

Miriquidica majae, a new lichen species from oldgrowth *Picea abies* forests in central Norway

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The new species *Miriquidica majae* Tønberg is described from northern boreal forests in Central Norway where it is restricted to trunks of *Picea abies*, mainly in oldgrowth forests. Chemically *M. majae* recalls *Myochroidea porphyrospoda*, but is distinct by the combination of the endosubstratal or indistinct, white thallus in non-sorediate parts, the scattered, effuse soralia, and the lack of areoles that are not completely sorediate. The apothecia are rare and usually poorly developed. The sequences from the ITS2 region of the two species differ markedly.

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Introduction

Recent field work in oldgrowth *Picea abies* forests in Central Norway yielded specimens of a sorediate and usually sterile crustose lichen that to the best of our knowledge is new to science. It recalls *Myochroidea porphyrospoda* (Anzi) Printzen, T. Sprib. & Tønberg, but proved to be distinct from that species morphologically, ecologically, and genetically based on nuclear (ITS2) sequence alignments.

Material and Methods

This study is mainly based on the first author's field work in Nord-Trøndelag [now part of Trøndelag] and Nordland counties in 2012, and 2016–2018. The collections of the new species are deposited in BG if not otherwise stated. As fertile specimens proved to be difficult to recognize in the field, quite a few specimens were collected and subjected to close examinations under the dissecting microscope in search of apothecia. Due to the limited access to apothecia, the description of them is not exhaustive. Elevational data given for the collection localities are derived from Kartverket (2019), based on field GPS data (datum WGS84). Thin-layer chromatography (TLC) was carried out in solvent systems A, B' and C according to Culberson and Kristinsson (1970), Culberson (1972), and Menlove (1974), with glass plates in solvent C allowing for the detection of fatty acids. All specimens filed as *Myochroidea porphyrospoda* in B, BG, TRH and O were studied for comparison with and in search for possible specimens of the new species. The term *petticoat spruce* is used for the Norwegian *skjortegran* which denotes spruces with dry, hanging branches reaching down towards the ground around the base of the trunk (Fig. 1; see



Figure 1. Petticoat spruce (*Picea abies*) on peninsula Hotelltangen in lake Majavatnet – one of two localities where *Miriquidica majae* was found fertile. Photo T. Tønsberg 2017-08-18.

also Holien et al. 2015, page 49, Fig. 3). When such spruce trees support live branches elsewhere on the trunk all the way up to the top, rain-water will be drained away from the trunk causing a dry environment at the base. Petticoat spruces are typical for open forests with good light conditions in boreal forests (H. Holien, pers. comm. March 2019).

The phylogeny of the genera *Myochroidea* and *Miriquidica* is currently studied by Mika Bendiksby and Andreas Frisch, the Norwegian University of Science and Technology – NTNU, and Einar Timdal and Reidar Haugan, the University of Oslo. Based on their unpublished results it became clear that the species described as new below belongs in *Miriquidica*. Insertion of this species into a phylogenetic tree awaits their results, and the present study is based mainly on morphological characters. Yet, both apothecia (holotype) and soralia were subjected to DNA-sequencing at the University of Bergen, using the methods described by Zahradníková et al. (2017).

Genetic results and discussions

We were not able to get sequences from soralia. From apothecia of the holotype we successfully generated sequences of the mtSSU and ITS2 regions (see GenBank). The ITS2 sequences showed that, over an alignment of 259 bases, 20 bases differed between *Miriquidica majae* and *Myochroidea porphyrospoda*. This clearly indicates that the two are distinct species.

Taxonomy

Miriquidica majae Tønsberg sp. nov. Figs. 2–3.

MycoBank: MB 830184

Diagnosis: The species differs from *Myochroidea porphyrospoda* by the indistinct or endosubstratal, whitish thallus in non-sorediate parts, the scattered, effuse soralia, the absence of areoles being not completely sorediate, the apothecia being rare and poorly developed, and the strong preference for trunks of mature *Picea abies* in oldgrowth spruce forests.

