

THE EARLIEST RECOGNITION OF *SCHISTIDIUM OCCIDENTALE* (GRIMMIACEAE, BRYOPHYTA), WITH A REVIEW OF SPECIES OF *SCHISTIDIUM* SUBG. *CANALICULARIA*
О ПЕРВОМ ВЫДЕЛЕНИИ *SCHISTIDIUM OCCIDENTALE* (GRIMMIACEAE, BRYOPHYTA)
В КАЧЕСТВЕ САМОСТОЯТЕЛЬНОГО ТАКСОНА,
С ОБЗОРОМ ВИДОВ ПОДРОДА *CANALICULARIA* РОДА *SCHISTIDIUM*

RYSZARD OCHYRA¹ & HALINA BEDNAREK-OCHYRA¹

РИШАРД ОХЫРА¹, ХАЛИНА БЕДНАРЕК-ОХЫРА¹

Abstract

Schistidium occidentale (E. Lawton) S.P. Churchill, a species described in 1967 as *Grimmia occidentalis* E. Lawton, was distinguished as a separate taxon in 1940. It was described as *G. alpicola* Hedw. var. *rivularis* (Brid.) Wahlenb. fo. *acutifolia* Grout. The identity of this taxon with *S. occidentale* is confirmed, its name is lectotypified, and some diagnostic characters of this form are illustrated. Species of *Schistidium* Bruch & Schimp. subg. *Canalicularia* Ochyra are reviewed and a key to their determination is provided.

Резюме

Schistidium occidentale (E. Lawton) S.P. Churchill, описанный в 1967 как *Grimmia occidentalis* E. Lawton, на самом деле был выделен в качестве отдельного таксона еще в 1940 году, в статусе разновидности *G. alpicola* Hedw. var. *rivularis* (Brid.) Wahlenb. fo. *acutifolia* Grout. Данный таксон лектотипифицирован, его признаки, доказывающие тождество с *S. occidentale*, проиллюстрированы. Обсужаются виды *Schistidium* Bruch & Schimp. subg. *Canalicularia* Ochyra и приводится ключ для их определения в мировом масштабе.

KEYWORDS: Bryophyta, key to determination, nomenclature, North America, rheophyte, *Schistidium*, taxonomy.

INTRODUCTION

Although *Schistidium* is a well defined and easily recognised genus of acrocarpous mosses, it is also one of the most troublesome, confusing, and taxonomically least understood of all moss genera. Despite remarkable progress in taxonomic studies on this genus in the last quarter of century (e.g., Ochyra, 1989; Blom, 1996; Ignatova *et al.*, 2010), resulting in the description of many new species and the resurrection of others from obsolescence, much remains to be done with regard to its diversity and taxonomy in most regions of the world. Not only outside the Holarctic which are traditionally considered to be underexplored and understudied but also in many areas of Europe, Asia, and North America, which are usually much better studied bryologically.

Schistidium remains underinvestigated in North America north of Mexico. In the recently published moss Flora of this continent, only 30 species of this genus were accepted (McIntosh, 2007). However, in this treatment several taxa that are considered distinct were not accepted and their names synonymised with names of other species, including *S. platyphyllum* (Mitt.) Perss., *S. andreaeopsis* (Müll. Hal.) Laz., *S. umbrosum* (J.E.Zetterst.) H.H. Blom, *S. lancifolium* H.H. Blom, *S. submuticum*

H.H. Blom subsp. *arcticum* H.H. Blom and *S. trichodon* (Brid.) Poelt var. *nutans* H.H. Blom. On the other hand, *S. recurvum* H.H. Blom was excluded from the flora since the North American material so named appeared to deviate markedly from the European type specimen (McIntosh, 2007) but, unfortunately, without suggesting its true identity. In addition, three species have recently been described as new to North America, *S. viride* H.H. Blom (Blom & Darigo, 2009), *S. frahmianum* Ochyra & Afonina (Ochyra & Afonina, 2010), and *S. echinatum* Ignatova & H.H. Blom. Two other species, *S. abrupticostatum* (Bryhn) Ignatova & H.H. Blom and *S. canadense* (Dupr.) Ignatova & H.H. Blom were originally described as varieties of *S. apocarpum* (Hedw.) Bruch & Schimp. but have proved to warrant species recognition (Ignatova *et al.*, 2010).

