Studies in Indiana Bryophytes IV

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The mosses used in this study are Indiana collections in herbaria in the following institutions: Indiana University, Butler University, DePauw University, University of Illinois, and Earlham College; and the personal herbaria of Charles C. Deam, J. P. Naylor, and the author. The collections presented to the author by Charles C. Deam, Ralph M. Kriebel, William D. Gray, Earl L. Harger, Jr., and Frederick H. Test have contributed to the range of distribution.

The nomenclature is that of A. J. Grout, *The Moss Flora of North America North of Mexico* 2: 1-65 (1933) and 106-145 (1935).

Although the families, Grimmiaceae and Orthotrichaceae, do not succeed each other in the manuals on mosses, I am considering them in the same paper because the plants are so similar in appearance that the student of bryophytes frequently finds it necessary to compare various species in these two families to make a correct determination.

The distribution of each species is based largely upon Indiana specimens examined by the author and is shown by the list of counties in which collected. The asterisk preceding the name of a county indicates that the species has been reported from that locality according to published records but not studied by the author.

The asterisk following the name of a species or a variety is an indication that, according to available literature, this is the first published record for Indiana.

I am indebted to Dr. Henry S. Conard and to Dr. George Neville Jones for assistance in determining some of the collections of Grimmia.

The author's collections of bryophytes from May, 1937, to August, 1939, were made with the financial assistance of an Indiana Academy of Science research grant through the American Association for the Advancement of Science, and those since June, 1940, by the aid of a research grant from the Graduate Council of DePauw University. I wish this acknowledgment to express my sincere appreciation of this assistance.

Key

Plants commonly growing upon rocks, blackish-green when dry, almost black below; young tips of stems and branches chlorophyll green; leaves frequently with a hyaline tip which consists of the leaf apex; capsule smooth (in Indiana species); peristome single, teeth 16, erect or spreading, or none ..... *Grimmiaceae*

Plants commonly growing upon trees, blackish or brownish green below; calyptra commonly hairy; capsules usually with very distinct longitudinal ridges when dry and empty; peristome usually double, teeth 16, commonly reflexed when dry, inner peristome of 16 cilia ---------- *Orthotrichaceae*

Grimmiaceae

1. Leaves ecostate, cells with bifurcate papillae, apices large and hyaline ---------- *Hedwigia ciliata*

   Leaves costate ---------- 2

2. Plants in hoary tufts; blades of upper leaves 1.0-1.5 mm. long; hyaline hair point nearly as long as or longer than the blade and decurrent on the leaf apex; walls of upper basal leaf cells not sinuose; seta erect; capsule emergent ---------- *Grimmia laevigata*

   Plants in dark or olive green tufts; blades of upper leaves longer; hyaline hair point not decurrent ---------- 3

3. Blades of upper leaves 1.5-2.0 mm. long; margins narrowly recurved; apices ± obtuse; hyaline hair points usually short (about 0.5 mm.), occasionally longer, frequently absent; capsule immersed ---------- *Grimmia apocarpa*

   Blades of upper leaves 2-3 mm. long, ± canaliculate; hyaline hair points usually longer ---------- 4

4. Leaves lanceolate or narrowly ovate-lanceolate, ± canaliculate, acuminate; hair points about one-fourth the length of the blade; margins strongly recurved in lower half; upper basal leaf cells with thick, sinuose walls; seta erect; capsule immersed ---------- *Grimmia pilifera*

   Leaves linear lanceolate from ovate base, canaliculate-concave; hair points longer; margins plane; upper basal leaf cells usually thin-walled and not sinuose; seta curved; capsule exserted ---------- *Grimmia Olneyi*

Orthotrichaceae

1. Plants with primary stems closely applied to bark, up to 10 cm. or more in length, crowded with short, densely foliated branches; capsule on long seta; peristome scarcely apparent ---------- *Drummondia prorepens*