Type: **Norway**, *Nordland*: Grane, Majavatn, the NW-facing slope of Mt. Litlfjellet E of/uphill from Majavatn Railway Station, 65.16496°N, 13.38216°E, 425 m alt., on trunk of mature *Picea abies* of the petticoat type, in steep slope with oldgrowth spruce forest, 2017-06-24, T. Tønsberg 47166 (BG L-102205, holotype [fertile]; NY, O, OSC, TRH, UBC, UPS, WTU, isotypes [all sterile]).

Description: Thallus indistinct, indeterminate, of hyphae and photobiont cells in the uppermost cell layer(s) of the substrate forming a white surface on which soralia are developed; hyphae colourless, 1.5–3 mm wide. Soralia irregular and effuse, discrete or a few becoming fused forming sorediate patches to a few mm in diameter, mottled pale brown due to a pigment in the outwardly facing part of the external soredia, pale green where the external soredia have been shed and in particularly shaded niches such as bark crevices; soredia 10–20 µm, consoredia 15–30 µm in diameter. Medulla not evident. The uppermost layer of the substrate tends to get detached and fragmented forming small, white, flat, scales that often support soralia (Fig. 3). Photobiont unicellular, chlorococcoid, usually globose, 5–15 µm in diameter.

Apothecia very rare (observed in a few specimens only), mostly poorly developed and misshaped, occasionally situated on the soralia, circular, 0.20–0.40 mm in diameter, without pruina; disc flat to deeply concave, pale brown or, rarely, dark brown, mat; margin usually raised



Figure 2. *Miriquidica majae*. Holotype. Thallus and apothecia. Scale 1 mm. Photo Einar Timdal.

above the disk, 0.04–0.08 mm wide, pale brown, mostly circular, rarely distinctly flexuose;. Excipulum 36–90 μm wide at upper rim, brown in outer part, colourless inside; hyphae branched; apical cell globose, to 3(–4) μm wide. Epihymenium brown; paraphyses usually unbranched, sometimes bifurcately branched in upper part, 1.5–2 μm wide; tips sometimes protruding unequally; uppermost cell widening to 3.5 μm , mostly with a brown cap; hymenium 36–55 μm tall, colourless; asci 8-spored, clavate to \pm cylindrical, 20–34 \times 10–14 μm , with a distinct K/I+ blue tholus, usually without an evident ocular chamber, sometimes with a short ocular chamber narrowing towards the ascus tip; spores simple, ellipsoid to oblong-ellipsoid, 7–10 \times 2–4 μm . Hypothecium 48–96 μm tall, colourless, sometimes with oil drops. Pycnidia not observed.

Chemistry: TLC: Lobaric acid. Colour reactions (soralia): C–, K–, KC+ fleetingly violet, Pd–. UV: Reaction of the soralia not evident against the white thallus/substrate surface.

Etymology: In the South Sami language the mountains Majafjellet and Majaklumpen in the southwestern corner of Nordland Co., Grane municipality, are called *Maajehtjahke* and *Maajehsnuhkie*, respectively (Kartverket 2019). To the east of these mountains is lake Majavatnet with the Sami name *Maajehjaevrie*. *Maaje* is translated as *with wide views* for the mountains and as *long distance* for the lake (Bergsland 1995: 24, Norsk Stadnamleksikon 1997; see also Bergsland & Magga 1993, and Jernsletten 2009: page 89 [all in Norwegian]); the name of the lake regarded as secondary to the name of the mountain (Bergsland 1995). The new species is named after lake Majavatnet where surrounding hillsides and some of the islands and peninsulas are inhabited with old spruce trees supporting the new species.



Figure 3. *Miriquidica majae*. T. Tønsberg 47835. Thallus with soralia on flaking spruce bark. A few apothecia of *Lecanora cadubriae* at bottom left. Scale 1 mm. Photo Einar Timdal.

