

Studies in Indiana Bryophytes XI

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The writer has followed closely the treatment of Sphagnaceae by A. LeRoy Andrews in North American Flora 15:1-31, 1913, and O. E. Jennings, Manual of Mosses of Western Pennsylvania, pp. 20-42, 1951. The author acknowledges this aid with deep gratitude. To Dr. Andrews for his determination of the sphagnum collected in Indiana as well as for his criticisms and suggestions regarding this paper, and to Dr. Jennings and the American Midland Naturalist for the illustrations of the diagnostic characteristics, the writer is greatly indebted, and in this way expresses sincere thanks and appreciation.

SPHAGNACEAE. THE SPHAGNUM FAMILY

Plants deeply caespitose, large, erect, usually light grayish-green, sometimes yellowish, occasionally reddish, growing in younger portions as dying in the older; stem without rhizoids and a central strand, usually composed of an outer cortical sheath of parenchyma cells, an intermediate cylinder of prosenchymatous thick-walled cells (wood-cylinder), and a central area of parenchymatous cells (pith); branches in fascicles of two or more, the fascicles spirally arranged on the stem, near the apex densely crowded, usually some branches spreading at right angles to stem and others appressed-pendent; leaves in spiral arrangement, ecostate, composed of a layer of two kinds of cells, large, hyaline, somewhat elliptic or rhomboidal cells with walls usually perforated and spirally thickened (fibrillose) separated by narrow chlorophyllose cells uniting at the ends and forming a continuous cellular net; branch-leaves imbricate or nearly so, usually porose and fibrillose; stem-leaves distant, often lacking pores and spiral fibrils; monoicous or dioicous; seta none to very short; capsule borne upon an outgrowth of gametophyte (pseudopodium), globose, chestnut-colored to black; operculum small, convex; annulus and peristome lacking; calyptra irregularly lacerate; spores yellowish, tetrahedral with one large convex face and three smaller plane triangular ones, 18-45 μ in longest diameter, disseminated by an explosive discharge from the capsule.

SPHAGNUM [Dill.] L.

Characters the same as those of the family.

Key to species of Sphagnum

1. Cortical cells of stem and branches reinforced by spiral fibril-bands.2
2. Chlorophyllose cells of branch-leaves short elliptic in cross section, centrally placed and entirely enclosed by the hyaline cells.....
..... *S. magellanicum*.

2. Chlorophyllose cells of branch-leaves usually triangular in cross section, with the base exposed on the inner (ventral) surface of the leaf3
3. Chlorophyllose cells of branch-leaves usually narrowly triangular or isosceles-triangular in cross section.....*S. palustre*.
3. Chlorophyllose cells of branch-leaves very broadly triangular or equilateral-triangular in cross section.....4
 4. Branch-leaves with fringe- or comb-fibrils on walls of hyaline cells.....*S. imbricatum*.
 4. Branch-leaves without fringe- or comb-fibrils on walls of hyaline cells.....*S. imbricatum* var. *affine*.
1. Cortical cells of stem and branches without fibril-bands.....2
 2. Cortical cells of branches uniform, each with a pore at the upper end; chlorophyllose cells of branch-leaves in cross section enclosed on both surfaces.....*S. compactum*
 2. Cortical cells of branches of two kinds, or, if uniform, without pores; chlorophyllose cells of branch-leaves in cross section exposed on one or both surfaces.....3
 3. Chlorophyllose cells of branch-leaves in cross section free on outer (dorsal) surface of leaf; hyaline cells strongly convex on inner (ventral) surface.....4
 4. Cortical cells of stem small and scarcely different from inner cells, thick-walled; chlorophyllose cells of branch-leaves in cross section isosceles-triangular, the base of the triangle exposed on the outer (dorsal) surface of the leaf, the apex of the triangle reaching the inner (ventral) surface....5
 5. Branch-leaves 1-2 mm. long, strongly undulate when dry*S. recurvum*.
 5. Branch-leaves about 1 mm. long, scarcely undulate when dry.....*S. recurvum* var. *tenuis*.
 4. Cortical cells of stem moderately inflated, in one layer, different from inner cells, thin-walled; chlorophyllose cells of branch-leaves in cross section exposed equally on both surfaces or more broadly on the outer (dorsal) one.....
.....*S. subsecundum*.
3. Chlorophyllose cells of branch-leaves in cross section free on the inner (ventral) surface of leaf, and hyaline cells strongly convex on the outer (dorsal) surface.....4
 4. Stem-leaves fimbriate-lacerate in apical portion.....5
 5. Stem-leaves spoon-shaped, fimbriate-lacerate on upper margins and the apex.....*S. fimbriatum*.
 5. Stem-leaves tongue-shaped, fimbriate-lacerate only across the apex.....*S. Girgensohnii*.
 4. Stem-leaves toothed in the truncate apical portion.....
.....*S. capillaceum*.

