terricolous lichen with a Eurasian–North American range. In Russia, the species is distributed in the Arctic (all sectors), the European part, the Caucasus, the Urals, Siberia, and the north and south of the Russian Far East (Urbanavichus 2010).

Specimens examined: Khasynsky district, Ola Plateau, 60°37'41.01"N 151°15'16.29"E, 1164 m a.s.l., stony *Dryas* tundra, on soil with plant debris, 12.07.2017, E. Zheludeva, (MAG).

Scytinium teretiusculum (Wallr.) Otálora, P.M. Jørg. et Wedin [*Leptogium teretiusculum* (Wallr.) Arnold]

This is an epiphytic lichen species with a Eurasian–North American range. In Russia, the species is known in the north and in the center of the European part, in the Caucasus, the Northern and Southern Urals, in South and Western Siberia, in the north of the Russian Far East (Urbanavichus 2010).

Specimens examined: Ola District, Ola River valley, 59°52'56.84"N 151°34'18.64"E, 140 m a.s.l., *Larix cajanderi* forest with sparse *Chosenia*, on *Chosenia*, 07.07.2013, E. Zheludeva, O-4476 (MAG).

DISCUSSION

Five species: *Collema furfuraceum*, *C. subflaccidum*, *Leptogium saturninum*, *Rostania occultata*, *Scytinium teretiusculum* are found on tree trunks (on cortex). They are all epiphytes in the centers of their ranges; the last two species are quite common in the northern regions. All species inhabits floodplain poplar-chosenia forests along the valleys of large rivers in their lower reaches. Due to milder climatic conditions, many rare and relict mesophilous plant species occur in these localities.

Four species, *Collema ryssoleum*, *C. flaccidum*, *Leptogium* cf. *hirsutum* and *L. cyanescens*, are mesophilous forest lichens. In the centers of their ranges they are epiphytes or predominantly epiphytes, also living on mossy rocks. In the Magadan Region, the first three species were found in habitats that are completely unusual for them: in the highlands of the Ola Basalt Plateau – in the subalpine belt (at altitudes of 1000–1180 m above sea level) in the dryad tundra. *Leptogium cyanescens* occurs exclusively on the coast of the Sea of Okhotsk (Atargan Peninsula and Island Nedorasumenia) on mossy stones and larch roots.

Six species, *Lathagrium cristatum*, *L.* cf. *undulatum*, *Blennothallia crispa*, *Enchylium tenax*, *Scytinium intermedium*, *S. tenuissimum* are calciphilous lichens: the first two are epiliths, the rest are terricolous species inhabiting calciferous soil (naked or with mosses).

It should be noted that the same phenomenon, when mesophilous thermophilous lichen species, including relict ones, live in the subalpine belt, is also observed in the mountains of South Siberia. This is facilitated by high solar radiation (higher than in the forest belt), which compensates for the lack of heat, high snow cover that protects lichens from winter frosts, and temperature inversions (Makryi 2002, 2003). On the Ola Plateau, an additional factor is the presence of basalts (basic rocks containing calcium oxide and magnesium oxide), which form neutral and slightly carbonate substrates favorable for many rare and relict plants and lichens.

The narrow zone of the coast of the Sea of Okhotsk is characterized by a maritime monsoon climate, the mildest in the region. Therefore, the rarest relict species of plants and lichens are found here, for example, *Pseudocyphellaria crocata* (L.) Vain.

All of the above localities, including the islands and coast of the Sea of Okhotsk, the valleys of large rivers in their lower reaches, the Ola Basalt Plateau are considered by Khokhryakov (1979) and Mochalova & Khoreva (2012) as refugia of the Arctic-Tertiary mesophilic flora. Coastal dry rocks and stony slopes, on which hemixerophytic communities develop, are also refugia, including for xerophilous plants (Khokhryakov 1979). Relic lichens *Peccania coralloides* (A. Massal.) A. Massal. and *Thallinocarpon nigritellum* (Letau) P.M. Jörg. were collected in just such an ecotope (Makryi & Zheludeva 2022), *Lathagrium cristatum* and *Blennothallia crispa* were also found there.

CONCLUSIONS

In the Magadan Region, sixteen species of the family Collemataceae have been discovered. *Collema glebulentum* is recorded for the first time in the Far East; *Blennothallia crispa* is first found in the northern part of the Far East; and thirteen species are new for the Magadan Region.

