

Lichen-forming and lichenicolous fungi new to Kazakhstan

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Although there is a published lichen flora of Kazakhstan, the diversity of lichen-forming and lichenicolous fungi of this country is incompletely known. Here we publish records of 41 species of lichens and 2 species of lichenicolous fungi for the first time from Kazakhstan. All collections are from the Kazakh Altai and the Saur Mountains, East Kazakhstan. *Caloplaca monacensis*, *Immersaria iranica*, *Lepraria elobata*, *L. rigidula* and *Parmelina pastillifera* are new for the wider surroundings of Kazakhstan, as they have neither been found in Central Asia so far, nor in southern Siberia. Several species are new to Central Asia, but were already known from the nearby Siberia.

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Obwohl es eine publizierte Flechtenflora von Kasachstan gibt, ist die Diversität der Flechten bildenden und bewohnenden Pilze dieses Landes unvollständig bekannt. Hier veröffentlichen wir Neunachweise von 41 Flechtenarten und 2 Arten Flechten bewohnender Pilze für Kasachstan. Alle Aufsammlungen stammen vom Kasachischen Altai und dem Saur-Gebirge in Ostkasachstan. *Caloplaca monacensis*, *Immersaria iranica*, *Lepraria elobata*, *L. rigidula* and *Parmelina pastillifera* sind neu für die weitere Umgebung Kasachstans, da sie bisher weder in Zentralasien noch in Südsibirien gefunden wurden. Mehrere Arten sind neu für Zentralasien, waren aber bereits aus dem nahen Sibirien bekannt.

Key words: Lichen diversity, Central Asia, Altai, Saur-Tabagatai.

Introduction

Kazakhstan, the earth's largest landlocked country, has a highly continental climate and is mainly covered by steppe, semidesert and desert. Forests are found in the north where the Siberian taiga protrudes into the country and on mountain ranges in eastern and south-eastern Kazakhstan. These mountain ranges include the Altai, the Saur and Tarbagatai Mountains, the Dzungarian Alatau, and the Tianshan. There is a recent checklist of the lichens of Kazakhstan by WAGNER & SPRIBILLE (2005), which is based on the lichen flora of Kazakhstan published in Russian language (ANDREEVA 1978, 1983, 1987) and few other publications. Information on lichenicolous fungi from Kazakhstan is virtually absent. In the present paper, we present data on new species of lichen-forming and lichenicolous fungi from the Kazakh Altai and the Saur Mountains in eastern Kazakhstan. Several of these species are technically new to Central Asia, which is, however, little meaningful due to the nearby border to southern Siberia, which is not part of Central Asia. *Caloplaca monacensis*, *Cyphelium pinicola*, *Immersaria iranica*, *Lepraria elobata*, *L. rigidula* and *Parmelina pastillifera* were neither known from Central Asia, nor from Siberia so far and thus their records from Kazakhstan merit greater biogeographical attention.

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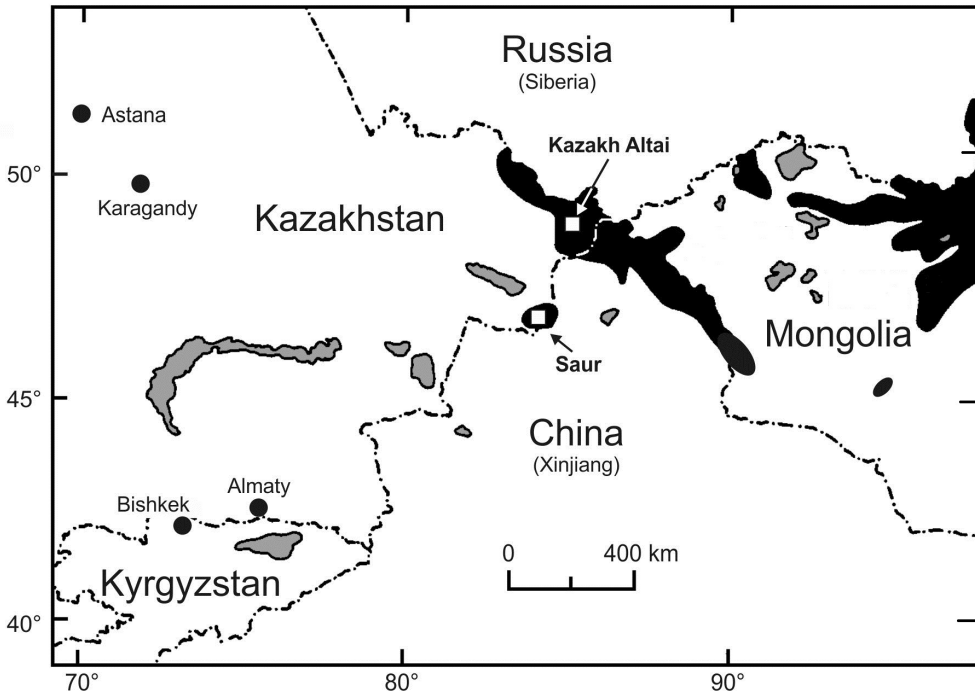


Fig. 1: Location of the Kazakh Altai and the Saur Mountains in eastern Kazakhstan. The black areas indicate the distribution of *Larix sibirica*-dominated taiga forests in Kazakhstan, China and Mongolia; the distribution of larch forests in Russia (complete map section falls in the distribution range of *L. sibirica*) is not shown for the sake of clarity. Gray areas are lakes.

Materials and methods

The material was collected in the province of East Kazakhstan in the Katon-Karagai National Park in the Kazakh Altai and in the Saur Mountains, south of the city of Zaisan, in 2010 and 2011. The sites were all located in the forest-steppe in forests dominated by Siberian larch (*Larix sibirica*). These larch-dominated forests in eastern Kazakhstan represent moderately disturbed habitats, whereas many woodlands in the forest-steppe are dominated by silver birch (*Betula pendula*) indicating mostly heavy anthropogenic disturbance. Nevertheless, also the larch forests are partly grazed by free-roaming livestock and highly fragmented. Some collections are from steppe grasslands or rock outcrops in the forests or the steppe.