INDIANA SPECIES OF SPHAGNUM

S. capillaceum (Weiss) Schrank (Pl. A, as *S. acutifolium* Ehrh. var. *viride* Warnst.)¹ Plants generally short, 5-8 cm. high, compact, green, with a tinge of red; wood-cylinder mostly reddish; cortical cells of stem in 2-4 layers, thin-walled, without fibrils, the outer cells longer than wide, without pores; stem-leaves lingulate to triangular-ovate, 1-2 mm. long, very concave, usually two or more times as long as wide, border strong with cell walls strongly pitted, leaf apex usually involute pointed, toothed; hyaline cells of stem-leaves rhomboidal, 4-5:1 in apical part, with traces of fibrils; branches up to 1.5 cm. long, in fascicles of 3-5, 2 commonly spreading and recurved, others appressed-pendent, cortical cells of two kinds, in one layer, without fibrils, the retort-cells well differentiated with conspicuous neck and terminal pore; branch-leaves imbricate to slightly spreading, 1-2 mm. long, ovate-lanceolate to lanceolate, involute above to the toothed apex, bordered; hyaline cells of branch-leaves narrowly rhomboidal, 10-12:1 near base and shorter above, fibrillose, with small pores at cell-angles and sometimes lateral pores opposite the angle pores; chlorophyllose cells triangular to trapezoidal in cross section with the longer wall adjoining the hyaline cells, free on both surfaces but the hyaline cells projecting far beyond them both ventrally and dorsally; hyaline cells in cross section convex on the inner leaf surface and strongly so on the outer; capsule brown; spores yellow, 20-25 μ in diameter, smooth to slightly granular-roughened. Specimens seen from Lake, Lawrence, Porter, and Putnam counties.

S. compactum DC. (Pl. A, as *S. compactum* DC. var. *squarrosus* Russ.) Plants usually short and compact, 4-8 cm. high, grayish green, glaucous green, or dirty white, especially when dry, sometimes grayish brown, occasionally green or nearly so; wood-cylinder usually brown, occasionally yellowish; cortical cells of stem in 2-3 layers, large, thin-walled, without fibrils, the outer cells quadrangular to pentagonal, sometimes longer than wide, without pores; stem-leaves 0.6-0.8 mm. long, concave, short lingulate to triangular-lingulate, cell walls pitted, especially in narrow marginal cells, leaf apex occasionally lacerate or slightly so; hyaline cells of stem leaves broadly rhomboidal without fibrils or pores; branches short, up to 1 cm. long, compactly arranged in close fascicles of 4-5, 2 stronger, spreading or ascending, rigid, others appressed-pendent, cortical cells in one layer, uniform, without fibrils, apex of each cell produced outwardly into a slight neck which ends in a pore; branch-leaves imbricate to strongly squarrose, large, 2-3 mm. long, ovate-hastate, margins involute, slightly denticulate, apex truncate, toothed; hyaline cells of branch-leaves rather broadly rhomboidal or irregularly hexagonal-rhomboidal, 6-8:1 near base, shorter above, fibrillose, on outer leaf surface with several large round pores irregularly scattered and also in cell-angles, usually 4-8 per cell, on inner leaf surface pores small oval and in cell-angles, commonly 3 in each cell; chlorophyllose cells elliptic in cross

1. In Jennings, Manual of Mosses, plate 5 illustrates both *Sphagnum acutifolium* and the variety *viride* Warnst. Jennings, on page 41, regards *S. capillaceum* as a synonym of *S. acutifolium*.

section, enclosed dorsally and ventrally by the moderately convex hyaline cells which are not at all to very slightly convex on outer leaf surface and more convex on inner surface of leaf; capsule brown; spores brownish yellow, 24-28 μ in diameter, slightly granular-roughened. Specimens seen from Cass and Jasper counties.