   Plants erect in rounded tufts and not as above ---------- 2

2. Growing on limestone; upper leaves slenderly acute, margins revolute; lower leaves narrowly obtuse, margins ± plane, frequently bistratose above; capsule immersed to emergent, 8-ribbed, stomata immersed; peristome teeth erect to spreading when dry ---------- *Orthotrichum strangulatum*

   Growing on trees ---------- 3

3. Leaves strongly crisped when dry; capsule exserted; peristome teeth reflexed when dry ..... *Ulota crispa*

   Leaves not crisped when dry; capsule immersed to emergent ... 4

4. Leaf margins usually plane and apices broadly obtuse; calyptra naked; stomata of urn superficial* ..... *Orthotrichum obtusifolium*

   Leaf margins revolute; stomata of urn immersed* 5

* Usually stomata are found here and there in the capsule, about the level of the base of the spore-sac. They may be superficial when the guard cells are entirely in view or immersed when the guard cells are ± hidden by overlapping superficial cells. The type of stomata is quickly determined by separating the urn of a mature capsule from the seta at the base of the neck, splitting it lengthwise, removing the spore sac and spores, and mounting it outer surface upwards.

5. Leaves entire, apices subacute to obtuse; urn strongly 8-ribbed and strongly contracted beneath mouth when dry and empty, reddish brown ..... *Orthotrichum stellatum*

   Leaves (some at least) dentate with projecting cells 6

6. Leaf apices usually acute, some with an apiculus of a single projecting cell; calyptra usually with a few short hairs near apex; urn distinctly 8-ribbed when dry ..... *Orthotrichum pumilum*

   Leaf apices obtuse, some sharply denticulate at apex with several projecting cells; calyptra naked; urn usually not ribbed or only faintly so when dry ..... *Orthotrichum pusillum*

GRIMMIACEAE

Grimmia

G. apocarpa [L.] Hedw. (Figs. 1-3.) Plants variable, usually in small, loose, dark or olive green tufts; stems 1.5-2.5 cm. high; leaves imbricate, 1.5-2.0 mm. long, ovate-lanceolate, margins narrowly recurved, apices ± obtuse; hyaline hair points slightly spinulose, usually short, up to 0.5 mm. or more in length, occasionally reaching ¼ length of leaf, frequently absent; costa distinct, not papillose on back; leaf cells with thick, slightly sinuose walls, upper ones roundish quadrate, 9-10μ in diameter; seta erect; capsule immersed, ovoid-ellipsoid, dark reddish brown, about 1 mm. long, wide mouthed when empty; peristome teeth reddish, papillose, reflexed-revolute when dry and mature; spores reddish, smooth, 8-12μ in diameter, mature spring to summer. On rocks, frequently limestone; Cass, Crawford, Delaware, Fountain, Harrison, Henry, Jasper, Jefferson, Jennings, Lawrence, Martin, Monroe, Owen, Perry, Putnam, and Warren Counties.

G. laevigata (Brid.) Brid.* (*G. leucophaea* Grev.) (Figs. 4-5.) Plants in loose, flat, fragile, hoary tufts; stems erect, up to 1 cm. high; leaves closely appressed when dry, lower leaves small and muticous, upper leaves gradually larger, ovate-lanceolate, concave, 1.0-1.5 mm. long, hyaline hair point as long as or longer than the rest of the leaf,

All figures (with the exception of 26, 30, and 31) are taken with permission from A. J. Grout, Mosses with Hand-lens and Microscope (M.H.M.). Figs. 26, 30, and 31 are copied from Grout, Moss Flora of North America North of Mexico (M.F.). (The figures in parentheses refer to these books.) *Grimmia apocarpa* (M.H.M., pl. 18). Fig. 1. Gametophyte and sporophytes, enlarged. Fig. 2. Apex of upper leaf, enlarged. Fig. 3. Mature urn and periostome, enlarged. *Grimmia laevigata* (M.H.M., fig. 57). Fig. 4. Leaf, enlarged. Fig. 5. Apex of leaf, enlarged.

usually strongly spinulose, flattened at the base and decurrent on the leaf apex; costa weak, flat; upper leaf cells thick-walled, roundish-quadrate, 6-9μ in diameter, basal cells quadrate, walls thin and not sinuose; perichaetial leaves larger, with longer hair points; seta erect; capsule emergent, ovoid or ellipsoid, reddish brown, narrow at the mouth; peristome teeth reddish, papillose; spores yellow, smooth, 12-16μ in diameter, mature in spring. On dry rocks, usually non-calcareous; Parke and Warren Counties.

