

Additions to the lichen flora of the Gaupne area – a species hot-spot in Norway

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Three lichen species, *Fuscopannaria praetermissa*, *Lepraria borealis* and *Xanthomendoza fulva*, are reported as additions to the biodiversity of the Gaupne area, Sogn og Fjordane, Norway. The fungal universal barcode DNA sequence (nrITS) is provided for *Fuscopannaria praetermissa* and *Lepraria borealis*. Results of preliminary molecular analyses indicate the need for a systematic revision of *Lepraria borealis* and other taxa in the *L. neglecta* group.

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Introduction

The area around Gaupne in Sogn og Fjordane, SW Norway, has recently been reported as a hot-spot for several organism groups including lichens (Lorentzen et al. 2019, Ellis et al. 2020, Arup et al. 2021). The presence of limestone outcrops, which are otherwise scarce in the subalpine-alpine zone in Norway, is the major abiotic factor explaining the high biodiversity with occurrences of rare bryophytes and lichens. Three interesting lichen species from the Gaupne area are reported here as an addition to the species list in Arup et al. (2021).

Material and Methods

The specimens were collected during a field trip to the Gaupne area, Luster municipality, Sogn og Fjordane, Norway 12–14 June 2018. Field work encompassed 17 localities in total (Arup et al. 2021).

Specimens were studied using a Zeiss stereozoom microscope. Standard spot tests were done with K (10% KOH in water), C (calcium hypochlorite), and PD (p-phenylenediamine solution in ethanol). Molecular work for the fungal universal barcode marker (nrITS) was conducted with standard protocols in the DNA Lab at University of Bergen (Øvstedal et al. 2018). Sequences were edited in Geneious Prime 2022.0.2 (Biomatters Ltd., New Zealand) and deposited in GenBank (NCBI). Sequence identities were confirmed using the standard NCBI BLASTn query option. For *Lepraria borealis* a FastTree analysis, which infers approximately-maximum-likelihood phylogenetic trees (Price et al. 2009, 2010), was constructed in Geneious with default settings. Two ITS sequences were deposited in GenBank (ON000259, OP554448).

The Species

Fuscopannaria praetermissa (Nyl.) P.M. Jørg.

In the locality Øksnavollen (loc. 9 in Arup et al. 2021) a *Fuscopannaria* specimen was collected on a slate cliff. It was lacking apothecia but had structures that in the field were interpreted as soredia. In the key in the Nordic Lichen Flora (Jørgensen 2007) there is a choice between “sorediate” and “not sorediate, often with apothecia”. Keying both alternatives resulted in either *F. mediterranea* or *F. praetermissa*. Of these, *F. praetermissa* seemed the most likely determination given that the “soredia” were actually outgrowths as described there (Jørgensen 2007: 103). A BLASTn query of the ITS marker confirmed the determination to *F. praetermissa*.

Fuscopannaria praetermissa is widespread in Norway; most common in arctic-alpine regions and rarer in the south (Jørgensen 2007, Artskart 2023). In Sogn og Fjordane there are eight previous records (in the years 1903–2018) on a wide variety of substrates, that is, corticolous on *Sorbus aucuparia*, on rock wall, on detritus in crevice in serpentinite bedrock, in spray zone from waterfall, and among bryophytes (NLD2 2023). It is red-listed as NT in Norway (Henriksen & Hilmo 2015).

Specimen examined: Norway. Sogn og Fjordane: Luster municipality, Engjadalen, Øksnavollen, 61.42049°N, 7.30184°E, alt. ca 735 m, on calciferous slate cliff on open mountain slope, 13.06.2018, L. Lindblom 1363 (O L-229233, GenBank ON000259).

Lepraria borealis Lohtander & Tønsb.

At the junction to Skisete (loc. 1 in Arup et al. 2021), a light grey leprose crust growing in a moss cushion was noted on a low slate cliff. The thallus was compact and rosette-like with marginal lobes (Fig. 1). It was hypothesized in the field that it was a species of the *Lepraria neglecta* group (Lohtander 1994, 1995, Lindblom 1995, Ekman & Tønsberg 2002, Saag et al. 2009, Fehrer et al. 2008) and noted that it was either *L. borealis*, *L. caesioalba*, or *L. neglecta* known from the Nordic countries (Foucard 2001).