Habitat and distribution: *Miriquidica majae* has been found on *Picea abies* only. All specimens were from trunks. The trees were of the petticoat type (Fig. 1) and mostly with thick, rough and deeply furrowed bark. *M. majae* occurred on the outer surface of the bark and in the crevices. Associated species (found with *M. majae* on the bark pieces in the herbarium packets) included, e.g. *Arthonia* sp., *Lecanora cadubriae* (A. Massal.) Hedl. (the most common one), *Lecanora phaeostigma* (Körb.) Almb., *Lecidea leprarioides* Tønsberg, *Protoparmelia ochrococca* (Nyl.) P.M. Jørg., Rambold & Hertel, *Pycnora sorophora* (Vain.) Hafellner, and *Toensbergia leucococca* (R. Sant.) Bendiksby & Timdal. Other species occurring on the same trunks as *Miriquidica majae* included *Calicium glaucellum* Ach., *C. viride* Pers., *Chaenotheca sphaerocephala* Nád., *C. subroscida* (Eitner) Zahlbr., and *C. trichialis* (Ach.) Th. Fr. In two localities (the type locality and Hotelltangen) *Acolium inquinans* (Sm.) A. Massal. occurred on trunks and/or branches of *Picea abies*. At the locality near the river between Kjerringvatnet and Storsvenningvatnet, branches of *Picea abies* supported *Bactrospora brodoi* Egea & Torrente and *Cliostomum piceicola* Holien & Tønsberg. The type locality supported pieces of wood of spruce with *Pertusaria mccroryae* C.R. Björk et al.

Miriquidica majae is mainly known from the northwest facing slope of Mt. Littlefjellet east of lake Majavatnet and on the islands and in the surroundings of that lake (altitude 312 m according to Norgeskart) in Nordland Co., Grane municipality in central Norway, in addition to a few localities further to the north of Majavatn in Grane and to the south in Namsskogan municipality, Nord-Trøndelag Co. The altitudinal range was 199–441 m. Specimens with apothecia were found

in two localities only: in the steep, northwest facing slope of Mt. Litlefjellet (the type locality) and on peninsula Hotelltangen in lake Majavatnet.

Discussion: Within the genus *Miriquidica*, *M. majae* is distinct due to the combination of a white thallus/substrate surface, the effuse but \pm discrete soralia, the lack of esorediate areoles, the production of lobaric acid, the corticolous habit, and the apparent restriction to trunks of mature *Picea abies* of the petticoat type in oldgrowth forests. The species is not very variable. The soralia vary in colour from the usual mottled brown, to pale greenish in specimens growing in deep and shaded bark crevices. The outermost bark layer tend to get detached forming small, fragile, white, flaking scales supporting soralia (Fig. 2–3); apparently these scales function as diaspores dispersing whole soralia.

Myochroidea porphyrospoda, which also contains lobaric acid and is sorediate and often corticolous, differs in the substrate surface which is usually dark brown to blackish, the distinct and usually much thicker thallus (up to 1 mm in Tønsberg 8047) which may be continuous, the soralia which are usually more densely packed and may become confluent forming sorediate patches to several cm or more in diameter or, more rarely, becoming more or less leprose throughout, and the always presence of at least some areoles that are not completely sorediate. The apothecia and spores of that species are larger than those of *Miriquidica majae*, with apothecia up to 1.2 mm (Aptroot et al. 2009) and spores $11.5\text{--}15.5 \times 5\text{--}8 \mu\text{m}$ (Printzen et al. 2008). In *M. majae* the corresponding values are 0.40 mm and $7\text{--}10 \times 2\text{--}4 \mu\text{m}$, respectively. It should be noted that for *M. majae* these numbers are based on poorly developed apothecia from a few specimens only.