All species are rare on the studied territory. They are different in ecology, both in relation to substrates, and in relation to air humidity and temperature. Since the climate of the Magadan Region is generally subarctic, all thermophilous species, are found here in special habitats: on the coast of the Sea of Okhotsk and in the valleys of large rivers. Exclusive ecotopes represent habitats in the subalpine belt of mountains and on calcium-bearing rocks. Most of the species were found on the Ola Basalt Plateau and the Atargan Peninsula, six and five species, respectively. Both the Ola Plateau and the Atargan Peninsula are refugia of relict plants. Localities of *Collema ryssoleum*, *Leptogium cyaneses*, *L.* cf. *hirsutum* are outside their ranges; in the Magadan Region, these lichens are relics of the Miocene-Pliocene flora.

ACKNOWLEDGEMENTS

This work was conducted in accordance with the Federal Program for Fundamental Scientific Research of the State Academies of Sciences within the framework of the projects of both the Central Siberian Botanical Garden SB RAS (AAAAA211210112900245) and the Institute of Biological Problems of the North FEB RAS (AAAAA171171225900020). The authors are grateful to O.N. Vokhmina for providing lichen specimens.

LITERATURE CITED

Andreev, M., Y. Kotlov & I. Makarova 1996. Checklist of lichens and lichenicolous fungi of the Russian Arctic. *The Bryologist* 99(2):137–169.

Chabanenko, S.I. 2002. *Conspectus of the lichen flora of the south of the Russian Far East*. Dalnauka, Vladivostok, 231 pp. (in Russian). [Чабаненко С.И. 2002. Конспект флоры ли-

шайников юга российского Дальнего Востока. Владивосток: Дальнаука. 231 с.].

Degelius, G. 1954. The lichen genus *Collema* in Europe. Morphology, taxonomy, ecology. *Symbolae Botanicae Upsalienses* 13(2):1–500.

Degelius, G. 1974. The lichen genus *Collema* with special references to the extraeuropian species. *Symbolae Botanicae Upsalienses* 20(2):1–215.

Fadeeva, M.A., N.S. Golubkova, O. Viticainen & T. Ahti 2007. *Conspectus of lichens and lichenicolous fungi of the Rebublic of Karelia*. Petrozavodsk, 192 pp. (in Russian). [Фадеева М.А., Голубкова Н.С., Витикайнен О., Ахти Т. 2007. Конспект лишайников и лихенофильных грибов Республики Карелия. Петрозаводск. 192 с.].

Hermansson, Ya., T.N. Pystina, B. Ove-Larsson & M.P. Zhurbenko 2006. Lichens and lichenophilous fungi of the Pechoro-Ilychsky Reserve. *Flora I Fauna Zapovednikov* 109:1–76 (in Russian). [Херманссон Я., Пыстина Т.Н., Ове-Ларссон Б., Журбенко М.П. 2006. Лишайники и лихенофильные грибы Печоро-Илычского заповедника // Флора и фауна заповедников. Вып. 109. 76 с.].

Himelbrant, D.E., I.S. Stepanchikova & E.S. Kuznetsova 2014. Lichens. In: *Vegetation cover of volcanic plateaus of Central Kamchatka*. (V.Yu. Neshataeva, ed.), pp. 121–164, KMK Scientific Press, Moscow (in Russian). [Гимельбрант Д.Е., Степанчикова И.С., Кузнецова Е.С. 2014. Лишайники // Растительный покров вулканических плато Центральной Камчатки / под ред. В.Ю. Нешатаевой. Москва: Изд-во КМК. С. 121–164].

Himelbrant, D.E., I.S. Stepanchikova, T. Ahti & V.Yu. Neshataeva 2019. The first lichenological survey in Koryakia (Northern Kamchatka, Russia) – the last unexplored part of Beringia. *Novosti Sistematiki Nizshikh Rastenii* 53(1): 107–142.

Jørgensen, P.M. 1973. Über einige *Leptogium*-arten vom *Mallotium*-typ. *Herzogia* 2: 453–468.

