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THE GENUS *SCHISTIDIUM* (GRIMMIACEAE, MUSCI) IN HUNGARY

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All available specimens of *Schistidium* (collected in Hungary) in Hungarian herbaria (BP, EGR and private herbaria) and collections of the first author (B) were revised. The following 15 taxa were found to occur in Hungary: *Schistidium apocarpum*, *S. brunnescens* subsp. *brunnescens*, *S. brunnescens* subsp. *griseum*, *S. confertum*, *S. confusum*, *S. crassipilum*, *S. dupretii*, *S. elegantulum*, *S. flaccidum*, *S. helveticum*, *S. lancifolium*, *S. papillosum*, *S. platyphyllum* (new to South-Eastern Central Europe), *S. pruinosum*, and *S. robustum*. All except *S. apocarpum*, *S. brunnescens* subsp. *brunnescens*, *S. crassipilum*, *S. flaccidum* and *S. helveticum* are new to Hungary. Descriptions, illustrations, distribution maps and a key are provided. Some taxonomic, bryogeographical and conservation issues are briefly discussed.

Key words: bryophytes, distribution maps, habitat requirements, illustrated key, *Schistidium platyphyllum*

INTRODUCTION

Since the revision of the *Schistidium apocarpum* complex by BLOM (1996, 1998), his concepts – developed for the taxa found in Scandinavia – have been widely and rather successfully applied in other parts of Europe (BLOCKEEL and LONG 1998, GRIMS 1999, HOLZ 2000, CASAS *et al.* 2001, CORTINI-PEDROTTI 2001, SOTIAUX and VANDERPOORTEN 2001, SIEBEL 2003, MÜLLER 2004, SMITH 2004, CASAS *et al.* 2006, BLOM *et al.* 2006, IGNATOV *et al.* 2006, IGNATOVA *et al.* 2006, MEINUNGER and SCHRÖDER 2007). A recent molecular study seems to support the narrow species concept of Blom (GORYUNOV *et al.* 2007). As information on the distribution of taxa in a wider geographical area is accumulating, their ecological profile and additional knowledge about their variability is becoming more precise as well. At the same time, some new species have been described (BLOM 1998, BLOM and LÜTH 2002).

After the preliminary treatment of *Schistidium* in the checklist of Hungarian bryophytes (ERZBERGER and PAPP 2004), the present work aims at closing this gap by the revision of a large number of specimens of this genus. Apart from answering the question of which taxa occur in Hungary, their distribution in the floristical regions of the country as defined by BOROS (1968) is assessed and mapped. For each taxon, selected morphological characters are described, based on observations in Hungarian material and the literature, and illustrated. The authors propose a determination key for *Schistidium* in Hungary. Habitat preference and distribution in Hungary are discussed and compared with the results from other countries.

MATERIAL AND METHODS

All specimens collected in Hungary and labelled *Schistidium* (or synonyms) in the bryophyte herbarium of the Hungarian Natural History Museum (BP), the herbarium of the Eszterházy College in Eger (EGR), and of some private herbaria (P. Ódor, Budapest, P. Szűcs, Almásfüzitő) as well as the recent collections of the first author were examined by light microscopy and revised, apart from incomplete or non-fruiting material. Drawings of some morphological features were achieved with a Leitz drawing apparatus. In order to observe the pattern of the exothecial cells and stomata in the basal part of the capsule, sporophytes were emptied and well soaked in 2% KOH, sometimes by boiling for some seconds with a cigarette lighter to remove air bubbles, and then cut in half using a razor blade. In order to completely flatten the capsule wall, an additional longitudinal cut of about half of the capsule length was applied to the basal part of each half.

In randomly selected specimens measurements of urn length and width were taken from emptied capsules soaked in 2% KOH. From these data, the ratio length/width was computed, and means and standard errors were also evaluated for each taxon.

Distribution maps were prepared on the basis of the Central European mapping scheme (NIKLFELD 1971). Open circles represent collections before 1977, closed circles after that year.

Frequency of taxa is estimated by the number of different growth sites as noted on the specimen labels.

Nomenclature of bryophytes follows ERZBERGER and PAPP (2004) with the exception of *Schistidium*, *Bryum moravicum* Podb. (= *B. laevifilum* Syed) and *B. kunzei* Hornsch., where HILL *et al.* (2006) is followed.

Taxonomic characters

Central strand – Visible in stem cross sections of sporophyte bearing plants. In sterile shoots, the central strand may not fully be developed.

Hair-point structure – Two types of hair-point can be distinguished (BLOM 1996): (1) **fine** (Figs 3C, 9C, E, 11B 15C, 23C, 25B): cell walls clearly visible; transverse section canaliculate, flattened or lens-shaped; hair-point irregularly bent or flexuose in the dry state (but straight in *S. dupretii* and *S. confusum*). (2) **coarse** (Figs 5E, 7B, E, 13C, 17E, 21C, 30B, C, 32B, D): cell walls usually not clearly visible; transverse section lens-shaped or terete; hair-point usually straight.

Lamina cells – Sinuose (*e.g.* in *S. robustum*, Fig. 32E) or esinuose, size in different parts of leaf (basal, central and apical) is also important.

Papillae – Hemispherical or conical cell wall structures on leaf lamina (Figs 11E, 25F, 30G, H), costa and margins (Figs 3B, 13B–D, 15C, 23B, C, E, 28B, 30B, C). Since in papillose species only a fraction of lamina cells bear papillae, papillosity is a property of the lamina, not of cells. Young leaves should be examined for papillosity.

K+ – Upper leaves torn off the stem and placed in a drop of 2% KOH solution develop either yellow (in Confertum group) or red (in all other taxa) colours.

Urn form and size, exothecial cells, stomata, striolae – These important characters are best assessed in empty capsules soaked in 2% KOH solution, because after this procedure even old, fragile or damaged capsules assume their original shape, the capsule wall becomes less fragile and can thus be cut more easily, and the pattern of exothecial cells and stomata will also become much clearer. If only green, unripe capsules are available, these should be boiled for a short time in 2% KOH solution and then cut and emptied for examination of exothecial cells and stomata; however their shape and size will not correspond to that of ripe, emptied urns.

Urn form may be the widest at the mouth (*e.g. S. platyphyllum*, Fig. 27D) or about the middle (*e.g. S. elegantulum*, Fig. 17F); measurements of length and width are important in absolute terms (*e.g.* for the differentiation between *S. apocapum* and *S. lancifolium*, compare Figs 3E and 23F) as well as their ratio. Measurements should be taken under a stereomicroscope without flattening the urn.

The pattern of exothecial cells must be carefully observed in different parts of the capsule (see Fig. 1C–E), most relevant is the pattern in the lower half, especially at the base immediately above the seta, where the stomata may be observed. The pattern of seta surface cells is also sometimes useful (*e.g.* in the Rivulare group, Fig. 27G, 28F; BREMER 1980).

In some taxa, ripe emptied urns may show a very fine striolation due to the arrangement of exothecial cells in vertical rows (Fig. 1). Transverse sections of the capsule wall (Fig. 1A) show an exothecium of even thickness, as in the capsule walls of *Grimmia* species (MAIER 2004). Sometimes (*e.g.* in *S. dupretii*) striolae develop due to the fact that long narrow exothecial cells, alternating with shorter cells, collapse (Fig. 15I, J). These striolae are not comparable to the plicae in the urns of other genera, *e.g. Orthotrichum* (MAIER 2004).

Peristome – Orientation of peristome teeth should be observed in freshly deoperculate capsules. Peristome teeth may be patent to spreading with ascending tips

(*e.g. S. apocarpum*, Fig. 3E) to squarrose-recurved (*e.g. S. confusum*, Fig. 11G). Apart from colour and papillosity, the size and shape of peristome teeth is important, as is the amount of perforation by pits and holes in cribrose peristome teeth.

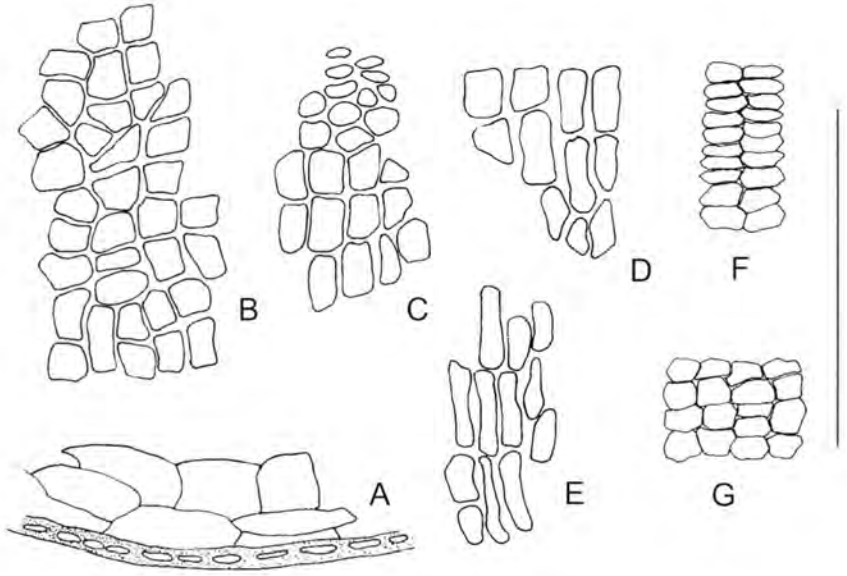


Fig. 1. Capsule walls without (**B**) and with striolae (**C–G**). **A** = transverse section of capsule wall (exothecium stippled); **B** = exothecial cells in *Schistidium apocarpum*; **C–E** = exothecial cells in *S. crassipilum* at top of urn / in mid urn / at base of urn; **F**, **G** = exothecial cells in *S. lancifolium* in upper/lower part of urn. Scale bar: 200 μm. [Del. Schröder]

RESULTS AND DISCUSSION

According to the revision of all available herbarium material presented here, in Hungary the genus *Schistidium* comprises fifteen taxa, which can be grouped in the following informal infrageneric categories (BLOM 1998):

Rivulare group: *S. platyphyllum* (Mitt.) H. Perss. subsp. *platyphyllum*;

Apocarpum group, Apocarpum subgroup: *S. apocarpum* (Hedw.) Bruch et Schimp., *S. lancifolium* (Kindb.) H. H. Blom;

Apocarpum group, Strictum subgroup: *S. confusum* H. H. Blom, *S. papillosum* Culm., *S. pruinosum* (Wilson ex Schimp.) G. Roth;

Robustum group: *S. dupretii* (Thér.) W. A. Weber, *S. robustum* (Nees et Hornsch.) H. H. Blom;

Confertum group: *S. confertum* (Funck) Bruch et Schimp., *S. flaccidum* (De Not.) Ochyra;

Atrofuscum group: *S. brunnescens* Limpr. subsp. *brunnescens*, *S. brunnescens* subsp. *griseum* (Nees et Hornsch.) H. H. Blom, *S. crassipilum* H. H. Blom, *S. elegantulum* H. H. Blom, *S. helveticum* (Schkuhr) Deguchi (= *S. singarense* (Schiffn.) Laz.).

Historical aspects

The oldest specimens of *Schistidium* in the bryophyte collections of the Hungarian Natural History Museum (BP) date from the second half of the 19th century. Two are without date (*S. apocarpum* s. str.: "Magyarhon virányából Hazslinszky Frigyes, *Grimmia apocarpa* L. Ágasvár Mátra l. Borbás" BP 5758; *S. crassipilum*: "*Grimmia apocarpa* Kalkfelsen b. Tapolcza; ex herbario Frid. Hazslinskyi" BP 5699). The oldest specimens with a date are *S. crassipilum* from 1870 (BP 5667 Herbar. Musei Nat. Hungar. Budapest Specimen in herb. Simonkai L. inter *Grimmia apocarpa* insertum erat "In rupestribus montis 'Kis Eged' prope Agriam. Comitat. Heves in Hungaria. 6. Apr. 1870 Vrabélyi"), and *S. elegantulum* from 1886 (BP 5624 "Ex herbario C. Schilberszky, Farkasvölgy, mészkő [18]86.V.2"). Among the older collections there are some by Á. Degen from 1901 and L. Simonkai from 1904. Table 1 lists the collectors, the period of collection (of *Schistidium* specimens), and the number of specimens (corrected for duplicates).

In his bryophyte flora of the surroundings of Budapest and the Pilis Mts SZEPESFALVI (1941) treats *Schistidium* under *Grimmia* and mentions 2 species: *S. flaccidum* (as *G. flaccida*) and *S. apocarpum* s. l. (as *G. apocarpa*) with three varieties: var. *brunnescens*, var. *conferta*, and var. *gracilis*. While his specimens of *S. flaccidum* and var. *brunnescens* could be confirmed in the present revision, the plants labelled var. *conferta* proved to be *S. apocarpum* s. str., *S. brunnescens* subsp. *brunnescens*, or *S.* cf. *crassipilum*, but not *S. confertum*. We did not see any specimens collected by Szepesfalvi labelled var. *gracilis*.

In an earlier paper SZEPESFALVI (1935) stated that *S. brunnescens* was rare in the surroundings of Budapest and in Hungary, thus contradicting

PÉTERFI (1916), who held the opposite opinion. It is interesting that Péterfi considered the possibility that plants named *S. confertum* growing on limestone rocks might prove to be *S. brunnescens* – and that in our revision this turned out to be true.

BOROS's (1968) taxonomic treatment is similar to that of SZEPESFALVI (1941), he lists some more forms (f. *irrigata*, f. *epilosa*, f. *laxum* = f. *gracile*), varieties (var. *nigrescens*) and subspecies (subsp. *conferta*, subsp. *brunnescens*) of *S. apocarpum* s. l. His f. *irrigata* was revised to *S. apocarpum* s. str.; under f. *epilosa* many different taxa were found, some belonging to different genera (*S. apocarpum* s. str., *S. brunnescens* subsp. *brunnescens*, *S. crassipilum*, *S. helveticum*, *S. lancifolium*, *Didymodon acutus*, *D. insulanus*, *D. luridus*, *D. rigidulus*); similarly "f. *gracile*" was found on specimen labels of *S. crassipilum*, *S. apocarpum* and *S. lancifolium*. Some specimens of *S. crassipilum* and *S. apocarpum* were labelled "var. *nigrescens*" by Boros. Specimens labelled "ssp. *conferta*" by Boros proved to be *S. crassipilum* or *S. brunnescens* subsp. *brunnescens*. However, plants that he named subsp. *brunnescens* consistently could be referred to *S. brunnescens* subsp. *brunnescens*.

ORBÁN and VAJDA (1983) treat all taxa of *Schistidium* as subspecies, varieties or forms of *S. apocarpum*, even *S. flaccidum*, in this respect adopting the concept of LOESKE (1930). As for specimens collected by Vajda and bearing various subspecific labels, roughly the same applies as for Boros's collections: his f. *irrigata* and *S. rivulare* proved to be *S. apocarpum*, subsp. *gracile* was revised to *S. crassipilum* and *S. apocarpum*, but one specimen (BP 67976) labelled *Grimmia apocarpa* var. *conferta* could be confirmed as *S. confertum*, and *S. brunnescens* was also consistently confirmed.

In Figure 2 the number of specimens of *Schistidium* collected in the years between 1870 and 2007 (including the collections of the first author) is depicted, clearly showing two periods of collecting activity with respect to *Schistidium* in Hungary: the first between 1905 and 1965, with major contributions by Boros, Degen, Szepesfalvi, Szurák and Vajda (compare Table 1), and the second between 1985 and 2007, with major contributions of Rajczy, Papp and the first author. In the distribution maps, collections from these two periods are represented by different symbols (open circles for the older collections, closed circles for the recent ones).

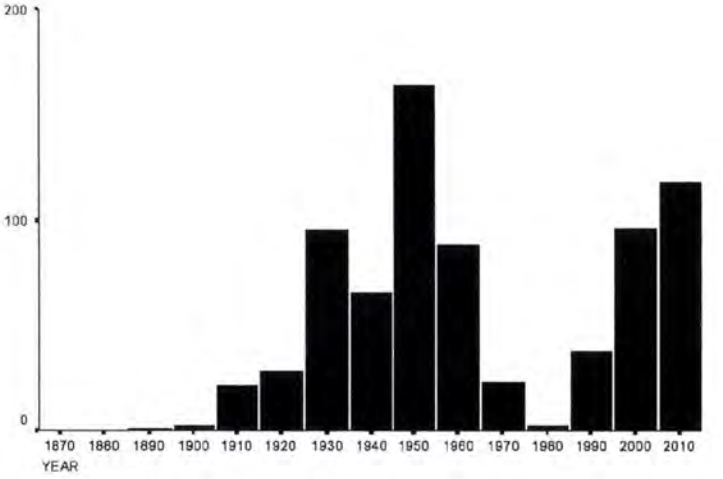


Fig. 2. Bryological activity in Hungary – number of specimens of *Schistidium* (without duplicates) collected between 1870 and 2007

Table 1. Collectors of *Schistidium* from Hungary in BP, EGR, and B

Collector	Period or year of collection	No. of specimens
Balanyi, L.	1959	1
Bán, E.	1934	1
Borbás, V	s.t.	1
Boros, Á.	1917–1968	259
Degen, Á.	1901–1924	15
Erzberger, P.	1991–2008	179
Felföldy, L.	1952–1956	6
Gelencsér, I.	1954	1
Glatz, W.	1936	1
Györffy, I.	1921–1928	2
Héder, I.	1953	1
Igmándy, J.	1924–1941	4
Károlyi, Á.	1947–1956	10
Kenyeres, J. [= "uxor mea", Boros's wife]	1956	1
Kis, G.	1984	1
Kovács, M.	1957	1
Lengyel, G.	1909–1921	2
Ódor, P.	1996–2001	4
Ötvös, L.	1933	1
Papp, B.	1989–2008	39
Pénzes, A.	1947	1
Péter, B.	1936	1

Table 1. (continued)

Collector	Period or year of collection	No. of specimens
Pócs, T.	1950–2007	7
Polgár, S.	1932–1935	3
Prágai, Z.	1958	1
Priszter, Sz.	1953	1
Rajczy, M.	1976–1994	21
Redinger, K.	1931	3
Sándor	s.t.	1
Sass-Gyarmati, A.	2001	1
Simonkai, L.	1904	2
Schilberszky, K.	1885	1
Szemes, G.	1947	1
Szepesfalvi (Szurák), J.	1911–1937	61
Szűcs, P.	2004–2006	14
Timár, L.	1914–1952	12
Timkó, Gy.	1924	1
Vajda, L.	1942–1971	93
Vidéki, R.	2006	1
Visnya, A.	1931–1953	9
Vrabélyi, M.	1870	1
Wagner, J.	1927	1

Descriptions, selected diagnostic features

The descriptions are based on BLOM (1996, 1998), HOLZ (2000), WEIBULL (2006), and our own observations. The data on the urn length/width ratio of Hungarian material include (minimum) mean ± 2s.e. (maximum), sample size. Vertical distribution: elevation of lowest and highest location according to specimen labels. For convenience, in this paragraph, the taxa will be treated in alphabetical order.

Schistidium apocarpum (Hedw.) Bruch et Schimp. (Figs 3, 4)

Plants medium-sized to large, forming lax or dense tufts or mats. Central strand absent or narrow and indistinct. Hair-point 0–0.8 mm, fine, thin and ± flexuose, from not to longly decurrent. Abaxial side of costa and leaf margin papillose, distantly denticulate in upper part of leaf, rarely smooth (longipilose plants).

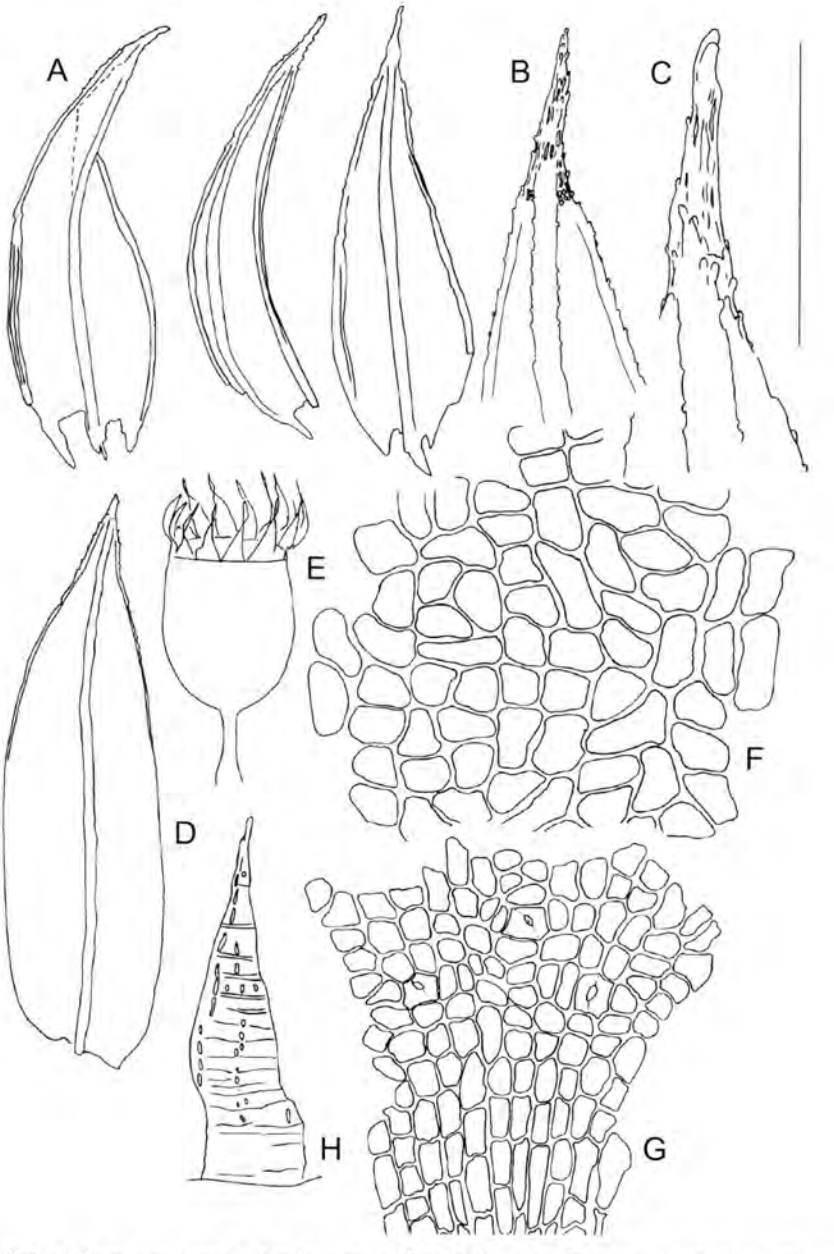


Fig. 3. *Schistidium apocarpum.* **A** = leaves; **B, C** = leaf apices; **D** = perichaetial leaf; **E** = capsule; **F, G** = exothecial cells in mid urn / at base of urn and seta surface cells; **H** = peristome tooth. Scale bar: A, D, E – 2 mm; B – 800 μm; C, H – 400 μm; F, G – 200 μm. [Erzberger 12084, del. Erzberger]

Lamina without papillae, smooth, predominantly unistratose, but often with bistratose patches or striae in upper half. Lamina cells from slightly to strongly sinuose, in upper part 8–10 μm wide. K+ red.