Whereas *M. majae* so far is known only from central Norway the geographical range of *M. porphyrospoda* includes Fennoscandia (where it is common and widely distributed in Norway and Sweden (Nordin et al. 2019)), Scotland, Central/southeastern European mountains including the Alps from where it was described (Anzi 1864), Iceland, western North America and the Sub-Antarctic island South Georgia (Hinteregger 1994, Øvstedal & Lewis Smith 2001, Printzen et al. 2008, Aptroot et al. 2009, McCune 2017). In Norway *Myochroidea porphyrospoda* occurs corticolous, more rarely on wood, on trunks and branches of many species of trees and shrubs, the most common being *Betula pubescens*, *Juniperus communis*, *Picea abies*, and *Salix* spp. (see Timdal 2019). Based on the presently known material, *Miriquidica majae* has been found corticolous on trunks of *Picea abies* only.

Miriquidica majae often occurs mixed with *Lecanora cadubriae* which also has brownish apothecia (Fig. 3). *Miriquidica majae* is distinct from that species, e.g. by the sorediate thallus (versus no vegetative diaspores), the non-pruinose apothecia (versus usually distinctly pruinose), and the chemical constituent lobaric acid (versus norstictic acid, i.e. chemotype 1 of Holien & Hilmo 1991; the chemotype of *Lecanora cadubriae* with virensic acid (chemotype 2 of Holien & Hilmo 1991) was not found in material associated with *M. majae*). The crustose and sorediate associates, *Lecidea leprarioides* and *Pycnora sorophora*, are unlikely to be confused with *M. majae*, because they have soralia that become confluent and produce the diagnostic constituents pseudoplacodiolic and alectorialic acid, respectively.

Miriquidica majae is a species of old-growth *Picea abies* forests in the northern boreal zone. The type locality on Mt. Litlefjellet, with its many mature *Picea abies* trees (the largest one observed measuring 2.29 m in circumference at chest height on 18 August 2016), stands out as the richest site for the new species so far in terms of the size of the area and the number of trees supporting the new species.

The distribution of the species is apparently not well known. The presently known distribution is within the area for the Trøndelag phytogeographical element (see Holien &

Tønsberg 1996). Species with a strong preference for *Picea abies* in this area (Central Norway and neighbouring parts of Sweden) are, e.g., *Bactrospora brodoi* and *Cliostomum piceicola* which in Scandinavia have their main occurrences in eastern part of Nord-Trøndelag county (Holien et al. 2015, Holien & Tønsberg 2017), and *Chaenotheca sphaerocephala* which in Norway is mainly distributed in eastern parts of Southern Norway (see Timdal 2019). In Northern Norway, *C. sphaerocephala* is known only from a few localities including the type locality for *M. majae*. In spite of their preference for branches or twigs, *Miriqidica majae* may prove to be most similar in distribution to *Bactrospora brodoi* and *Cliostomum piceicola* which are characterized by Holien et al. (2015) as species of oldgrowth *Picea abies* forests in boreal areas. However, based on what is presently known, the species with the most similar distribution pattern to that of *M. majae*, appears to be *Pertusaria mccroryae*, which was reported as new to Europe by Tønsberg (2011) based on a specimen from the type locality for *Miriqidica majae*. Like *M. majae*, that species is known only from northern Nord-Trøndelag and southern Nordland (see Timdal 2019)

Bactrospora brodoi and *Chaenotheca sphaerocephala* are listed as EN (endangered) in the current redlist (Timdal et al. 2015)), and *Cliostomum piceicola* should be considered a candidate for the redlist (Holien & Tønsberg, unpublished). At the type locality for *M. majae* on Mt. Littlefjellet three redlisted species have been found: *Chaenotheca sphaerocephala* (EN), *C. subroscida* (NE, near threatened), and *Acolium inquinans* (VU, vulnerable; as *Cyphelium inquinans* (Sm.) Trevis).

