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Errata

Page 18, the comma at the end of line 7 belongs at the end of line 6, and the period at the end of line 8 belongs at the end of line 7.

Page 87, line 32, for *Harvardii* read *Havardi.*

Page 88, line 36, for *Clathorix* read *Cladothrix.*

Page 215, line 10, for **innovota** read **innovata.**

Page 288, line 15, for "urspünglich." read "ursprünglich."

Page 347, line 18, for "Blowing Rock" read "Flat Rock."

Page 569, lines 33 and 37, for *E.* read *G.*

The most important errors in the *Index to American botanical literature* which have been noted are the following :

Abrams, L. R. Flora of Los Angeles, etc. In the note, for "following" read "flowering" (page 231).

Barrett, O. W. Correction and comment. The date should be 1904 instead of 1902 (page 232).

Eaton, A. A. A preliminary list of *Pteridophyta*, etc. For "Dead County" read "Dade County" (page 362).

Emerson, J. T. Initials incorrectly given as **J. E.** (page 618).

Parlin, J. C. Some causal elements, etc. For "causal" read "casual" (page 519).

Pierre, L. Incorrectly spelled **Peirre** (page 413).

Sheldon, E. P. The forest wealth of Oregon. For "1–52" read "1–32" (page 580).

VOL. 31 JANUARY, 1904 NO. 1

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LANCASTER, PA.

THE TORREY BOTANICAL CLUB

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PUBLICATIONS

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Preliminary Catalogue of Anthophyta and Pteridophyta within 100 miles of New York City, 1888. Price, $1.00.

VOL. 31 No 1.

BULLETIN

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TORREY BOTANICAL CLUB

JANUARY, 1904

New species of Uredineae — III.

J. C. ARTHUR

The following sixteen species of rusts have been detected among material sent for identification, in large part submitted by Professor F. S. Earle, curator of fungi of the New York Botanical Garden. I am also directly indebted for material to E. W. D. Holway, C. V. Piper, J. M. Bates and E. Bartholomew and indirectly to Messrs. Heller, Baker, Tracy, Goodding, Craig, Underwood and Griggs. Two thirds of the species are trans-Mississippian, and the remainder from Porto Rico. It is worthy of special note that, with the exception possibly of four species at the most, the descriptions here given are incomplete, as they include but one or two out of the possible three, four, or even more spore-forms. It should be the endeavor of those botanists, who are privileged to collect in the regions where these species abound, to secure the remaining spore-forms in order that the descriptions may be completed.

Uromyces Pavoniae sp. nov.

III. Teleutosori hypophyllous, round, crowded in circinating groups, 1–3 mm. across, compact, early naked, pulvinate, chestnut-brown; teleutospores obovate-globose, 18–20 by 23–28 μ, rounded at both ends; wall medium thick, 2–3 μ, thicker above, 4–7 μ, smooth, chestnut-brown; pedicel slender, colorless, once to twice length of spore.

On *Pavonia racemosa* L., between Mayaguez and Joyua, Porto Rico, June 14 to July 22, 1901, *L. M. Underwood, no. 193*. The species belongs to the section *Lepto-Uromyces*, as the spores germinate in the sorus.

[The preceding number of the BULLETIN, Vol. 30, No. 12, for December, 1903 (30: i-vi, 641–709, *pl. 29, 30*), was issued 5 D 1903.]

Uromyces Hellerianus sp. nov.

O, I. Spermogonia and aecidia unknown.

II. Uredosori hypophyllous, round, early naked, pulverulent, light chestnut-brown, encircling epidermis inconspicuous; uredospores globose, sometimes triangular-globose, 20–26 μ in diameter; wall thin, 1.5–2 μ, cinnamon-brown, pores 2 or 3, scattered.

III. Teleutosori hypophyllous, round, early naked, pulverulent, dark chestnut-brown, encircling epidermis inconspicuous; teleutospores globoid to ovoid, 21–24 by 27–36 μ, rounded at both ends; wall smooth, chestnut-brown, thick, 3 μ, apex with a prominent, hyaline umbo, 7–11 μ; pedicel less than half length of spore, delicate, colorless.

On *Cayaponia racemosa* (Sw.) Cogn., Adjuntas road five miles from Ponce, Porto Rico, December 4, 1902, *A. A. Heller, no. 6206.* Differs from *Uromyces Cayaponiae* P. Henn. especially in having smooth teleutospores with a large umbo.

Puccinia Canadensis sp. nov.

III. Teleutosori amphigenous, somewhat gregarious, pustular, coalescing, soon naked, pulverulent, chestnut-brown, remains of the membranous epidermis conspicuous; teleutospores narrowly elliptical or linear-oblong, 10–15 by 37–58 μ, obtuse at both ends; wall thin, 1–2 μ, cinnamon-brown, minutely rugose, hyaline and thicker at apex, 3–5 μ; pedicel delicate, very short, colorless, partially deciduous.

On *Viola orbiculata* Geyer (type), Laggan, Alberta, August 23, 1902, and Glacier, British Columbia, September 3, 1902; both collections by *E. W. D. Holway.* Hosts determined by Edward L. Greene. This species is the American representative of the European *P. alpina*, and like it belongs to the section *Micropuccinia.* It differs in having paler and more slender spores, with more irregular sculpturing, which is so minute that it can scarcely be detected except when dry.

In July, 1901, the writer with Mr. Holway published a paper in the *Minnesota Botanical Studies* on the violet rusts of North America, in which *Aecidium pedatum* (Schw.) Arth., *Puccinia Violae* (Schum.) DC. and *P. effusa* D. & H., the then known species, were fully described. Since that time Mr. Holway has not only collected the above additional species, but has also found *P. Fergussoni* B. & Br. on *Viola Langsdorfii* Fisch., at Glacier, B. C., August 10, 1901.

Puccinia Parnassiae sp. nov.

III. Teleutosori amphigenous, somewhat gregarious, pustular, coalescing, soon naked, pulverulent, chocolate-brown, membranous epidermis conspicuous; teleutospores elliptical, 16–20 by 30–37 μ, rounded or obtuse at both ends; wall uniformly thin, 1–2 μ, chestnut-brown, smooth or obscurely punctate above, sometimes with slight hyaline umbo at apex; pedicel colorless, half the length of spore or less, appearing shorter by being partially deciduous.

On *Parnassia fimbriata* Banks, Banff, Alberta, August 16, 1902 (type), *E. W. D. Holway.* Also on same host at Silver Lake, Utah, 9,000 ft. alt., August 15, 1903, *A. O. Garrett, no. 288.* The species apparently possesses no uredo, as no trace of uredospores could be found even in the teleutosori. It may belong to the section *Micropuccinia.* A species of *Uromyces* occurs on *Parnassia* in Europe and a heteroecismal *Aecidium,* but no *Puccinia.* The *Uredo Parnassiae* West. of Belgium, said to be on *Parnassia palustris,* is shown by Lagerheim to be an error for *Uromyces Valerianae.*

Puccinia Sieversiae sp. nov.

III. Teleutosori amphigenous, but more beneath, scattered, round or oval, at first bullate and covered by the thin epidermis, soon naked, pulverulent, chestnut-brown; teleutospores elliptical or obovate-oblong, 20–26 by 32–40 μ, rounded at both ends or somewhat narrowed below, slightly or not constricted at the septum; wall obscurely rugose, appearing smooth, cinnamon-brown, medium thick, 1.5–2.5 μ, thicker above, 4–6 μ, sometimes with semi-hyaline umbo; pedicel short, half length of spore or less, delicate, nearly colorless.

On *Sieversia turbinata* (Rydb.) Greene, Fish Lake, Uintah Mts., Utah, July 17, 1902, *Leslie N. Goodding, no. 1377.* The species is one of the very few belonging to this genus occurring upon the *Rosaceae.*

Puccinia Bakeriana sp. nov.

II. Uredosori hypophyllous, round, early naked, pulverulent, cinnamon-brown; uredospores large, globose, or obovoid, 34–42 by 39–45 μ; wall light honey-yellow, thick, 4–6 μ at sides, 12 μ at apex, closely and coarsely tuberculate, pores large, three, approximately equatorial; contents orange when fresh, segregated.

III. Teleutosori hypophyllous, scattered, round, early naked, pulverulent, chocolate-brown; teleutospores ellipsoid, sometimes obovate-oblong, irregular, 24–32 by 40–55 μ, rounded at both ends, slightly or not constricted at the septum; wall uniformly medium thick, 2.5–3 μ, noticeably and closely tuberculate, chocolate-brown; pedicel short, colorless, incompletely deciduous.

On *Heracleum lanatum* Michx., Pillar Point, San Mateo County, California, October 1, 1902, *C. F. Baker, no. 1735.*

Puccinia Diplachnis sp. nov.

II. Uredospores in the teleutosori broadly ellipsoid or nearly globose, 19–21 by 24–26 μ; wall colorless, thick, 3 μ, closely and finely verrucose, pores apparently 4, equatorial.

III. Teleutosori chiefly hypophyllous, oblong or linear, soon naked, pulvinate, prominent, compact, blackish-brown; teleutospores ellipsoid, 20–24 by 32–39 μ, slightly or not contracted at the septum, rounded or obtuse at both ends; wall smooth, medium thick, 1.5–2.5 μ, thicker at the apex, 3–7 μ, chestnut-brown; pedicel tinted next the spore, one to two and a half times length of the spore.

On *Diplachne dubia* Benth., Big Springs, Texas, October 13, 1902, *S. M. Tracy, no. 8270.* The description of the uredo stage is incomplete, as no separate sori were seen. It is probable that the rust on *Diplachne serotina* of Germany is the same species, judging from Sydow, *Uredineen, no. 414*, although both the uredo and teleutospores are a little larger than in the American specimen. The species differs materially from *Puccinia australis* Körn. on *Molinia*, which has its aecidum on *Sedum*. In *P. australis* the teleutosori and spores are lighter colored, and the uredospores have thicker, deep golden yellow walls, with coarser sculpturing.

Puccinia Helianthellae sp. nov.

II. Uredosori amphigenous, scattered, round, soon naked, pulverulent, chestnut-brown; uredospores globose, large, 25–32 μ in diameter; wall chestnut-brown, thick, 3 μ, finely and sparingly echinulate with blunt points, pores 2, equatorial and opposite.

III. Teleutosori amphigenous, scattered, round, soon naked, pulverulent, chestnut-brown; teleutospores ellipsoid, or obovate-oblong, 20–26 by 30–40 μ, rounded or obtuse at both ends, slightly or not constricted at the septum; wall smooth, chestnut-brown, medium thick, 2–2.5 μ, sometimes slightly thicker at apex, 2.5–4 μ; pedicel colorless, delicate, often as long as the spore, imperfectly fugacious.

On *Helianthella Nevadensis* Greene, Nevada County, California, July 31, 1903, *A. A. Heller, no. 7072.* An easily recognizable species on account of its large, thick-walled uredospores, which are of the same shade of brown as the teleutospores. It is probable that *Aecidium Helianthellae* Arth. (Bull. N. Y. Bot. Gard. **2**: 348), found in Wyoming, is an early stage of this species, but no direct proof is at hand.

Ravenelia Caesalpiniae sp. nov.

O. Spermogonia chiefly epiphyllous, arising beneath the cuticle, crowded in small groups, depressed, 15–18 μ high by 60–100 μ broad, golden yellow, becoming brownish.

II. Uredosori chiefly hypophyllous, arising beneath the cuticle, at first in small groups circinating about the spermogonia, finally irregularly scattered, roundish or oblong, at first yellowish, afterward ochraceous, ruptured cuticle noticeable; uredospores obovate-cuneate, 16–23 by 28–35 μ; wall thin, 1.5–2 μ, sometimes slightly thicker above, 1.5–3 μ, chestnut-brown, often paler and almost hyaline below, nearly or entirely smooth above, prominently and evenly echinulate below, pores 4, a little above the middle; paraphyses of the periphery clavate, nearly colorless, wall uniformly thin, 1–1.5 μ, paraphyses intermixed with the spores numerous, capitate, slightly tinted above, head globose with very thick wall, pedicel solid.

III. Teleutospores unknown.

On *Caesalpinia* sp., near Bayamon, Porto Rico, June 14–July 22, 1901, *L. M. Underwood* and *R. F. Griggs, no. 879.*

Ravenelia Portoricensis sp. nov.

II. Uredosori amphigenous, in circinating groups about 3 mm. across, subepidermal, soon naked, pulverulent, fulvous, encircling epidermis noticeable; uredospores elliptical, 16–18 by 24–29 μ; wall medium thick, 2.5 μ, golden yellow, thickly echinulate, pores 8, scattered; paraphyses none.

III. Teleutospores unknown.

On *Cassia emarginata* L., Ponce, Porto Rico, December 3, 1902, *A. A. Heller, no. 6193.*

Uredo superior sp. nov.

II. Uredosori amphigenous, elongated, tectate, spores escaping through slits in the epidermis; uredospores globoid, 28–34 by 32–34 μ; wall thick, 3–4 μ, light chestnut-brown, thickly echinulate, pores 2, in upper hemisphere.

On *Fimbristylis spadicea* Vahl, borders of low swampy ground along the coast eight miles west of Ponce, Porto Rico, December, 1902, *A. A. Heller, no. 6279*. The spores are very much larger and coarser than those of the *Puccinia* occurring on *Fimbristylis* in Mexico. No teleutospores were found.

Aecidium Onosmodii sp. nov.

O. Spermogonia amphigenous, in very small circular groups, inconspicuous, punctiform, honey-yellow, entirely immersed, subepidermal, seen in vertical section globose, 90–120 μ in diameter; ostiolar filaments 60–80 μ long.

I. Aecidia hypophyllous, is small circular groups, or solitary, small, pustular; peridia delicate, erect or somewhat recurved, margin coarsely lacerate, peridial cells much thicker on outer than on inner side; aecidiospores globoid, 19–23 by 20–29 μ; wall colorless, medium thick, 2–2.5 μ, closely and finely verrucose.

On *Onosmodium molle* Michx. Type collection from Callaway, Nebraska, May 25, 1902, *J. M. Bates*. It has also been reported from Kansas (Bartholomew, Kans. Ured. 180) and North Dakota (Bolley, Agric. Sci. **5**: 263), both on *O. Carolinianum* DC.

Aecidium Mertensiae sp. nov.

O. Spermogonia epiphyllous, in small circular groups, crowded, punctiform, wholly immersed, subepidermal, seen in vertical section, globose, 65–120 μ in diameter; ostiolar filaments 60–90 μ long.

I. Aecidia hypophyllous, in circular groups, crowded, broad and low; peridia spreading, recurved, coarsely lacerate; aecidiospores globoid, 19–26 by 22–28 μ; wall colorless, very thin, 1–2 μ, minutely and closely verrucose, appearing smooth; contents deep orange-yellow.

On *Mertensia paniculata* (Ait.) Don, near Lolo Creek, in the Bitter Root Mountains, Idaho, August 10, 1902, *C. V. Piper*. On *M. Sibirica* (L.) Don, Jefferson Lake, Marion County, Oregon, August, 1892, *Moses Craig*. The former to be taken as the type.

Aecidium malvicola sp. nov.

O. Spermogonia epiphyllous, in groups, punctiform, honey-yellow, immersed, subepidermal, in vertical section globose, 100–125 μ in diameter; ostiolar filaments very numerous, 35–80 μ long.

I. Aecidia hypophyllous, in diffuse circular groups often 10 mm. in diameter; peridia short, cylindrical, margin erect or somewhat revolute, erose; aecidiospores globoid, 14–22 by 16–24 μ; wall colorless, thin, 1.5 μ, minutely and evenly verrucose.

On *Althaea rosea* L. (type), Callaway, Nebraska, July 1, 1902, *J. M. Bates.* On *Malvastrum coccineum* (Pursh) Gray, Wakeeney, Kansas, June 15, 1903, and *Callirrhoe involucrata* (Nutt.) Gray, Rooks County, Kansas, May 31, 1902, *E. Bartholomew.* There are three species of *Aecidium* occurring upon various malvaceous hosts found on the western plains. It is not difficult to distinguish them. *Aecidium tuberculatum* E. & K. has very large aecidial cups of a bright orange color when fresh, *Ae. malvicola* Arth. has average-sized aecidial cups also orange-colored when fresh, and *Ae. Napaeae* A. & H. (of which *Ae. Callirrhoes* E. & K. is a synonym) has slightly smaller aecidial cups which are nearly or quite colorless even when fresh. Beside these, *Ae. roestelioides* E. & E. of Texas has orange-red aecidial cups, the margins of which are slit into long spreading filaments that appear yellow.

Aecidium occidentale sp. nov.

O. Spermogonia amphigenous, in small groups, crowded, rather prominent, honey-yellow, punctiform, wholly immersed, subepidermal, in vertical section globose or somewhat depressed, 110–150 μ in diameter; ostiolar filaments free or somewhat agglutinate, 30–75 μ long.

I. Aecidia hypophyllous, in circular or sometimes elongated groups, rather crowded, broad and low; peridia pale, margin erect, erose; aecidiospores globoid, 18–24 by 23–29 μ; wall medium thick, 2.5–3 μ, colorless, closely and finely verrucose.

On *Clematis Douglasii* Hook., Pullman, Washington, June 2, 1894, *no. 499* (type), and June, 1893, *no. 132, C. V. Piper;* Pullman, Washington, June, 1892, *N. R. Hull;* Moscow, Idaho, May 30, 1897, *L. F. Henderson, no. 4326;* Helena, Montana, June 5, 1889, *F. D. Kelsey.* This species is distinguished from *Ae. Clematidis* DC., which occurs in the same region, by its somewhat smaller and more delicate aecidial cups and spores. The aecidia are also more diffusely grouped, and the spermogonia more prominent. The fungus does not appear to thicken the leaf materially, or produce distortions.

Aecidium recedens sp. nov.

O. Spermogonia amphigenous, few, in small circular groups, punctiform, honey-yellow, wholly immersed, subepidermal, in vertical section globose, 90–110 μ in diameter; ostiolar filaments 45 μ long.

I. Aecidia amphigenous, in restricted circular groups, pustular, constricted by the tissues of the substratum; peridia delicate, evanescent; aecidiospores globoid, 16–23 by 22–29 μ; wall thick, 3 μ, golden-yellow, closely and finely verrucose.

On *Solidago mollis* Bartl., Callaway, Nebraska, June 7, 1902 (type), *J. M. Bates;* Cypress Hills, Assiniboia, *J. Macoun.* The second collection is in the Ellis Herbarium at the New York Botanical Garden, and is erroneously labeled "Aecidium of *Puccinia Columbiensis* E. & E. on *Oenothera biennis.*" It is referred to by Mr. Holway in Jour. Myc. **8**: 171, December, 1902. A part of the same collection is in the National Herbarium at Washington. The species is readily told from the common *Aecidium* on *Solidago* by the evanescent peridium, and by the larger spores, having thick, golden-yellow walls.

PURDUE UNIVERSITY.

Explorations in the coastal plain of Georgia during the season of 1902

Roland M. Harper

My explorations in Georgia in 1902, beginning at Augusta on June 5 and ending near the same place on November 16, were confined to those counties lying wholly or partly in the coastal plain. Notes and collections were made in the counties of Columbia (nos. *1294–1302*, *1310–1314*[*]), Richmond (*1303–1309*, *1315–1321*), Burke, Jefferson, Glascock (*1322–1326*), Washington (*1327–1331*), Johnson (*1332–1347*), Laurens (*1348–1373*), Dodge, Pulaski (*1374–1387*), Wilcox, Dooly (*1712*), Sumter (*1388–1406*, *1713–1731*), Marion (*1407–1410*), Schley (*1411–1413*), Irwin (*1414–1422*, *1702–1704*, *1708–1711*), Coffee (*1423–1463*), Appling, Pierce (*1464–1467*), Ware (*1468–1470*), Charlton (*1471–1516*, *1573–1577*), Wayne, Glynn (*1518–1537*), Camden (*1517*, *1538–1572*), Clinch (*1578–1580*, *1583–1585*), Echols (*1581–1582*), Lowndes (*1586–1615*), Brooks (*1616–1633*), Thomas (*1634–1639*), Colquitt (*1640–1676*), Berrien (*1677–1696*, *1699–1701*, *1705–1707*), Worth (*1697*, *1698*), Lee, Terrell, Randolph (*1732–1745*, *1758–1784*), Quitman (*1746–1757*), Clay (*1786–1793*), Webster, Stewart, Chattahoochee (*1794*, *1795*), Muscogee (*1796–1800*), Talbot, Taylor (*1801–1803*), Crawford (*1804*), Houston, Bibb (*1805–1808*), Jones, Wilkinson and Screven, approximately in the order named. Numbers *1294–1387* were collected in June, *1388–1463* in July, *1464–1585* in August, *1586–1701* in September, *1702–1793* in October, and *1794–1808* in November. One hundred and fifty-two numbers of bryophytes and thallophytes, which do not appear in the foregoing enumeration, were also collected.

My travels by rail within the state covered more than 1500 miles, less than 200 of which were the same as had been traversed the previous season. About 400 photographs of the vegetation and scenery were taken.

Whenever opportunity offered special attention was paid to the

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[*] Numbers of the plants collected.

problem of determining the exact location of the fall-line, or inland boundary of the coastal plain. I ascended the Savannah, Ocmulgee, Flint and Chattahoochee Rivers and Rocky Comfort Creek (the latter in Glascock County) to beyond their intersections with this line, and also followed it pretty closely by rail through the counties of Muscogee and Talbot.

Many of the oldest and largest cities of the Middle and South Atlantic States are situated on this fall-line, which usually marks the head of navigation, and in many cases the greatest water-power, on the rivers which cross it. But botanists who have collected around these cities have almost invariably failed to indicate whether their plants came from the hill country above or the coastal plain below. From a phytogeographical standpoint this is a most serious omission, for the fall-line, throughout its length of hundreds of miles, is (in the words of Dr. McGee *) "one of the most strongly marked physiographic and cultural lines on the surface of the globe," and "the most important structural line of eastern United States." The rather vaguely defined "Austroriparian area" of some botanists — or rather biologists — is practically the coastal plain, and the boundary between that and the "Carolinian area" is simply the fall-line, the cause of which is purely geological, and not climatic.

It should not be inferred, however, that the fall-line is always so sharply defined as to be visible in the field at a single glance. On the contrary it cannot usually be definitely located within a mile or two, except along the larger streams. Nevertheless, it seems to be an impassable barrier for many species of plants ; and the great difference in aspect of the topography and flora on opposite sides of this line is apparent to the most indifferent observer.

A few places of historical or geographical interest visited on this trip will now be mentioned.

In June I spent a week in the vicinity of Augusta, where the most interesting natural feature, to a botanist at least, is the sand-hills, so well known to winter visitors. These are part of a line of sandy elevations which extend along or near the fall-line from

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* Ann. Rep. U. S. Geol. Surv. 12^1: 356, 357. 1891. The introductory portion of this paper is recommended to the careful consideration of the reader.

central North Carolina to western Georgia, with some interruptions. Little is known of the origin and geological history of these fall-line sand-hills, and they deserve further study. Their flora is of course eminently xerophytic, but need not be discussed here.

Augusta was visited in the eighteenth century by Bartram and Michaux, and in the nineteenth by Baldwin, Croom, Leavenworth, Olney, Ravenel, McCarthy, Sargent, Small and other botanists. It is now the home of Mr. A. Cuthbert, the discoverer of several species new to science, with whom I had the pleasure of comparing notes. The influence of Michaux's work in this vicinity is strikingly shown by the fact that of the flora of these particular sand-hills most of the characteristic species and several of the genera were discovered and described by him.

FIG. 1. General view of fall-line sand-hills near Augusta. June 8.

In November I examined other portions of the fall-line sand-hills, in the counties of Talbot, Taylor and Jones. The area in Talbot and Taylor Counties extends about twenty miles east and west and perhaps nearly as far north and south, but is little known.

Here the sand-hills rise to six or seven hundred feet above sea-level and considerably above the adjacent metamorphic hills. They are comparatively level, however, as is well illustrated at Tangent in Taylor County, where the railroad track is straight beyond the horizon in both directions. This region is sparsely settled, and its pine forests still furnish lumber and turpentine in merchantable quantities. The manufacture of turpentine here is of interest because a distance of at least fifty miles, including the whole width of the outcrop of the Eocene formations, intervenes between this and the pine-barren region where the rest of the turpentine of Georgia is now produced.

This western sand-hill area seems to have been first made known to science by Elliott. Bartram, who traversed these counties (or rather the area now included in them) in the summer of 1776, and again the following winter, must have passed just to the north of the sand-hills, for he does not mention them in his *Travels*. Elliott visited them early in the nineteenth century, and discovered there several new species, among them *Chrysopogon secundus*, *Thysanella fimbriata*, *Dicerandra linearifolia* and *Chrysopsis pinifolia*, * all of which I also saw in the same region. Elliott's route was along the "Federal Road," which runs along or near the fall-line and connects the present cities of Macon and Columbus (neither of which existed in Elliott's time).