The last two examples show that more infraspecific taxa of *Schistidium* may prove to be distinct species. For example, Bryhn (1906) described, apart from *S. apocarpum* var. *abrupticostatum* Bryhn which is now considered to be a distinct species, two additional new varieties from the Canadian Arctic: *S. apocarpum* var. *ovatum* Bryhn which has not been assessed taxonomically, whilst *S. gracile* (Roehl.) Limpr. var. *scabrius* Bryhn is identical to *S. papillosum* Culm. The latter species was descri-

¹ – Laboratory of Bryology, Institute of Botany, Polish Academy of Sciences, ul. Lubicz 46, 31–512 Kraków, Poland; e-mail: r.ochyra@botany.pl

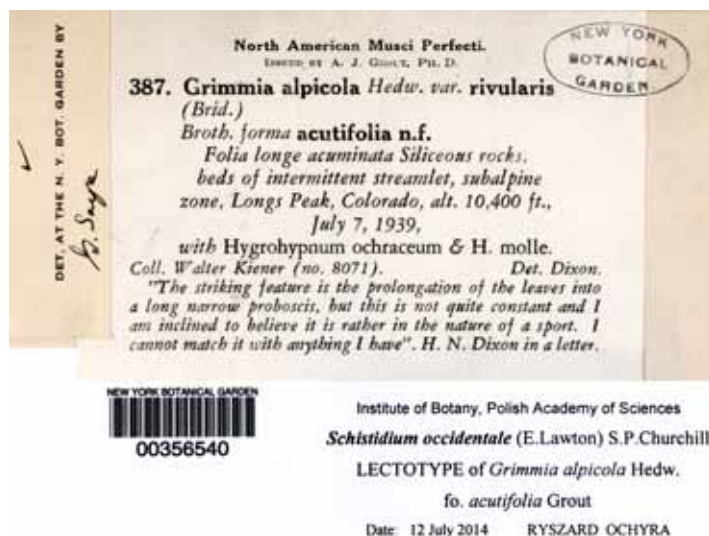


Fig. 1. The lectotype specimen of *Grimmia alpicola* Hedw. var. *rivularis* (Brid.) Wahlenb. fo. *acutifolia* Grout.

bed by Culman (in Amann, 1918) much later after its first recognition in Europe at the varietal level. The same case is represented by *S. occidentale* (E. Lawton) S.P. Churchill which was described over a quarter of century earlier as a form, *Grimmia alpicola* Hedw. var. *rivularis* (Brid.) Wahlenb. fo. *acutifolia* Grout (Grout, 1940) which is discussed in the present account.

CHARACTERISATION OF *GRIMMIA ALPICOLA* VAR.

RIVULARIS FO. *ACUTIFOLIA*

In July 1939, Walter Kiener collected a puzzling moss in the subalpine zone of the Rocky Mountains of Colorado growing in the bed of a streamlet together with *Platyhypnum molle* (Hedw.) Loeske and *Hygrohypnella ochracea* (Wilson) Ignatov & Ignatova. He presented this moss to A.J. Grout who consulted its identity with the eminent English bryologist H.N. Dixon. Dixon commented briefly on this moss in a letter as follows: "The striking feature is the prolongation of the leaves into a long narrow proboscis, but this is not quite constant and I am inclined to believe it is rather in the nature of a sport. I cannot match it with anything I have".

The material collected by W. Kiener was subsequently distributed by Grout (1940) in his exsiccata *North American Musci Perfecti* as No. 387 (Fig. 1). He described this plant as a separate form, *Grimmia alpicola* Hedw. var. *rivularis* (Brid.) Wahlenb. fo. *acutifolia* Grout. The new form differed from the typical expression of this variety by its *folia longe acuminata* and this brief diagnosis was published on the herbarium label. It was a frequent practice in the nineteenth and in the first half of the last century to describe new species of plants and fungi on the printed labels of the specimens distributed in the exsiccatae. According to Article 30.7 of the Melbourne Code (McNeill *et al.*, 2012) such descriptions constitute effective publication provided that they appeared prior to January 1, 1953.

