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Schistidium spinosum, a new species from Europe and its relationship to *S. liliputanum*

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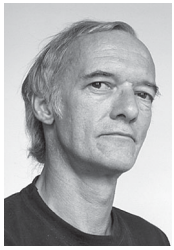
M. Lüth

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Schistidium spinosum Blom & Lüth is described. It grows on siliceous rocks in hill and mountain areas in the western parts of continental Europe. It is placed in the confertum group, whereas the very similar *S. liliputanum* (C. Müll.) Deguchi has its closest relatives among species of the apocarpum group. *Schistidium liliputanum* is reported as new to North America where it is widespread in the eastern part of the continent.

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In January 1996 Lüth discovered and collected a small *Schistidium* with conspicious terete and coarsely spinulose hair-points, forming small tufts and cushions in a rock quarry by Yach in the southwestern part of the Black Forest, SW Germany. The plant was not determinable using the key in Blom (1996), and the material was subsequently sent to Blom who found it identical with a few other European specimens which he had tentatively named *Schistidium liliputanum* (C. Müll.) Deguchi. Detailed studies including all available specimens of the strange *Schistidium* and many collections of *S. liliputanum* revealed important differences between them, and we consequently decided to describe the unknown plant as new.

***Schistidium spinosum* Blom & Lüth sp. nov.** – Fig. 1.

Plantae humiles pulvinos formantes. Pilus teres, angustus, grosse spinuloso-denticulatus. Folia marginibus bistratosis, partim recurvatis. Laminae in parte superiore irregulariter bistratosae; cellulae laminarum irregulares, ± sinuosae. Thecae breves, obloideae, 0.70–0.90×0.50–0.70 mm; cellulis exothecialis magnis, irregularis, partim longitudinalibus et valde sinuosis. Dentes peristomiorum aurantiacorubri, dense papillosi, papillis valde angustis in seriebus dispositis.

Holotype: Germany. Baden-Württemberg, Black Forest, Yachtal by Elzach, rock quarry facing Schneiderbauernhof, 600 m a.s.l., 14.XII.1998 leg. M. Lüth 2368 (STU). Isotypes: G, TRH.

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Description

Plants small, in upper part dirty olivaceous or yellow-olivaceous, in lower part pale brownish to greyish black, forming rounded cushions or tufts. Stem 0.50–1.35 cm, orange-red, strongly branched with mostly long branches; epidermis of 1–2 rows of thick-walled cells; cortical cells mostly thin-walled but not sharply delimited from epidermis; central strand indistinct, of rather large cells (3–15 cells in transverse section) or occasionally absent from sterile stems. Leaves smooth, erect, imbricate, ± straight, arranged in ± distinct spiral rows, narrowly ovate-lanceolate to ovate-triangu-