Sporophytes common, deeply immersed. Urn dark red, widest at mouth, length/width ratio (1.2–)1.3–1.6(–2.0) (BLOM 1996), in Hungarian material (1.0–)1.51 ±0.06(–2.0), n = 65. Exothecial cells predominantly isodiametric and short transversely rectangular, but often with patches of elongate and rectangular cells. Stomata (4–)8–12(–18) per urn. Peristome teeth (350–)400–710 μm, red, patent to spreading with ascending tips, longly tapering to a fine point, in lower part ± semi-perforated, in central and upper parts from almost entire to strongly perforated with small oval cracks in submarginal rows.

Normally easily identified by the combination of denticulate leaf tips and isodiametric exothecial cells, but longipilose forms occur with smooth leaf margin and costa.

Habitat: On often shaded or moist, but sometimes also exposed or dry siliceous (andesite, porphyric rock, aleurolitic slate, sandstone, basalt) or more rarely calcareous rocks, often near streams or springs, but also on walls, even on loess.

Associated bryophytes: *Amphidium mougeotii*, *Brachythecium populeum*, *Ceratodon purpureus*, *Didymodon rigidulus*, *D. sinuosus*, *D. vinealis*, *Grimmia hartmanii*, *Hedwigia ciliata* var. *ciliata*, *Hypnum cupressiforme*, *Lejeunea cavifolia*, *Orthotrichum urnigerum*, *Orthotrichum* sp., *Schistidium crassipilum*, *S. dupretii*, *S. elegantulum*, *S. lancifolium*, *S. pruinosum*, *Taxiphyllum densifolium*, *Tortella tortuosa*, *Tortula ruralis*.

Vertical distribution: 83–900 m a.s.l.

Selected specimens examined: **Zemplén Mts: 7594/1** Comit. Abaúj-Torna. In rupibus irrigatis rivi Ósva-patak (pars superior) prope pag. Telkibánya, montes Sátor-hegység, 17.09.1959, leg. L. Vajda, BP 63350;

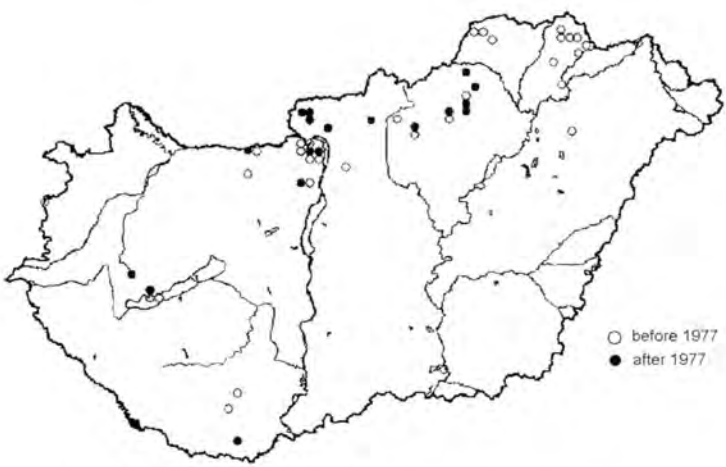


Fig. 4. Distribution of *Schistidium apocarpum*

Aggtelek Karst: 7589/2 Comit. Abaúj-Torna. In rupibus calcareis umbrosis silvat. ad fontem vallis Kopolya prope Szinpetri, 200 m, 19.06.1953, leg. Á. Boros, BP 110955; **Rudabánya Mts: 7590/3** Comit. Abaúj-Torna et Borsod. In rupibus calcar. alvei rivi vallis Telekes-völgy prope Perkupa, 180 m, 24.06.1953, leg. Á. Boros, BP 110966; **Bükk Mts: 7988/4** Felsőtárkány, Lök-völgy, aleurolite slate rocks at road, N 48° 00' 25.2", E 20° 27' 57.8", 337 m, 06.04.2007, leg. P. Erzberger and T. Pócs, herb. Erzberger, (B) 12108; **Mátra Mts: 8185/2** Sorkő/Sombokor, 800–860 m, 02.06.2001, leg. B. Papp, BP 170576; **Tarna Region: 8087/2** Radiolarit-Felsen an der Straße *ca* 1 km S Bátor, 230 m, 26.03.2008, leg. P. Erzberger and T. Pócs, herb. Erzberger, (B) 12842a; **Cserhát Hills: 8083/3** Cserhátszentiván, Cserkuti patak, 05.08.2002, leg. P. Erzberger, herb. Erzberger, (B) 7312; **Gödöllő Hills: 8381/4** Comit. Pest. In saxis andesit. vallis "Bükkös" ad "Sikáros" in Fageto, 350 m, 05.07.1933, leg. J. Szepesfalvi, BP 5859; **Börzsöny Mts: 8079/2** Comit. Hont. In rupibus andes. silvat. alvei rivi Kemence-patak infra Barsi-bükk pr. Kemence, 300 m, 12.10.1958, leg. Á. Boros, BP 110874; Kemence-patak, on andesite boulder near the water, N 47° 59' 07.8", E 18° 58' 20.7", 384 m, 05.04.2007, leg. P. Erzberger, herb. Erzberger, (B) 12084; **Visegrád Mts: 8280/3** Comit. Pest. In petrosis andesiticis in ripa rivi vallis "Apátkuti völgy" prope Visegrád, 200–300 m, 24.04.1924, leg. Á. Boros, BP 110905; **Naszály: 8180/2** Szendehely-Katalinpuszta, Lósi-patak, sandstone near stream, N 47° 51' 01.1", E 19° 06' 24.4", 180 m, 09.04.2007, leg. P. Erzberger and P. Szücs, herb. Erzberger, (B) 12163; **Buda Mts: 8479/4** Budapest: János-hegy, mészkövön, 21.04.1924, leg. J. Szurák, BP 5628; **Gerecse Mts: 8276/4** Comit. Esztergom. In cava rupe in decliv. sept. silvat. montis Nagyteke-hegy prope pag. Süttő, 300 m, 17.05.1941, leg. Á. Boros, BP 110850; **Balaton Uplands: 9170/4** County Veszprém. On rock in forest on the southern slope of Szent György-hegy at Hegymagas, 300 m, 13.08.1999, leg. B. Papp, BP 166930; **Keszthely Mts: 9069/4** Tátika, 30.07.2000, leg. P. Erzberger, herb. Erzberger, (B) 6258; **Kőszeg Mts: 8664/2**: *Querceto-Luzuletum* sub font. Szénégető-forrás, supra pag. Velem, 13.07.1954, leg. T. Pócs et I. Gelencsér, BP 58482; **Mecsek Mts: 9875/2** Comit. Baranya. In rupibus irrigatis vallis Csatornavölgy prope pag. Vasas, 26.07.1952, leg. L. Vajda, BP 5619; **Villány Mts: 0175/2** Comit. Baranya. In rupibus calcareis umbrosis in sylva Tenkes-erdő in monte Tenkes prope pag. Bisse, 300 m, 07.08.1999, leg. B. Papp, BP 166507; **Danube–Tisza Interfluve: 9687/1** Comit. Csongrád. Sándorfalva. Tegmen lapidarium (andesiticum) aggeri ad Sajtos, 83 m, 09.08.1957, leg. L. Timár, EGR; **Tiszántúl: 8194/4** In cippo in sepultura Felső-temető prope Hajdunánás, com.: Hajdu, 02.04.1941, leg. J. Igmándy, BP 111365; **Northern Plain: 7698/2** Comit. Ung. In muris pontis viae ferreae ad Záhony, 100 m, 07.09.1925, leg. Á. Boros, BP 111357.

Schistidium brunnescens Limpr. subsp. *brunnescens*
(Figs 5, 6)

Plants small, forming dense tufts, brownish. Central strand mostly broad and distinct. Hair-point absent or short in leaves below perigonia, in subperichaetial and perichaetial leaves 0.15–1.0 mm, coarse and terete, but flattened towards insertion, not or shortly decurrent, but embracing parts of the upper lamina.

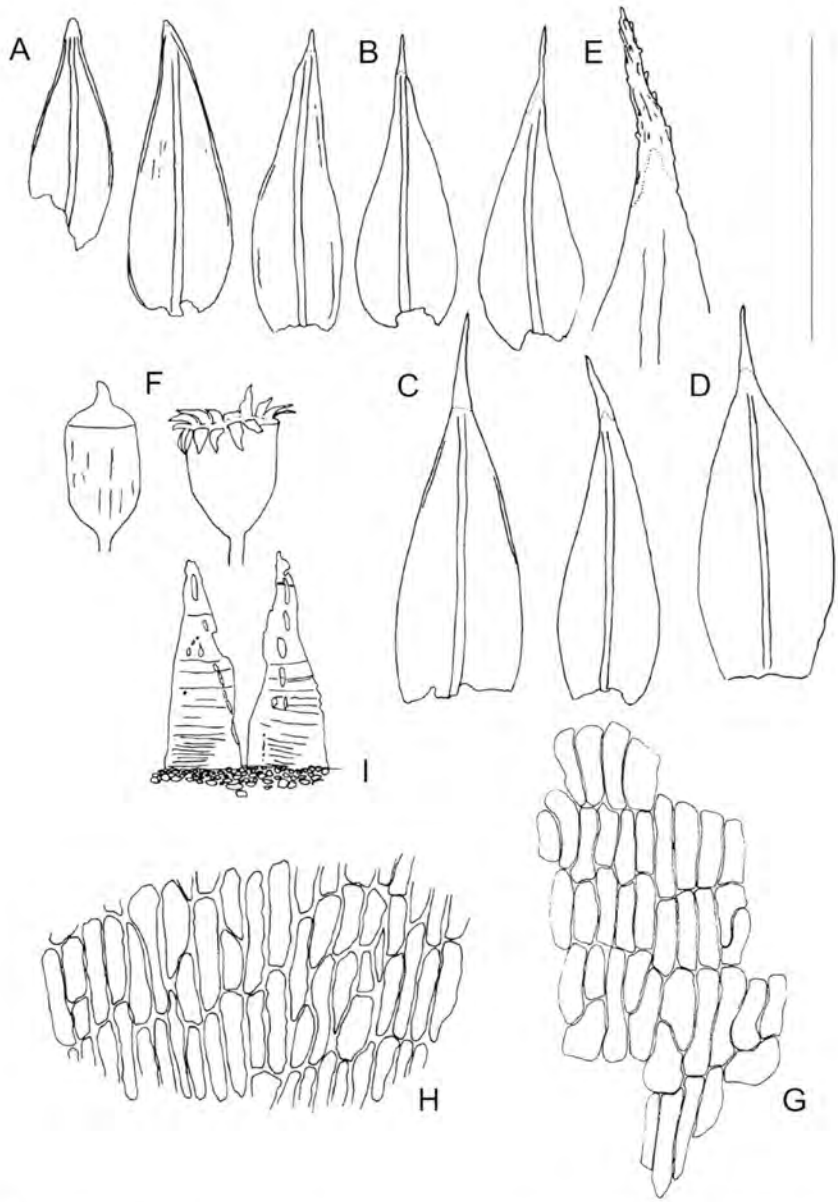


Fig. 5. *Schistidium brunnescens* subsp. *brunnescens.* **A** = leaves; **B** = subperichaetial leaves; **C**, **D** = perichaetial leaves; **E** = perichaetial leaf apex; **F** = capsules; **G**, **H** = exothecial cells in lower third / at base of urn; **I** = part of peristome. Scale bar: A–D, F – 2 mm; E – 800 μm; I – 400 μm; G, H – 200 μm. [A–C, E–F, I: Erzberger 12198; D: EGR Vajda 1946 (Pomáz); H: BP 37650, A–F, H: del. Erzberger, G: del. Schröder]

Costa and leaf margins smooth. Lamina smooth, in lower part unistratose, in upper part with bistratose spots. Upper lamina cells rounded, 6–9 μm wide, lower cells wider and slightly sinuose, basal marginal cells sometimes subhyaline, with slightly thickened cross-walls. K+ red.

Sporophytes frequent, mostly shallowly immersed. Urn orange to reddish-brown, often finely striolate, widest below middle, length/width ratio (1.3–)1.4–1.6–1.8 (BLOM 1996), in Hungarian material (0.94–)1.34 ±0.04(–1.93), n = 91. Exothecial cells elongate, especially in basal part, at least some up to 50 μm (often up to 80 μm) long, arranged in a regular pattern. Stomata absent. Peristome teeth 220–340 μm, orange, in central and upper parts mostly strongly perforated to cribrose.

Variability: The exothecial cells in the lower part of the urn sometimes only reach (50–)55 μm, but in other samples they attain 75–80 μm.

The brown, dense cushions with hair-points only around the sporophytes give this plant a very characteristic appearance. However, some forms of *S. crassipilum* can look quite similar, and in that case the strongly elongate exothecial cells (Fig. 5G, H, compare with Fig. 13I, J), and the shorter and wider urn of *S. brunnescens* are diagnostic. Confusion could also occur with forms of *S. helveticum* lacking the typical black colour, but again the pattern of exothecial cells is quite different. For the difference between subsp. *brunnescens* and subsp. *griseum* see the note under the latter.

Habitat: *S. brunnescens* subsp. *brunnescens* grows nearly exclusively on exposed calcareous rocks (limestone, dolomite), and is a very typical member of the bryophyte vegetation in calcareous grasslands. It was found associated with the lichen *Fulgensia fulgens* (det. V. Otte).

Associated bryophytes: *Bryum argenteum*, *Didymodon rigidulus*, *D. vinealis*, *Grimmia dissimulata*, *G. orbicularis*, *G. pulvinata*, *Grimmia tergestina*, *Pseudocrossidium revolutum*, *Pseudoleskeella catenulata*, *Schistidium crassipilum*, *S. helveticum*, *Tortella inclinata*, *Tortula crinita*, *Trichostomum* sp.

Vertical distribution: 150–780 m a.s.l.

Selected specimens examined: **Aggtelek Karst**: **7589/1** Comit. Gömör. In rupibus calc. montis "Baradla-tető" prope pag. Aggtelek, 350 m, 03.06.1928, leg. Á. Boros, BP 111757; **Bükk Mts**: **7988/3** Comit. Borsod. In rupibus calcar. montis Bélkő prope Bélapátfalva, 500–780 m, 03.09.1959, leg. Á. Boros, BP 110944; **8088/2** Lehmschieferfelsen an der Straßenböschung zwischen Bükkzsérc und Felsőtárkány, *ca* 400 m, mit *S. crassipilum*, 27.03. 2008, leg. P. Erzberger and T. Pócs, herb. Erzberger, (B) 12886; **Tarna Region**: **7986/1** Glaukonit-Sandsteinfelsen "Noé szőllője" im Ort Istenmezeje, 230 m, 26.03.2008, leg. P. Erzberger and T. Pócs, herb. Erzberger, (B) 12861; **Cserhát Hills**: **8181/4** Comit. Pest. In rupibus dolomit. apricis montis Vár-hegy prope Csővár, 350 m, 06.05.1953, leg. Á. Boros, BP 111748; **Gödöllő Hills**: **8381/3** Comit. Pest. In monte Somlyó prope Fóth, 21.05.1901, leg. Á. Degen, BP 37650; **Pilis Mts**: **8380/3** Comit. Pest. In rupibus dolomiticis merid. montis Nagykevély prope pag. Pilisborosjenő, 500 m, 25.03.1947, leg. Á. Boros, BP 111750; Hung. centr., com. Pest. In rupibus calcareis supra pag. Pomáz, 31.03.1946, leg. L. Vajda, EGR; **Buda Mts**: **8380/3** Budakalász, comit. Pest, in monte "Monalovác" ad saxa calcarea, 250 m, III.1911, leg. J. Szurák, revid. M. Péterfi, BP 5645; **Gerecse Mts**: **8477/2** Gyermely,

Kecske-kő, N 47° 35' 52.9", E 18° 36' 57.9", 250 m, 11.04.2007, leg. P. Erzberger, herb. Erzberger, (B) 12198; **Vértes Mts**: **8675/2** Comit. Fejér. In rupibus dolomit. montis adv. "Pap irtás" prope Csákberény, 350–400 m, 26.04.1936, leg. Á. Boros, BP 111730; **8676/2** Comit. Fejér. In rupibus dolomiticis apricis montis Szóló-kő prope Csákvár, 200–240 m, 21.03.1937, leg. Á. Boros, BP 111726, EGR;

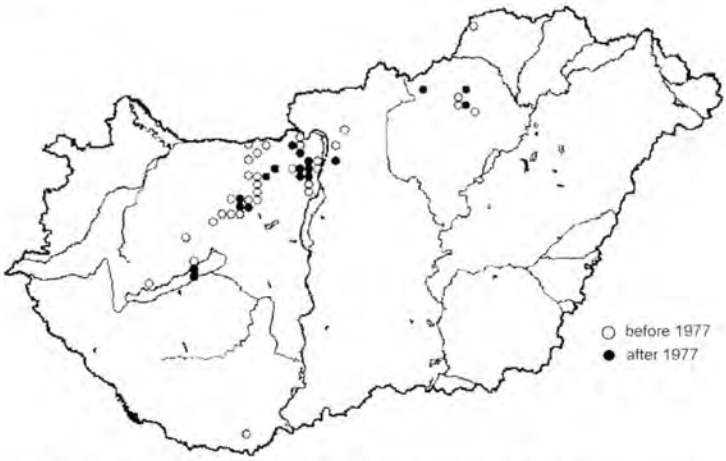


Fig. 6. Distribution of *Schistidium brunnescens* subsp. *brunnescens*

Bakony Mts: **8774/3** Comit. Veszprém. In dolomiticis montis Móroc-tető prope Várpalota, 500 m, 08.04.1951, leg. Á. Boros, BP 111693; **Balaton Uplands**: **9073/3** Comit. Zala. In rupibus basalt. tophac. merid. montis Csucs-hegy prope Tihany, 200 m, 14.11.1962, leg. Á. Boros, BP 111010; **Villány Mts**: **0176/1** Comit. Baranya. In calcareis montis Harsányi-hegy ad Nagyharsány, 200–400 m, 22.03.1925, leg. Á. Boros, BP 111385.

Schistidium brunnescens subsp. ***griseum*** (Nees et Hornsch.) H. H. Blom (Figs 7, 8)

Differs from subsp. *brunnescens* in the following characters. Plants larger, medium-sized. Central strand of few cells or absent. Hair-point not distinctly longer in subperichaetial leaves, more finely spinulose, 0.25–0.9 mm. Leaves of different shape (Figs 5A and 7A), often with ridge-like plicae (Fig. 7F, G), costa stronger (58–90 μm wide versus 45–60 μm wide in central part of subsp. *brunnescens*), 3–4 stratose in upper and 5–6 stratose in lower part (Fig. 7F, G).

Sporophytes sparse. Urn length/width ratio 1.4–1.6–1.9 (BLOM 1996), in Hungarian material (1.3–)1.48 ±0.08(–1.6), n = 7. Peristome teeth 190–320(–370) μm, orange, less perforated than in subsp. *brunnescens* (Figs 5I, 7I).

Habitat: Exposed dry calcareous rocks.

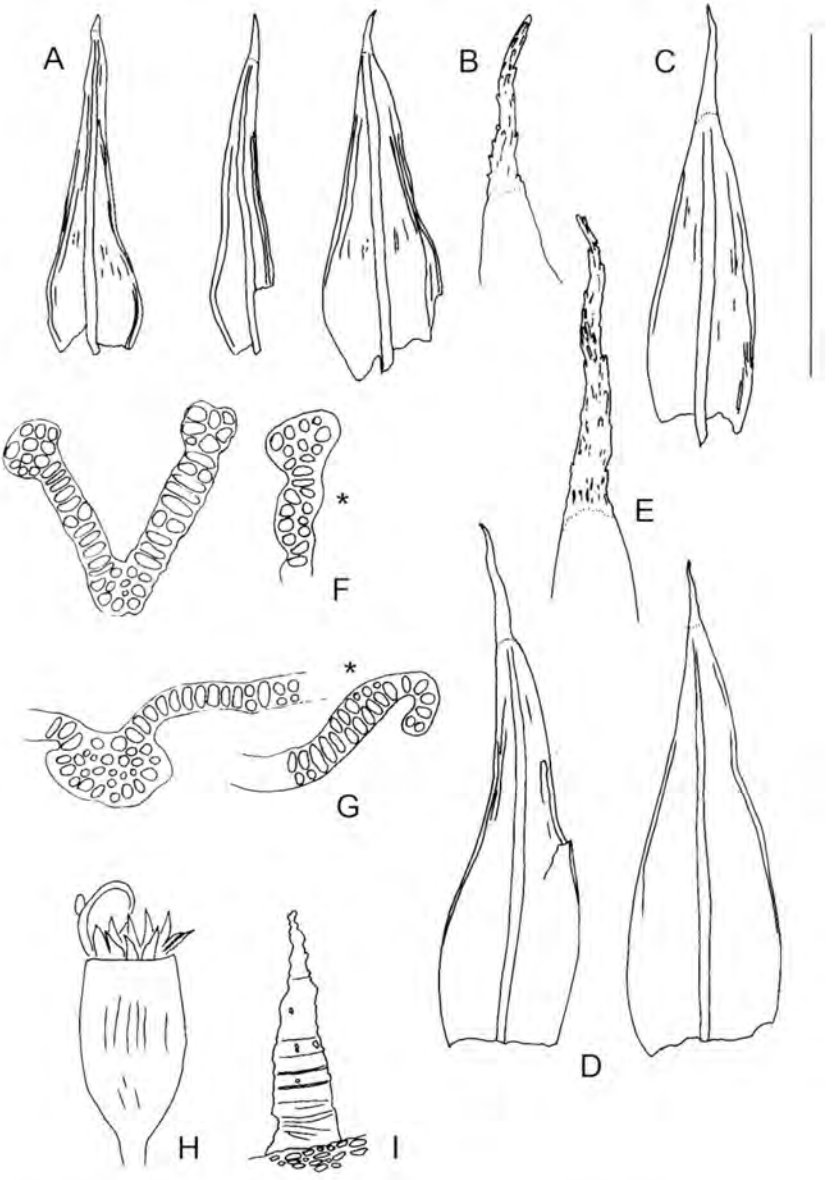


Fig. 7. *Schistidium brunnescens* subsp. *griseum*. **A** = leaves; **B** = leaf apex; **C** = subperichaetial leaf; **D** = perichaetial leaves; **E** = perichaetial leaf apex; **F**, **G** = transverse sections in upper/lower part of leaf (showing bistratose ridges near margin: *); **H** = capsule; **I** = peristome tooth. Scale bar: A, C, D, H – 2 mm; B, E – 800 μm; I – 400 μm; F, G 200 μm. [Erzberger 12147, A–E, H, I: del. Erzberger; F, G: del. Schröder]

Associated bryophytes: *Grimmia orbicularis*, *G. tergestina*, *Orthotrichum* sp.
Vertical distribution: 300–826 m a.s.l.