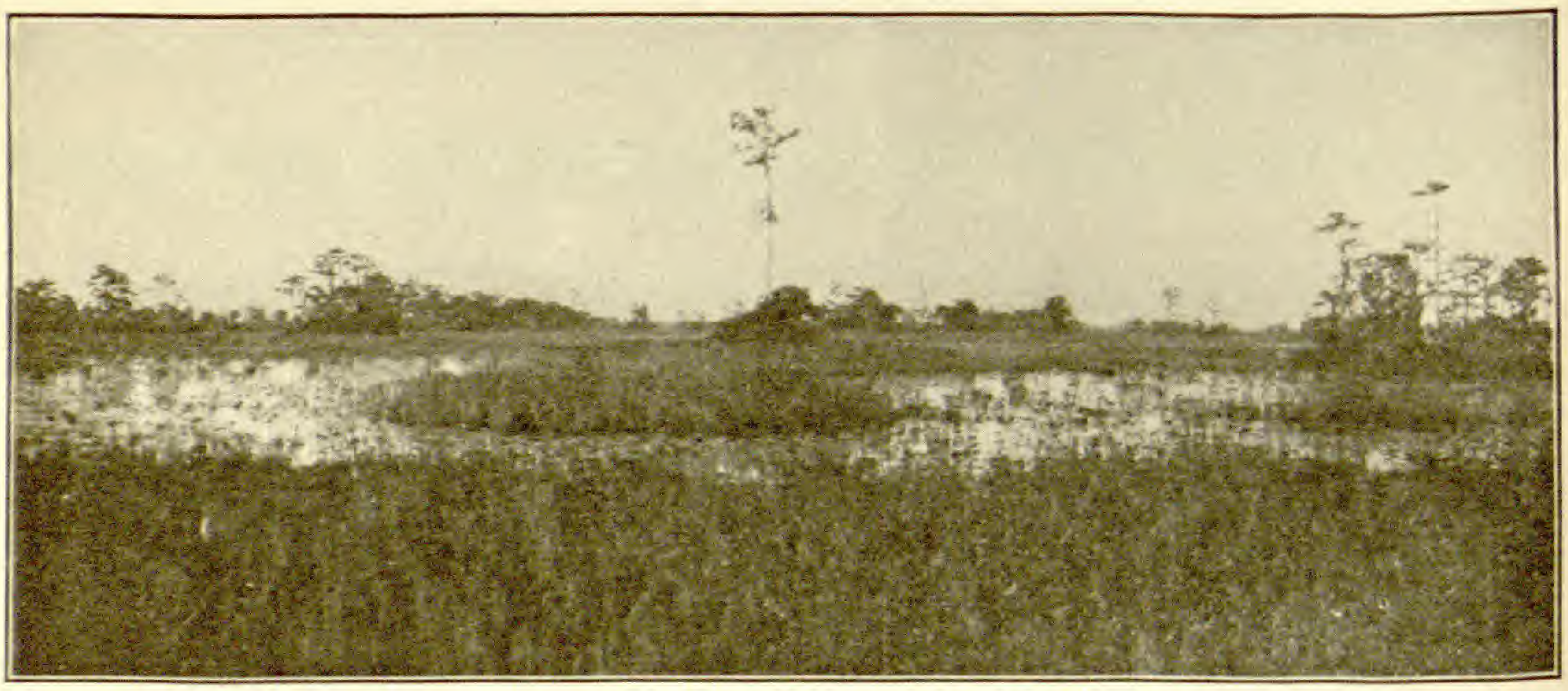

FIG. 2. Open portion of Okefinokee Swamp. August 7.

Since Elliott no botanist seems to have explored these western

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* See Bot. S. C. & Ga. 1 : 580, 583; 2 : 94, 335.

sand hills except the late Dr. Hugh M. Neisler, who lived for many years in Butler, the county-seat of Taylor County, and sent specimens from there (many of which are now preserved in the Torrey Herbarium) to Dr. Torrey. At Reynolds, in the same county, I met a grandson of Dr. Neisler, who took me to another historic spot, the site of the Indian Agency at the crossing of the Federal Road and Flint River, where Dr. Baldwin spent several weeks in the spring of 1812.* The two species which Dr. Baldwin discovered here I was unable to find. But on the river bank just above the Agency (and at or near the fall-line) I saw growing in intimate association *Hydrangea quercifolia* and *Hypericum aureum*, both of which were discovered within a few miles of this place by Bartram in July, 1776, the former east of the river and the latter west. Both were also noted near the Agency by Dr. Baldwin.

In June I explored portions of the sand-hills of the Oconee and Ocmulgee Rivers, opposite Dublin and Hawkinsville respectively. These river sand-hills are probably of a different origin from the fall-line sand-hills, but their flora is similar in composition and almost identical in aspect. Analogous sand-hills occur along the left sides of many other streams in Southeast Georgia, but are rare in Southwest Georgia and seem to be unknown in Alabama.

In August I spent two days (6th to 8th) in Okefinokee Swamp (which is mostly in Charlton County), in company with Mr. P. L. Ricker, of the U. S. Department of Agriculture. Okefinokee Swamp differs materially from the two other great swamps of the eastern United States (Dismal Swamp and the Everglades) in being about 50 miles inland and over 100 feet above sea-level, but it has several features in common with each. No account of the flora of Okefinokee has ever been published, but space will not permit a detailed description here. The swamp, although exceedingly interesting phytogeographically, seemed to contain no endemic species of flowering plants. About 75 species were observed, but this may not be over half the total number in the swamp.

Later in the same month we visited two islands on the neighboring coast, both now favorite summer resorts: St. Simon's, in Glynn County, and Cumberland, in Camden. These islands were

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* See Reliq. Baldw. 58–62 *et seq.*

visited in the eighteenth century by Bartram and Michaux, but seem to have been untouched in the nineteenth by all botanists except Dr. Baldwin, who visited Cumberland occasionally during the few years of his residence at St. Mary's, on the adjacent mainland. Some portions of Cumberland island rise about 50 feet above sea-level, which is higher than most, if not all, of the other islands along the Georgia coast, and probably as high as any part of the mainland of Camden County. The floras of the two islands are remarkably different, considering their proximity to each other and to the mainland.

On September 4 I visited two interesting bodies of water in the southern part of Lowndes County, near Lake Park. Ocean Pond, the larger of the two, is said to be about two miles in diameter, and is probably the largest pond in the state. But, strange to say, for over fifty years it has been represented seven or eight miles from its true position on all maps of the state which show it at all. Its water is quite clear and the shore mostly sandy, like that of Open Pond in Decatur County,* which I visited the summer before. Among other interesting plants seen in Ocean Pond and along its shores were *Sagittaria isoetiformis*, *Hydrochloa fluitans*, *Eriocaulon septangulare* (*no. 1608*), *Lachnocaulon Beyrichianum* (*no. 1607*), *Polygonum hirsutum* (*no. 1609*), and *Nymphaea orbiculata* (*no. 1610*).

FIG. 3. Ocean Pond, Lowndes County. September 4.

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*See Bull. Torrey Club, 30: 290. My 1903.

Long Pond, about a mile away, is about half as large as Ocean Pond. Its water is also clear, but it has no shore (at least on the side examined), being bordered by a fringe of cypress swamp. It is analogous in many ways to Cane Water Pond in Decatur County.* In Long Pond I collected an apparently undescribed species of *Nymphaea* (*no. 1611*). These two ponds, like the two similar ones in Decatur County, are partly surrounded by dry sandy areas characterized by *Eriogonum tomentosum* and other xerophytes.

Toward the end of the same month I revisited the type locality of *Rhynchospora solitaria* and *Baldwinia atropurpurea*, the two species which I discovered in Tifton two years before. The locality (a characteristic area of primeval moist pine barrens) is so near the center of the city that it is in imminent danger of destruction by the encroachments of civilization, but fortunately both species are common enough elsewhere in the same and adjoining counties.

In October I studied portions of Randolph, Clay and Quitman Counties, in the Cretaceous and Eocene regions, making headquarters at Cuthbert for about three weeks. Cuthbert is one of the oldest cities in southwest Georgia, but seems never to have been visited by a traveling botanist before, though there was resident in the city at that time an enthusiastic amateur, Rev. C. H. Hyde, to whom I am indebted for his hospitality and for guiding me to many interesting places in the vicinity.

Cuthbert, though south of latitude 32°, has an elevation of nearly 500 feet and is several miles outside of the pine-barrens, in a region of red hills not unlike some of those in Middle Georgia. *Pinus palustris* seems to be entirely absent from a considerable area (whose limits have not yet been accurately determined) around Cuthbert and extending through several counties, where *P. echinata* takes its place.

On steep shaded hillsides and in rich ravines in this part of the state, where the original forest has not been destroyed, plants of more northern range abound, and I was continually surprised at finding such species as *Adiantum pedatum*, *Phegopteris hexagonoptera*, *Brachyelytrum erectum*, *Vagnera racemosa*, *Polygonatum biflorum*, *Uvularia perfoliata*, *Trillium erectum*, *Pogonia verticillata*

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* See Bull. Torrey Club, 30: 290. My 1903.

(*no. 1762*), *Sanguinaria Canadensis*, *Actaea alba*, *Xanthorrhiza apiifolia*, *Hydrangea arborescens*, *Viola tripartita glaberrima*, *Dirca palustris* (*no. 1790*), *Panax quinquefolium*, *Kalmia latifolia* and *Phryma Leptostachya*, associated with coastal plain types like *Pinus glabra*, *Rhapidophyllum Hystrix* and *Magnolia grandiflora*. Other very interesting plants were found on the banks of the Chattahoochee River near Georgetown (in the Cretaceous region) and Fort Gaines (Eocene).

On October 23, in company with Mr. Hyde, I visited a cave (known as Grier's Cave), in Randolph County, about ten miles north of Cuthbert. Over several acres around this cave a compact limestone of the Midway or Clayton period (lowest Eocene) crops out in huge boulders and ledges, and supports a deciduous forest containing a great variety of herbs as well as trees. The aspect of the place is much like that of the Mountain Limestone area at the north end of Pigeon Mountain in Walker County,* and some species are common to the two places. An interesting feature of the flora of the rocky woods around Grier's Cave is the large number of plants with barbed fruits, adapted for dissemination by animals. Representatives of at least six families with this adaptation were observed.

The following species of more than ordinary interest were collected or observed in 1902:

ADIANTUM PEDATUM L.

Grows luxuriantly on the steep shady north side of a high bluff along Samochechobee Creek in Clay County, where I collected it on October 28 (*no. 1786*). This locality (in latitude 31° 38′) is, I believe, considerably farther south than any other known for this species, and is the only one known in the coastal plain in Georgia and adjacent states.

ADIANTUM CAPILLUS-VENERIS L.

Very abundant on the perpendicular rocky walls (Eocene) of the same creek near its confluence with the Chattahoochee River just above Fort Gaines. Seen also on the bluff of the river itself

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* See Bull. Torrey Club, **28**: 456, 482. 1901.

at Fort Gaines, and just above Georgetown, where I collected it on overhanging Cretaceous rocks on October 16 (*no. 1756*).

ERAGROSTIS AMABILIS (L.) Wight & Arn.; Hook. & Arn. Bot. Beechey, 251. 1841

In the BULLETIN for July, 1902, Scribner and Merrill have reported the occurrence of this Asiatic ornamental grass in Middle Florida. In September I found it quite common as a weed along moist roadsides and railroad ditches in the vicinity of Quitman (*no. 1616*) and Moultrie. There is nothing in its mode of occurrence to suggest its having escaped from cultivation (if indeed it has ever been cultivated in that part of the country) and it seems to be thoroughly naturalized.

ERAGROSTIS SIMPLEX Scribn. Bull. Div. Agrost. U. S. Dept. Agric. No. 7, ed. 3, 250. 1900

"*E. Brownei* Nees" of Chapman and several other authors.

A weed of unknown origin which is common along most railroads in South Georgia, especially in the pine-barren region. Collected in Colquitt County, September 22 (*no. 1656*). Previously reported only from Florida.

FIMBRISTYLIS PERPUSILLA Harper; Small, Fl. S. E. States, 188. 1903

Although this species has already been described, it has several peculiarities which could not be mentioned in the limited space of the original description.

The plant was collected (in flower) on the muddy bottom of a dried-up pine-barren pond near Leslie, Sumter County, on the morning of October 9 (*no. 1729*). It was very abundant, but so small as to be scarcely visible to a person standing up. Its only associates visible to the naked eye were two bryophytes, *Riccia Sullivantii* and *Ephemerum tenerum*, the latter almost microscopic. The vegetative period of the *Fimbristylis* must be very brief and irregular, for the pond in which it grows cannot be expected to dry up at the same time every year, and there may be years in which it does not dry up at all.* In this respect our

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*On July 13, 1903, I revisited the type-locality and found it covered by about three feet of water. No trace of the *Fimbristylis* could be found in several handfuls of mud taken from the bottom.

plant is inversely analogous to some species of *Isoetes* (*I. melanospora* and *I. Orcuttii*, for instance), which grow in shallow depressions on rocks and vegetate only in wet seasons.

Fimbristylis perpusilla is one of the smallest and simplest species of the genus, but it is too different from the other species occurring in the vicinity to be regarded as a depauperate form of any of them and besides the specimens were perfectly healthy and vigorous, *F. autumnalis* sometimes finds its way into pine-barren ponds as they dry up in summer or fall, but in so doing it changes none of its characters. A depauperate form of *F. Frankii* (also associated with a *Riccia*) has been found by Mr. A. A. Eaton on muddy shores of a pond in Kingston and East Kingston, N. H., but it is quite different from my plant.

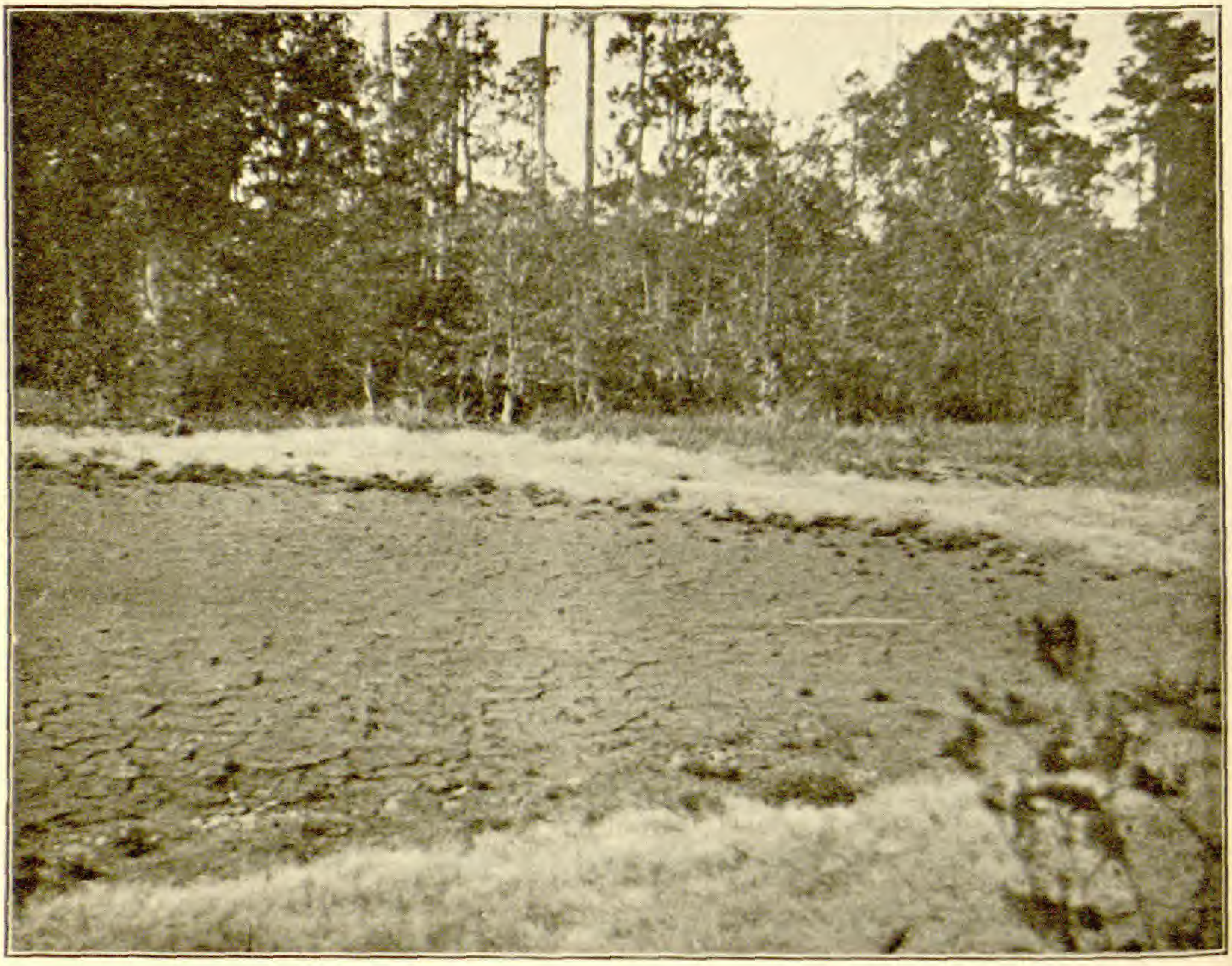

FIG. 4. Type-locality of *Fimbristylis perpusilla*, near Leslie, Sumter County. October 9.

By its floral characters *F. perpusilla* seems nearest related to *F. Vahlii*, but in that species (which is not known in Georgia) the culms are densely tufted and erect or nearly so, and the spikelets are all sessile, while in *F. perpusilla* the culms (8 or 10 to each plant) are prostrate, and of the 3 to 6 spikelets in each umbel some are sessile and some on peduncles 1–4 mm. long. (That part of the original description conflicting with this is erroneous.)

Mr. M. L. Fernald has suggested the resemblance of my plant to *F. dipsacea* (Rottb.) B. & H., an Asiatic species, but this resemblance is probably only accidental. *F. dipsacea* has been treated as the type of a distinct genus (*Echinolytrum* Desv.), on account of some peculiarities of its achenes, which find no parallel in my plant. It should be borne in mind that nearly all the pine-barren plants are endemic species, so that the probability of one of them being identical with an Asiatic species is very small. And there is not the slightest possibility of my plant having been introduced.

RHYNCHOSPORA SOLITARIA Harper, Bull. Torrey Club, 28: 468. 1901

Collected again at the type-locality in Tifton, September 26 (*no. 1677*); also seen in similar situations in Colquitt County a few days earlier and in Irwin County a few days later. Since seeing this species in the field again I can now indicate its affinities with more certainty. It seems nearest related to *R. ciliaris* (Michx.) Mohr (*R. ciliata* Vahl), from which it differs principally in being more slender and glabrous, with longer erect leaves, narrower spikelets and longer perianth bristles, and in its later flowering period. These two species, together with *R. Baldwinii*, seem to form a small natural group. If my view is correct *R. solitaria* is not a near relative of *R. Tracyi* (which is scarcely a true *Rhynchospora*), which it immediately follows in Dr. Small's Flora.

RHAPIDOPHYLLUM HYSTRIX (Pursh) Wendl. & Drude

This, one of the rarest of our palms, I first found in rich shady woods northwest of Cuthbert, on October 21 (*no. 1769*). Here there were only a few specimens, but a few days later I found it more abundant in similar situations along Samochechobee Creek in Clay County.

This species seems to have been previously known in Georgia only from the type-locality, "near the town of Savannah," but I am not aware that any botanist now living has seen it in that part of the state.

LACHNOCAULON BEYRICHIANUM Sporleder; Koernicke, Linnaea, **27**: 597. 1854

In rather dry pine-barrens near the eastern edge of Okefinokee Swamp in Charlton County, August 9 (*no. 1491*); also above high-water mark on the sandy shore of Ocean Pond, Lowndes County, September 4 (*no. 1607*). Previously known in Georgia only from the type-locality, "ad ripas paludum prope Ebenezer," where it was discovered by Beyrich about seventy years ago. Dr. Morong, in his remarks on this species,* erroneously places Ebenezer in Middle Georgia. The original Ebenezer, visited by Beyrich, was on the Savannah River in Effingham County, but is now extinct or nearly so. In later years there have been two or three other Ebenezers in Georgia, and it was probably one of these which misled Dr. Morong.

ERIOCAULON TEXENSE Koernicke, Linnaea, **27**: 594. 1854

Collected on July 2 in flat pine-barrens near Huntington, Sumter County, in a place which was quite dry at the time, but becomes a shallow pond in wet weather (*no. 1395*). Previously known only from Texas. (The reference to Florida under this species in Dr. Small's Flora is an error, probably typographical, Georgia having been intended.) This species is about intermediate in appearance between *E. compressum* and *E. decangulare*, and if it has been seen elsewhere in the East it has probably been mistaken for one of these other species.

TRADESCANTIA COMATA Small

In rich woods on Germain's Island in the Savannah River, Columbia County, 15 or 20 miles above the fall-line, June 7 (*no. 1296*). Altitude about 175 feet. Previously reported only from the mountains.

JUNCUS BRACHYCARPUS Engelm.

In river-bottoms near the same island, collected on the same

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* Bull. Torrey Club, 18: 361, 362. D 1891.

day (*no. 1295*). Very few stations for this in the Southeastern States are known, probably no other in Georgia.

MELANTHIUM DISPERSUM Small

Several specimens collected in a sandy bog in the pine-barrens east of Folkston, Charlton County, in full bloom on the morning of August 12 (*no. 1506*). Previously known only from a single imperfect specimen from Walton County, Florida, collected by A. H. Curtiss in 1885. *M. Virginicum*, its nearest relative, flowers a month or two earlier in Georgia.

UVULARIA FLORIDANA Chapm. (*Oakesiella Floridana* Small)

Not rare, in rich damp woods, Dublin, Laurens County, with full-grown fruit in June (*no. 1363*). Seen in October in similar situations near Cuthbert. The fruit, which has not hitherto been described, furnishes additional characters for distinguishing this species from its congeners. The capsule is always acuminate, tapering into a short beak, instead of being obtuse as in the two related species, *U. puberula* and *U. sessilifolia*. The bracted peduncle mentioned by Chapman, but overlooked by Small, seems to be also a perfectly constant character which is not shared by the other species.

CROOMIA PAUCIFLORA (Nutt.) Torr.

Collected in rich shady woods on the bank of the Chattahoochee River in Quitman County, October 16 (*no. 1757*), with flowers and fruit all gone. This is doubtless the only station in Georgia now known for this rare plant. Its resemblance to *Smilax ecirrhata*, which grows with it, is striking.

SALIX FLORIDANA Chapm.

I refer tentatively to this almost unknown species specimens collected in wet woods at the outer (eastern) base of the sand-hills of the Ocmulgee in Pulaski County below Hawkinsville, June 27 (*no. 1381*). My specimens were slender erect trees about ten feet tall and two inches in diameter, with tasteless bark roughish below and smooth above. The twigs were very brittle not only at the bases but throughout. No trace of fruit was found, but my material, as far as it goes, seems to be a perfect match for the type-specimen in the Torrey Herbarium, collected by Dr. Chapman in West Florida.

QUERCUS MYRTIFOLIA Willd.

Abundant on the driest sand-hills of the Satilla River in Pierce County near Waycross, where with other shrubby plants (and no herbs or trees) it forms almost impenetrable thickets six to ten feet high and of unknown extent (*no. 1466*). This locality is about 60 miles inland and 100 feet above sea-level. On August 19 I collected the same oak in a thicket of similar aspect, but somewhat different composition, in the interior of Cumberland Island (*no. 1540*). This species strikes me as being much more closely related to *Q. nigra* L. (*Q. aquatica* Walt.) than to *Q. Virginiana*, of which it was long considered a variety.

POLYGONUM ARIFOLIUM L.

In the swamp of the Satilla River in Camden County opposite Woodbine, within the influence of tide, but in fresh water, August 23 (*no. 1563*). My specimens are all sterile. Previous records of the occurrence of this species as far south as the coast of Georgia seem to be lacking. With it I found among other things *Juncus Canadensis* J. Gay, which was also a novelty in these parts.

MAGNOLIA MACROPHYLLA Michx.

This tree is common in rich woods along Samochechobee Creek all the way across Clay County (*no. 1793*), but I have never met with it elsewhere.

SARRACENIA FLAVA × MINOR Harper, Bull. Torrey Club, **30**: 332. Je 1903

Although described from a single specimen, this hybrid seems to be not particularly rare or evanescent. In July, 1902, I found (and photographed) several specimens within a few feet of each other in wet pine-barrens in Douglas, Coffee County (*no. 1437*). Here, as at the type-locality (about sixty miles distant) both parents were growing in the immediate vicinity. The hybrid has shown no tendency to flower yet.

SARRACENIA PURPUREA L.

After looking in vain for this species in Georgia for several years, I found a quantity of it in a sandy bog in Randolph County not far from Coleman (which is several miles outside of the pine-barrens) on October 28 (*no. 1783*). About the same time Mr. Hyde obtained a flowering specimen collected by the late Mrs. Sarah Thompson in Lee County, May 11, 1895.

Dr. Mohr in his "Plant Life of Alabama" says nothing about this species being rare in that state, but it is certainly rare in Georgia, and very few stations for it are known in the other southern states. All of the seven known species of *Sarracenia* have now been found in the coastal plain of Georgia. With the possible exception of Florida, no other state is known to contain them all.

CHRYSOBALANUS OBLONGIFOLIUS Michx.

Specimens collected in Coffee County on July 22 (*no. 1433*) showed a variation apparently hitherto unknown in this species and the genus and family to which it belongs. Many of the flowers had two or three carpels, and several specimens showed both or all three well on the way to maturity. The plants were perfectly normal in other respects, and there is no reason for supposing the extra number of carpels a freak. It is simply a variation which has been overlooked.

CUBELIUM CONCOLOR (Forst.) Raf.

Common on the bank of the Savannah River on Germain's Island, Columbia County (in the metamorphic region), June 7 (*no. 1297*). Also seen among limestone rocks in woods near Grier's Cave, Randolph County, October 23. Not previously reported from Georgia. My specimens differ from those which have been described, in being glabrous throughout, but seem to be otherwise identical.

ERYNGIUM LUDOVICIANUM Morong (*E. integrifolium Ludovicianum* C. & R.)

Observations on this species during the season convince me that it is specifically distinct from *E. integrifolium* Walt. (*E. virga-*

tum Lam.). While the two species are similar in habitat, their ranges are different. Near the southern border of the state, in the counties of Lowndes, Brooks and Thomas, *E. integrifolium* alone occurs, while fifty miles farther north, in the vicinity of Tifton, I have seen only *E. Ludovicianum.* But around Moultrie, an intermediate point, both species occur, often together, without showing any tendency to intergrade.

E. integrifolium has much the wider range, even in Georgia, where it is found in the metamorphic region as well as in the coastal plain. It is represented by *no. 1612*, from Valdosta, September 5, and *E. Ludovicianum* by *no. 1664*, from Colquitt County, September 24.

PANAX QUINQUEFOLIUM L.

In rich shady woods northwest of Cuthbert, Randolph County; also on the high bluff along Samochechobee Creek in Clay County. Rarely found so far south, these localities being below latitude 32°. I have heard several rumors of the occurrence of this much-sought plant elsewhere in the coastal plain, but most of these on being investigated prove to be based on *Tetragonotheca helianthoides* L., a totally dissimilar plant which in some unaccountable way has also received the name of "ginseng," * and moreover is said to possess valuable medicinal properties, being "good for rheumatism."

CHIMAPHILA MACULATA (L.) Pursh

A few specimens seen on September 29 in rich woods near Little River southwest of Tifton, Berrien County. This species does not seem to have been found so far south before.

ANANTHERIX CONNIVENS (Baldw.) Feay; Wood, Class Book, 594. 1861

The authorship of this combination is usually credited to Gray (Proc. Am. Acad. **12**: 66. 1876), but it was published in Wood's Class Book several years earlier. I collected this species in full bloom in wet pine-barrens in Coffee County near Douglas, July 18 (*no. 1426*), and observed it in similiar situations in several other

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* This fact was noted by Messrs. Pollard and Maxon in 1900. See Plant World, **3**: 142. S 1900.

Southeast Georgia counties. It seems to be always scarce, rarely more than three or four specimens being visible at once.