Other specimens (selected) examined of Miriqidica majae (all specimens were from the base of trunks of *Picea abies* of the petticoat type, and mainly from oldgrowth *Picea abies* forests): **Norway. Nordland:** Grane, Majavatn, the NW-facing slope of Littlefjellet, Majavatn, N of the creek, 65.16198°N, 13.3790°E, 440 m alt., corticolous in dry, shallow cavity near base of trunk in old-growth *Picea abies* forest, 2012-06-15, T. Tønsberg 41444 (BG L-103006); 65.16199°N 13.37858°E, 429 m alt., corticolous on dry, overhanging face near base of trunk of mature *Picea abies* in small ravine, 2016-08-16, T. Tønsberg 46657 (BG L-103007); 65.16266°N 13.37866°E, 417 m alt., 2016-09-19, T. Tønsberg 46790 (BG L-103008); 65.16313°N 13.37983°E, 427 m alt., 2016-09-19, T. Tønsberg 46792 (BG L-103009); 65.16214°N 13.37866°E, 428 m alt., 2016-09-24, T. Tønsberg 46990 (BG L-103010); 65.16197°N 13.37900°E, 441 m alt., corticolous in shallow cavity at NW-facing side of base of huge trunk, 2016-09-24, T. Tønsberg 47010 (BG L-103011); 65.16524°N E13.38161°E, 409 m alt., corticolous on dry and shaded face near base of trunk of mature *Picea abies*, 2017-06-24, T. Tønsberg 47149 (BG L-103012); 65.16504°N 13.38209°E, 422 m alt., dry and shaded face near base of trunk, 2017-06-24, T. Tønsberg 47155 (BG L-103013); 65.16636°N 13.38303°E, 408 m alt., 2018-06-17, Tønsberg 47738 (BG L-103333); at lake Majavatnet, SW of Majavatn Railway Station, Hotelltangen, 65.16348°N 13.36319°E, 312 m alt., corticolous on dry face near base of trunk in open *Picea abies* forest, 2017-06-28, T. Tønsberg 47223 (BG L-103015), 47225 (BG L-103017, sub *Toensbergia leucococca*); 65.16258°N 13.36230°E, 315 m alt., 2017-06-28, T. Tønsberg 47228 (BG L-103018); 65.16377°N 13.36211°E, 314 m alt., 2017-08-18, T. Tønsberg 47448 (BG L-103022); 65.16314°N 13.36151°E, 314 m alt., 2017-08-18, T. Tønsberg 47452 (BG L-101440); lake Majavatnet, island Buholmen W, just S of Trongundet, 65.18276°N 13.30219°E, 320 m alt., 2017-08-15, T. Tønsberg 47426 (BG L-103023); Buholmen S, 65.17905°N 13.30257°E, 330 m alt., 2018-07-22, Tønsberg 47833a (BG L-103024), 47835 (BG L-103025); island Sauholmen, 65.18558°N 13.31445°E, 320 m alt., corticolous in open *Picea abies/Betula pubescens* forest, 2018-07-22, T. Tønsberg 47849a (BG L-103026); island Storholmen S, 65.17910°N 13.29547°E, 329 m alt., 2018-07-26, T. Tønsberg 47882 (BG L-103027); Storholmen SE, 65.17970°N 13.29721°E, 322 m alt., 2018-07-26, T. Tønsberg 47897 (BG L-103028); W of lake Majavatnet, the E-facing slope of Dunfjellandet, 65.17774°N 13.27950°E, 322 m alt., on trunk of *Picea abies* in steep E facing oldgrowth forest, 2018-08-02, T. Tønsberg 47940 (BG L-103029), 47941 (BG L-103030); at lake Majavatnet SW, just inland from cove Mellingsbukta, 65.17774°N 13.27950°E, 322 m alt., 2018-08-02, T. Tønsberg 47954 (BG L-103031); along and E of the river from Majavatnet to Little-Majavatnet, S of Flya, 65.19473°N 13.31123°E, 320 m alt., corticolous on trunk of *Picea abies* in *Picea abies/Pinus sylvestris/Betula pubescens* forest, 2018-08-04, T.