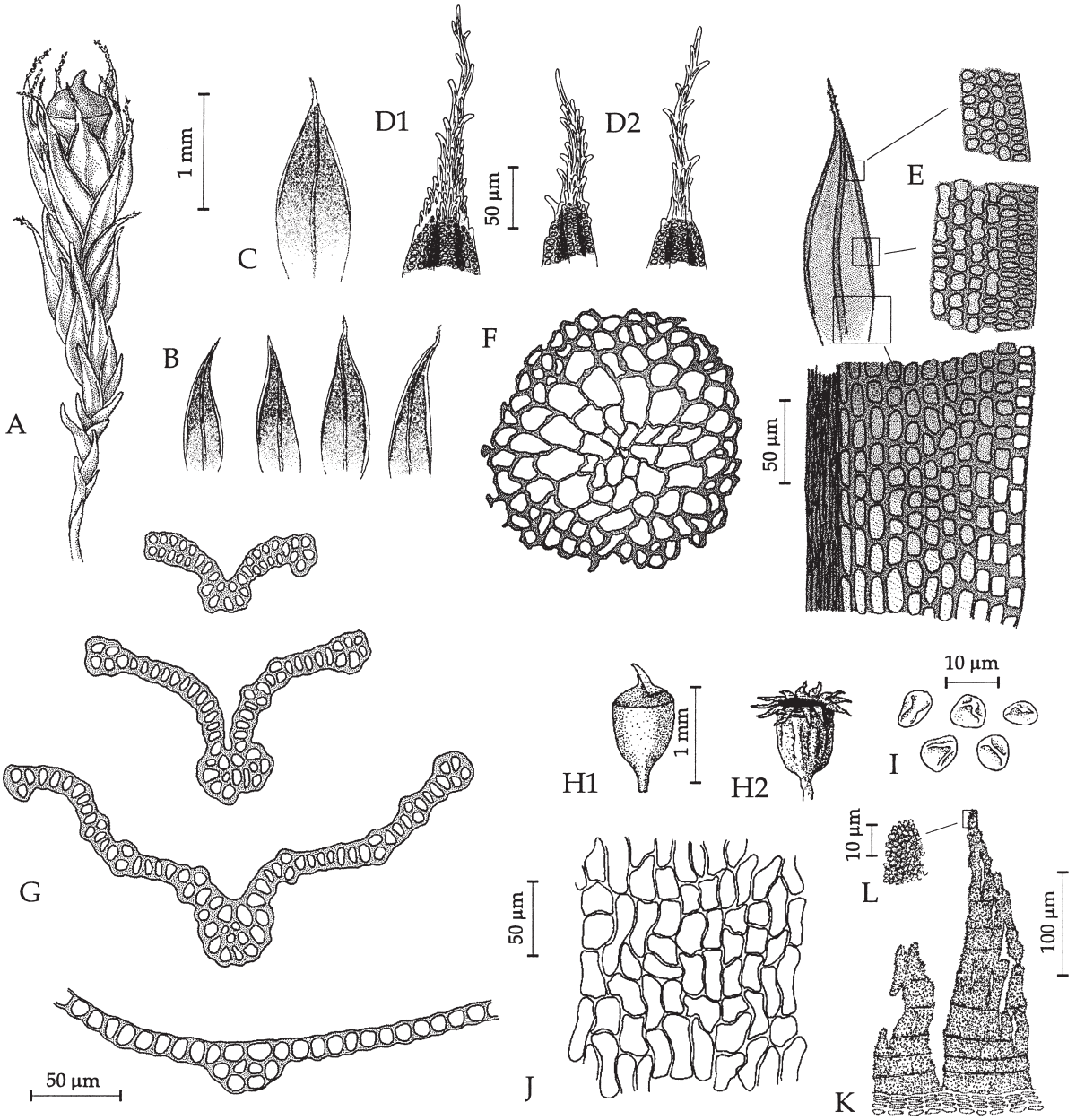

Fig. 1. *Schistidium spinosum* Blom & Lüth. A. Habitus. B. Leaves. C. Perichaetial leaf. D. Leaf apices (D1. perichaetial leaf, D2. stem leaves). E. Leaf cells. F. Stem, transverse section. G. Leaves, transverse sections. H. Sporophytes (H1. operculate urn with calyptra, H2. deoperculate urn). I. Spores. J. Exothecial cells in lower part of urn. K. Peristome teeth. L. Peristome teeth papillae. All from holotype except H2, which is from the same locality (Lüth 2209) (illustration M. Lüth).

lar, sharply keeled, acute, 1.45–2.20(–2.50)×0.30–0.60(0.70) mm. Hair-point usually long, 0–0.80 mm, terete and narrow throughout with cell walls clearly visible, erect, straight or slightly bent, not or shortly and narrowly decurrent, mostly strongly spinulose with some very long spines (22–30(–75) µm). Costa excurrent, 42–73 µm wide, in upper and central parts strongly projecting dorsally and situated in a deep and narrow leaf furrow ventrally, hemispherical in transverse section, (bi-)three- or four-stratose, in lower part three-stratose. Margins strongly and mostly broadly recurved in upper and central part, plane on one or both sides of the leaf in basal part, in upper and central parts from bistratose (1- several rows) to four(five)-stratose, in lower part bistratose for 1 row or unistratose with bistratose spots. Lamina from unistratose with several bistratose spots to irregularly bistratose in upper and central parts, unistratose in lower part of the leaf. Lamina cells thick-walled, in upper part ovate and shortly oblong, not or slightly sinuose, 6–8 µm wide, in central and lower parts oblong, from slightly to strongly sinuose, 7–9 µm wide and up to 11–20 µm long; basal cells mostly hyaline or yellowish, 6–12 µm wide and up to (35–)47–78 µm long, forming a sharply delimited group, basal marginal cells ± hyaline, shortly oblong with thickened transverse walls, forming a border or a rectangular group in 1–6 rows with up to 22 cells in the outer row. Perichaetial leaves sometimes faintly plicate, 2.30–3.00×0.60–0.80 mm; hair-points similar to those of the vegetative leaves, up to 0.6 mm; margins narrowly recurved in upper 1/3–2/3 of the lamina length. Calyptra cucullate.