The listing of localities is supplemented with information on diagnostic characters of the relevant species as supporting information to make the identifications comprehensible. This is considered to be important especially against the background that the mutual exchange of herbarium specimens for loan between institutions in Central Asia and other parts of the world is difficult. All descriptions refer to material collected in Kazakhstan, but sometimes to more than the cited specimens, as specimen citation was limited to one selected sample per study area (Kazakh Altai, Saur Mountains). All samples were collected and if not stated otherwise also identified by M. Hauck using standard microscopy techniques and spot tests. Thin-layer chromatography (TLC) in solvents A, B, C (ORANGE et al. 2001) was carried out by T. Tønberg where specified. Herbarium specimens are deposited in the private herbarium of M. Hauck.

The nomenclature of lichen-forming and lichenicolous fungi is based on URBANAVICHUS (2010), except for *Anaptychia ulotrichoides* (POELT & VĚZDA 1977), *Coenogonium* (LÜCKING et al. 2004), *Xanthoparmelia* (BLANCO et al. 2004), and the Teloschistaceae (ARUP et al. 2013).

The species

Abrothallus parmeliarum (Sommerf.) Arnold

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'28"N/86°1'41"E, 1410 m a.s.l., on *Parmelia sulcata* on *Betula pendula*, 13.08.2010.

Abrothallus parmeliarum is a widespread, cosmopolitan lichenicolous fungus on *Parmelia* s.str. In the Kazakh Altai, the species was found on the thallus of *Parmelia sulcata* on birch and larch. The specimens had typically brown, verrucose spores of 12–15 × 5–6 μm with two cells of unequal size, clavate asci, a dark brown, K+ green epihymenium, a hyaline, c. 80 μm high hymenium, and a red brown hypothecium. The nearest published records of the species are from Siberia where it occurs, e.g., in the Russian Altai, the eastern Sayan Mountains and Tuva (ZHURBENKO & DAVYDOV 2000, ZHURBENKO & OTNYUKOVA 2001, ZHURBENKO 2009).

Arthonia mediella Nyl.

Kazakh Altai, Katon-Karagai National Park, 10 km WSW Enbek, 49°8'41"N/86°0'43"E, 1315 m a.s.l., on *Larix sibirica*, 17.08.2010. Saur Mountains, c. 25 km S Zaisan, 47°15'49"N/84°55'1"E, 1755 m a.s.l., on *Larix sibirica*, 08.07.2011.

The species is characterized by its triseptate ascospores of 13–17 × 3–4 μm, dark brown caps of the paraphysoids, a hyaline hymenium, a brown hypothecium and the chlorococcoid photobiont. In eastern Kazakhstan, *A. mediella* seems to be a widespread species on the lower trunks of larch, especially in forest interiors, but also at not eutrophicated forest margins. *Arthonia mediella* differs from most species of its genus by its circumpolar northern distribution type in boreal and temperate-montane forests. The species is known from all forested regions of European and Asian Russia (URBANAVICHUS 2010).

Arthopyrenia punctiformis (Pers.) A.Massal.

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'28"N/86°1'41"E, 1410 m a.s.l., on *Betula pendula*, 13.08.2010.

The Kazakh material has black perithecia of 150–225 μm in diameter and 125 μm height, a K– involucrellum (as observed under the compound microscope), numerous persistent pseudoparaphysoids, obpyriform to broadly clavulate asci of 35–48 × 15–17 μm and 2- to 4-celled hyaline ascospores of 15–20 × 4–5 μm. A visible thallus is absent or restricted to a small brown zone around the perithecia; *Trentepohlia* algae (10–15 μm in diameter) are few, but were repeatedly observed. The species was found on many birch trees of the Kazakh Altai. Typically, relative large smooth areas of the trunk, which were not much colonized by other epiphytes, were overgrown by single perithecia, which grow in a distance of a few millimeters or centimeters from one another. *Arthopyrenia punctiformis* is a cosmopolitan species and is, for instance, known from western and southern Siberia and the Russian Far East (URBANAVICHUS 2010).

Arthopyrenia rhypontha (Ach.) A.Massal.

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'28"N/86°1'41"E, 1410 m a.s.l., on *Betula pendula*, 14.08.2010.

Arthopyrenia rhypontha is already conspicuous in the field due to its very thin, effuse, brownish thallus, which clearly contrasts with the color of the bark, at least in the case of birch bark, which was the substratum in the Kazakh Altai. The material from Kazakhstan has triseptate, hyaline ascospores (15–17 × 5–6 μm), which are slightly constricted at the septae (especially the middle one) and formed in broadly clavulate asci of 40 × 15–18 μm. The perithecia are 250 μm in diameter and 80–150 μm high and do not react with K. The perithecia are always associated with *Trentepohlia* algae (15–17 μm in diameter). In the Kazakh Altai, *A. rhypontha* grew on smooth bark in association with *A. punctiformis* on the same tree, though both species grew on distant patches of the bark. *Arthopyrenia rhypontha*

is widespread on the smooth bark of broadleaved trees in Europe and Asia, but apparently lacking in North America (HARRIS 1995). Asian records include specimens from Turkey (BREUSS & JOHN 2004), Iran (SEAWARD et al. 2004), western and southern Siberia, the Russian Far East (URBANAVICHUS 2010), and Mongolia (BIAZROV et al. 1983). Though *Populus* seems to be a preferred substrate of *A. rhyponia*, the complete range of phorophytes inhabited by the species includes several tree genera, including *Betula* (KESSLER 1936).

Athelia arachnoidea (Berk.) Jülich

Kazakh Altai, Katon-Karagai National Park, 11 km WSW Enbek, 49°8'59"N/85°59'54"E, 1200 m a.s.l., on *Cyphelium tigillare* on *Larix sibirica*, 15.08.2010.

This basidiomycete is a widely distributed parasite on various species of lichens and algae. It can be identified by its white circles (few to several centimeters in diameter) of cotton-like hyphae with dead thalli of the host lichen in the center. The hyphae have single clamp connections between adjacent cells. *Athelia arachnoidea* is a species of the temperate and (mostly southern) boreal zones and is found in Eurasia and North America (CLAUZADE et al. 1989, GINNS & WORRALL 1999). Published records in Russia refer only to the European part (URBANAVICHUS 2010).

Biatora chrysantha (Zahlbr.) Printzen

Saur Mountains, c. 25 km S Zaisan, 47°15'49"N/84°55'1"E, 1755 m a.s.l., on *Larix sibirica*, 06.07.2011.

