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Articles

New records of lichens from the Russian Far East. IV. The lichens of limestone outcrops of the southern part of the Russian Far East

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The new records of the lichens of limestone outcrops in the southern part of the Russian Far East (Primorye Territory and Sakhalin Region) are presented. Among them, *Catillaria detractula*, *Gyalecta jenensis*, *Myriolecis semipallida*, *Physconia jacutica*, *Sarcogyne regularis*, *Thyrea confusa*, *Verrucaria caerulela*, *V. viridula* and *Xanthoria calcicola* are newly reported for the Russian Far East; *Acarospora glaucocarpa*, *A. macrospora*, *Lecanora valesiaca*, *Protoblastenia calva* and *Thelidium decipiens* are newly reported for the southern part of the Russian Far East. *Xanthocarpia crenulatella* is a new species for Sakhalin Region. Diagnostic traits of the species, peculiarities of the material from the Russian Far East, distribution, ecology and comparison with the closest species are given.

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Keywords

Sikhote-Alin’ Range, lichenized fungus, calciphile species, floristic findings, biodiversity, flora, Sakhalin Region, Primorye Territory, temperate East Asia

Introduction

The limestone outcrops have a scattered distribution in the Russian Far East; they are mostly located in its southern part, in Sikhote-Alin’ Range within the Primorye Territory. The calcareous massifs of the southern part of the Russian Far East are the oldest formations which are dated to the upper Permian and Trias (Dudkin 2004; Gular’yantz 2010). They were formed during marine regressions when the ocean level decreased to 200-300 m. Therefore, all calcareous massifs are composed of marbled limestone. The Cretaceous fauna (Foraminifera, Bryozoans, Crinoids) is well represented in them (Dudkin 2004). The limestone massifs of the southern part of the Russian Far East are divided into three groups depending on the time and place of their formation: Chandalazskaya (the formation time is about 140 million years ago), Barabashskaya (is about 110-115 million years ago) and Lyaodunskaya (110 million years ago). The limestone outcrops are mainly represented by oblong ridges up to 7.5 km long which are often confluent in chains. Thus, for example, a chain of limestone ridges: Sakharnaya Mt. – Bolnichnaya Mt. – Chyortovy Vorota Mt. stretches up to 15 km from Dal’negorsk toward the southwest (Gular’yanz 2010). The tops of calcareous massifs are conus-shaped or ridge-shaped or platform or combined. The highest point is 760 m a. s. l. (Chyortov Utes Mt. as part of the Lozovy Ridge (Chandalaz). The slopes are steep, often with cliffs and divided by deep valleys. At the base there are grottos, niches and caves which are usually hidden by the forest. Three vegetation belts are distinguished: valley, broad-leaved and coniferous-broad-leaved forests. The rocky relief causes a peculiar structure of vegetation including rare, endemics and relict species (Gorovoy and Dudkin 1998; Dudkin 1998, 2004; Dudkin et al. 2001).

The special studies of the lichens of calcareous habitats in the southern part of the Russian Far East have not yet been conducted. The lichens of calcareous substrates were first mentioned in Knyazheva (1973) where 9 species from the southern part of Primorye Territory were listed. Several calciphile species are also cited in Tchabanenko (2002). In Dudkin et al. (2015) 9 species are reported, most of them have been mentioned before by Knyazheva (1973), and the role of calciphile lichens in the destruction of calcareous rocks is discussed. The sparse floristic records of calcicolous species are reported in Yakovchenko et al. (2020), Kuznetsova et al. (2022), Makryi and Skirina (2022), Kotkova et al. (2022, 2023), Yakovchenko et al. (2023) including a new species for science *Porpidinia brevispora* Yakovchenko & Davydov (Yakovchenko et al. 2020) described from the Dal’negorsky and Kavalerovsky Districts of Primorye Territory. The studies of lichens of limestone outcrops are mostly conducted in Primorye Territory including Lozovy Ridge (Chandalaz), Livadiysky Ridge, Yekaterinovsky Ridge, Sestra Mt., Zmeinaya Mt. as well as limestone outcrops at the vicinity of Dal’negorsk and Kavalerovo (Knyazheva 1973; Tchabanenko 2002; Dudkin et al. 2015; Yakovchenko et al. 2020; Kotkova et al. 2022, 2023; Yakovchenko et al. 2023). Only a few calciphile species were reported from Amur Region (Kuznetsova et al. 2022), the Jewish Autonomous Region (Makryi and Skirina 2022) and Sakhalin Region (Tchabanenko 2002; Kotkova et al. 2023).

During the field work on limestone outcrops in the lowlands of the central and southern Sikhote-Alin’ Range in Primorye Territory as well as Sakhalin Region the authors revealed the first localities of nine species new for the Russian Far East and the fist records of five species for the southern part of the Russian Far East as well as *Xanthocarpia crenulatella* (Nyl.) Frödén, Arup & Søchting s. lat. as a new record for Sakhalin Region. The purpose of this paper is to report, illustrate and discuss new records of calciphile lichens.

Materials and methods

The herbarium material was collected from limestone outcrops at the vicinities of Dal’negorsk, Kavalerovo, Nakhodka (Sestra Mt.) and Yekaterinovka (Yekaterinovsky Ridge) in Primorye Territory in 2011, 2017, 2022 as well as vicinity of Zaozernoe and Vaida Mt. in Sakhalin Region in 2019. The specimens examined are deposited in the herbarium of the Altai State University (ALTB), Herbarium of Institute Botanic Garden of the Ural Branch of the Russian Academy of Sciences (IBG) and Herbarium of Federal Scientific Center of East Asian Terrestrial Biodiversity of the Far Eastern Branch of the Russian Academy of Sciences (VLA). Cross-sections of apothecia and thalli were made by hand with a razor blade and observed after mounting in water using a stereomicroscope (Zeiss Stemi 2000-C) and a compound microscope (Zeiss Axio Lab. A1). Photo were made by camera Axio Cam ERc5s. Polarized light (POL) was used for locating crystals in the sections of *Myriolecis semipallida* (H. Magn.) Śliwa et al. and *Lecanora valesiaca* (Müll. Arg.) Stizenb. Measurements are presented as minimum – maximum observed with the extreme values in parentheses. Lichen substances of some species were studied by spot-tests using potassium hydroxide solution (K), sodium hypochlorite solution (C), 1,4-Phenylendiamine (P), and iodine (I), and by thin-layer chromatography (TLC) in solvent systems A, B, and C (Orange et al. 2001).

Result

***Acarospora glaucocarpa* (Wahlenb. ex Ach.) Körb.**

Figures 1–5

Material examined. Russia, Primorye Territory, Dal’negorsky District, Sikhote-Alin′ Range, at 3.5 km NW from Dal’negorsk, upstream the Barachnyi Stream, polydominant broadleaf deciduous forest, calcareous rocks massif, 44°35′21″N, 135°33′15″E, elev. 570 m, 03.ix.2017, on calcareous rocks, leg. E.A. Davydov 19362 and L.S. Yakovchenko (ALTB); Sakhalin Region, Smirnykhovsky District, at 47 km E of Smirnykh Settlement, Vaida Mt., NW slope at the headwaters of Vitnitsa River, left bank, limestone rock outcrops, 49°52′48″N, 143°28′00″E, elev. 680 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 18088 (ALTB); a sinkhole on N slope, 49°52′49″N, 143°28′00″E, elev. 700 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 18113, 18127 (ALTB); limestone outcrops, 49°52′49″N, 143°28′02″E, elev. 700 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 18092, 18076 (ALTB).

Distribution and ecology. *Acarospora glaucocarpa* is reported here for the first time to the southern part of the Russian Far East from Primorye Territory and Sakhalin Region. The nearest locality is in Chukotka Autonomous Okrug (Andreev et al. 1996). The species is distributed in Europe, Asia, Africa, North and South America (Fletcher et al. 2009). This is a characteristic and common calciphile in suboceanic to continental climate from low to high elevation. It occurs on calcareous rocks, rarely on granite in both exposed to somewhat shaded habitats, sometimes in places seasonally flushed by water (Knudsen 2008; McCune 2017; Nimis et al. 2018).

Notes. The species is well distinguished morphologically by having squamulose, often pruinose thallus with pale lower surface and anatomically by having jagged algal layer penetrated by thick hyphal bundles. However, McCune (2017) noted a broad morphological variation, particularly in the degree of thallus development and pruinosity of the disc. The material from the Russian Far East fits well in the available descriptions of the species (Golubkova 1988; Knudsen 2008; McCune 2017; Knudsen et al. 2021). The size of ascospores and width of paraphyses in Far Eastern material are 3.5–5.0 × (1.5–)2.0–2.5(–2.7) µm, and paraphyses are 2.0–3.5 µm wide at the base and jagged algal layer. The majority of our material possess well developed squamulose thallus composed of roundish squamules often forming a stipe wherevers part of material has reduced thallus to a thalline margin. In this case the large lecanorine apothecia pruinose partly or completely with the thick elevated thalline margin were observed. The checking spore number per ascus is easily

distinguished such morpho forms from *Lecanora* spp. *Acarospora cervina* A. Massal. can also develop a thallus reduced to margin-like rim around the apothecia similarly with *A. glaucocarpa*. The easiest way to separate them is that anatomically the margin of *A. cervina*is represented by a thalline margin and filled with algae while thalline margin in *A. glaucocarpa* has eventually been excluded due to expanded proper margin (Knudsen et al. 2021). The jagged algal layer is distinguished *Acarospora glaucocarpa* from *A. badiofusca* (Nyl.) Th. Fr. which in addition has narrower ascospores (Knudsen 2008).