Autoicous. Sporophytes present in all studied plants, abundant, deeply immersed. Seta dark red or blackish, 0.1B0.4 mm; exothecial cells square, thin-walled. Urn red-brown, slightly shiny, obovoid (cyathiform when old and empty), 0.55–0.70–0.90×0.50–0.80 mm; length/width ratio 0.9–1.1–1.3. Exothecial cells with curved, unevenly thickened longitudinal walls and distinct trigones, in upper and central parts isodiametric and oblong, in lower part predominantly oblong (up to 38–55 µm long), forming an irregular pattern. Stomata reddish, 6–8(10) per urn. Peristome teeth (240–)280–430 µm long, orange-red, straight or slightly curved, spreading but soon becoming revolute, tapering to a narrow or rather broad, obtuse point, narrowly perforated in 1(2) vertical median rows or occasionally almost entire, densely papillose with short, very narrow papillae arranged in ± distinct rows (horizontal to oblique rows in lower part and vertical rows in upper part). Columella narrow or broad, 0.50–0.80 mm. Operculum convex; rostrum very short, 0.08–0.17(–0.25) mm, erect to oblique, ± curved, obtuse. Spores thick-walled, finely papillose or almost smooth, 8–9 µm.

Variation

Based on the study of plants from the locality in the Black Forest, *Schistidium spinosum* seems to exhibit standard variation for the genus with regard to character modification along the dry-wet gradient (cf. Blom 1996: 288): plants from irrigated rocks possess short hair-points, strongly thickened leaf margins and shorter, less thick-walled and less sinuose leaf cells than plants from dry sites. The specimens from Thuringia possess, on average, a less coarsely spinulose hair-point than the other specimens.

Differentiation

Schistidium spinosum is characterized and distinguished from related and similar species in *Schistidium* by the combination of the following character states: (1) leaf hair-point narrow and terete, not flexuose, strongly spinulose and partly with very long spinulae (2) costa situated in a deep and narrow leaf furrow in upper ventral part of the leaf (3) urn obovoid, 0.7–1.3 times longer than wide (4) exothecial cells of the urn with curved, irregularly thickened longitudinal walls in an irregular pattern (5) rostrum of the operculum very short (6) peristome papillae short and very narrow. The species is quite similar to *S. liliputanum*, a species previously known from SE Asia (Deguchi 1979, Cao and Vitt 1986), in size and habit, and shares the short and broad urn and the narrow, terete and strongly spinulose hair-points with this species. Comparative studies, however, have revealed some minor differences between the two species also in these characters: the tufts of *S. liliputanum* are much denser, and the hair-point tends to be weaker, (sometimes flexuose), and more distantly spinulose than in *S. spinosum*. Some of the longer spinulae in *S. liliputanum* are usually squarrose (as in *S. tenerum* (Zett.) Nyh.), but erecto-patent to patent in *S. spinosum*. Both species also have a similar leaf cell areolation. Their basal margin cells possess thickened transverse walls and form a sharply delimited group and their basal cells are long and ± hyaline. However, the areolation is more irregular in *S. liliputanum*. The most important distinguishing characters between the two species are found in the sporophyte and in plant colour and KOH (2 percent solution) colour reactions: in *S. liliputanum* the plants have ferrugineous secondary colours (most plants are distinctly rusty in their lower part), and the leaf cell walls react K+ red, whereas *S. spinosum* lacks any trace of red pigmentation and the cell walls react K+ yellow. The exothecial cells of *S. liliputanum* are short transversely rectangular with ± straight and equally thickened walls, forming a regular pattern, and strongly contrast with the predominantly oblong, but irregular cells with curved walls in *S. spinosum.* The

peristome teeth are distinctly curved and have a marked twist around the axis in *S. liliputanum*, but almost straight and untwisted in *S. spinosum*. In *S. spinosum*, the leaves are entirely smooth, whereas many specimens of S. *liliputanum* (especially from N America) possess scattered papillae on the upper dorsal part of the costa and at the upper leaf margins.

Among the central European species, *S. spinosum* is most likely to be confused with *S. confertum* (Brid.) Bruch & Schimp. In *S. confertum*, however, the hair-point is flattened and mostly broadened towards the insertion, and the irregular, strongly perforated peristome teeth of that species are quite different from the teeth in *S. spinosum*. The leaf cells tend to be isodiametric and not or only slightly sinuose in most of the leaf in *S. confertum*, but elongated and distinctly sinuose in the central part of the leaf in *S. spinosum*. The basal cells are distinctly longer in *S. spinosum* (47–78 µm vs. 23–40 µm) than in *S. confertum*.

