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Three new species of *Parmeliaceae* (*Ascomycota*) from Siberia

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Abstract—*Cetrelia sayanensis*, *Myelochroa sibirica* and *M. sayanensis* from Russia (West Sayan Mountains, southern Siberia) are described as new to science. All three species are characterized by the presence of capitate-pustulate or subpustulate soralia, as well as other morphological features and their respective secondary chemistries.

Keywords—*Cetrelia cetrarioides*, *Cetrelia chicitae*, *Cetrelia olivetorum*, *Cetrelia monachorum*, *Myelochroa metarevoluta*, *Myelochroa upretii*

Introduction

In addition to intensive investigations of the lichen flora of southern Siberia (Makry 1990, Urbanavichene & Urbanavichus 1998, Sedel'nikova 2001) we have recently found three new species of *Parmeliaceae* in collections from the West Sayan Mountains. The most interesting region in West Sayan is a relict fir-aspen tall-herbaceous forest situated at 350–500 m altitude and dominated by *Abies sibirica*, *Pinus sibirica* and *Populus tremula* with *Sorbus sibirica*, *Padus avium* and *Salix rorida*. The main substrate for the new species was the bark from *Salix*, *Sorbus,* and *Padus* species, and less frequently the bark from *Abies* and *Betula*. In the dark-fir undershrub-moss taiga situated at higher altitudes

(up to 930 m), the main substrate was *Sorbus sibirica* and, very rarely, *Abies sibirica*.

The new *Myelochroa* taxa differ in a number of characters from recently described sorediate species from China (Wang et al. 2001) and India (Divakar et al. 2001a, b) and also from *M. metarevoluta* (Asahina) Elix & Hale, which is common in Siberia and the Russian Far East.

Material and methods

The lichen specimens were examined using Zeiss Axiostar and Zeiss Stemi 2000C stereomicroscopes and a Zeiss Axiolab compound microscope fittedwith an Axio Imager D1 camera. Chemical constituents were identified by thin layer chromatography (Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix et al. 2003) and by comparison with authentic samples.

The new species

Cetrelia sayanensis Otnyukova, Stepanov & Elix, sp. nov. Figs 1-8
MycoBank MB 512978

Diagnosis: *Sicut* Cetrelia monachorum *sed soraliis capitato-pustulatibus differt.*

typus—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, Kulumys Ridge, 52°58'N, 92°57'E, Kulumys Stream, 800 m alt., on old bark of stem of *Sorbus sibirica*, 24 Jul. 2007, T.N. Otnyukova (**holotype**–KRF; isotypes–KRSU, LE).

etymology: the specific epithet derives from the Latin *-ensis* (place of origin) and the type locality, the Sayan Mountains in southern Siberia.

Thallus foliose, regular to irregular, loosely adnate, 3–6 cm wide. Lobes imbricate, apically rotund or incised, 0.3–1.1(1.5) cm wide. Upper surface gray to greenish-gray, somewhat shiny, with pseudocyphellae, pustules and soredia. Pseudocyphellae laminal, flat, fleck-like, rounded or irregular, whitish, less than 0.1 mm wide; pustules convex, laminal, usually scattered, very rarely crowded; soralia laminal, submarginal or marginal, laminal and submarginal soralia subpustulate-capitate, arising from convex pustules (0.1) 0.5–2.0(3.0) mm; marginal soralia convex, labriform, usually absent on young lobes but always present on older lobes; soredia farinose. Lower surface black in the center, rhizinate, but brown or white at the margins, erhizinate at the lobe apices, pustulate; pustules concave, usually white within or very rarely black, (0.1)0.5–2.0(3.0) mm wide. Apothecia very rare, laminal, subpedicellate, up to 6 mm wide; mature disc weakly concave, smooth, brown; thalline exciple pseudocyphellate; pseudocyphellae projecting slightly, soredia absent; margin thin. Ascospores broadly ellipsoid to subglobose, 12–16 × 10–12 µm. Pycnidia not seen.

Chemistry: Cortex K+ yellow; medulla C+ rose, KC+ pinkish to rose; containing atranorin [minor], imbricaric acid [major], perlatolic acid [minor], divaricatic acid [minor], anziaic acid [minor], 4-*O*-demethylimbricaric acid [minor], glomelliferic acid [trace] and loxodellic acid [trace].

