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On the occurrence of *Schistidium subconfertum* and *S. succulentum* in Europe

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We here clarify that currently there are no records of the Asiatic *Schistidium subconfertum* (Broth.) Deguchi in Europe. The only European specimen referred to this species represents *S. succulentum* Ignatova & H.H. Blom, a taxon rather recently described from Caucasus. Furthermore, we provide new records of the latter species in the French and Swiss Alps. The two species share a reduced peristome, but can be distinguished by characteristics of the gametophyte such as lamina thickness (unistratous in *S. subconfertum* versus partially bistratous in *S. succulentum*) and shallowly versus strongly projecting costa.

Keywords: Alps, Finland, European bryophyte checklist, France, Grimmiaceae, Switzerland

Schistidium subconfertum (Broth.) Deguchi was included in the European checklist of bryophytes based on a single specimen from the Italian Alps ('*Grimmia atrofusca*. Italien: An der Strasse über das Stilfser Joch auf der Paßhöhe, 26/8 1909, J Glowacki', GJO 0102803; Hodgetts and Lockhart 2020, Hodgetts et al. 2020). Hans H. Blom determined the specimen back in 1996, thus long before *S. succulentum* Ignatova & H.H. Blom was described (Ignatova et al. 2010). Consequently, the discovery of *S. succulentum* in the European Alps (Kiebacher 2020) rose doubts about the identity of the Glowacki-specimen, because *S. succulentum* likewise has a reduced peristome and share several other sporophytic and gametophytic character states with *S. succulentum* (Ignatova et al. 2010). To solve the task, we re-examined the Glowacki-specimen morphologically and found that it represents *S. succulentum* (Fig. 1, 2). Hence, *S. subconfertum* should be excluded from the list of European species and again represents a taxon to-date solely known from China, Japan and North Korea (Tong and Yuhuan 1998, Gao et al. 2003). The major difference between the two taxa is found in the morphology of the leaves (Table 1). *Schistidium succulentum* has at least some leaves with a partially bistratose distal lamina, a dorsally strongly projecting and often papillose costa and strongly thickened, 2–4 stratous upper leaf margins. In contrast, according to the descriptions and images provided by

Cao and Vitt (1986) and Deguchi (1978), *S. subconfertum* has an unistratous lamina (except the bistratose margins), and the costa is only shallowly projecting dorsally and smooth. The paracostal basal lamina cells are very long and thin-walled in *S. subconfertum*, forming somewhat inflated, sharply delimited hyaline areas (windows), whereas they are shorter and with thicker walls, forming much less pronounced areas in *S. succulentum*. Furthermore, in *S. succulentum* the upper part of the perichaetial leaves is inclined above the capsule (Fig. 1, 3) whereas in *S. subconfertum* the perichaetial leaves are more or less straight (Fig. 4). In addition, in *S. subconfertum* the exothecial cells have distinct corner thickenings (cf. Deguchi 1978) that are absent or indistinct in *S. succulentum*. Although there are several marked differences between the two species, identification should be carried out with caution due to the great variation in salient characters as leaf papillosity and lamina thickness in *S. succulentum* and because little is known about variation in *S. subconfertum*. Indeed, additional collections and molecular studies are needed to understand the relationships and variation in the little known and apparently rare *S. subconfertum*. In Europe, *S. succulentum* is unlikely to be mistaken for any other species of *Schistidium*, because of the reduced peristome which is shared only with few other species, namely *S. atrofusum* (Schimp.) Limpr., *S. flaccidum* (De Not.) Ochyra, *S. foraminis-martini* Kiebacher, Köckinger & H.H. Blom and *S. grande* Poelt. Among these, *S. atrofusum* and *S. grande* can be most easily separated by the absence of stomata and *S. foraminis-martini* by the muticous leaves with rounded apices (versus acute, and at least perichaetial leaves often with short hair point). *Schistidium flaccidum* is closely related to *S. succulentum* and may superficially look similar.