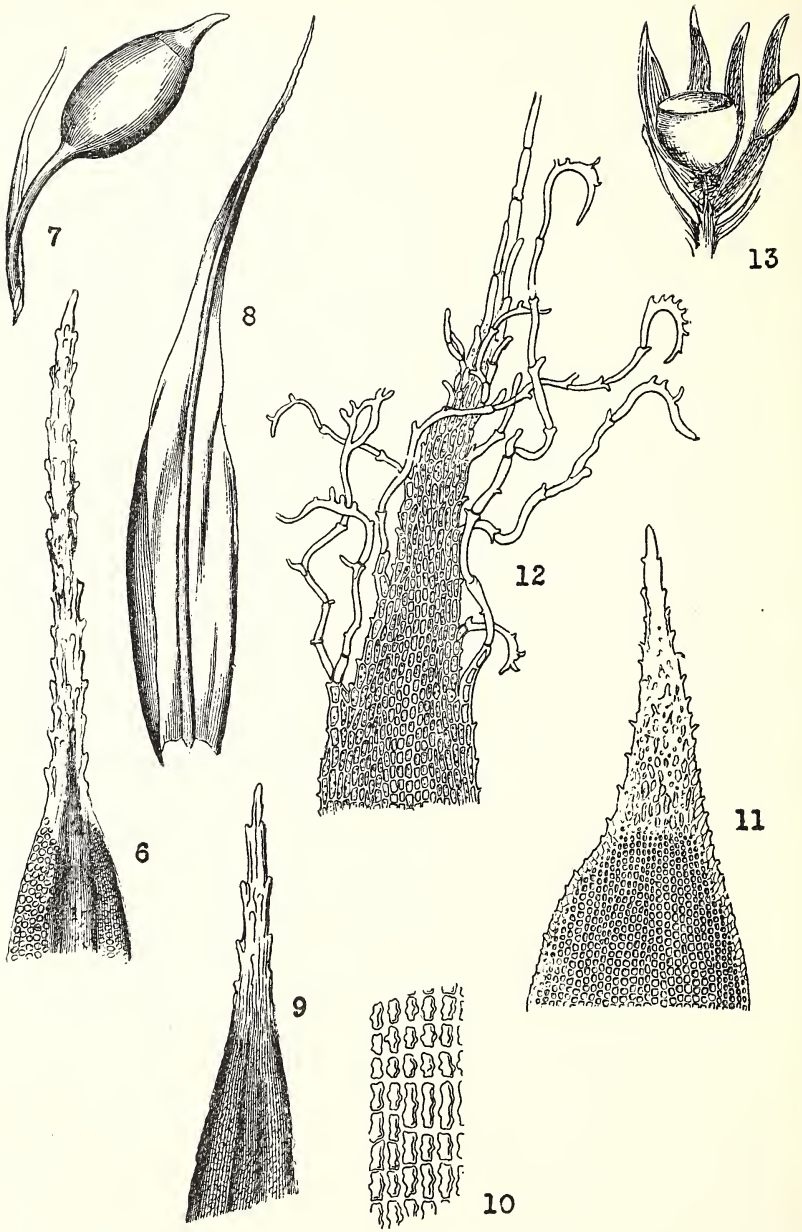
G. Olneyi Sull.* (Figs. 6-7.) Plants in dark green tufts, blackish below; stems about 2 cm. high; leaves linear-lanceolate from an ovate base, 2-3 mm. long, canaliculate-concave, the upper ending in a long, spinulose, hyaline hair point; margins plane; upper and median leaf cells densely opaque, 6-9μ in diameter, walls not sinuose; basal cells usually thin-walled and not sinuose; costa obscure in upper part of leaf; seta curved, longer than the capsule; capsules exserted, ellipsoid or ovoid, yellowish green; spores mature in early spring. On non-calcareous rocks; Perry and Warren Counties.

