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Bryological note

ITS sequence data confirm the presence of *Schistidium marginale* in Scandinavia and indicate connections to the Caucasus

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We document the presence of *Schistidium marginale* (Grimmiaceae) in Trollheimen, central Norway. The sequence of the nuclear ITS region aligns identically with an accession from the Caucasus, distinct from Alpine accessions. This may suggest post-glacial colonization originating from south-eastern rather than southern populations. The new locality exhibited only a few tufts and shared habitat similarities with Alpine locations, albeit with a potentially more base-rich substrate.

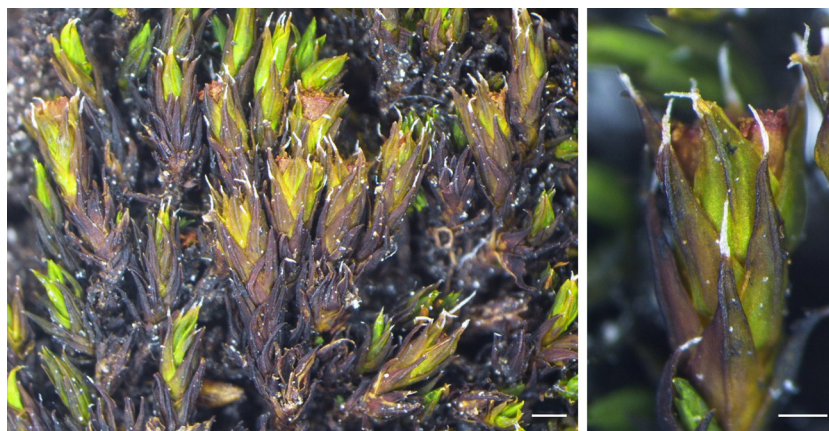
Keywords: biodiversity, biogeography, grimmiaceae, norway, saxicolous

Although being only recently described (Blom et al. 2016), *Schistidium marginale* H.H. Blom, Bedn.-Ochyra & Ochyra is one of the widespread and regionally common species of the genus. In Europe, it is locally frequent in the Alps (Austria, France, Italy, Switzerland) and the Caucasus mountains but also known from Albania, Macedonia, NW Russia (Murmansk Province) and Spain (Blom 1997, Köckinger et al. 2008, Ignatov et al. 2017, Hodgetts and Lockhart 2020). In Asia, it is reported from east and south Siberian mountains: Altai, Kuznetzky Alatau, Putorana Plateau and the Transbaikalian region (Ignatov et al. 2017). Notwithstanding the intensive work on *Schistidium* carried out by HHB in Scandinavia (Blom 1996, 1998), *S. marginale* has so far not been recorded there. Only recently HHB discovered small plants that showed characteristics of *S. marginale* at Mt Høghøa in the Trollheimen mountains, Trøndelag county (Fig. 1):

Norway, Trøndelag, Oppdal, Høghøa, SE slope, ca 1120 m a.s.l., 22 July 2020, leg. H.H. Blom (TRH).

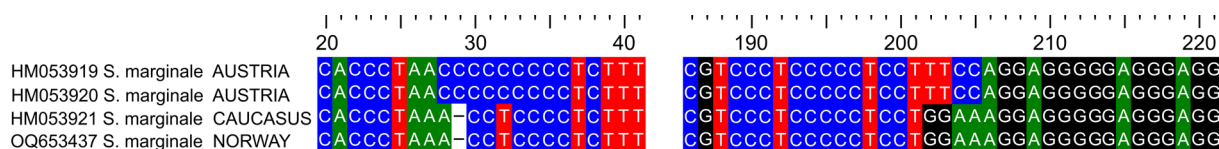
At this locality *S. marginale* was only found in 2–3 small tufts at one site where it grew on low inclined (40°) phyllite ledges on a steep south-faced slope. The bed-rock is base-rich siliceous mica-shist with garnets (https://geo.ngu.no/kart/berggrunn_mobil) and *S. marginale* grew together with *Schistidium dupretii* and a yet undescribed *Schistidium* species.

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Since the plants were poorly developed (Fig. 1), we aimed at confirming the morphological diagnosis molecularly. We targeted the ITS region which is the most used molecular marker for species delimitation and phylogenetic inference in the genus (Ignatova et al. 2010, Milyutina et al. 2010). We extracted DNA and performed PCR and sequencing following previous work (Kiebacher 2020, Kiebacher et al. 2021). A BLAST search using the generated sequence (GenBank no. OQ653437) as input to the megablast algorithm (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>) with default settings confirmed the morphological hypothesis. The sequence from the Norwegian specimen was identified as most similar to the three *S. marginale* accessions available in GenBank (two from Austria and one from Russia; Ignatova et al. 2010). The subsequent manual alignment to these accessions showed that the sequence from the Norwegian specimen is identical with the Russian accession from Caucasus (Karachaevo-Cherkessiya, HM053921) and these two differ from the Austrian accessions (HM053919, HM053920) at two sites in ITS2 (Fig. 2): an indel (position 29 of ITS2), a transversion (28) and a transition (32) at the first site and an inversion (202–205) at the second site.

refugia close to the Alps and its rarity in Scandinavia could be due to later long-distance dispersal and limited local spread since then. Certainly, also other scenarios are possible such as recolonisation of Scandinavia from glacial refugia following the last glacial maximum (LGM) and limited spread due to sub-optimal ecological conditions for the founder genotype(s). Under both scenarios, the molecular uniformity of the Norwegian and Caucasian accession suggests colonisation from south-eastern rather than southern populations, although, due to the limited sampling we cannot exclude the occurrence of this genotype in the Alps or central and western Europe. Colonisation of Scandinavia after the LGM from refugia east of the Scandinavian ice shield has been proposed also for other bryophyte species (Kyrkjeeide et al. 2014) and within the genus, the connections between Scandinavia and the Caucasus are further evidenced by *S. flexipile* (Lindb. ex Broth.) G.Roth. This primarily northern-Holarctic species was described from Caucasus and is widespread and locally abundant in Scandinavia (and Island), but was hitherto not reported from the Alps.



We aim to further explore these issues in our future studies, which will require an in depth morphological and genetic analysis of an extended set of well-developed specimens sampled across the area of occurrence of *S. marginale*. Here, we primarily aim to update our knowledge on the moss flora of the Scandinavian mountains and to rise the attention to this inconspicuous species. *Schistidium marginale* is a representative of the *Confertum* group (Blom 1996, Ignatova et al. 2010) as indicated by its small to medium size, the spinulose hair point, the partially bistratose lamina and the slightly sinuous lamina cells. It is distinctive in the prominent costa that is often subangular or even dorsally furrowed in transverse section and the very thick leaf margins, that are often four-stratous in the upper part of the leaves.

In the Alps, *S. marginale* typically colonises rather poor and acidic rocks at warm sites in the subalpine and alpine zones. This pattern aligns with the Norwegian locality, with the exception of potentially more base-rich conditions. Hence, the search for further localities in the Scandinavian mountains should focus on such habitats, especially S-facing cliffs in the alpine zone.

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Data availability statement

There are no additional data for this paper.

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