DICERANDRA ODORATISSIMA Harper, Bull. Torrey Club, **28**: 479. 1901

Collected on the sand-hills of Little River southwest of Tifton, Berrien County, September 30 (*no. 1695*). At this station, which is probably near the western limit of the species (sand-hills being rare farther west), the plants are much less abundant and vigorous than at the type-locality, forty miles farther east.

GERARDIA GEORGIANA C. L. Boynton, Biltmore Bot. Stud. **1**: 148. 1902

Collected in rather dry pine-barrens around a small pond in Thomas County south of Thomasville on the morning of September 19 (*no. 1637*). Intimately associated with *G. paupercula* (Gray) Britton (*no. 1638*), which it much resembles, though this is not necessarily its nearest relative. Previously known only from the type-locality, near Cordele. One character overlooked by the author is that the corolla of *G. Georgiana* is spotless. I find that the markings of the corollas in *Gerardia*, which can be studied to advantage only in living specimens, often afford valuable diagnostic characters.

GERARDIA FILICAULIS (Benth.) Chapm.

Seen only in rather dry grassy pine-barrens near Tyty, Worth County, on the morning of September 30 (*no. 1698*). Fairly abundant but very inconspicuous. Not previously reported north of Florida.

LOBELIA FLACCIDIFOLIA Small

Collected in the swamp of Cedar Creek near Wrightsville, Johnson County, in flower June 16 (*no. 1341*), also in the swamp of Ochlocknee Creek near Moultrie, Colquitt County, September 25 (*no. 1676*). Flowers earlier than most species of *Lobelia*.

EUPATORIUM INCARNATUM Walt.

Seen only in the rocky woods near Grier's Cave, Randolph County, in flower October 23 (*no. 1771*). Probably not known elsewhere in Georgia. Dr. Mohr reports but one station for it in Alabama.

CHRYSOPSIS PINIFOLIA Ell.

On the fall-line sand-hills near Butler, Taylor County, November 6 (*no. 1802*). The only earlier specimen I have seen was collected by Elliott himself in the same region. This species becomes stoloniferous late in the season, a fact which has not been noted before.

SOLIDAGO AMPLEXICAULIS T. & G. Fl. N. A. **2**: 218. 1842

Not rare in rich shady woods in Randolph County northwest of Cuthbert, in full bloom on October 21 (*no. 1764*). Not previously reported from Georgia. This species was named in a rather unusual way. The authors when describing it assumed it to be the same as *S. amplexicaulis* Martens,* of which they had seen the name but not the description. Soon afterward † they found that Martens' *S. amplexicaulis* was a synonym of *S. Riddellii* Frank. According to the views held at that time, this necessitated no change in the name of Torrey and Gray's plant, but on the principle of "once a synonym always a synonym," it would have to be changed. This is a case which seems to have escaped the attention of the nomenclature reformers.

BALDWINIA ATROPURPUREA Harper, Bull. Torrey Club, **28**: 483. 1901

At the time I described this species I had some doubts as to its validity, but I have none now. In 1902 I collected it near Moultrie on September 20 (*no. 1644*), and in the next two weeks saw it at many other places in the counties of Colquitt, Worth, Berrien, Irwin and Dooly, always in moist slightly sloping pine-barrens. It grows in wetter places than does *B. uniflora* (but the two species are often found near together), and flowers several weeks later. I find also that its involucral bracts are smaller and more numerous than those of its congener. Also that the stems are usually purplish at the base, and commonly produce more branches (and consequently more heads) than in *B. uniflora*. There is not the slightest possibility of confusing the two species, and it is remarkable that *B. atropurpurea* was overlooked so long.

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* Bull. Acad. Brux. **8**: 66. 1841.

† Fl. N. A. **2**: 504. 1843.

MARSHALLIA RAMOSA Beadle & Boynton, Biltmore Bot. Stud. **1**: 8. *pl. 2.* 1901

In dry pine-barrens and at bases of imperfectly developed sand-hills in Johnson county near Wrightsville. In flower June 16 (*no. 1342*). This seems to be the second collection made of this species. Its corollas are decidedly paler than those of the common species, *M. graminifolia*, being nearly white.

MESADENIA SULCATA (Fernald) Small (*Cacalia sulcata* Fernald)

Collected in wet woods about a mile east of Killen, Clay County, October 29 (*no. 1792*), also seen in similar places in Randolph County south of Cuthbert. The affinity of this species with *Cacalia ovata* Ell. (which may not be the same as *C. ovata* Walt.), to which Mr. Fernald compared it, is rather remote. It is much more closely related to *M. tuberosa* (Nutt.) Britton and *M. Floridana* (Gray) Greene. These three species, *tuberosa*, *sulcata* and *Floridana*, differing from each other principally in range, habitat and shape of leaves, form a small group characterized by grooved or sharply angled stems, plantain-like leaves green on both sides and tapering at the base, and especially by the winged keels of the involucral bracts. This latter character was overlooked by the authors of the two latter species and is very rarely mentioned in descriptions, being inconspicuous in dried specimens. The wings are usually 1–2 mm. broad.

A specimen collected by A. H. Curtiss on "Borders of swamps, Walton County, Florida," in September, probably many years ago (*no. 1560*, distributed as *Cacalia Floridana*), is *Mesadenia sulcata.* In the Biltmore Herbarium there are specimens of it collected at different points in the same county, August 1, 1899, and September 26, 1900.

COLLEGE POINT, N. Y.

The Polyporaceae of North America — VI. The genus Polyporus

William Alphonso Murrill

The genus *Polyporus*, as established by Micheli (Nov. Pl. Gen. 129. *pl. 70–71.* 1729), was such a natural division and so clearly distinguished that it remained intact for over a century. Its nomenclatorial type was *P. leptocephalus* (Jacq.) Fr. and associated with this species were some of the most common and well-known members of the family. Unfortunately, however, Linnaeus retained the name *Boletus* for all pore-bearing fungi, and those mycologists who adopted Micheli's genus failed to establish it according to modern ideas. Adanson, for example, only cited Micheli's figures and listed no properly named species; Haller used only polynomials; and Scopoli in his *Introductio* listed no species at all under *Polyporus*. It was thus left to Paulet (Icon. Champ. *pl. 13.* 1793) to securely establish the genus. Paulet's work, written twenty or more years before its publication, contains descriptions and figures of six species of *Polyporus*; *P. Ulmi*, *P. frondosus*, *P. umbilicatus*, *P. carbonarius*, *P. fasciatus* and *P. Tuberaster*, four of which belong to Micheli's genus in the strictest sense. The first species, *P. Ulmi*, is the very common one well known as *P. squamosus* (Huds.) Fr. and must be considered the nomenclatorial type of *Polyporus* according to principles now in vogue. The general use of *Polyporus* instead of *Boletus* is chiefly due to Fries, who, without knowledge of Paulet's work, "restored" the name in 1815 and made it popular in spite of the influence of Linnaeus.

In recent systems of classification the original significance of the term *Polyporus* has been somewhat perverted. Karsten, for example, assigned *Polyporus* to the terrestrial central-stemmed forms and placed the wood-loving species under the new genus *Polyporellus* (Medd. Soc. Faun. et. Fl. Fenn. **5**: 37. 1879). Quélet adopted new names for both of these groups, *Caloporus* for the first and *Leucoporus* for the second, and erected the monotypic genus *Cerioporus* on *Polyporus caudicinus* (Enchiridion Fungorum, 164–167. 1886). Patouillard followed Quélet in the main, but used *Polyporus* in the Karstenian sense instead of *Caloporus* and proposed the new name *Melanopus* for the group to which Karsten had assigned the name *Polyporellus* (Hymenom. Eur. 137. 1887). One finds, therefore, four modern generic names, *Polyporellus*, *Leucoporus*, *Cerioporus* and *Melanopus*, associated either with the type or with a near ally of the type of the genus *Polyporus* and hence synonymous with it.

The species of this genus are in general very similar in appearance and habit, most of them being small dark-colored plants attached to fallen branches and other decaying wood on or near the ground. One species, however, *P. caudicinus*, is very large and does considerable damage to living trees, especially in Europe where it is abundant. The smallest plant of the genus is *P. Acicula*, a tropical form only two millimeters in diameter represented by a single specimen in the Kew herbarium. Many other species of this group are based upon very scanty collections, some well preserved, others now in poor condition, and most of them inadequately described. The task of the monographer is, therefore, in this case unusually difficult and his results more or less unsatisfactory.

Synopsis of the North American species

1\. Stipe pallid or light brown, centrally attached, not darker than the pileus. 2.
Stipe wholly or partly black or fuliginous, variously attached, usually darker than the pileus. 17.

2\. Margin of pileus not ciliate. 3.
Margin of pileus ornamented with cilia, which often disappear with age. 12.

3\. Pileus beset near the margin with hydnoid processes. 1. *P. hydniceps.*
Pileus plainly villose, tomentose or scabrous, often becoming glabrous with age. 4.
Pileus minutely tomentose or glabrous from the first. 8.

4\. Pileus scabrous, irregular, umbrinous, margin involute; stipe scabrous, tubes small, 4 to a mm., dissepiments dentate. 2. *P. scabriceps.*
Pileus villose or tomentose. 5.

5\. Pileus becoming virgate from the rupture of the cuticle, tubes 2 to a mm., decurrent, dissepiments dentate. 3. *P. virgatus.*
Pileus not becoming virgate. 6.

6\. Pileus less than 2 cm. in diameter, ochraceous, tubes 2 to a mm., decurrent to the base of the stipe. 4. *P. delicatus.*
Pileus more than 2 cm. in diameter. 7.

7. Tubes decurrent, very short, entire, pileus dark purple, ornamented here and there with paler radiating lines, surface finely tomentose, becoming glabrous. 5. *P. dibaphus.*
Tubes not decidedly decurrent, denticulate when mature, pileus yellowish to smoky black, villose, at length glabrous, spores oblong, curved, 6 × 2 *u*. 6. *P. Polyporus.*

8. Sporophore goblet-shaped, pileus less than 3 cm. broad, shallowly depressed at the center, stipe long, striate, expanding into the pileus. 7. *P. Tuba.*
Sporophore trumpet-shaped, pileus 5–10 cm. broad, deeply infundibuliform, stipe 3 cm. long, pallid, pulverulent. 8. *P. craterellus.*
Sporophore not as above. 9.

9. Pileus minute, 2 mm. in diameter, umbilicate, margin involute, pores alveolar. 9. *P. Acicula.*
Pileus large, 10 cm. or more in diameter, umbrinous, stipe short, thick, hispid, pores at length sinuous, dissepiments dentate. 10. *P. discoideus.*
Pileus of medium size, 2–5 cm. in diameter. 10.

10. Context whitish or brownish in color, extremely thin. 11.
Context golden-yellow, not extremely thin, tubes remote from the stipe. 11. *P. phaeoxanthus.*

11. Pileus brown, polished, context light brown, tubes decurrent. 12. *P. Columbiensis.*
Pileus white or pallid, more or less translucent, context white, tubes adnate, exceedingly minute, 8 to a mm. 13. *P. obolus.*

12. Tubes alveolar. 13.
Tubes not alveolar. 15.

13. Margin of pileus finely hispid, broadly sterile below, surface ochraceous, radiate-striate, stipe brown, pulverulent. 14. *P. aemulans.*
Margin of pileus strigose, fertile below. 14.

14. Pileus very thin, smooth, pellucid, fragile, stipe thicker below, setulose. 15. *P. arculariellus.*
Pileus not very thin, fuscous-squamulose to glabrous, stipe equal, grooved, squamulose, grayish-fuscous. 16 *P. arcularius.*

15. Tubes fairly regular, stipe slender, not polished, plants rather delicate, cilia variable in form and persistence. 16.
Tubes very irregular, stipe usually thick and polished, pileus tough, umbilicate, yellowish-white with brown marginal band, cilia short, fugacious. 17. *P. variiporus.*

16. Pileus opaque, not translucent, 1–4 cm. in diameter, cilia long, of uncertain duration, plants mostly cespitose. 18. *P. Tricholoma.*
Pileus very thin, more or less translucent, 1–2 cm. in diameter, cilia short, slender fugacious, plants not cespitose. 19. *P. Cowellii.*

17. Pileus squamose, very large, flabelliform, tubes large, alveolar. 20. *P. caudicinus.*
Pileus finely tomentose, drab-colored, with reddish-brown spots, small, circular, tubes rounded, minute. 21. *P. maculosus.*
Pileus glabrous, uniform in color, variable in form, tubes punctiform. 18.

18. Stipe ivory-black below, pileus usually ochraceous, surface scarcely depressed, margin even, not becoming extremely thin. 22. *P. elegans.*
    Stipe smoky-black below, pileus usually chestnut-colored, depressed at the center or behind, margin very thin and irregular. 23. *P. fissus.*

1. POLYPORUS HYDNICEPS B. & C. Jour. Linn. Soc. Bot. **10**: 305. 1868

This is one of Wright's plants collected in Cuba. Berkeley's description is characteristically brief, but, fortunately, the type still exists in fairly good condition in the Kew herbarium. It is readily distinguished from all other species in the genus by the short cylindrical or subpyramidal hydnoid processes which it bears on the surface of the pileus near the margin. In shape it is variable and quite irregular, often breaking into fan-shaped lobes as it develops and folding inward or outward at the margin as circumstances determine. The stipe is short, thick, usually blackish and often reticulate. The fruit bodies occur at times in clusters with their stipes closely united at the base. In general appearance this species resembles *Scutiger griseus* and its near allies, but it seems hardly fleshy enough for that group and is moreover so much like species of *Polyporus* in habit that I have retained it in the latter genus as here restricted.

2. POLYPORUS SCABRICEPS B. & C. Jour. Linn. Soc. Bot. **10**: 305. 1868

This species is well named. The type at Kew, collected by Wright in Cuba on decaying wood, is well preserved and still shows the characteristic scabrous covering. Other characters are the dark brown surface, involute margin, decurrent, dentate tubes and short brown stipe. Like most of the Cuban species, it is rare and very imperfectly known as regards distribution and variation.

3. POLYPORUS VIRGATUS B. & C. Jour. Linn. Soc. Bot. **10**: 304. 1868

Six type plants of this species are at Kew, collected in Cuba by Wright. They are of the typical *Polyporus* form and habit with rather delicate, fragile tubes and thin cuticle, which at length ruptures in a way quite characteristic of the species. This plant resembles *P. discoideus*, but is tougher, firmer and somewhat smaller in addition to being virgate.

4. POLYPORUS DELICATUS B. & C. Grevillea, **1** : 37. 1872

Only one small plant of this species is to be found in the Kew herbarium. It was collected in Alabama by Peters, growing on decaying wood. It is uniformly ochraceous in color, tomentose, of soft elastic substance, with a thin undulate revolute margin. The tubes are angular, 2 to a mm., decurrent even to the base and quite collapsed when dry. The stipe is central and radicate, and the buried portion is darker in color than the rest. At first sight, the surface suggests *Polyporus fractipes*, the color being very similar in both, but the central stipe, firmer substance and much larger tubes of *P. delicatus* readily distinguish it from that species.

5. POLYPORUS DIBAPHUS B. & C. Grevillea, **1** : 36. 1872

This plant resembles *P. Polyporus* in many respects, but its pore structure appears to be different. It was collected by Peters in Alabama on trunks of *Ilex*. The type at Kew is the larger share of a single specimen cut in two. A better developed plant might show closer resemblance to *P. Polyporus*. One can never be entirely free from the suspicion that species resting upon a slight material basis and closely resembling species that are common and variable may possibly be only undeveloped or depauperate or abnormal forms of the more abundant species. It seems best, however, in the present instance to consider *P. dibaphus* as distinct until its relationships are more clearly proved.

6. **Polyporus Polyporus** (Retz)

Boletus Polyporus Retz, Vet. Ac. Handl. 253. 1769.

Boletus brumalis Pers. Neues Mag. Bot. **1**: 107. 1794. Batsch, Elench. Fung. *pl. 10, f. 42a.* 1783.

Boletus fasciculatus Schrad. Spic. 154. 1794.

Polyporus brumalis Fr. Obs. Myc. **2** : 255. 1818.

Polyporus luridus B. & C. Grevillea, **1** : 37. 1872.

Polyporellus brumalis Karst. Medd. Soc. Faun. et. Fl. Fenn. **5** : 37. 1879.

Polyporellus Polyporus Murrill, Jour. Myc. **9** : 93. 1903.

There are two forms of this widely distributed plant, both occurring throughout Europe and North America. It was the yellow, or vernal, form which Retz described, while Schrader was dealing with the darker autumnal form of the plant. In his synopsis, Persoon separates the two forms as varieties *vernus* and *fasciculatus*. *P. luridus* of Berkeley and Curtis is to be referred to the latter variety.

This species is found on various kinds of decaying wood in forests and groves, usually upon branches lying on the ground. Its persistence far into the winter in the fresh state led Persoon to give it the name by which it is generally known. Among the specimens examined are the following: Tyrol, *Bresadola;* Berlin, *Sydow;* Finland, *Karsten;* Sweden, *Murrill;* Canada, *Dearness, Macoun;* Maine, *Ricker;* New Hampshire, *Miss Minns;* Connecticut, *Wright;* New York, *Shear, Underwood, Overacker;* Delaware, *Commons;* Ohio, *Morgan;* Wisconsin, *Lapham, Seymour;* Iowa, *Holway;* Montana, *Anderson.*

7. POLYPORUS TUBA B. & C. Jour. Linn. Soc. Bot. **10**: 305. 1868

This species is founded upon a single collection by Wright in Cuba, the types being at Kew. It is readily recognized by its peculiar goblet-shaped form, resembling a long-stemmed *Peziza* or a young stage of *Cantharellus cibarius*. Its substance is relatively quite thick, the depression at the center being shallow instead of deep as might be expected from its shape. The margin, if not straight, is rolled inward instead of outward, and the stipe is long, slender and undulate.

8. POLYPORUS CRATERELLUS B. & C. Jour. Linn. Soc. Bot. **10**: 305. 1868

The type collection of this species was made by Wright in Cuba. The name is well chosen and refers to a character by which the plant is easily distinguished from its near allies. Plants collected in Louisiana by Langlois are even more deeply infundibuliform than the types and are also somewhat larger. The species occurs on decaying wood and appears usually in small clusters.

9. POLYPORUS ACICULA B. & C. Jour. Linn. Soc. Bot. **10**: 304. 1868

This minute species is represented by a single specimen, two millimeters in diameter, collected on decayed wood in Cuba.

The stipe is long and slender, centrally attached and somewhat hairy at the base. The pileus is umbilicate with involute margin resembling a minute species of *Omphalia* in shape. In general appearance the plant resembles *P. Tricholoma*, but the margin is without cilia and the pores are alveolar.

10. POLYPORUS DISCOIDEUS B. & C. Jour. Linn. Soc. **10**: 303. 1868

This species was collected by Wright in Cuba. It is rather larger than most of the members of the genus, but resembles them closely in habit and structure. Its nearest ally is perhaps *P. virgatus*. Being large, it is rather fleshy, the context becoming soft, corky and elastic when dry. The tubes are rather large, at length sinuose, and become collapsed on drying, indicating a soft condition when fresh.

11. POLYPORUS PHAEOXANTHUS B. & Mont. Sylloge Crypt. 154. 1856

This rare species was collected at Columbus, Ohio, by Sullivant. It grew on fallen oak wood. The type at Paris is in fragments, but these are well preserved. The character by which the species is at once recognized is the deep yellow color of the context. The pileus is convex, reddish-brown, glabrous, scarcely a millimeter thick and about two centimeters broad; the stipe central and concolorous, the tubes minute and remote from the stipe.

12. POLYPORUS COLUMBIENSIS Berk. Lond. Jour. Bot. **1**: 454. 1842

This is one of the thinnest species of the family, resembling a brown cuticle stripped from some fruit having a smooth, waxy, polished coat. It is orbicular in shape with a dark central stipe and small decurrent tubes. The type was sent to Berkeley from the Columbia River region of South Carolina. There is also in the Berkeley herbarium a specimen from Chicalahi, Mexico, bearing the same name, which may be the same species.

13. POLYPORUS OBOLUS Ell. & Macbr. Bull. Iowa Univ. Lab. Nat. Hist. **4**: 68. 1896

A small plant with very thin partially translucent pileus, brown central stipe and exceedingly minute pores. Pileus orbicular, plane, 1.5–2.5 × 0.03–0.08 cm.; surface minutely tomentose, radiate-rugose, isabelline, fulvous at the center; margin straight or repand, even, glabrous, entirely devoid of teeth or cilia: context 0.2–0.7 mm. thick, tough, white, translucent, especially near the margin; tubes 0.1 mm. long, 8 to a mm., adnate, white, cylindrical, regular, edges thick, entire; spores ovoid, smooth, hyaline, 3.5–4 × 4.5–5 μ: stipe central, tough, elastic, slender, equal, chestnut-colored, glabrous, smooth, much compressed in drying, 2–4 cm long, 1–2 mm. thick.

The above description of this species is made from dried plants now in the herbarium of the New York Botanical Garden, collected by C. L. Smith in Nicaragua.

Type plants kindly furnished me by Macbride agree in all respects with these, being a part of the same collection. The species is nearly related to *P. Tricholoma*, but the pileus is very thin and translucent, the margin entirely glabrous and the pores scarcely one eighth of a millimeter in diameter.

14. POLYPORUS AEMULANS B. & C. Jour. Linn. Soc. Bot. **10**: 304. 1868.

Very little is known of this species beyond the small type collection from Cuba and Berkeley's rather meager description. The types are well preserved, however, and show decided characters. They resemble *P. arcularius* in having alveolar tubes, but these tubes are broad and shallow and disappear near the margin, leaving a sterile marginal band one or two millimeters in diameter. In habit, the species resembles *P. Polyporus*. The whole plant is thin and tough, with brown central stipe.

15. **Polyporus arculariellus** nom. nov.

Favolus Curtisii Berk. Grevillea, **1**: 68. 1872.

One specimen only of this plant seems to have been sent to Kew by Curtis from his North Carolina collections. This is well preserved, however, and shows the very thin pellucid pileus ornamented around the margin with long cilia, the oblong favoloid tubes and the centrally attached tapering stipe that characterize the species. It is a near ally of *Polyporus arcularius*, though smaller and much more delicate, and also closely resembles such ciliated forms as *P. Tricholoma* and its near allies; so that its natural affinities appear to be with *Polyporus* rather than with *Favo-*

lus. It is unfortunate that the existence of a *Polyporus Curtisii* renders it necessary to change the species name in the transfer from one genus to the other.

16. POLYPORUS ARCULARIUS (Batsch) Fr.

Boletus arcularius Batsch, Elench. Fung. 97. 1783. (Mich. *pl. 70. f. 5.* 1729.)

Boletus exasperatus Schrad. Spic. 153. 1794.

Polyporus arcularius Fr. Syst. **1** : 342. 1821.

This species was described by Batsch as follows : "Stipitatus ; stipite subgracili, subclavato ; pileo membranaceo convexo, subulato-fimbriato ; stipiteque concoloribus, spadiceo-rufis ; cellulis latissimis, rhombeis, aequalibus albis." Fries placed it in the genus *Favolus*, which he treated as a subgenus under *Polyporus*. Its tubes are certainly favoloid, but its close relationship to *P. Polyporus* has kept it near this species rather than with species of *Favolus*. Wright's specimen of *P. lentus* from Connecticut seems nothing more than *P. arcularius*. There is at Kew also the remains of a specimen from Ohio, which very probably belonged in the same category.

P. arcularius shows little variation except in size throughout its wide range. It occurs on decaying wood and shows much the same habit as *P. elegans* and *P. Polyporus*, but differs from these species in occurring more abundantly in the south. Specimens have been examined from the following localities : Tyrol, *Bresadola ;* Connecticut, *Earle ;* Pennsylvania, *Everhart ;* New Jersey, *Ellis ;* Georgia, *Ravenel ;* Ohio, *James, Morgan ;* Missouri, *Demetrio ;* Nebraska, *Bates ;* Colorado, *Crandall ;* New Mexico, *Earle ;* Michigan, *Longyear ;* Kansas, *Bartholomew ;* Kentucky, *Price ;* Mississippi, *Ricker ;* Alabama, *Earle, Baker ;* Florida, *Rau, Calkins ;* Mexico, *C. L. Smith.*

17. **Polyporus variiporus** sp. nov.

A small plant resembling *P. Tricholoma*, but firmer and tougher with thicker stipe and more irregular pores. Pileus orbicular, convex to depressed, 1–2.5 × 0.1–0.2 cm., surface glabrous, more or less radiately striate, somewhat concentrically rugose, straw-colored to isabelline, fulvous to chestnut-colored around the margin, which is thin, inflexed, undulate, finely ciliate, the cilia being fugacious: context 1–1.5 mm. thick, tough, white; tubes 0.5 mm. in length, 2–4 mm. in diameter, very irregular, much elongated radially near the stipe or in marginal folds, not noticeably decurrent, yellowish, polygonal to lamelloid, edges firm, entire, becoming denticulate or fimbriate with age; spores ellipsoid, smooth, hyaline, $4 \times 7\,\mu$: stipe central, hollow, increasing above, lighter than the pileus, subglabrous with a silky luster, 2 cm. long, 2–6 mm. thick, the buried base enlarged, tomentose and frequently black.

This species was collected by Earle on his recent trip to Porto Rico. It grew on sticks buried in sandy soil in woods. The thick stipe and irregular tubes suggest *P. pachypus* of Montagne, but it is evidently not that species. It differs from nearly related ciliated forms in being conspicuously tougher and thicker with tubes that are in one place small, regular and polygonal and in another transformed by confluence into long sinuate furrows resembling the gills of an agaric. This transformation commonly occurs near the stipe or in pockets made by the partial folding of the pileus.

18. POLYPORUS TRICHOLOMA Mont. Ann. Sc. Nat. Bot. II. 8: 365. 1837. Pl. Cell. Cuba, 249. *pl. 17, f. 1.* 1842

This species was originally well described and figured by Montagne and several specimens of typical plants are still in existence, so that no doubt exists concerning its identity. In addition to this, a large number of fresh specimens have recently been collected in Cuba and Jamaica by Earle and Underwood and some study made of the habits and variations of the species. It is found to grow in abundance throughout the West Indies and Central America, varying but slightly in color, but more in size and surface markings, occurring usually on dead sticks in woods, but sometimes upon logs and even on cocoanut husks. When seen in the fresh state it is commonly pure white and easily mistaken for some small agaric, but often with age and always in drying the color changes to pallid or light yellowish-brown, or even to a pale reddish-brown. The type plants were, of course, dried specimens and happened to be darker than is usual with the species.