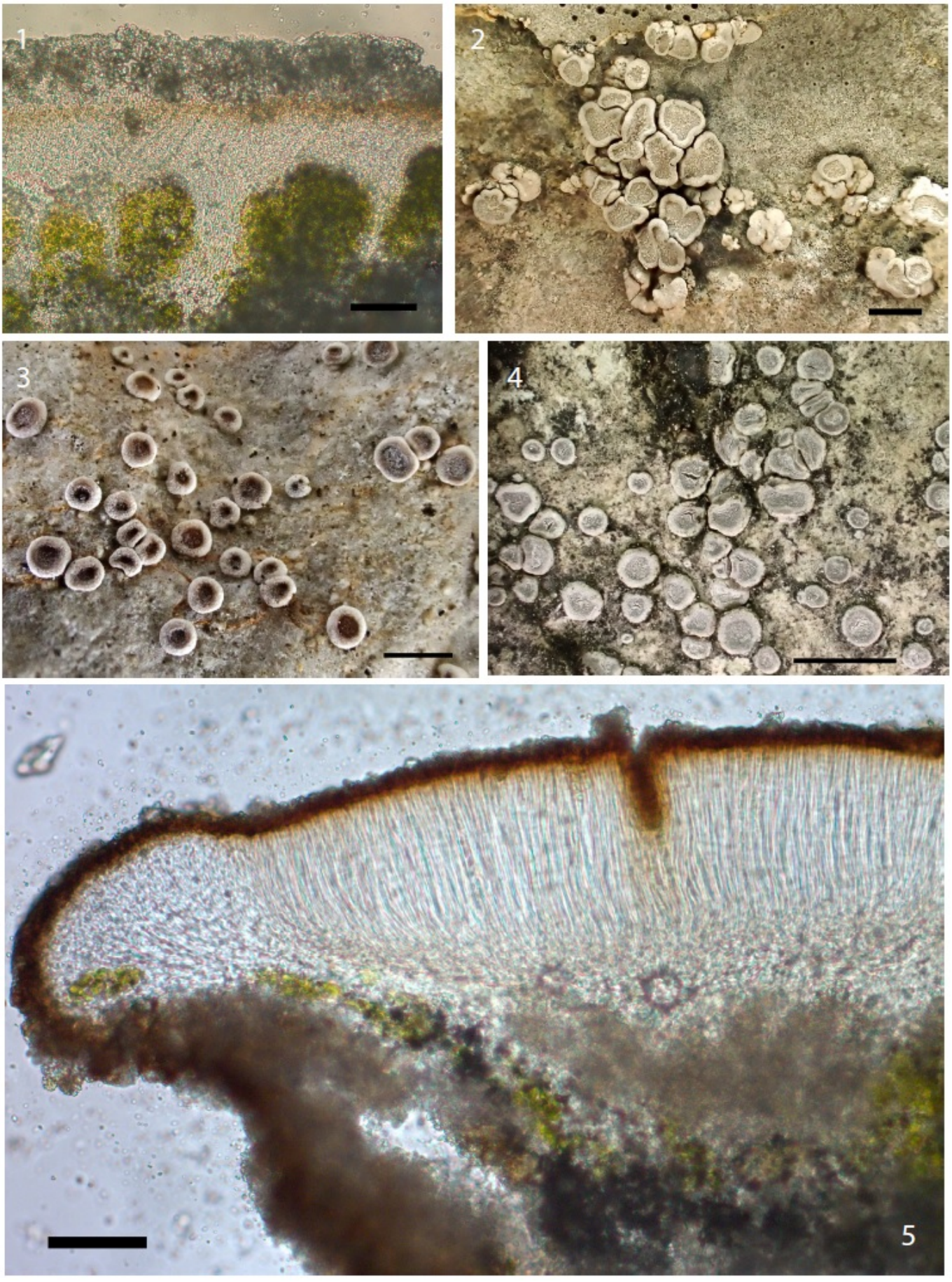
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Figure 1. *Figures 1–5. Acarospora glaucocarpa: 1. Thallus section with jagged algal layer, scale bar = 50 µm, photo by L.S. Yakovchenko; 2. Squamulose thallus, scale bar = 2 mm, field photo by E.A. Davydov; 3. Thallus reduced to thalline margin, partly pruinose apothecia, scale bar = 1 mm, field photo by E.A. Davydov; 4. Thallus reduced to thalline margin, completely pruinose apothecia, scale bar = 2 mm, field photo by E.A. Davydov; 5. Apothecium section with excluded thalline margin due to expanded proper margin, scale bar = 50 µm, photo by L.S. Yakovchenko.*

***Acarospora macrospora* (Hepp) A. Massal. ex Bagl.**

Figures 6–8

Material examined. Russia, Primorye Territory, Dal'negorsky District, Sikhote-Alin′ Range, at 3.5 km NW from Dal'negorsk, upstream the Barachnyi Stream, polydominant broadleaf deciduous forest, calcareous rocks massif, 44°35′21″N, 135°33′15″E, elev. 570 m, 03.ix.2017, on calcareous rocks, leg. E.A. Davydov 19361,19371 and L.S. Yakovchenko (ALTB); Sakhalin Region, Smirnykhovsky District, at 47 km E of Smirnykh Settlement, Vaida Mt., NW slope at the headwaters of Vitnitsa River, left bank, limestone rock outcrops, 49°52′49″N, 143°28′02″E, elev. 700 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 18105 (ALTB).

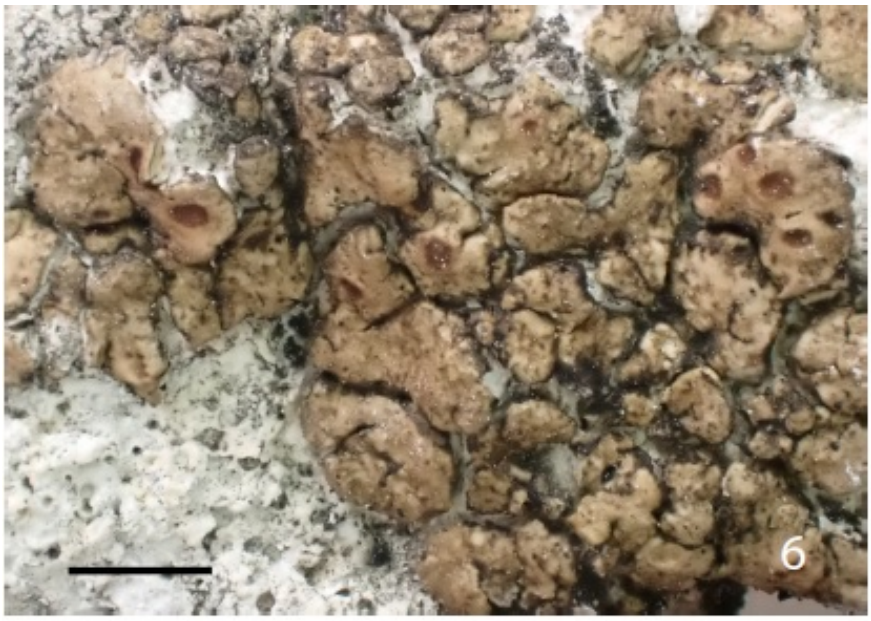
Distribution and ecology. *Acarospora macrospora* is reported here for the first time to the southern part of the Russian Far East from Primorye Territory and Sakhalin Region. The nearest localities are in Wrangel Island and Chukotka (Andreev et al. 1996). This species is distributed in Europe, Asia and North America (Golubkova 1988; Knudsen 2008; Chesnokov et al. 2017; McCune 2017). It grows predominately on calcareous rocks and pebbles, rarely on sandstones, decaying granite rocks in washes from the cost to inland and from the low elevations up to mountains and Arctic (Golubkova 1988; Knudsen 2008; McCune 2017; Nimis et al. 2018).

Notes. The species is characteristic by its large ascospores which are up to 80 per ascus and white lower surface. The material from the Russian Far East completely agrees with descriptions (Golubkova 1988; Knudsen 2008; McCune 2017; Knudsen et al. 2021) possessing a peltate brown thallus with even algae layer. Moreover, the sequences obtained from the Far Eastern material were identical to those from NCBI GenBank (www.ncbi.nlm.nih.gov). The main diagnostical features from our material are following: hymenium up to 120.0 µm tall, paraphyses 2.7–3.0 µm wide at the base, apices expanded up to 6.0 µm wide. Ascospores broadly ellipsoid, 8.0–12.0 × 4.0–5.0 µm, about 50 per ascus. All spot tests are negative. Close species, *Acarospora oligospora* (Nyl.) Arnold has smaller ascospores and occurs on silicate rocks (Knudsen 2008).