G. pilifera Beauv. (*G. pensilvanica* Schwaegr.) (Figs. 8-10.) Plants in dense, coarse, dark green tufts; stems 1-3 cm. high; leaves loosely imbricate when dry, lower leaves small, muticous, upper leaves 2-3 mm. long, lanceolate or narrowly ovate-lanceolate, ± canaliculate, acuminate, with short spinulose hair points, about one-fourth the length of the blade; costa strong, percurrent; margins strongly recurved in lower half of leaf, thickened in upper half; median and upper leaf cells opaque, with thick, sinuose walls, roundish or hexagonal, 6-9μ in diameter, upper basal leaf cells with thick, sinuose walls; perichaetial leaves longer, with longer hair points; seta erect; capsule immersed, ellipsoid; peristome teeth 2-3 cleft; spores mature in autumn or winter. On dry rocks; Parke and *Wayne Counties.

Grimmia conferta Funck, now *G. apocarpa* [L.] Hedw., var. *conferta* (Funck) Spreng., is included in the list of mosses which Mrs. Mary P. Haines collected in Wayne county, Indiana, published in Annual Report of Geological Survey of Indiana, pp. 235-239, in 1879. In a list of the Indiana Mosses, collected by Mrs. Haines, prepared for me by Dr. Seville Flowers, who is in possession of the Haines Herbarium and who has carefully checked the plants, the only Grimmia included is *G. pensilvanica* Schwaegr., now *G. pilifera* Beauv.

Hedwigia

H. ciliata [Ehrh.] Hedw. (*H. albicans* (Web.) Lindb.) (Figs. 11-13.) Plants in loose, grayish green patches; stems spreading, irregularly branched, 2-10 cm. long; leaves imbricate, ecostate, ovate, papillose, 1.5-3.0 mm. long, apex ± hyaline, papillose-denticulate to ciliate, margins revolute; perichaetial leaves ciliate at apex; capsule immersed, concealed by perichaetial leaves, erect, ovoid to globose, wide-mouthed when empty; peristome none; spores yellowish, 25-32μ in diameter,



Grimmia Olneyi (M.H.M., pl. 19). Fig. 6. Apex of leaf, enlarged. Fig. 7. Sporophyte, enlarged. *Grimmia pilifera* (M.H.M., pl. 20). Fig. 8. Leaf, enlarged. Fig. 9. Apex of leaf, enlarged. Fig. 10. Upper basal leaf cells, enlarged, showing thick, sinuose walls. *Hedwigia ciliata* (M.H.M., figs. 50 and 51). Fig. 11. Apex of leaf, enlarged. Fig. 12. Apex of perichaetial leaf, enlarged. Fig. 13. Urn and several perichaetial leaves, x 10.

mature in spring. On rock, rarely limestone; Carroll, Cass, Delaware, Dubois, Fountain, Grant, Henry, Jasper, Jefferson, Laporte, Madison, Marion, Martin, Monroe, Montgomery, Noble, Parke, Perry, Putnam, Steuben, Warren, and Wayne Counties.