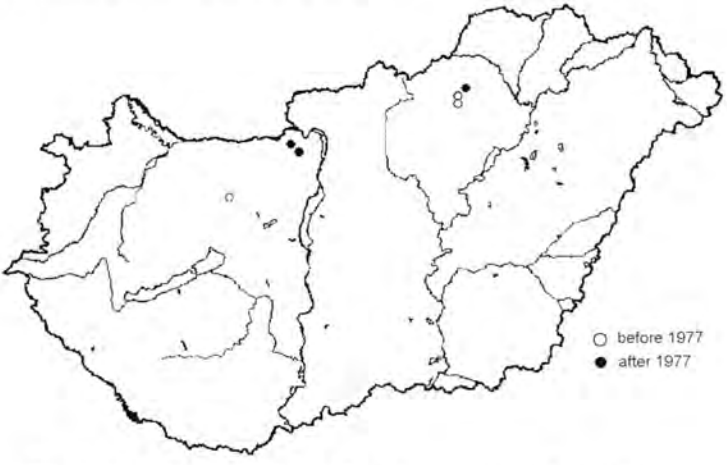


Fig. 8. Distribution of *Schistidium brunnescens* subsp. *griseum*

Selected specimens examined: **Bükk Mts**: **7988/2** Répáshuta, Három-kő, auf exponiertem Kalkstein, N 48° 03' 41.0", E 20° 28' 54.1", 826 m, 08.04.2007, leg. P. Erzberger, herb. Erzberger, (B) 12147; **Pilis Mts**: **8379/1** Gipfel des Pilis-Berges, offener Felsrasen, auf exponiertem Kalkstein, N 47° 41' 16.5", E 18° 51' 56.6", 750 m, 12.04.2007, leg. P. Erzberger, herb. Erzberger, (B) 12204; **Vértes Mts**: **8675/1** Com. Fejér. In rupibus calcareis siccis montis Csókahegy prope pag. Mór, montes Vértes, 01.07.1951, leg. L. Vajda, EGR, BP 5668.

Schistidium confertum (Funck) Bruch et Schimp. (Figs. 9, 10)

Plants small, glossy, usually forming dense cushions. Central strand narrow or sometimes absent in sterile shoots. Hair-point short (0–0.45 mm), weak and flattened, straight or irregularly bent, not decurrent, sharply and strongly spinulose-denticulate with erecto-patent to squarrose spinulae. Costa and leaf margins smooth. Lamina smooth, partly bistratose in upper and central parts. Upper lamina cells rounded, 5–8(–9) μm wide, lower cells wider and slightly sinuose, basal marginal cells often subhyaline, forming a rectangular alar group composed of several rows of square to shortly rectangular cells with thickened cross walls. K+yellow.

Sporophytes common, shallowly or deeply immersed. Urn orange-yellow, length/width ratio 0.9–1.4–1.7 (BLOM 1996), in Hungarian material 1.29, n = 1. Exothecial cells predominantly elongate. Stomata 3–8 per urn. Peristome teeth 230–320 μm, orange, strongly perforated with long and ± wide cracks along the median line, sometimes with prongs split off at margins, coarsely papillose with rather distant, short papillae with broad basal part (appearing pebble-like).

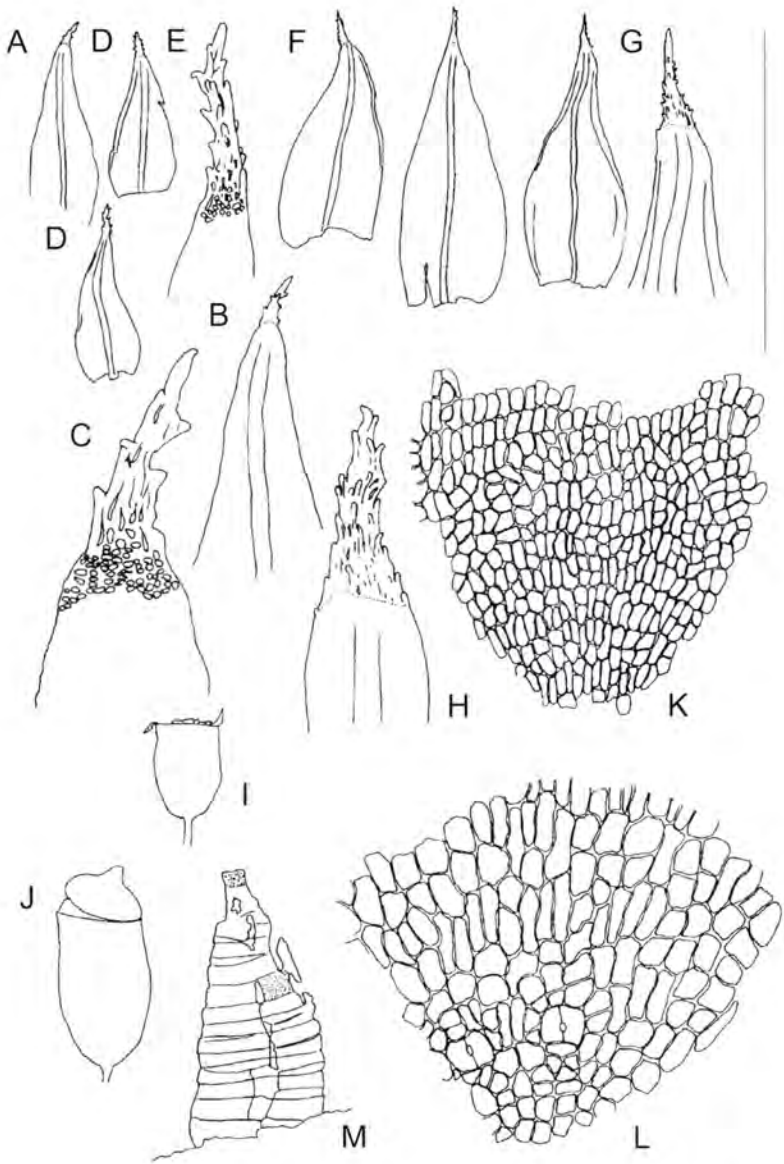


Fig. 9. *Schistidium confertum*. **A**, **D** = leaves; **B**, **C**, **E** = leaf apices; **F** = perichaetial leaves; **G**, **H** = perichaetial leaf apices; **I**, **J** = capsules; **K**, **L** = exothecial cells in lower third / at base of urn; **M** = peristome tooth (showing papillae, in part). Scale bar: A, D, F, I, J – 2 mm; B, G – 800 μm; E, H, K – 400 μm; C, L, M – 200 μm. [A–C, K, L: EGR Vajda 1956 (Börzsöny, Hollókő); D–I: BP 67976 Vajda 1962 (Börzsöny, Hollókő); J, M: BP 111013 Vajda 1952 (Mátra, Disznókő), del. Erzberger]

The spinulose, flattened hair-point with visible lumina is quite unique to this species, it is not likely to be confused with any other *Schistidium* species in Hungary. The rather short urn with strongly perforated peristome, and the preference of siliceous substrata are further characteristics.

Habitat: In Hungary, *S. confertum* grows exclusively on dry, andesitic rock. In Scandinavia, it grows on dry, ± exposed siliceous or base-rich rocks (BLOM 1996, 1998). It prefers acid rocks in Catalonia (CASAS *et al.* 2001).

Vertical distribution: 600–750 m a.s.l.

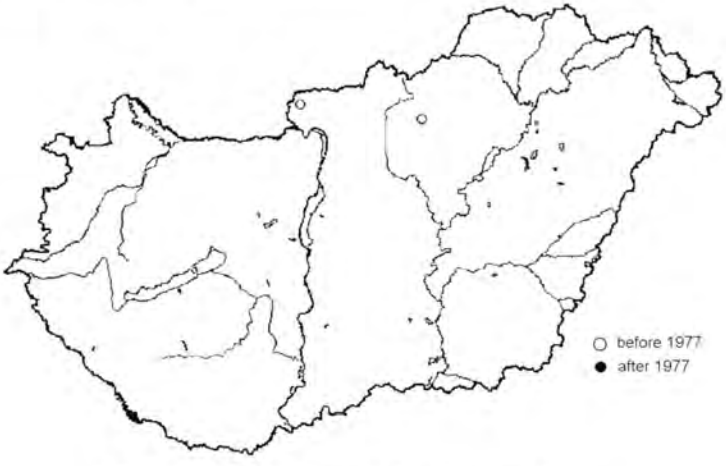


Fig. 10. Distribution of *Schistidium confertum*

Selected specimens examined: **Mátra Mts**: **8186/1** Com. Heves. In rupibus andesiticis siccis montis Disznókő prope pag. Parádfürdő, 750 m, 24.04.1952, leg. L. Vajda, BP 5608 and 111013 (sub *Grimmia plagiopodia*); **Börzsöny Mts**: **8079/1** Comit. Nógrád. In rupibus andesiticis siccis montis Hollókő, prope pag. Perőcsény, montes Börzsöny, leg. L. Vajda, 30.05.1962, BP 67976 (sub *Grimmia apocarpa* var. *conferta*); Comit. Nógrád. In rupibus andesiticis siccis cacuminis montis Hollókő prope pag. Kemence, montes Börzsöny, 21.04.1956, leg. L. Vajda, EGR.

Schistidium confusum H. H. Blom
(Figs. 11, 12)

Plants medium-sized, forming rather loose tufts of variable colour (olivaceous, brownish or blackish). Central strand wide and distinct. Hair-point 0–0.65 mm, narrow throughout or sometimes ± abruptly widened at insertion, not coarse but stiff and ± straight, from not to longly decurrent, irregularly spinulose-denticulate with short, blunt spinulae.

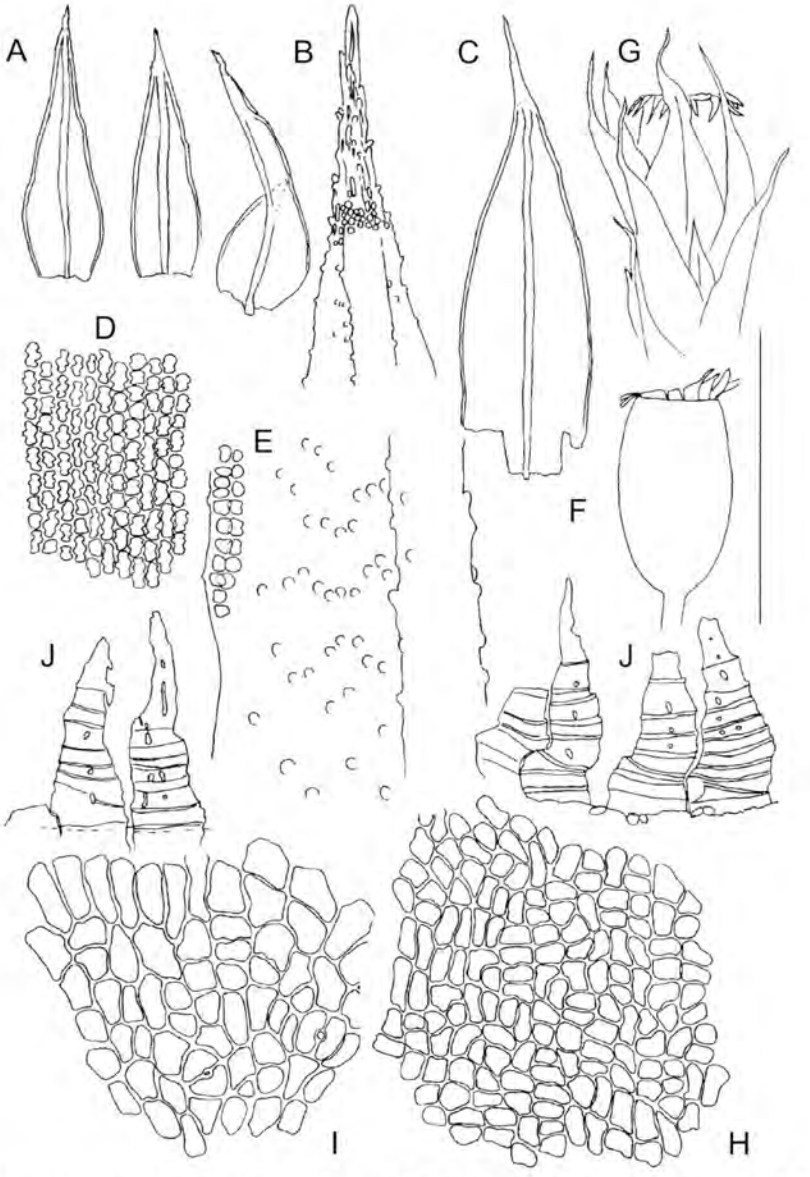


Fig. 11. *Schistidium confusum.* **A** = leaves; **B** = leaf apex; **C** = perichaetial leaf; **D** = lamina cells in lower third of leaf; **E** = papillae and lamina cells at abaxial side of leaf near costa; **F** = capsule (moist); **G** = perichaetium with capsule (dry) showing reflexed peristome teeth; H, I = exothecial cells at lower third / at base of urn; **J** = part of peristome. Scale bar: A, C, F, G – 2 mm; B, H, J – 400 μm; D, E, I – 200 μm. [Erzberger 12896, del. Erzberger]

Abaxial side of costa with scattered low papillae in upper part; leaf margins papillose-denticulate in upper part, more rarely smooth, broadly and strongly recurved throughout or in upper 3/4–4/5 of leaf length, ± bistratose. Lamina with scattered dorsal papillae, particularly near costa, and mostly with few ventral papillae, unistratose with bistratose spots and striae in upper part. Lamina cells in upper part rounded, slightly sinuose, 8–11 μm wide, in lower part wider and sinuose to nodulose, basal marginal cells with slightly thickened crosswalls. K+ red.

Sporophytes abundant, shallowly immersed. Urn red-orange-brown, glossy, length/width ratio (1.3–)1.5–1.9–2.3(–2.5) (BLOM 1996), in Hungarian material 1.78–1.83, n = 2. Exothecial cells predominantly isodiametric and transversely rectangular, but also rectangular, forming an irregular pattern. Stomata 4–9 per urn. Peristome teeth 310–420 μm, squarrose-recurved, red, gradually tapering to a fine point, from entire to strongly and irregularly perforated in central part, densely papillose.

In Hungary, *S. confusum* is the only member of the Strictum subgroup that grows on calcareous substrates, whereas *S. papillosum* and *S. pruinosum* grow on siliceous rocks. From those species, *S. confusum* differs by its less papillose lamina (Fig. 11E), with more papillae on the abaxial, fewer on the adaxial side of the leaf (*S. pruinosum* is strongly papillose on both sides: Fig. 30G, H). *S. papillosum* is similar in this respect (usually more papillae on the abaxial side than on the adaxial side), but differs by the lack of a distinct central strand and the peristome teeth erecto-patent (Fig. 25G, but squarrose when old). Other differences between *S. confusum* and *S. pruinosum* include the wider and more sinuose lamina cells (Figs 11D, 30F) and the narrower perichaetial leaves of the former species (Figs 11C, 30D).

Habitat: In Hungary, *S. confusum* was found on exposed concrete adjacent to dolomite. In Scandinavia, it grows in similar situations, on exposed calcareous substrates (BLOM 1996).

Associated bryophytes: None.

Vertical distribution: 250 m a.s.l.

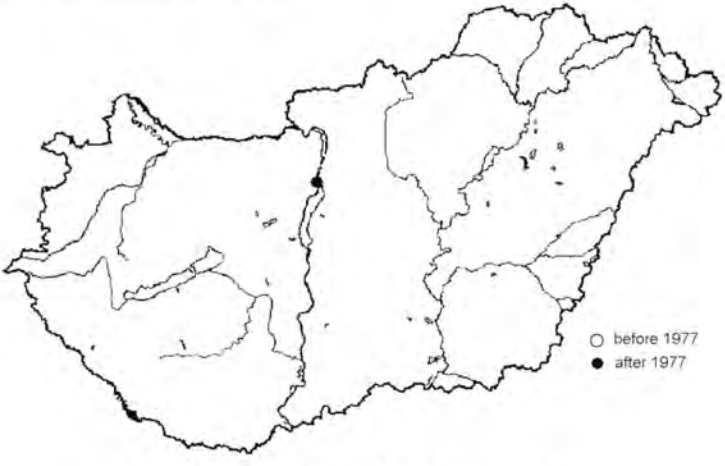


Fig. 12. Distribution of *Schistidium confusum*

Specimen examined: Buda Mts: 8580/1 Buda: Sas-hegy, on exposed concrete adjacent to dolomite, N 47° 28' 59.5", E 19° 01' 09.3", *ca* 250 m a.s.l., 28.03.2008, leg. P. Erzberger, herb. Erzberger, (B) 12896.

Schistidium crassipilum H. H. Blom
(Figs 13, 14)

Plants medium-sized or small, forming dense or lax tufts of variable colour (olivaceous, brownish, black). Central strand distinct. Hair-point 0–1.1 mm, coarse and stiff, mostly somewhat flattened in lower part, but sometimes terete throughout, straight or more rarely irregularly curved in upper part, from shortly to longly and broadly decurrent or sometimes not decurrent, finely to coarsely spinulose-denticulate. Abaxial side of costa with scattered low papillae in upper part, more rarely smooth; leaf margins distantly and finely denticulate to papillose-denticulate in upper part, more rarely smooth. Lamina smooth, unistratose in lower part to irregularly bistratose in upper part. Lamina cells in upper part rounded, not or slightly sinuose, 8–9 μm wide, in lower part wider and sinuose, basal cells often noticeably wider than cells above, basal marginal cells with thickened crosswalls. K+ red.

Sporophytes common, mostly deeply immersed. Urn orange-brown (yellowish when empty and becoming finely striolate), length/width ratio (1.3–)1.6–1.8–2.2 (BLOM 1996), in Hungarian material (1.2–)1.78 ±0.03(–2.6), n = 190. Exothecial cells predominantly elongate. Stomata 0–4(–6) per urn, sometimes ± rudimentary. Peristome teeth 300–450 μm, red, smooth or finely papillose-striated in lower part, papillae often in oblique rows.

Very variable. The most common morph with denticulate leaf apices (Fig. 13C, D) and shortly elongate exothecial cells (Fig. 13I) is easily identified, but more deviant forms can be hard to name. They may closely resemble *S. elegantulum* or *S. helveticum*. According to our observations, the number of stomata can be greater than 6, the number given by BLOM (1996). This makes the differentiation between *S. crassipilum* and *S. elegantulum* subsp. *wilsonii* (8–16 stomata per urn, BLOM 1996) more problematic. *S. elegantulum* differs from *S. crassipilum* in the absence of a central strand and the structure of the hair-point, which is terete throughout in the former (Fig. 17), and usually distinctly flattened and somewhat broadened towards insertion in the latter species (Fig. 13B). See also the note under *S. elegantulum*. *S. helveticum* has a shorter hair-point of different structure (Fig. 21B, C), no stomata and a characteristically different exothecial cell pattern. (Fig. 21G, H).

Habitat: In Hungary (as in Scandinavia) *S. crassipilum* is by far the most common *Schistidium* species on calcareous rocks (limestone, dolomite) or concrete, but it is also found more rarely on siliceous rock types (andesite, trachyte, breccia, sandstone, granite, basalt, muskovite) and basic or even acidic types of soil, in a great variety of conditions (dry or moist, exposed to the sun or shaded, even in caves, in northern or southern exposition, in forests or in open habitats, *e.g.* calcareous grasslands). A rather weedy species.

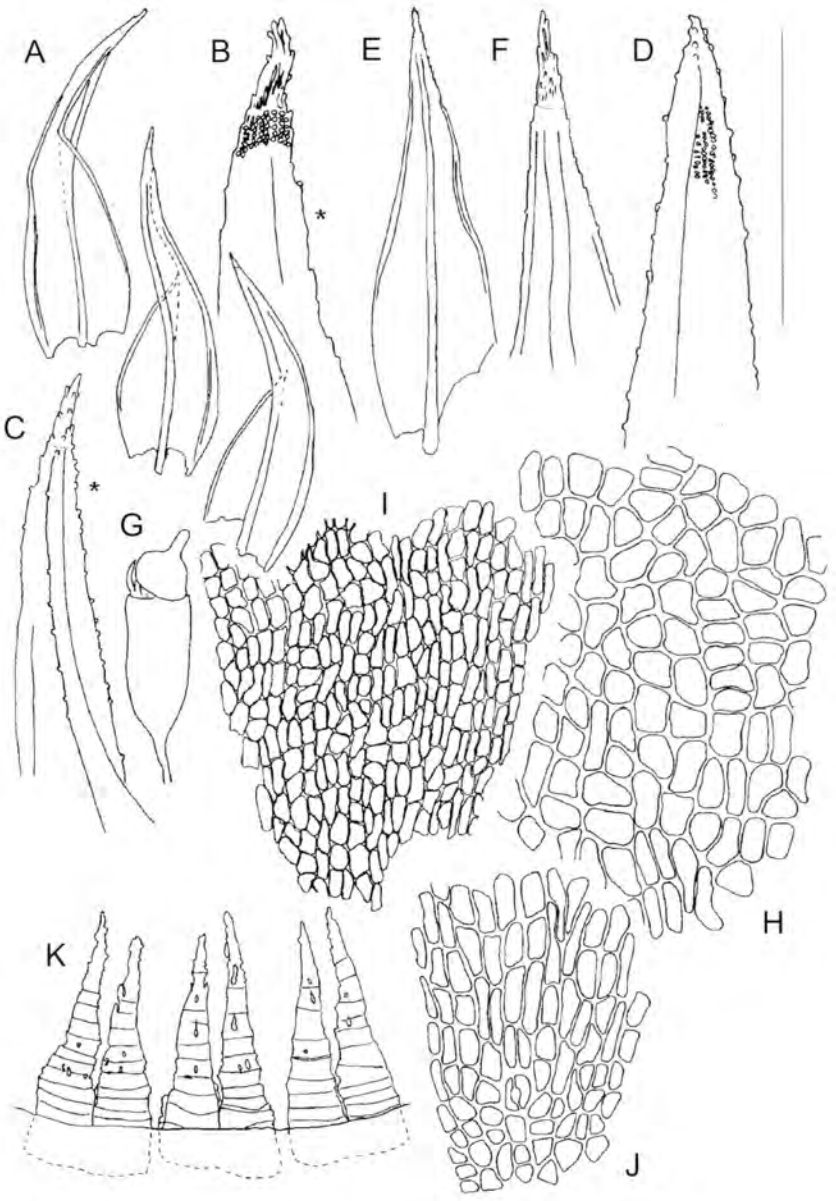


Fig. 13. *Schistidium crassipilum*. **A** = leaves; **B–D** = leaf apices (B, C in lateral view, * costa); **E** = perichaetial leaf; **F** = perichaetial leaf apex; **G** = capsule; **H, I, J** = exothecial cells at mid urn / at lower third of urn / at base of urn; **K** = part of peristome. Scale bar: A, E, G – 2 mm; F – 800 μm; B, C, D, I, K – 400 μm; H, J – 200 μm. [A–C, E–H, J–K: Erzberger 12090; D, I: EGR Vajda 1941 (Pilishegy), del. Erzberger]

Associated bryophytes: *Amblystegium serpens, Anomodon attenuatus, Barbula unguiculata, Bryoerythrophyllum recurvirostrum, Bryum argenteum, B.* cf. *kunzei, B. moravicum, Ceratodon purpureus, Cirriphyllum tommasinii, Didymodon acutus, D. fallax, D. rigidulus, Ditrichum flexicaule, Eurhynchium hians, E. pulchellum, Grimmia laevigata, G. pulvinata, Hedwigia ciliata* var. *leucophaea, Homalothecium lutescens, Homomallium incurvatum, Leskea polycarpa, Orthotrichum anomalum, O. cupulatum, O.* sp., *Oxystegus tenuirostris, Pottia lanceolata, Pseudoleskeella catenulata, P. nervosa, Pylaisia polyantha, Schistidium apocarpum, S. brunnescens* subsp. *brunnescens, S. dupretii, S. elegantulum, S. helveticum, S. lancifolium, S. robustum, Seligeria pusilla, Thuidium abietinum, Tortella tortuosa, Tortula crinita, T. muralis, T. ruralis.*

Vertical distribution: 83–910 m a.s.l.