***Catillaria detractula* (Nyl.) H. Olivier**

Figures 9–10

Material examined. Russia, Primorye Territory, Dal'negorsk District, Sikhote-Alin′ Range, at 3.5 km NW from Dal'negorsk, upstream the Barachnyi Stream, W slope of calcareous rocks within trees, 44°35′20″N, 135°33′14″E, elev. 450 m, 23.viii.2022, on calcareous rocks, leg. E.A. Davydov 20744 and P.Yu. Ryzhkova (ALTB); 44°35′21″N, 135°33′15″E, elev. 570 m, 03.ix.2017, on calcareous rocks, leg. E.A. Davydov 20702 and L.S. Yakovchenko (ALTB); NW slope of Sakharnaya Mt., polydominant broadleaf deciduous forest, calcareous rocks massif, 44°31′22″N, 135°30′28″E, elev. 550 m, 24.viii.2022, on calcareous rocks, leg. E.A. Davydov 20768, 20769, 20770, 20771 and P.Yu. Ryzhkova (ALTB); Sakhalin Region, Smirnykhovsky District, at 47 km E of Smirnykh Settlement, Vaida Mt., NW slope at the headwaters of Vitnitsa River, left bank, limestone rock outcrops, 49°52′49″N, 143°28′02″E, elev. 700 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 18117 (ALTB).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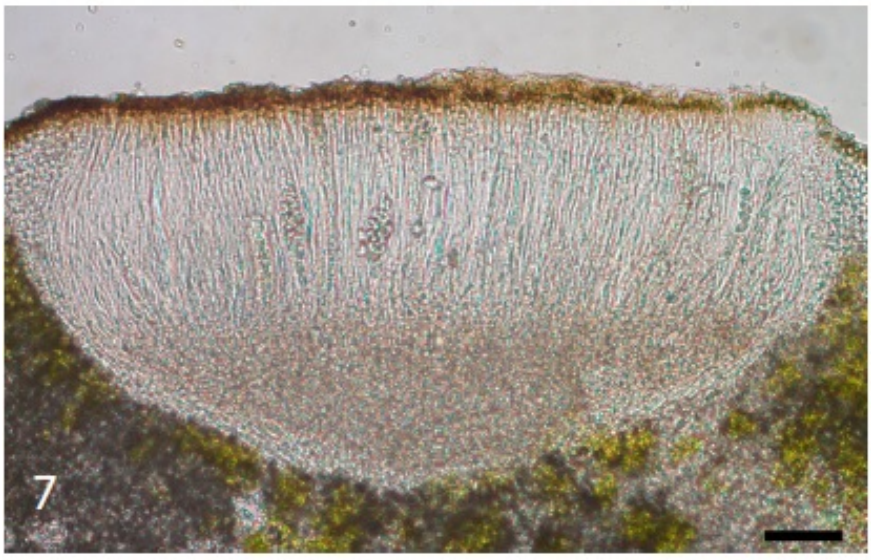
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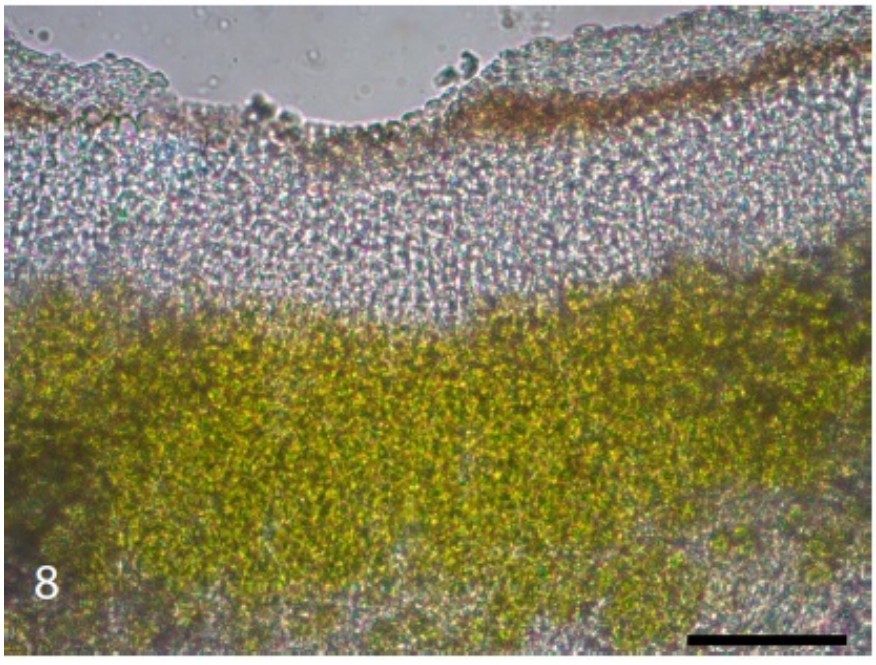
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Figure 2. ***Figures 6–8.*** *Acarospora macrospora:* ***6.*** *Habitus, scale bar = 2 mm, field photo by E.A. Davydov;* ***7.*** *Apothecium section with polyspored asci, scale bar = 50 µm, photo by L.S. Yakovchenko;* ***8.*** *Thallus section with even algal layer, scale bar = 50 µm, photo by L.S. Yakovchenko.*

Distribution and ecology. *Catillaria detractula* is reported here for the first time to the Russian Far East from Primorye Territory and Sakhalin Region as well as the third time to Russia. The nearest locality is in Baikal Siberia (Makryi 1999). It is also reported in North Ossetia (Urbanavichene and Urbanavichus 2019). Worldwide, the species is distributed from Mediterranean Regions of Central and Southern Europe where it grows on calcareous rocks mainly in dry and open habitats (Kotlov 2003; Wirth et al. 2013a; Nimis et al. 2018).

Notes. Morphologically specimens from the Russian Far East fit completely to the descriptions in Kotlov (2003) and Wirth et al. (2013a) possessing a poorly developed to partly endolithic thallus with plane to slightly convex black brown apothecia but brown when wet contrasting with a black proper margin. Anatomically, the material from the Russian Far East agrees closely but not completely differing in general by the smaller height of hymenium (37.5–42.5 µm tall), smaller ascospores 8.0–10.5 × (3.0–)4.0–4.5 µm and the presence of green algae at the base of apothecia while the other traits indicated the specimen as a representative of *Catillaria*: asci of *Catillaria*-type, hyaline and 1-septated ascospores and presence of swollen (up to 6.0 µm wide), dark colored apices of paraphyses. In addition, the blast search in NCBI shows the sequences refers to *Catillaria* lichen genus with the closest species *Catillaria lenticularis* (Ach.) Th. Fr. (there is no sequences of *Catillaria detractula* in the Genbank). The presence of algae at the base of apothecia is not mentioned in the available literature but the fact that the species was described as *Lecanora* (Nylander 1875) and later was accepted under *Lecania* (Arnold 1884). In addition, in the ma- terial from the Russian Far East the disc of apothecia was pruinose or not even in the same specimen. We have not found any mentions about pruinosity of the disc in the literature (*ibid*.). The closest species, *Catillaria lenticularis* has a smaller hymenium (35.0–50.0(–70.0) µm tall vs. 50.0–75.0 µm tall), narrower and smaller ascospores (7.0–10.0(–12.0) × (2.0–)2.5–3.5(–4.0) µm vs. 9.5–13.5 × 4.0–5.5 µm) and differ morphologically possessing a proper margin paler than the disc (Cannon et al. 2022c).

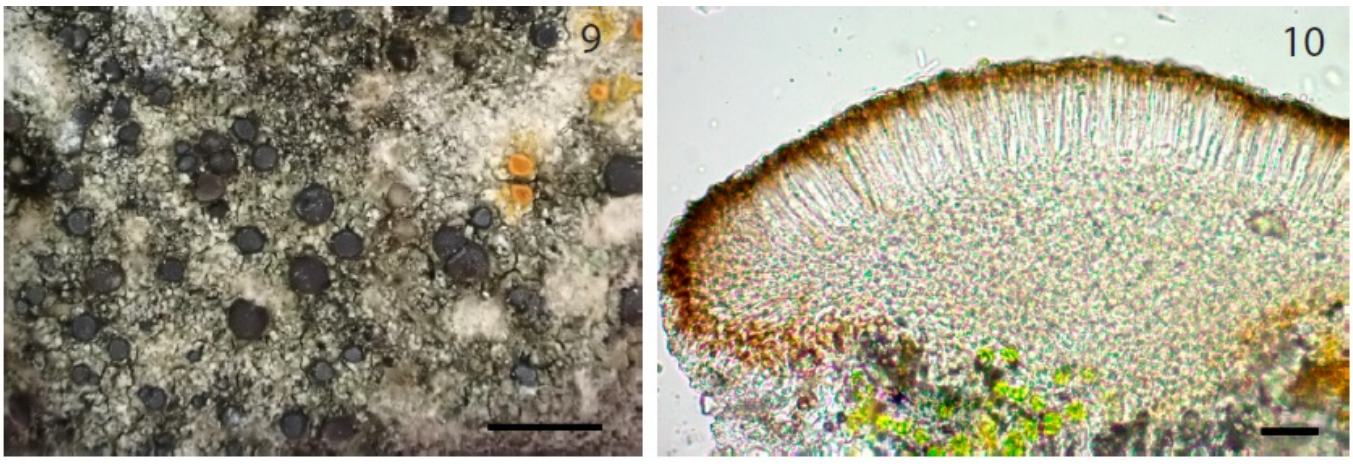

Figure 3. ***Figures 9–10.*** *Catillaria detractula:* ***9.*** *Pale grey crustose thallus and brown black lecideine apothecia with darker proper margin, scale bar = 1 mm, photo by E.A. Davydov;* ***10.*** *Apothecium section with green algae at the base, scale bar = 20 µm, photo by L.S. Yakovchenko.*

***Gyalecta jenensis* (Batsch) Zahlbr.**

Figures 11–12

Material examined. Russia, Primorye Territory, Dal’negorsk District, Sikhote-Alin’ Range, at 3.5 km NW from Dal’negorsk, upstream the Barachnyi Stream, polydominant broadleaf deciduous forest, calcareous rocks massif, W slope, 44°35′20″N, 135°33′14″E, elev. 450 m, 23.viii.2022, on E

exposed calcareous rocks within trees, leg. E.A. Davydov 20750, 20752, 20781 and P.Yu. Ryzhkova (ALTB).

Distribution and ecology. *Gyalecta jenensis* is reported here for the first time to the Russian Far East from Primorye Territory. The nearest localities are in Japan (Kawakami et al. 2011) as well as in Altai Territory (Davydov 2001) and Kemerovo Region (Sedel'nikova 1990). Worldwide, the species was reported from Europe, Asia, North America, Greenland and Tasmania (Gagarina 2017). It occurs both on calcareous and silicate rocks, sometimes inhabits mosses, soil and wood. The species prefers moist habitats, most often along river valleys. It is often associate with *Trentepohlia* and *Nostoc* (Gagarina 2015).

Notes. *Gyalecta jenensis* is characterized by its thin, white-gray or pale gray-green, continues or fine-granulose thallus, apothecia up to 2.0 mm in diam. with thick pale grey margin and often shiny disc, paraphyses longer than mature asci and ellipsoid, muriform or submuriform ascospores (12.5–)14.0–18.0(–25) × (6.0–) 8.5–11.0(–12.5) µm (Gagarina 2015, 2017). The species from the Russian Far East agrees well with the available descriptions (*ibid*.) although having somewhat narrower ascospores (12.5–)15.0–17.5 × 6.5–8.0 µm. The other important diagnostic traits are: apothecia up to 0.5 mm wide, hymenium up to 125.0 µm high, excipulum ca. 100.0 µm wide, ascospores ellipsoid with obtuse ends, submuriform to muriform with (5)6-8 cells. From the close species, *G. schisticola* Werner, *G. jenensis* differs by its wider excipulum (100.0–180.0 µm vs. 50.0–60.0 µm). In contrast to another related species *G. cernohorskyi* Vězda, *G. jenensis* has lower hymenium (100.0–150.0 µm vs. up to 200.0 µm). *Gyalecta jenensis* is distinguished from *G. kukriensis* (Räsänen) Räsänen by its indistinctly septate, non-granulate paraphyses and ellipsoid ascospores with obtuse ends or rarely indistinctly pointed wherever paraphyses in *G. kukriensis* are distinctly septate, granular and the ascospores are elongated-fusiform, pointed at the ends or prolated at one end. In addition, *G. jenensis* has apothecia larger than those of *G. kukriensis* (up to 2.0 mm vs. up to 0.5 mm) (Gagarina 2015).

Lecanora valesiaca (Müll. Arg.) Stizenb.