Habitat

Schistidium spinosum grows on exposed, often sunny, siliceous rocks, and it seems to be one of few species in the genus which can grow on rocks very poor in nutrients. At the locality near Yach, the occurrence of *S. spinosum* is restricted to a part of a rock quarry which was abandoned 50 years ago. Here, the species grows abundantly in fissures near the top of an exposed, S-SW facing granite wall, constantly together with *Grimmia trichophylla* Grev. and *Racomitrium heterostichum* (Hedw.) Brid. Other species recorded in five (1–3 dm^2) releveés were *Schistidium papillosum* Culm., *Hedwigia ciliata* (Hedw.) P. Beauv., *Hypnum cupressiforme* Hedw. and *Ptychomitrium polyphyllum* (Sw.) Bruch & Schimp. The bryophyte assembly on the wall shows affinity to communities of the Grimmio-Racomitrion heterostichi (Marstaller 1982, 1993). The oceanic *Ptychomitrium polyphyllum*, rare in Central Europe, indicates a humid microclimate. The Thuringian localities are also situated in abandoned rock quarries. Here, *S. spinosum* grows on exposed excavated clay schist walls (L. Meinunger pers. comm). At one of the Pyrenean localities *S. spinosum* was collected from heavy-metal bearing rocks, and *Mielichoferia mielichoferiana* (Funck) Loeske, an indicator of such rocks, occurs near one of the Thuringian localities.

Distribution

Schistidium spinosum is known from scattered hill and mountain areas of western continental Europe (Thuringia, Black Forest, Alsace, Pyrenees). The altitude of the localities range from 450 m a.s.l. (Thuringia) to 1237 m a.s.l. (Alsace), but one of the Pyrenean localities may be situated at considerably higher altitude.

Relationship

Schistidium spinosum shares several character states with species of the confertum group (Blom 1996), although its exothecial cells are reminescent of those of species in the dupretii group (Blom 1996). We refer *S. spinosum* to the confertum group, but the close relationship between *S. liliputanum* and *S. confertum* suggested by Deguchi (1979) and Cao and Vitt (1986) must be reevaluated. The most important distinguishing character states listed above between this species and *S. spinosum* (and all members of the confertum group) are exactly those states used to characterize the apocarpum group (Blom 1996: 315), and we think *S. liliputanum* has its closest relatives among the species in the apocarpum subgroup of that group (Blom 1996). The apocarpum subgroup is most species rich in the forest regions of SE Asia (Japan, China, the Himalayas) and the Appalachian mountains of eastern N America.

Notes on *Schistidium liliputanum*

Through herbarium revisions by Blom it has become clear that *S. liliputanum* is not restricted to SE Asia, but also occurs widespread in eastern North America (see list of studied specimens), thus belonging to the eastern N American – eastern Asian disjunct bryogeographical element (Iwatsuki 1972, Iwatsuki and Sharp 1967, Schofield and Crum 1972, Schofield 1980). Many specimens of *S. liliputanum* in N American herbaria are labeled *Grimmia apocarpa* var. *ambigua* (Sull.) Jones in Grout. Jones (1933) reported *S. ambiguum* Sull. from New Jersey and Pennsylvania, based on specimens of *S. liliputanum*. *Schistidium ambiguum* is a distinctive species, only known from the mountain ranges of SW USA. It is easily distinguished from *S. liliputanum* by its plane leaf margins and oblong-cylindrical urns.

Specimens examined of *Schistidium spinosum*

GERMANY: Thuringia, Sonneberg, "Alter Fellberg", Fellberghöhe W of Steinach, TK 55321/4, 800–840 m, Meinunger 4465, 4476, 4471, 4477, 7071, (JE), 12. VIII. 1968 ("Karlsblick") Meinunger (JE); Griffelbruch W of Brann by Spechtsbrunn, TK 5533/1, 800 m, Meinunger 4714 (JE); Breitenberg in Haselbach, S foothills, TK 5533/1, 17.II.1968 Meinunger