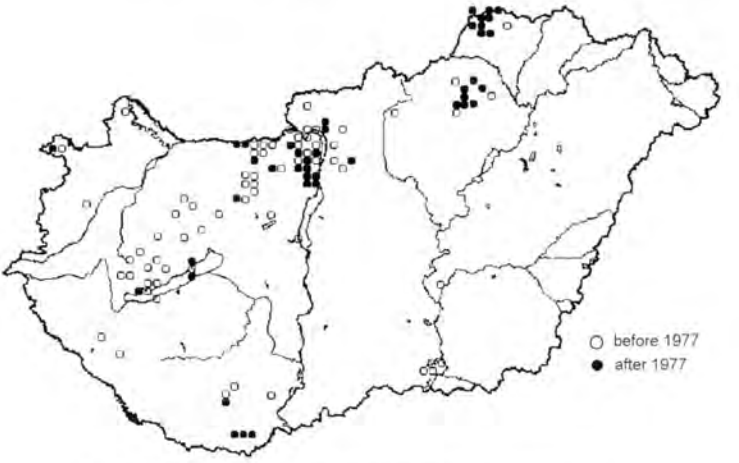


Fig. 14. Distribution of *Schistidium crassipilum*

Selected specimens examined: Aggtelek Karst: 7589/1 Comit. Abaúj-Torna. In rupibus calcareis apricis "Tohonya-bérc" prope Jósvafő, 250 m, 01.05.1953, leg. Á. Boros, BP 110956; **Bükk Mts: 7889/3** Garadna-Tal, angesprengte schattige, feuchte Kalkwand an der Straße *ca* 2 km östlich Ómassa, N 48° 06' 43.8", E 20° 32' 19.6", *ca* 460 m, 07.04.2007, leg. T. Pócs and P. Erzberger, herb. Erzberger, (B) 12119; **Mátra Mts: 8084/4** Comit. Heves. In declivibus dumetosis inter vallem rivi Csevice-patak et jugum montis Ágasvár supra pag. Tar, 300–600 m, 06.05.1928, leg. Á. Boros, BP 110920; **Cserhát Hills: 8181/4** Com. Pest. In rupibus siccis in decl. montis Várhegy prope pag. Csővár, montes Cserhát, 17.03.1951, leg. L. Vajda, BP 5641; **Gödöllő Hills: 8382/3** Pest county. Babat valley, Gödöllő city, basalt rock, oak forest-grassland transition, N 47.623°, E 19.384°, 200 m, 11.03.2001, leg. P. Ódor, herb. Ódor, 20010311-10; **Börzsöny Mts: 8279/2** Comit. Hont. Hung. cent. In valle "Ernő forrásvölgye" ad pag. Zebegény. Solo trachyt., 16.07.1928, leg. J. Szepesfalvi, BP 5709; **Visegrád Mts: 8380/1** In saxis trachyticis rivuli Kőhegy ad Pomáz cottus Pest, 24.04.1904, leg. L. Simonkai, BP 5657; **Naszály: 8180/4** Comit. Nógrád.

In monte Nagyszál supra Kosd, 10.09.1916, leg. Á. Degen, BP 46951; **Pilis Mts: 8379/1** Hung. centr., com. Pest. In rupibus calcareis montis Pilishegy supra pag. Pilisszentkereszt, 01.06.1941, leg. L. Vajda, EGR; **8379/4** Comit. Pest. In rupibus calcareis sept. montis Oszoly prope Csobánka, 250 m, 31.03.1946, leg. Á. Boros, BP 110884; **Buda Mts: 8479/1** Comit. Pest. In saxis calcar. pedis montis Zsíros-hegy prope pag. Budajenő, 350 m, 21.03.1948, leg. Á. Boros, BP 110887; **Gerecse Mts: 8275/4** Szomód, Betlehem-vadászház, tölgyes-EF, árnyas mészkő, N 47° 42.058', E 18° 19.496', 321 m, 26.08.2006, leg. P. Szűcs, herb. Szűcs, NYG 7; **Vértes Mts: 8576/2** Comit. Komárom. In rupibus calc. occid. dumetosis montis Lófő supra pag. Várgesztes, 350 m, 12.05.1935, leg. Á. Boros, BP 110835; **Velence Mts: 8777/2** Comit. Fejér. In rupibus graniticis montis Zsidó-hegy prope Pázmánd, 150–200 m, 27.06.1938, leg. Á. Boros, BP 110832; **Bakony Mts: 8673/3** Comit. Veszprém. In rupibus calc. vallis Cuhavölgy prope Csesznek, 350 m, 07.06.1928, leg. Á. Boros, BP 5679; **Balaton Uplands: 9270/2** Hung. occid. Ad muros vinearum mtis "Badacsonyhegy" ad lac. Balaton. Solo basalt., 300 m, 11.08.1933, leg. J. Szepesfalvi, BP 39074; **Keszthely Mts: 9169/2** Comit. Zala. In rupibus dolomit. sept. montis Rezi-vár prope Rezi, 300–400 m, 23.03.1962, leg. Á. Boros, BP 110798; **Sopron Mts: 8365/1** Sopron, Bot. kert, muszkovit-szilikát sziklán, 04.02.2004, leg. P. Szűcs, herb. Szűcs, SOP/1; **Vas Region: 8667/3** Comit. Vas. In muris in arboreto ad Szeleste, 180 m, 10.06.1962, leg. Á. Boros, BP 111371; **Zala: 8970/3** Comit. Zala. In rupibus calcar. eocen. ad fontem majorem ripae rivi Marcal prope Gyepükaján, 170 m, 15.09.1961, leg. Á. Boros, BP 110807; **Belső-Somogy: 9669/1** Comitat Somogy Ad muros pr. pag. Inke, 180 m, 23.02. 1956, leg. Á. Károlyi, BP 59108; **Mecsek Mts: 9875/2** Mánfa. Téglakerítésen, 23.08.1931, leg. A. Visnya, BP 111391; **Villány Mts: 0175/2** Comit. Baranya. In rupestribus ad Sárga-bánya in monte Csukma prope pag. Máriagyüd, 200 m, 08.08.1999, leg. B. Papp, BP 166476; **Hanság: 8069/3** Comit. Moson. In muris viae ferreae ad fluv. lajta prope pag. Hegyeshalom, 120 m, 10.04.1920, leg. Á. Boros, BP 111360; **Danube–Tisza Interfluve: 9687/3** Comit. Csongrád. Sándorfalva. Tegmen lepidarium aggeri ad Sajtos, 83 m, 09.08. 1951, leg. L. Timár, BP 111355; **Tiszántúl: 9687/3** Com. Hajdú. In cippo in sepultura Felső-temető prope Hajdúnánás, 02.04.1941, leg. J. Igmándy, BP 111365; **Danube inundation area: 8276/4** Comit. Komárom. In saxis calcareis deportatis marginis alvei Danubii inter pagos Piszke et Lábatlan, 100 m, 15.02.1925, leg. Á. Boros, BP 110860.

Schistidium dupretii (Thér.) W. A. Weber
(Figs 15, 16)

Plants small, forming low tufts. Central strand distinct. Hair-point mostly very short, but rarely absent on all leaves, 0–0.15(–0.25) mm, weak and narrow throughout, erect, straight, not or very shortly and narrowly decurrent, from nearly smooth to distinctly spinulose. Costa and leaf margins smooth (BLOM 1996), but in some Hungarian specimens distinctly papillose in apical part (Fig. 15B, C). Lamina smooth, usually unistratose. Lamina cells (7.5–)8–9.5(–11) μm wide and not or slightly sinuose in upper part of leaf, wider and more sinuose below (Fig. 15E). Perichaetial leaves narrow (Fig. 15D), hardly concealing the urn. K+ red.

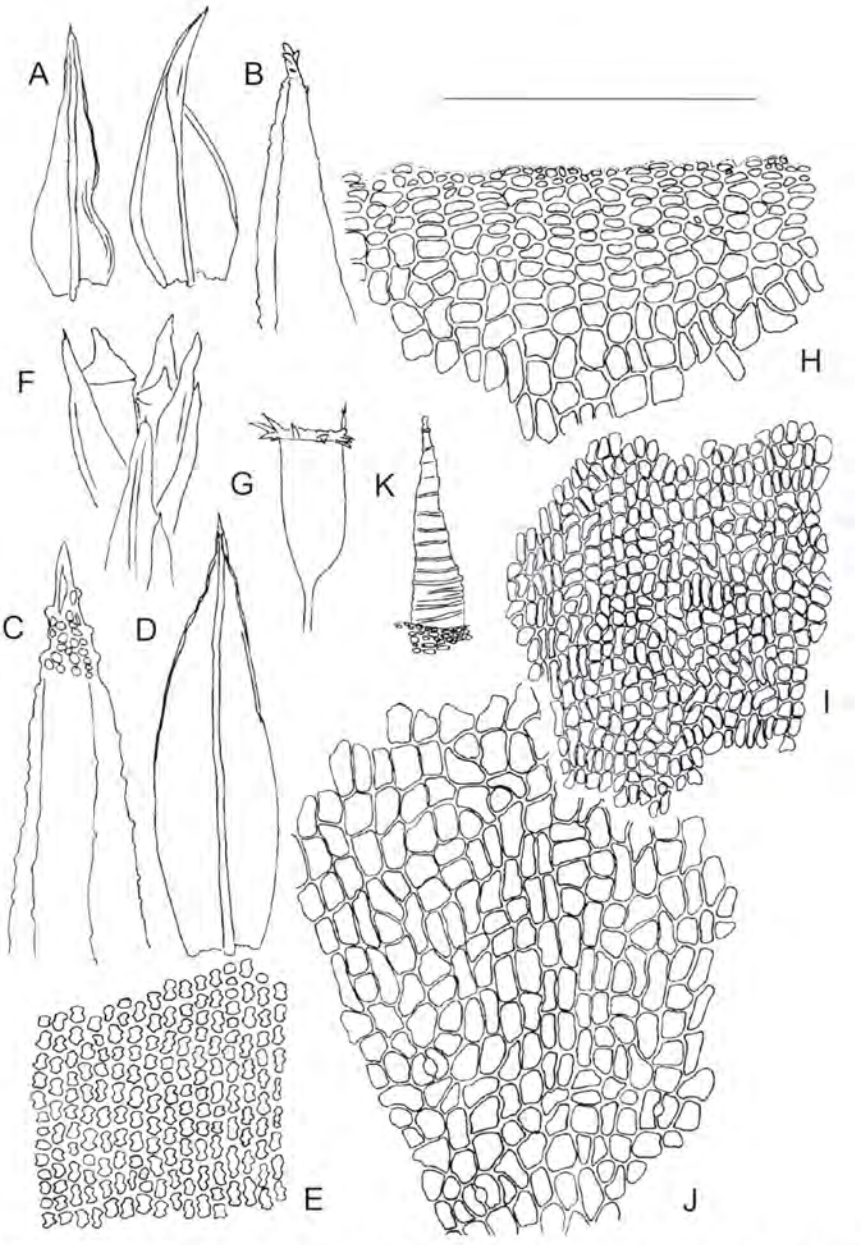


Fig. 15. *Schistidium dupretii*. **A** = leaves; **B**, **C** = leaf apices; **D** = perichaetial leaf; **E** = lamina cells in lower part of leaf; **F** = capsules in perichaetium; **G** = capsule; **H**, **I**, **J** = exothecial cells at urn mouth / mid urn / base of urn; **K** = peristome tooth. Scale bar: A, D, F, G – 2 mm; B, I, K – 400 μm; C, E, H, J – 200 μm. [Erzberger 8056, del. Erzberger]

Sporophytes common, much exposed in lateral view (Fig. 15F). Urn red-brown, finely striolate after dehiscence, length / width ratio (1.2–)1.5–1.9–2.3(–2.6) (BLOM 1996), in Hungarian material 1.85 ±0.3, n = 2. Exothecial cells irregular in size and shape, striolae composed of collapsed narrowly elongate cells. Stomata about 6 per urn. Peristome teeth (250–)290–380 µm, red, entire or rarely with median cracks in central part, finely papillose.

Characteristic features of this species are the narrow hair-point (if present), which appears to be "glued on" to the leaf apex, being much narrower than the chlorophyllose part of the apex (Fig. 15A–C, F), and the capsule being well visible between the thin, appressed perichaetial leaves.

Habitat: In Hungary, *S. dupretii* grows on ± exposed, dry limestone rocks or walls, but it has also been found on siliceous rock (trachyte); a wide substrate tolerance is also reported by BLOM (1996).

Associated bryophytes: *Schistidium apocarpum*, *S. crassipilum*.

Vertical distribution: 250–375 m a.s.l.

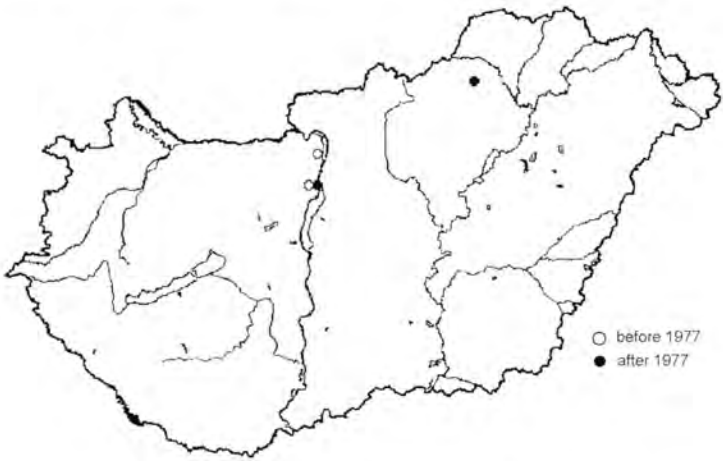


Fig. 16. Distribution of *Schistidium dupretii*

Selected specimens examined: **Bükk Mts: 7889/3** Ómassa, Vörös-kő, top of limestone wall near stream, 375 m, 07.04.2007, leg. P. Erzberger and T. Pócs, herb. Erzberger, (B) 12117; **Visegrád Mts: 8380/1** Comit. Pest Hung. centr. Ad pedem montis Kőhegy versus pag. Pomáz. Solo trachytico, 11.04.1928, leg. J. Szepesfalvi, BP 5651; **Buda Mts: 8580/1** Buda: Sas-hegy, on exposed dolomite, N 47° 28' 59.5", E 19° 01' 09.3", *ca* 250 m a.s.l., 05.04.2002, leg. P. Erzberger, herb. Erzberger, (B) 8056.

Schistidium elegantulum H. H. Blom
(Figs 17, 18)

Plants medium-sized to large, forming mats or decumbent tufts. Central strand absent. Hair-point 0.3–1.0 mm, erect, ± pellucid, hyaline but often brownish at insertion (Fig. 17A, C), straight and stiff, terete, narrow throughout, not decurrent (the transition between the hyaline and the chlorophyllose part of the apex smooth), distantly spinulose-denticulate throughout. Costa and leaf margins smooth. Lamina smooth, unistratose with bistratose patches in upper part. Lamina cells not or slightly sinuose, predominantly isodiametric, in upper part 8–10 μm wide, in lower wider. K+ red.

Sporophytes common, immersed, but partly visible among the perichaetial leaves. Urn straw-yellow to orange, becoming finely striolated when old, oval, widest at middle (narrowed towards mouth), length/width ratio 1.6–2.0–2.4 (BLOM 1996), in Hungarian material (1.4–)1.87 ±0.12(–2.5), n = 25. Exothecial cells predominantly elongate, 50–70 μm long. Stomata 6–8 per urn (8–16 in subsp. *wilsonii*). Peristome teeth 350–430 μm long, orange to red, entire or with narrow submarginal slits in central part, densely and coarsely papillose, in lower part smooth or with papillae more distantly arranged.

S. elegantulum subsp. *wilsonii* (which has not yet been found in Hungary) differs from the typical subspecies in a broader and coarser hair-point that appears rather whitish (pellucid in subsp. *elegantulum*) and smooth (*i.e.* the spinulae are denser and smaller than in subsp. *elegantulum* and not visible with a hand lens). Other differences include growth form (dense tufts versus mats or decumbent tufts in subsp. *elegantulum*), hair-point length in perichaetial leaves (up to 1.0–1.5 mm versus up to 0.7–0.9 mm), costa width at leaf base (75–88 μm versus 53–78 μm), costa stratosity at leaf base (5–7 *vs* 4–5) and number of stomata (8–16 *vs* 6–8).

In Hungarian plants of *S. elegantulum*, the hair-point appears smooth when viewed in low magnification (as in subsp. *wilsonii*), due to few / short spinulae as seen in the compound microscope. Otherwise, they possess the characteristics of subsp. *elegantulum*.

The differentiation between *S. elegantulum* and *S. crassipilum* can be very difficult in Hungarian plants, although in other geographical regions (*e.g.* in Germany), *S. elegantulum* poses no problems. Some plants could be considered transitional between the two species, *e.g.* displaying sporophytes typical of *S. elegantulum* (oval urns with many stomata); but leaves characteristic of *S. crassipilum*. The converse situation is observed as well. Such plants have been placed in the latter, variable species during the present revision.

Habitat: *S. elegantulum* typically grows on ± shaded limestone or dolomite boulders and rocks, sometimes on concrete; in Hungary it has rarely also been found on base-rich siliceous rock (basalt, andesite). In Scandinavia, *S. elegantulum* subsp. *wilsonii* is reported to grow on exposed to semi-shaded calcareous rocks, often on wall-tops.

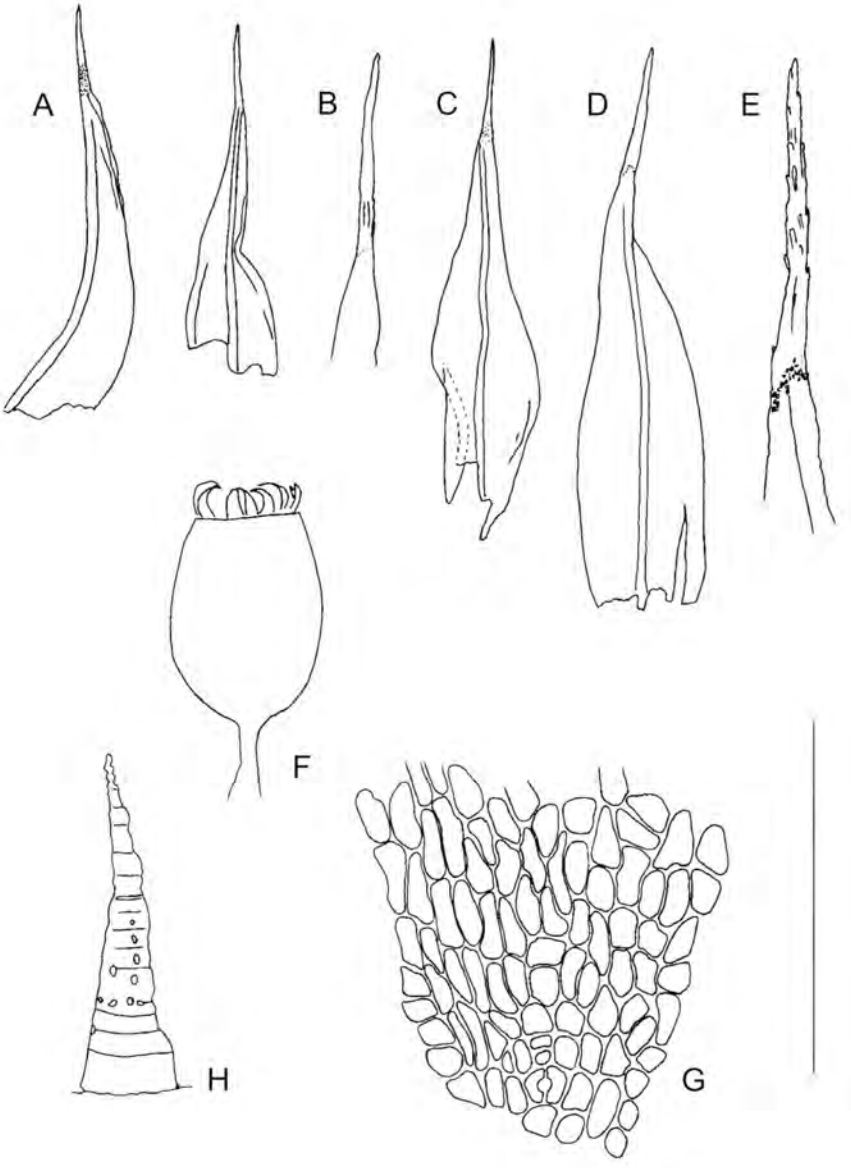


Fig. 17. *Schistidium elegantulum*. **A** = leaves; **B** = leaf apex; **C** = subperichaetial leaf; **D** = perichaetial leaf; **E** = perichaetial leaf apex; **F** = capsule; **G** = exothecial cells at base of urn; **H** = peristome tooth. In A and C the coloured part of the hair-point is stippled. Scale bar: A, C, D, F – 2 mm; B, E – 800 μm; H – 400 μm; G – 200 μm. [Erzberger 12125, del. Erzberger]

Associated bryophytes: *Bryum capillare, Didymodon rigidulus, Leucodon sciuroides, Orthotrichum anomalum, Plagiochila porelloides, Pseudoleskeella nervosa, Schistidium apocarpum, S. crassipilum, S. helveticum, Tortella tortuosa, Tortula muralis, T. ruralis.*

Vertical distribution: 82–910 m a.s.l.