Biatora chrysantha with its yellowish, sorediate, C+ red (gyrophoric acid), often sterile thallus is a characteristic and quite frequent epiphyte of the semi-arid conifer forests of Central Asia and southern Siberia. It occurs in both the more humid dark taiga (with *Pinus sibirica*, *Abies*, *Picea*) and the more continental light taiga (with *Larix*). It typically grows on the base of tree trunks (as in eastern Kazakhstan) and on deadwood in the forest interior. *Biatora chrysantha* is a circumboreal species, which occurs throughout the European and Asian parts of Russia (URBANAVICHUS 2010), including the Russian Altai (DAVYDOV & PRINTZEN 2012). It is also known from Mongolia (HAUCK & JAVKHLAN 2006, PALKA & ŚLIWA 2006). *Biatora chrysantha* is similar to *B. chrysanthoides* Printzen & Tønberg, which also produces gyrophoric acid, but differs in the smaller size of the apothecia and ascospores (PRINTZEN & TØNSBERG 2003). If sterile, *B. chrysantha* can be recognized by its yellowish green soralia. Fresh material of *B. chrysanthoides* has a deep dark green color, which is only rarely found in *B. chrysantha* (PRINTZEN & TØNSBERG 2003).

Bilimbia sabuletorum (Schreb.) Arnold

Saur Mountains, c. 25 km S Zaisan, 47°16'59"N/84°53'15"E, 1660 m a.s.l., on bryophytes, 22.07.2011.

The Kazakh specimen is characterized by 4–6-celled verruculose ascospores of 25 × 5 μm, a dark brown to olive epihymenium, a hyaline, 85–100 μm high hymenium and a light brown to yellowish brown hypothecium. It was found on mosses, which grew over siliceous rock under an overhang in a larch forest. *Bilimbia sabuletorum* is a widely distributed, bipolar species, which is, among others, known from Siberia, the Russian Far East (URBANAVICHUS 2010) and Xinjiang (ABBAS et al. 2001).

Bryoria fuscescens (Gyeln.) Brodo & D.Hawksw.

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'36"N/86°1'52"E, 1320 m a.s.l., on *Larix sibirica*, 13.08.2010. Saur Mountains, c. 25 km S Zaisan, 47°15'49"N/84°55'1"E, 1755 m a.s.l., on *Larix sibirica*, 06.07.2011.

WAGNER & SPRIBILLE (2005) assigned the report of ANDREEVA (1987) of *Alectoria jubata* (L.) Ach. to *Bryoria* cf. *fuscescens*, because the name *A. jubata* has been misapplied for various pendent *Bryoria* species since its introduction in 1753 and has therefore been rejected by BRODO & HAWKSWORTH (1977), when they separated the brown *Alectoria* species in *Bryoria*. In fact, *B. fuscescens* is a common epiphyte in the mountain forests of eastern Kazakhstan.

Buellia erubescens Arnold

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'36"N/86°1'52"E, 1320 m a.s.l., on *Larix sibirica*, 13.08.2010.

The Kazakh material of *B. erubescens* is characterized by brown, 2-celled ascospores of 14–17(–23) × 7.5–9 μm, a hyaline hymenium of 75–80 μm height without oil droplets, and the dark brown color of the epihymenium, true exciple (K+ yellow) and hypothecium. The thallus reacts K+ yellow, then red, indicating the presence of norstictic acid, but KC–, UV–. The species was found on trunks and branches of larch trees. *Buellia erubescens* is widespread in Asian Russia (URBANAVICHUS 2010), including southern Siberia (BUDAEVA 1989, SEDELNIKOVA 1990, SVIRKO 2006), and is also known from northern and western Mongolia (COGT 1995, HAUCK & JAKHLAN 2009).

***Buellia griseovirens* (Turner & Borrer ex Sm.) Almb.**

Kazakh Altai, Katon-Karagai National Park, 14 km WSW Enbek, 49°8'20"N/85°57'39"E, 1480 m a.s.l., on decorticated *Larix sibirica*, 21.08.2010.

The species is characterized by its thin crustose to endosubstratal grayish thallus with discrete yellowish green, partly dark bluish, soralia, which react K+ yellow and then (mostly indistinctly) red (norstictic acid). *Buellia griseovirens* was found on decorticated branches of a larch tree. The species is widely distributed in the boreal, temperate and also the meridional zones of both hemispheres. It is also known from southern Siberia (URBANAVICHUS 2010) and Mongolia (PALKA & ŚLIWA 2004, HAUCK & JAVKHLAN 2006).

***Caloplaca chlorina* (Flot.) Sandst.**

Saur Mountains, c. 25 km S Zaisan, 47°16'59"N/84°53'15"E, 1660 m a.s.l., on *Larix sibirica*, 12.07.2011.

The Kazakh material has a dark gray areolate, blastidiate to sorediate thallus and *C. cerina*-type apothecia with esorediate margins. The species grew on the bark of a moderately nutrient-enriched trunk base of *Larix sibirica* at the forest edge together with *Candelariella xanthostigma*, *Lecanora hagenii*, and *Physcia caesia*. The species is known from Eurasia and North America (ŠOUN et al. 2011). In Asian Russia, it occurs in the Caucasus, the Ural Mountains, western and southern Siberia and the Russian Far East (URBANAVICHUS 2010).

***Caloplaca monacensis* (Leder.) Lettau**

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'36"N/86°1'52"E, 1320 m a.s.l., on *Larix sibirica*, 13.08.2010.

The dark gray thallus of the specimen is completely granulose (50–100[–160] μm) and resembles otherwise that of *C. chlorina*. The apothecia are partly white pruinose. The species grew on a mossy trunk base of a larch tree at the forest edge to the steppe, together with *Anaptychia ulotrichoides*. The distribution of *C. monacensis* is incompletely known, as it has not received much attention until recently. The species is widespread in temperate Europe (including Russia and Ukraine) and has been recorded from Anatolia (ŠOUN et al. 2011). The specimen from the Kazakh Altai is the first record from Central Asia. *Caloplaca monacensis* is a neglected name for *C. cerina* var. *cyanolepra* (DC.) J.J.Kickx (VONDRÁK et al. 2009).

***Candelariella reflexa* (Nyl.) Lettau**

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'28"N/86°1'41"E, 1410 m a.s.l., on *Larix sibirica*, 12.08.2010.