Figures 13–14

Material examined. Russia, Primorye Territory, at the vicinity of Nakhodka City, the left bank of the Partizanskaya River near its mouth, the conical limestone summit of the Sestra Mt. (318 m), 42°49′40″N, 132°59′39″E, elev. 310 m, 16.viii.2022, on calcareous rocks, leg. E.A. Davydov 20817 and P.Yu. Ryzhkova (ALTB); Partizansky District, at 1.5 km NE from Yekaterinovka Village, the right bank of the Partizanskaya River, 13.5 km upstream from its mouth, Yekaterinovsky Ridge, oak forest (*Quercus mongolica*) with calcareous rocks, 42°56′09″N, 133°03′54″E, elev. 80 m, 17.viii.2022, on calcareous rocks, leg. E.A. Davydov 20742 and P.Yu. Ryzhkova (ALTB); Dal'negorsk District, Sikhote-Alin′ Range, at 3.5 km NW from Dal'negorsk, upstream the Barachnyi Stream, polydominant broadleaf deciduous forest, calcareous rocks massif, W slope, 44°35′20″N, 135°33′14″E, elev. 450 m, 23.viii.2022, on E exposed calcareous rocks within trees, leg. E.A. Davydov 20818 and P.Yu. Ryzhkova (ALTB).

Distribution and ecology. *Lecanora valesiaca* is reported here for the first time to the southern part of the Russian Far East from Primorye Territory. The nearest locality is in the northern part of the Russian Far East (Urbanavichus 2010). The species is recorded to Europe, Asia and North America (Aptroot and Moon 2015; Karagöz et al. 2011; McCune 2017). It occurs on calcareous rocks and base-rich rocks (gneiss, porphyr, schists, etc.) containing some calcium, in warm and dry situations (McCune 2017; Nimis et al. 2018).

Notes. The species is characteristic by its foliose, placodioid, white, completely pruinose thallus with adnate apothecia in the center of the thallus and yellowish brown to light brown disc with thick, eventually crenulate thalline margin. The material from the Russian Far East agrees well with the descriptions (Ryan et al. 2004; McCune 2017) having the thallus 1.5–2.7(3.2) cm in diam.,

lobes 0.5–0.7(1.0) mm wide and up to 3.5 mm long, apothecia 0.75–1.5(2.0) mm in diam., ascospores 8.5–11.5 × 5.0–6.0 µm. Epithecium brown with pol + crystals soluble in KOH. It can be confused with *Myriolecis pruinosa* (Chaub.) Śliwa, Zhao Xin & Lumbsch but the last one has thallus C+ orange due to presence of xanthones (Cannon et al. 2022b). From the morphologically close species, *Protoparmeliopsis muralis* (Schreb.) M. Choisy, it differs by its closely adnate, densely pruinose thallus and incurved apothecial margins. Morphologically close species, *Lecanora freyi* Poelt differs by its apothecia with thin, entire thalline margin and blackish green disc while *L. valesica* possesses thick, crenulate thalline margin and yellowish-brown disc (Ryan et al. 2004).

The species was illustrated by I. F. Skirina in Dudkin et al. (2015) from Yekaterinovsky Ridge but with wrong identification as *Lobothallia alphoplaca* (Wahlenb.) Hafellner. Both species possesses placodioid thallus but belong to different lichen families and even orders thus the differences in ascus type and shape of paraphyses.

***Myriolecis semipallida* (H. Magn.) Śliwa, Zhao Xin & Lumbsch**

= *Lecanora semipallida* H. Magn., = *L. xanthostoma* Cl. Roux ex Froberg

Figures 15–16

Material examined. Russia, Sakhalin Region, Smirnykhovsky District, at 47 km E of Smirnykh Settlement, Vaida Mt., NW slope at the headwaters of Vitnitsa River, left bank, limestone rock outcrops, 49°52′49″N, 143°28′02″E, elev. 700 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 18068, 20731 (ALTB); mountain tundra with *Pinus pumila*, 49°52′50″N, 143°28′04″E, elev. 680 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 20803 (ALTB); rock at the local summit, 49°52′47″N, 143°28′07″E, elev. 800 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 20813 (ALTB).

Distribution and ecology. *Myriolecis semipallida* is reported here for the first time to the Russian Far East from Sakhalin Region. The nearest locality is in Altai Territory (Davydov 2001, as *Lecanora xanthostoma*). The species is probably cos- mopolitan and recorded in Europe, North America, Asia, Australia and Antarctica (Edwards et al. 2009). It occurs on calcareous rocks, especially hard limestone or growing on other lichens on rocks. It is often found on the top of sun exposed boulders, in sites often visited by birds (McCune 2017; Nimis et al. 2018; Cannon et al. 2022b).

Notes. The material from the Russian Far East fits completely in available descriptions (Ryan et al. 2004; Wirth et al. 2013a; McCune 2017; Cannon et al. 2022b) possessing a grey indistinct thallus due to dominated apothecia with thick, whitish, farinose, elevated and even thalline margin which is C+ yellow, K+ yellow, UV+ bright orange and yellowish to blackish disc even in the same specimen. Epithecium with POL+ granules dissolving in KOH. The main diagnostical traits from our material: apothecia up to 1.2 mm wide, thalline margin up to 0.15 mm wide, hymenium up to 55.0 µm tall, ascospores 9.5–11.0 × (4.5–)5.0–6.5 µm. TLC indicated the presence of vinetorin. The species is a member of the *Lecanora dispersa*-group. The closest species, *Myriolecis dispersa* (Pers.) Śliwa et al. differs by the absence of a UV reaction, thalline margin K–, C– and epithecial granules are not soluble in KOH. *Lecanora flowersiana* H. Magn. in contrast to *Myriolecis semipallida* possess apothecial margin with deep radial cracks and non-granulate epithecium POL–.

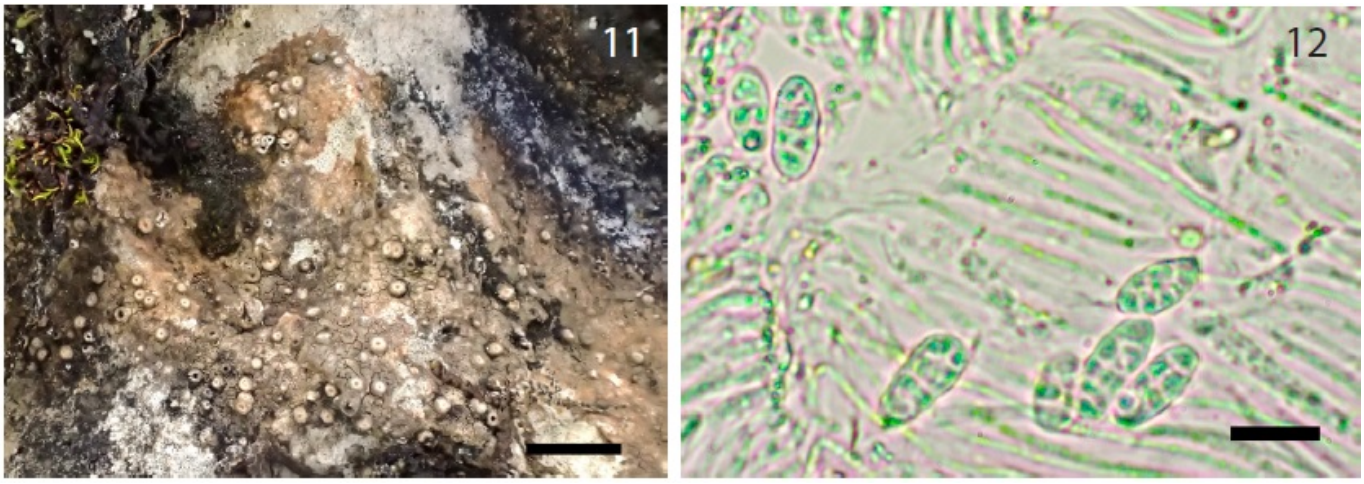

Figure 4. ***Figures 11–12.*** *Gyalecta jenensis:* ***11.*** *Habitus, scale bar = 2 mm, field photo by E.A. Davydov;* ***12.*** *Muriform ascospores with obtuse ends, scale bar = 10 µm, photo by L.S. Yakovchenko.*