Another variation still more marked and the cause of considerable confusion is in the size and persistency of the cilia around the margin of the pileus. Sometimes they are long and rigid, sometimes short and flexible; they usually disappear at early maturity, but occasionally persist until the plant has passed its prime. It is doubtful if Montagne himself knew of these variations, and it is certain that Berkeley was much confused by them. In dealing with the types of this plant it is best to consider the Cuban specimens only, since plants from elsewhere were later included in the species concept, which are in reality different things. Likewise, in examining Berkeley's specimens of *Polyporus similis*, one must confine himself to the Brazilian plants, since the Cuban ones are only *P. Tricholoma* with the cilia gone. In the same way *P. flexipes*, *P. stipitarius* and a few other species have undoubtedly become confused with *P. Tricholoma* in the minds of not a few mycologists and many collectors.

The following collections are in the herbarium of the New York Botanical Garden: Jamaica, *Earle 502*, *592*, *Underwood 2953*; Cuba, *Underwood and Earle 246*, *579*, *744*, *851*; Mexico, *C. L. Smith;* Nicaragua, *C. L. Smith;* Cozumel Island, *Millspaugh 1556*.

19. **Polyporus Cowellii** sp. nov.

A small light-colored plant resembling an agaric, having a very thin translucent context, minute pores and a slender central stipe. Pileus orbicular, convex to plane, umbilicate, 1–2 × 0.02–0.05 cm.; surface nearly glabrous, minutely concentrically rugose, straw-colored to isabelline, becoming darker and hygrophanous around the margin or in blotches or even over the entire surface, often faintly radiate-striate about the center with delicate white or brown lines; margin very thin, straight or inflexed, somewhat irregular in outline, finely denticulate, the teeth prolonged into short fugacious cilia: context extremely thin, membranous, 0.1–0.2 mm. thick, white or pallid, partially or entirely translucent; tubes 0.2–0.4 mm. long, 3–6 to a mm., larger by confluence, adnate, pallid, polygonal, edges very thin, subentire, becoming fimbriate with age; spores ellipsoid, smooth, hyaline, binucleate, 2.5 × 5 μ: stipe central, solid, very slender, equal, concolorous or slightly darker, pruinose to glabrous, smooth, longitudinally striate, 2–3 cm. long, 0.3–1 mm. thick, soft and milk-white at the center.

This species is described from dried plants collected in the island of St. Kitts by Britton and Cowell during September and

October, 1901. It was found in considerable quantity growing on decaying wood. There is also in the herbarium of the New York Botanical Garden another good collection of this species from Porto Rico made by Mr. and Mrs. A. A. Heller in March, 1899. It also grew on dead wood. This latter collection, however, is not considered typical.

20. POLYPORUS CAUDICINUS (Scop.) Murrill

Boletus caudicinus Scop. Fl. Carn. ed. 2, **2**: 469. 1772.
Boletus Juglandis Schaeff. Fung. **3**: 75. *pl. 101–102.* 1774.
Boletus squamosus Huds. Fl. Angl. 614. 1778.
Polyporus Ulmi Paul. Icon. Champ. *pl. 13.* 1793.
Polyporus squamosus Fr. Syst. **1**: 343. 1821.
Polyporus caudicinus Murrill, Jour. Myc. **9**: 89. 1903.

Exsicc.: France, *Roumeguère 2706, 2707, 3403;* Germany, *Krieger 860*, *Sydow 212*, *Magnus*, *Murrill;* Sweden, *Murrill;* England, *Murrill;* Canada, *Dearness;* Connecticut, *Underwood.*

This species is the largest of the genus and occurs in very conspicuous clusters on the trunks of injured deciduous trees in Europe and America. In London and in some of the cities of Germany I have found it especially abundant on elms, maples, horse chestnuts and other shade trees. It is at present comparatively rare in America and need not here be seriously considered from an economic standpoint for some years to come.

Scopoli's description is not so clear and definite as might be desired, but in the first variety described there can be no question as to the plant he had in mind, for he speaks of it as multiple, lobed, fleshy, large, growing on the trunks of trees, variegated above with darker spots, light-colored beneath, with large polygonal pores. The large pores connect it with the genus *Hexagona*, but its general structure and habit are those of *Polyporus*. Young plants collected in Connecticut, by Underwood, in May, showed very short favoloid tubes with thin toothed dissepiments, a milk-white fleshy-tough context and a scaly pileus differing little in color from that of the mature plant. The odor of the fresh plant is strong and somewhat mealy; the base of the stipe is clothed with short dark-brown or black velvety tomentum. It is quite possible that in this species we have modifications produced by an abundance of nutritious food such as is not supplied to the common species growing on dead wood. Large size, very rapid growth, ample pores and a somewhat softer context are probably connected with a better food supply and a more vigorous mycelium.

In addition to *Polyporus*, the present species has served as the nomenclatorial type of two recent genera, *i. e.*, *Cerioporus* Quél. (Ench. Fung. 167. 1886) and *Melanopus* Pat. (Hymenom. Eur. 137. 1887).

21. **Polyporus maculosus** sp. nov.

A small tough plant nearly related to *P. fissus*, but minutely tomentose, with rounded nearly glabrous spots of a reddish-brown color. Pileus irregularly orbicular, deeply depressed, 3–3.5 × 0.1–0.2 cm., surface finely and densely tomentose, radiately striate, drab-colored, ornamented with several light-bay or chestnut spots mostly situated about midway between the center and the margin, which is very thin, striate, irregular and somewhat fissured but entirely devoid of teeth or cilia: context 0.5–1.5 mm. thick, tough to corky, pallid; tubes 0.2–0.4 mm. long, 6–7 to a mm., decurrent, pallid or yellowish, subcylindrical, edges entire; spores ovoid, hyaline, smooth, $3 \times 4\,\mu$, immature in these specimens: stipe central, solid, woody, tapering upward, chestnut-black at the base with blotches of light-yellow, uneven, subglabrous, 2 cm. long, 2–4 mm. thick.

This plant was collected in Central America by C. L. Smith. The hymenium is not quite mature, but the other characters are well marked. The peculiar reddish spots seem to be caused by the disappearance of the thick tomentum at certain points. The species occurs on wood and has the habit of representative plants of this genus.

22. POLYPORUS ELEGANS (Bull.) Fr.

Boletus elegans Bull. Herb. France, *pl. 46.* 1780.

Boletus nummularius Bull. Herb. France, *pl. 124.* 1782.

Polyporus elegans Fr. Epicr. 440. 1836–1838. Pat. Tab. Fung. 137. 1883–1886.

Abundant throughout Europe and North America on decaying branches and trunks of various trees. Being exceedingly variable in form, it is not strange that in Europe it is confused with its variable near relative, **Polyporus Calceolus** (*Boletus Calceolus*

Bull.) [*Polyporus varius* (Pers.) Fr.], and some European mycologists go so far as to say that *P. elegans* and *P. Calceolus* are the same thing; but field studies in Sweden have convinced me that we have nothing in America to correspond to *B. Calceolus* of Bulliard, whose description and figure of this species may be easily matched with European specimens from either field or laboratory, while even our most closely allied Canadian forms of *P. elegans* fail to connect with the European relative.

The variety first described as *B. nummularius* by Bulliard is quite distinct from the typical form when seen in the herbarium, but when both are picked from the same branch in the woods the differences speedily become of minor importance. In the following partial list of specimens examined, no distinction is made between the two: Tyrol, *Bresadola;* Finland, *Karsten;* Canada, *Macoun*, *Dearness;* Vermont, *Burt;* Maine, *Ricker*, *Miss White;* Connecticut, *Earle;* New York, *Underwood*, *Cooke*, *Lobenstine;* New Jersey, *Ellis;* Ohio, *Morgan;* West Virginia, *Nuttall;* Michigan, *Ward;* Iowa, *Holway;* Colorado, *Bethel*, *Crandall;* Washington, *Piper*, *Parker.*

23. POLYPORUS FISSUS Berk. Lond. Jour. Bot. **6**: 318. 1847
Polyporus trachypus B. & Mont. Syll. Crypt. 154. 1856.

Both of the above names were assigned to plants sent from Ohio. Those sent by Lea were small and undeveloped and one or two were accidentally lobed. The tubes were so small as to be overlooked and he labelled them *Thelephora.* The collection made by Sullivant at Columbus was evidently described by Montagne. The description is accurate and quite complete. The reason why neither of these names has come into common use is due to the fact that our plant was at first miscalled *P. picipes*, a name given by Fries without good reason to plants of *P. calceolus* having particularly black stems. This latter species, so far as we are aware, does not occur in America, but American specimens at Kew are labeled *P. picipes* Fr. In the herbarium of Fries at Upsala there is only one specimen of "*P. picipes*" from North America and that is determined by Ellis. For our common species, then, which has been so generally known as *P. picipes*, we must make use of Berkeley's name.

The plant grows upon dead wood and has the habit of *P. elegans*, but is larger and darker in color. It often persists, however, until bleached nearly white. Exsiccati have been studied from Maine, *Harvey*, *Miss White;* Connecticut, *Underwood;* Massachusetts, *Seymour;* New York, *Clinton*, *Overacker;* Pennsylvania, *Everhart;* Vermont, *Farlow;* Kentucky, *Price;* Washington, *Parker;* Michigan, *Wood*, *Miss Minns.*

SPECIES INQUIRENDAE

Polyporus amygdalinus B. & Rav. Grevillea, **1**: 49. 1872. This species is said to differ from *P. caudicinus* in having smaller tubes, but it is probably only a form of that species in an undeveloped stage. I have not been able to find a type specimen.

Polyporus cyathiformis Lev. Ann. Sci. Nat. Bot. III. **2**: 181. 1844. The type of this species was probably burned with most of Leveillé's types during the occupation of Paris by the Germans. The description corresponds closely with *P. craterellus*, but it is difficult to determine that the two species are identical.

Polyporus pachypus Mont. Pl. Cell. Cuba, 421. 1842. This species is described as caespitose, with thick excentric stipe and membranaceous tubes, which are small and rounded near the margin and large and favoloid near the stipe. No types have been found in foreign herbaria and Montagne himself said in his *Sylloge* that the species needed further investigation.

Polyporus stipitarius B. & C. Jour. Linn. Soc. Bot. **10**: 304. 1868. The original description just cited does not materially assist one in interpreting the type plants in the Berkeley herbarium. Most of these types so closely resemble *P. Tricholoma* that a new description of them seems superfluous; and the one card of specimens which appears to be somewhat different from the rest was listed under *P. Tricholoma* by Berkeley at the time that *P. stipitarius* was described. Judging from the Kew collections, *P. stipitarius* appears to differ from *P. Tricholoma* chiefly in possessing a longer stipe, yet the description calls for a stipe shorter than that of *P. Tricholoma.* New material may possibly throw light on this problem, but I seriously doubt if Berkeley's species can ever be entirely disentangled from the earlier one of Montagne.

Polyporus gracilis Kl. Ann. Nat. Hist. **3**: 384. 1839. This is a caespitose species with slender pruinose stipe, small pellucid pileus, ciliate margin and very minute polygonal or sinuose tubes. Saccardo considers it the same as *P. flexipes* Fr. and *P. hapalus* Berk., but these two species do not, so far as I know, occur in the West Indies or even in Central America.

Polyporus Humphreyi P. Henn. Hedwigia, **37**: 280. 1898. From the description of this species it appears to resemble *P. Tricholoma*, but has adnate instead of decurrent tubes with whitish fimbriatulate edges. This and the next species are placed here because I have not yet examined the type specimens.

Melanopus marasmioides Pat. Bull. Soc. Myc. France, **18**: 173. 1902. This species is found in Guadeloupe and Martinique and is related to *Favolus melanopus*. It is deeply umbilicate, ochraceous, with translucent denticulate margin, which is sterile below, large shallow radiating tubes and a black central stipe. Undeveloped plants resemble certain species of *Xylaria*. An examination of the plant is necessary to determine whether or not it properly belongs with *Polyporus*.

NEW YORK CITY.

The spines of Fouquieria *

WINIFRED J. ROBINSON

The six species now comprised in the genus *Fouquieria* occupy collectively a region extending from the vicinity of the City of Mexico northward into California, Arizona, New Mexico and Texas. Nearly all of the species find their habitat in arid districts, and the localities from which they have been reported may be comprised within the southern extensions of the Chihuahuan and Sonoran deserts. Among other adaptations, the various species exhibit a capacity for casting off the leaves during seasons of drought, more or less irrespective of the time of the year, while some interesting features of the formation and casting away of the bark have been noticed.

All of the species bear strong spines and seem to be included under the single colloquial name "ocotillo" by the Mexicans, who use the living plants for hedges and sometimes erect barriers by thrusting the ends of heavy branches into the ground in rows. Messrs. Coville and MacDougal report having seen shrubs of *Fouquieria splendens* planted within a few inches of young shade trees in the streets of Alamogordo, New Mexico. The spreading spiny branches were held in a cylindrical clump around the trunk of the tree by means of wire and formed a most effective protection against damage by animals.

During the course of some recent work upon this genus, Mr. G. V. Nash called my attention to the unusual manner in which the spines were formed, which he described as "developed within the petioles of the leaves on the new growth, becoming apparent when these fall." † The general anatomical facts presented seemed of sufficient interest to warrant a detailed examination, and the results of my observations upon *Fouquieria splendens* and *F. Macdougalii*, specimens of which are growing in the conservatories of the New York Botanical Garden, are presented below.

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* The results described in the following paper were obtained by the aid of a Research Scholarship in the New York Botanical Garden, in 1903.

† Nash, G. V. A revision of the family *Fouquieriaceae*. Bull. Torrey Club, 30: 449. 1903.

On the lower side of the petiole of the primary leaves, a woody thickening is developed (FIGS. 11 and 12, *w*) which increases in firmness as the leaf matures. This arises from the cortex, which even in the bud is proliferated to form a thickened area on the outer side of the base of each leaf (FIG. 1, *c*). As the leaf emerges from the bud a conical portion of the cortex on the lower side of the petiole begins to lose its parenchymatous character. The cells lengthen, their ends become pointed (FIG. 2, *s*) and their walls thicken; these changes are accompanied by a diminution in their lumina (FIG. 3, *s*). With phloroglucin and hydrochloric acid they take the violet color characteristic of sclerenchymatous cells. The conversion of the parenchyma into sclerenchyma is incomplete in *F. splendens*, and a slender cone shaped mass of thin-walled cells extends about two thirds of the distance from the base toward the tip of the newly formed spine. This is illustrated by the diagrams of longitudinal and transverse sections shown in FIGS. 4, 6 and 7, *p*. About the time when the leaf-blade is cast off, the parenchyma-core disintegrates and a hollow spine remains. In *Fouquieria Macdougalii*, on the other hand, almost the entire mass of the cortex on the outer (lower) side of the petiole is transformed into sclerenchyma, making a solid heavy spine (FIGS. 5 and 8, *s*).

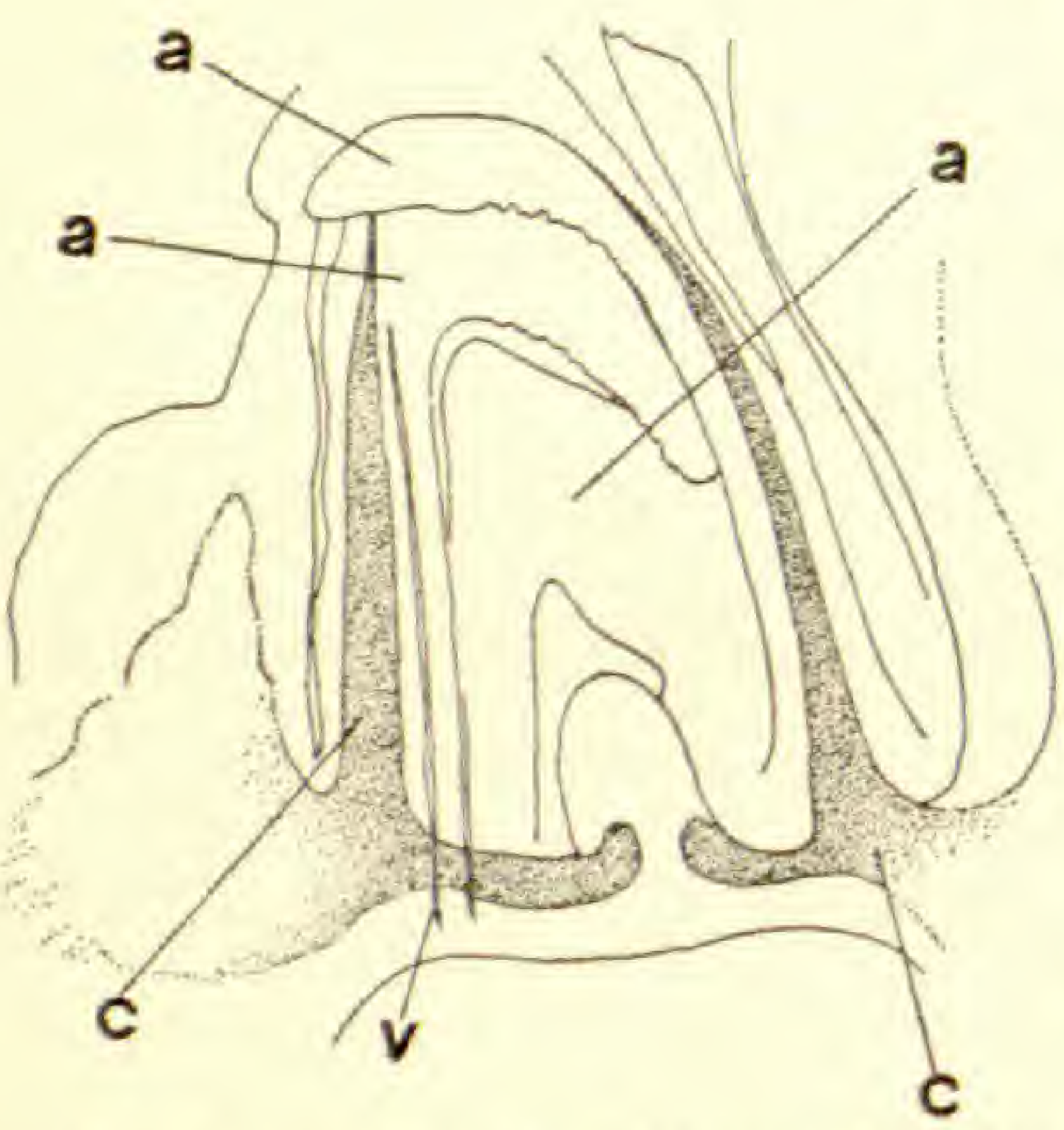


FIG. 1. Section through bud. *a*, young leaf; *c*, cortex, thickened to form spine; *v*, vascular tissue.

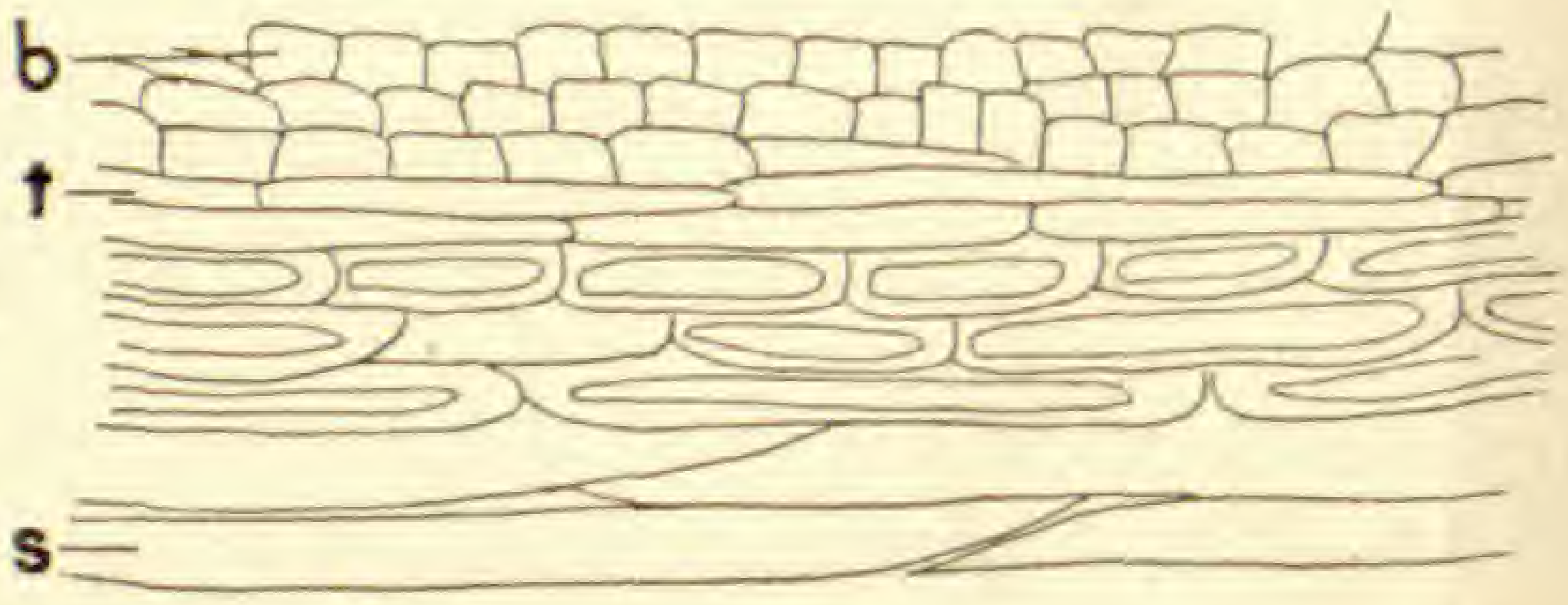


FIG. 2. Portion of longitudinal section through petiole. *b*, cortex; *t*, separating layer; *s*, sclerenchyma.

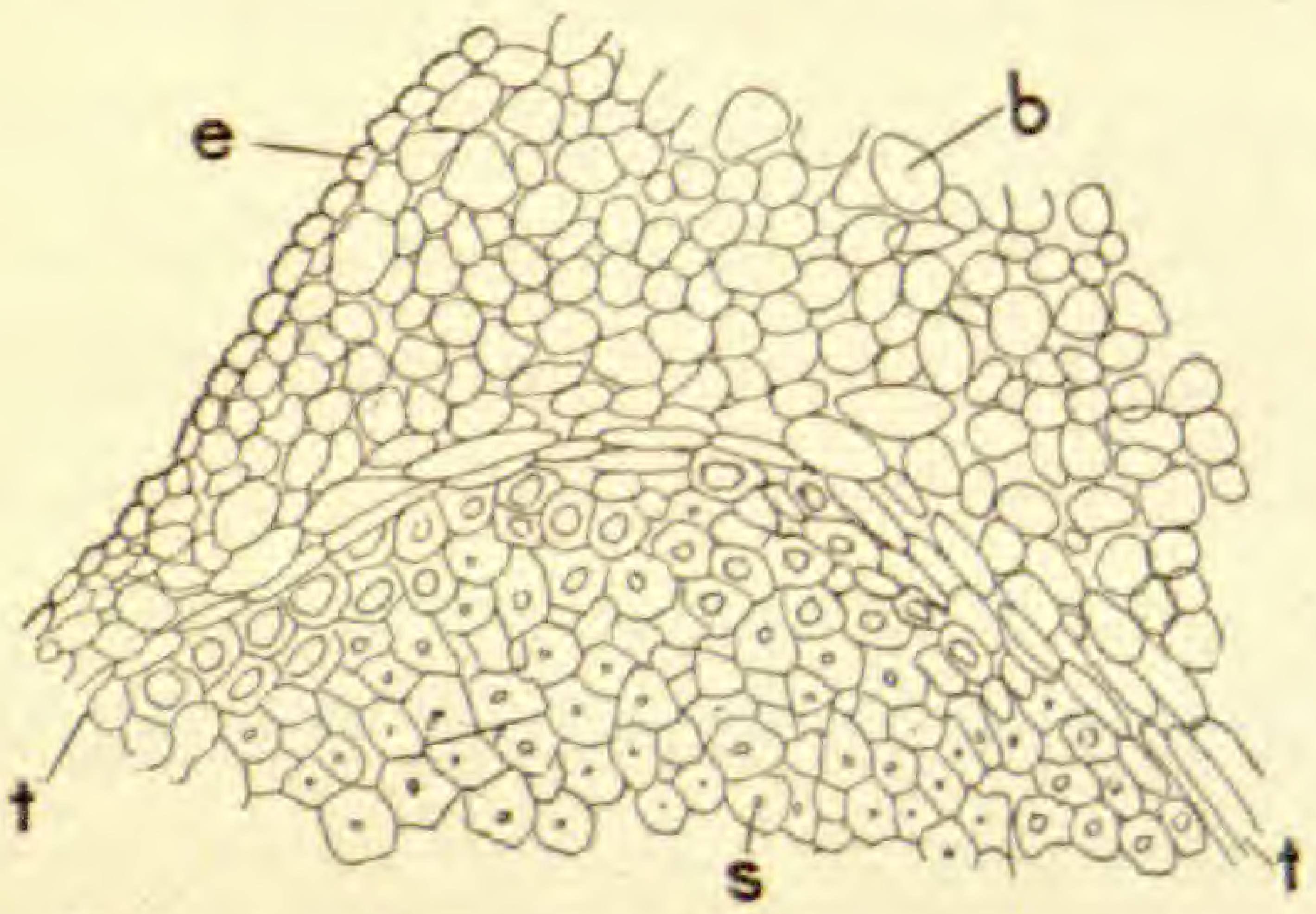
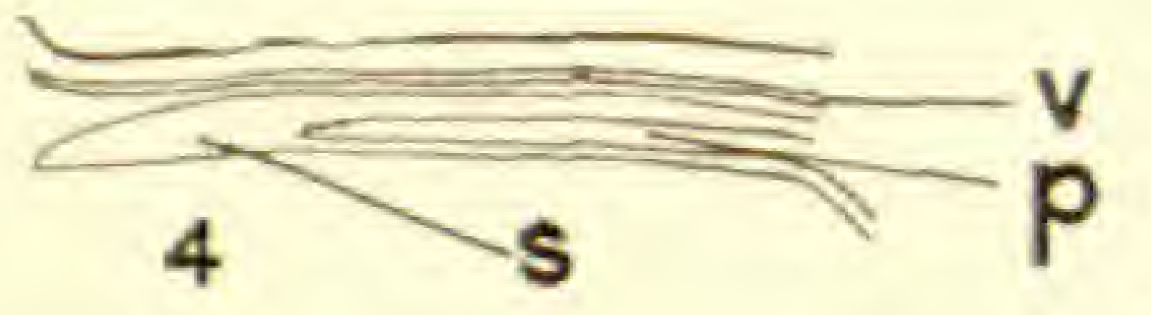
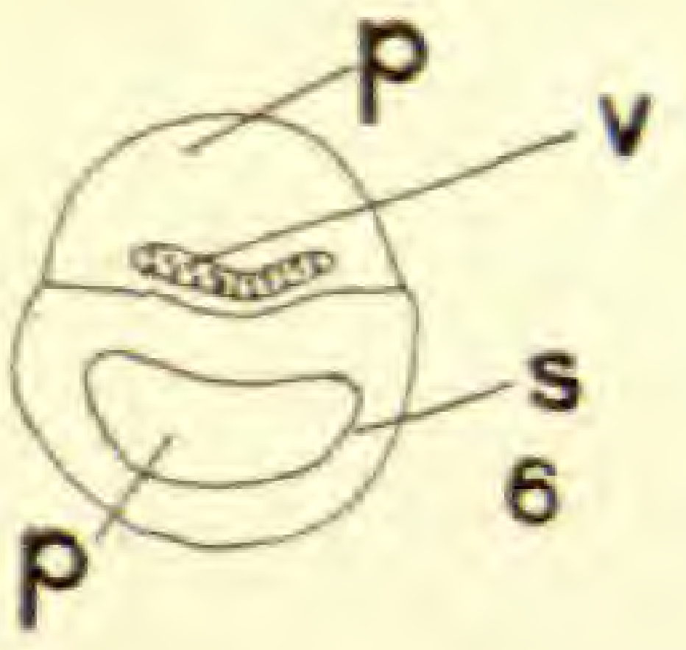