The specimens of *C. reflexa* from eastern Kazakhstan consist of soredia of 30–50(–60) μm and have only very few lobes (c. 0.3 mm) and have no apothecia. In other specimens, lobes are even lacking. This scarcity of lobes is quite typical of the species also in other areas, but critical for identification. If sterile, which is mostly the case, specimens without lobes formally cannot be distinguished from *C. efflorescens*, which has 16–32 spores per ascus, in contrast to 8 spores per ascus in *C. reflexa* (HARRIS & BUCK 1978). The identity of such specimens, which are common among populations of *C. reflexa* in Eurasia should be clarified in a molecular study. At the present state of knowledge, it is assumed that most purely sorediate thalli in Eurasia belong to *C. reflexa*, as *C. efflorescens* is primarily a North American species. It has only a few verified occurrences in Europe (ARUP & EKMAN 1992, KUBIAK & WESTBERG 2011). URBANAVICHUS (2010) listed *C. efflorescens* also for southern Siberia and the Russian Far East. Specimens without lobes can be separated from *C. xanthostigma*, which has a similar

ecology as *C. reflexa* and also occurs in Kazakhstan (ANDREEVA 1983), by the formation of corticated granules of 30–110(–150) µm in that species (WIRTH et al. 2013). *Candelariella reflexa* is widespread at lower elevations of the Kazakh Altai on moderately nutrient-enriched trunk bases of *Larix sibirica*, especially at forest edges and in open occasionally grazed forests. It is a cosmopolitan species, which is also recorded from southern Siberia (URBANAVICHUS 2010) and the Mongolian Altai (COGT 1995).

***Chaenotheca gracilentia* (Ach.) J.-E.Mattsson & Middelb.**

Kazakh Altai, Katon-Karagai National Park, 11 km WSW Enbek, 49°8'59"N/85°59'54"E, 1275 m a.s.l., on *Larix sibirica*, 16.08.2010.

The specimen of *C. gracilentia* from Kazakhstan is characterized by its stalked apothecia (up to 2 mm high) with slender, flexuose, partly branched, black stalks. The lower side of the excipulum and the upper stalks are partly covered by a faint grayish pruina. The ascospores are globose, faintly brownish and have a diameter of only 2.5 µm. The thallus is green, farinose and contains *Stichococcus*. The species is closely related to *C. gracillima*, which has a similar overall appearance and ascospores of similar size, but a reddish brown pruina (TIBELL 1978). *Chaenotheca nitidula* Tibell is also similar, but lacks a pruina and has larger spores of 4–5 µm in diameter and is, so far, only known from North America (TIBELL & KOFFMAN 2002). *Chaenotheca gracilentia* is apparently rare in eastern Kazakhstan and was found on the trunk base of *Larix sibirica* in the forest interior. The species is widely distributed in the boreal and temperate zones of Eurasia (including the Russian Altai, southern Siberia; DAVYDOV et al. 2007) and North America, but quite rare in most areas, because it prefers old-growth forests, which are little disturbed by forest management (TIBELL 2002). *Lobaria scrobiculata*, another old-growth forest lichen, which is rare in eastern Kazakhstan, occurred in the same stand.

***Chaenotheca stemonea* (Ach.) Müll.Arg.**

Kazakh Altai, Katon-Karagai National Park, 11 km WSW Enbek, 49°8'59"N/85°59'54"E, 1275 m a.s.l., on *Larix sibirica*, 16.08.2010.

The *Stichococcus*-containing thallus of *C. stemonea* is farinose (in contrast to the granulose to minutely squamulose thallus of *C. trichialis*), the excipulum has a faint white pruina on its lower side and the spores are globose, brown and 2.5–3.5 µm in diameter. The species occurs on trunk bases of larch in the forest interior of the Kazakh Altai, often together with *C. trichialis* in the same stand or sometimes on the same tree. *Chaenotheca stemonea* has a wide distribution in the boreal and temperate forests of Eurasia and North America, but even occurs in the Neotropics and Australia (KANTVILAS 1989, TIBELL 1996). In Central and North-Eastern Asia, it occurs in Siberia, the Russian Far East (URBANAVICHUS 2010), Xinjiang (ABBAS et al. 2001), Tibet (WEI & JIANG 1986), and Sichuan (TITOV 2000).

***Chaenotheca trichialis* (Ach.) Th.Fr.**

Katon-Karagai National Park, 8 km WSW Enbek, 49°9'28"N/86°1'41"E, 1410 m a.s.l., on *Larix sibirica*, 12.08.2010. Saur Mountains, c. 25 km S Zaisan, 47°16'35"N/84°53'27"E, 1690 m a.s.l., on *Larix sibirica*, 11.07.2011.

The species differs from *C. stemonea* by its thicker granular to minutely squamulose thallus. It is a common species on trunk bases in the interior of larch forests in eastern Kazakhstan.

Chaenotheca trichialis is probably a cosmopolitan species, which is, among others, known from Siberia and the Russian Far East (URBANAVICHUS 2010), Mongolia (HAUCK & JAVKHLAN 2006) and Sichuan (TITOV 2000).

***Chrysothrix candelaris* (L.) J.R.Laundon**

Kazakh Altai, Katon-Karagai National Park, 14 km WSW Enbek, 49°8'20"N/85°57'39"E, 1480 m a.s.l., on *Larix sibirica*, 22.08.2010.

The species is easily to identify by its deeply golden-yellow (pulvinic acid derivatives), leprose thallus. It is obviously a rare species in the Kazakh Altai and was found in bark furrows of the trunk base of larch tree in the forest interior; it was associated with, e.g., *Chaenotheca stemonea*. *Chrysothrix candelaris* is widely distributed in both hemispheres and is recorded from western and southern Siberia, the Russian Far East (URBANAVICHUS 2010) and Mongolia (HAUCK & JAVKHLAN 2006). It is also reported from Tibet (OBERMAYER 2004).

Coenogonium pineti (Ach.) Lücking & Lumbsch (= *Dimerella pineti* (Ach.) Vězda)

Kazakh Altai, Katon-Karagai National Park, 10 km WSW Enbek, 49°9'8"N/86°0'38"E, 1260 m a.s.l., on *Larix sibirica*, 18.08.2010. Saur Mountains, c. 25 km S Zaisan, 47°16'35"N/84°53'27"E, 1690 m a.s.l., on *Larix sibirica*, 15.07.2011.