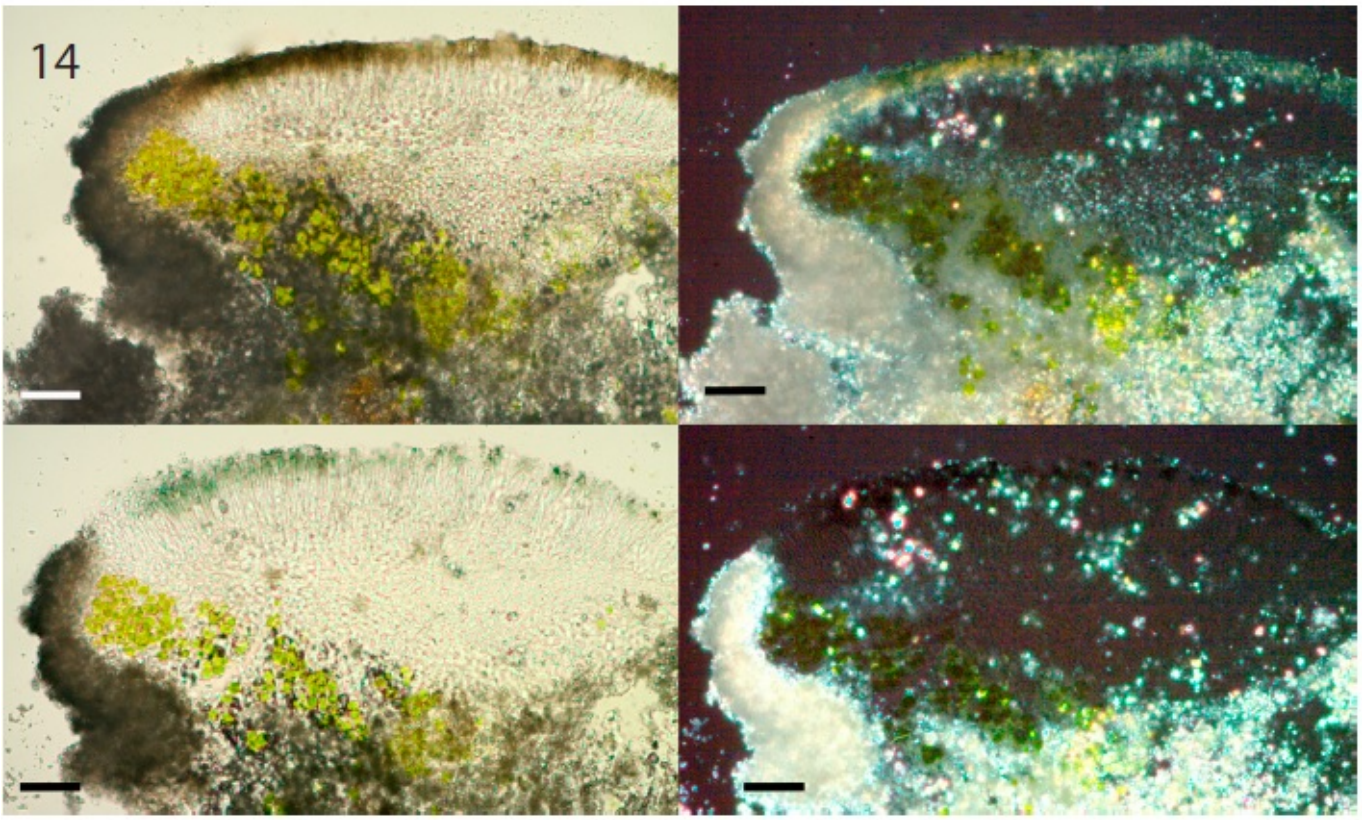

Figure 5. ***Figures 13–14.*** *Lecanora valesiaca:* ***13.*** *Habitus, scale bar = 5 mm, field photo by E.A. Davydov;* ***14. upper left*** *Apothecium section in water, epithecium brown,* ***upper right*** *Epithecial crystals POL+,* ***lower left*** *Apothecium section in KOH, epithecium green,* ***lower right*** *Epithecial crystals dissolved, POL-, scale bar = 50 µm, photo by L.S. Yakovchenko.*

***Physconia jacutica* Urbanav., Ahti Loht.**

Figure 17

Material examined. Russia, Sakhalin Region, Smirnykhovsky District, at 47 km E of Smirnykh Settlement, Vaida Mt., NW slope at the headwaters of Vitnitsa River, left bank, limestone rock outcrops, 49°52′49″N, 143°28′02″E, elev. 700 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 18116 (ALTB); rock at the local summit, 49°52′47″N, 143°28′07″E, elev. 800 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 20812 (ALTB).

Distribution and ecology. *Physconia jacutica* is reported here for the first time to the Russian Far East from Sakhalin Region. It is the first record in non-continental part of Russia. The nearest locality is in Sakha Republic (Yakutia) from where the species was described (Lohtander et al. 2007). It is also recorded in Irkutsk Region and Republic of Buryatia (Lohtander et al. 2007; Urbanavichus and Urbanavichene 2008; Urbanavichene and Urbanavichus 2009; Kharpukhaeva 2013). The species is not yet known outside of Russia. *Physconia jacutica* occurs on soil covering of calcareous rocks in exposed to shaded conditions. This record expands our understanding about this species ecology. Previously the species was known from highly continental arias with southern to middle boreal climate (Lohtander et al. 2007) while it was found in Sakhalin Island with moderate monsoon climate.

Notes. The comparison of our material with the holotype (LE) as well as protologue (Lohtander et al. 2007) shows that the material from the Russian Far East fits completely. The species is characteristic by its foliose, isidiate thallus bluish due to completely pruinose upper surface and lower surface darkening toward the center. The Far Eastern material possess completely pruinose thallus up to 3.0 cm in diam. with the lobes up to 0.8 cm long and 1.0 mm wide and the spherical to cylindrical isidia turned to lobules mostly in the center of the thallus. It has a scleroplecten-chymatous upper cortex and prosoplectenchymatous lower cortex and all spot tests are negative. *Physconia jacutica* can be confused with North American species, *P. elegantula* Essl. which also possessing cylindrical or coralloid isidia but has a white lower surface.

***Protoblastenia calva* (Dicks.) Zahlbr.**

Figures 18–19

Material examined. Russia, Primorye Territory, Dal’negorsky District, at 6.5 km northeast from Dal’negorsk on the Dal’negorsk-Cheremshany road, Gorbusha River valley, Rudnaya River basin, limestone cave at the top of the mountain, 44°37′01.4″N, 135°39′26.3″E, elev. 350 m, 16.ix.2011, on calcareous rocks, leg. L.S. Yakovchenko 1263 (VLA).

Distribution and ecology. *Protoblastenia calva* is reported here for the first time to the southern part of the Russian Far East from Primorye Territory. The nearest locality is in Chukotka (Andreev et al. 1996). This is a widespread and common Holarctic species known from Europe, Asia, North America and Greenland with a wide altitudinal range but most common in the mountains, descending to lower altitudes in humid areas and occurring on steeply inclined faces of hard limestones and dolomite (Kainz and Rambold 2004; Nimis et al. 2018).

Notes. It is characterized by endolithic to epilithic, thin, whitish-gray thallus and orange to reddish-brown, large 0.6-1.5(–2.0) mm in diam., convex apothecia (K + purple-reddish), not immersed into substrate. The hypothecium of *Protoblastenia calva* varies from colorless to brownish. The specimens from the Russian Far East completely fit into the available descriptions (Kainz and Rambold 2004; Andreev and Titov 2008; McCune 2017; Cannon et al. 2022a) possessing an endolithic thallus, convex, orange apothecia up to 1.0 mm in diam., not associated with pits of substrate as well as a colorless hypothecium, yellow-brown epithecium turning red after KOH and ellipsoid to broadly ellipsoid ascospores (10.0–)12.0–15.0(–16.5) x 5.5–6.0(–8.0) µm. The close

species, *Protoblastenia incrustans* (DC.) J. Steiner also has an endolithic or poorly developed epilithic thallus but differs in the smaller size of the apothecia (0.3–0.5 mm in diam.), which develop in the pits of the sub- strate. *Protoblastenia rupestris* (Scop.) J. Steiner differs by its distinct crustose thallus (Kainz and Rambold 2004; Andreev and Titov 2008; Cannon et al. 2022a).


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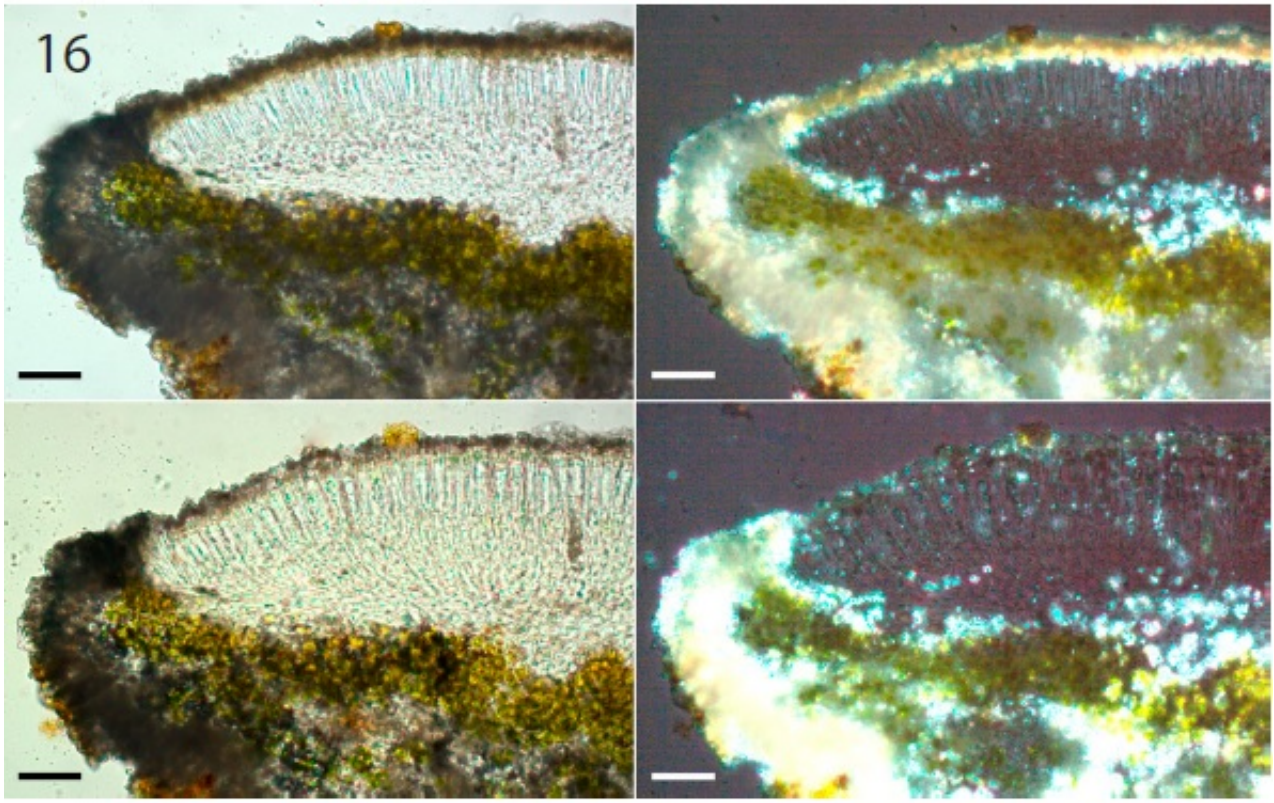

16

Figure 6. ***Figures 15–16.*** *Myriolecis semipallida:* ***15.*** *Habitus, scale bar = 2 mm, field photo by E.A. Davydov;* ***16. upper left*** *Apothecium section in water, epithecium brown,* ***upper right*** *Epithecial crystals POL+,* ***lower left*** *Apothecium section in KOH, epithecium brown,* ***lower right*** *Epithecial crystals dissolved, POL-, scale bar = 50 µm, photo by L.S. Yakovchenko.*