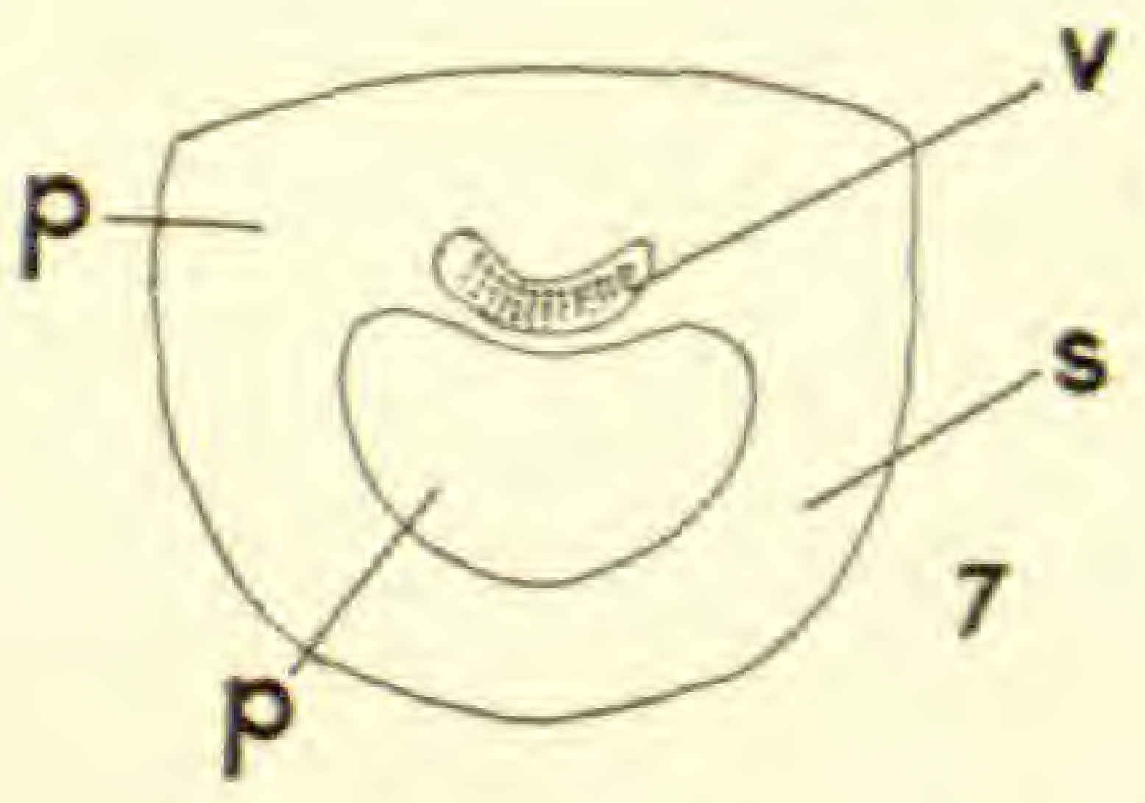
FIG. 3. Portion of transverse section through petiole.

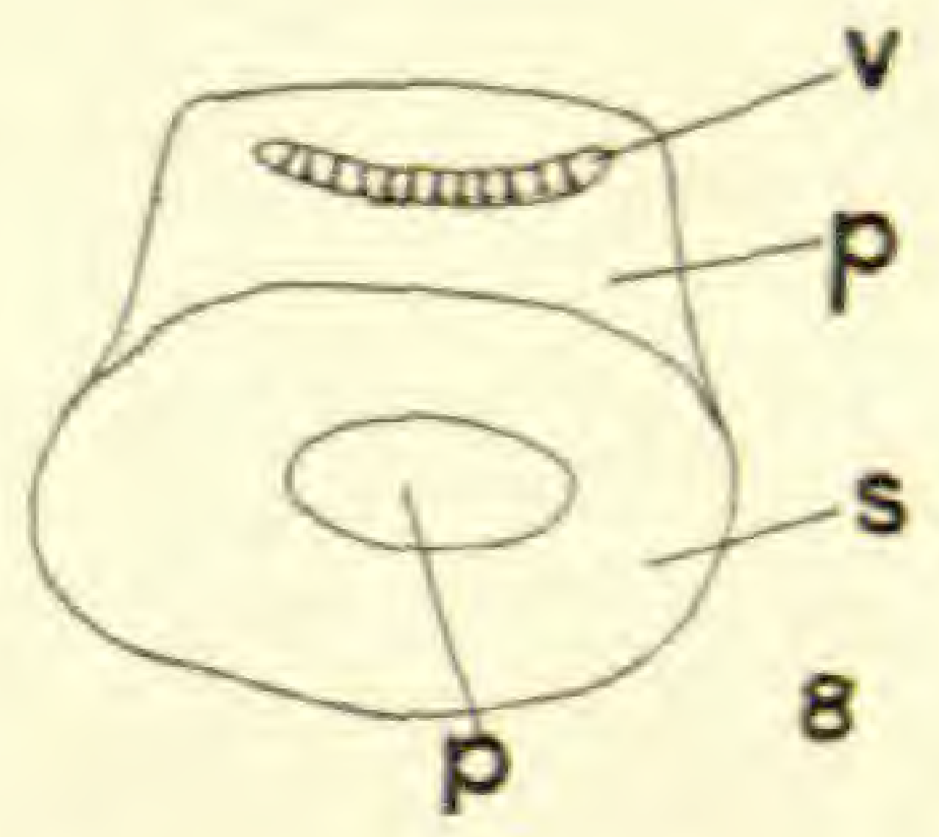
The growth of the leaf and the development of the spine is accompanied by the differentiation of a separatory layer of thin-walled, elongated cells (FIGS. 2 and

3, *t*) in the cortex, between the sclerenchymatous tract and the fibrovascular tissue of the petiole. The sclerenchymatous tissue sustains only mechanical relations to the leaf, and the lamina may be held for extended periods after the completion of the separatory layer. When the vegetative season reaches its end by reason of drought or low temperature, the leaf-blade is cast off; and as its fall occurs simultaneously with its drying out, this desiccation may be taken as the direct cause of the splitting of the separatory layer above mentioned. The separation is identical with that which occurs in the fall of the leaves of many deciduous trees in the autumn in general procedure, but the author is not acquainted with any other instance in which the petiole is cut in a longitudinal plane making necessary a separatory layer two or three centimeters in extent (FIG. 13, *d*). Again, this unique method of excision results in leaving an elongated pointed portion of the petiole 3 or 4 cm. in length attached to a mass of thickened epidermis and cork on the stem where it is retained rigidly for an indefinite period. The spine and the contiguous portion of the outer tissues of the stem may easily be pulled from the underlying tissues in *Fouquieria Macdougalii* (FIG. 10, *k*) when they are young, but in *F. splendens* they are less yielding.









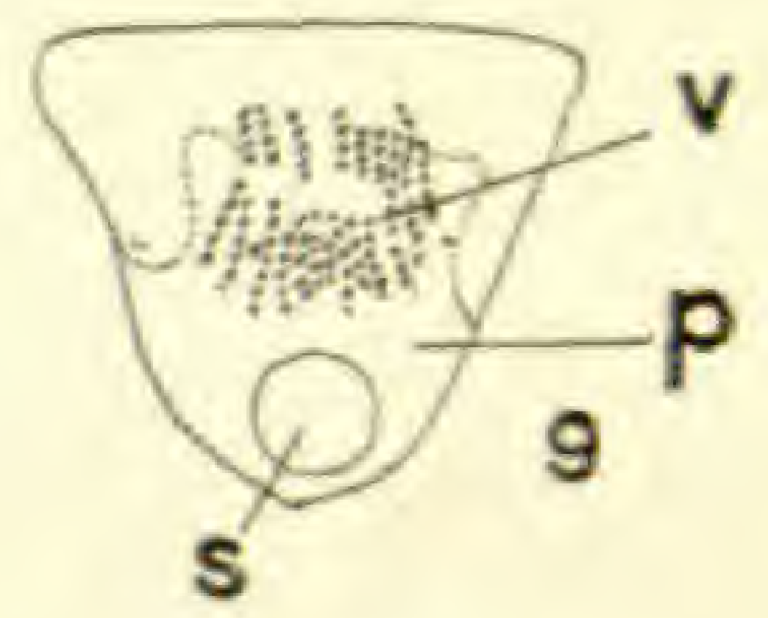


FIG. 4. Diagram of longitudinal section through petiole of *Fouquieria splendens*. *p*, parenchyma; *s*, sclerenchyma; *v*, vascular tissue.

FIG. 5. Diagram of longitudinal section through petiole of *Fouquieria Macdougalii.*

FIG. 6. Diagram of transverse section through petiole of *Fouquieria splendens* near the apex of spine.

FIG. 7. Diagram of transverse section through petiole of *Fouquieria splendens*, near base.

FIG. 8. Diagram of transverse section through petiole of *Fouquieria Macdougalii* near base.

FIG. 9. Diagram of transverse section through petiole of *Fouquieria Macdougalii* near the apex of spine.

In *Idria*, another genus of the same family, a similar spine, originating in the petiole of the leaf, has been described by Poisson (Bull. Mus. Hist. Nat. **1** : 278. 1895) and in some species of the nearly related *Cantua*, of the *Polemoniaceae*, there is a woody ridge at the base of each node. The latter, however, is more like the structure which protects the axillary bud in *Syringa* and *Philadelphus* than the spines of the *Fouquieriaceae*.

The majority of the buds in the axils of the primary leaves do not elongate to form branches, but develop small clusters of spatulate leaves which are almost sessile and do not form spines (FIGS. 11 and 12, *c*).

Engelmann (Bot. Gaz. **8** : 338. 1883) was the first to call attention to this peculiar mode of dehiscence of the leaves of *Fouquieria*. Plank (Garden & Forest, **9** : 73. 1896) says: "The bases of the spines appear to arise in the cellular part, leaving the wood full of holes in their decay," which statement was doubtless made because of the peculiar growth of the cork between the spines and the portions of the outer tissues, which adhere to them, making the spines, with their adhering pieces of bark, dry, papery structures, which still have close enough contact with the adjacent cells to leave a scar when they drop off. Van Tieghem

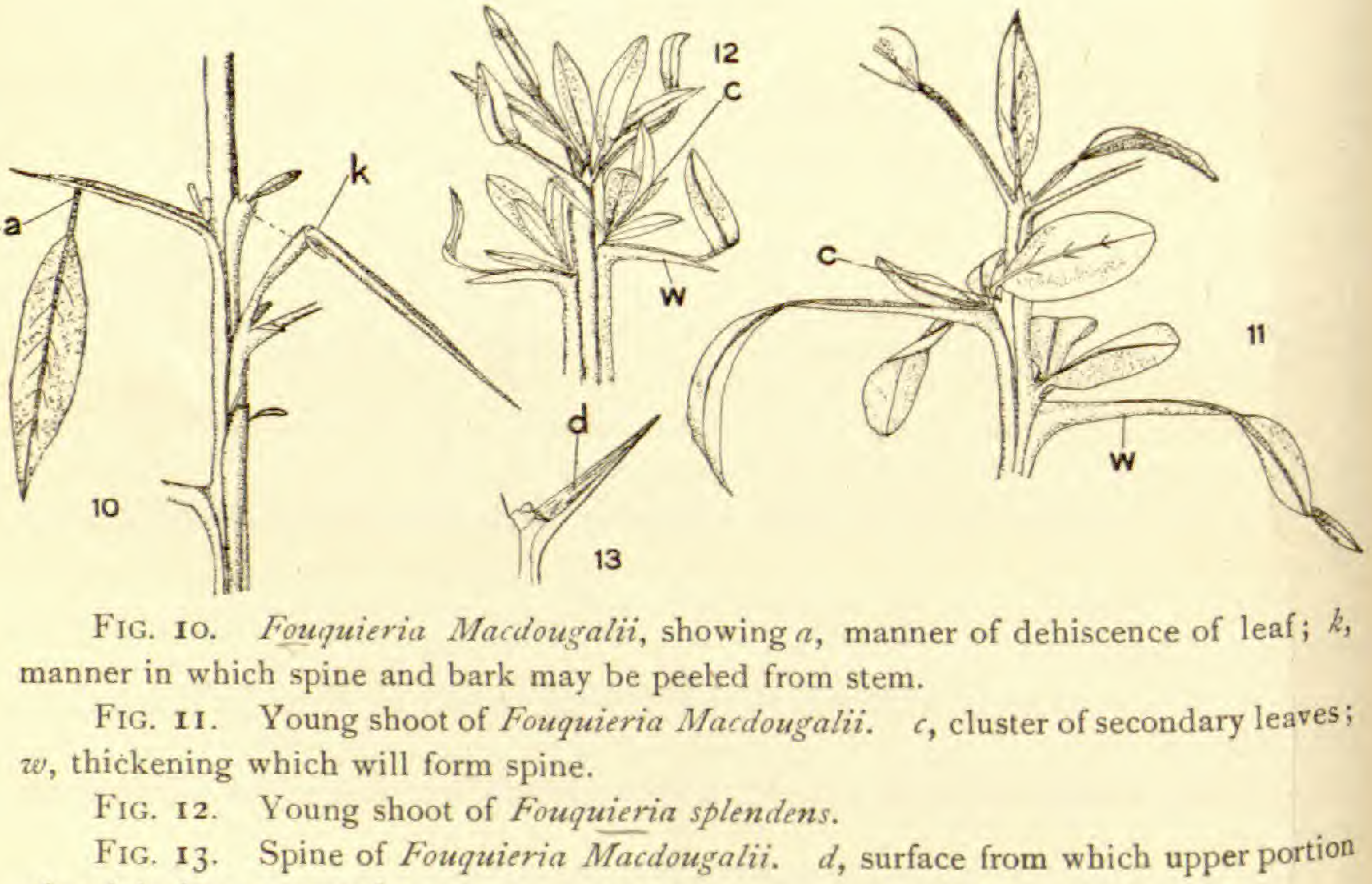


FIG. 10. *Fouquieria Macdougalii*, showing *a*, manner of dehiscence of leaf; *k*, manner in which spine and bark may be peeled from stem.

FIG. 11. Young shoot of *Fouquieria Macdougalii*. *c*, cluster of secondary leaves; *w*, thickening which will form spine.

FIG. 12. Young shoot of *Fouquieria splendens*.

FIG. 13. Spine of *Fouquieria Macdougalii*. *d*, surface from which upper portion of petiole has separated.

(Jour. de Bot. **13**: 295. 1899) has described the leaves of the long branches as having sclerenchymatous cells prolonged from the sclerenchymatous layer beneath the epidermis of the stem, on the under side where the epidermis is in contact with the cortex. He considers this subepidermis as the outer part arising from the division of the cortex into two well-differentiated layers, and criticises Baillon (Hist. Pl. **9**: 242. 1888) for referring to the spines as leaves reduced to a midrib. Such a section as that shown in diagram in FIG. 9, where there are several layers of parenchymatous cells between the sclerenchyma (*s*) and the epidermis, shows that the sclerenchymatous cells arise not from a distinct outer layer of the cortex, but within the cortex. Like the prickles of the blackberry and rose, the spines of *Fouquieria* have no vascular tissue, but unlike them, the sclerenchymatous tissue arises from the cortex, not from the cuticle and the abscission layer is nearly at right angles with the axis of the stem instead of being parallel with it and in the surface of the stem.

Various questions naturally arise in the study of such a structure as the spines of the *Fouquieriaceae*. How did these spines originate? Was the stimulus external or internal which caused the original variation? Is *Fouquieria* a genus that was separated from its parent form at a remote period, so that the intermediate forms between it and the other *Polemoniales* have become extinct, or is it a relatively new genus? Is it a stable form, or do the different plants vary in wide range?

Spinose processes are so characteristic of desert flora that the inference was long ago drawn that there is a close association between their structure and environment. The usual corollaries of spine development, reduction in surface and elaborate adaptations for water-holding, as well as the protective character of the spines themselves in warding off the attacks of animals, are such important factors in the maintenance of a genus in arid regions, that it is easy to reason that they are the outcome of influences in those localities external to the plant.

Kerner, Henslow, and others of the older botanists have been inclined to emphasize the principle that "specific forms, on the whole, fit the places they have to live in," rather than their inherent tendency to variation. No experiments have been performed upon

Fouquieria to test the effect of changed climatic conditions upon it, but it has been observed that in greenhouses the leaves remain attached to the plant a number of months, while in nature they are usually cast off at the end of a few weeks ; and in some years, in the wild state, no leaves are produced. Lothelier's experiments upon the barberry (Rev. Gén. Bot. **2** : 276. 1890) showed that when grown in moist air it loses its spines. Henslow (Jour. Linn. Soc. Bot. **30** : 223. 1895) has made a similar observation for *Ononis spinosa*, one variety of which living upon sandy shores is covered with spines, but becomes less and less spinose in favorable conditions or under cultivation, and he cites the cultivated apple and pear as similar examples. Miss Dale (Ann. Bot. **15** : 59, 497. 1901) has noted that when tubers of *Dioscorea* sent out shoots in light and without moisture, the leaves were scarcely developed at all, and the same thing may now be observed in the Museum of the New York Botanical Garden, where tubers of *Dioscorea* in the exhibition cases have sent out branches, the leaves of which are greatly reduced.

There is a wide gap between *Fouquieria* and *Cantua*, its nearest relative among the *Polemoniales*, which fact together with the small number of species in the genus, its confinement to a limited area, and its stability may be taken to indicate that it is an old form, though there is no geological record so far as is known of any similar spine-bearing form.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1901-1903)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material ; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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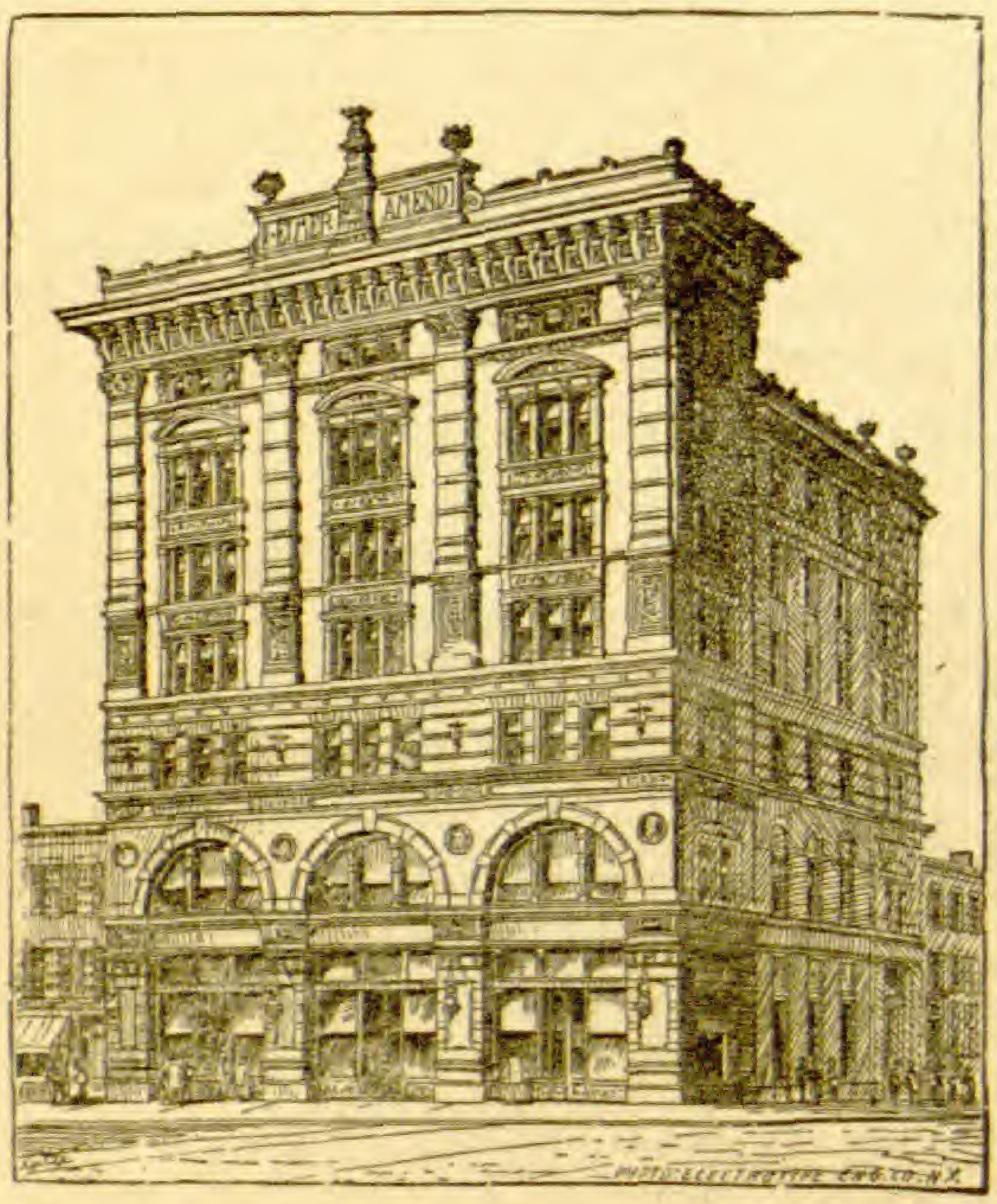
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FEBRUARY, 1904

The influence of carbon monoxide and other gases upon plants*

H. M. RICHARDS AND D. T. MACDOUGAL

Some time since the authors began an investigation of the influence of carbon monoxide upon plants, in which this gas was used to replace partially or entirely the nitrogen of the air. Attention was directed chiefly to the effects upon the cell-contents, upon growth and developmental phenomena and no consideration was given to the possibility of the use or absorption of the substance by the plant. Later comparative series of experiments were made with nitrous oxide and various mixtures furnished for illuminating purposes.

The striking character of the results already obtained, as well as the recent publication by Bottomley and Jackson of their conclusions as to the ability of the green plant to utilize carbon monoxide in the construction of food-material (Proc. Roy. Soc. **72**: 130. 31 Jl 1903), led the authors to make public at this time some of the important facts that have been brought to light in their work.

In most of these experiments the CO used was prepared by the decomposition of oxalic acid with strong sulphuric acid. As a check, however, some additional series have been tried with the gas prepared from other sources, namely, potassic ferro-cyanide, which when treated with concentrated sulphuric yields CO as the only gaseous product, and by passing a current of carbon dioxide over glowing charcoal, giving pure CO. Although in all cases

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* Read before the Botanical Society of America at St. Louis, December 30, 1903.

[The preceding number of the BULLETIN, Vol. 31, No. 1, for January, 1904 (31: 1–56) was issued 19 Ja 1904.]

the chemicals used were of the purest form obtainable, it was not thought advisable to trust to the product being free from impurities. Of course in preparing CO from oxalic acid it was necessary to wash out the CO_2, which may easily be done, but in addition to this in all but the preliminary experiments the gas was passed over potassium permanganate, mercuric chloride, etc. The analyses of gases produced by both methods showed the presence of no impurity except a small portion of atmospheric air, which varied from 1.3 per cent. to 9 per cent. according to the method of preparation and the setting up of the experiment. The illuminating gas used was taken directly from the mains at Barnard College and at the New York Botanical Garden. No thorough analysis of this mixture was made, but the tests applied showed the presence of an amount of carbon monoxide not far from 40 per cent. of the total volume.

A small number of tests were made upon germinating seedlings and it was found that a proportion of 90 per cent. or higher of carbon monoxide in the air around the seeds prevented all action of swollen seeds except in the pea, which succeeded in making roots less than a centimeter in length, and ultimately killed all the seeds. A smaller proportion of the illuminating gas mixture was found to be inhibitory and fatal. Swollen seedlings of several species germinated in atmospheres containing about 70 per cent. of carbon monoxide, but the consequent growth and development was restricted.

The results obtained from the exposure of seedlings germinated in the usual manner gave many facts of great interest and significance. The seeds were placed in moist sphagnum and allowed to remain until the seedlings began to free themselves from the seed-coats, in short until the seedling reached a period of rapid growth when there would be likelihood of quick reactions to abnormal conditions. Glass vessels, varying in size according to the size of the seedlings, were then taken and after the flower-pots had been properly arranged in them, the air was completely replaced with water, after which a mixture of the gases desired was run in to displace the water, except for a water seal at the bottom. In the water some potash was placed, to absorb the CO_2 given off, great care being taken to have the flower-pot containing the seedlings so supported that there would be no danger of the potash "crawling" and reaching the young plants. The diminution in volume caused by the absorption of CO_2 was corrected by running in pure oxygen at intervals as required — usually twice every twenty-four hours. Thus the atmosphere (as repeated analyses showed) was kept at normal oxygen pressure and the CO, being so very slightly soluble in water, did not diminish perceptibly. The same is also true of the illuminating gas experiments. In all respects, even to the mechanical manipulation, the controls were treated in the same way as the experiments with the gases. All of the plants had equal illumination, and while of course in the winter time some etiolation is unavoidable, the conditions of the bell-jars were precisely similar in any one experiment.