The specimens have narrowly ellipsoid, 2-celled, hyaline ascospores of c. $10 \times 2 \mu\text{m}$, cream white apothecia and an inconspicuous crustose thallus with *Trentepohlia*. The species was found on the trunk of larch trees, preferably at the base, mostly in the forest interior. *Coenogonium pineti* is a temperate to southern boreal species and known from both hemispheres; it is recorded from western and southern Siberia and the Russian Far East (URBANAVICHUS 2010).

Collema subflaccidum Degel.

Kazakh Altai, Katon-Karagai National Park, 15 km WSW Enbek, 49°8'39"N/85°57'58"E, 1310 m a.s.l., on *Larix sibirica*, 24.08.2010.

Collema subflaccidum is an isidiate species and the Kazakh specimen was, as often, lacking apothecia. The species differs from other isidiate *Collema* species by the shape of the isidia, which are first globose and later cylindrical on the same thallus. The isidia are evenly distributed over the thallus, which has an olive-green tinge and a smooth surface without ridges (in contrast to *C. nigrescens* and *C. furfuraceum*). In the Kazakh Altai, *C. subflaccidum* was found on the base of old (diameter at breast height 50–70 cm) trees of *Larix sibirica* at the forest line to the steppe, and was associated with *Leptogium saturninum*. *Collema subflaccidum* is a cosmopolitan species, which has already been reported from western and southern Siberia, the Russian Far East (URBANAVICHUS 2010), Kyrgyzstan (LITTERSKI 2006), China (DEGELIUS 1974), and Mongolia (HAUCK & JAVKHLAN 2006).

Cyphelium pinicola Tibell

Kazakh Altai, Katon-Karagai National Park, 14 km WSW Enbek, 49°8'20"N/85°57'39"E, 1480 m a.s.l., on *Larix sibirica*, 22.08.2010.

The species is characterized by its bright-yellow thallus and differs from the similar, more widespread *C. tigillare* by smaller 2-celled ascospores ($12.5\text{--}17\text{--}(20) \times 8\text{--}10 \mu\text{m}$) and sessile apothecia with a clearly developed excipulum at the base (TIBELL 1971). The thallus of *C. pinicola* tends to be thinner than that in *C. tigillare* and the morphologically identical *C. notarisii* (with submuriform ascospores), which also occurs in eastern Kazakhstan. *Cyphelium pinicola* was rarely found on trunks (mostly at the base) of *Larix sibirica*, where it was associated with, e.g., *C. tigillare*, *Chaenotheca stemonea*, *Hypogymnia austerodes* and *Lecanora cadubriae*. In Russia, *Cyphelium pinicola* is not known from southern Siberia, but occurs in eastern Siberia, the Russian Far East and the European part (URBANAVICHUS 2010). The species is new to Central Asia.

Hypogymnia bitteri (Lyngé) Ahti

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'36"N/86°1'52"E, 1320 m a.s.l., on *Larix sibirica*, 13.08.2010. Saur Mountains, c. 25 km S Zaisan, 47°15'49"N/84°55'1"E, 1755 m a.s.l., on *Larix sibirica*, 06.07.2011.

Hypogymnia bitteri resembles little to moderately melanized shade forms of *H. austerodes*, but differs from the latter by the formation of capitate soralia in addition to laminal ones; *H. austerodes* has only laminal soralia. Furthermore, the soralia in *H. austerodes* are at least partly isidia-like, whereas those in *H. bitteri* are granular (GOWARD et al. 2012). *Hypogymnia bitteri* is widespread, but relatively rare in the conifer forests of the Kazakh Altai and apparently even rarer in the Saur Mountains, while *H. austerodes* (occurring in both dark brown forms at sun-exposed sites and with little melanized thalli in the forests) and *H. physodes* are dominant epiphyte species. It matches with the known preference of *H. bitteri* for continental climates that the species is one of the most abundant epiphytes on the lee side of the Altai Mountains in Mongolia (HAUCK et al. 2012). In that country, *H. bitteri* is a common epiphyte everywhere in the forest belt in both the light (*Larix sibirica* dominated) and the dark (*Pinus sibirica*, *Picea obovata*, *Abies sibirica* dominated) taiga (COGT 1995, HAUCK et al. 2007, HAUCK & JAVKHLAN 2009). *Hypogymnia bitteri* has a circumboreal distribution and is recorded from all parts of Siberia and the Russian Far East (URBANAVICHUS 2010). In China, it is among others known from Tibet and Inner Mongolia (WEI 1991).

Immersaria iranica Valadbeigi, Sipman & Rambold

Saur Mountains, c. 25 km S Zaisan, 47°16'59"N/84°53'15"E, 1660 m a.s.l., on siliceous rock, 22.07.2011.

Immersaria iranica is unique in having numerous stellate, white, ecorticate cracks on the thallus surface, which represent the opening of pycnidia. These cracks are frequent in the Kazakh material, although it has many red brown immersed apothecia with nearly globose ascospores (7–8 µm in diam.). The thallus is brown, smooth, deeply areolate, C–. The cited specimen is from small pieces of rain-exposed siliceous rock on the forest floor of a *Larix sibirica* stand immediately at the forest line to the steppe. *Immersaria iranica* was, so far, only known from steppes in Iran (VALADBEIGI et al. 2011). The occurrence in eastern Kazakhstan suggests that this recently described species could be widespread in the Inner Asian steppe belt.

Lecanora cadubriae (A.Massal.) Hedl.

Kazakh Altai, Katon-Karagai National Park, 14 km WSW Enbek, 49°8'20"N/85°57'39"E, 1480 m a.s.l., on *Larix sibirica*, 21.08.2010.

The Kazakh material of *L. cadubriae* has a thallus of convex, ecorticate, light grayish brown to yellowish grey areoles of 0.1–0.3 mm, which react K+ yellow, then red due to the presence of norstictic acid. Most apothecia are (like the epihymenium) red brown (more rarely blackish brown), flat and have a thin persistent margin, which is slightly raised above the disc. The ascospores are narrowly clavate (7.5–11 × 3 µm). Black pycnidia are frequent and more or less immersed into the thallus, producing straight bacilliform, rarely slightly curved conidia of 3–7 × 1 µm. *Lecanora cadubriae* was rarely found on trunk bases of *Larix sibirica* in the forest interior. The species was associated with, for instance, *Chaenotheca stemonea*, *Cyphelium tigillare* and *C. pinicola*. *Lecanora cadubriae* has a circumboreal distribution; its known distribution includes southern Siberia (URBANAVICHUS 2010).