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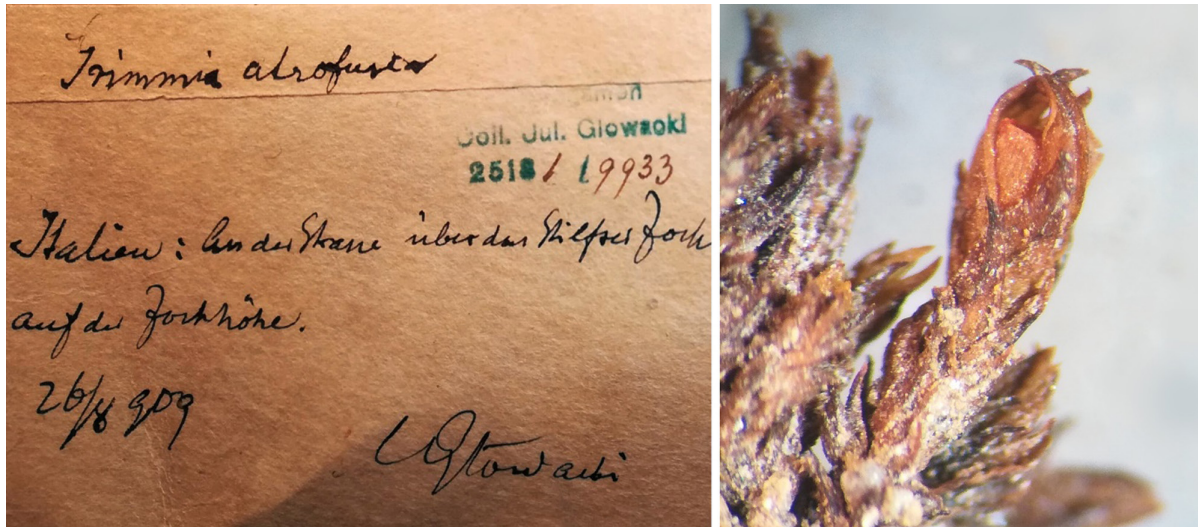


Figure 1. Original label (left) and shoot with sporophyte (right) of the specimen of *Schistidium succulentum* collected by J. Glowacki in the Italian Alps (GJO 0102803). Photos: T. Kiebacher.



Figure 2. Leaf cross sections of *Schistidium succulentum* from the Glowacki-specimen (GJO 0102803). Scale: 50 μm . Photo: T. Kiebacher.

However, it can easily be distinguished from *S. succulentum* by the short capsules (up to $1.3 \times$ as long as wide) and the very short rostrum formed as a mamilla. In contrast, *S. succulentum* has elongate capsules ($1.5\text{--}1.7 \times$) and a distinctly rostrate lid. Another *Schistidium*-species with a reduced peristome is *S. cryptocarpum* Mogensen & H.H. Blom, known from arctic parts of Asia and North America. It differs from *S. succulentum* in the 1 (–2) stratose leaf margins (versus 2–4 stratose) and the campanulate (versus cylindrical) capsules.

During recent field trips we discovered further populations of *S. succulentum* in the European Alps (Fig. 5). These

records represent the first records of the species in France and Switzerland:

France, Hautes-Alpes, St. Veran, ca 500 m SW Refuge De la Blanche, $44^{\circ}39'49.8''\text{N}$, $6^{\circ}56'15.4''\text{E}$, 2553 m a.s.l., at base of large N-facing rock outcrops, greenschist (probably serpentinite or serpentinised peridotite), 14 Jul 2021, T. Kiebacher 2975 (priv. Herb. T. Kiebacher).

Switzerland, Canton of Obwalden, Engelberg, N-slope of Mt Titlis, $46^{\circ}47'1.2''\text{N}$, $8^{\circ}25'17.0''\text{E}$, 2545 m a.s.l., rock outcrops on W-facing slope, on schist, superficially acidic, 3 Sep 2021, T. Kiebacher 3048 (priv. Herb. T. Kiebacher).