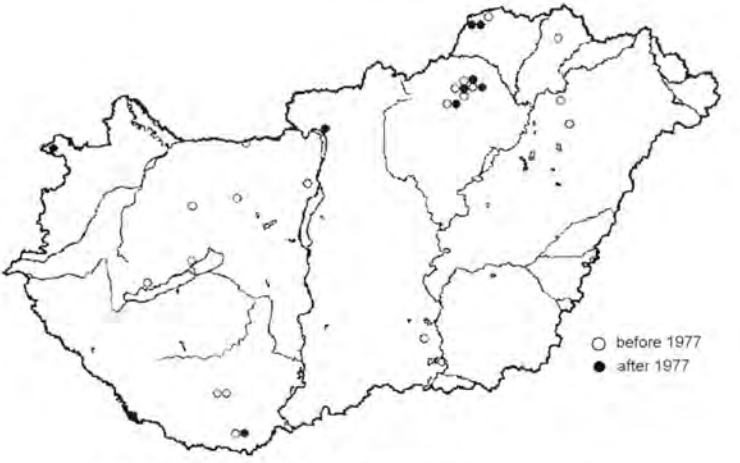


Fig. 18. Distribution of *Schistidium elegantulum*

Selected specimens examined: **Zemplén Mts**: **7694/1** Comit. Abaúj-Torna. In rupibus andesit. tophac. ad ruinam Regéci-várrom prope Regéc, 600 m, 03.11.1959, leg. Á. Boros, BP 111933 sub *Grimmia commutata* Hüben., rev. P.E. **Aggtelek Karst**: **7490/3** Comit. Abaúj-Torna. In rupibus calcar. sept. silvat. montis Szádvár prope Szögliget, 450 m, 01.05.1953, leg. Á. Boros, BP 106976; **Bükk Mts**: **7889/3** Szentlélek: Örvény-kő, niedriger Kalkblock in lichtem *Quercetum*, N48° 07' 48.4", E 20° 32' 22.9", 766 m, 07.04.2007, leg. P. Erzberger, herb. Erzberger, (B) 12125; **7988/2** Répáshuta, Három-kő, auf Kalkstein in lichtem Wald, N 48° 03' 41.0", E 20° 28' 54.1", 820 m, 08.04.2007, leg. P. Erzberger, herb. Erzberger, (B) 12145; **Naszály**: **8180/4** Bergrutsch, auf Kalkstein, N 47° 50' 24.7", E 19° 07' 49.6", 350 m, 09.04.2007, leg. P. Szűcs and P. Erzberger, herb. Erzberger, (B) 12179; **Buda Mts**: **8579/2** Ex herb. C. Schilberszky, Farkasvölgy, mészkő 02.05.1886, unknown collector, BP 5624; **Gerecse Mts**: **8276/3** Comit. Komárom. In rupibus calcareis montis Kőpite-hegy prope pag. Dunaalmás, 150–250 m, 27.04.1942, leg. Á. Boros, BP 110856; **Vértes Mts**: **8675/2** Comit. Fejér. In rupibus dolomit. sept. montis Vár-hegy prope Csókakő, 350–400 m, 20.08.1948, leg. Á. Boros, BP 111711; **Bakony Mts**: **8673/3** Comit. Veszprém. Bakony. In valle Cuha-völgy, 28.05.1928, leg. Á. Degen, BP 5677; **Balaton Uplands**: **9073/1** Comit. Zala. In calcareis montis Péter-hegy supra Balatonarács, 200–300 m, 02.04.1926, leg. Á. Boros, BP 110802; **Comit. Zala**: **9170/4** In monte Szent György-hegy prope Tapolcza, 05.05.1912, leg. Á. Degen, BP 5673; **Sopron Mts**: **8365/1** Sopron, Bot. kert, 61/7 parcella, betonon, 04.02.2004, leg. P. Szücs, herb. Szücs, SOP/2; **Mecsek Mts**: **9875/3** Comit. Baranya. In rupibus calcar. merid. montis Tubes prope Pécs, 600 m,

26.04.1962, leg. Á. Boros, BP 111397; **Villány Mts: 0176/1** Comit. Baranya. In rupestribus in decl. merid. montis Szársomlyó prope pag. Nagyharsány, 200–300 m, 07.02.2000, leg. B. Papp, BP 166467; **Danube–Tisza Interfluve: 9687/3** [between Szeged and Hódmezővásárhely] Algyő felett, sajtos szék, pyrog. andesit kő, 22.06.1928, leg. I. Győrffy, BP 86585; **Tiszántúl: 9586/1** Comit. Csongrád. Szeged. Sövényháza. Stratura "P...(?)-töltés" ad 1. gátőrház, 82 m, 21.04.1951, leg. L. Timár, BP 111353.

Schistidium flaccidum (De Not.) Ochyra
(Figs 19, 20)

Plants small to medium-sized, forming dense, sometimes hoary cushions. Central strand narrow and indistinct. Hair-point 0.15–0.85 mm, straight or slightly bent, weak and flattened, wide or narrow at insertion, not or shortly decurrent, finely and distantly denticulate. Costa and leaf margins smooth. Lamina smooth, unistratose or occasionally with bistratose spots in upper part. Lamina cells in upper part transversely ovate to shortly oblong, not or slightly sinuose, in lower part slightly sinuose, 7–9(–10) μm wide throughout except for wider basal cells. Basal marginal cells square to shortly rectangular, with ± strongly thickened cross-walls, forming a rectangular alar group. Perichaetial leaves much larger than vegetative leaves (compare Fig. 19A and C), concave and plicate, with hair-points up to 1.0 mm, wide in lower part and embracing a large portion of the upper lamina, but not or very shortly decurrent. K+ yellow.

Sporophytes common, deeply immersed and often completely hidden in lateral view. Seta short, 0.05–0.13(–0.28) mm. Urn yellowish brown to orange brown, with a conspicuous bright red rim at the mouth, length/width ratio 0.9–1.3 (BLOM 1996), in Hungarian material 1.17, n = 1. Exothecial cells rectangular in lower half (Fig. 19H, I), irregular in shape in upper half (Fig. 19G). Stomata small and obscure, 3–6(–8)per urn. Peristome teeth rudimentary, 17–25 μm, consisting of short basal segments not or only shortly extending beyond the capsule mouth (but sometimes up to 320 μm long: BLOM 1996: p. 177, not seen in Hungarian specimens). Operculum mamillate, not rostrate.

Usually an easily recognised species, with a unique combination of short and wide urn (Fig. 19E), rudimentary peristome and mamillate operculum. Superficially resembling *Grimmia anodon* in the lack of a well-developed peristome, but that species grows on calcareous rocks, not on siliceous rock as *S. flaccidum*.

Habitat: In Hungary, *S. flaccidum* grows on exposed andesite and other volcanic rock; this tallies with its preference for siliceous substrata in other parts of its distribution area (Europe, North America; BLOM 1996).

Associated bryophytes: *Bryum moravicum*, *Grimmia laevigata*, *G. muehlenbeckii*.

Vertical distribution: 320–355 m a.s.l.

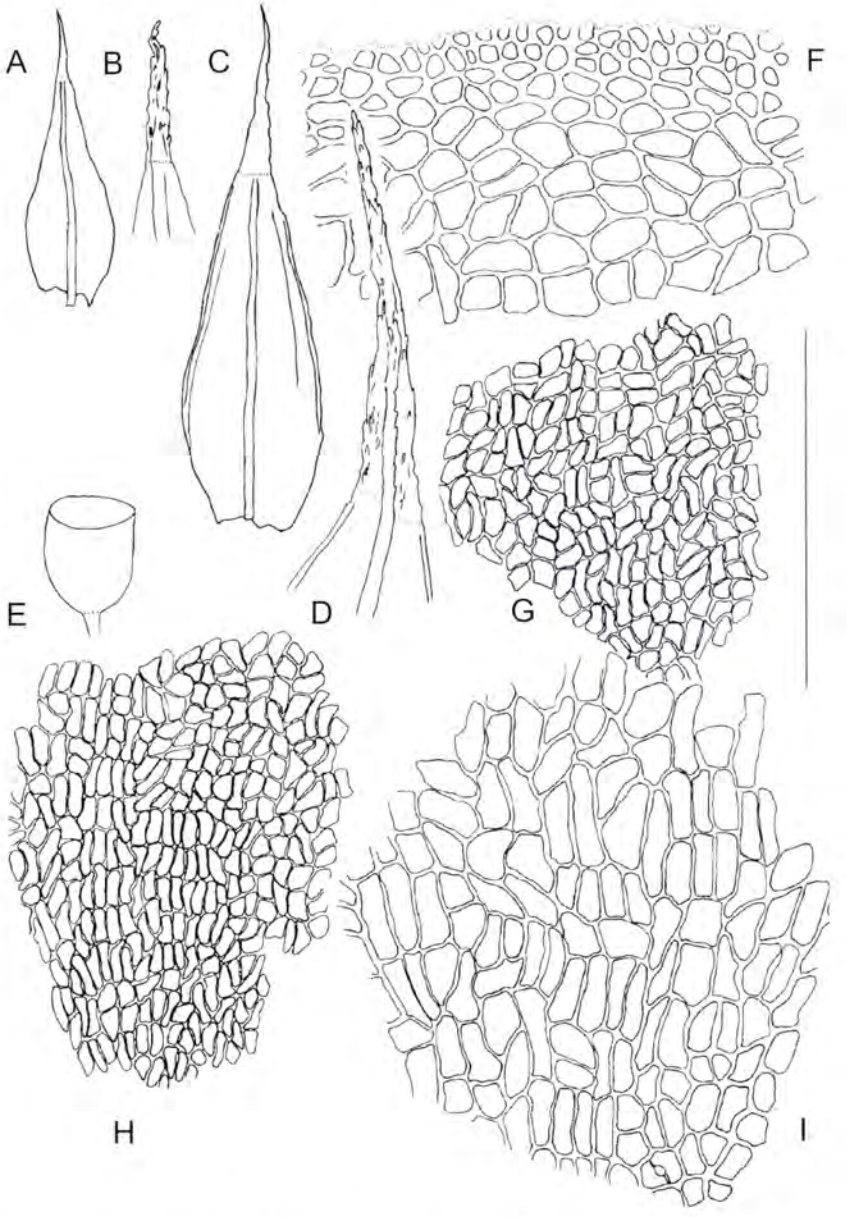


Fig. 19. *Schistidium flaccidum*. **A** = leaf; **B** = leaf apex; **C** = perichaetial leaf; **D** = perichaetial leaf apex; **E** = capsule; **F–I** = Exothecial cells at mouth of urn /shortly above mid urn / at base of urn (H + I). Scale bar: A, C, E – 2 mm; B, D – 800 μm; G, H – 400 μm; F, I – 200 μm. [Erzberger 6343, del. Erzberger]

Distribution: *S. flaccidum* was known in Hungary from two locations, one near Pomáz in the Visegrád Mts and one between Nagymaros and Zebegény, on the left side of the Danube. Phytogeographically this site, Mt Szentmihály or Mt Ördög, belongs to the Visegrád Mts (BOROS 1968). Here the plant was apparently found only once (SZEPESFALVI 1941), and only a single, very small specimen exists in BP, whereas at the Pomáz site, in the year 2000, the population was still present and vigorous. From this site, numerous collections exist, the oldest from 1921 (leg. Győrffy). *S. flaccidum* grows on the treeless, sunny slopes of the hill Kis Csikóvár, in fissures of andesite rock outcrops. Recently, B. Papp discovered a third locality at Szarvaskő in the Bükk Mts.

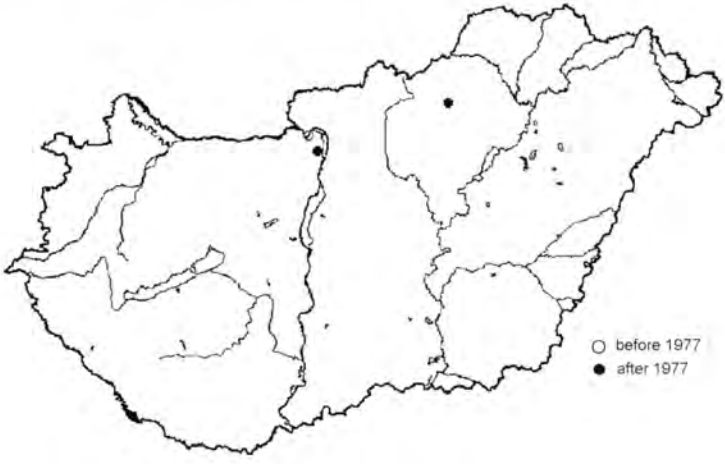


Fig. 20. Distribution of *Schistidium flaccidum*

Selected specimens examined: **Bükk Mts**: **8087/2**, Szarvaskő, vártól ÉK-re, sziklagyep, volcanic rocks, N 47° 59' 35.3", E 20° 19' 48.3", 355 m, 04.06.2008, leg. B. Papp, BP 175454; **Visegrád Mts**: **8279/2** Comit. Hont, Hungariae centr. In fissuris rupium andesit. inter pag. Zebegény et Nagymaros, 07.1927, leg. J. Szepesfalvi, BP 5586; **8380/1** Comit. Pest. In rupium fissuris montis Kis Csikóvár ad Pomáz, sol. andesit., 320 m, 01.04.1923, leg. Á. Degen, BP 163958 (numerous dupl.); Pomáz, Kis Csikóvár, 09.08.2000, leg. P. Erzberger, herb. Erzberger, (B) 6343.

Schistidium helveticum (Schkuhr) Deguchi
(Figs 21, 22)

Plants medium-sized to large, ± glossy, in upper part jet-black or olivaceous, forming tufts. Central strand distinct. Hair-point short, but rarely absent on all leaves, 0–0.2 mm, coarse and ± terete, coarsely spinulose with short and broad, patent to squarrose spinulae.

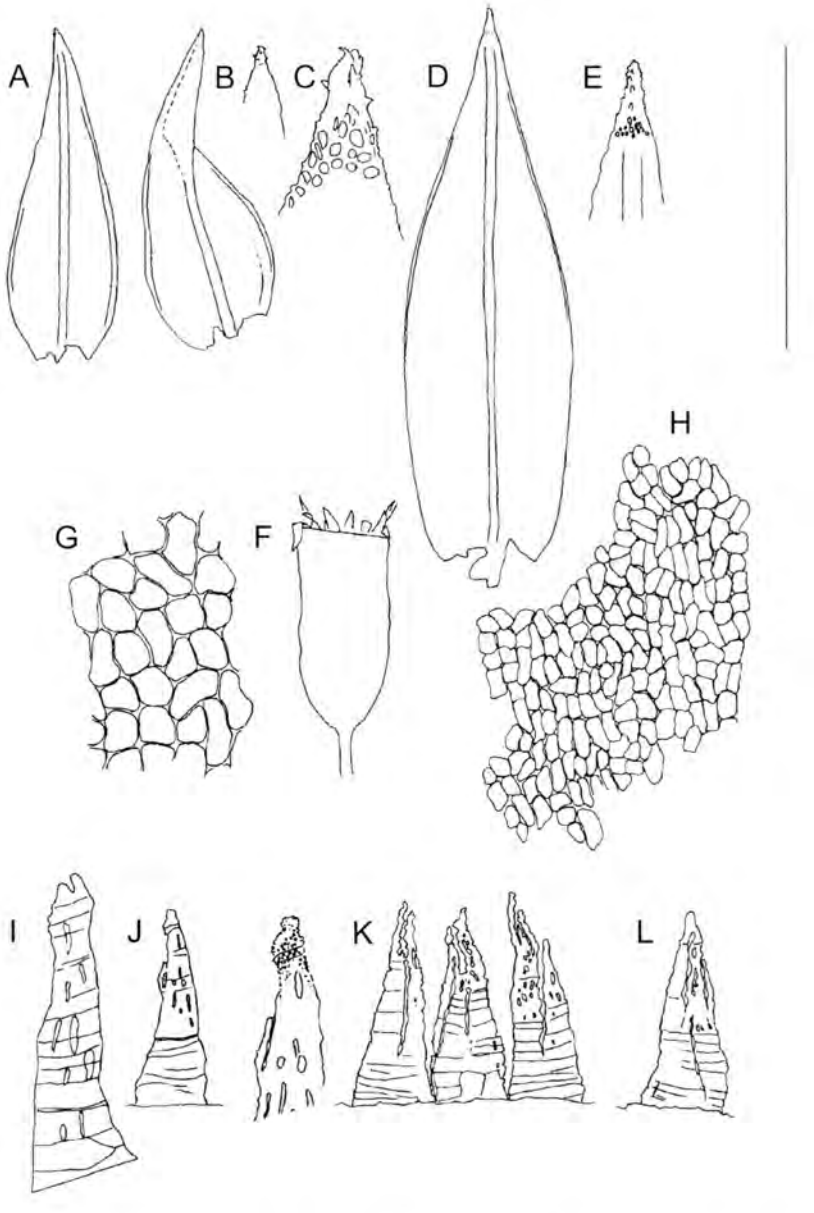


Fig. 21. *Schistidium helveticum*. **A** = leaves; **B**, **C** = leaf apices; **D** = perichaetial leaf; **E** = perichaetial leaf apex; **F** = capsule; **G**, **H** = exothecial cells in mid urn; **I**, **J**, **L** = peristome teeth; **K** = part of peristome. Scale bar: A, D, F – 2 mm; B, E – 800 μm; H, J–L – 400 μm; C, G, I – 200 μm. [A–F, K, L: Erzberger 8015; G–J: Erzberger 12188, del. Erzberger]

Costa and margins usually smooth, but sometimes with few papillae immediately below apex (Blom, pers. comm. in CASPARI 2004). Lamina smooth, irregularly bistratose or more rarely unistratose with bistratose patches in upper part. Lamina cells rounded, esinuose, (6–)7–8(–9) μm wide in upper part of leaf, 7–10 μm wide and slightly to strongly sinuose in central and lower parts of leaf. K+ red.

Sporophytes common, deeply immersed, but partly exposed in lateral view. Urn yellowish to orange-brown, length / width ratio (1.4–)1.6–1.9–2.3(–2.5) (BLOM 1996), in Hungarian material (1.4–)1.6 ±0.14(–1.9), n = 7. Exothecial cells variable in size and shape, in central and lower part predominantly elongate, forming an irregular pattern (Fig. 21G, H). Stomata absent. Peristome teeth 300–430(–460) μm, orange to reddish, ending in a conical or flattened horizontal bar, often split in prongs at top, ± semi-perforated in lower part, strongly perforated to cribrose in upper part (Fig. 21I–L).

Habitat: On often dry, more rarely humid calcareous rocks (limestone, dolomite) in usually open vegetation, often exposed to the sun. This habitat preference of Hungarian plants is the same as that reported in BLOM (1996).

Associated bryophytes: *Bryum argenteum*, *Didymodon acutus*, *D. luridus*, *D. rigidulus*, *Grimmia tergestina*, *Schistidium brunnescens* subsp. *brunnescens*, *S. crassipilum*, *S. elegantulum*.

Vertical distribution: 200–600 m a.s.l.

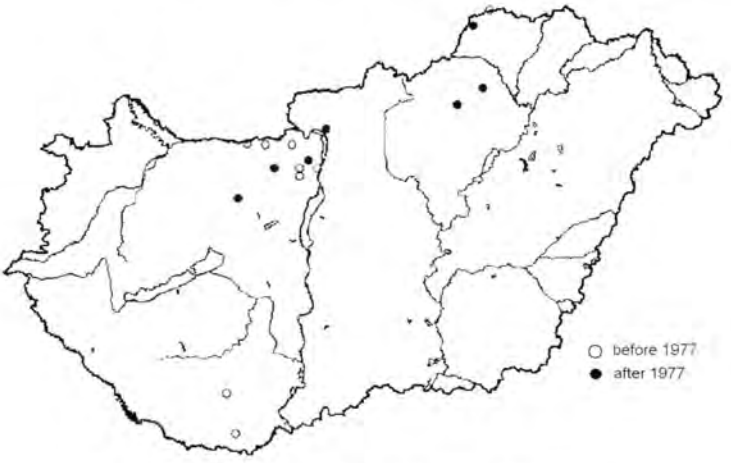


Fig. 22. Distribution of *Schistidium helveticum*

Selected specimens examined: **Aggtelek Karst**: **7589/1** Comit. Borsod-Abaúj-Zemplén. In rupibus calcareis supra vallem Jósva-völgy contra vallem Almás-völgy, 220 m, 17.08.1988, leg. M. Rajczy, BP 165391; **Bükk Mts**: **8088/1** Eger-Felnémet, Berva-völgy, auf exponiertem Kalkfels, 350 m, 03.04.2002, leg. T. Pócs and P. Erzberger, herb. Erzberger, (B) 8015, dupl. in EGR; **Naszály**: **8180/4** Vác, Dolomit-Felsrasen Látó-hegy, N 47° 50' 11.6", E 19° 07' 59.2", *ca* 500 m, 09.04.2007, leg. P. Erzberger and P. Szűcs, herb. Erzberger, (B) 12188; **Pilis Mts**: **8278/4** Comit. Esztergom. In rupibus calcareis or. montis Öreg-szirt

prope Kesztölc, 450 m, 14.04.1946, leg. Á. Boros, BP 111736; **Buda Mts: 8479/3** Com. Pest. In rupibus calcareis montis Telkihegy prope pag. Telki, 22.03.1948, leg. L. Vajda, BP 58480; **Gerecse Mts: 8277/3** Comit. Esztergom. In rupibus calcareis montis Öregkő prope Bajót, 300–375 m, 05.04.1936, leg. Á. Boros, BP 110846; **Vértes Mts: 8675/2** Csákberény, Ugró-völgy, auf w-exponierten, besonnten niedrigen Dolomitfelsen, 29.04.2001, leg. P. Erzberger, herb. Erzberger, (B) 7081; **Mecsek Mts: 9875/3** Comit. Baranya. In rupibus calcar. merid. montis Tubes prope Pécs, 600 m, 26.04.1962, leg. Á. Boros, BP 111398; **Villány Mts: 0175/2** Comit. Baranya. In rupestribus calcar. montis Tenkes-hegy prope Máriagyüd, 300–400 m, 17.04.1942, leg. Á. Boros, BP 111384.

Schistidium lancifolium (Kindb.) H. H. Blom
(Figs 23, 24)

Plants small to medium-sized, forming lax tufts. Central strand absent or indistinct. Hair-point short or absent, 0–0.3 mm, decurrent, sharply and strongly spinulose-denticulate. Costa distantly papillose in upper (1/2–)2/3–4/5 of the leaf length with papillae increasing in height towards the leaf apex (about 8 μm wide and 9–11 μm high in apical part). Margins irregular dentate in upper part with teeth pointing in various directions. Lamina unistratose, smooth or rarely with few papillae on the abaxial side near apex. Lamina cells sinuose, 7–10 μm wide in upper part, (8–)9–10 μm wide in lower parts of leaf. K+ red.

Sporophytes usually present, mostly shallowly immersed and much exposed in lateral view. Urn dark red to reddish-brown, small, 0.7–0.85–1 mm long, length / width ratio 1.3–1.5–1.7 (BLOM 1996), in Hungarian material (0.9–)1.3 ±0.08(–1.6), n = 33. Exothecial cells thin-walled, short transversely rectangular and isodiametric, square, arranged in regular perpendicular rows (Figs 1F, G, 23G–I). Stomata large, 6–10 per urn. Peristome teeth 320–400 μm, orange, semi-perforated in lower part, from almost entire to strongly perforated in upper part.