Lecanora impudens Degel.

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'28"N/86°1'41"E, 1410 m a.s.l., on *Larix sibirica*, 12.08.2010. Saur Mountains, c. 25 km S Zaisan, 47°15'44"N/84°55'36"E, 1845 m a.s.l., on *Larix sibirica*, 06.07.2011.

The specimens have yellowish green soralia on a whitish to light gray, K+/P+ yellow (atranorin) thallus. Since the material was partly fertile, it could be separated from the similar *L. allophana* f. *sorediata* (Schaer.) Vain. by the broadly sessile apothecia with a thin, ± even margin and the thin wall of the ascospores (<1 µm; WIRTH et al. 2013). *Lecanora impudens* is widespread in Asian Russia, including western and southern Siberia and the Russian Far East (URBANAVICHUS 2010).

Lecidella scabra (Taylor) Hertel & Leuckert

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'36"N/86°1'52"E, 1320 m a.s.l., on *Larix sibirica*, 13.08.2010.

The specimen has a brownish gray to brownish rimose, minutely verrucose, UV+ orange (xanthonenes), K+ yellow (atranorin) thallus with discrete greenish yellow soralia. The species grew together with *Candelariella reflexa* on the trunk base of a larch tree at the forest edge to the steppe. *Lecidella scabra* occurs in Eurasia and the Americas and is primarily an inhabitant of siliceous rock, while TØNSBERG (1992) pointed out that the species is also an inhabitant of nutrient-rich bark. In the Asian part of Russia, *L. scabra* has been reported from southern Siberia (URBANAVICHUS 2010).

Lepraria elobata Tønsberg

Kazakh Altai, Katon-Karagai National Park, 10 km WSW Enbek, 49°8'41"N/86°0'43"E, 1315 m a.s.l., on *Larix sibirica*, 19.08.2010, det. T. Tønsberg [TLC: atranorin, stictic acid, zeorin]. Saur Mountains, c. 25 km S Zaisan, 47°16'37"N/84°53'27"E, 1680 m a.s.l., on *Larix sibirica*, 12.07.2011, det. T. Tønsberg [TLC: atranorin, stictic acid, zeorin], duplicate specimen in BG.

Lepraria elobata shares the secondary chemistry with *L. lobificans*, but lacks a medulla and has compact soredia without projecting hyphae. The species was found on trunk bases in the Kazakh Altai and the Saur Mountains. It is new to Central Asia. *Lepraria elobata* is known from the Russian Far East, the Urals Mountains, and the Caucasus, but not from Siberia so far (URBANAVICHUS 2010).

Lepraria rigidula (de Lesd.) Tønsberg

Saur Mountains, c. 25 km S Zaisan, 47°16'59"N/84°53'15"E, 1660 m a.s.l., on siliceous rock, 22.07.2011, det. T. Tønsberg [TLC: atranorin, nephrosteranic acid].

The species forms long projecting hyphae on the surface of bluish to whitish gray soredia and is characterized by its secondary chemistry. *Lepraria rigidula* was found over bryophytes and directly on siliceous rock in an overhang situation. The species is new to Central Asia. From Russia, *L. rigidula* is only known from the European part, the southern Ural Mountains and the Caucasus (URBANAVICHUS 2010).

Ochrolechia szatalaënsis Verseghy

Saur Mountains, c. 25 km S Zaisan, 47°15'48"N/84°55'32"E, 1795 m a.s.l., on *Larix sibirica*, 21.07.2011; duplicate specimen in BG [TLC: variolaric acid, two fatty acids, two unknown substances].

The specimen has K/C/KC– apothecia (disc and margin), two spores of (50–)63–73(–90) × 27–38 µm, a 400 µm high hymenium and a 35–50 µm thick hypothecium. The cortex of the amphithecium was c. 25 µm wide laterally, but c. 150 µm and opaque at the base, which separates the species from the similar *O. upsaliensis* (BRODO 1991, KUKWA 2011). *Ochrolechia szatalaënsis* is rare in eastern Kazakhstan. It was only found once on a lying thick deadwood trunk of *Larix sibirica* in the forest interior directly on the wood and over plant debris, which had accumulated on the deadwood; over debris the thallus was rugose resembling that of *O. upsaliensis*. The species occurred in a species-poor community with *Parmelina pastillifera*. *Ochrolechia szatalaënsis* is not known from Siberia, but from the northern Russian Far East, the Caucasus (URBANAVICHUS 2010) and Turkey (KUKWA 2011).

Ochrolechia turneri (Sm.) Hasselrot

Saur Mountains, c. 25 km S Zaisan, 47°15'44"N/84°55'36"E, 1845 m a.s.l., on *Larix sibirica*, 06.07.2011, det. T. Tønsberg [TLC: variolaric acid].

Ochrolechia turneri has a continuous, rather smooth, whitish gray thallus with discrete to partly confluent, C+ yellow soralia. The similar *Ochrolechia microstictoides* differs by the presence of the fatty acid lichesterinic acid, which was absent in the Kazakh specimens. The species is quite common on the trunks of larch trees in the Saur Mountains. *Ochrolechia turneri* is known from southern Siberia, the southern Russian Far East (URBANAVICHUS 2010) and Iran (KUKWA 2011).

Parmelina pastillifera (Harm.) Hale

Saur Mountains, c. 25 km S Zaisan, 47°15'51"N/84°55'00"E, 1670 m a.s.l., on *Larix sibirica*, 07.07.2011. Saur Mountains, c. 25 km S Zaisan, 47°16'59"N/84°53'15"E, 1660 m a.s.l., on rain-exposed siliceous rock in *Larix sibirica* forest, 22.07.2011.