ORTHOTRICHACEAE

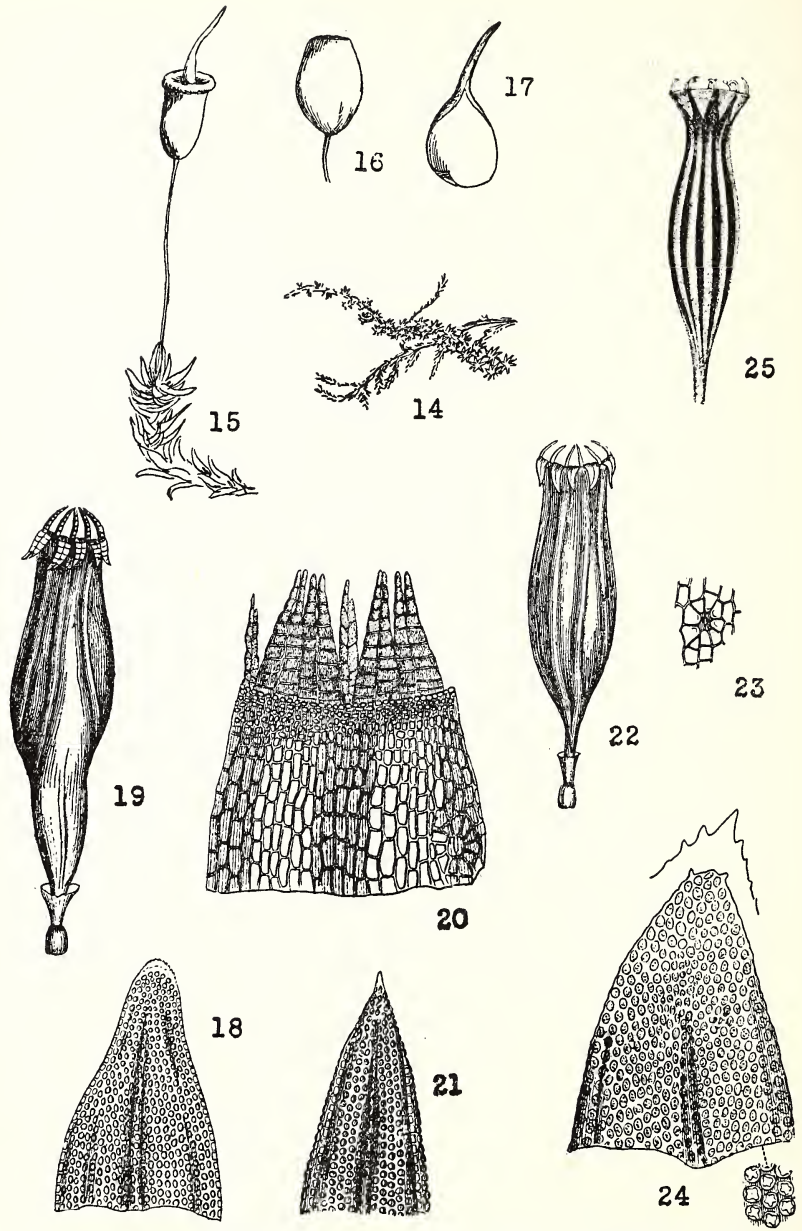
Drummondia

D. prorepens (Hedw.) Jennings. (Figs. 14-17.) Plants in thin, dark green mats; primary stems closely applied to bark, apparent only upon removal from tree, up to 10 cm. or more in length, producing numerous, close, short (2-10 mm. in length), densely foliated branches; leaves closely appressed when dry, erect-spreading when moist, ovate-lanceolate, acute to narrowly obtuse, 1-2 mm. long; calyptra conic, cucullate, without hairs; seta erect, 2-3 mm. long; capsule erect, ovoid-globose, 1.0-1.3 mm. long; operculum conic-rostrate with a long oblique beak; peristome short and truncate, scarcely apparent, teeth 16, smooth; spores 60-90μ in diameter, mature in spring. On bark of trees; Decatur, *Hamilton, Jefferson, Jennings, Monroe, Montgomery, Putnam, *Tippecanoe, and Wayne Counties.

Orthotrichum

O. obtusifolium [Schrad.] Brid.* (Figs. 18-20.) Plants in small, dense tufts, light green to yellow-green; stems about 1 cm. high; leaves closely imbricate when dry, up to 2.5 mm. long, ovate to oblong-lingulate, concave, margins plane, rarely slightly involute; apex commonly broadly obtuse, occasionally narrowly obtuse to subacute; costa ending below apex; median and upper leaf cells papillose on both surfaces; upper cells rounded, about 12μ wide; calyptra naked; capsule immersed or emergent, ovoid to elongate-pyriform, with neck as long as spore case, 8-ribbed and contracted beneath mouth when dry; stomata of urn superficial; peristome teeth 16, reddish, densely and finely papillose, reflexed when dry; spores finely roughened, mature in spring. On bark of deciduous trees; Cass, Dubois, Henry, Jefferson, Jennings, Monroe, Owen, and Putnam Counties.