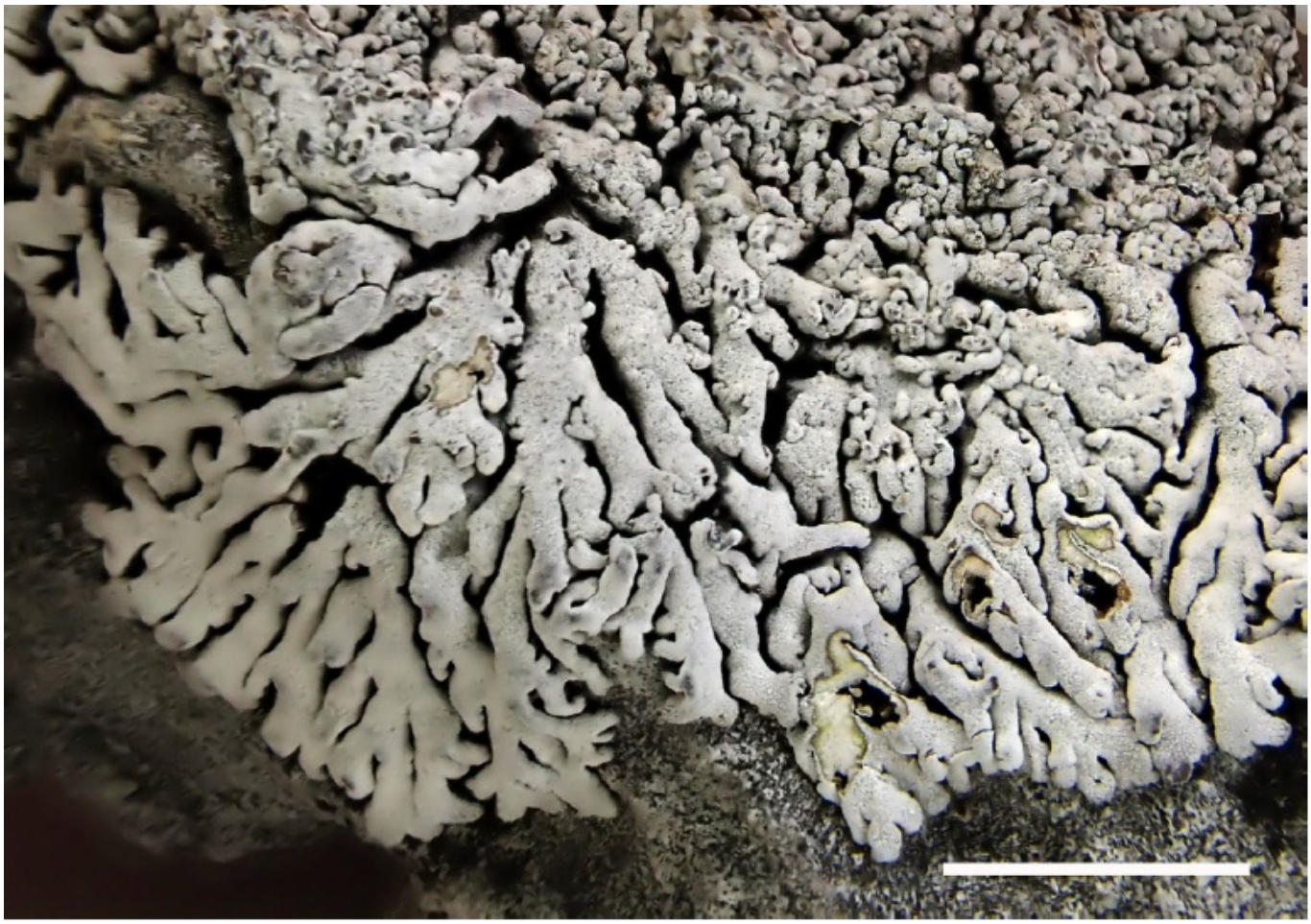


Figure 7. ***Figure 17.*** *Physconia jacutica, scale bar = 5 mm, field photo by E.A. Davydov.*

Sarcogyne regularis **Körb.**

Material examined. Russia, Sakhalin Region, Smirnykhovsky District, at 47 km E of Smirnykh Settlement, Vaida Mt., NW slope at the headwaters of Vitnitsa River, left bank, limestone rock outcrops, 49°52′49″N, 143°28′02″E, elev. 700 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 20820 (ALTB).

Distribution and ecology. *Sarcogyne regularis* is reported here for the first time to the Russian Far East from Sakhalin Region. The nearest locality is in South Siberia (Sedel’nikova 2007). The species has Holarctic – sub cosmopolitan distribution with a very wide altitudinal range (Nimis et al. 2018). It is a common calciphile epilithic species both in urban areas (e.g. on asbestos-cement and old mortar walls) and in natural situations (e.g. chalk pebbles, sea-shells), mostly in lichen-poor stands in lowland areas (Fletcher and Hawksworth 2009; Nimis et al. 2018). It is rarely recorded on sandstone or on vertical flush surfaces on acidic rocks (Knudsen and Standley 2008).

Notes. The material from the Russian Far East fits completely in the available descriptions of the species (Golubkova 1988; Knudsen and Standley 2008; Fletcher and Hawksworth 2009; McCune 2017) possessing an indistinct thallus with lecideine apothecia up to 0.8 mm wide with black

conspicuously blue-pruinose disc and becoming excluded proper margin, polyspored asci with ascospores 3.0–5.0(–6.0) × 1.5–2.0 µm. From the closest species, *Sarcogyne privigna* (Ach.) A. Massal., *S. regularis* differs by its thin, soon excluded proper margin (Golubkova 1988).

***Thelidium decipiens* (Nyl.) Kremp.**

Figures 20–21

Material examined. Russia, Primorye Territory, Kavalerovsky District, Sikhote- Alin′ Range, at S from the Kavalerovo, at right bank of the Zerkal′naya River, polydominant broadleaf deciduous forest, calcareous rock cliff, 44°14′51″N, 135°03′33″E, elev. 213 m, 01.ix.2017, on calcareous rocks, leg. E.A. Davydov 20714, 20743, 21573 and L.S. Yakovchenko (ALTB).

Distribution and ecology. *Thelidium decipiens* is reported here for the first time to the southern part of the Russian Far East from Primorye Territory. The nearest locality is in Wrangel Island (Andreev et al. 1996). It is a cool-temperate to arctic-alpine, circumpolar species known from Europe, North America, North Africa, Asia and Australia (Kudratov 2002; Zhdanov 2009; Rohrer et al. 2012; Urbanavichus and Urbanavichene 2013; McCarthy 2014; McCune 2017; Nimis et al. 2018) as well as in Arctic (Andreev et al. 1996). It occurs on calcareous rocks, including large pebbles, in rather sheltered situations (Nimis et al. 2018).

Notes. The specimens from the Russian Far East fits completely possessing an endolithic, pale beige thallus with perithecia up to 0.4 mm wide with the rarely projecting apex and immersed in calcareous rock leaving pits in the rock following their decay, lacking an involucrellum, excipulum dark brown, ascospores hyaline, 1-septated, 8 per ascus, 27.5–35.0 × 10.0–12.5 µm. From the close species, *Thelidium fontigenum* A. Massal. and *Thelidium incavatum* Mudd, it mainly differs by its 1-septated ascospores.

***Thyrea confusa* Henssen**

Figures 22–23

Material examined. Russia, Primorye Territory, Kavalerovsky District, Sikhote-Alin′ Range, at S from the Kavalerovo, at right bank of the Zerkal′naya River, near the summit of the calcareous rock cliff surrounded by polydominant broadleaf deciduous forest, 44°14′50″N, 135°03′38.5″E, elev. 290 m, 01.ix.2017, on calcareous rocks, leg. E.A. Davydov 20766 and L.S. Yakovchenko (ALTB); Dal′negorsk District, Sikhote-Alin′ Range, at 3.5 km NW from Dal′negorsk, upstream the Barachnyi Stream, polydominant broadleaf deciduous forest, calcareous rocks massif, W slope, 44°35′20″N, 135°33′14″E, elev. 450 m, 23.viii.2022, on E exposed calcareous rocks within trees, leg. E.A. Davydov 20819 and P.Yu. Ryzhkova (ALTB).

Distribution and ecology. *Thyrea confusa* is reported here for the first time to the Russian Far East from Primorye Territory. The nearest localities are in Japan (Ohmura and Kashiwadani 2018), South Korea (Schults and Moon 2011) and South Siberia (Kharpukhaeva and Lishtva 2020). This epilithic calciphile species has a Holarctic distribution (e.g., Schultz 2002; Wirth et al. 2013b; Makryi 2022; Khodosovtsev and Kuzemko 2023). The species prefers steeply inclined, sunny faces of calcareous rocks with short periods of water seepage after rain (Nimis et al. 2018).

Notes. The material from the Russian Far East agrees well with the protologue (Henssen and Jørgensen 1990) and available descriptions (Schultz 2002; Wirth et al. 2013b; McCune 2017) possessing a characteristic umbilicate foliose thallus up to 15 mm wide. *Thyrea confusa* is most likely to be confused with *Lichinella nigritella* (Lettau) P.P. Moreno & Egea. The last one has thinner, more rounded, epruinose lobes and polyspored asci, while *Thyrea confusa* has thicker, strap-shaped, usually bluish-pruinose lobes and 8-spored asci.