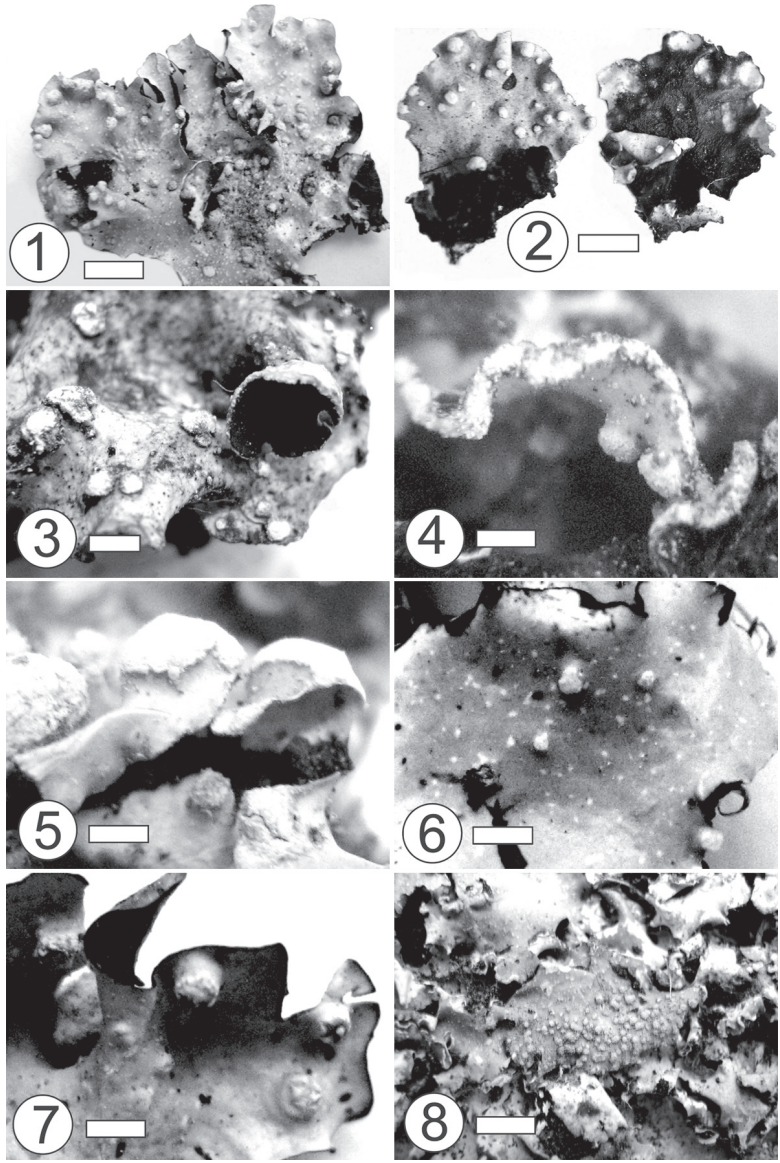
Paratypes—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, 52°55'–53°04'N, 92°57'–93°15'E: Kulumys Ridge, Maralii Stream, 440 m alt., on *Salix rorida,* N.V. Stepanov, 15 Jul. 2005 (KRSU); Tchebizhek River, middle part, 930 m alt., on *Sorbus sibirica*, N.V. Stepanov, 24 May 2007 (KRSU); Tchebizhek River, lower part, 405 m alt., on *Sorbus sibirica*, N.V. Stepanov, 17 Jun. 2007 (KRSU), ibid., 21 Jul. 2008 (KRSU); Kulumys Stream, 800 m alt., on old branches of *Abies sibirica*, T.N. Otnyukova, 24 Jul. 2007 (KRF); Bagazyul River, 500 m alt., on *Salix rorida*, N.V. Stepanov, 16 Jul. 2008 (KRSU); Bolschoi Kebezh River basin, Krutoi Klyuch Stream, 410 m alt., on *Betula platyphylla*, N.V. Stepanov, 16 Jul. 2007 (KRSU); Staroverskii Stream, 400 m alt., on *Betula platyphylla*, N.V. Stepanov, 17 Jul. 2008 (KRSU); Kedranskii Ridge, Krutoi Klyuch Stream, 410 m alt., on *Abies sibirica*, N.V. Stepanov, 18 Jul. 2008 (KRSU).

Comments—This new species is similar to the sorediate *Cetrelia* species, *C. cetrarioides* (Delise ex Duby) W.L. Culb. & C.F. Culb., *C. chicitae* (W.L. Culb.) W.L. Culb. & C.F. Culb., *C. olivetorum* (Nyl.) W.L. Culb. & C.F. Culb., and *C. monachorum* (Zahlbr.) W.L. Culb. & C.F. Culb., but it differs from the all of these species in having pustulate-capitate soralia. In addition, *C. monachorum* has a thicker thallus (200–300 µm vs. 130–180 µm in *C. sayanensis*), while *C. cetrarioides* has labriform marginal soralia (marginal soralia more convex and appearing labriform-capitate in *C. sayanensis*). The chemistry of *C. sayanensis* is identical to some specimens of *C. monachorum*.