The authorship of this taxon is somewhat obscure. Grout (1940) indicated on the label that H.N. Dixon determined the material and quoted his comment on the

label from his letter and he provided diagnostic features of this moss. However, Dixon stated only that this moss did not match anything known to him and failed to state whether this moss deserved a description and neither a rank nor a name was indicated. Because there is no evidence that he contributed these essential elements for the valid publication of this taxon name, its authorship is ascribed to A.J. Grout alone.

However, *Grimmia alpicola* var. *rivularis* fo. *acutifolia* has little in common either with *Schistidium alpicola* (Hedw.) Limpr. var. *rivulare* (Brid.) Limpr., which is now accepted as a distinct species, *S. rivulare* (Brid.) Podp., or *S. alpicola* which is now a rejected name against *S. agassizii* Sull. & Lesq. *Schistidium rivulare* is distinct in the shape of the leaves which are broadly ovate-triangular to ovate-lanceolate with subobtuse to bluntly acute and usually distantly repand-denticulate to serrulate apices, in having strong, subpercurrent to excurrent costae, and the leaf margins which are distinctly recurved in the lower two thirds to three quarters. In addition, the species has large, papillose spores, (15–)19–24 µm in diameter. Likewise, *S. agassizii* is distinct from *S. alpicola* var. *rivularis* fo. *acutifolia* by its leaves that are linear-lanceolate to narrowly or broadly oblong-ligulate from a somewhat broader base, nearly flat distally, and with rounded or bluntly obtuse apices. In addition, the spores in this species are granulate to finely verruculose and large, (12–)14–20 µm wide, whereas those in fo. *acutifolia* are smooth and smaller, 9–11 µm in diameter.

In the large and morphologically diverse genus *Schistidium*, the vast majority of species have ovate-lanceolate to ovate-triangular, carinate leaves. Species with other leaf shapes, *e.g.*, lanceolate, elliptical, lingulate, or broadly ovate, are infrequent and they are usually coupled with the distinct concavity of the leaves. *Schistidium alpicola* fo. *acutifolia* possesses one of the rarest leaf shapes in the genus. The leaves are linear-lanceolate, gradually long acuminate, usually falcate-secund, and concave, and such leaves are only known in four species of *Schistidium*.