O. pumilum Dicks. (*O. Schimperi* Hamm.; *O. fallax* Schimp.) (Figs. 21-23.) Plants in dark green tufts; stems up to 1 cm. high; leaves oblong-lanceolate, about 2 mm. long, imbricate when dry; acute to narrowly obtuse, often apiculate with usually a single subhyaline cell at apex; margins revolute nearly to apex; upper leaf cells large, 12-16μ in diameter, with thin walls, slightly collenchymatous, papillose; costa ending below apex; calyptra usually with a few short hairs near apex but occasionally naked; capsule usually light colored, immersed or slightly emergent, up to 1.5 mm. long, oblong or oblong-ovoid, 8-ribbed and contracted beneath mouth when dry; stomata of urn immersed; peristome teeth 16, finely papillose, reflexed when dry; spores mature in spring. On trees; Cass, Delaware, Harrison, Jasper, Jefferson, Law-



Drummondia prorepens (M.H.M., fig. 83). Fig. 14. Plants, x 1. Fig. 15. Gametophyte and sporophyte, x 10. Fig. 16. Mature capsule, x 10. Fig. 17. Cucullate calyptra, x 10. *Orthotrichum obtusifolium* (M.H.M., fig. 91). Fig. 18. Leaf apex, enlarged. Fig. 19. Mature urn and peristome, enlarged. Fig. 20. Portion of peristome, enlarged, showing superficial stomatal apparatus. *Orthotrichum pumilum* (M.H.M., fig. 89). Fig. 21. Leaf apex, enlarged, showing apiculus. Fig. 22. Mature urn and peristome, enlarged. Fig. 23. Immersed stomatal apparatus, enlarged, (from M.H.M., fig. 87). *Orthotrichum pusillum* (M.H.M., fig. 90). Fig. 24. Leaf apex, enlarged, showing denticulate apex and thick-walled median cells. *Orthotrichum stellatum* (M.H.M., fig. 88). Fig. 25. Mature urn and peristome, enlarged.

rence, Marion, *Monroe, Noble, Owen, Pulaski, Putnam, Scott, Steuben, Warren, Wayne, and Whitley Counties.

O. pusillum Mitt.* (Fig. 24.) Plants blackish-green, small; stems up to 5 mm. high; leaves obolong-lanceolate to oblong-lingulate, 1.5-2.5 mm. long, narrowly to broadly obtuse, some or all denticulate at apex with several projecting cells; margins strongly revolute; upper leaf cells irregularly rounded, thick-walled, approximately 15μ in diameter, papillose; calyptra naked; capsule immersed or nearly so, subglobose to ovoid, almost sessile on a very short seta, urn usually not ribbed or only faintly so when very old and dry, whitish, about 1.6 mm. long; stomata immersed; peristome teeth 16, densely and coarsely papillose, reflexed when dry; spores about 15μ in diameter, mature in early spring. On trees; Harrison, Jasper, Jefferson, Posey, and Putnam Counties.

O. stellatum Brid. (*O. strangulatum* Sull.; *O. Braunii* B. & S.) (Fig. 25.) Plants in small, dense cushions; stems up to 1 cm. high; leaves appressed-imbricate when dry, lanceolate, approximately 2 mm. long; apices subacute to obtuse; margins revolute nearly to base and apex or only in the middle; costa ending just below apex; upper leaf cells irregular, isodiametric to slightly elongated, 10-13μ in diameter, papillose, thick-walled; basal cells quadrate to short-rectangular with $\pm$ rounded corners; calyptra naked and strongly plicate; capsule obovoid-pyriform, immersed to emergent, 1.0-1.5 mm. long, $\pm$ abruptly contracted to short seta, strongly 8-ribbed and strongly contracted beneath mouth when dry and empty, dark colored, reddish brown; stomata immersed; peristome teeth 16, in pairs, reflexed when dry, pale yellow, finely papillose; spores 10-13μ in diameter, mature in late spring. On trees; Carroll, Jefferson, Monroe, Morgan, Putnam, Steuben, and Wayne Counties.