The pustulate-capitate soralia of *C. sayanensis* could be confused with the laminal, capitate soralia present in *C. cetrarioides* and *C. monachorum* (Obermayer & Mayrhofer 2007) and *C. olivetorum* (Randlane & Saag 1992), which are usually very rare but may be quite dense on the upper surface of older thalli. The development of such laminal, capitate soralia is often initiated within the pseudocyphellae on the upper surface and might be caused by an aging effect or other exogenous or endogenous factors (Obermayer & Mayrhofer 2007).

In Siberia such laminal, capitate soralia were found in *C. monachorum* together with mature apothecia and structures that appear to be primordia of apothecia; such soralia are typically crowded on one older lobe and absent on neighbouring lobes (Fig. 8). The pustulate-capitate soralia present in *C. sayanensis* are derived from scattered dull white maculae on the upper surface which develop into small round, convex pustules and differ markedly from the surrounding irregular shaped, flat, pseudocyphellae (Fig. 6). These pustules ultimately erupt into (3)5–8 petal-like flaps (Fig. 7).

At present, *C. sayanensis* is known from the bark of *Abies*, *Betula*, *Salix* and *Sorbus* from several neighboring localities in the West Sayan Mountains at 400–930 m altitude.



Figures 1-8. *Cetrelia* species. 1-7. *C. sayanensis* (holotype in KRF). 1. Part of the holotype. 2. View of thalli, upper surface (left), lower surface (right). 3. Thallus with apothecia. 4. Marginal soralia and subpustulate-capitate soralia. 5. Subpustulate-capitate soralia. 6. Maculae developing into convex pustules in contrast to surrounding flat, irregular pseudocyphellae. 7. Erupting pustules with petal-like flaps. 8. *Cetrelia monachorum* (KRF), laminal capitate soralia on old part of thallus.

Scale bars: 1, 2, 8 = 5 mm; 3 = 2.5 mm; 4-7 = 100 μm.

Myelochroa sayanensis Otnyukova, Stepanov & Elix, sp. nov. Figs 9–11
MycoBank MB 512979

Diagnosis: *Sicut* Myelochroa metarevoluta *sed thallus diminutus et irregularus, lobis angustioribus et acidum leucotylicum continente differt.*

typus—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, Tanzibeiskaya Hollow, Malyi Kebesh River, 53°10'N, 92°57'30"E, Tanzybeika locality, 340 m alt., on bark of old *Padus avium*, N.V. Stepanov & T.N. Otnyukova, 13 Jun. 2007 (**holotype**–KRF; isotypes–KRSU, LE).

etymology: the specific epithet derives from the Latin *-ensis* (place of origin) and the the type locality, the Sayan Mountains in southern Siberia.

Thallus irregularly foliose or consisting of scattered lobes, loosely adnate, very small, 3–8(12) mm wide, thalli often coalescing into irregular patches 2–5 cm wide. Lobes sublinear to subirregular, flat, apically subtruncate, 0.1–0.8 (1.2) mm wide; margin ciliate, cilia dense, simple or sparsely branched, regularly dispersed, to 0.5 mm long. Upper surface grayish-white, margins black due to the projecting lower surface, slightly shiny, smooth, sorediate; soralia subpustulate or pustulate-capitate, laminal or submarginal near lobe apices, rarely helmet-like, soredia farinose. Medulla white, medullary hyphae forming 2–4-celled, bead-like chains, cells (6)8–10 µm diam. Lower surface black or mid-brown towards the lobe apices, rhizinate to the margins; rhizines dense, black, simple or rarely furcate, 0.5–1.5 mm long, often conspicuous and projecting beyond the margins. Apothecia common, 0.5–1.5(2.5) mm wide; disc pale brown, flat; thalline exciple thin, smooth, esorediate; margin thin, esorediate or very rarely sparsely sorediate. Ascospores ellipsoid, 8–12 × 5–8 µm. Pycnidia not seen.

Chemistry: Cortex K+ yellow then red-brown; medulla K+ yellow then red-brown, P+ yellow; containing atranorin [major or minor], chloroatranorin [trace], galbinic acid [major], salazinic acid [minor], norstictic acid [trace], secalonic acid W [trace], leucotylic acid [major], zeorin [major].