Jørgensen, P.M. 2007. Collemataceae. In: *Nordic Lichen Flora, vol. 3* (T. Ahti, P.M. Jørgensen, H. Kristinsson, R. Moberg, U. Søchting & G. Thor, eds), pp. 14–42, Svenska Botaniska Föreningen, Uppsala.

Khokhryakov, A.P. 1979. Refugia of mesophilic relict floristic elements at the northern coast of the Sea of Okhotsk and in the Upper Kolyma River Basin. *Byulleten' Moskovskogo Obshchestva Ispytatelei Prirody, Otdel Biologicheskii* 84(6):84–96 (in Russian). [Хохряков А.П. Убежища мезофильных реликтовых элементов флоры на севере охотского побережья и в бассейне верхней Колымы // Бюллетень Московского общества испытателей природы, Отдел биологический. Т. 84, вып. 6. С. 84–96].

Lendemer, J.C. & D.F. Stone 2022. *Leptogium stancookii*, a new name for the western North American lichen referred to as *L. cookii* whose type corresponds to *L. saturninum* s. str. *The Lichenologist* 54(1): 85–86.

Liu, H.J. & S. Guan 2012. A new hairy species of *Leptogium* (Collemataceae) from China. *Mycotaxon* 119:413–417.

Makryi, T.V. 2002. The mesophilous relics in the lichenflora of Pribaikalie. In: *Problems of botany of Southern Siberia and Mongolia. Materials of the First International Scientific and Practical Conference (Barnaul, November 26–28)*, pp. 48–55, Barnaul (in Russian). [Макрый Т.В. 2002. Мезофильные реликты в лихенофлоре Прибайкалья // Проблемы ботаники Южной Сибири и Монголии. Материалы Первой международной научно-практической конференции (Барнаул, 26-28 ноября 2002 г.). Барнаул. С. 48–55].

Makryi, T.V. 2013. *Collema texanum* (Collemataceae) – a new lichen for Russia, and other saxicolous *Collema* species from Stanovoye Upland (Baikal Siberian Region). *Novosti Sistematiki Nizshikh Rastenii* 47:230–236 (in Russian). [Макрый Т.В. 2013. Новый для России лишайник *Collema texanum* (Collemataceae) и другие эпилитные виды *Collema* со Станового нагорья (Байкальская Сибирь) // Новости систематики низших растений. Т. 47. С. 230–236].

Makryi, T.V. 2014. A review of the sect. *Mallotium* of the genus *Leptogium* (Collemataceae) in Russia and *L. pseudopapillosum* and *L. hirsutum* new records for Russia. *Novosti Sistematiki Nizshikh Rastenii* 48:264–290 (in Russian). [Макрый Т.В. 2014. Обзор секции *Mallotium* рода *Leptogium* (Collemataceae) в России и новые для России виды *L. pseudopapillosum* и *L. hirsutum* // Новости систематики низших растений. Т. 48. С. 264–290].

Makryi, T.V. & I.F. Skirina 2009. Rare and poorly studied in Russia epiphytic species of *Collema* (Collemataceae, Lichenes) from south part of Far East. *Turczaninowia* 12(3–4):53–62 (in Russian). [Макрый Т.В., Скирина И.Ф. 2009. Редкие и слабо изученные в России эпифитные виды *Collema* (Collemataceae, Lichenes) из южной части Дальнего Востока // Turczaninowia. Т. 12, вып. 3–4. С. 53–62].

Makryi, T.V. & E.V. Zheludeva 2022. New and rare species of jelly cyanolichens for Asia and the Russian Far East. *Botanica Pacifica* 11(2):153–158.

Masaryk University, Department of Botany and Zoology. *Masaryk University – Herbarium BRNU*. Occurrence dataset https://doi.org/10.15468/soarvd Accessed via GBIF.org on 04.01.2023 https://www.gbif.org/occurrence/2382568535 Last accessed 13.01.2023.

Mochalova, O.A. & M.G. Khoreva 2012. Rare plants in wildlife reserves of the Magadan Region. *Vestnik DVO RAN* 3:74–82 (in Russian). [Мочалова О.А., Хорева М.Г. 2012. Редкие виды сосудистых растений на особо охраняемых природных территориях Магаданской области // Вестник ДВО РАН. № 3. С. 74–82].