Like in the specimen from the Italian Dolomites (Mt Seceda, 02 Sep 2002, M. Lüth 3925; Kiebacher 2020) and opposed to Russian specimens (Ignatova et al. 2010) leaf papillae were not observed in the specimens from France (Fig. 3) and Switzerland as well as in the Glowacki-specimen. The plants from France and Switzerland even lack distinct papillae on the costa and most leaf laminae have relatively few bistratose spots and striae. Furthermore, the alpine plants, especially the specimen from Switzerland are somewhat glossy (versus dull, according to the original description, Ignatova et al. 2010). However, the other morphological characteristics, especially the reduced peristome, the cylindrical urns, the \pm thin-walled, mostly short and irregular exothelial cells, the awned perichaetial leaves that largely hide the capsules, the distinctly sinuous lamina cells and the sharply keeled leaves in transverse sections, the strongly thickened margins and strongly projecting costa

Table 1. Morphological differences between *Schistidium subconfertum* and *S. succulentum*.

	<i>S. subconfertum</i>	<i>S. succulentum</i>
Lamina	Unistratose	At least some leaves partially bistratose, sometimes extensively bistratose in upper part
Costa	Shallowly projecting dorsally, smooth	Strongly projecting dorsally, often papillose
Leaf margins in upper part	2-stratose	2–4-stratose
Paracostal basal lamina cells	Long and thin-walled, forming a well delimited hyaline group	Rather short and thick-walled, forming an indistinct group
Exothelial cells	With corner thickenings	Without or with indistinct corner thickenings
Perichaetial leaves	Straight	Usually inclined above the capsules



Figure 3. Plant of *Schistidium succulentum* from the French Alps with the perichaetial leaves that are typically inclining above the capsules (from T. Kiebacher 2975). Photo: T. Kiebacher.

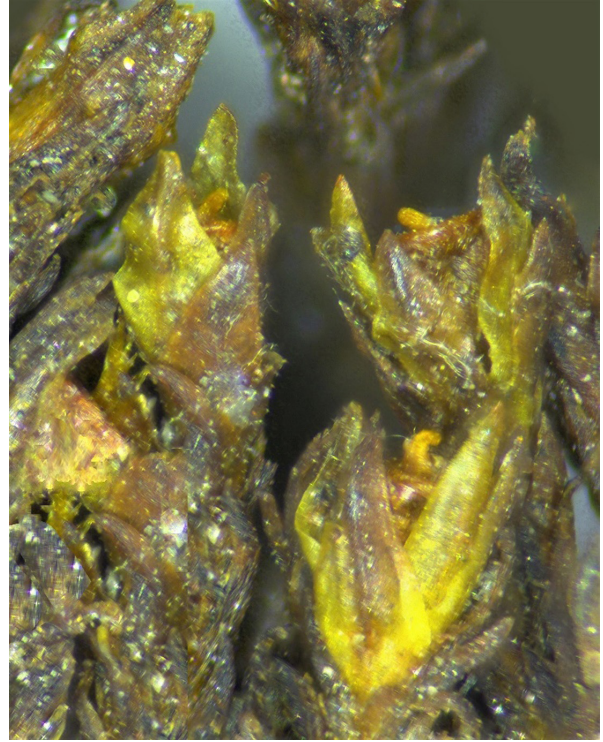


Figure 4. Fertile shoots of *Schistidium subconfertum* with straight perichaetial leaves and shallowly projecting costae. From isotype specimen in G: Dr. Heinr. Frh. v. Handel-Mazzetti. (Diar. Nr. 1353); G-00046108. Photo: T. Kiebacher.

(except in the specimen from Switzerland) clearly indicate *S. succulentum*. In plants from Switzerland the costa is generally less strongly projecting dorsally than in the other specimens from the Alps known to date, and the usually distinct leaf cross section with the costa set-off from the lamina (cf. Fig. 2) is evident only in some of the leaves.

We believe that the deviating characteristics observed in alpine specimens (less papillose lamina and costa, glossiness, p.p. not strongly projecting costa) compared to the original description that is based on specimens from Caucasus and

Anabar (Ignatova et al. 2010) are due to phenotypic plasticity, presumably in response to habitat conditions. This has support from the ITS sequences that are identical in specimens from Italy and Caucasus (Kiebacher 2020). However, a certain (genetic) differentiation caused by the isolation of the alpine population of the species cannot be excluded.



Figure 5. Known distribution of *Schistidium succulentum* in Europe. Previous record (grey circle; Kiebacher 2020) and records presented here (black circles). The record from the border region between Italy and Switzerland was previously referred to *S. subconfertum*.

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Data availability statement

There are no additional data for this paper.

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