Under the dissecting microscope it was observed that the thallus consisted of coarse large soredia grains that were firmly packed together, with no or only short protruding hyphae. Spot tests resulted in K+ faint yellow, C–, KC–, PD–, and UV+ dull pink reactions characteristic of *L. borealis* (Tønsberg 1992, Lohtander 1994, Lindblom 1995), which was described from Norway (Lohtander 1994). An HPTLC analysis will be carried out in the future to reliably establish the secondary chemistry of the specimen (Arup et al. 1993).

The BLASTn query of the ITS marker confirmed the identity to the genus *Lepraria*. However, the most similar sequences in GenBank were not even close to *L. borealis*, *L. caesioalba*, or *L. neglecta* sequences from Norwegian specimens. Instead, the sequence was 100% identical to three *L. borealis* sequences from the Czech Republic (OK332989, OK332990, Vondrák et al. 2022) and Madeira (OL625599, Vančurová et al. 2021, as *Lepraria* sp. 1). To further explore the barcode data the first author made a phylogenetic analysis of totally 21 nucleotide sequences of *Lepraria* species downloaded from GenBank. Accession numbers, species determinations, and place of origin registered in GenBank are used as labels in Fig. 2. The data set included sequences from Norwegian material of species in the *L. neglecta* group as well as sequences with a high sequence similarity to the Gaupne sequence (OP554448). There were a total of 529 positions in the final alignment. The resulting tree illustrates the unexpected results from the BLAST query (Fig. 2). The Gaupne sequence together with the three identical *L. borealis* sequences from the Czech Republic and Madeira as well as a *L. jackii* sequence from Italy form a monophyletic clade with strong support



Figure 1. *Lepraria borealis*. Herbarium photograph of the specimen from Gaupne (Lindblom 1360, O L-229230, GenBank OP554448). Scale bar = 5 mm. Photo E. Timdal.

(denoted “*L. neglecta* B” in Fig. 2), which is only distantly related to the *L. neglecta* group in Norway (denoted as “*L. neglecta* A” in Fig. 2). In other words, specimens identified to *L. borealis* appear in the two distant clades “*L. neglecta* A” and “*L. neglecta* B” in our phylogenetic reconstruction. Hence, results from this admittedly very small study show that Norwegian material determined to *L. borealis* is heterogeneous and that the clade “*L. neglecta* B” may represent an undescribed species. This result is supported by a comment by Vondrák et al. (2022, Supplementary Data S1): “Sequences of saxicolous and terricolous specimens of *L. borealis* are currently absent in NCBI database. (ITS Sequence from corticolous ‘*L. borealis*’ recorded on bark of *Populus tremula* (Ekman & Tønberg 2002) is a different species related to *L. neglecta*)”. Regrettably, no barcode sequence from the type specimen of *L. borealis* is available, that could establish to which clade in our phylogenetic tree the name should be applied.

Lepraria borealis as well as the two *L. neglecta* groups (“A” and “B”) in the phylogenetic tree (Fig. 2) are clearly in need of comprehensive systematic revision, preferably including the specimen from Gaupne cited here.

Specimen examined: Norway. Sogn og Fjordane: Luster municipality, junction to Skisete, 61.34917°N, 7.23956°E, alt. ca 405 m, in moss cushion on calciferous slate cliff by a dirt road on open mountain slope, 12.06.2018, L. Lindblom 1360 (O L-229230, GenBank OP554448).