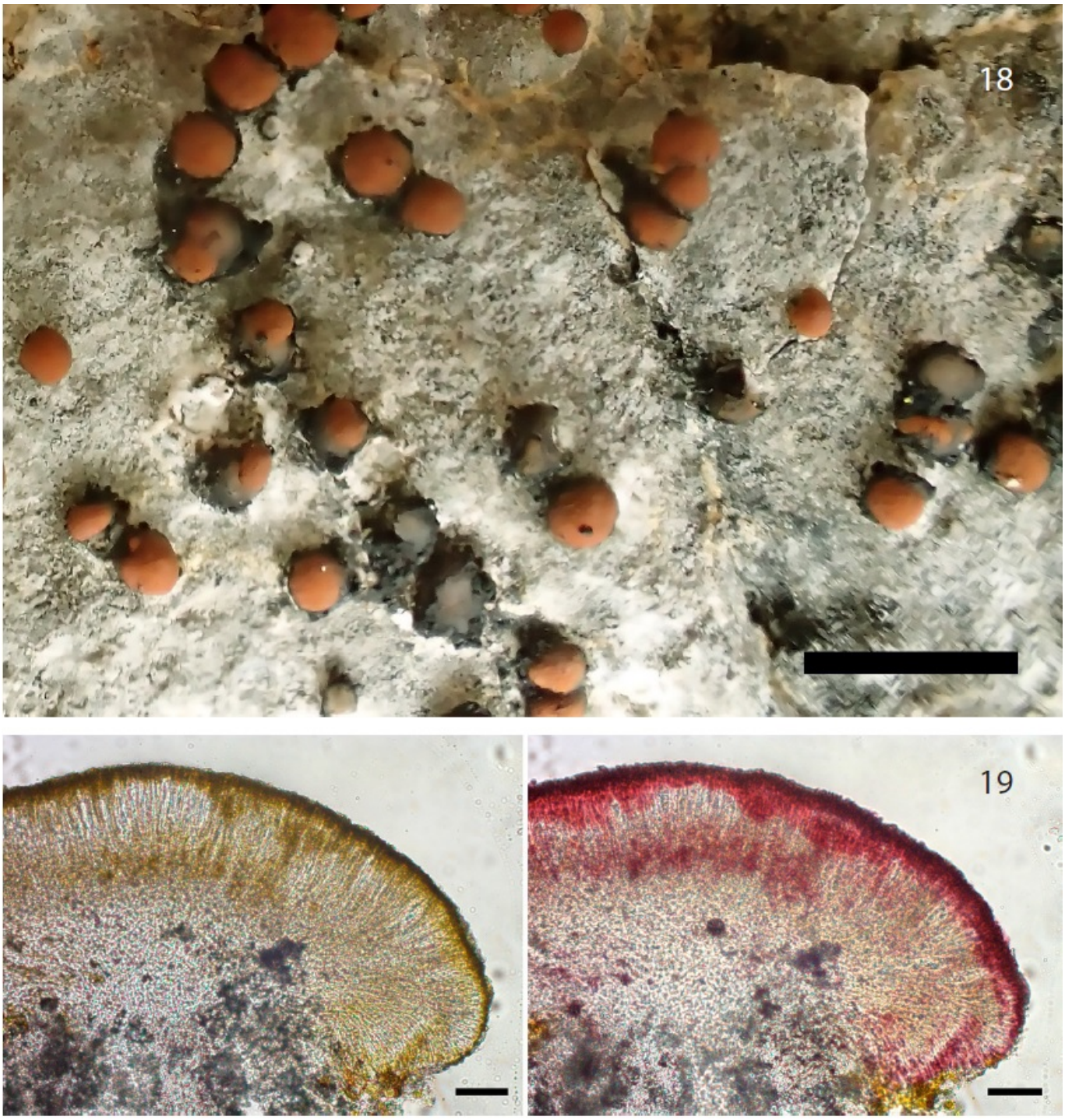


Figure 8. ***Figures 18–19.*** *Protoblastenia calva:* ***18.*** *Habitus, scale bar = 2 mm, field photo by E.A. Davydov;* ***19.*** ***left*** *Apothecium section in water, epithecium brown,* ***right*** *Apothecium section after KOH+, epithecium red, scale bar = 50 µm, photo by L.S. Yakovchenko.*

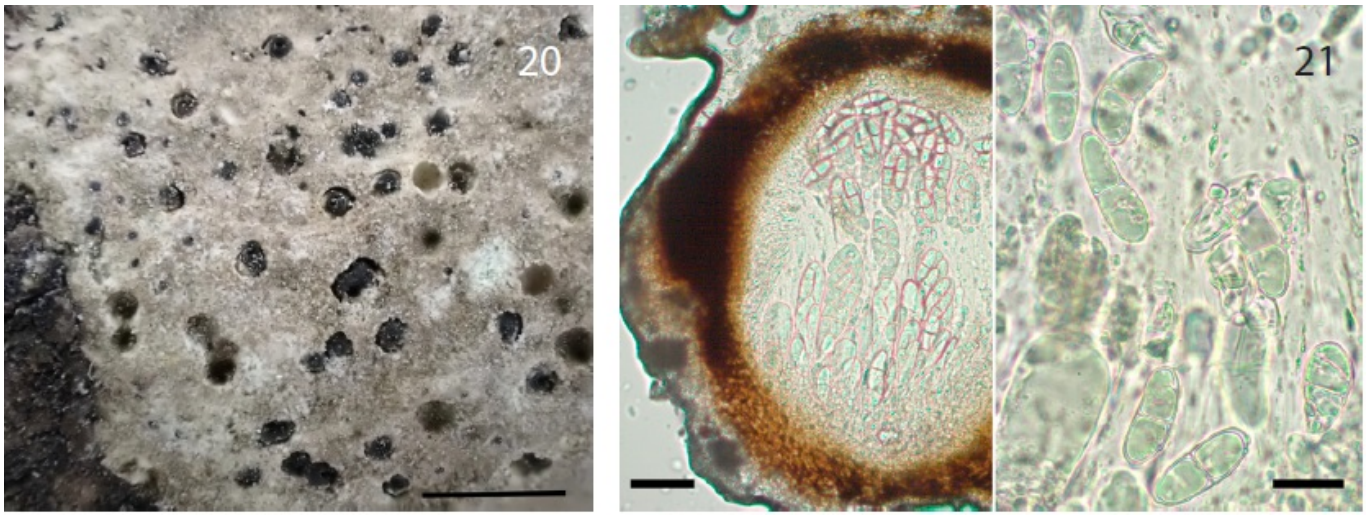


Figure 9. ***Figures 20–21.*** *Thelidium decipiens:* ***20.*** *Habitus, perithecia immersed in pits of calcareous rock, scale bar = 1 mm, field photo by E.A. Davydov;* ***21.*** *Perithecial section, 8-spored asci and hyaline, 1-septated ascospores, scale bar = 20 µm, photo by L.S. Yakovchenko.*

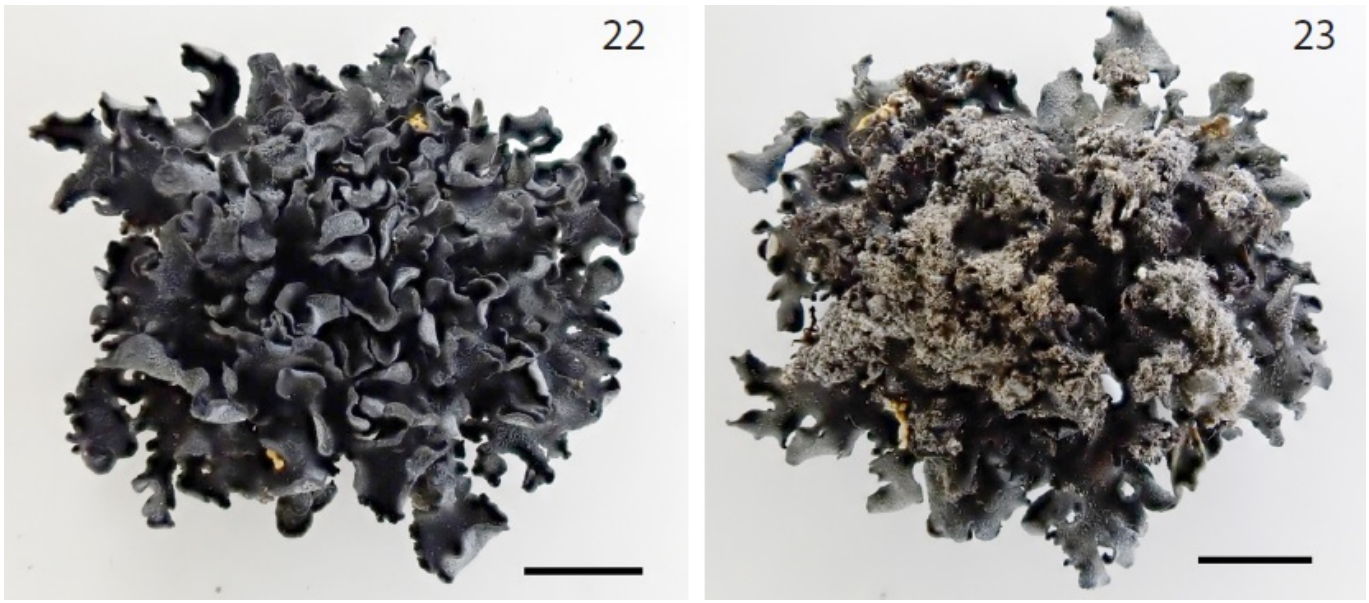


Figure 10. *Figures 22–23. Thyrea confusa: 22. Habitus, upper surface, scale bar = 3 mm, photo by E.A. Davydov; 23. Habitus, lower surface, scale bar = 3 mm, photo by E.A. Davydov.*

Verrucaria caerulea **DC.**

Figures 24–25

Material examined. Russia, Sakhalin Region, Smirnykhovsky District, at 47 km E of Smirnykh Settlement, Vaida Mt., NW slope at the headwaters of Vitnitsa River, left bank, limestone rock outcrops, 49°52′48″N, 143°28′00″E, elev. 680 m, 11.viii.2019, on calcareous rock, leg. E.A. Davydov 18126, 20821 (ALTB).

Distribution and ecology. *Verrucaria caerulea* is reported here for the first time to the Russian Far East from Sakhalin Region. The nearest locality is in South Siberia (Sedel’nikova 2007). Worldwide the species is distributed in Europe, Asia and North America (Orange et al. 2009). It occurs on steeply inclined surfaces of compact calcareous rocks restricted to upland areas (Nimis et al. 2018).

Notes. The species is distinguished by its epilithic, pale grey, closely to finely rimose to areolate thallus with epinecral layer, often with pruina and the perithecia three-quarters to completely immersed in the thallus as well as relatively small ascospores (12.0–)13.0–17.5(–23.5) × (5.0–)5.5–7.0(–9.5) µm. The material from the Russian Far East agrees well with the descriptions (Kopachevskaya 1977; Orange et al. 2023) having a pale grey, rimose-areolate thallus delimited by a dark prothallus, perithecia up to 0.3 mm wide, excipulum pale colored, involucrellum covered by excipulum up to half or less, ascospores 15.0–21.0 x 7.0–9.0 µm. *Parabagliettoa pinguicula* (A. Massal.) Orange differs in the more projecting and larger perithecia (Orange et al. 2023).

***Verrucaria viridula* (Schrad.) Ach.**

Figures 26–27

Material examined. Russia, Primorye Territory, Sikhote-Alin′ Range, Dal’negorsky District, at 3.5 km NW from Dal’negorsk, upstream the Barachnyi Stream, polydominant broadleaf deciduous forest, calcareous rocks massif, 44°35′19.0″N, 135°33′12.0″E, 550 m, 03.ix.2017, on calcareous rocks, leg. E.A. Davydov 20707 and L.S. Yakovchenko (ALTB); Sakhalin Region, Smirnykhovsky District, Vaida Mt., at 47 km E of Smirnykh Settlement, NW slope at the headwaters of Vitnitsa River, left bank, limestone rock outcrops, 49°52′48″N, 143°28′00″E, elev. 680 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 20712 (ALTB); 49°52′49″N, 143°28′02″E, elev. 700 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 20716 (ALTB).