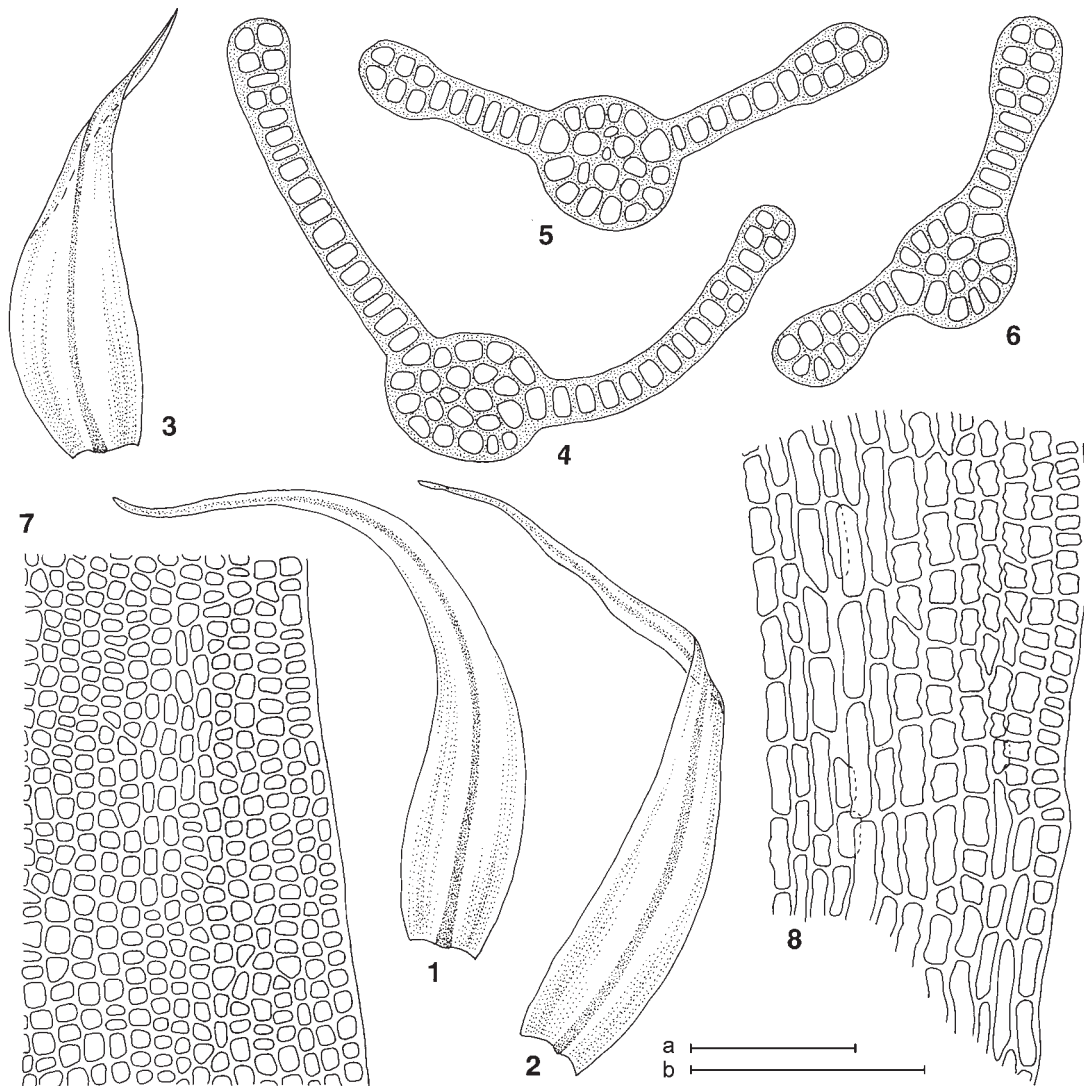


Fig. 2. *Schistidium occidentale* (E. Lawton) S.P. Churchill. 1–3 – Leaves. 4–6 – Transverse sections of leaves in apical part. 7 – Mid-leaf cells. 8 – Basal cells. (All from Kiener 8071, KRAM, isotype of *Grimmia alpicola* Hedw. var. *rivularis* (Brid.) Wahlenb. fo. *acutifolia* Grout). Scale bars: a – 1 mm for 1–3; b – 100 μ m for 4–8.

Three of them are known to occur in western North America.

The first of these is *Schistidium cinclidodonteum* (Müll. Hal.) B. Bremer, described by Karl Müller of Halle (in Röhl, 1890) on the basis of a collection from Washington State. It was subsequently considered conspecific with *Grimmia alpicola* (Jones, 1933) but Robinson & Hermann (1964) reinstated it as a species in its own right and, since then, the species has gained a wide acceptance (e.g., Lawton, 1971; Flowers, 1973; Bremer, 1980; Anderson *et al.* 1990; McIntosh, 2007). The species has evenly bistratose laminal cells in the distal portion and a salient costa, to 190 μ m wide near the base, which is rarely excurrent as a short or, occasionally, long, terete awn. The costa is 5–9-stratose in the proximal part and plano-convex throughout, making the leaves stiff and rigid. Additionally, the perichaetial leaves are gradually long acuminate and are similar to the vegetative leaves. These diagnostic traits exclude the identity of this spe-

cies with *Grimmia alpicola* var. *rivularis* fo. *acutifolia*.