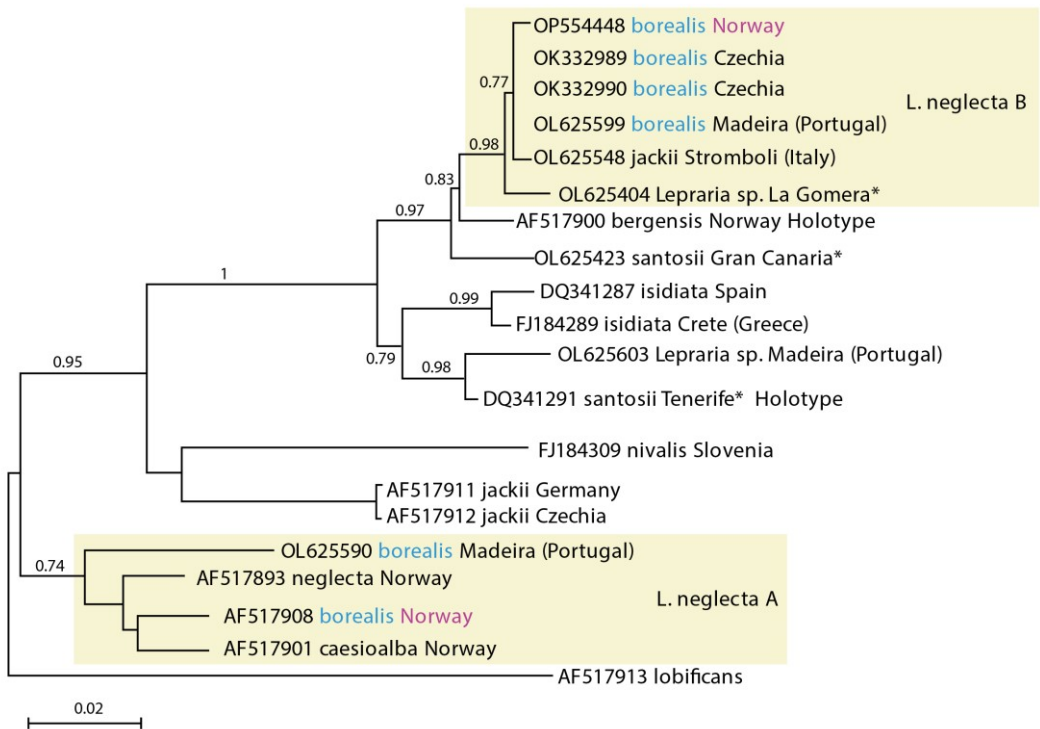


Figure 2. FastTree analysis of nrITS of *Lepraria* and the Gaupne specimen (OP554448), rooted with *L. lobificans*. Geneious FastTree support values > 0.7 are given above branches. Scale bar represents the estimated number of nucleotide substitutions from the most recent node. Blue font marks all *L. borealis* sequences; pink font highlights the two different *L. borealis* from Norway. *) Canary Islands, Spain.

***Xanthomendoza fulva* (Hoffm.) Søchting, Kärnefelt & S.Y. Kondr.**

Xanthomendoza fulva is one of five *Xanthomendoza* species known from Norway (Lindblom et al. 2019). It has a south - southeastern subcontinental distribution in Norway and is not found north of Steinkjer (Nord-Trøndelag). The species becomes increasingly rarer towards the more oceanic west (and absent in the hyperoceanic SW) and there are only eight previous records from Sogn og Fjordane, all of them occurring on solitary deciduous trees (NLD2 2023). The rare lichen *Candelaria concolor* s. str. (Westberg & Arup 2010) is also known from ornamental trees in Gaupne (BG L-76821).

Specimens examined: Norway. Sogn og Fjordane: Luster municipality, junction to Skisete, 61.34917°N, 7.23956°E, alt. ca 405 m, on *Populus tremula* on open mountain slope, 12.06.2018, L. Lindblom 1361 (O L-229231); Luster municipality, Gaupne by Sandvikvegen, 61.40171°N, 7.30042°E, alt. ca 5 m, on ornamental *Fraxinus excelsior*, 13.06.2018, L. Lindblom 1362 (O L-229232).

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answering *Lepraria* questions as best as they could. LL is grateful to the other authors for inviting her to join the field trip to Gaupne, which turned out very rewarding.