O. strangulatum Schwaegr. (*O. Porteri* Aust.; *O. Peckii* Aust.) (Fig. 26.) Plants in dense mats, blackish except young tips; stems up to 1 cm. in height; leaves closely imbricate when dry, ovate-lanceolate to oblong-lanceolate, 1.7-2.5 mm. long, upper leaves commonly slenderly acute with revolute margins, some of the lower leaves $\pm$ plane margined and narrowly obtuse, frequently bistratose on margins above; upper leaf cells in a single layer, 10-15μ in diameter, thick-walled; costa strong, reaching nearly to apex, occasionally percurrent; calyptra hairy with papillose hairs; capsule typically subcylindric, immersed to emergent, about one-half emergent when dry, 8-ribbed, approximately 1.5 mm. long, gradually tapering to seta; peristome usually simple, teeth 16, erect to spreading when dry, papillose; stomata immersed; spores mature in spring. On limestone; Cass, Jefferson, Jennings, Kosciusko, Lawrence, Monroe, Owen, Parke, and Putnam Counties.

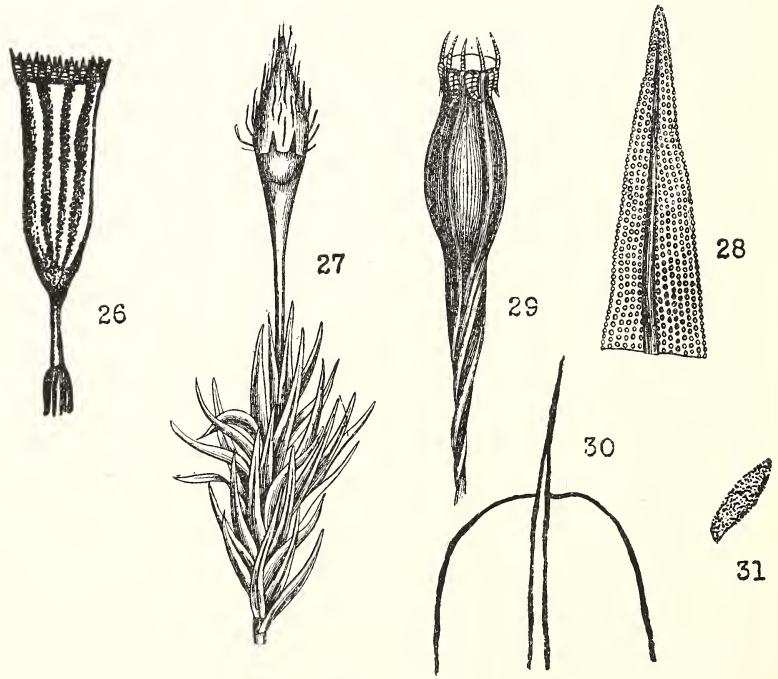
The collections determined as *Orthotrichum anomalum* Hedw. and Zygodon sp., in Glenn and Welch, Ecological relationships of the most common mosses in a certain vicinity near Bloomington, Indiana, (Proc. Ind. Acad. Sci. 40:87-101, 1931) consist of sterile plants. Since in the absence of the capsules it is difficult to make accurate determinations

in these genera and since no other reports or collections of these plants in the state are available, I am omitting them from this paper.

In F. L. Pickett, Some mosses from Monroe County, Indiana, (The Bryologist 18:33-34, 1915) both *Orthotrichum Lescurii* Aust. and *O. Porteri* Aust. are reported for the same collection of plants. I consider the material to be *O. strangulatum* Schw.