S. fimbriatum Wils. (Pl. A.) Plants usually very slender and delicate, 4-5 cm. high, grayish green, occasionally yellowish, or yellowish brown; wood-cylinder green; cortical cells of stem in 1-3 layers, large with thin walls, without fibrils, outer cells quadrangular to irregularly pentagonal and hexagonal, generally longer than broad, with one large round pore in the upper end; stem-leaves broadly obovate-spatulate to short spatulate, 0.7-0.8 mm. long, often broader than long, concave, clasping the stem, apical portion fimbriate-lacerate on margins and apex; hyaline cells of stem-leaves rhomboidal, 2-3:1, without fibrils and pores; branches slender, up to 2.5 cm. long, usually in fascicles of 3-5, 2-3 spreading, others pendent, cortical cells of two kinds, in one layer, without fibrils, the retort-cells elongate and slender without distinct necks; branch-leaves imbricate, small, ovate-lanceolate to ovate, strongly concave, involute above, border entire, of 2-3 rows of narrow cells, leaf apex narrowly truncate and dentate; hyaline cells of branch-leaves narrowly rhomboidal, 8-12:1, with 4-6 fibrils, on the inner leaf surface 4-6 large rounded pores with diameter approximately equal to width of cell, on the outer leaf surface 5-8 smaller, elliptic pores; chlorophyllose cells trapezoidal in cross section, free on both surfaces, with slightly broader exposure on the inner leaf surface; walls of hyaline cells in cross section convex on both surfaces, more strongly so on the outer; capsule dark brown, briefly exserted; spores greenish yellow, 18-20 μ in diameter according to Andrews and 25-30 μ according to Jennings, smooth to slightly granular-roughened. Specimens seen from Elkhart county.

S. Girsensohnii Russow (Pl. A.) Plants commonly fairly robust, often very tall, 10-15 cm. high, usually green or grayish green, sometimes yellowish to brownish; wood-cylinder green, yellowish, or brownish; cortical cells of stem in 2-4 layers, large, thin-walled, without fibrils, the outer cells longer than wide, with a single large rounded pore in the upper end; stem-leaves 1-1.2 mm. long, short-lingulate, often as broad as long, slightly concave, broadened toward base where cell walls are pitted, the broad obtuse apex lacerate; hyaline cells of stem-leaves rhomboidal, 2-3:1 in apical part, without fibrils; branches 1.5-2.5 cm. long, in fascicles of 4-5, 2 spreading, others pendent and accumbent to stem, cortical cells of two kinds, in one layer, without fibrils, the retort-cells well developed with conspicuous necks; branch-leaves imbricate, rarely squarrose, 1-1.4 mm. long, lanceolate, lanceolate-ovate, or ovate, involute to involute tubular above, border entire, of 2-3 rows of narrow cells, leaf apex toothed, somewhat squarrose spreading; the median hyaline cells of branch-leaves ring-fibrillose and with many lateral pores between the fibrils; chlorophyllose cells commonly triangular to trapezoidal in cross section, with broader exposure on the inner leaf surface; hyaline cells in cross section slightly or not at all convex on inner surface of leaf, strongly convex on the outer, nearly enclosing the chlorophyllose cells; capsule

dark brown; spores brownish yellow, 20-25 μ in diameter, strongly granular-roughened. Specimens seen from La Porte and Wells counties.

S. imbricatum Hornsch. var. *affine* (Ren. & Card.) Warnst. (Pl. A, as *S. affine* R. & C.) Plants low and compact to fairly robust, 4-8 cm. high, green or somewhat tinged with brown; wood-cylinder brown; cortical cells of stem in 3-4 layers, thin-walled, fibrillose, the outer cells irregularly quadrilateral to pentagonal, generally longer than wide, each with 4-10 irregularly rounded pores; stem-leaves lingulate to slightly spatulate, 1-1.8 mm. long, with hyaline border; hyaline cells of stem-leaves usually without fibrils and pores, sometimes divided; branches up to 1.5 cm. long, usually in fascicles of 5, 2 spreading, others appressed pendent, cortical cells in one layer, inner wall fibrillose, outer wall showing usually one pore; branch leaves usually imbricate, sometimes squarrose-spreading, ovate, not bordered, margin denticulate, apex cucullate; hyaline cells of branch-leaves 4-6:1, fibrillose, on inner leaf surface a few small ringed pores in corners of cells in apex and 2-12 large rounded pores in each cell, arranged usually in one row but sometimes in two rows, on outer leaf surface 4-12 elliptic pores in cells; chlorophyllose cells equilateral-triangular in cross section, widest on inner surface of leaf; hyaline cells in cross section very convex on outer leaf surface; basal hyaline cells of branch leaves without fringe- or comb-fibrils on the inner wall opposite the adjoining chlorophyllose cells; capsule globose, brown; spores brownish yellow, 20-25 μ in diameter, smooth. Specimens seen from Lawrence and Porter counties.