(JE); Saalfeld, above Gräfenthal, TK 5433/4, Meinunger 4463 (JE); Hildburgshausen, Valley 1 km N of Walden, Albertsberg, E foothills, 450 m, TK 5430/44, Meinunger 7820 (priv. herb.). B Bavaria, Kronach, Valley SE of Wolfersgrün, TK 5635/3, 450 m, 17.I.1999 Meinunger & Schröder (priv. herb.); Meinunger 18433 (priv. herb.). – Baden-Württemberg, Black Forest, Yachtal by Elzach, Steinbruch facing Schneiderbauernhof, TK 7814NO, 600 m, Lüth 1204, 2211, 2216 (priv. herb.), Lüth 2209 (BCB, E, JE, STU, TRH); Obermünstertal, by Cafe Bergfreude, upper Lochmatte, TK 8113 NW, 720 m, Lüth 2253 (STU). FRANCE: Alsace, Route des Crêtes, Le Hundskopf, 1237 m, 7.IV.1994 Greven (priv. herb.); Hundskopf, S of Markstein, 1210 m, Lüth 2508 (priv. herb.); Batteriekopf S of Rothenbachkopf, 1230 m, Lüth 2510 (priv. herb.); Col de la Schlucht, 1130 m, Lüth 2513 (priv. herb.). – Ariège, along road D703 2 km E of Col de Pause, 1230 m, 13.V.1996 Greven (priv. herb.). B Pyrenees [locality uncertain, either] France: vallis de Castel-loubon [or] Spain: Port de Bénasque, Spruce Musci Pyrenaici exsicc. 266 (E).

Selected N American specimens of S. liliputanum (from all states and provinces where the species is known): CANADA. Newfoundland. vic. of Sop's Arm Prov. Park, 49°46'N 56°5'–55'W, Brassard 10897 (MICH, NFLD, NY). New Brunswick. York Co., 2 mi N of Tweedsdale, 45'38'N 67°01'W, Ireland 13066 (ALTA, CANM, MICH, NY, S, WTU). Nova Scotia. Victoria Co., Cape Breton Highlands Nat. Park, Mary Ann Falls, Ireland 10433, 10454 (CANM). – Ontario. Algoma Distr., Lake Superior Prov. Park, near Agawa R., 47°21'N 84°38'W, Ireland 15047 (ALTA, CANM, MICH, MO, NY, S); Thunder Bay Distr., Mt. McKay, 48°27'N 89°12'W, Garton 5434 (NY). – Quebec. Pontiac Co., Parc de la Vérendrye, 47°11'N 76°41'W, Ireland & Koponen 16184 (ALTA, CANM, MICH, NY, S); Lac à L'eau Claire, 56°13'N 74°30'W, Ireland 20900 (NY). – USA Arkansas. Franklin Co., White Rock Mt., Allen 6228, 6230 (MO). Connecticut. Mt. Carmel, 1891 Eaton, Renauld & Cardot exsicc. 168 (NY). – Illinois. Rock State Park, Illinois Canyon, Conard 9–193 (WTU). – Maine. Franklin Co., Tumbledown Mt., along West Brook, Chimney Trail and summit, Allen 15868, 15878 (MO). – Massachusetts. Norfolk Co., Hammonds Pond, Brookline, 10.III.1898 Hall (DUKE). – Michigan. Gogebic Co., Ottawa Nat. Forest, near Bessemer, 12.VIII.1981 Duell & Duell (priv. herb.). – Minnesota. Cook Co., Temperance R., 7.IX.1951 Clebsch (TENN). – Missouri. St Clair Co., along Sac R., Buzzard's Bluff, Ireland 22683 (CANM, DUKE). – New Hampshire. Fitzwilliam Mt., 30.IX.1935 coll. ignot. (DUKE). – New Jersey. Passaic Falls, Austin, Musci Appalachiani exsicc. 138 (MICH, MO). New York. "High Torn" near Haverstraw, Austin, Musci Appalachiani exsicc. 142 (MICH, MO). – North Carolina. Swain Co., Great Smoky Mts. Nat. Park, Rocky Spur, trail to Rainbow Springs, Anderson 10703 (DUKE). B Pennsylvania. Fulton Co., just E of Harrisonville, along U.S. 30, Pursell 10199 (MO). – Tennesee. Carter Co., Laurel Creek above Hampton, Sharp. s.n. (DUKE). – Vermont. Newfane, Baker Brook, 11.VII.1934 Grout (DUKE). – Virginia. Giles Co., 1.5 mi N of McCoy, Pursell & Kral 3829 (MO, TENN). – West Virginia. Cass, Barford, Gray M997 (DUKE). – Wisconsin. Ashland Co., Penokee Gap, Freckmann 2278 (MICH).

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