A list of the seedlings on which experiments have been completed, up to date, is as follows: *Vicia faba, Zea Mays, Sinapis alba, Helianthus annuus, Triticum vulgare, Fagopyrum Fagopyrum* and *Oryza sativa.*

The effect of these gases on the condition and growth of the above-named seedlings may be considered under the following heads: (1) Growth in length; (2) growth of secondary members; (3) growth in thickness (primary); (4) growth curvatures; (5) formation of chlorophyl. It is to be understood that in all of the experiments of this series the nitrogen of the air was replaced with either CO or illuminating gas (referred to hereafter merely as "gas").

Under the first head we may take up for consideration a considerable number of measurements which have been made. These measurements are of the length of the primary root and of the shoot, or in the case of the monocotyledonous forms of the distance from the seed to the tip of the longest leaf. There is shown in general to be a very clearly marked retardation, which must finally amount to a toxic effect, in both CO and gas. Taking the average of three experiments with *Vicia*, each experiment being in itself an average of from 8–10 individuals, we find the approximate ratio of the length of the shoot about as follows: The normal being 25, in CO it is 15, and in gas only 10; while a similar comparison of the length of the primary root gives the following ratio: control 30, in CO 12, in gas 10. Corn seedlings showed like discrepancies between the normal and the plants grown in CO and gas atmospheres. The ratios of the length of the seedling from the seed to the tip of the longest leaves, taken from three experiments each of which were the averages of at least 8 individuals, is: control 21, in CO 11, in gas 10; of the actual main axis itself: control 20, in CO 15, in gas 10; and of the primary root: control 40, in CO 15, in gas 10. The controls showed about twice as many unfolded leaves as did the plants grown in CO, while in gas the leaves had barely begun to break through their sheaths.

Buckwheat, sunflower and mustard seedlings exhibited similar behavior and the ratios of the length of their hypocotyledonary stems and of their primary roots would be nearly the same as the forms given above. Squash seedlings showed especially well-marked differences in the different gases, the caulicles of the controls being seven times longer than those in gas, while the roots of the former were ten times longer. Those in CO, though a little more developed than the ones in gas, were dwarfed as compared with the normal. Naturally the squash is sensitive to diminished light so that some etiolation was to be expected, but all were under equal light conditions. Perhaps the most striking of all the experiments were those with wheat and rice. The wheat grew but little in gas, but fared better in CO. As to the length of the shoot to the tip of the longest leaf, we have the following ratios: control 12, in CO 9, in gas 1; while on comparison of the average length of the several adventitious roots the difference is not so marked: control 2, in CO 1.2, in gas 1. The difference in the roots became evident on examining the branches; secondary rootlets were almost absent in the specimens from the gas, and were few in those plants grown in CO, but were not only plentifully developed but also branched again in the control experiment. The normal also showed two unfolded leaves with a third just unrolling, while in the CO specimens there was barely one, and in those from gas the leaves had hardly broken out of the curiously swollen leaf-sheath. Rice exhibited one of the most prettily graded series. It grew luxuriantly in the moist atmosphere, and the length of the leaf-tip from the seed being 1 in the gas culture, that in CO would be about 2 and the control 6, with a nearly similar ratio as regards the average length of the several roots. As to the branching of the roots and the unrolling of the leaves, what was said about the wheat applies here.

In considering the secondary members both of the root and of the shoot, it may be said in general that the seedlings in gas and CO presented a very imperfect development. Branches of the shoot were only observed in *Vicia* and while the control showed such branches frequently the others did not. Secondary roots were observed in all cases, however, and it was found that in CO and gas the formation of the regular root-system was greatly retarded if not inhibited. In the latter secondary branches were few and poorly developed, while the controls would have a healthily developed system. In gas especially the roots often appeared sickly, more so indeed than the shoots. In the corn, while the normal root-system was far from being completely formed in CO or in gas, an interesting exception was seen as to the production of lateral members, which as has been said are usually fewer in these cases than in the normal. Below the circle of adventitious roots ordinarily developed in corn seedlings a considerable number of supernumerary secondary roots arose without order and grew out for a millimeter or two.

In connection with this may be introduced a description of the peculiar thickening noticed at the base of the stem of many of the seedlings grown in CO or in gas. In *Vicia* for instance the normal diameter of the base of the stem next the seed being 3.5 mm., the CO specimens were 4.5 mm., and those in gas were 5.0 mm. in diameter. *Helianthus*, *Fagopyrum* and *Sinapis* also showed a similar but less well-marked thickening, and the curious enlargement of the leaf-sheath in the wheat and rice seedlings has already been referred to. In corn, however, the difference in size of the stem-base is most conspicuous and seems to be connected with the formation of the supernumerary roots just spoken of. The corn is the only form that has so far been examined microscopically and the anatomical conditions are briefly as follows. The cells of the cortical parenchyma are greatly enlarged, though apparently no more in number. In the plants grown in CO these cells measure from one third to one half more in diameter than do those of the control, while in the gas specimens they are swollen to nearly twice their ordinary diameter. The bundle-ring of the developing plerome cylinder is scarcely greater in diameter in the CO specimens than it is in the normal and in the sections examined shows little or no difference in structure. Not so, however, in the plants from the gas cultures. Here the axial bundle-strand is nearly twice the normal diameter, the size of all of the developing bundle-elements is exaggerated to about the same extent as is the parenchyma, and the walls are much less thickened than they normally are. The difference is very striking. The whole stem-base appears to be in a less differentiated condition than normal to it at that age, a circumstance which perhaps accounts for the very free formation of the extra roots.

The normal growth being in general checked by the gases used, it is natural to suppose that the growth-curvatures would also be affected, and such appears to be the case. In CO the seedlings most sensitive (*e. g.*, mustard) showed little or no curvature in response to phototropic stimulus, and in gas whatever development took place was quite irrespective of the angle of the incident rays. Similarly there seemed to be a less degree of sensibility to geotropic stimulus, especially noticeable in the adventitious roots of the corn and in those supernumerary roots formed in the thickened stem of the same plant.

Together with the other inhibitive effects of CO and gas it was noticed that the chlorophyl formed much less quickly than under normal conditions. In fact mustard seedlings, sprouted in the dark, scarcely greened after a week's exposure to sunlight while in an atmosphere with gas, though the control showed the effects of the light in the course of a few hours. In CO the action was also retarded, but not nearly so much as in gas. It must not be supposed, however, that this lack of chlorophyl is necessarily the explanation of the retarded growth. Most of the seedlings in the above described experiments did not in the course of the experiment pass beyond the stage where they chiefly rely upon the stored food in the seed. Also in some cases the chlorophyl did finally assume its normal color, without bringing about any increase in the rate of growth. Finally it may be said that some experiments which were kept in the dark all the time, showed that the etiolated plants behave similarly to the ones in the light.

Effect of nitrous oxide. — N_2O was prepared from NH_4NO_3, and purified over ferrous sulphate, potassic hydrate and water. Seedlings of mustard were arranged in the bell-jars in the same manner as in the CO experiments, except that a mercury seal was used. At the beginning of the experiment the hypocotyledonary stems of the seedlings were on the average 4 mm. long. After five days those of the control were 5 cm. and of the ones in 80 per cent. N_2O, 2.6 cm., while the average of those in 40 per cent. N_2O was about half-way between the two. The root-system also showed the effect of the gas, being both shorter and less branched in the seedlings exposed to the N_2O.

A trial experiment was also made with fungi to see if these plants could use the gas as a source of nitrogen. Three parallel series were set up, one with a normal culture fluid containing a nitrate and two with the same culture fluid minus the nitrate. Of the last two, one was left in air, the other exposed to an atmosphere containing about 60 per cent. N_2O, and normal oxygen. Up to this time neither of the series without nitrates have shown any development, while the control with the normal culture solution has produced a thick fruiting felt. The fungi used were *Sterigmatocystis nigra*, *Penicillium glaucum* and *Rhizopus nigricans*. It has, indeed, been reported somewhat indecisively that nitrous oxide can serve as a nitrogen source, but these negative experiments do not agree with such a conclusion.

Another phase of the influence of the gases was to be found in their action upon the shoots and roots of woody or succulent perennials. If the basal portion of a shoot of such plants as *Gossypium* or *Haematoxylon* were enclosed in a bell-jar with the stem extruding through a tubulure properly sealed around it, both illuminating gas and carbon monoxide acted as a very slow poison which caused the leaves to become desiccated and to fall off after periods varying from about four to twenty days, and the plants were killed.

If entire plants of *Haematoxylon, Mimosa, Meibomia* (*Desmodium*), *Opuntia* or *Mesembryanthemum,* were enclosed in the bell-jar containing the gases, several important reactions might be noted. First it was to be seen that if the enclosing chambers were filled with a mixture of carbon monoxide or illuminating gas containing over

90 per cent. of carbon monoxide, practical asphyxiation occurred in *Meibomia*, *Haematoxylon* and *Mimosa*, the leaves becoming discolored and turning brown, but not being cast away, the small amount of oxygen present and the strong toxic action of the other gases coöperating to kill the leaf before separatory layers could be formed.

In all tests in which a supply of oxygen fairly equal to the normal was present, the leaves of the three plants were discolored and cast away within a week, and at the end of that period appeared to be much more seriously damaged than those in higher percentages, which appearance however might be seen to be erroneous on closer examination. Plants exposed to both higher and lower proportions for two weeks revived and sent out new leaves when placed in the propagating houses. Tests with young plants of *Opuntia tuna* and with cuttings of a species of *Mesembryanthemum* showed that the last named is much more readily killed by the gases, the entire plant perishing after exposures for a month to atmospheres containing as much as 25.5 per cent. carbon monoxde.

In marked contrast with the foregoing is the behavior of the gametophytes of some of the mosses. Such forms as *Catherinea angustata*, *Dicranella heterophylla* and *Physcomitrium turbinatum*, were able to endure atmospheres containing the highest practicable proportions of carbon monoxide or of illuminating gas for periods of over three months, with but little damage and that to the older leaves, in which the cell-contents and chloroplasts were variously and deleteriously affected. In two instances sporophytes were formed. During this period the gametophytes had formed numbers of new leaves, and their resistance could not be attributed to the possibility of being in a resting condition.

Some observations on a more delicate moss, presumably *Mnium undulatum*, show that these gases are not always without effect even on these plants. It should be said, however, that the changes in the cell-contents herein noted proceed so far and no farther, without involving the death of the plant as a whole.

The *Mnium* leaves after exposure for about three weeks to atmospheres of 80 per cent. CO and of 80 per cent. gas respectively, were in general lighter in color. Microscopical examination confirmed this and revealed the fact that the chloroplasts had been considerably affected. In the control the cells were full of large, somewhat elliptical chloroplasts and about 2 per cent. of the cells appeared to be dead. In CO the chloroplasts were smaller, with considerable spaces between them, and were fewer in number. In shape they were usually similar to the normal, though in some cases they were curiously elongated. About 20 per cent. of the cells seemed to be dead. In gas as many as 33 per cent. of the cells were dead and often quite empty, and the chloroplasts were much fewer, paler and smaller than in the control, being often nearly spherical in shape. Some of the specimens were returned to the respective gases in which they had been, some were returned to the air. After two weeks the specimens returned to the air were examined. The cells not actually killed, had in both the CO and the gas specimens almost regained their normal appearance, though still somewhat paler than the normal. In the gas specimen, however, so many of the cells had been killed that the older leaves dried up. The growing tips of all appeared fairly healthy. The plants returned to the gases were examined after an additional five week's interval and very little difference was seen as compared with the condition presented at the first examination.

Philotria Canadensis (*Elodea Canadensis*) was exposed to the same conditions, being arranged so that it came in contact with the moist surrounding atmosphere. The leaves showed a somewhat similar degeneration, but rather more serious. After eight days exposure an examination of the CO experiment demonstrated that while the young leaves were not so much affected as compared with the normal, the older leaves were. Many cells in the latter had their contents plasmolyzed or completely disorganized. In the specimens from the gas more than half of. the cells were dead and in those that were not the chloroplasts were small and pale. The occurrence of large oxalate crystals was common, suggesting a derangement of the assimilatory functions. In the control almost all of the cells appeared healthy and showed rotation.

Some specimens of a *Nitella* were followed in a control and an 80 per cent. CO experiment. The older cells of both were attacked by bacteria and killed, but the younger cells remained healthy. In the control the typical rotation was observed and the cells appeared quite normal. In CO the younger cells while alive were paler than the normal and the peripheral layer of motionless protoplasm was enormously thick and apparently very much denser than in the usual condition. The chloroplasts were gorged with starch.

As a result then of progress already made in our experiments it may be said definitely that carbon monoxide, which has been hitherto considered neutral and without influence on plants, is in effect highly toxic when used to replace, partially or entirely, the nitrogen of the atmosphere. The experiments have not yet yielded sufficient detail to allow any determination of the point at which it ceases to be toxic, or to determine whether or not, like carbon dioxide, it stimulates growth when present in small proportions in the atmosphere. It has been shown, however, that a wide range of reaction to this substance is to be found among plants.

The deleterious action of the carbon monoxide results in modifications, of the rate and amount of growth, of the differentiations of the primary tissues, and of the formation of chlorophyl.

Illuminating gas, containing proportions of carbon monoxide slightly above and below 40 per cent., affords, in addition to the toxic action of the carbon monoxide, the results of the action of other substances deleterious to the plant.

The contents of this abstract will be published as soon as practicable, but the description of the details of the experimental tests and a consideration of the whole subject will await the conclusion of the investigation.

Additions to the flora of the Matawan formation

EDWARD W. BERRY

(WITH PLATES 1–5)

The following notes are based for the most part on collections made by the writer near Cliffwood, Monmouth County, New Jersey, during the spring and summer of 1903, although some of the material was collected the previous year.

This locality, in all probability, furnished the specimens described by Newberry in his Flora of the Amboy Clays as from "near Keyport." He did not, however, recognize it as a distinct horizon. Hollick in 1897 published a brief paper on this flora, recognizing twenty-six species from this locality. The writer in previous papers * increased this number to seventy-two and the present contribution raises the number of known species to eighty-five, most of which are represented by well-characterized remains.

A complete discussion of this flora is postponed for the present and will be included in a subsequent paper on the geology of the Matawan formation now in course of preparation.

No attempt has been made to give the synonymy except where the species mentioned is new to the flora.

FILICALES

GLEICHENIA ZIPPEI (Corda) Heer. (PLATE 4, FIGURE 6.)

Pecopteris Zippei Corda in Reuss, Verstein. 95. *pl. 49. f. 1.* 1846. Unger, Kreidef. Ostr. Sitz. Acad. Wien. 8. *pl. 2. f. 1.* 1867. Schimper, Pal. Vég. 1 : 672. 1869.

Gleichenia Zippei Heer, Fl. Foss. Arct. 1 : 79. *pl. 43. f. 4.* 1868; 3 : 44, 90, 97. *pl. 4, 5, 6. f. 1–3; pl. 7. f. 2; pl. 25. f. 1–3; pl. 26. f. 10–13.* 1874; 4 : 49. *pl. 32. f. 6, 7.* 1877; 6^2 : 36. *pl. 3. f.* 2. 1882; 7 : 7. 1883. Newb. Fl. Amboy Clays, 37. *pl. 3. f. 5.* 1896. Ward, Ann. Rep. U. S. Geol. Surv. 19^2 : 664. *pl. 162. f. 9.* 1899.

This widespread species is represented in our collections by a single poor specimen, much broken, and showing only the pinnules of one side. Easily distinguished from *Gleichenia Saundersii*

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* Berry, Bull. N. Y. Bot. Gard. 3 : 45–103. *pl. 43–57.* 1903. American Naturalist, 37 : 677–684. *f. 8.* 1903.

Berry, from this formation, by the comparatively longer more rounded pinnules with more numerous secondary veins, nearly all of which are forked. The recorded range for this species is from the Neocomian to the Senonian, inclusive, in Europe, and from the Urgonian to the Cenomanian, inclusive, in this country.

GYMNOSPERMAE

GEINITZIA FORMOSA Heer. (PLATE 4, FIGURES 2, 3.)

Poorly characterized cones of this species were recorded by Hollick from this formation in 1897. Collections made during the past summer contain three characteristic twigs of this species. Leaves are upwards of 12 mm. in length, slender, averaging 1.2 mm. in width, much recurved; only spreading to about 5 mm. from the stem on each side.

Differs from the material described by Knowlton * from the Montana formation in the greater length of the leaves, which are also more slender and much more crowded; both have the thickened stem. Our specimens agree admirably with Newberry's figured specimen from the Raritan, which Knowlton (*l. c.*) considers positively identified. *Sequoia Reichenbachi* (Gein.) Heer from the Matawan formation is much more common, with more slender stems and less crowded leaves, which are also shorter and less recurved.

Pinus delicatulus sp. nov. (PLATE 1, FIGURE 12.)

The single specimen shows a large number of linear, pointed, apparently flat and ribbed, not terete or thickened, much broken and macerated leaves; of which none is apparently perfect. Some fragments are 12 mm. long and all are somewhat less than 1 mm. in width, and a midrib is plainly discernible in some of the fragments. While the illustration apparently shows needle-like leaves, they appear in the clay as of thin and delicate texture.

While these remains may appertain to the same species as the seed described by me from this formation, it has seemed best to keep them separate until they are found more nearly associated. There is considerable resemblance shown to Fontaine's *Laricopsis* of the Potomac formation in appearance and in the deciduous nature of their leaves.

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* Knowlton, U. S. Geol. Surv. Bull. 163: 28. *pl. 5. f. 1, 2.* 1900.

PROTOPHYLLOCLADUS SUBINTEGRIFOLIUS (Lesq.) Berry.[*] (PLATE 1, FIGURE 5.)

The Cliffwood specimen has the nervilles fine, .75–1.00 mm. apart, and shows no trace of a midrib, a feature which is scarcely defined in small leaves of this species, and wanting in several of Heer's figures, as well as in Hollick's leaf from Staten Island.

SEQUOIA GRACILLIMA (Lesq.) Newb. (PLATE 2.)

These cones are exceedingly common in the shingle on the beach after severe storms. Last summer's collections contain no less than thirty-nine specimens, many of which are of considerable size.

Following are the lengths of the largest specimens: 7.3 cm., 7.9 cm., 8.1 cm., 8.25 cm., 8.6 cm., 9 cm., 9.5 cm., 10.2 cm.

Plate 2 gives an excellent idea of the appearance and size variations of these cones. *Figure 3* is the least flattened by compression, being nearly round. The scales are hexagonal and in juxtaposition. Most of the specimens, however, are considerably flattened, the scales are somewhat separated, and they do not preserve their hexagonal outline with any degree of regularity. This is well shown in *figure 4*.

SEQUOIA REICHENBACHI (Gein.) Heer. (PLATE 4, FIGURE 8.)

The specimen figured is probably a small cone of this species, although there is considerable resemblance to some of the cones of the widespread *Sequoia Langsdorfii* (Brongn.) Heer, of the upper Cretaceous and Tertiary of both continents, which comparison is heightened by the finding at Cliffwood of a single detached leaf (*no. 506*) not figured or described, which seems referable to that species, but which may perhaps be a leaf of *Cunninghamites elegans* or *Sequoia heterophylla*.

DAMMARA CLIFFWOODENSIS Hollick. (PLATE 1, FIGURE 11.)

The proofs of my Matawan Flora were not revised until after I had collected the specimen here figured, and I removed the interrogation mark which Hollick placed after this species, as it seems more nearly allied to the scales of the existing *Dammara* than any of Heer's species.

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[*] See Berry, Bull. Torrey Club, **30**: 440. 1903.

The specimen is an unusually perfect one and shows that the nearly straight lateral margins which become very thin are not usually preserved. There is no indication of the apical point figured by Hollick; on the contrary the apex is evenly rounded. In outline and size it is very similar to the scale from Tottenville, Staten Island, doubtfully referred by Hollick to *Dammara borealis* Heer. In the present collections these scales are not as abundant as in those of the previous season, although they still form a decided element in this flora.

CUNNINGHAMITES ELEGANS (Corda) Endl. (PLATE 3, FIGURES 7, 8, 9, 11.)

Last summer's collections contain numerous unmistakable fragments of this species, one a twig 7.7 cm. long.

CUNNINGHAMITES SQUAMOSUS Heer.

Remains of this species are not so common as in the previous season's collections, but several good specimens were collected including some twigs 8 cm. long. The portions of stems shown on *plate 5, figures 2* and *3*, are of this species or the preceding.

MORICONIA CYCLOTOXON Deb. & Ett.

Sparingly represented in the collections of 1903 by the same large-sized forms as those previously found.

FRENELOPSIS Schenk, Palaeont. **19**[1]: 13. 1869

Several species of Cretaceous plants have been referred to this genus, so named from their resemblance to the existing species of *Frenela* of the Australian region. The consensus of opinion seems to be that they are referable to the *Cupresseae*, although Heer is inclined to ally them with *Ephedra* among the *Gnetales*, and Schimper includes them in the *Taxaceae*. In lower Cretaceous times they ranged from the Mediterranean region of Europe to Greenland and North America, and their latest known appearance is in the Senonian of Westphalia. That these somewhat peculiar forms did not become extinct is evidenced by the remains referred to the closely allied, if not identical, genera *Widdringtonia*, *Widdringtonites* (*Frenelites*) and *Callitris* which occur both in Europe and in America, where they are common in the Cretaceous Atlantic coastal plain from New Jersey to Greenland. They persist as late as the Miocene, both in Europe (Bohemia, France, Germany and Italy) and in the Arctic region (Kudliset). Schenk (*l. c.*) calls attention to the great resemblance to *Frenelopsis* of the remains from the Italian Tertiary which Massalongo describes under the name of *Aularthrophyton* and of which Fontaine (1889) says: "It is difficult to believe that they belong to different genera."

The living genus is, according to modern usage, included in *Callitris* Vent., which as thus constituted becomes divisible into four sections: (1) *Octoclinis* (*Frenela* Benth.), (2) *Hexaclinis* (*Frenela* Mirb.), (3) *Pachylepis* (Brongn.) = *Widdringtonia* Endl., and (4) *Eucallitris* (Brongn.). The first two sections with some seven species are confined to the Australian region, while section 3 is confined to South Africa and Madagascar, and section 4 with one species, *Callitris quadrivalvis* Vent., is confined to the north coast of Africa. The habitat of the latter leads Coulter (1901) to suggest a recent avenue of migration through the southern Asiatic region, but it should be remembered that northern Africa was geographically and biologically a part of Europe in the upper Eocene, again in the lower Miocene, and finally during the early Pliocene, so that *Callitris quadrivalvis* might well be a relict of the similar species we find in the European Miocene. The South Africa and Madagascar forms may have traversed the ancient land connection between Africa and Asia in order to reach Australia, although their absence in the present Asiatic flora is remarkable if this was the route taken. It is quite possible that their actual migration was over the land bridge formed by the northerly extension of the continent Antarctica, which recent zoo-geographers are making so much use of (Blanford 1890, Forbes 1893, Osborn 1900).

The distribution of the *Cupresseae* as a whole, in past times as well as in the present, while a problem so intricate as to baffle our present knowledge, is one of exceeding interest.

FRENELOPSIS HOHENEGGERI (Ett.) Schenk. (PLATE 4, FIGURES 9, 10.)

? *Culmites priscus* Ett. Beitr. Fl. Wealdenp. 1^3: 24. *pl. 1. f. 5* 1852.
Thuites Hoheneggeri Ett. *ibid.* 26. *pl. 1. f. 6, 7.* 1852.

Frenelopsis Hoheneggeri Schenk, Palaeont. **19**^{1} : 13. *pl. 4. f. 5–7; pl. 5. f. 1, 2; pl. 6. f. 1–6; pl. 7. f. 1.* 1869. Heer, Fl. Foss. Arct. **3** : 73. *pl. 18. f. 5–8.* 1874; **6**^{1} : 7. *pl. 2. f. 1–3.* 1880; **6**^{2} : 16. 1882. Fontaine Proc. U. S. Nat. Mus. **16** : 275. *pl. 42. f. 4, 4a.* 1893. Newb. Fl. Amboy Clays, 58. *pl. 12. f. 4, 5.* 1896.

This species which is common in the Urgonian of Austrian Silesia has been quite elaborately described and figured by Schenk (*l. c.*). If the various identifications of other authors are correct it was a widespread and persistent type, ranging from the Neocomian to the Turonian in Moravia, France, and Austrian Silesia, as well as in Greenland (Kome). In the United States it has been recorded from the Trinity of Texas and the Raritan of New Jersey, while very similar species occur in the Potomac of Maryland and Virginia. Its occurrence in the Matawan brings it down to a still later period. The Matawan specimens are numerous and fragmentary, and are distinguished with difficulty from the many fragments of other twigs preserved in the clays, all of which except the silicified forms have shrunk and have a more or less jointed appearance. All are decorticated and I fail to find any traces of leaves, but the regularity of the joints and the absence of longitudinal cracks in the larger specimens, which are always present in other twigs of similar size, has constrained me to refer them to the above species. Until material with positive traces of leaves is found this reference can only be provisional.

Gymnospermous Cone. (PLATE 4, FIGURE 7.)

I cannot conclude whether this is a cone with comparatively thin overlapping pointed scales, or whether it is a much-worn cone with thick-keeled scales which would then be inverted in the figure. The scales certainly seem to overlap in places, but this feature is much obscured, and I rather incline to the interpretation that we have a petrified cone of *Sequoia* which has washed out of the clay and become much reduced and worn smooth in the wash of the beach. As it stands it might be compared, except for its larger size, with the staminate strobili of *Podocarpus* or *Phyllocladus.* If it should prove to be a cone with imbricated pointed scales I would be inclined to associate it with the genus *Cunninghamites,* remains of which are so abundant in this formation. In this connection its resemblance to the cones described by Ettingshausen as *Cunninghamites Sternbergii*, from the synchronous horizon of Niederschöna, Saxony, is perhaps more than suggestive.*

ANGIOSPERMAE

MYRICA Linn. Sp. Pl. 1024. 1753

A cosmopolitan genus at the present time, except for the Australian region (Notogaea), although remains referred to this genus have been described by Ettingshausen from the Tertiary of eastern Australia and New Zealand.

The existing species number about three-score and are wide-ranging, the same species thriving within wide limits of climate and soil conditions. As might be expected from its scale of organization, *Myrica* is abundant during the Cretaceous, showing its greatest display of extinct forms in the Tertiary, however. Well represented in the fossil floras of Europe, Schimper thirty years ago records eighty-six species of leaves and one of fruit, mostly from European localities, where they make their greatest display somewhat later in the Tertiary than they do in America. The fossil species found on this continent number some seventy forms, distributed as follows: Potomac 1; Raritan (N. J.) 8; Raritan (Islands) 3; Dakota 10; Atane 5; Patoot 3; Montana 2; Laramie 2; Eocene 11; Green River group 19; Miocene 4; Miocene (so-called) of Greenland 9.