Natural History Museum 2022. *Natural History Museum (London) Collection Specimens*. Occurrence dataset https://doi.org/10.5519/0002965 accessed via GBIF.org on 01.01.2023. https://www.gbif.org/occurrence/1055789295 Last accessed 13.01.2023.

Neshataeva, V.Yu., D.E. Himelbrant, E.S. Kuznetsova & I.V. Chernyadjeva 2003. The species composition of vascular plants, mosses and lichens and the community structure features of pristine oldgrowth stonebirch forests of Southwest Kamchatka. In: *Papers of the III Scientific Conference "Conservation of Biodiversity of Kamchatka and Adjacent Seas"*, pp. 100–123, Petropavlovsk-Kamchatsky (in Russian with English summary). [Нешатаева В.Ю., Гимельбрант Д.Е., Кузнецова Е.С., Чернядьева И.В. 2003. Ценотические, бриофлористические и лихенобиотические особенности коренных старовозрастных каменноберезовых лесов Юго-Западной Камчатки. // Доклады III научной конференции «Сохранение биоразнообразия Камчатки и прилегающих морей». Петропавловск-Камчатский. С. 100–123].

Otálora, M.A.G., P.M. Jørgensen & M. Wedin 2013. A revised generic classification of the jelly lichens, Collemataceae. *Fungal Diversity* 64(1):275–293.

Poryadina, L.N. 2005. Lichens. In: *Diversity of plant life in Yakutia*, pp. 126–149, Novosibirsk (in Russian). [Порядина Л.Н. 2005. Лишайники // Разнообразие растительного мира Якутии. Новосибирск. С. 126–149].

Ryabkova, K.A. 1998. Systematic list of lichens of the Urals. *Novosti Sistematiki Nizshikh Rastenii* 32:81–87 (in Russian). [Рябкова К.А. 1998. Систематический список лишайников Урала // Новости систематики низших растений. Т 32. С. 81–87].

Stone, D.F., J.W. Hinds, F.L. Anderson & J.C. Lendemer 2016. A revision of the *Leptogium saturninum* group in North America. *The Lichenologist* 48(5): 387–421.

Stone, D.F. & B. McCune 2022. Two new hairy *Leptogium* (Collemataceae) species from western North America. *The Bryologist* 125(1):157–169.

Zheludeva, E.V. 2015. Lichen species from North-Eastern Priokhotye (Okhotsk Sea region) new for Magadan Region. *Turczaninowia* 18(4):5–15 (in Russian). [Желудева Е.В. 2015. Новые для Магаданской области виды лишайников из Северо-Восточного Приохотья // Turczaninowia. Т. 18, вып. 4. С. 5–15].

Zheludeva, E.V. 2018. Addition to the lichen flora of the Kava-Chelomdzhinsky section of the "Magadansky" Reserve. *Vestnik Severo-Vostochnogo nauchnogo Centra DVO RAN* 4:90–98 (in Russian). [Желудева Е.В. 2018. Дополнение к лихенофлоре Кава-Челомджинского участка заповедника «Магаданский» // Вестник Северо-Восточного научного Центра ДВО РАН. № 4. С. 90–98].

Urbanavichus, G.P. 2010. *A checklist of the lichen flora of Russia*. Nauka, St. Petersburg, 194 pp. (in Russian with English introduction). [Урбанавичюс Г.П. 2010. Список лихенофлоры России. Санкт-Петербург: Наука. 194 с.].

Urbanavichus, G., T. Ahti & I. Urbanavichene 2008. Catalogue of lichens and allied fungi of Murmansk Region, Russia. *Norrlinia* 17:1–80.

Vershinina, S.E., D.E. Himelbrant, E.S. Kuznetsova, L.M. Gabysheva & E.M. Gabyshev 2015. Addition to the lichen flora of state nature reserve "Olyokminsky", (Sakha-Yakutia Republic). In: *Trudy Gosudarstvennogo prirodnogo zapovednika "Olyekminskii"* 1:90–106 (in Russian). [Вершинина С.Э., Гимельбрант Д.Е., Кузнецова Е.С., Габышева Л.М., Габышев Э.М. 2015. Дополнения к лихенофлоре государственного природного заповедника «Олёкминский», (Республика Саха-Якутия) // Труды Государственного природного заповедника «Олёкминский». Вып. 1. С. 90–106].