The type material of *Grimmia alpicola* var. *rivularis* fo. *acutifolia* is characterised by its weaker costa, to 100 μ m wide near the base, which is distinctly biconvex and 4–6-stratose throughout, and with laminal cells that are unistratose in the distal portion, except for the 2–4-seriate, bistratose marginal border forming a fleshy limbidium (Fig. 2.4–6). The costa is percurrent and does not fill the entire subulate acumen of the leaf which is linear-lanceolate and gradually acuminate into a subulate point (Fig. 2.1–3). Leaf areolation is uniform throughout and consists of isodiametric, quadrate, irregular to short-rectangular, or oblate cells, 8–9 μ m wide, with esinouse and moderately thickened walls (Fig. 2.7) and only the basal juxtacostal cells are short-rectangular, 15–40 μ m long, with thickened and porose longitudinal walls (Fig. 2.8).

The aforementioned features of *Grimmia alpicola* var. *rivularis* fo. *acutifolia* perfectly agree with the characters of *Schistidium occidentale* and, therefore, these

names must be considered synonymous. This was suggested by Lawton (1971) and herein the synonymy of these names is effected and *Grimmia alpicola* var. *rivularis* fo. *acutifolia* is lectotypified. This taxonomic conclusion implies that *S. occidentale* was recognised as a separate taxon in 1940 as a form, some twenty-seven years before its description in the rank of species.

Schistidium occidentale (E. Lawton) S.P. Churchill in Funk & Brooks, *Advances Cladist.*: 143. 1981 ≡ *Grimmia occidentalis* E. Lawton, *Bull. Torrey Bot. Club* 94: 461, f. 1–15. 1967. Type citation: [U.S.A.] Wyoming: Carbon Co., Medicine Bow Mountains, North French Creek, at about 8000 ft, Lawton 1687 [Holotype: WTU, non vidi].

Grimmia alpicola Hedw. var. *rivularis* (Brid.) Wahlenb. fo. *acutifolia* Grout, *N. Am. Musci Perf.*: No. 387. 1940. Type citation: [U.S.A.] Siliceous rocks, beds of intermittent streamlet, subalpine zone, Longs Peak, Colorado, alt. 10,400 ft., July 7, 1939, with *Hygrohypnum ochraceum* & *H. molle*. Coll. Walter Kiener (no. 8071). Det. Dixon. [Lectotype (selected here): NY!; isotype: KRAM!]. First synonymised with *Grimmia occidentalis* by Lawton (1971: p. 138).

Schistidium occidentale was originally described (as *Grimmia occidentalis*) by Lawton (1967) based on several specimens from the Rocky Mountains of Wyoming and Montana, the Ruby Mountains in Nevada, and the Sierra Nevada of California. The species was subsequently transferred to *Schistidium* (Churchill, 1981) and later it proved to be widely distributed in other western states, including Washington, Oregon, Utah, and Colorado (McIntosh, 2007). Recently, it was also found in Europe in the Sierra Nevada in Spain (Casas *et al.*, 2001), confirming the well known biotic disjunction between western North America and the Mediterranean in Europe and North Africa. This disjunctive pattern is expressed by a number of species associated with Mediterranean climates and it is worth noting that it is also shown with *S. cinclidodonteum*, a close relative of *S. occidentale*, which was discovered in Morocco (Ros *et al.*, 2000).

Lawton (1979) described another species closely related to *Schistidium occidentale* from Oregon, *Grimmia pacifica* E. Lawton. Interestingly, she placed in this species the specimen from the Dixie Mountains in California which initially was included by herself in the protologue of *G. occidentalis*. The only difference separating this new species from *S. occidentale* was the presence of a minute hyaline hair-point. This species was considered to be identical to *S. occidentale* by Anderson *et al.* (1990), whereas McIntosh (2007) found it to be conspecific with *S. cinclidodonteum*.

A BRIEF ACCOUNT ON *SCHISTIDIUM* SUBG.

CANALICULARIA

Schistidium occidentale is a rheophytic moss growing in stream beds of altimontane brooks. This unique ecological feature exhibits a number of *Schistidium* species.

They constitute a distinct group which is well characterised by the erect and plane leaf margins and broadly concave leaves. Taxonomically, it is recognised as a separate subgenus, *Schistidium* subg. *Canalicularia* Ochyra (Ochyra *et al.*, 2003).