The species differs from the similar *P. tiliacea*, which was already known from Kazakhstan (ANDREEVA 1983) by the black, rounded isidia with flattened apices. *Parmelina pastillifera* is widespread on the middle stem of larch trees in the Saur Mountains, but usually found in single, mostly small individuals. Associated species include *Melanohalea exasperatula*, *Parmelia sulcata*, *Parmeliopsis ambigua*, *Physcia stellaris*, *Usnea lapponica*, and *Vulpicida pinastri*. It was rarely found on deadwood and rain-exposed siliceous rock (with *Xanthoparmelia stenophylla*). *Parmelina pastillifera* is not known from Siberia; records from Russia are restricted to the southern Ural Mountains, the Caucasus and the European part (URBANAVICHUS 2010). The species is new to Central Asia.

Psora testacea Hoffm.

Kazakh Altai, Katon-Karagai National Park, 15 km WSW Enbek, 49°8'33"N/85°58'7"E, 1395 m a.s.l., on calcareous rock, 23.08.2010.

The species is easily recognized by its squamulose, grayish to olivaceous thallus and convex, emarginate apothecia, which are orange due to the production of anthraquinones (TIMDAL 1984). In the Kazakh Altai, *P. testacea* was found in crevices of calcareous rock in the steppe on a south-facing slope. In Central Asia, the species has already been reported from Mongolia (SCHUBERT & KLEMENT 1971). Most published records of *P. testacea* are from warm habitats with calcareous rock from Central Europe and the Mediterranean countries, including Europe, Africa (Morocco) and the Near East (Turkey, Syria) (WERNER 1958, 1967, ÖZTURK 1990).

Psorula rufonigra (Tuck.) Gotth. Schneid.

Kazakh Altai, Katon-Karagai National Park, 10 km WSW Enbek, 49°9'3"N/86°0'32"E, 1270 m a.s.l., on *Spilonema revertens*, 17.08.2010., det. O. Breuss.

The thallus of this green-algal lichen is formed by dark brown, 0.5–1.5 mm, imbricate, ascending squamules with blackish margins and greenish black lower surface. The upper cortex is paraplectenchymatous, whereas the lower cortex consists of partly periclinally oriented hyphae with small cell lumina. The species was found over a thin soil layer covering siliceous rock or directly on stones on a steppe slope. The squamules of *P. rufonigra* grew on and between the thallus of the cyanolichen *Spilonema revertens*; association with this species seems to be mandatory for *P. rufonigra* (SCHNEIDER 1979). *Psorula rufonigra* is widespread, but nowhere frequent in the semiarid regions of the northern hemisphere. The known distribution includes southern and eastern Siberia, the Russian Far East (URBANAVICHUS 2010), Mongolia (COGT 1995), Xinjiang (ABBAS et al. 2001), Inner Mongolia (WEI 1991) and Iran (SCHNEIDER 1979).

Rinodina septentrionalis Malme

Kazakh Altai, Katon-Karagai National Park, 8 km WSW Enbek, 49°9'36"N/86°1'52"E, 1320 m a.s.l., on *Larix sibirica*, 13.08.2010, det. H. Mayrhofer.

The species has a copper-brown thallus of discrete areoles, small, scattered, sessile and basally constricted apothecia and *Physcia*-type ascospores with thick apical walls. *Rinodina septentrionalis* was found on branches and trunk bases of larch trees. It has a northern circumpolar distribution, including the southern Arctic and the boreal forests (MAYRHOFER & MOBERG 2002, SHEARD 2010) and is widespread in Asian Russia (SHEARD 2010, URBANAVICHUS 2010).

Rinodina trevisanii (Hepp) Körb.

Saur Mountains, c. 25 km S Zaisan, 47°15'49"N/84°55'1"E, 1755 m a.s.l., on *Larix sibirica*, 14.07.2011, det. H. Mayrhofer.

The material from Kazakhstan has a continuous to deeply areolate brownish gray thallus. The ascospores of the *Physconia*-type (MAYRHOFER & SHEARD 2007) are characterized by strong cell wall thickenings at the septum and thin or lacking apical thickenings. The species is apparently widespread on trunk bases of larch trees in the Saur Mountains. *Rinodina trevisanii* is also known from southern and eastern Siberia (MAYRHOFER & SHEARD 2007, URBANAVICHUS 2010), Europe (Alps, Balkan Peninsula, Corse, Scandinavia, Vosges, southern Italy; MAYRHOFER & SHEARD 2007), Turkey (MAYRHOFER & SHEARD 2007) and western North America (MAYRHOFER & SHEARD 2007, SHEARD 2010).

Rusavskia soredata (Vain.) S.Y.Kondr. & Kärnefelt [= *Xanthoria soredata* (Vain.) Poelt]

Saur Mountains, c. 25 km S Zaisan, 47°16'59"N/84°53'15"E, 1660 m a.s.l., on siliceous rock, 22.07.2011.

The species resembles *Rusavskia elegans* (= *Xanthoria elegans*), but differs by its soredate thallus. In the Saur Mountains, it was found under a rock overhang in a larch forest. The species was also seen in the Kazakh Altai, but no specimen could be collected. The species has a bipolar distribution and occurs primarily in arctic, boreal and high mountain areas. Its known distribution includes Siberia and the Russian Far East (URBANAVICHUS 2010) as well as Kyrgyzstan (LITTERSKI 2006).

Spilonema revertens Nyl.

Kazakh Altai, Katon-Karagai National Park, 10 km WSW Enbek, 49°9'3"N/86°0'32"E, 1270 m a.s.l., on thin soil layer over siliceous rock, 17.08.2010, det. O. Breuss.

Spilonema revertens is a filamentous cyanolichen with cushion-forming erect, branched, blackish filaments. The species grew together with *Psorula rufonigra* on a steppe slope. *Spilonema revertens* is a cosmopolitan species and occurs, among others, in southern and eastern Siberia, the Russian Far East (URBANAVICHUS 2010) and Mongolia (COGT 1995).

Tetramelas chloroleucus (Körb.) A.Nordin

Saur Mountains, c. 25 km S Zaisan, 47°15'48"N/84°55'32"E, 1795 m a.s.l., on *Larix sibirica*, 09.07.2011.

The specimen had a yellowish, UV+ orange (xanthenes) thallus and 2-celled brown ascospores of 22–25 × 7.5 μm, a brown epihymenium and hyaline hymenium, which was not interspersed with oil droplets. The similar *T. insignis* has wider ascospores (GIRALT et al. 2000, NORDIN 2000a). *Tetramelas chloroleucus*

was found on the middle stem of a larch tree in the forest interior together with *Lecanora subintricata*, *Hypogymnia austerodes* and *Usnea lapponica*. *Tetramelas chloroleucus* is widely distributed in the northern hemisphere and also occurs in southern Siberia and the Russian Far East (URBANAVICHUS 2010).