References

- Artskart. 2023. <https://artskart.artsdatabanken.no/>. Accessed on 30-01-2023.
- Arup, U., Ekman, S., Lindblom, L. & Mattsson, J.-E. 1993. High performance thin layer chromatography (HPTLC), an improved technique for screening lichen substances. *Lichenologist* **25**: 61–71.
- Arup, U., Blom, H. H. & Lindblom, L. 2021. The Gaupne area in Sogn og Fjordane – a hot-spot for lichens in Norway. *Graphis Scripta* **33**: 31–49.
- Ekman, S. & Tønsberg, T. 2002. Most species of *Lepraria* and *Leproloma* form a monophyletic group closely related to *Stereocaulon*. *Mycological Research* **106**: 1262–1276.
- Ellis, L. T., Alikhadzhiev, M. Kh., Erzhapova, R. S., Blom, H. H., Bednarek-Ochyra, H., Burghardt, M., Cano, M. J., Czernyadjeva, I. V., Kuzmina, E. Yu., Potemkin, A. D., Doroshina, G. Ya., Dagnino, D., Turcato, C., Minuto, L., Drapela, P., Dulin, M. V., Fuertes, E., Graulich, A., Hassel, K., Hedenäs, L., Hofton, T. H., Hoitomt, T., Jukonienė, I., Kırmacı, M., Koroleva, N. E. Krajewski, Ł., Kropik, M., Kürschner, H., Kushnevskaia, E. V., Larraín, J., Lebouvier, M., Maksimov, A. I., Pisarenko, O. Yu., Plášek, V., Skoupá, Z., Popov, S. Yu., Fedosov, V. E., Puglisi, M., Stebel, A., Ștefănuț, S., Vončina, G., Wierzgoń, M. & Guo S.-L. 2020. New national and regional bryophyte records, 64. *Journal of Bryology* **42**: 393–412. doi: 10.1080/03736687.2020.1831289
- Fehrer, J., Slavíková-Bayerová, Š. & Orange, A. 2008. Large genetic divergence of new, morphologically similar species of sterile lichens from Europe (*Lepraria*, Stereocaulaceae, Ascomycota): concordance of DNA sequence data with secondary metabolites. *Cladistics* **24**: 443–458. doi: 10.1111/j.1096-0031.2008.00216.x.
- Foucard, T. 2001. *Svenska skorplavar och svampar som växer på dem*. Interpublishing, Stockholm.
- Henriksen, S. & Hilmo, O. 2015. *Norsk rødliste for arter 2015*. Artsdatabanken, Norge.
- Jørgensen, P. M. 2007. Pannariaceae. *Nordic Lichen Flora* **3**: 96–112.
- Lindblom, L. 1995. Släktet *Lepraria* i Skåne [The genus *Lepraria* in the province of Skåne, southernmost Sweden]. *Graphis Scripta* **7**: 49–60.
- Lindblom, L., Blom, H. H. & Timdal, E. 2019. The genus *Xanthomendoza* in Norway. *Graphis Scripta* **31**: 54–75.
- Lohtander, K. 1994. The genus *Lepraria* in Finland. *Annales Botanici Fennici* **31**: 223–231.
- Lohtander, K. 1995. The lichen genus *Leproloma* in Finland and some notes on the *Lepraria neglecta* group. *Annales Botanici Fennici* **32**: 49–54.
- Lorentzen, M. N., Gaarder, G. & Tellnes, S. 2019. *Naturverdier for lokalitet Havåsen-Rydalen, registrert i forbindelse med prosjekt Kalkskog 2018*. NaRIN faktaark. BioFokus, MFU. <https://biofokus.no/narin/?nid=6483>
- NLD2. 2023. Norwegian Lichen Database 2. <https://nhm2.uio.no/lav/nld2/>. Accessed on 24-10-2023.
- Øvstedal, D. O., Lindblom, L., Knudsen, K. & Fryday, A. M. 2018. A new species of *Acarospora* (Acarosporaceae, Acarosporales, lichenized Ascomycota) from the Falkland Islands (Islas Malvinas). *Phytotaxa* **340**: 86–92.
- Price, M. N., Dehal, P. S. & Arkin, A. P. 2009. FastTree: Computing large minimum-evolution trees with profiles instead of a distance matrix. *Molecular Biology and Evolution* **26**: 1641–1650. doi:10.1093/molbev/msp077
- Price, M. N., Dehal, P. S. & Arkin, A. P. 2010. FastTree 2 - Approximately maximum-likelihood trees for large alignments. *PLoS ONE* **5**(3): e9490. doi:10.1371/journal.pone.0009490
- Saag, L., Saag, A. & Randlane, T. 2009. World survey of the genus *Lepraria* (Stereocaulaceae, lichenized Ascomycota). *Lichenologist* **41**: 25–60.
- Tønsberg, T. 1992. The sorediate and isidiate, corticolous, crustose lichens in Norway. *Sommerfeltia* **14**: 1–331.

- Vančurová, L., Malíček, J., Steinová, J. & Škaloud P. 2021. Choosing the right life partner: Ecological drivers of lichen symbiosis. *Frontiers in Microbiology* **12**: 769304. doi: 10.3389/fmicb.2021.769304
- Vondrák, J., Svoboda, S., Malíček, J., Palice, Z., Kocourková, J., Knudsen, K., Mayrhofer, H., Thüs, H., Schultz, M., Košnar, J. & Hofmeister, J. 2022. Cinderella became the princess - an exceptional hot-spot of lichen diversity in a long-inhabited Central European landscape. *Preslia* **94**: 143–181.
- Westberg, M. & Arup, U. 2010. *Candelaria concolor* – a rare lichen in the Nordic countries. *Graphis Scripta* **22**: 38–42.