Tønsberg 47971 (BG L-103032); E of Mellingsdalen, between Holmtjønna and Nordre Steinvatnet, 65.14059°N 13.24946°E, 369 m alt., 2018-08-01, T. Tønsberg 47926 (BG L-103033); E of N end of lake Tomasvatnet, along trail Jengelvegen, 65.17390°N 13.43389°E, 396 m alt., corticolous on *Picea abies* in open forest with *Picea abies* and *Betula pubescens*, T. Tønsberg 47913 (BG L-103034); Trolldalen, 65.25042°N 13.32234°E, 301 m alt., corticolous at base and in somewhat overhanging face of trunk near bog, 2017-06-23, T. Tønsberg 47122 (BG L-103019); the steep, W-facing slope just uphill from the river between Kjerringvatnet and Storsvenningvatnet, 65.28821°N 13.33161°E, 225 m alt., 2017-06-25, T. Tønsberg 47201 (BG L-103020); 65.28987°N 13.33181°E, 199 m alt., corticolous on dry and slightly concave face near base of trunk of mature *Picea abies*, 2017-06-25, T. Tønsberg 47204 (BG L-103021). *Nord-Trøndelag* [Trøndelag]: Namsskogan, Smalåsen, along trail between Solhaug and Åsheim, 65.07613°N 13.33561°E, 290 m alt., 2017-06-25, T. Tønsberg 47192 & A. Botnen (BG L-103038).

*Specimens (selected) of Myochroidea porphyrospoda studied for comparison: Czech Republic. Bohemia: S-Bohemia, Šumava Mts, Volary: Mt. Plechý, light boggy spruce forest NW of “Rakouská louka” and NE of “Trojmezi”, ca. 48°46.5′N 13°50.5′E, 1280–1320 m alt., on dry bark of old *Picea*, 1998-05-28, Z. Palice 1654 dupl. (BG L-44044; note: This rich collection recalls *M. majae* in comprising some bark pieces supporting thalli with only completely sorediate areoles. However, as esorediate areoles occur on other bark pieces, the whole collection is here regarded as being within the variation range of *M. porphyrospoda*).*

Norway. *Oppland:* Nordre Land, Dokka river ravine, the E-facing slope W of Høgfossen, N of the tributary creek, alt. 640–680 m alt., corticolous on log of *Picea abies*, 1996-09-28, T. Tønsberg 24404 (BG L-32081). *Telemark:* Vinje, Haukelifjell, S-facing slope of Mt. Krekledyrnuten, 1020 m alt., on base of *Betula*, 1991-10-07, T. Tønsberg 17415 (BG L-24169). *Hordaland:* Granvin, at Spunsofosfossen in Granvin, ca. 500 m alt., at base of trunk of *Betula pubescens* [as *B. odorata*], Sept. 1944, Havaas, Lich. Exs. Norv. 656 (BG L-5943; as *Biatora porphyrospoda* Anzi). *Nord-Trøndelag* [Trøndelag], Namsskogan, Børgfjell National Park, Namskroken, N side of river Namsen, 340 m alt., corticolous on *Picea abies*, 1982-08-17, T. Tønsberg 7452 (BG L-24152). *Nordland:* Grane, lake Majavatnet, Sveumtangen, 315 m alt., on *Picea abies*, trunk, 1988-07-21, T. Tønsberg 11054 (BG L-24166); Majavatn, Mt. Litlfjellet, 500 m alt., corticolous at base of *Betula*, 1983-08-08, T. Tønsberg 8047 (BG L-24155). **USA.** *Washington:* Pierce Co., Crystal Mountain Ridge, near summit 6872, 46°56′N 121°30′W, 2060–2095 m alt., on *Abies lasiocarpa*, 1996-08-04, Tønsberg 24015 (BG L-35214), 24020 (BG L-35217).

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