Eighteen of these forms are common to Europe.

Myrica Cliffwoodensis sp. nov. (PLATE 4, FIGURE 1.)

This species is founded on a single drupe or nutlet, which is 4.1 mm. in diameter, and which is almost certainly referable to *Myrica*. Although slightly flattened by pressure, it was evidently globose and had a short stem, somewhat under 2 mm. in length. While it may appertain to *Myrica Heerii* Berry, the only species represented by leaves in this formation, we cannot be certain of this and it was thought best to keep it separate.

Seeds, so called, of *Myrica* are reasonably common as fossils, of which the following have come to my notice:

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* Ettings. Kreidef. v. Niederschöna: Sitzb. Akad. Wiss. Wien, **55**^{1}: 12. *pl. 1. f. 4-6.* 1867.

Ludwig, 1858, describes them from the Miocene lignite beds of Wetterau at Dorheim in Hesse, and Engelhardt, 1870, detects the same species (*Myrica granulosa*) in the Tertiary of Saxony, at Quatitz and Kleinsaubernitz.

Heer, 1859, describes fruits of *Myrica Ungeri* from the Miocene of Switzerland.

Heer, 1868, refers fruit and leaves from the Tertiary of North Greenland (Atanekerdluk) to *Myrica acuminata* Unger.

Heer, 1869, describes seeds in the same clays with the leaves of *Myrica Schenkiana* from Quedlinburg (Senonian). The same year Heer describes fruit from Rixhöft which he referred to *Myrica Studeri* and from Rauschen which he referred to *Myrica* (*Comptonia*) *Vindobonensis* both from the Baltic Amber (Oligocene).

Saporta, 1866, discovered the fruit of *Myrica hakeaefolia* in the French Miocene at Armissan.

Lesquereux, 1874, describes stems and seeds from the Dakota group of Nebraska (*Myricae*? semina).

Heer, 1874, describes seeds and leaves from Atanekerdluk, Greenland (Cenomanian) under the name of *Myrica Thulensis*.

Lesquereux, 1878, describes as *Carpites Myricarum*, seeds found with the leaves of *Myrica Torreyi* at Black Buttes, Wyoming (Laramie).

Heer, 1882, describes fruit from Ivnanguit, Greenland (Cenomanian).

Heer, 1883, figures the fruit of *Myrica* (*Comptonia*) *parvula* Heer from the Patoot beds (Senonian) of Greenland.

Velenovsky, 1883, describes and figures catkins and fruit of *Myrica* from the Cenomanian of Bohemia.

POPULITES TENUIFOLIUS Berry.

A single leaf of this species collected on July 29, 1903.

QUERCUS HOLLICKII Berry. (PLATE 3, FIGURES 4, 5.)

The present season's collection contains two specimens of this species in which the margin is less serrate and more inclined to be crenate, characters which are not very well brought out in the plate. They show some resemblance to *Celastrophyllum crenatum* Heer, but have a more ascending base and straighter secondaries.

Quercus eoprinoides sp. nov. (PLATE 4, FIGURE 11.)

Leaf ovate-lanceolate, about 10 cm. long by 3.5 cm. in greatest width; coarsely toothed, the rounded teeth becoming mere undulations toward the base; secondaries straight craspedodrome, leaving the midrib at an angle of about 35°; venation much obscured; leaf-substance apparently thin but coriaceous in texture.

Among the fossil leaves of this genus, ours shows some resemblance to the *forma obtusata* of *Quercus Westfalica* of Hosius & von der Marck (Senonian). In size and outline it may be compared with *Quercus flexuosa* Newb. from the Cretaceous of

Washington (state) and with *Quercus Lyellii* Heer from the Greenland Tertiary, both of which however have camptodrome venation. A leaf-fragment from the Laramie of Yellowstone Park termed by Knowlton *Phyllites* sp.* also seems to be quite similar.

Among the living species of oaks this Matawan species bears considerable resemblance to some of the leaves of the hybrid *Quercus Rudkinii* Britton, which may be found growing within a short distance of where the fossils were obtained. The living species has the venation camptodrome, however. The resemblance to *Quercus prinoides* Willd. in size, outline, and venation is most striking; the only difference being the tendency of the modern leaves to become wider and more decidedly toothed; numerous identical leaves may be found, however. *Quercus prinoides* has a wide range throughout the United States, mostly east of the Mississippi river, and may be phylogenetically related to the Matawan leaf.

FICUS ATAVINA Heer. (PLATE 1, FIGURES 8, 9; PLATE 3, FIGURE 6.)

Ficus protogaea Heer (non Ettingshausen, 1867), Fl.. Foss. Arct. **3**: 108. *pl. 29. f. 2b; pl. 30. f. 1–8.* 1874. Hollick, Bull. Torrey Club, **21**: 51. *pl. 175. f. 4.* 1894.

Ficus atavina Heer, Fl. Foss. Arct. **6²**: 69. *pl. 11. f. 5b, 7b, 8b; pl. 17. f. 8b; pl. 19. f. 1b; pl. 20. f. 1, 2.* 1882. **7**: 26. 1883.

Remains of several leaves of this species have been found at Cliffwood recalling the handsome leaves of the commonly cultivated *Ficus elastica* Roxb. with which Heer originally compared it along with *Ficus Benjaminea* and *F. stricta*. There is considerable resemblance to *Ficus Krausiana* Heer, which is recorded from the Dakota group of Kansas, the Raritan of New Jersey and Marthas Vineyard, as well as from the Cenomanian at Moletein, Moravia. The latter species is however more ovate. Our leaf is almost the counterpart in size, outline and venation of *Ficus Peruni* Velen. from the Cenomanian of Bohemia. The venation of his *figure 2* is identical with the Matawan leaf figured at *6* on our *plate 3*. Velenovsky compares *F. Peruni* with the living *Ficus nitida* Thunb. and *F. cuspidata* and *F. pulchella* Schott. He compares it with the fossil *F. Krausiana* Heer, and with the species we are considering.

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* U. S. Geol. Surv. Monogr. **32²**: *pl. 78 f. 7.* 1899.

MAGNOLIA SPECIOSA Heer. (PLATE 3, FIGURE 10.)

Magnolia speciosa Heer, Neue Denksch. Schw. Gesells. **23** : 20. *pl. 6. f. 1 ; pl. 9. f. 1 ; pl. 10. f. 1.* 1869. Lesq. Cret. & Tert. Fl. 72. 1874. Fl. Dak. Group, 202. *pl. 60. f. 3, 4.* 1892. Hollick, Trans. N. Y. Acad. Sci. **12** : 234. *pl. 7. f. 4.* 1893. Bull. Torrey Club. **21** : 60. *pl. 178. f. 5.* 1894. Bull. Geol. Soc. Am. **7** : 13. 1895. Knowlton in Hill, Ann. Rep. U. S. Geol. Surv. **21^2** : 318. 1901.

Described originally from the Cenomanian of Moravia (Moletein), it has been identified at various localities in the Dakota Group, Tuscaloosa, and Island Raritan. It has not as yet been detected in the Cenomanian of Greenland, although some of Heer's figures of *Magnolia Capellinii* are suggestively similar ; the latter species is, as a rule a wider, more robust leaf.

Magnolia speciosa seems related to a group of leaves exemplified by *Magnolia pseudoacuminata* Lesq., of the Dakota ; *M. tenuinervis* Lesq., as identified by Knowlton from the Montana formation ; *M. amplifolia* Heer, from Moletein and the Dakota, and *M. Californica* Lesq., from the Tertiary.

MAGNOLIA CAPELLINII Heer. (PLATE 3, FIGURE 3.)

Magnolia Capellinii Heer, Phyll. Crét. Nebr. 21. *pl. 3. f. 5, 6.* 1866. Fl. Foss. Arct. **3** : 115. *pl. 33, f. 1–4.* 1874 ; **6^2** : 90. *pl. 24. f. 3–5 ; pl. 25. f. 1–3 ; pl. 45. f. 1.* 1882. Lesq. Rept. on Clays, N. J. 29. 1878. Fl. Dak. Group, 203. *pl. 66. f. 1.* 1892. Velenovsky, Fl. Boehm. Kreidef. **3** : 20. 1884. Hollick, Trans. N. Y. Acad. Sci. **12** : 234. *pl. 6. f. 6.* 1893. Bull. Geol. Soc. Am. **7** : 13. 1895. Dawson, Trans. Roy. Soc. Canada, **11^4** : 63. *pl. 11. f. 49 ; pl. 13. f. 49a.* 1894.

Lesquereux in 1878 identified this species from the perishable material collected by Professor Cook at Sayreville, N. J., but it has not since been reported from the Raritan. None of Newberry's Amboy Clay material was of this species, although he made particular search for it. It should be remembered, however, that the majority of his specimens were from other horizons in the Raritan than the one at Sayreville. This is a characteristic Cenomanian species occurring not only in the Dakota, but in beds of this age in Greenland and in Bohemia.

MAGNOLIA TENUIFOLIA Lesq. (PLATE 1, FIGURE 7.)

A well-defined fragment of a large-leaved *Magnolia* with slender veins, referred to the above species because of other remains of this species found here.

LIRIODENDROPSIS Newb. Fl. Amboy Clays, 82. 1896

Comparatively small simple emarginate leaves of the mid-cretaceous, which are ancestral to the more typical species of *Liriodendron.* In view of the wide limits of variation exhibited by the living descendant of these early forms, I am inclined to question the wisdom of generic separation, particularly as the lines of demarcation between the species of the *simplex-primaevum* group have not been, nor can they be, closely drawn.

Saporta has described remains from the Cenomanian of Padrão Portugal, under the name of *Chondrophyton laceratum* * which Ward renames † *Liriodendropsis lacerata* and which he considers very close if not identical with the leaves of this type from the Raritan. I cannot concur in this reference. The remains in question are very vague. Saporta figures two possible interpretations, which are quite dissimilar both in venation and in the character of the apex; and the veins, both secondary and tertiary are depicted as running directly to the margin. The parallelism between the Cretaceous flora of Portugal and that of the United States is close and there is no reason why this type of plant may not have evolved independently in both regions, although in my opinion the remains do not, as yet, corroborate this supposition.

LIRIODENDROPSIS ANGUSTIFOLIA Newb. (PLATE 4, FIGURE 4.)

Liriodendropsis angustifolia Newb. Bull. Torrey Club, **14**: 6 (in part). *pl. 62. f. 4.* 1887. Fl. Amboy Clays, 84. *pl. 53. f. 8.* 1896. Hollick, Trans. N. Y. Acad. Sci. **12**: 235 (in part). *pl. 5. f. 3; pl. 7. f. 3.* 1893. Bull. Geol. Soc. Am. **7**: 13. 1895.

While the absence of the apex makes this reference provisional in view of minor differences in form and venation, I am inclined to so refer it. It is a species we would naturally expect to find in this formation because of its abundance in the Raritan both in New Jersey and the Islands.

LAURUS PLUTONIA Heer. (PLATE 3, FIGURE 1.)

A thick lauraceous leaf common at Cliffwood.

LAURUS HOLLICKII Berry. (PLATE 3, FIGURE 2.)

This species appears to be fairly common at Cliffwood.

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* Saporta, Fl. Foss. Port. 219. *pl. 38. f. 4, 5.* 1894.

† Ward, Rep. U. S. Geol. Surv. **16**: 540. 1896.

LAURUS PROTEAEFOLIA Lesq. (PLATE I, FIGURE 10.)

The leaf figured is of lauraceous texture and denotes a somewhat more slender leaf than Lesquereux's type specimens. The specimen figured was accidentally destroyed.

SASSAFRAS PROGENITOR Newb. (PLATE I, FIGURE 3.)

Sassafras progenitor Newb.; Hollick, Bull. Torrey Club, **21** : 53. *pl. 174. f. 1.* 1894. Bull. Geol. Soc. Am. **7** : 13. 1895. Newb. Fl. Amboy Clays, 88. *pl. 27. f. 1–3.* 1896. Berry, Bot. Gaz. **34** : 442. 1902.

While it may seem unwise to illustrate and include such an incomplete fragment, the exploitation of such imperfect specimens may often be of more importance in the study of ancient floras than that of more perfect and precisely definable remains. The specimen figured, which was the only one found, shows a part of the central and lateral lobes of a leaf that agrees fairly well with this species (compare with Newberry's *fig. 2*). This is probably a true species of *Sassafras.*

SAPINDUS MORRISONI Lesq.

The present season's collections contain larger leaves of this species than those found in this formation in 1902.

CELASTROPHYLLUM NEWBERRYANUM Hollick.

Hollick obtained this species at Cliffwood a number of years ago. It was not contained in my 1902 collections, but a single specimen was collected on July 29, 1903.

EUCALYPTUS GEINITZI Heer. (PLATE 4, FIGURE 5.)

The specimen figured from my 1903 collections is more decisive than the one previously found at this locality, and shows considerable details of venation. It is a fragment 6.8 cm. long of a linear, somewhat falcate leaf nearly 2 cm. in width, with numerous secondaries which leave the midrib at a wide angle and run without curving nearly to the margin, along which they loop in flat arches. This species resembles somewhat the leaf referred by Saporta and Marion and by Hollick to *Aralia transversinervia,* which leaf is almost certainly not an *Aralia.* It also resembles a single lobe of what I have called *Sterculia Cliffwoodensis* from this formation.

ARALIA RAVNIANA Heer.

The present season's collections contain a single, somewhat indefinite specimen of this species.

ARALIA PALMATA Newb. (PLATE 4, FIGURE 12.)

This was apparently a common species in Matawan times, if we may judge from the abundance of leaf fragments in the clays. The present season's collections contain numerous fragments of this leaf. The one figured I refer doubtfully to this species. It is certainly the same as *no. 6* of last year's collection, but both differ from the typical leaves in their straight secondaries.

ANDROMEDA PARLATORII Heer. (PLATE 1, FIGURES 1, 2.)

Well-characterized remains of doubtful botanical affinity common throughout the Cenomanian of the United States and Greenland. They are particularly abundant in the Raritan formation and the Matawan leaves here figured are the counterpart of several figured by Newberry. They are larger than the leaves from the Dakota group or from Greenland, and are also larger than the Matawan leaves of this species collected in 1902. The secondaries are less numerous and more regularly arched than in Newberry's Raritan leaves.

VIBURNUM Linn. Sp. Pl. 267. 1753

The American fossil forms which are referred to this genus number some forty-seven species, exclusive of seven varieties described by Lesquereux; two of these species occur in Spitzbergen and one on the Island of Sachalin. They have the following distribution: Raritan 1, which is obviously not a *Viburnum;* Dakota 6, plus 7 varieties; Patoot 3; Montana 4; Laramie 7; Denver 4; Eocene 2; Fort Union 17; Miocene of U. S. 2; of Greenland 3; Tertiary of Tongue River (Yellowstone Park) 3. Their distribution marks North America as the original home of the genus; they reached Alaska in the Eocene and crossing the emerged belt where Behring Straits now stand, are found in the Eocene or Oligocene of Sachalin Island. Toward the north and east we find them in Greenland in the Senonian (Patoot) and in Spitzbergen in Heer's "Miocene," which is Eocene or Oligocene.

Three species occur here, two of which are common to Greenland. On the continent of Europe we have one species in the Vraconnian, one in the Senonian, and the balance, which are few in number, Tertiary or recent.

The early appearance of *Viburnum*, one of the *Sympetalae*, associated with *Aralia*, both epigynous forms, suggests to Coulter* a connection of the *Umbellales* with the *Sympetalae* not admitted in current schemes of taxonomy.

Some have been led to doubt the authenticity of the reference of the Cretaceous forms to this genus. It may be noted, however, that most of them have leaves with well-marked characters, which are emphasized by undoubted remains of fruit in a number of instances. The majority of the *Sympetalae* are herbaceous and unsuited for fossilization, while *Viburnum* is shrubby and inhabits swamps and the banks of streams, thereby offering excellent opportunities for preservation. That it is a type of long standing is evidenced by the number of existing species, by the abundance of individuals, and their wide range. They number upwards of one hundred, of subtropical and temperate eastern Asia and North America; Europe has but three species, two of which occur in northern Africa. A probably distinct phylum (*Oreinotinus* Örsted) of about thirty species inhabits Central and South America along the Andes, two of the species being common to Jamaica.

Viburnum Mattewanense sp. nov. (PLATE 4, FIGURE 13.)

A single imperfect specimen of a leaf clearly referable to this genus, and differing from *Viburnum Hollickii* Berry from this formation in its more broadly oval outline and more decided marginal teeth; the ascending basal secondaries are wanting and the first pair leave the midrib at an angle more than twice as great as in *V. Hollickii.*

Leaf 7 cm. wide and between 10 and 11 cm. in length; substance thin; secondaries slender and curved, more remote than in the existing species; lower outside branches of the first secondary have their tips united by a thin vein parallel with the secondary, indicating that the basal portion of the margin was entire; distad the tertiaries curve directly to the marginal teeth; balance of the tertiaries percurrent at right angles to the secondaries.

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* Coulter, Morphology of the Angiosperms, 1903.

INCERTAE SEDIS

TRICALYCITES PAPYRACEUS Newb. (PLATE 1, FIGURE 4.)

Tricalycites papyraceus Newb.; Hollick, Bull. Torrey Club, **21**: 63. *pl. 180. f. 1 (?), 8.* 1894.

A well defined organism of unknown affinity, dicotyledonous according to Hollick. Consists usually of a small nucleus with three membranous wings and is very common in the Raritan of New Jersey, occurring also on Staten and Long Islands, Chappaquidick and Block Islands, also occurring in the Tuscaloosa formation of Alabama. From the Matawan I have obtained but a single specimen of but one wing. *Tricalycites* is probably comparable with the bracts so largely developed in some of the *Juglandaceae* and *Betulaceae*.

CARPOLITHUS JUGLANDIFORMIS Berry.

Carpolithus juglandiformis Berry, Bull. N. Y. Bot. Gard. **3**: 100. *pl. 46. f. 8.* 1903.

Carpolithus dubius Berry, Bull. N. Y. Bot. Gard. **3**: 100. *pl. 48. f. 7.* 1903.

The remains named by me *Carpolithus juglandiformis* in drying and shrinking away from the matrix leave an impression exactly similar to that of *Carpolithus dubius*, showing that both appertain to the same plant and are the remains of nut-like fruit with a striated husk, the botanical affinity of which I have not been able to conjecture. They show considerable resemblance in a general way to what Newberry * calls *Tricarpellites striatus*, and which occur abundantly in the Raritan formation at Woodbridge, N. J. The Matawan remains fail to show any pointed apex and have not been found associated in threes, or with any indication of such association. *Plate 46, figure 8* (Berry, *l. c.*) evidently hints at the internal structure but in too vague a manner for discussion.

Coniferous Stem. (PLATE 5, FIGURE 5.)

This is an interesting and unique specimen recalling the genus *Lepidodendron* of the Paleozoic. It represents a portion of a stem at the juncture of a branch, the leaf-scars of which were much hollowed out by decay before fossilization.

Prof. Lester F. Ward, to whom the specimen was submitted, suggested its possible relation to *Cunninghamites*, because of the latter's abundance in the Matawan formation.

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* Newb. Fl. Amboy Clays, 132. *pl. 46. f. 9–13.* 1896.

It may be compared with our *plate 5, fig. 2*, which represents a branching stem similar in size and outline; the latter is silicified and retains remains of the attached leaves, rendering it reasonably certain that it is a portion of a stem of *Cunninghamites.*

Although comparisons are impossible because of the destruction of the type specimen, Dr. Hollick suggests that his *Strobilites inquirendus* from this formation may represent a distorted section of a stem like the one here figured.

PASSAIC, N. J.

Explanation of plates

PLATE 1

FIGS. 1, 2. *Andromeda Parlatorii* Heer.
FIG. 3. *Sassafras progenitor* Newb.
FIG. 4. *Tricalycites papyraceus* Newb.
FIG. 5. *Protophyllocladus subintegrifolius* (Lesq.) Berry.
FIG. 6. *Sassafras acutilobum* Lesq.
FIG. 7. *Magnolia tenuifolia* Lesq.
FIGS. 8, 9. *Ficus atavina* Heer.
FIG. 10. *Laurus proteaefolia* Lesq.
FIG. 11. *Dammara Cliffwoodensis* Hollick.
FIG. 12. *Pinus delicatulus* sp. nov.

PLATE 2. (Reduced one tenth)

Cones of *Sequoia gracillima* (Lesq.) Newb.

PLATE 3

FIG. 1. *Laurus plutonia* Heer.
FIG. 2. *Laurus Hollickii* Berry.
FIG. 3. *Magnolia Capellinii* Heer.
FIGS. 4, 5. *Quercus Hollickii* Berry.
FIG. 6. *Ficus atavina* Heer.
FIGS. 7–9, 11. *Cunninghamites elegans* (Corda) Endl.
FIG. 10. *Magnolia speciosa* Heer.

PLATE 4

FIG 1. *Myrica Cliffwoodensis* sp. nov.
FIGS. 2, 3. *Geinitzia formosa* Heer.
FIG. 4. *Liriodendropsis angustifolia* Newb.
FIG. 5. *Eucalyptus Geinitzi* Heer.
FIG. 6. *Gleichenia Zippei* (Corda) Heer.
FIG. 7. Gymnospermous cone.
FIG. 8. *Sequoia Reichenbachi* (Gein.) Heer.
FIGS. 9, 10. *Frenelopsis Hoheneggeri* (Ett.) Schenk.
FIG. 11. *Quercus eoprinoides* sp. nov.
FIG. 12. *Aralia palmata* Newb.
FIG. 13. *Viburnum Mattewanense* sp. nov.

PLATE 5. (Reduced one tenth)

FIGS. 1, 5. Coniferous stems.
FIGS. 2, 3. Stems of *Cunninghamites.*
FIG. 4. Unknown organism.

Concerning some West American smuts

DAVID GRIFFITHS

Many of the following notes and descriptions have been prepared for nearly a year and are based mainly upon collections made in 1902 and 1903. The extensive territory visited during these two years has naturally yielded unrecorded species as well as furnished additional data regarding imperfectly known forms. This writing furnishes descriptions of only a part of the new species collected.

The writer is indebted to Professor G. P. Clinton for his kindness in examining and giving critical judgment upon many of the species mentioned here. All the specimens discussed will be found in the U. S. National Herbarium and in my private collection. Nearly all of them are also in Professor Clinton's private herbarium.

Sorosporium contortum sp. nov.

Sori involving the entire upper internode and head which are transformed into a cylindrical or fusiform black compact mass, the spore-balls wearing away from the outside gradually by abrasion or becoming reduced to a powdery mass within the unopened sheath, very variable in length, 5–30 mm. by .6–1.5 mm., completely enclosed within the upper sheath, the internode and head being reduced to a comparatively very short columella, the remainder of the cylinder consisting of the bases of the delicate, much contorted, partially developed awns; sterile membrane long-cylindrical and usually extending fully half its length beyond the sheath, the basal portion enveloping the sorus, but the exterior half or more sterile and containing only the distal parts of the awns, usually more or less contorted, rupturing easily, and becoming lacerated, giving to the plant a very ragged appearance; its cells hyaline, cuboidal to somewhat elongated with longitudinal, rib-like thickenings; spore-balls subglobose to ovoid, and often angular, many-spored, 50–62 μ by 50–80 μ; spores subglobose to angular-compressed, dark fuscous, 5–8 μ in diameter, with thin, smooth epispores, homogeneous contents, and usually very faint, central or eccentric nuclear area.

On *Andropogon contortus* L., Santa Rita Mountains, Arizona (within the area recently fenced by the U. S. Department of Agriculture), September 12, 1902 (type); Santa Rita Mountains, Arizona, October 1, 1902 (Griffiths & Thornber); Empire Ranch, Arizona, September 27, 1902 (Griffiths & Thornber).

This is a very common and conspicuous fungus throughout the Santa Rita Mountains. It was abundant in the type locality as well as on the south side of the mountains in 1903, but no collections were made of it. It usually destroys all of the heads on the bunch of grass which it attacks.

Sorosporium Eriochloae sp. nov.

Sori in ovary and surrounded by a sterile membrane which projects but slightly beyond the glumes of the host, its base surrounding the aborted pistil and black powdery mass of spores, but the distil end empty or containing only the distal portions of the aborted pistil; its cells hyaline, slightly longer than broad, upper portion early becoming lacerated and recurved; spore-balls subglobose, angular and very irregular in both outline and size, 50–65 μ by 50–105 μ, easily separable; spores dark fuscous, subglobose, 10–13.5 μ in diameter, angular, with thin, smooth epispore, coarsely granular contents and small but distinct nuclear area.

On *Eriochloa punctata* (Linn.) W. Hamilt., Empire Ranch, Santa Rita Mountains, Arizona, September 28, 1902 (Griffiths & Thornber). The material cited above is quoted as the type because it is more plentiful than other collections which the writer has made. It was collected by me in the spring of 1901 in native hay on the ranch of Col. H. C. Hooker in Sulphur Spring Valley, Arizona, and subsequently observed during the fall of 1903 in various localities in southern Arizona. It is a very common species.