Schistidium subg. *Canalicularia* was reviewed by Ochyra (2003) who placed nine species in it. Since then, one species, *S. pacificum* (E. Lawton) Ochyra, has been shown to be conspecific with *S. cinclidodonteum* (McIntosh, 2007). However, this loss is balanced with a wide margin by five recently described species, namely *S. crassithecium* B.H. Allen from eastern North America (Allen, 2005), *S. frahmianum* Ochyra & Afonina from Chukotka and Alaska (Ochyra & Afonina, 2010), *S. mucronatum* H.H. Blom, Shevock, D.G. Long & Ochyra and *S. riparium* H.H. Blom, Shevock, D.G. Long & Ochyra from China (Blom *et al.*, 2011) and *S. deguchianum* Ochyra & Bednarek-Ochyra from Peru (Ochyra & Bednarek-Ochyra, 2011). The remaining species which are currently positioned in *S.* subg. *Canalicularia* include *S. lewis-smithii* Ochyra (Antarctica), *S. agassizii* (panholarctic arctic-alpine disjunct), *S. falcatum* (Hook.f. & Wilson) B. Bremer (amphiatlantic south-cool-temperate species), *S. flexifolium* (Hampe) Ochyra (SE Australia and New Zealand), *S. cribrodontium* (Herzog) Ochyra (Ruwenzori Mts in the Democratic Republic of Congo) and *S. malacophyllum* Herzog (Bolivia). They can be recognised in the following key.

1. Peristome absent or vestigial *S. lewis-smithii*
— Peristome well-developed 2
2. Leaves almost flat distally; margins plane or shortly and narrowly recurved in the proximal part
..... *S. agassizii*
— Leaves broadly canaliculate distally; margins erect to incurved throughout 3
3. Dioicous; exothecial cells with strongly incrassate walls *S. crassithecium*
— Monoicous; exothecial cells thin-walled 4
4. Spores large, (15–)18–28 µm in diameter, granulose to finely verruculose 5
— Spores small, 7–17(–19) µm in diameter, smooth or nearly so 6
5. Leaves lanceolate, mostly falcate-secund; costa usually excurrent as a cuspidate point *S. falcatum*
— Leaves ovate to oblong-ligulate, erect-spreading, straight but usually curled toward stem apex when dry; costa percurrent to subpercurrent
..... *S. flexifolium*
6. Leaves linear-lanceolate, gradually long-acuminate, usually falcato-secund 7
— Leaves lanceolate, oblong- or ovate-lanceolate to broadly ovate, gradually short-acuminate, straight 9
7. Costa percurrent, biconvex in transverse section; leaves fairly soft *S. occidentale*

- Costa excurrent as a stout terete subula, plano-convex in transverse section; leaves stiff and rigid 8
8. Capsule turbinate when dry; costa narrow, 45–65 μm wide near base, long-excurrent; spores (12–)14–17(–19) μm in diameter *S. frahmianum*
- Capsule obloid when dry; costa broad, 100–190 μm wide near base, short-excurrent; spores 9–11 μm in diameter *S. cinclidodontum*
9. Leaves broadly ovate to ovate-lanceolate, deeply concave to cochleariform, obtuse, rounded to broadly acute at the apex *S. cribrodontium*
- Leaves lanceolate, oblong- or ovate-lanceolate, canalliculate, narrowly acute at the apex 10
10. Leaf lamina unistratose throughout, except for 1–2-seriate bistratose margins in the distal portion
..... *S. malacophyllum*
- Lamina at least with bistratose strips and patches in the distal part 11
11. Leaves thick-textured, alutaceous; laminal cells entirely 2–4-stratose throughout, with some unistratose strands in the proximal portion *S. deguchianum*
- Leaves thin-textured, not alutaceous; laminal cells unistratose with extensive bistratose streaks or patches in the distal portion 12
12. Peristome teeth 270–340 μm long, patent to squarrose, not twisted round the axis; leaves not arranged in spiral rows, narrowly ovate-triangular, 0.45–0.8 mm wide *S. riparium*
- Peristome teeth 370–450 μm , erecto-patent, strongly twisted half way round the axis; leaves in \pm spiral rows, ovate-lanceolate, 0.7–1.1 mm wide ... *S. mucronatum*

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