S. magellanicum Brid. (Pl. B.) Plants compact to robust, up to 8-10 cm. high, bright green, grayish green, bluish green, tinged with brown, pink, red, or purple-red; wood-cylinder usually red, occasionally brown, walls of cells thick; cortical cells of stem in 3-5 layers, walls very thin, reinforced by weak fibril-bands, outer cells smallest and varying in shape and size, their pores rather large, round to laterally elongate, 1-2 in each cell; stem-leaves 1-2 mm. long, long lingulate to broadly lingulate spatulate, upper margins and broadly rounded apex fimbriate; hyaline cells of stem leaves non-fibrillose to fibrillose, porose on dorsal surface of leaf; branches usually short, up to 1 cm. long, occasionally up to 1.5 cm. in length, in fascicles of 4-5, 2 spreading, others appressed pendent, cortical cells in one layer, fibrillose, porose; branch-leaves imbricate to spreading, 1.5-2 mm. long, broadly ovate, very concave, cucullate, margins denticulate, especially near apex; hyaline cells of branch-leaves rhomboidal, 4-7:1, fibrillose with weak fibril bands, porose dorsally and ventrally, on outer surface of leaf 4-10 large elliptic pores per cell in angles of cells, on inner surface very few pores and in angles of apical and lateral cells of leaf; chlorophyllose cells central and elliptic in cross section, usually entirely enclosed by the hyaline cells which are scarcely convex on ventral surface of leaf and not convex to very slightly so on the dorsal surface; capsule considerably exserted, dark brown; spores brownish yellow to rust colored, 24-30 μ in diameter, minutely papillose or finely punctulate. Specimens seen from Fulton, Kosciusko, Noble, and Porter counties.

S. palustre L. (Pl. B, as *S. palustre* and as *S. cymbifolium* Ehrh.) Plants low, compact to robust, usually 8-10 cm. high, sometimes up to 30

cm. in height, green, bluish green, yellowish green, at times tinged with brown; wood-cylinder brownish or yellowish; cortical cells of stem in 3-4 layers of inflated cells, innermost largest, outer cells rectangular, quadrilateral, or pentagonal, walls thin, fibrillose, with 1-4 irregularly rounded pores; stem-leaves up to 3 mm. long and 1.25 mm. wide, spatulate-lingulate, margin toothed, apex broadly rounded, slightly erose-fimbriate; lower hyaline cells of stem-leaves sometimes septate, neither fibrillose nor porose, the upper hyaline cells frequently as broad as long, fibrillose and porose; branches 1-2.5 cm. in length, in fascicles of 4-5, 2 spreading, others pendent and closely appressed to stem, cortical cells in one layer, inflated, rectangular, fibrillose, porose; branch leaves imbricate or spreading to squarrose, up to 3 mm. long, broadly ovate, very concave, margins involute, apex cucullate; hyaline cells of branch leaves rhomboidal, 3-5:1, fibrillose, on ventral surface of leaf porose with large elliptic to rounded pores, usually in cell-angles but occasionally in central portion of cell, more numerous in marginal cells where 2-8 per cell, dorsally 3-10 pores per cell, large round pores in ends of cells and small elliptic ringed ones in angles of cells; chlorophyllose cells narrowly isosceles-triangular in cross section with a short base exposed on ventral surface of leaf and almost even with ventral surface of hyaline cells, on dorsal surface hyaline cells very convex and projecting much beyond chlorophyllose cells; capsule considerably exserted, brown; spores yellow, 20-33 μ in diameter, granular-roughened. Specimens seen from Allen, Delaware, Hamilton, Harrison, Jackson, Kosciusko, Lagrange, Marshall, Monroe, Noble, Porter, Steuben, and Tippecanoe counties.

S. recurvum Beauv. (Pl. B.)² Plants usually somewhat robust, up to 30 cm. high, green, greenish yellow, whitish yellow, or brownish; wood-cylinder yellowish green; cortical cells of stem scarcely differentiated, composed of 3-4 layers of small to medium-sized thick-walled cells, outer cells elongate-quadrilateral, without fibrils and pores; stem-leaves 0.5-0.8 mm. long, sometimes up to 1 mm. in length, triangular, ovate-triangular, to triangular-lingulate, with very wide border of linear hyaline cells at base, the border narrowing upwards and extending almost to the mucronate, rounded, or truncate, sometimes erose-denticulate apex; hyaline cells of stem-leaves usually neither fibrillose nor porose; branches usually up to 1 cm. in length, occasionally up to 1.5 cm. long, commonly in fascicles of 4-5, 2 spreading, others appressed-pendent, cortical cells of branches in one layer, elongate-rectangular, perforate, non-fibrillose, retort cells with inconspicuous necks; branch-leaves imbricate, 1-2 mm. long, undulate when dry with apices recurved, when moist erect-appressed and not undulate, tapering to a narrowly obtuse apex with two to three teeth, narrowly lanceolate or lanceolate-ovate, involute in apical portion, border entire, composed of 2-4 rows of very narrow cells; hyaline cells of branch leaves narrowly linear-rhomboidal, in basal portion 10-12:1, in upper portion 6-7:1, fibrillose and porose, on the ventral surface of leaf usually with 4-7 large pores per cell in cell-angles, on the dorsal surface

2. In correspondence with Dr. Jennings regarding plate 3, *Sphagnum recurvum*, it has been learned that the upper group of leaf-cells is median dorsal (2 cd) and the lower is median ventral (2 cv).