Usually an easily known plant with a unique combination of apically papillose costa and margins, with the size of papillae increasing towards the apex (Fig. 23B, C) and small capsules exhibiting a characteristic pattern of exothecial cells. In moist shaded habitats, costal papillae may be confined to the apical part of the leaf. *S. apocarpum* differs from *S. lancifolium* by its larger size in nearly all aspects (leaf length, width, urn length, width, peristome teeth length – compare Figs 4 and 23), but there is a small overlap in these quantitative characters.

In Hungary, *S. lancifolium* is a typical plant of shaded andesite rocks, with a preference for higher altitudes. In Scandinavia, this species is an early pioneer on dry acidic to slightly basic (typically greenstone, but very occasionally also limestone) cliffs and boulders in relatively dense and moist forests (WEIBULL 2006).

Habitat: On shaded siliceous (andesite, porphyric rock, slate, sandstone) or more rarely calcareous rock (dolomite), often near streams or flushes and in ravines, in forests, preferably, but not exclusively at higher altitude (700–900 m).

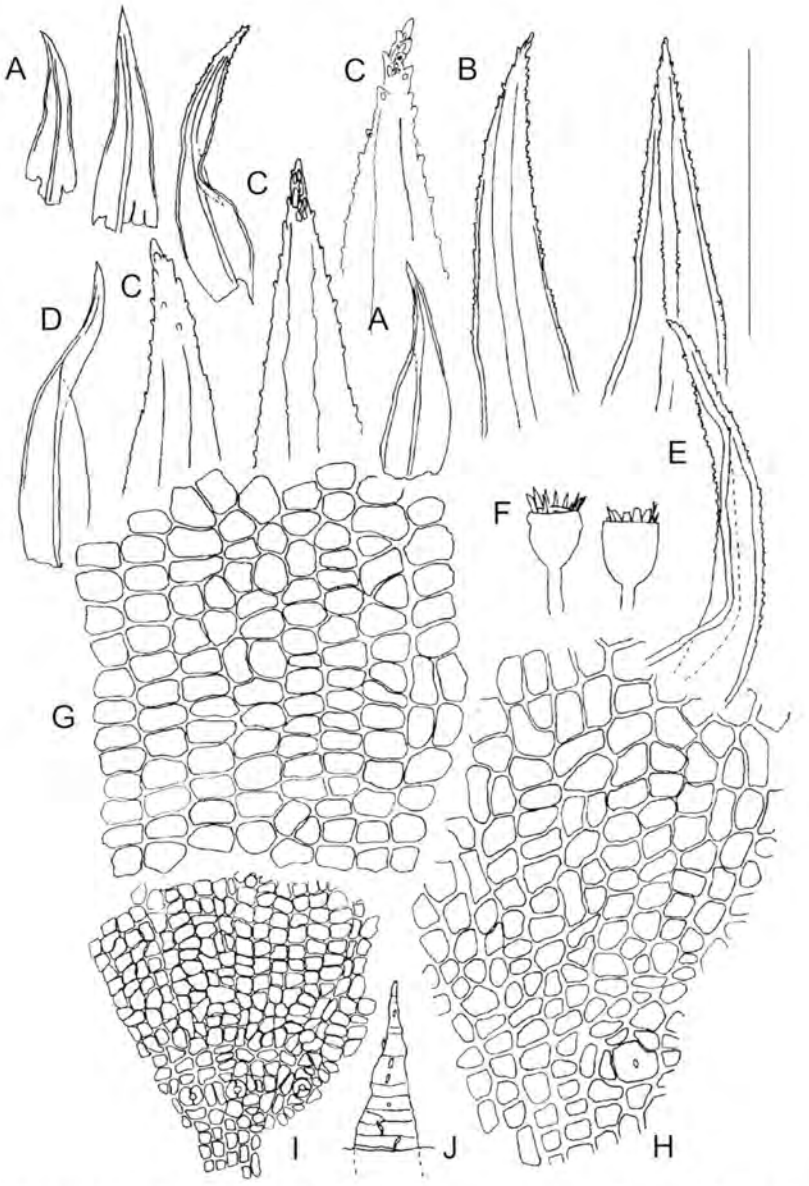


Fig. 23. *Schistidium lancifolium*. **A** = leaves; **B** = upper parts of leaves; **C** = leaf apices; **D** = perichaetial leaf; **E** = upper part of perichaetial leaf; **F** = capsules; **G**, **H**, **I** = exothecial cells in mid urn / at base of urn (H + I); **J** = peristome tooth. Scale bar: A, D, F – 2 mm; B, E – 800 μm; C, I, J – 400 μm; G, H – 200 μm. [A–F, J: Erzberger 6136; G, I: EGR, Vajda 1958 (Börzsöny, Rakottyás-bérc); H: EGR, Boros 1957 (Börzsöny, Bacsina-patak), del. Erzberger]

Associated bryophytes: *Apometzgeria pubescens, Brachythecium populeum, B. velutinum, Bryum capillare, Ceratodon purpureus, Ctenidium molluscum, Didymodon insulanus, D. rigidulus, D. vinealis, Grimmia hartmanii, Hedwigia ciliata, Homalia besseri, Isothecium alopecuroides, Lophocolea minor, Mnium stellare, Plagiochila porelloides, Rhynchostegium murale, Schistidium apocarpum, S. crassipilum, Seligeria pusilla, Thuidium abietinum, Tortella tortuosa, Tortula ruralis.*

Vertical distribution: 120–900 m a.s.l.

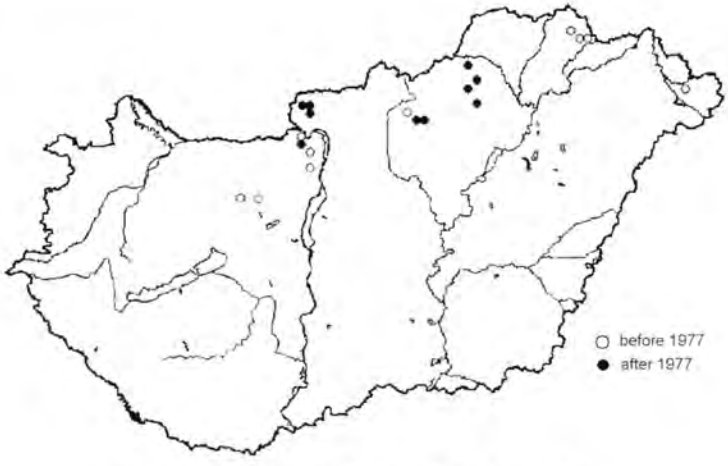


Fig. 24. Distribution of *Schistidium lancifolium*

Selected specimens examined: **Zemplén Mts**: **7695/1** Hungaria bor.-or., com. Zemplén. In rupibus andesiticis montis Szappanyos supra vall. Radványpatak völgye prope pag. Sárospatak, 11.09.1946, leg. L. Vajda, EGR; **Bükk Mts**: **7988/2** Comit. Borsod. In rupibus porphyrit. sept. silvat. montis "Nagy István erőse" prope Nagyvisnyó, 900 m, 30.09.1950, leg. Á. Boros, BP 110942; **Mátra Mts**: **8186/1** Heves county, Kékes North-Forest Reserve, Mátraháza village, andesite rock, montane beech forest, N 47.874°, E 020.007°, 800–900 m, 10.05.1996, leg. P. Ódor, herb. Ódor, 19960510-2, dupl. in BP; **Börzsöny Mts**: **8079/2** Comit. Nógrád. In rupibus umbrosis montis Rakottyás-bérc supra vallem rivi Bacsina-patak prope Királyháza, montes Börzsöny, 20.05.1958, EGR, dupl. BP 59580; **Visegrád Mts**: **8279/3** Szerkövek. Az andezit sziklacsoport északi oldalának aljában, 650 m, 11.1984, leg. G. Kis, EGR; **Buda Mts**: **8479/2** Budapest. In silvis sept. montis Csúcs-hegy ad Óbuda, 300–400 m, 15.03.1941, leg. Á. Boros, BP 106900; **Vértes Mts**: **8676/2** Comit. Fejér. In rupibus dolom. dumetosis vallis Balog-völgy supra Csákvár, 250 m, 10.09.1953, leg. Á. Boros, BP 110831; **8675/2** Comit. Fejér. In rupibus dolomiticis Papirtás prope Csákberény, 300–400 m, 29.03.1936, leg. Á. Boros, BP 110833; **Northern Plain**: **7901/3** Comit. Bereg. Ad saxa andesit. pedis montis Nagy-hegy pr. Tarpa, 120 m, 15.03.1961, leg. Á. Boros, BP 111358.

Schistidium papillosum Culm.
(Figs 25, 26)

Plants small to large, in upper part often reddish, forming lax or dense tufts or mats. Central strand absent or rarely narrow and indistinct. Hair-point 0–1.25 mm, thin, flexuose, from shortly to longly and widely decurrent, slightly to strongly spinulose-denticulate in lower part, distantly denticulate to smooth in upper part. Costa ± densely papillose on abaxial side (papillae 6–8 μm wide and 5–11 μm tall). Margins ± papillose-denticulate in upper part of leaf. Lamina unistratose or with bistratose spots in upper part, ± densely papillose on abaxial side (papillae 6–7(–9) μm wide and 5–8 μm tall), on the adaxial side scattered papillae particularly near the margins. Lamina cells incrassate, sinuose, 8–10 μm wide in upper, 8–11 wide in central and lower parts of leaf. K+ red.

Sporophytes common, from deeply immersed to emergent. Urn dark reddish, widest at about middle, length/width ratio 1.5–1.9–2.3(–2.8) (BLOM 1996), in Hungarian material 1.81, n = 1. Exothecial cells transversely rectangular and square. Stomata 10–17 per urn. Peristome teeth (310–)330–500 μm, reddish, gradually narrowed into a long, fine point, entire or with few to several median or submarginal perforations.

When growing in sufficiently sun-lit places, *S. papillosum* usually (but not always) develops red-coloured spots in the lamina of upper leaves, which are diagnostic. In other respects, *e.g.* papillosity, hair-point length, this species is highly variable.

Habitat: In Scandinavia, *S. papillosum* grows on both acidic and basic rock (from granite to limestone, but becoming more calcifuge towards the south) and occurs in dense forests as well as at exposed sites in open pastures (BLOM 1996, WEIBULL 2006). It prefers acid rocks in Catalonia (CASAS *et al.* 2001).

In Hungary, this species was only recently discovered during fieldwork of the first author, and is presently known from a single location in the Bükk Mts, in the valley Lök-völgy near Felsőtárkány, where it grows in open vegetation on aleurolitic slate near the road, associated with *S. apocarpum* and *S. pruinosum*.

Vertical distribution: 445 m a.s.l.

Specimen examined: **Bükk Mts: 7988/4** Felsőtárkány, Lök-völgy, aleurolite slate rocks at road, N 48° 01' 51.1", E 20° 28' 46.5", 445 m, 06.04.2007, leg. P. Erzberger and T. Pócs, herb. Erzberger, (B) 12097.

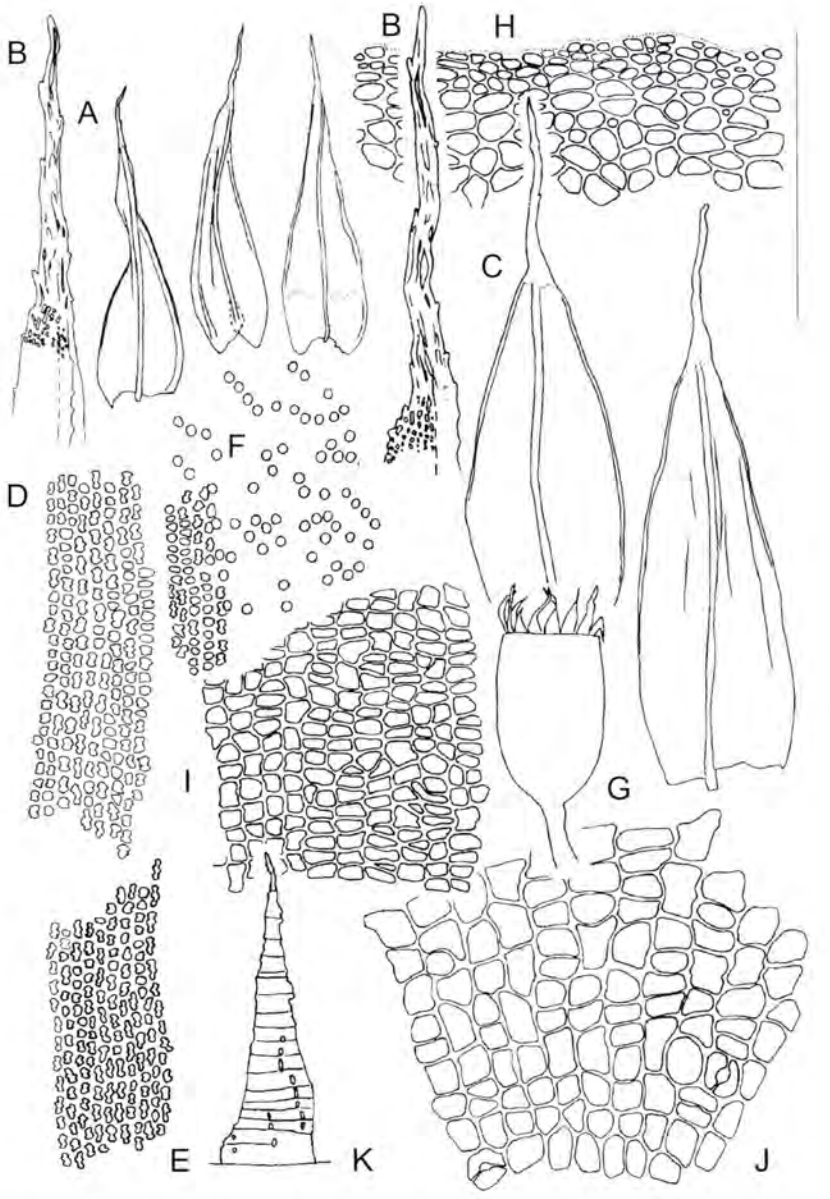


Fig. 25. *Schistidium papillosum*. **A** = leaves; **B** = leaf apices; **C** = perichaetial leaves; **D**, **E** = lamina cells at mid leaf / at widest part of leaf; **F** = papillae and lamina cells at abaxial side of leaf; **G** = capsule; **H**, **I**, **J** = exothecial cells at mouth of urn / at mid urn / at base of urn; **K** = peristome tooth. Scale bar: A, C, G – 2 mm; B, I, K – 400 μm; D, E, F, H, J – 200 μm. [Erzberger 12097, del. Erzberger]

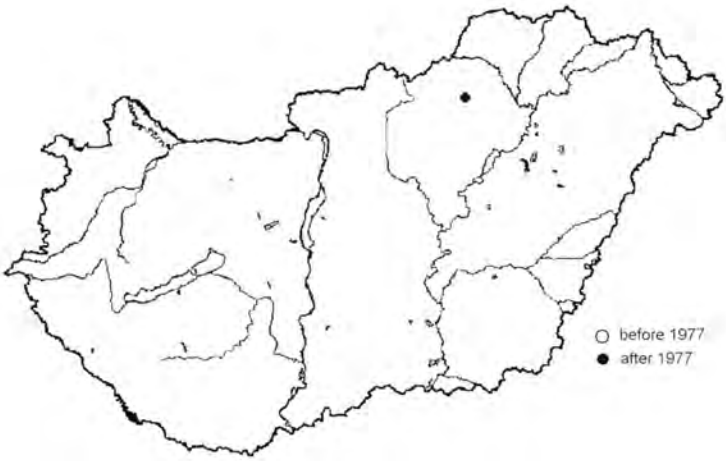


Fig. 26. Distribution of *Schistidium papillosum*

Schistidium platyphyllum (Mitt.) H. Perss.
(Figs 27, 29)

Plants small to medium-sized, forming dense or lax tufts. Central strand distinct, but narrow. Hair-point 0–0.3 mm, frequently yellow or reddish in lower part or throughout, thin and narrow, not decurrent. Costa smooth, margins entire or irregularly denticulate just below apex. Lamina smooth, in upper and central parts partly bistratose or more rarely unistratose. Lamina cells slightly incrassate, collenchymatous, in upper part of leaf ± isodiametric and shortly elongate, 9–11 μm wide, in central and lower parts more elongate. K+ red.

Sporophytes occasional to frequent, immersed. Urn yellowish to red-brown, subspherical to obovoid (cyathiform when old), length/width ratio 0.8–1.3 (BLOM 1998), not measured in Hungarian material. Exothecial cells thin-walled or slightly incrassate, in central and lower part of urn predominantly shortly elongate, forming a ± regular pattern. Stomata absent. Peristome teeth 380–570 μm, red, tapering to a narrow point, semiperfoated in lower part, strongly irregularly perforated in upper part. Spores finely granulose, 16–24 μm.

This is in Hungary the only species of the Rivulare group, which is characterised by spores (16–24 μm) larger than those of the *Schistidium apocarpum* complex ((8–)9–10.4–12(–19) μm).

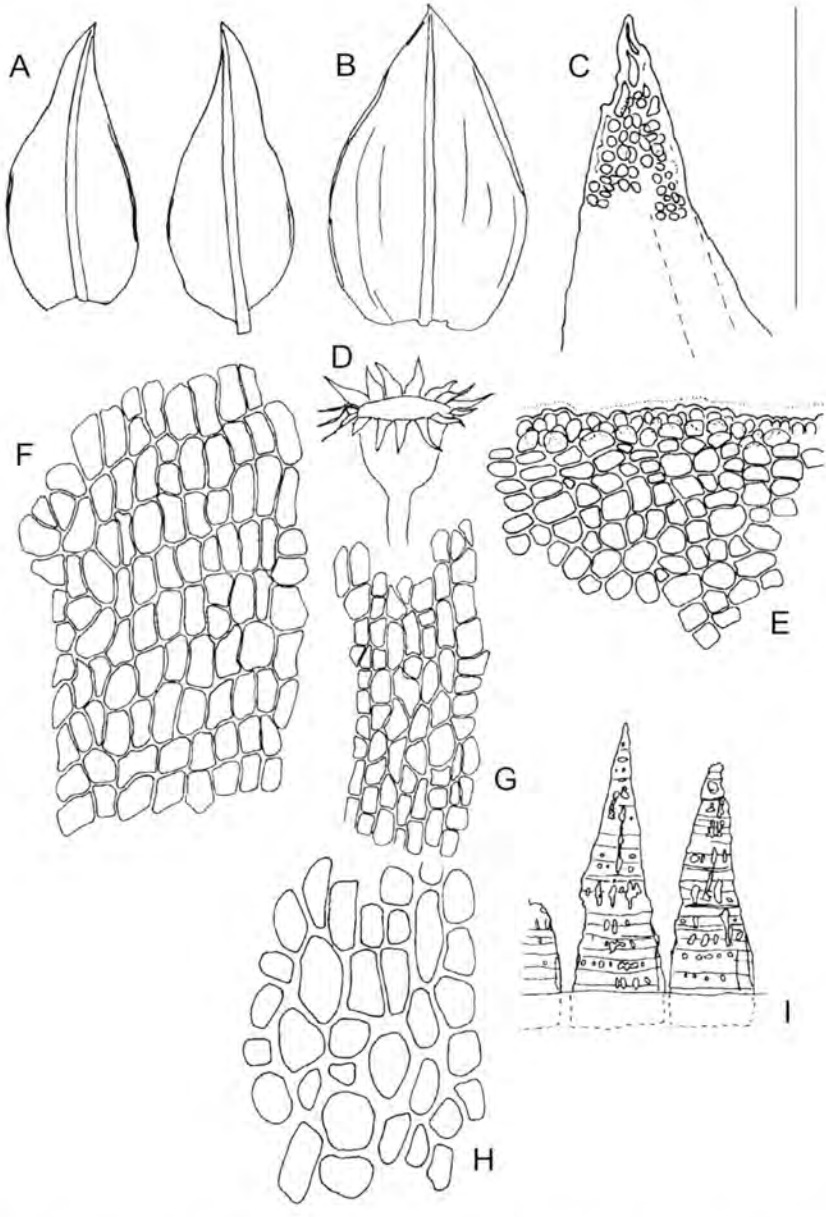


Fig. 27. *Schistidium platyphyllum*. **A** = leaves; **B** = perichaetial leaf; **C** = leaf apex; **D** = capsule; **E, F** = exothecial cells at mouth of urn / at mid urn; **G, H** = seta surface cells in upper / lower part of seta; **I** = part of peristome. Scale bar: A, B, D – 2 mm; I – 400 μm; C, E–H – 200 μm. [A–C, E–H: BP 163340; D, I: Erzberger 12625 (Sweden, Abisko), del. Erzberger]

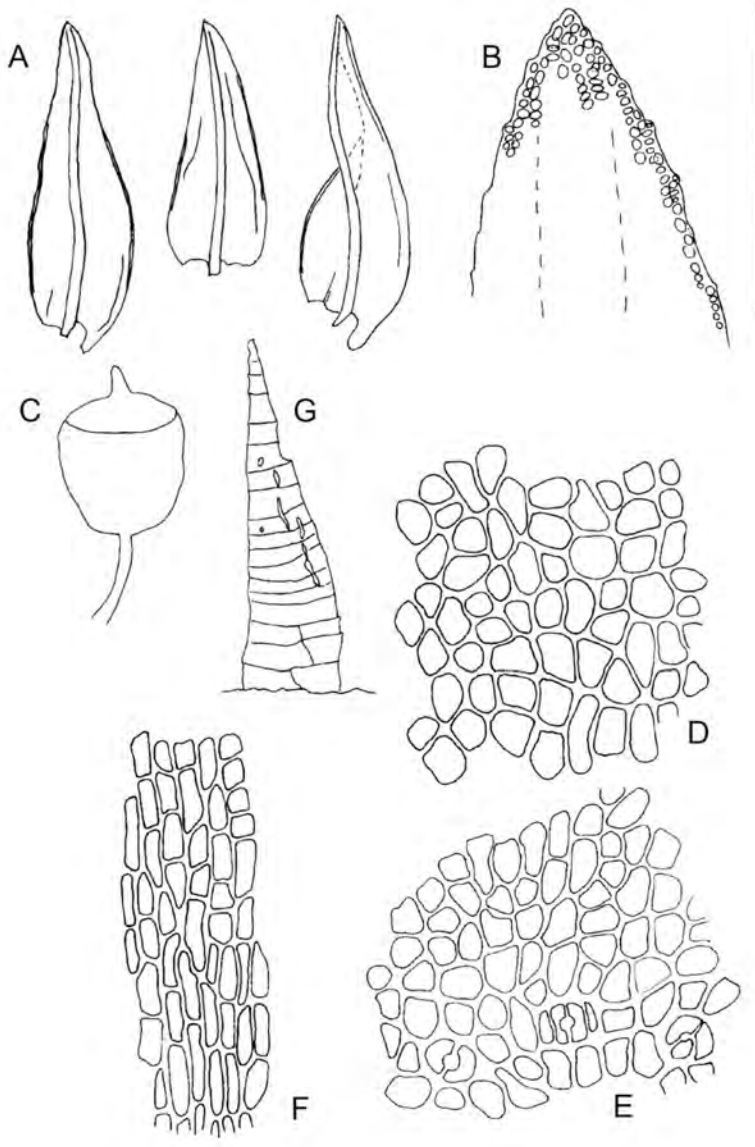


Fig. 28. *Schistidium rivulare* (Erzberger 6529, Germany: Hessen). **A** = leaves; **B** = leaf apex; **C** = capsule; **D**, **E** = exothecial cells at mid urn / at base of urn; **F** = seta surface cells in upper part of seta; G = peristome tooth. Scale bar: A, C – 2 mm; G – 400 μm; B, D, F – 200 μm. [Del. Erzberger]

From *S. rivulare* (which has not yet been found in Hungary – Fig. 28), it can be distinguished by gametophytic characters, *e.g.* the entire leaf margins (except at apex – compare Figs 27C and 28B) and the more shallowly keeled, symmetric leaves (sharply keeled and often asymmetrically secund in *S. rivulare*: Fig. 28A), and sporophytic characters, particularly the patterns of exothecial cells and seta surface cells (exothecial cells isodiametric and incrassate in *S. rivulare*: Fig. 28D, E), shortly elongate and rather thin-walled in *S. platyphyllum* (Fig. 27F); seta surface cells ± strongly elongate, incrassate in *S. rivulare* (Fig. 28F), shortly elongate to isodiametric and rather thin-walled in *S. platyphyllum*: Fig. 27G), and by the absence of stomata.