Paratypes—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, 52°55'–53°04'N, 92°57'–93°15'E: Tanzibeiskaya Hollow, Tanzybeika River (Vtoroye Koltso), 340 m alt., on bark of old *Padus avium*, N.V. Stepanov, 9 May 2008 (KRSU); Bolshoi Kebezh River basin, Maramzina Stream, 350 m alt., on old bark of *Padus avium* stem, N.V. Stepanov & T.N. Otnyukova, 15 Aug. 2008 (KRF, KRSU), Maramzina Stream, 350 m alt., on bark of *Padus avium*, N.V. Stepanov, 26 Aug. 2008 (KRSU).

Comments—This is the smallest species of *Myelochroa* and is invariably fertile, with lobes as short as 3 mm long bearing apothecia. In Siberia even juvenile specimens of *M. sibirica* (see below) and *M. metarevoluta* form small, ±rosette-like thalli, whereas in *M. sayanensis* the thalli are always irregular, mainly with irregularly branched, sublinear-elongate lobes. Furthermore, *M. metarevoluta* contains leucotylin and associated triterpenes rather than leucotylic acid. The subpustulate soralia and medullary chemistry resemble those of *M. sibirica* and

M. upretii Divakar & Elix, but those species have much larger thalli and broader lobes (see discussion under *M sibirica* below).

At present *M. sayanensis* is known only from the bark of *Padus avium* from several neighboring localities in the West Sayan Mountains at 340–350 m altitude.

Myelochroa sibirica Otnyukova, Stepanov & Elix, sp. nov. FIGS 12–15
MycoBank MB 512980

Diagnosis: *Sicut* Myelochroa upretii *sed thallus diminutus, lobis angustioribus ad apicibus appressus et medulla albidus differt.*

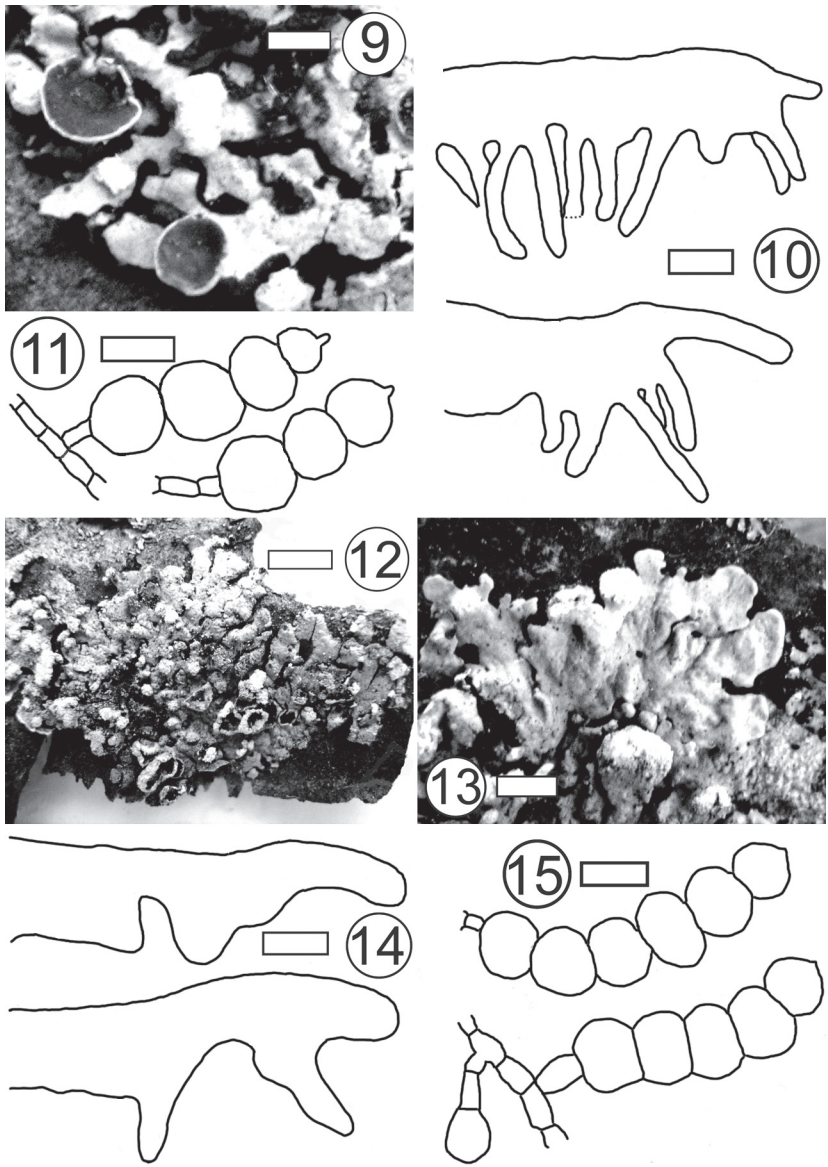
typus—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, Malii Kebezh River basin, Filin Klyuch Stream, 53°01'30"N, 92°58'30"E, 480 m alt., on bark of stem, branches and young twigs of *Padus avium*, T.N. Otnyukova & N.V. Stepanov, 14 Jul. 2004 (**holotype**–KRF; isotypes–KRSU, LE).

etymology: the epithet derives from the occurrence of this species in Siberia.