Distribution and ecology. *Verrucaria viridula* is reported here for the first time to the Russian Far East from Primorye Territory and Sakhalin Region. The nearest locality is in South Siberia (Sedel’nikova 2007). Worldwide the species is distributed in Eurasia, North Africa and North America mostly in upland but also in coastal sites and urban areas occurring on calcareous rock, including limestone, mortar, mudstone and brick, occasionally on soil as well as on walls, roofing tiles (Breuss 2008; Nimis et al. 2018; Orange et al. 2023).

Notes. The species is characteristic by large ascospores (27.0–)28.5–34.0(–41.0) × (12.0–)14.5–20.0(–23.5) µm and up to 0.6 mm wide perithecia. Breuss (2008) and Orange et al. (2023) noted variability in thallus morphology from immersed to rimose-areolate, from pale grey to grey-brown and perithecia half- to almost completely immersed. Anatomically, involucrellum can be weakly developed only around the ostiole or reaching to mid-level, excipulum at first pale, but soon turning dark brown to black. Kopachevskaya (1977) and Breuss (2008) noted the bottleshaped of perithecia. The material from the Russian Far East fits well in descriptions (Kopachevskaya 1977; Breuss 2008, Orange et al. 2023). Among three specimens studied two possess pale grey areolate thallus with half projecting perithecia and the last one has scarcely developed pale grey brown thallus with completely immersed perithecia. Anatomically all of them have brown excipulum with involucrellum covered upper half on excipulum and ascospores 24.0–30.0(–32.0) x 13.0–16.0 µm. It is easily mistaken with *V. macrostoma* DC. which has narrower ascospores and thicker thallus. *Verrucaria hochstetteri* Fr. differs mostly by absence of an involucrellum and endolithic thallus (Orange et al. 2009, 2023).

***Xanthocarpia crenulatella* (Nyl.) Frödén, Arup Søchting s. lat.**

Material examined. Russia, Sakhalin Region, Smirnykhovsky District, at 47 km E of Smirnykh Settlement, Vaida Mt., NW slope at the headwaters of Vitnitsa River, left bank, limestone rock outcrops, 49°52′49″N, 143°28′02″E, elev. 700 m, 11.viii.2019, on calcareous rocks, leg. E.A. Davydov 18069 (ALTB); limestone outcrops, 49°52′42.3″N, 143°28′18.9″E, elev. 850 m, 29.vi.2019, on calcareous rocks, leg. I.V. Frolov (IBG); Makarov District, about 1 km W Zaozernoe, old concrete dam in the Lazovaya River, 48°21′35.9″N, 142°39′04.2″E, elev. 10 m, 27.vi.2019, on concrete, leg. I.V. Frolov (IBG).

Distribution and ecology. *Xanthocarpia crenulatella* is reported here for the first time to Sakhalin

Region. The nearest localities are in Primorye Territory (Rodnikova et al. 2019) and Kamchatka Territory (Khodosovtsev et al. 2004). This is a common species occurring in Europe and Asia (Vondrák et al. 2011, 2019; Urbanavichene and Urbanavichus 2018). *Xanthocarpia crenulatella* is a crustose lichen growing on xerothermic limestone outcrops.

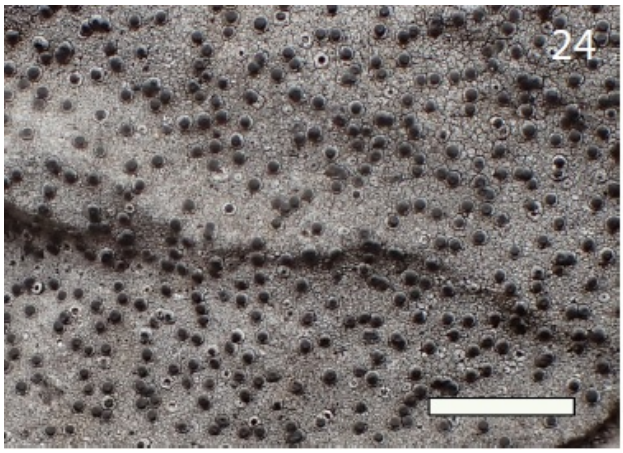
Notes. Usually, it has endolithic thallus and yellow zeorine apothecia with thin proper margin and thick thalline margin (at least in older apothecia), paler than proper margin and often crenulate. According to the phylogenetic study by Vondrák et al. (2011), the species is paraphyletic and contains several lineages, which the authors were not able to distinguish using morphological characters. The material from the Russian Far East agrees well with the description (Kondratyuk et al. 2004). The main diagnostical traits of our material: apothecia up to 0.5 mm wide, hymenium up to 55.0 µm tall, ascospores 15.0–17.5 × 6.0–7.5 µm with the septum 1.5–2.0 µm.

Xanthoria calcicola **Oxner**

Material examined. Russia, Primorye Territory, at the vicinity of Nakhodka City, the left bank of the Partizanskaya River near its mouth, the conical limestone summit of the Sestra Mt. (318 m), 42°49′40″N, 132°59′39″E, elev. 310 m, 16.viii.2022, on calcareous rocks, leg. EA. Davydov 20816 and P.Yu. Ryzhkova (ALTB).

Distribution and ecology. *Xanthoria calcicola* is reported here for the first time to the Russian Far East from Primorye Territory. The nearest locality is in South Siberia (Sedel'nikova 2007). Worldwide it is known from Europe, Near East and Northern Africa (Kondratyuk 2004; Nimis et al. 2018). It is a mainly Mediterranean to mild-temperate lichen found on the top of isolated calcareous and basic siliceous boulders. *Xanthoria calcicola* is a foliose lichen growing on more or less calcareous rocks, rarely on bark. In strongly eutrophicated situations it can occasionally overgrow bryophytes and plant remains (Nimis et al. 2018).

Notes. The isidiate thallus is an important characteristic of this species (Lindblom and Ekman 2005). The isidia, or isidia-like structures, are simple and erect or sometimes flattened and lobule-like, usually crowded. The upper surface of the thallus is dark orange to red or orange brown. Chemosyndrome A3 is characteristic (Søchting 1997).



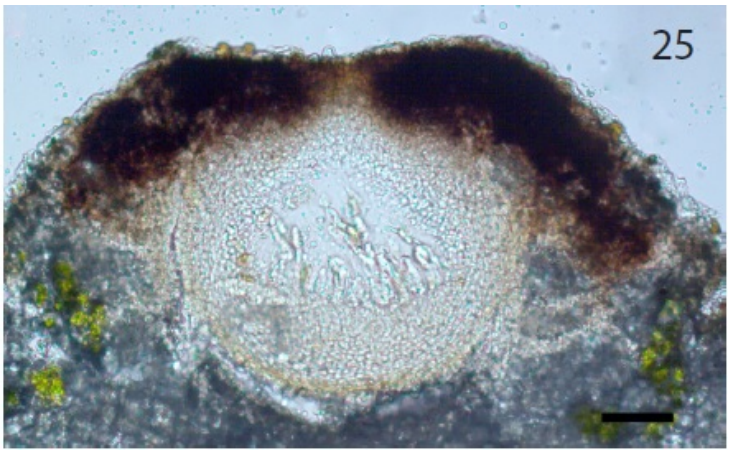


Figure 11. *Figures 24–25. Verrucaria caerulea: 24. Habitus, pale grey rimose-areolate thallus with protruding perithecia, scale bar = 5 mm, field photo by E.A. Davydov; 25. Perithecial section, involucrellum covered ca. upper half and pale excipulum, scale bar = 50 µm, photo by L.S. Yakovchenko.*

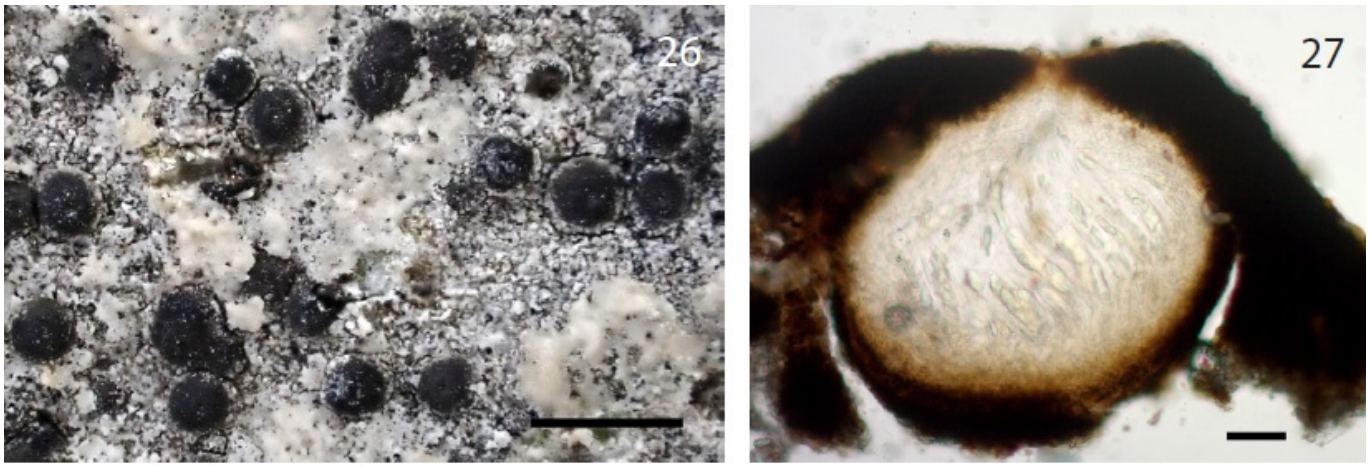


Figure 12. ***Figures 26–27.*** *Verrucaria viridula:* ***26.*** *Habitus, scale bar = 1 mm, field photo by E.A. Davydov;* ***27.*** *Perithecial section, well developed involucrellum and dark excipulum, scale bar = 50 µm, photo by L.S. Yakovchenko.*

Acknowledgements

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