Habitat: In Scandinavia *S. platyphyllum* grows on base-rich or calcareous rocks in or beside streams (rarely submerged), occasionally in fissures of irrigated ledges and cliffs in the mountains, or on regularly inundated sea- or lake-shore boulders (BLOM 1998, WEIBULL 2006). In NW Germany it was found mainly on siliceous blocks at the rivers Elbe, Weser, Ems, Rhine and some of their tributaries (MEINUNGER and SCHRÖDER 2007). The Hungarian habitat on block edging at the banks of the Danube corresponds to the German type of lowland habitat on river banks.

Vertical distribution: 100 m a.s.l.

Distribution: In Hungary at present known from a single collection.

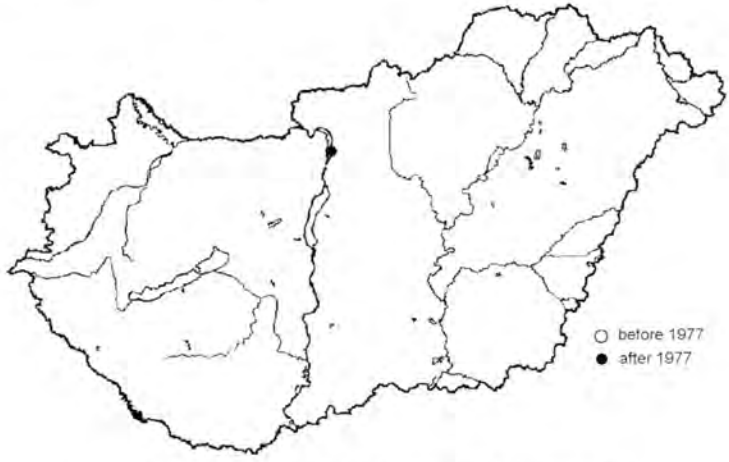


Fig. 29. Distribution of *Schistidium platyphyllum*

Specimen examined: **Danube inundation area: 8380/2** Comit. Pest. In saxis irrigatis Danubii ad urb. Szentendre, 100 m, 11.08.1994, leg. B. Papp and M. Rajczy (sub *S. rivulare*), rev. P. Erzberger 2007, conf. W. Schröder 2007, BP 163340.

The plants conserved in this specimen were growing on stones in the inundation area at the Danube in the small island "Pap-sziget" near Szentendre (B. Papp, ex verbis). A recent search of the site and of similar places near Szentendre and in the Danube valley between Szob and Vác by the first author was unsuccessful.

This record represents a considerable range extension within the European area of *S. platyphyllum*, *viz.* towards the river Danube in the southeastern part of Central Europe. The species was hitherto known from Asia, Africa, America, Greenland, Svalbard (SMITH 2004), and in Europe from Scandinavia (BLOM 1998), Great Britain (SMITH 2004), and Germany (HOMM 1998, SIEMSEN *et al.* 2003, SCHULZ and DENGLER 2006, MEINUNGER and SCHRÖDER 2007). In the meantime, *S. platyphyllum* has been discovered in South Germany, at a tributary of the Danube, too ("Innschleife auf Uferpackungen bei Ebing, 7740/4, 15.05.1998", leg. W. S. sub *S. rivulare*, rev. 01.03.2008; in MEINUNGER and SCHRÖDER 2007 erroneously under *S. rivulare*). Its discovery in the Austrian part of the Danube valley is to be expected sooner or later.

Schistidium pruinosum (Wilson ex Schimp.) G. Roth (Figs 30, 31)

Plants medium-sized, forming dense, often hoary tufts. Central strand narrow but distinct. Hair-point 0.2–1.25 mm, ± coarse, not or shortly and broadly decurrent, densely spinulose in lower, more distantly spinulose in upper part. Abaxial side of costa densely papillose (papillae 3–6 μm wide and tall), margins ± smooth except at dentate apex. Lamina partly bistratose in upper part, densely papillose with low, broad papillae (3–4.5 μm wide and tall) on both adaxial and abaxial sides of leaf. Lamina cells rounded, not or slightly sinuose in upper part, mostly sinuose in central and lower parts, 6–9 μm wide throughout except for wider basal cells. Perichaetial leaves large and conspicuous, broadly elliptical or broadly ovate, 0.8–1.25 mm wide, strongly contrasting the lower leaves (0.6–0.85(–1.0) mm wide). K+ red.

Sporophytes common, deeply immersed. Urn dark red to red-brown with a mother-of-pearl shine, widest at middle (narrowed towards mouth), length / width ratio (1.2–)1.3–1.5–1.8(–1.9) (BLOM 1996), in Hungarian material (1.5–)1.6 ±0.05(–1.7), n = 6. Exothecial cells predominantly square. Stomata 6–8 per urn. Peristome teeth 270–390(–450) μm, reddish, in lower part entire or semi-perforated, in upper part mostly strongly perforated with narrow slits.

S. pruinosum differs from other species with papillose lamina in the elliptical perichaetial leaves contrasting the narrower lower leaves (compare Fig. 30A and D), the small rounded and oval upper leaf cells (Fig. 30E), the irregularly bistratose lamina, the distinct central strand and the papillae usually abundant on both sides of the leaf, arranged in oblique rows (Fig. 30G, H).

Habitat: In Hungary on rather exposed or more rarely shaded siliceous rocks (andesite, aleurolitic slate), in Scandinavia on ± exposed, often warm, base-rich or siliceous (especially basalt and porphyric) rocks (BLOM 1998).

Associated bryophytes: *Hypnum cupressiforme*, *Schistidium apocarpum*, *S. papillosum*.

Vertical distribution: 200–730 m a.s.l.

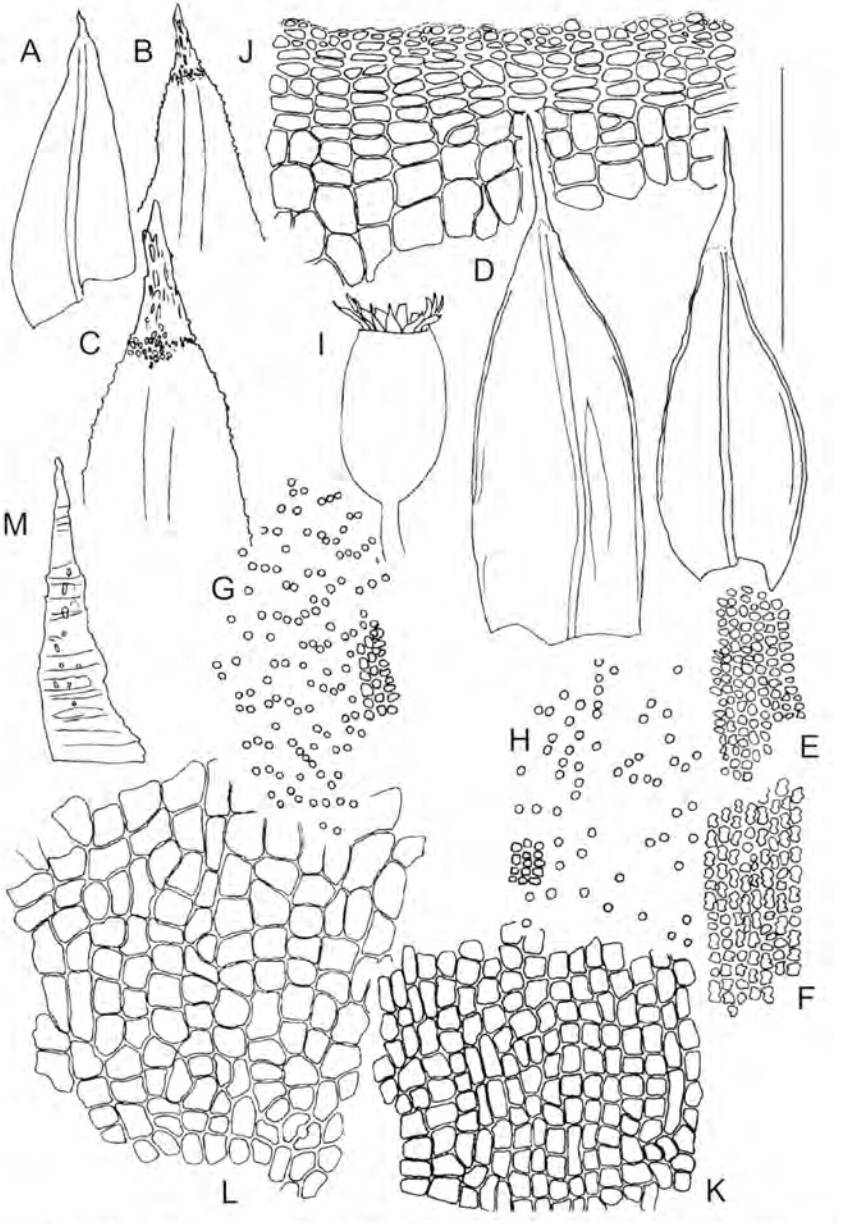


Fig. 30. *Schistidium pruinosum*. **A** = leaf; **B**, **C** = leaf apices; **D** = perichaetial leaves; **E**, **F** = lamina cells at mid leaf / at lower third of leaf; **G**, **H** = papillae and lamina cells at abaxial / adaxial side of leaf; **I** = capsule; **J**, **K**, **L** = exothecial cells at mouth of urn / at mid urn / at base of urn; **M** = peristome tooth. Scale bar: A, D, I – 2 mm; B – 800 μm; C, K, M – 400 μm; E–H, J, L – 200 μm. [A–H, J–M: BP 171483; I: Erzberger 12095, del. Erzberger]

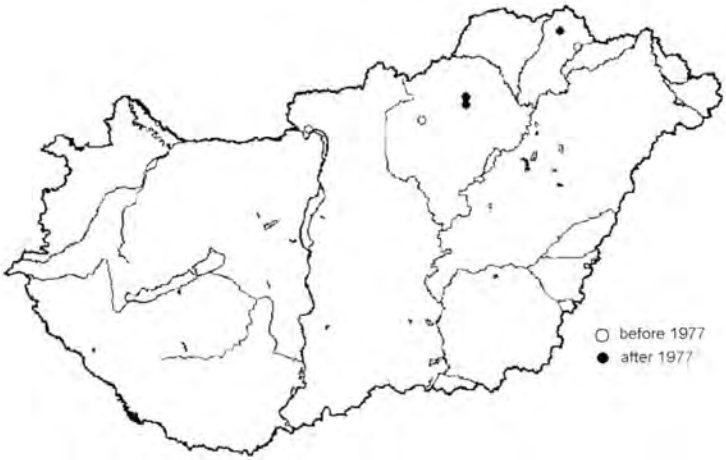


Fig. 31. Distribution of *Schistidium pruinosum*

Selected specimens examined: **Zemplén Mts**: **7594/3** Nagy szárkő/Regéc, 665–695 m, 04.04.2004, leg. B. Papp, BP 171483; **7695/3** Hungaria bor.-or., com. Zemplén. In rupibus umbrosis in sylvestribus montis Darnó supra pag. Hercegkút, 04.09.1948, leg. L. Vajda, EGR; **Bükk Mts**: **7988/4** Felsőtárkány, Lök-völgy, aleurolite slate rocks at road, N 48° 01' 51.1", E 20° 28' 46.5", 445 m, 06.04.2007, leg. P. Erzberger and T. Pócs, herb. Erzberger, (B) 12095; **8088/2** Lehmschieferfelsen an der Straßenböschung zwischen Bükkzsérc und Felsőtárkány, mit *Hypnum cupressiforme*, N 47° 59' 43.4", E 20° 28' 59.5", *ca* 400 m, 27.03.2008, leg. P. Erzberger and T. Pócs, herb. Erzberger, (B) 12883; **Mátra Mts**: **8186/1** Comit. Heves. In rupibus andesit. septen. montis Disznókő prope Parád, 730 m, 25.03.1951, leg. Á. Boros, BP 110915; **Börzsöny Mts**: **8179/4** Comit. Hont, Hung. centr. In saxis vallis "Malomvölgy" sub mont. "Nagycsitár" inter pag. Zebegény et Kóspallag, 200 m, 07.07.1927, leg. J. Szepesfalvi, BP 5723.

Schistidium robustum (Nees et Hornsch.) H. H. Blom (Figs 32, 33)

Plants medium-sized to large, forming small or large, typically conspicuously hoary tufts. Central strand distinct, mostly broad. Hair-point ± coarse, mostly long and conspicuous, (0.2–)0.4–0.8(–1.1) mm, stiff and straight, decurrent, densely and evenly spinulose with sharp, strongly protruding spinulae. Costa and margins smooth. Lamina smooth, unistratose or less frequently with bistratose spots. Lamina cells mostly elongated and becoming shorter towards apex, (8–)9–10(–11) μm wide in upper, 8–11 μm wide in central and lower parts of leaf, sinuose to strongly sinuose with incrassate walls. K+ red.

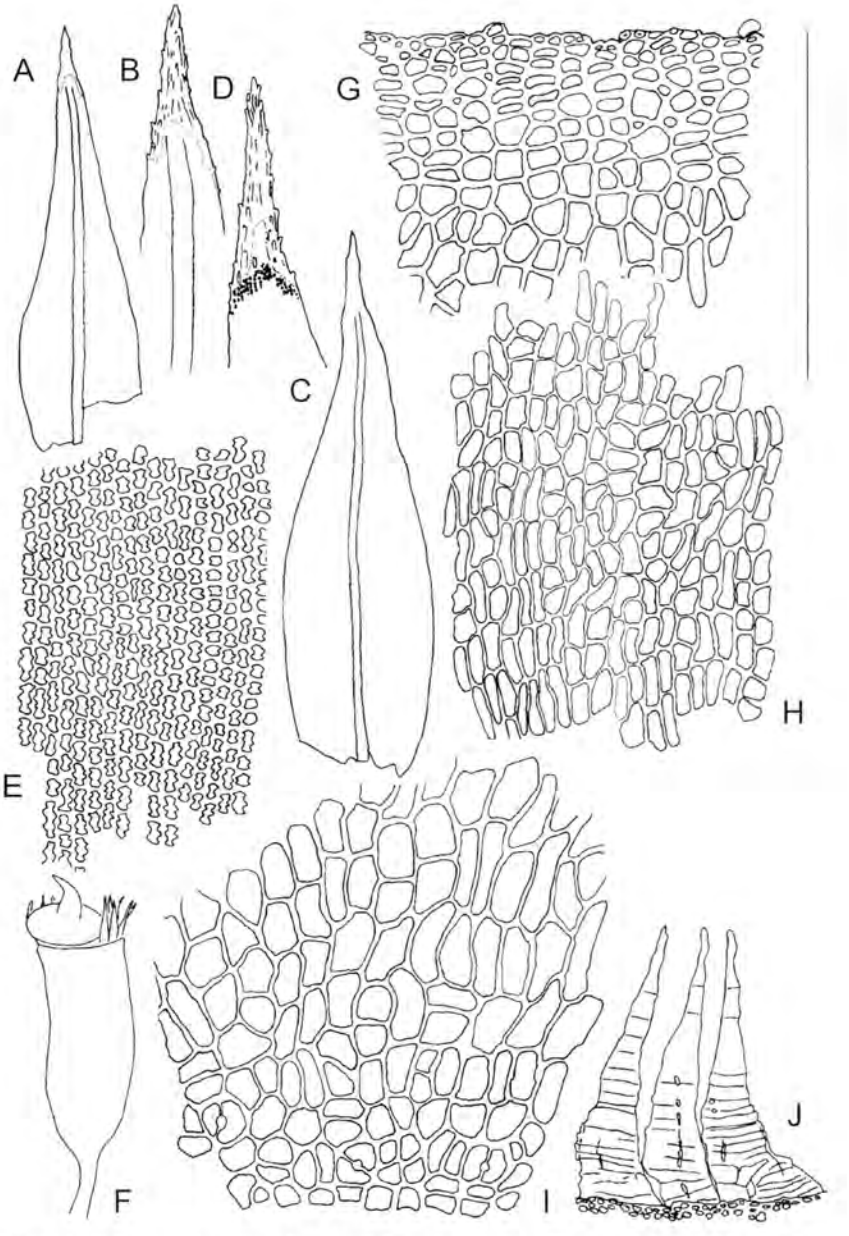


Fig. 32. *Schistidium robustum*. **A** = leaf; **B** = leaf apex; **C** = perichaetial leaf; **D** = perichaetial leaf apex; **E** = lamina cells at widest part of leaf; **F** = capsule; **G**, **H**, **I** = exothecial cells at mouth of urn / at lower third / at base of urn; **J** = part of peristome. Scale bar: A, C, F – 2 mm; B, D – 800 μm; H, J – 400 μm; E, G, I – 200 μm. [Erzberger 8024, del. Erzberger]

Sporophytes common, shallowly immersed, much exposed in lateral view. Urn light brown, sometimes faintly striolate, widest at about middle, length/width ratio (1.9–)2.1–2.4–3.1 (BLOM 1996), in Hungarian material 2.15, n = 1. Exothecial cells irregular in size and shape, predominantly elongate. Stomata 8–10(–12) per urn. Peristome teeth 300–440 μm, orange-red, narrow and longly tapering to a very thin and fragile point, frequently perforated.

In typical plants, the strongly sinuose, incrassate leaf cells, somewhat resembling those in *Racomitrium*, are very characteristic (Fig. 32E). Plants from moist, shaded habitats can have less sinuose leaf cells. *S. robustum* can superficially approach *S. elegantulum*, but differs in the decurrent hair-point (Fig. 32B), usually not pronounced leaf bistratosity, a distinct central strand, and in leaf areolation as well as urn shape, long and narrow in *S. robustum* (Fig. 32F).

Habitat: In Hungary as in Scandinavia *S. robustum* grows on ± dry calcareous rocks (limestone, dolomite) in exposed or moderately shaded sites.

Associated bryophytes: *Schistidium crassipilum*.

Vertical distribution: 200–770 m a.s.l.

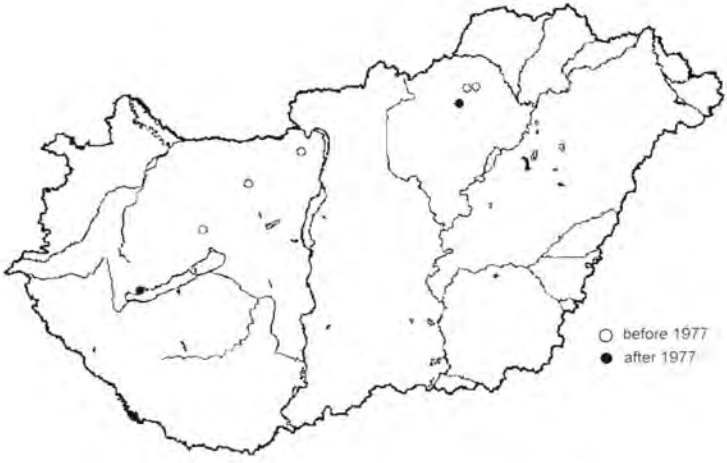


Fig. 33. Distribution of *Schistidium robustum*

Selected specimens examined: **Bükk Mts: 8088/1** Felsőtárkány, Mész-völgy, auf grobem Kalkschotter, 03.04.2002, leg. P. Erzberger and T. Pócs, herb. Erzberger, (B) 8024; **Pilis Mts**: **8379/1** Comit. Pest: in m. Pilis, 19.09.1909, leg. G. Lengyel, BP 110898; **Vértes Mts**: **8576/1** Comit. Fejér. In saxis dolom. silvat. versus Várgesztes prope Vérteskozma, 400 m, 24.04.1932, leg. Á. Boros, BP 110826; **Bakony Mts**: **8873/2** Mons Tobán, ad rupes, 10.06.1932, collector unknown, BP 26270; **Keszthely Mts**: **9270/1** County Veszprém. On exposed calcareous rock Szamár-kő in valley Kígyós-völgy at Balatongyörök, 200 m, 18.10. 1999, leg. B. Papp BP 166860.

ARTIFICIAL KEY FOR *SCHISTIDIUM* IN HUNGARY

Apart from the 15 taxa found in Hungary, several others have been reported from parts of Central Europe (BLOM 1996, 1998, BLOM and LÜTH 2002, GRIMS 1999), and might therefore occur in Hungary as well, though hitherto undetected. Since the highest elevation of present-day Hungary is 1,015 m a.s.l. (RADÓ 1979), the occurrence of high-mountain and alpine taxa is not to be expected. Taxa that have not yet been shown to occur in Hungary, but might be expected, should, in our opinion, be included in a key for naming taxa of *Schistidium* collected in Hungary. In addition to those taxa that we have found in this revision, our key therefore includes the following: *S. elegantulum* subsp. *wilsonii, S. pulchrum, S. rivulare, S. spinosum, S. trichodon* var. *nutans, S. trichodon* var. *trichodon*.

Taxa that have been shown to occur in Hungary are printed in **bold** type; taxa not printed in bold might occur in Hungary, but have not yet been found.