***Tetramelas triphragmoides* (Anzi) A.Nordin & Tibell**

Kazakh Altai, Katon-Karagai National Park, 16 km WSW Enbek, 49°8'20"N/85°55'57"E, 1425 m a.s.l., on *Larix sibirica*, 28.08.2010.

The species is characterized by the yellowish, C+/UV+ orange thallus and trisepatate brown ascospores. The ascospores in the specimen from Kazakhstan exceed with $26\text{--}31 \times 8\text{--}10 \mu\text{m}$ the range of $19\text{--}27.5 \times 7.5\text{--}10.5 \mu\text{m}$ given by NORDIN (2000b) and NORDIN & TIBELL (2005). The spore size of the Kazakh specimen falls in the range of that in *T. geophilus*, which is specified as $23.5\text{--}38 \times 6.5\text{--}13.5 \mu\text{m}$, but this species is an arctic-alpine terricolous taxon with a white to grayish white thallus. The specimen from Kazakhstan has a dark yellowish color in both the thallus and a pruina on the apothecia. *Tetramelas triphragmoides* is already known from Siberia and Mongolia (NORDIN 2000b, HAUCK & JAVKHLAN 2006).

***Trapeliopsis flexuosa* (Fr.) Coppins & P.James**

Kazakh Altai, Katon-Karagai National Park, 11 km WSW Enbek, 49°8'59"N/85°59'54"E, 1275 m a.s.l., on *Larix sibirica*, 16.08.2010. Saur Mountains, c. 25 km S Zaisan, 47°15'47"N/84°55'42"E, 1775 m a.s.l., on *Larix sibirica*, 08.07.2011.

The material is characterized by its greenish to greenish gray, C+ red (gyrophoric acid) areolate thallus and lacks apothecia. It was found on the trunk bases of larch. The similar gray-colored *T. granulosa* occurred in the same habitat, but not on the same tree. The cosmopolitan *T. flexuosa* is also known from all forested parts of Asian Russia (URBANAVICHUS 2010) and Mongolia (PALKA & ŚLIWA 2004).

***Tuckermannopsis chlorophylla* (Willd.) Hale**

Saur Mountains, c. 25 km S Zaisan, 47°15'44"N/84°55'36"E, 1845 m a.s.l., on *Larix sibirica*, 08.07.2011.

This easily recognized loosely attached foliose, brown cetrarioid lichen with marginal soralia was only found once on the trunk base of a larch tree in the forest interior. The bipolar distribution range of the species includes Siberia, the Russian Far East (URBANAVICHUS 2010) and Mongolia (SCHUBERT & KLEMENT 1971). It is also recorded from Tibet (OBERMAYER 2004).

***Xanthomendoza fallax* (Hepp) Søchting, Kärnefelt & S.Y. Kondr. [= *Oxneria fallax* (Hepp) S.Y. Kondr. & Kärnefelt, *Xanthoria fallax* (Hepp) Arnold]**

Kazakh Altai, Katon-Karagai National Park, 15 km WSW Enbek, 49°8'39"N/85°57'58"E, 1310 m a.s.l., on *Padus*, 25.08.2010.

Xanthomendoza fallax belongs to *Xanthoria* s.lat. and is characterized by lobes with extensive labri-form soralia (in addition to few blastidia) at the lobe margins and mostly downward-curved lobe tips (POELT & PETUTSCHNIG 1992, KONDRATYUK 2004). The individual lobes combine to more or less continuous thalli of several centimeters (3.5 cm in the cited specimen). *Xanthomendoza fallax* is apparently a rare species in the Kazakh Altai. It was found on *Padus* in the forest-steppe near a *Larix sibirica* stand. It is known from the Russian Far East and all parts of Siberia (URBANAVICHUS 2010), Mongolia (HAUCK & JAVKHLAN 2006) and Kyrgyzstan (LITTERSKI 2006).

***Xanthomendoza ulophyllodes* (Räsänen) Søchting, Kärnefelt & S.Y. Kondr. [= *Oxneria ulophyllodes* (Räsänen) S.Y. Kondr. & Kärnefelt, *Xanthoria ulophyllodes* Räsänen]**

Kazakh Altai, Katon-Karagai National Park, 11 km WSW Enbek, 49°8'59"N/85°59'54"E, 1200 m a.s.l., on *Larix sibirica*, 15.08.2010.

Xanthomendoza ulophyllodes differs from *X. fallax* by the production of blastidia, instead of true soredia, which are limited to the lobe margins (POELT & PETUTSCHNIG 1992). The thalli are usually smaller and the individual lobes are more scattered than in *X. fallax*. *Xanthomendoza ulophyllodes* is a characteristic species of nutrient-enriched, sun-exposed trunk bases and branches of *Larix sibirica* in the eastern Kazakh forest-steppe, where it is often associated with *Polycauliona candelaria* (= *Xanthoria* c., *Massjukiella* c.), *Physcia dubia* and *Candelariella reflexa*. *Xanthomendoza ulophyllodes* is also typical for broad-leaved shrubs and trees (*Sorbus* in the understory of larch forests) in sunlit

situations, where it is associated with, for example, *Physciella chloantha*, *Physcia biziana*, and *P. stellaris*. *Xanthomendoza ulophylloides* is known from southern and western Siberia, the Russian Far East (URBANAVICHUS 2010) and Mongolia (HAUCK & JAVKHLAN 2006).

Xanthoparmelia loxodes (Nyl.) Blanco et al.

Saur Mountains, c. 25 km S Zaisan, 47°16'59"N/84°53'15"E, 1660 m a.s.l., on siliceous rock, 22.07.2011.

This light brown, isidiate lichen with C+/KC+ red medulla grew on siliceous rock in a larch forest. It is widespread in the northern hemisphere, including southern Siberia and the southern Russian Far East (URBANAVICHUS 2010), Mongolia (COGT 1995), Armenia (HARUTYUNYAN et al. 2011), Afghanistan (STEINER & POELT 1986), Kyrgyzstan (LITTERSKI 2006), and Tajikistan (KUDRATOV & MAYRHOFFER 2002).

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