Thallus foliose, irregular, tightly adnate, 1–4 cm wide. Lobes convex, regularly or irregularly branched, apically subrotund or subrotund and incised, 1–3(5) mm wide; marginal lobes convex and appressed to the substratum; margin eciliate or very sparsely ciliate. Upper surface greenish-gray to greenish-white, dull, becoming shiny at apices, becoming rugose with age, sorediate. Soralia subpustulate or pustulate-capitate, submarginal but spreading laminally, very rarely helmet-like, originating at the apices; soredia granular. Medulla white, sometimes pigmented red in soralia and exposed cracks in the upper cortex; medullary hyphae forming 2–6-celled, bead-like chains, cells 6–8 µm diam. Lower surface black, brown in a narrow marginal, erhizinate zone; rhizines relatively dense, black, simple, not furcate or projecting beyond the lobe margins. Apothecia common, 1.5–4.0 mm wide; disc brown, markedly concave with age, inner margin convolute; thalline exciple sorediate; margin thin or thick, invariably sorediate. Ascospores ellipsoid, 10–12 × 6–8 µm. Pycnidia not seen.

Chemistry: Cortex K+ yellow then red-brown; medulla K+ yellow then red-brown, P+ yellow; containing atranorin [major or minor], chloroatranorin [trace], galbinic acid [major], salazinic acid [minor], norstictic acid [trace], secalonic acid W [trace], leucotylic acid [major], zeorin [major].

Paratypes—Russia, Krasnoyarsk Region. Southern Siberia, West Sayan Mountains, 53°04'–53°10'N, 92°57'–93°07'E: Tanzibeiskaya Hollow, Tanzybeika River (Vtoroye Koltso), 340 m alt., on bark of *Salix rorida*, N.V.Stepanov, 15 Jul. 2008 (KRSU); Bolshoi Kebezh River basin, Krutoi Klyuch Stream, 410 m alt., on bark of *Salix rorida*, N.V.Stepanov, 17 Jul. 2007 (KRSU); Maramzina Stream, 350 m alt., on bark of stem, branches and young twigs of *Padus avium*, N.V.Stepanov & T.N. Otnyukova, 15 Aug. 2008 (KRF, KRSU); Kulumys Ridge, Aleev Stream, 405 m alt., on bark of *Salix rorida*, N.V.Stepanov, 18 Jul. 2008 (KRSU).



Figures 9–15. New species of *Myelochroa*. 9–11. *M. sayanensis* (holotype in KRF); 9. Thallus with apothecia; 10. Cross sections of thallus, margins with cilia and rhizines; 11. 3–4-celled hyphal chains. 12–15. *M. sibirica* (holotype in KRF); 12. Thallus with apothecia; 13. Lobes of thallus; 14. Cross sections of thallus, margins lacking cilia and rhizines; 15. 5–6-celled hyphal chains.

Scale bars: 9 = 1 mm; 10, 14 = 250 μm; 11, 15 = 10 μm; 12 = 5 mm; 13 = 2.5 mm.

Comments–*Myelochroa sibirica* most closely resembles *M. upretii* from India (Divakar et al. 2001) as both have subpustulate soralia and similar medullary chemistry, but it differs in having smaller thalli (1–4 cm vs. 7–11 cm wide), narrower lobes (1–6 mm vs. 2–10 mm wide), in the subpustulate soralia spreading laminally (vs. mainly marginal in *M. upretii*), and in the white medulla (pale yellow in patches in *M. upretii*). *Myelochroa sibirica* differs both chemically and morphologically from *M. metarevoluta,* which also occurs in Siberia. Thus, *M. metarevoluta* has capitate soralia on ascending lobe apices and 8-celled hyphal chains whereas *M. sibirica* has subpustulate soralia on lobes appressed at the apices and 2–6-celled hyphal chains. Although both *M. metarevoluta* and *M. sibirica* contain galbinic acid as a major constituent, *M. metarevoluta* contains leucotylin and associated triterpenes rather than leucotylic acid.

At present, *M. sibirica* is known from the bark of *Padus* and *Salix* species from several neighbouring localities in the West Sayan Mountains at 340–480 m altitude.

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