Ulota

U. crispa (Hedw.) Brid.* (Figs. 27-29.) Plants in small, dense tufts, yellowish-green above, brown below; stems 5-10 mm. long; leaves strongly crisped when dry, 2-3 mm. long, acute to narrowly obtuse at apex, rather strongly papillose above; margins plane; calyptra hairy; seta 1-2 mm. long; capsule exserted, neck slender, longer than spore sac, urn striate, contracted under mouth when dry and empty, abruptly contracted to the shrunken, wrinkled neck, 8-ribbed; peristome teeth 16, finely papillose, reflexed when dry; spores finely papillose, up to 22μ in diameter, maturing late spring to early summer. On rough bark of deciduous trees; Jefferson County.



Orthotrichum strangulatum (M.F. 2: pl. 53). Fig. 26. Mature urn and peristome, x 20. *Ulota crispa* (M.H.M., pl. 38). Fig. 27. Gametophyte and sporophyte, enlarged. Fig. 28. Upper portion of leaf, enlarged. Fig. 29. Mature urn and peristome, enlarged. *Tortula pagorum* (M.F. 1: pl. 114). Fig. 30. Outline of leaf apex, x 80. Fig. 31. Propagula, x 60.

Note concerning **Tortula pagorum** (Milde) DeNot.

In the Proceedings of the Indiana Academy of Science 50:63 (1941) was published the first known report of the genus and species of *Tortula ruralis* for the state, collected by the author in Porter county. During the examination of the Orthotrichum material for the present paper I found plants of *Tortula pagorum* in four collections which I had made in Hanover, Indiana, Jefferson County, in July, 1937. Three of these collections were taken in the lawn of the long-time home of the late Prof. A. H. Young and one from the Presbyterian Church lawn. This find is of interest not only because it is the first report for Indiana but also because the general range of this species in North America is southern.

Tortula pagorum (Milde) DeNot.* (Figs. 30-31.) Plants densely caespitose in mats or cushions, very fragile, dark green when dry; stems usually up to 5 mm. high, sometimes up to 10 mm.; leaves mostly in a terminal rosette, often slightly twisted when dry, erect-spreading when moist, obovate, concave above, 2.0-2.5 mm. long (blade and awn), apex rounded or truncate; leaf margin plane, rarely involute, strongly papillose-crenulate; costa smooth on the back, excurrent as a smooth (occasionally slightly roughened) awn about 1 mm. long; upper leaf cells roundish-quadrate to hexagonal, papillose with numerous crescent-shaped or circular papillae; leaf-like propagula occur at apex of stem and in axils of upper leaves. On trunks of living trees, rarely on rocks; Jefferson County.

Growing on trees; plants up to 10 mm. high; leaves 2.0-2.5 mm. long including awn; costa smooth on back; awn ± smooth, 1 mm. long ---------- *Tortula pagorum*

Growing on rocks or soil; plants 2-8 cm. high; leaves 3-7 mm. long including awn; costa densely spinose-papillose on back; awn serrate, 1-3 mm. long ---------- *Tortula ruralis*

Note concerning **Fissidens closteri** Austin*

Fissidens closteri Austin was collected in fruit by Mrs. Betty Wilson Higinbotham in Floyd County, Indiana, five miles from New Albany. It was growing on stone on the side of a very steep ravine in an oak and pine woods. Mrs. Higinbotham referred the material to Dr. A. J. Grout for determination. Dr. Grout commented that this is the first report west of the Hudson Valley and the third known locality for *F. closteri.* (Mrs. Higinbotham kindly sent me this information in a letter, January 16, 1941.)

Fissidens closteri is distinguished from other species of terrestrial, Indiana Fissidens by plants minute, up to 0.5 mm. high, and almost stemless; leaves 2-3 pairs, the lower leaves ovate, the upper lanceolate from an ovate base, 0.4-0.6 mm. long, and none bordered with a band of narrow, elongated, colorless cells. In crevices of decomposing rocks; Floyd County.