1a Leaf lamina with papillae **2**

1b Lamina smooth, but papillae sometimes at leaf margin and dorsal side of costa **4**

2a Upper lamina in part bistratose, papillae on both (dorsal and ventral) sides of lamina; leaves never with red spots; up to 8 stomata per urn; central strand distinct **3**

2b Lamina unistratose or rarely with bistratose patches in upper part; papillae numerous on dorsal side, sparse or missing on ventral side (if present, then near margin, costa or apex); hair-point fine, often rather long; lamina occasionally with red spots (absent in plants from shaded sites); usually more than 8 stomata per urn; central strand absent or indistinct (< 6 cells)

S. papillosum (siliceous rocks, also on old walls and concrete)

3a Hair-point coarse, especially well developed in perichaetial leaves; costa dorsally hardly projecting; mid-leaf cells 6–9 μm wide and rounded, dorsal and ventral side of lamina with numerous papillae arranged in rows (examine young leaves!), usually with extended bistratose patches; perichaetial leaves very wide and differing in form from stem leaves; central strand of 3–10 cells

S. pruinosum (base-rich or siliceous rocks, esp. basalt and porphyric)

3b Hair-point fine (but mostly straight), costa dorsally prominent; mid-leaf cells 10–12 μm wide and ± sinuose; papillae on both sides of lamina, but less numerous on adaxial side; bistratose patches not conspicuous; perichaetial leaves only slightly wider than stem leaves; central strand of 20–30 cells

S. confusum (exposed calcareous rocks, also on old walls and concrete)

4a Urn length / width ratio 0.8–1.3, shape not oblong or oblong-cylindrical (but *S. brunnescens* – 17a – with oblong exothecial cells, small spores, K+ red and stomata absent sometimes has urns with length / width ratio < 1.3) **5**

4b Urn length / width ratio ≥ 1.3, shape oblong to oblong-cylindrical **9**

5a Spores 15–24 μm; hair-point absent on most leaves or very short (0–0.3 mm); K+ red; stomata absent or present; leaves 0.5–1.3 mm broad (Rivulare group) **6**

5b Spores 8–13 μm; hair-point usually present; K+ yellow; stomata present; leaves 0.3–0.85 mm broad (Confertum group) **7**

6a Exothecial cells incrassate, isodiametric, stomata present; hair-point absent; capsule-bearing branches in fascicles of (2–)3–6; leaves 2.1–3.2 × 0.7–1.3 mm, carinate, slightly asymmetric, apex sometimes boat-shaped, leaf margin in upper half of leaf often dentate by projecting cells

S. rivulare (siliceous or calcareous rocks in and beside rivers and streams)

6b Exothecial cells thin-walled, predominantly oblong; stomata absent; hair-point short or absent, 0–0.3 mm, smooth or finely spinulose- denticulate; capsule-bearing branches not in fascicles; leaves 1.4–2.3 × 0.5–1.0 mm, obtusely keeled, symmetric, margins entire or irregularly denticulate immediately below apex

S. platyphyllum subsp. ***platyphyllum*** (base-rich rocks in or beside rivers or streams, rarely submerged)

7a Peristome absent or rudimentary (< 25 μm), stomata 3–6 per urn; hair-point usually long, finely denticulate; perichaetial leaves plicate; operculum mamillate; plants small to medium-sized

S. flaccidum (siliceous rocks)

7b Peristome perfect, stomata 3–10 per urn; hair-point short or long, coarsely spinulose; operculum rostrate, but rostrum sometimes short; plants small **8**

8a Hair-point short, 0–0.45 mm, fine, flattened and mostly broadened towards insertion; peristome teeth strongly and irregularly perforated, pattern of exothecial cells not very irregular, stomata small, 3–8 per urn ***S. confertum*** (exposed siliceous or base-rich rocks)

8b Hair-point usually long, 0–0.8 mm, coarse, terete and narrow throughout, not or shortly and narrowly decurrent, in young leaves strongly spinulose with some very long spines (22–30(–75) μm); peristome teeth almost entire or narrowly perforated in 1(2) rows, exothecial cells forming an irregular pattern; stomata 6–8(10) per urn

S. spinosum (exposed siliceous rocks)

9a Leaf margin or dorsal side of costa in upper half of leaf with papillae or projecting cells (denticulate) **10**

9b Leaf margin and dorsal side of costa smooth (few papillae may occur at leaf apex immediately below the hair-point, in *S. dupretii* also further down) **13**

10a Exothecial cells in central part of urn predominantly oblong, up to 60 μm; peristome teeth 300–450 μm long, in freshly deoperculate capsules stellate-straight, scarcely twisted, orange; hair-point coarse, of variable length; urn usually with 0–4(6) stomata at base, but sometimes more, pores rudimentary or lacking; central strand distinct (> 6 cells); spores 8–11 μm ***S. crassipilum*** (calcareous rocks, often on concrete)

10b Exothecial cells predominantly isodiametric and transversely elongate; peristome teeth 300–710 μm long, strongly curved, bent clockwise and twisted; stomata with distinct pores present; hair-point fine, of variable length; central strand absent or narrow (< 6 cells); spores (9)11–15(19) μm **11**

11a Peristome teeth forming a dome above the urn mouth, (410)450–700 μm long, very finely and longly pointed, red; columella not falling with the lid; plants often black, hair-point absent or short (0–0.18 mm)
S. trichodon (moist calcareous rocks)

aa) urn never cyathiform, length / width ratio 1.6–2.4, plants brownish, never jet-black *S. trichodon* var. *nutans*

bb) urn often cyathiform, length / width ratio 1.3–2.1, plants often jet-black
S. trichodon var. *trichodon*

11b Peristome teeth reflexed or spreading, 320–710 μm long, their points may be bent upwards, but never form a dome, red-orange; columella falling with the lid **12**

12a Urn 0.7–1.0 mm long and 0.5–0.65 mm wide, exothecial cells quadrate to transversely rectangular, in regular perpendicular rows, peristome teeth 320–400 μm; costa strongly papillose on abaxial side in upper half of leaf, papillae increasing in length towards leaf apex (up to 9–11 μm high), leaf margin strongly and irregularly denticulate to serrate in upper part of leaf; perichaetial leaves 0.5–0.8 mm wide, small plants
S. lancifolium (shaded siliceous, rarely calcareous rocks)

12b Urn 0.9–1.35 mm long and 0.5–0.85 mm wide, exothecial cells isodiametric, but pattern less regular; peristome teeth 400–700 μm; leaf margin finely denticulate or rarely smooth, costal papillae lower; perichaetial leaves 0.8–1.5 mm wide, medium-sized plants
S. apocarpum (calcareous or siliceous substrata)

13a Exothecial cells in central and lower part of urn predominantly isodiametric and transversely elongate **14**

13b Exothecial cells predominantly oblong **16**

14a Peristome teeth strongly curved, often semi-perforated in lower part and with small perforations in longitudinal rows in upper part, leaves mostly falcate to falcato-secund, mostly large plants
S. apocarpum (longipilose plants; calcareous or siliceous substrata)

14b Peristome teeth straight or slightly curved, entire or irregularly perforated in upper part; leaves usually straight; small to medium-sized plants **15**

15a Perichaetial leaves broad, 0.8–1.1(1.25) mm wide (urn not or slightly exposed in lateral view); hair point structure intermediate between fine and coarse: rather coarse and stiff, but remnants of cell walls mostly clearly visible, broad (as broad as chlorophyllose part of the apex), up to 0.7 mm long, intensely white, urn smooth, plants glossy
S. pulchrum (on siliceous or calcareous rocks in humid sites)

15b Perichaetial leaves narrow, 0.5–0.6 mm wide (urn much exposed in lateral view); hair point fine but straight when dry, consisting of few cells, distinctly narrower than the chloropyllose part of the apex, up to 0.15 (0.25) mm long; urn finely striolate after dehiscence, plants dull, small, growing in compact cushions
S. dupretii (exposed calcareous, less often siliceous rocks)

16a Basal marginal cells with thick transverse walls, more or less hyaline; urn hemispherical to ovate, peristome teeth short (< 340 μm) and cribrose (*i.e.* with numerous pits and holes); hair-point mostly fine and long (except *S. brunnescens*), flattened at base and composed of cells with clearly visible lumen **17**

16b Basal marginal cells usually without thick transverse walls (examine several leaves), sometimes elongate; urn ovate to oblong, peristome teeth 220–430 μm; hair-point always coarse, variable in length, terete or indistinctly flattened at base **18**

17a Stomata present; plants on siliceous substrate; hair-point flat and fine, short; exothecial cells in mid-urn 20–42 μm long
S. confertum (exposed siliceous or base-rich rocks)

17b Stomata absent; plants of calcareous rocks; hair-point coarse, well developed in perichaetial leaves, often absent or short in normal leaves; exothecial cells up to 50–80 μm long, forming a regular pattern
S. brunnescens (dry, exposed calcareous rocks)

aa) Leaves ovate-lanceolate to ovate-triangular, often with shoulders, 1.85–2.6 mm, usually with longitudinal ridge-like striae on one or both sides of costa; costa 58–90 μm wide in central part of leaf ***S. brunnescens*** subsp. ***griseum***

bb) Leaves oblong, ovate or short ovate-triangular, 1.1–2.0 mm; shoulders and longitudinal ridge-like striae absent; costa 38–60 μm in central part of leaf
S. brunnescens subsp. ***brunnescens***

18a Urn with 6–10 stomata; leaves acuminate; hair-point usually conspicuous, 0.3–1 mm **19**

18b Urn with 0–4 stomata; leaves not acuminate; hair-point conspicuous or less than 0.2 mm **20**

19a Central strand absent, urn usually ovate in shape, with 6–8(–16) stomata; exothecial cells with hardly incrassate longitudinal walls; hair-point of normal leaves terete at base, not decurrent; upper lamina cells isodiametric, not sinuose, not distinctly incrassate; lamina with irregular bistratose patches ***S. elegantulum*** (shaded calcareous rocks)

aa) Hair-point broad, very finely but densely spinulose with only slightly protruding spinulae (appearing smooth with a hand lens); peristome teeth straight, patent to squarrose; costa in lower part of leaf 75–88 μm wide, 5–7 stratose; plants forming tufts; stomata 8–16 per urn *S. elegantulum* subsp. *wilsonii*

bb) Hair-point narrow, distantly spinulose with longer spinulae (visible with a hand lens); peristome teeth curved, erect to erecto-patent with tips curved inward; costa in lower part 53–78 μm wide, 4–5 stratose; plants forming mats or decumbent tufts; stomata 6–8 per urn ***S. elegantulum*** subsp. ***elegantulum***

19b Central strand always distinct (> 20 cells); urn usually cylindrical in shape, with 8–10 stomata; exothecial cells with irregularly thickened longitudinal walls; hair-point usually flattened at base, decurrent; upper lamina cells sinuose, incrassate, bright yellowish, especially in lower lamina distinctly incrassate and sinuose; lamina rarely with bistratose patches ***S. robustum*** (calcareous rocks)

20a Plants green, olive or brownish, rarely black, in loose tufts or decumbent; hair-point often > 0.2 mm, slightly flattened at base and often decurrent; exothecial cells not forming an irregular pattern, stomata usually few (0–6)

S. crassipilum (calcareous rocks, often on concrete)

20b Plants usually black, glossy, in compact cushions; hair-point absent or short (up to 0.2 mm), coarse and coarsely spinulose with short and broad, patent to squarrose spinulae, terete, not decurrent; exothecial cells forming an irregular pattern, stomata absent

S. helveticum (= *singarense*) (calcareous rocks)

FREQUENCY AND RARITY OF TAXA IN HUNGARY

Fig. 34 shows the proportion of each taxon in a total of 448 sites of all *Schistidium* specimens examined. The most frequent taxa are: *S. crassipilum* (43.5%), *S. brunnescens* subsp. *brunnescens* (16.3%), *S. apocarpum* (14.1%), *S. lancifolium* (7.6%), *S. elegantulum* (7.6%), and *S. helveticum* (4.0%). The other taxa are known from less than 8 sites each: *S. robustum* (7 sites), *S. pruinosum* and *S. brunnescens* subsp. *griseum* (6 sites each), *S. dupretii* (4 sites), *S. flaccidum* (3 sites), *S. confertum* (2 sites), *S. confusum*, *S. papillosum* and *S. platyphyllum* (1 site each).

From a glance at the geological map of Hungary (RADÓ 1979) it is evident that, apart from large parts of the country (in the lowlands) covered by quaternary deposits and thus less inviting for colonisation by saxicoles, there is (in the mountains and hills) a high diversity in both carboniferous and siliceous rocks, *i.e.* potential sites for taxa of *Schistidium*.

Schistidium has been recorded in 30 out of 43 bryogeographical regions in Hungary (after Boros 1968). This clearly does not reflect the true distribution, since weedy species like *S. crassipilum*, which colonise walls and concrete, are to be expected in all regions. Among the regions without *Schistidium* records (Cserehát Hills, Putnok Hills, Karancs–Medves Mts, Fertő Hills, Vend Region, Őrség, Hetés, Göcsej, Zselic, Külső-Somogy, Little Hungarian Plain, Nyírség, Dráva Region), there are even some siliceous mountains (Karancs–Medves Mts). They were not visited by Hungarian bryologists as frequently as the other mountain areas, since they were thought to be less interesting and poorer in species (BOROS 1968).

However, for the study of *Schistidium* distribution in Hungary, these areas may still hide unexpected treasures.

Species like *S. brunnescens*, *S. crassipilum*, *S. elegantulum* and *S. helveticum* with a strong substrate preference for calcareous rocks naturally show their maximum number of sites in the carboniferous mountains (Aggtelek Karst, Bükk, Pilis, Buda, Gerecse, Vértes, Bakony, Mecsek, Villány Mts). On the other hand, among the more frequent species, *S. apocarpum* and *S. lancifolium*, both have most growth sites in the Börzsöny Mts (and less in the Zemplén, Visegrád, Mátra and Bükk Mts), thus demonstrating a preference for siliceous substrates. The distribution maps of the less frequent species give immediate evidence of their respective substrate preferences: *S. robustum*, *S. brunnescens* subsp. *griseum*, *S. confusum* and *S. dupretii* predominantly grow on calcareous rocks (Bükk, Pilis, Buda, Vértes, Bakony Mts), whereas *S. pruinosum*, *S. papillosum*, *S. confertum* and *S. flaccidum* are found exclusively on siliceous rocks (Zemplén, Bükk, Mátra, Börzsöny, Visegrád Mts).

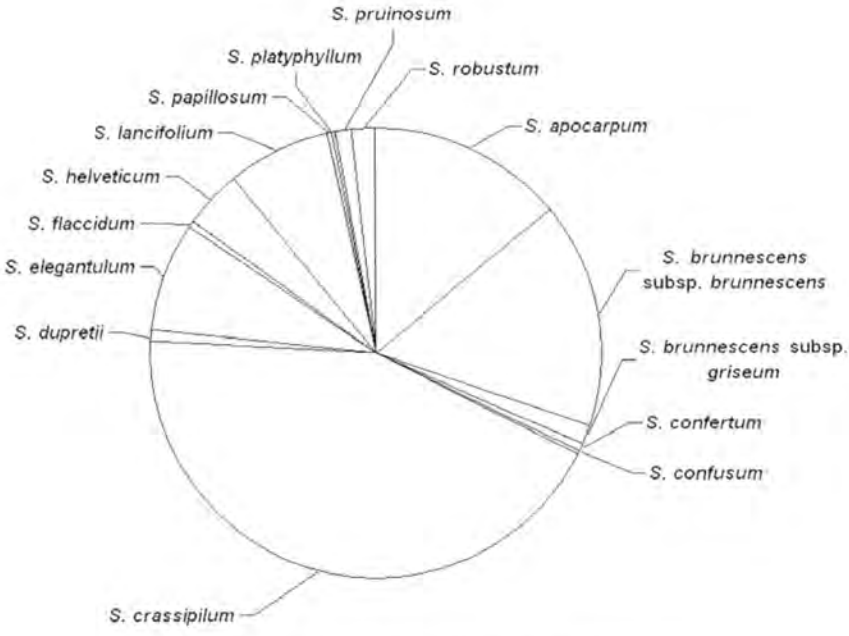


Fig. 34. Frequency of *Schistidium* taxa in Hungary

However, these frequency data are not without bias. This becomes obvious when considering the number of sites in different regions (Table 2): a large number of collection sites of *Schistidium* taxa can in fact indicate a high diversity of growth sites in the region, but it could also just be the consequence of more thorough bryological collecting. In this context, it is interesting to regard the two regions with the highest numbers of sites: the Bükk Mts (62 sites) and the Buda Mts (43 sites). In the case of the Bükk Mts species number is also highest (12 taxa), therefore this seems to be a centre of diversity for *Schistidium* in Hungary. On the other hand, the high number of collection sites in the surroundings of Budapest, where species number is only 8, might be indicative of bryological activity concentrated around the capital. The high diversity of the Bükk Mts is certainly due to the presence of different geological bedrocks (calcareous as well as siliceous), but perhaps other factors, *e.g.* the altitudinal range (up to 900 m), low density of human settlements and the large area protected as a national park are also important.

Table 2. Number of growth sites of *Schistidium* taxa as recorded on specimen labels in regions of Hungary with 10 or more sites.

Region (as defined in Boros 1968)	No. of sites	No. of Schistidium taxa
Bükk Mts	62	12
Buda Mts	43	8
Aggtelek Karst	34	5
Gerecse Mts	34	5
Vértes Mts	33	6
Pilis Mts	33	5
Börzsöny Mts	28	5
Balaton Uplands	24	4
Visegrád Mts	23	5
Bakony Mts	18	4
Zemplén Mts	13	3
Mátra Mts	12	5
Mecsek Mts	12	4
Villány Mts	10	5

As regards rare species, it is important to distinguish between species that are probably under-recorded and others that are truly rare. We consider *S. platyphyllum* and *S. papillosum*, both with a single growth site

known at present, to be under-recorded. Although a first search along the banks of the Danube to find more *S. platyphyllum* was unsuccessful, it is hardly conceivable that there should be no more potential sites along this river in Hungary, considering the occurrence of this species along German lowland rivers. *S. papillosum* was discovered only recently at its only known growth site during a search of siliceous substrata for *Schistidium*. Although a few excursions were undertaken into such areas (in the Bükk and Börzsöny Mts), there remain many potentially rewarding places with siliceous bedrock in these mountains as well as in the Zemplén, Mátra, Karancs–Medves, Börzsöny and Visegrád Mts to be explored in more detail.

On the other hand, there are reasons to believe that *S. confusum*, with only one site, and in particular *S. confertum* and *S. flaccidum*, with two and three sites, respectively, might be truly rare. *S. confusum* and *S. flaccidum* are considered to be rare in Europe, and *S. confertum* is rare in Fennoscandia, but more widespread in Central and Southern Europe (BLOM 1996). In Hungary, *S. confusum* has been discovered only recently in a single population, in spite of plenty of potential growth sites on calcareous substrate throughout the country. The species circumscription of *S. confertum* and *S. flaccidum* has been stable within the last hundred years, and was known to Hungarian bryologists of former times. Their populations have been detected about fifty (*S. confertum*) and a hundred (*S. flaccidum*) years ago. No new site of either of them was found during fieldwork of the first author, but a single new location of *S. flaccidum* has been discovered recently (B. Papp, unpublished).

The remaining taxa with only few records: *S. pruinosum*, *S. dupretii*, *S. robustum*, and *S. brunnescens* subsp. *griseum* are certainly not frequent, but may also be under-recorded, since there are two or three recently discovered sites for each of them.

It is interesting to compare frequency and rarity of Hungarian taxa with data from other Central European countries, *e.g.* Austria (GRIMS 1999), Baden-Württemberg (HOLZ 2000) and Germany (MEINUNGER and SCHRÖDER 2007). As in Hungary, *S. crassipilum* and *S. apocarpum* are frequent and widely distributed in the above-named countries. Nearly as frequent is *S. elegantulum* in Baden-Württemberg, much less so in other parts of Germany, and in Austria. In Scandinavia, this species has a southwestern distribution (BLOM 1996), and perhaps some oceanic affinity is reflected in the

fact that it becomes rarer towards continental parts of Europe like Hungary. It may be significant that most of its Hungarian records are in the Bükk Mts, the highest among the calcareous mountains, and receiving most precipitation (RADÓ 1979). On the other hand, *S. brunnescens* subsp. *brunnescens*, one of the most frequent taxa in Hungary, may appear to be more continental, since records are fewer in Germany and Austria. *S. lancifolium*, which in Hungary is among the five most frequent species, is definitely even more continental; it is not known from Baden-Württemberg and rare in Germany and Austria. The characterization of its German and Austrian habitats corresponds well to our observations in Hungary, and where elevation is given in the Austrian records, it ranges from 800 to 1,700 m a.s.l. *S. helveticum*, which is not rare in the south-western and central parts of Germany and in Hungary, appears to be very rare in Austria, maybe due to scarcity of xerothermic habitats.

For the remaining taxa, Hungarian records are few, but in the light of data from Germany and Austria, this may in some cases not reflect their true frequency. *S. papillosum, S. robustum* and *S. dupretii* are frequent in both countries, and we have at present no idea why they appear to be much rarer in Hungary. *S. pruinosum* is not infrequent in Baden-Württemberg and a few other, mainly western parts of Germany, but rare in Austria and perhaps also in Hungary. The taxa of the Confertum group, *S. confertum* and *S. flaccidum*, which are thought to be truly rare in Hungary, are rare and red-listed in Baden-Württemberg and Germany (in the highest threat categories, 2 and 1, respectively, of all extant *Schistidium* taxa in MEINUNGER and SCHRÖDER 2007); in Austria, however, *S. confertum* is moderately frequent in the siliceous parts of the Alps, whereas *S. flaccidum* is rare to occasional (H. Köckinger, pers. com.). *S. confusum* is rare in Germany as well as in Austria.

CONSERVATION

It seems premature to draw conclusions with respect to threat status according to the IUCN criteria (IUCN 2001), since much of the data is still insufficient for this purpose. To improve the state of knowledge, a more comprehensive field survey of Hungary with special focus on *Schistidium* would be desirable. This would probably lead to the discovery of several

new locations, and maybe even new taxa. It would also be necessary to re-visit the sites of old records and check if the species are still there. Some future field research should also aim at population dynamics, not only of rare or less frequent species, but also of species of intermediate frequency *viz. S. elegantulum* and *S. helveticum*, because we do not yet understand, why they are not much more widespread, given the many additional potential growth sites in the calcareous parts of Hungary. Thus *S. elegantulum* has most of its records in the Bükk Mts, but strikingly few in the other limestone and dolomite areas, none at all in the Pilis Mts. Does this reflect a preference for limestone vs. dolomite, or are there climatic reasons, or is it just an artefact of insufficient mapping? Similarly, it is not clear, why *S. helveticum* has not (yet?) been found in the Bakony Mts or the Balaton Uplands.

Many of the *Schistidium* growth sites mapped during this revision lie already in protected areas like the Bükk National park, the Aggtelek National Park and the Duna–Ipoly National Park.

However, since this protected status does not prevent the sometimes negative consequences to habitat quality of forestry management, it is important to make the localities of important populations known to the authorities concerned. In this context, we would like to draw attention to the sites of *S. flaccidum* (Bükk Mts, Visegrád Mts) and the two only sites of *S. confertum* (Mátra and Börzöny Mts). The status of *S. confertum* is uncertain. A short search at the surroundings of Holló-kő (Börzsöny Mts) by the first author was unsuccessful; no search has been made at Disznó-kő (Mátra Mts) for this species.

It is hoped that this survey of *Schistidium* in Hungary, where this genus is well represented, has outlined some of its interesting taxonomic, floristical and ecological features, and that it will help and stimulate future research.

* * *

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