PLATE B



Explanation of Plates A and B

All illustrations are reproductions of plates in O. E. Jennings, *A Manual of the Mosses of Western Pennsylvania and Adjacent Regions*, 1951, plates 1, 3, 5, 6, 7, and 9, with the exception of *Sphagnum cymbifolium*, which is from H. N. Dixon, *The Student's Handbook of British Mosses*, 1924, plate 1 A.

Explanation (from Jennings and Dixon) of letters and figures in the illustrations: a = apex; B = branch; b = base; bc = basal median; c = central or median; cr = cross section; d = dorsal; lm = lower margin; P = plant, habit sketch of plant or portion of plant; S = stem; upc = upper median; upm = upper margin; v = ventral; * = portion of plant; 1 = stem-leaf; 2 = branch-leaf; 5 = capsule.

usually 2-6 small end-pores per cell, occasionally a few ringed lateral pores; chlorophyllose cells usually triangular in cross section, with base of triangle exposed on dorsal leaf surface and the apex extending to the ventral surface or nearly so; hyaline cells in cross section scarcely convex on dorsal surface of leaf, slightly convex on the ventral surface; capsule brown; spores brownish yellow, 20-25 μ in diameter, smoothish to granular-roughened. Specimens seen from Allen, Kosciusko, Lagrange, Marshall, Porter, and St. Joseph counties.

S. recurvum Beauv. var. *tenue* H. Klinggr. (Pl. B.) Plants of the variety shorter than in the species, 10-12 cm. high; branch-leaves loosely imbricate, about 1 mm. long, lanceolate, concave, dry leaves scarcely undulate, apices very slightly recurved, border hyaline, narrow, about the same width above as below, margin involute towards the narrowed somewhat truncate, slightly erose apex; upper hyaline cells of branch leaves with pores both in cell-angles and along the sides of the cells; otherwise similar to the species. Specimens seen from Kosciusko, Lagrange, and Marshall counties.

S. subsecundum Nees (Pl. B.) Plants small and delicate to robust, 5-20 cm. high, green, yellowish or brownish green, or purplish brown; wood-cylinder yellowish green, purplish brown, or brown; cortical cells of stem in 1 layer of moderately inflated cells, outer cells quadrilateral, walls thin, without fibrils or pores; stem-leaves small, 0.6-0.8 mm. long, triangular-lingulate, lingulate, or ovate, slightly auriculate, lower margin with broad hyaline border, the border narrowing above, the broadly rounded apex and the upper margin of leaves erose-fimbriate to fimbriate, apical portion of leaves concave and cucullate or nearly so; hyaline cells of stem-leaves narrowly rhomboidal, shorter and wider in apical portion of leaf, usually without fibrils, some with pores, a few cells septate; branches short, 6-8 mm. long, in fascicles of 2-6, 2-3 spreading, remainder pendent, cortical cells of branches in one layer, without fibrils, the retort cells with inconspicuous necks; branch-leaves when dry closely imbricate to subsecund, small, 1-1.5 mm. long, very concave, short elliptic, suborbicular, broadly ovate, or lanceolate, acuminate to narrowly truncate apex with 3-5 teeth, margins entire, involute, with narrow hyaline border of 2-3 rows of linear cells; hyaline cells of branch-leaves narrowly rhomboidal, 8-10:1 below to 4-5:1 above, fibrillose, on the ventral surface of the leaf non-porose to a few small round pores in angles of cells, on the dorsal surface with numerous small ringed round or elliptic pores along the sides of the cells, usually 10-20 per cell, sometimes more and sometimes less; chlorophyllose cells in cross-section narrowly barrel-shaped, relatively large in comparison with hyaline cells, free on both surfaces; the hyaline cells in cross section slightly convex on either surface, a little more convex on inner leaf surface than on the outer; capsule dark brown, briefly exerted; spores yellowish to brownish yellow, 25-28 μ in diameter, finely papillose. Specimens seen from Cass, Harrison, Jefferson, Kosciusko, Porter, Spencer, and Starke counties.