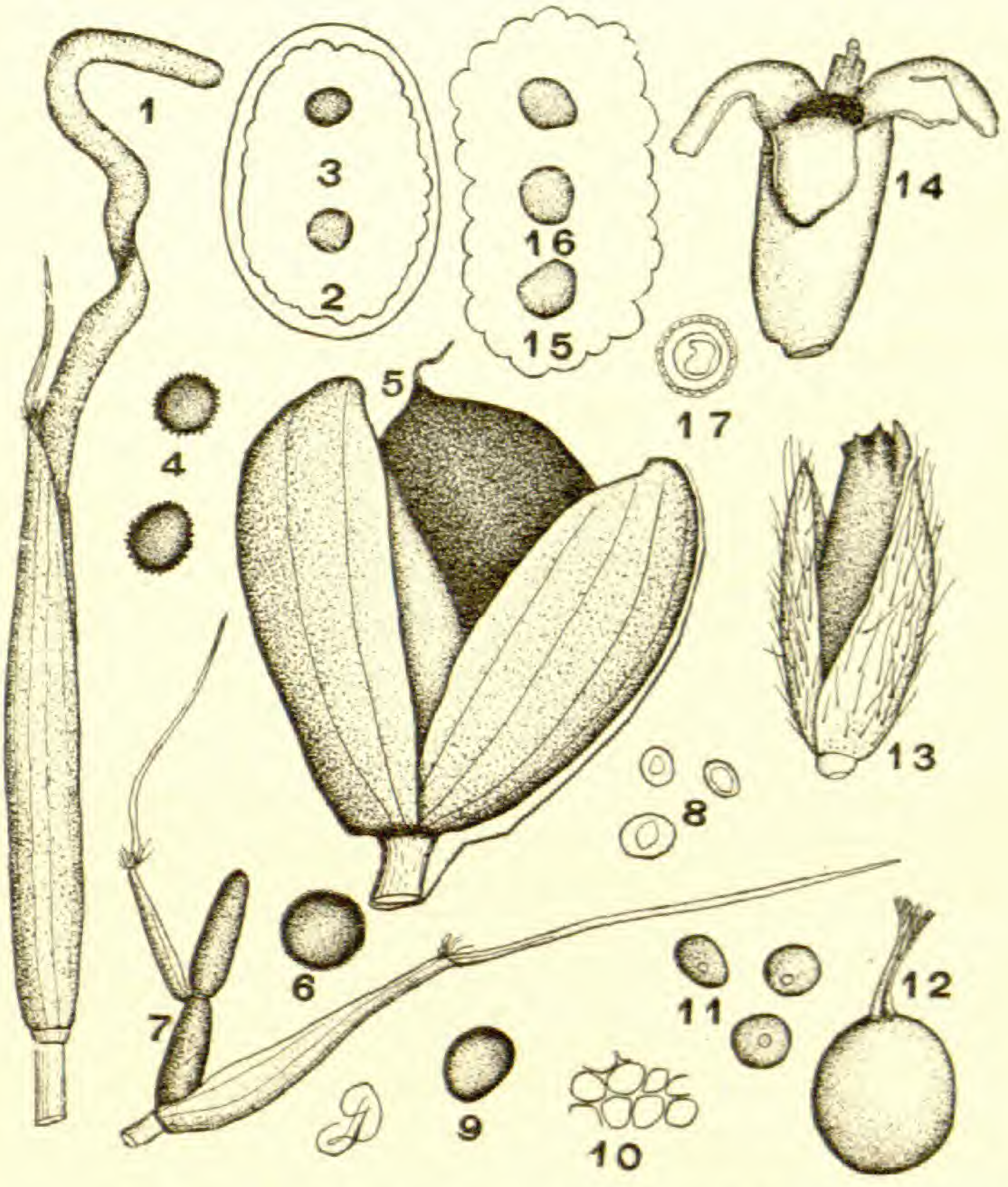
Ustilago lycuroides sp. nov.

Sorus in ovary which is inflated to a globular, olive green body, covered with the thin, wrinkled and modified integument, 1–1.5 mm. in diameter, bearing at its distal end the style and stigma but little modified, the interior being completely filled with a hard, brittle mass of spores which are brown, subglobose to slightly oval and angular, 9.5 to 13 μ in diameter; epispore thin, smooth, contents granular with a distinct central or eccentric nuclear area.

On *Lycurus phleoides* H.B.K., Santa Rita Mountains, Arizona, September, 1902 (Griffiths & Thornber). This appears to be a very rare species. Only a few smutty heads were found. The exact type locality is one mile north of Greaterville, on the road to Rosemont.

Ustilago calcara sp. nov.

Sorus circular, .5 mm. in diameter to linear and confluent, 5 mm. or more in length extending between the veins and erumpent upon the exterior of the modified, overlapping sheaths, and less frequently upon the leaves; internodes and culms in diseased host very much shortened and repeatedly branched, producing miniature witches' brooms; spores sooty, black in mass, irregular, globular to ovate, and often pointed, 7–10 μ by 7–10.5 μ with one



1. *Sorosporium contortum*, showing upper sheath and sterile membrane, × 2. 2. Outline of spore-ball, × 215. 3. Spores, × 315.

4. Spores of *Ustilago Scolochloae*, × 320.

5. *Tilletia pulcherrima* in spikelet of *Panicum obtusum*, × 12. 6. Spore, × 315.

7. Upper portion of culm of *Eragrostis Neo-Mexicana*, showing method of attack of *Ustilago strangulans*. Natural size.

8. Spores of *Ustilago calcara* on *Bouteloua breviseta*, × 315.

9. Spore-ball of *Thecaphora Thornberi*, × 35. 10. Portion of the spore-ball, × 315, showing outlines of the individual spores.

11. Spores of *Ustilago lycuroides*, × 315. 12. Ovary of the host distorted by the smut, × 8.

13. Spikelet of *Eriochloa punctata* showing distortion of ovary by *Sorosporium Eriochloae*, × 5. 14. Distorted ovary showing method of rupture, × 8. 15. Outline of spore-ball, × 215. 16. Spores, × 315.

17. Spore of *Tilletia Wilcoxiana*, × 320.

or more large, irregular, highly refractory central areas; epispore thin and smooth.

On *Bouteloua breviseta* Vasey, upon the gypsum deposits east of Roswell, N. M., May 4, 1903. This smut is very abundant in this region, but is easily overlooked because the effect upon the host is likely to be considered due to the work of insects. It is easily distinguishable from the other two species which appear on the leaves and culms of various species of the genus *Bouteloua*—first, by the effect upon the host; second, by the entire absence of pustules, which are always found in the other two species.

Ustilago Scolochloae sp. nov.

Fructification of the smut involving the leaves of the upper two to four nodes which are reduced to such an extent that the blades of the upper ones remain unopened, remainder of the plant nearly normal; sori normally epiphyllous, but sometimes hypophyllous in a few places on the inner, more delicate leaves; apparently confined to the blades and seldom if ever occurring on the sheaths, long, linear, often confluent the entire length of the leaf but the entire surface soon covered with the sooty mass of spores; spores subglobose, uniform in size and shape, 10–13 μ in diameter, dark, fuscous, but sooty black in mass, densely and uniformly covered with coarse, blunt tubercles.

On *Scolochloa festucacea* (Willd.) L., Donner & Blitzen River, Harney Valley, Oregon, July, 1902 (Griffiths & Hunter). Closely related to *Ustilago echinata* Schröt.

USTILAGO HYPODITIS (Schl.) Fr.

A very peculiar effect of this smut upon one of its common hosts was observed during the past season about 20 miles east of Roswell, N. M. *Distichlis spicata* is very commonly smutted with this species in fields and meadows near the Pecos river where it is reduced but little, if any, in size. In some of the salty ravines which lead up through the gypsum bluffs, however, the host appears to be very much reduced in size by the smut. The internodes are very much shortened and the whole plant reduced to an inch or two in length, with the leaves and sheaths reduced to bract-like structures or in some cases the upper two to four nodes confined within one swollen sheath, presenting an appearance not unlike the common smut upon species of *Hilaria*.

Specimens were collected here on the 7th of May and again on the 5th of September, showing the same effect but more pronounced at the earlier date.

The smut was especially destructive to *Stipa Vaseyi* in the Raton Mountains of Colorado and New Mexico during the past season.

There occurs in California a well-marked variety of this common species on a number of hosts, but it does not seem desirable to give it a name until field work determines whether the characters are constant, because the spores are not distinguishable from some of the common forms. The variation from the typical form on various species of the genera *Stipa*, *Agropyron* and *Elymus* is in the method of attack. Instead of the sorus being within the sheath it occurs on the leaf-blades and inflorescence which are more or less distorted by it. The writer has observed this method of attack on three hosts in California during the past two years. The first collection was made at Cedarville on *Puccinellia airoides* in July; the second on *Sitanion longifolium* in Jess Valley in August, 1902, by myself and Mr. Byron Hunter, and the third near Millwood upon two forms of *Elymus glaucus* by myself last June. In the first and last examples, especially, the hosts were in a very vigorous state of development and this phenomenon may be simply an expression of the vigor of the host. We can hardly suppose that there is difference enough in the structure of these species and their close relatives in the genera *Poa* and *Elymus* upon which the normal form occurs to cause this variation in the method of attack.

USTILAGO HIERONYMI Schröt.

This species is listed on two additional hosts *Bouteloua breviseta* Vasey, upon which it was found rather sparingly about 20 miles east of Roswell, New Mexico, in September, 1903, and *B. Harvardii* Vasey in the Santa Rita Mountains, Arizona, October, 1902. It is often very destructive to the latter species throughout southern Arizona.

USTILAGO STRANGULANS Issat.

This has been observed in but one locality, on *Eragrostis Neo-Mexicana*, in the Santa Rita Mountains, Arizona, near Rosemont, September, 1902, where it affected every plant upon an acre or more of ground in the vicinity of an old corral where the soil was thoroughly tramped.

Tilletia Wilcoxiana sp. nov.

Sorus produced in ovary of the host which becomes inflated to an olive green fusiform body, three or four times its normal size; spores light brown in mass, but hyaline by transmitted light, subglobose, 15–19 μ in diameter with a narrow, hyaline enveloping membrane but little exceeding the stout, blunt, uniformly distributed projections on the very thick epispore.

On *Stipa eminens Andersonii* Vasey, Santa Monica, California, Spring, 1901 (Dr. H. E. Hasse). Mr. E. N. Wilcox first discovered this smut while studying the genus *Stipa* (see Bot. Gaz. **34**: 66. 1902). · The same host infested by the same species of smut was collected in the original locality by Dr. Hasse again in April, 1902. In all the material at hand the spores are slightly under mature and the description so far as it relates to the color of the spores may have to be modified later.

TILLETIA PULCHERRIMA E. & G.

A very destructive smut upon *Panicum obtusum* H.B.K. throughout southern Arizona. It has been observed in a dozen localities since the autumn of 1900. It is very easily overlooked. A collection of it was made on the Empire Ranch, Santa Rita Mountains, Arizona, September, 1902.

Thecaphora Thornberi sp. nov.

Sorus in ovary which is inflated more or less symmetrically to a spherical body 4–7 or more mm. in horizontal diameter which usually slightly exceeds the vertical, the modified tissues rupturing irregularly at maturity; spore-balls reddish brown in mass, 70–100μ by 80–120μ, oval, subspherical or sometimes compressed angular, opaque at maturity with the individual spores scarcely distinguishable; spores apparently inseparably united, with thin walls, granular contents, and without visible nuclear areas, about 10 by 13μ. When young the exterior walls of the spores appear slightly reticulated, but this is entirely lost at maturity.

On *Clathorix lanuginosa* Nutt., Santa Rita Mountains, Arizona, about four miles north of Helvetia on the Tucson road, October 4, 1902 (Griffiths & Thornber). It was abundant in this place but has not been observed elsewhere.

U. S. DEPARTMENT OF AGRICULTURE.

The mechanics of seed-dispersion in Ricinus communis

J. B. Dandeno

Seed-dispersion is a matter of such common knowledge that almost everybody has had some experience with some special adaptation exhibited by certain plants, one way or another. The more common agents which serve the plant's purpose are wind, water and animals. But there are various other means, not so apparent, and consequently not so well known, which contribute towards the well-being of the plant in its struggle for space (or room) in which to flourish.

One method, not so uncommon as is generally supposed, is here examined in some detail with a view towards gaining some definite knowledge in regard to the actual dynamics involved in the projection of the fruit. To illustrate this problem the castor bean was selected.

The advantage to a plant of some special means of transporting its seed is so apparent that it needs no comment. How the plant came to possess this special means, is a question which largely belongs to the problem of evolution, and is not here discussed.

To understand the whole question fully it is necessary to examine all the conditions. Each plant of the castor bean produces on an average about five flower-clusters, the axis of each cluster being nearly perpendicular to the ground. On each cluster there are about fifty-eight fruits, each borne on a peduncle which inclines about forty-five degrees to the vertical. The axis of each fruit is at right angles (approximately) with the peduncle and inclining towards the ground at an angle, therefore, of forty-five degrees with the vertical. At this angle, one of the fruit-parts (carpels) would be projected at an angle of forty-five degrees above the horizontal (theoretically the angle of projection which produces the greatest range). But, as the carpels commence to separate, they do so from the *base* of the fruit, thereby lessening the angle of that one carpel some five or ten degrees ; and, since atmospheric conditions have to be taken into account, forty degrees is the angle which gives actually the greatest range, so it is easy to see that the plant has the best actual position to project its seed to the greatest distance. The other two carpels cannot be in so good a position, but the plant appears to be able to sacrifice several in order that a *few* seedlings may obtain a place of advantage the following season. It sacrifices *two* carpels that *one* may have the maximum of benefit in this respect.

As the fruit ripens it loses water gradually and begins to split open septicidally from the base and keeps on splitting thus, until a point is reached about three millimeters from the apex. While this is going on, the carpels are not only separating from one another, but also from the central column which is a continuation of the fruit-stalk. • On three sides of the apical end of this central column are the three placental processes. Each projects into the locule to some extent, but the seed breaks off early from the placenta, leaving this central column wholly separate from the three carpels, yet suspending them because the processes referred to extend into each carpel through a comparatively large opening near the apical end. The carpels are therefore suspended much in the same manner as if hanging upon a peg; but as the three are still joined together they cannot be separated entirely from the central column until *one* of the three is removed. This central column, upon separation from the carpels, is left with three projecting flanges which, together with the processes referred to, prevent any alteration in position of the fruit which might possibly result when the carpels become detached from the column. At first glance this would seem to make no difference; but, when we consider that the carpel *first* projected will have the greatest momentum it is of some importance. The carpel with its dorsal side uppermost will have the most sun exposure and will consequently dry out most quickly. This is the carpel which has the best position, and which will most likely reach the maximum range.

A second stage in the process of preparation for actual projection may be said to commence after the carpels are entirely free from the central column. As the carpel dries out, the dorsal wall contracts and this contraction produces a pressure which becomes greater and greater as contraction goes on until the carpel gives way at its weakest point. This is at the apical end, where there are three pairs of tooth-shaped arrangements meeting at a line about three or four millimeters long. Each carpel splits apart at this line with some violence. This acts just as a spring suddenly relaxed; thus the carpel is projected. This splitting is a loculicidal dehiscence and the seed, though projected with the carpel, is at this time, or soon after, released, but not before.

Another structural peculiarity is the prickly surface of the carpel, and this might easily act in conjunction with the explosion, from the fact that any slight disturbance immediately before the carpels were ready to explode, would *cause* the explosion, and these carpels might then attach themselves to such animal as might produce the disturbance. This, however, is not taken into consideration.

To ascertain the magnitude of the energy of expulsion it was necessary first to determine the actual distance some of the carpellary parts were projected. This was done in-doors by hanging the mature fruiting branches in a natural position at a given distance, approximately that of the plant, above the horizontal, and then measuring the actual range which the carpels were projected. The plants in the garden were similarly examined and the results did not differ very materially from those obtained in-doors. The average distance from the vertical, of those carpels which seemed to be projected from the position most favorable of the three carpels, was found to be 3.65 meters, and the average height of the cluster was 1.6 meters. Then, since the angle of rising equals the angle of falling, the real horizontal range would be $3.65 - 1.6 = 2.05$ meters. Since the angle of projection is 40°, then $2v^2.\sin 40^\circ \div 9.8 = 2.05$ meters. $\therefore v = 3.6$ (approx.) meters per second, where v is the velocity of projection. Hence the work done in projecting a body weighing .4 grams (the weight of one carpel with contents) would be

$$\left(\frac{3.6}{9.8}\right)^2 \times 4.9 \times .4 = .264 \text{ gram-meters per sec.}$$
$$= .000264 \text{ kgm. per sec.}$$

Since there are 3 carpels to one fruit, and 58 (average) fruits on one cluster, and 4 (average) clusters on one plant, each plant would do, by the sudden "filliping" of the carpels,

$3 \times 58 \times 4 \times .000264 \div 76 = .0024$ horse powers per second.

And if each plant requires 4 square feet of ground space upon which to grow, on one acre there would be 10,890 plants; therefore, a measure of the work done in exploding the carpels of the plants on one acre would be

$$10890 \times .0024 = 26.14 \text{ horse-powers per second.}^{1}$$

This simply means that the work done is equal to that which one good strong horse could do in 26 seconds. It does not mean the energy that might be required in threshing out the seeds, but it means that energy alone which *causes* the *projection* of the carpels.

It should also be observed that the calculated range was an approach toward a maximum rather than an average, because no account was taken of the fruit which seemed to have simply fallen, or of those projected from a disadvantageous position, although the energy in the latter case would undoubtedly be the same as that exerted in the projection of those which had been discharged from a position of advantage.

The energy expanded by the plant is developed directly from the atmosphere, coupled with the heat of the sun; and indirectly from the cells and contents built up by the plant. Indeed, it is the same quality of energy as that which raises water from the earth into the atmosphere. The part taken by the plant is the preparation of carpels of such a form as will store up this energy for a time and thus make the best use of it by liberating it *all at once*. What this means to the species in successfully contending for space in which to grow, may be best illustrated by a mathematical calculation.

Starting with a given plant, it may be seen from our measurements that the ground covered by the seedlings from this plant would be

In 1 year $3.65^2 \times \pi$ square meters,
In 2 years $7.30^2 \times \pi$ square meters,
In 3 years $10.95^2 \times \pi$ square meters,
In 100 years $365^2 \times \pi = 41.8707$ hectares $= 105$ acres (approx.).

This does not seem to be a very large area when the length of time is taken into consideration; but it must be borne in mind that this is only *one* means the plant has for scattering its seed. It takes no account of the washing away by water, or the transportation by wind or animals. The calculations are made upon the consideration of the fruit as a *projectile* alone, and from this the attempt is made to see just how much it has to do with the well-being of the plant.

Notes on Bahaman algae

MARSHALL A. HOWE

(WITH PLATE 6)

A collection of Bahaman algae, mostly marine, secured during the summer of 1903, by Dr. W. C. Coker, of the University of North Carolina, chief of the botanical staff of the Expedition of the Geographical Society of Baltimore to the Bahama Islands,* has been submitted to the writer for determination. This collection includes several rare or novel forms and some of the more interesting have been selected for comment below. Dr. Coker's specimens of algae were all preserved in fluids, either alcohol or solutions of formaldehyde, and they have for this reason proved especially satisfactory for study; though in some cases, as may necessarily happen, the material was less copious than could be desired.

Caulerpa compressa (Web.-v. Bosse).

Caulerpa paspaloides, var. *typica*, f. *compressa* Web.-v. Bosse, Ann. Jard. Bot. Buitenzorg, **15**: 353. *pl. 30. f. 3, 4.* 1898.

In four feet of water, off Clarence Harbor, Long Island, Bahamas, July 16, 1903.

This plant, which agrees closely with Mme. Weber's description and figures, is, we believe, absolutely distinct from *Caulerpa paspaloides* (Bory) Grev. In *C. paspaloides*, the primary pinnules are 3- or 4-ranked, so that the "frond" is distinctly 3- or 4-angled or 3- or 4-winged, a character that is more strikingly apparent in fresh or fluid-preserved material than in dried specimens; the secondary pinnules are pectinately secund along the upper side of the rachis and the lowermost of these secondary pinnules are always much shorter than the rachis itself. In *Caulerpa compressa*, on the other hand, the primary pinnules are so numerous and densely crowded that it is difficult to say how they are arranged, but they are probably 8–12-ranked, and the "frond" is as cylindrical and dense as that of *Dasycladus vermicularis* (Scop.) Krasser; the sec-

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* For organization of this expedition and outline of its results, see *Science*, II. **18**: 427. 2 O 1903.

ondary pinnules are pinnately distichous and corymbose, the lowermost being as long as the rachis or slightly longer; the "pedicel" supporting the four, five, or more digitate primary branches or "fronds" is very short, measuring in Dr. Coker's specimen only 0.5–1.0 cm.

CAULERPA PASPALOIDES (Bory) Grev.

Green Cay, in 4 fathoms.

RHIPOCEPHALUS PHOENIX (Ell. & Soland.) Kuetz.

Mangrove Cay, Andros, June 26, 1903. Dr. Coker's specimens accord very well with Ellis's original figure * in regard to the outline of the capitulum, but the flabella are broader, more crowded, and more erect. Specimens collected by the writer at Key West, Florida (*no. 1612*, distributed in Phyc. Bor.-Am. as *no. 1030*) are extremely varied as regards the form of the capitulum, only occasionally offering the oblong-ovoid outline figured by Ellis. The capitula of some of these Key West plants are conical, some are broadest near the top, tapering down to the stalk below, and others are much elongated and of uniform width throughout (sometimes 9–10 cm. × 1–1.5 cm.), but these extremes are connected by clearly intermediate forms and we think but one species is represented.

UDOTEA CONGLUTINATA (Ell. & Soland.) Lamour.

Collected by Dr. Coker at several points; at Green Cay in 4 fathoms of water. **Udotea Flabellum** (Ell. & Soland.),† which is much the more common in southern Florida and Porto Rico, does not appear to have been found by Dr. Coker.

MICRODICTYON CRASSUM J. Ag. Anal. Alg. Cont. 1: 107. 1894.

Green Cay, in 4 fathoms. We are using provisionally for these plants collected by Dr. Coker the specific name applied by J. Agardh to specimens from the Bahamas sent to him by Mrs. Curtiss, though it is not yet wholly clear how either are to be kept separate from *Microdictyon umbilicatum* (Velley) Zanard. J. Agardh in proposing *M. crassum* as a new species appears to have

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* Ell. & Soland. Nat. Hist. Zooph. *pl. 25. f. 2.* 1786.

† *Corallina Flabellum* Ell. & Soland. Nat. Hist. Zooph. 124. *pl. 24.* 1786. *Udotea flabellata* Lamour. Hist. Polyp. 311. 1816.

been influenced chiefly by the "articulis multo brevioribus quam in aliis speciebus" * * * * "diametro vix longioribus." But the articuli of the original *Conferva umbilicata* as figured by Velley (Trans. Linn. Soc. **5**: *pl. 7.* 1800) are also often "diametro vix longioribus," even though J. Agardh * describes the articuli of *Microdictyon umbilicatum* as "circiter 4-plo longioribus." Velley's specimens were from New South Wales, and J. Agardh's remark, "Quae prima vice ad insulas Sandwich detecta fuit *C. umbilicalis*, eandem quoque ad Novam Hollandiam obvenire statuit C. Agardh (*Syst. p. 85*)," seems to indicate that he had seen neither the original plants nor the original description and figures of the first-described species of the genus.

Coccocladus † **occidentalis laxus** var. nov.

Fertile plants reaching 7 cm. in height and 10–13 mm. in width, flaccid: sporangia obovoid, oblong-ellipsoidal, or pyriform-subclavate, 460–880 $\mu \times$ 315–430 μ, often twice as long as broad, lateral or occasionally terminal at the ends of branches of the first three (rarely four) orders: aplanospores for a long time closely coherent in a single peripheral layer surrounding a central cavity, radially elongated, 66–85 $\mu \times$ 55–72 μ, mostly 1½ times as long as broad, usually angular-obovoid or ellipsoidal. (PLATE 6, FIGURES 1 AND 2.)

In small sink-holes by Big Pond, Nassau, June 23, 1903.

This remarkable plant is so strikingly different from the usual form of *Coccocladus occidentalis* as to suggest at first sight not only a distinct species, but even a different genus, yet in the presence of some apparently intermediate forms from other collections we dare not propose for it a rank higher than that of variety; though it is possible that a fuller knowledge of its life-history would lead to another conclusion. Dr. Coker writes that the plant grows "about one mile inland," in slightly brackish water which responds to the changes of the tide. The lax habit, the elongated sporangia, and extension of the sporangium-bearing capacity to

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* *l. c.* 105.

† COCCOCLADUS Cramer, Neue Denkschr. Schweiz. Naturf. Ges. **30**: — (37). 1887.

Botryophora J. Ag. Till Alg. Syst. **5**: 139. 1887. Wille, E. & P. Nat. Pflanzenfam. 1^2: 157. 1891. Not *Botryophora* Bompard, Hedwigia, **6**: 129. 1867. The generic type of *Coccocladus*, as also of J. Agardh's *Botryophora*, is *Dasycladus occidentalis* Harv. Ner. Bor.-Am. **3**: 38. *pl. 41B.* 1858.

branches of the third (and even the fourth) order are in harmony with the variations which the recent researches of Dr. Livingston * might lead us to expect would occur in a transition from salt to fresh or slightly brackish water. The variety *laxus* is almost destitute of the yellowish staining matter which manifests itself so conspicuously in ordinary specimens of this genus whether dried or preserved in fluids. In all conditions of *Coccocladus*, the sporangia appear to mature almost simultaneously in all parts of a plant, so that a considerable number of fertile individuals is needed to follow out the stages of spore-formation. In Dr. Coker's material of the variety *laxus*, there occur two or three plants with smaller pyriform-obovoid sporangia showing numerous chlorophyl-bodies, but apparently no spores; these we take to be immature aplanosporangia, but in the absence of direct observation of intervening stages the possibility that they represent sporangia of a different sort has suggested itself.

Coccocladus occidentalis laxus evidently has a closer affinity with **Coccocladus occidentalis Conquerantii,**† judging from Cramer's description, than with the typical *C. occidentalis*, but, we believe, differs too much from that to bear the same varietal name. The sporangia of *C. occidentalis Conquerantii*, according to Cramer, are at most only slightly ellipsoidal and occur only on branches of the first two orders. The number of spores to a sporangium and the size of the spores, characters which are in part relied upon by Cramer to separate his *Botryophora Conquerantii* from his *B. occidentalis*, appear in a considerable series of specimens of this genus now accessible to be extremely variable and unreliable for a specific separation. And Cramer's selection of a comparatively few-spored form for the typical *C. occidentalis* is hardly justified in view of Harvey's description of the spores as "innumerable," a characterization that is well substantiated by

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* Livingston, B. E. On the Nature of the Stimulus which causes the Change of Form in Polymorphic Green Algae. Bot. Gaz. 30: 289–317. *pl. 17, 18.* 1900.

——. The Rôle of Diffusion and Osmotic Pressure in Plants. Dec. Publ. Univ. Chicago, II. 8. 1903.

† *Dasycladus Conquerantii* Crouan; Schramm & Mazé, Alg. Guadeloupe, 47 1865. Mazé & Schramm, Alg. Guadeloupe, 108. 1870–77.

Botryophora Conquerantii (Crouan) Cramer, Neue Denkschr. Schweiz. Naturf. Ges. 32: 6. *pl. 4. f. 1.* 1890.

specimens of Harvey's collecting at Key West now in the herbarium of Columbia University, in which the number of spores to a sporangium is 200 or more. The peripheral arrangement of the spores about a central cavity, which Cramer emphasizes as a distinctive character of his *Botryophora Conquerantii*, and which that variety has in common with our variety *laxus*, seems to be more constant than number and size of spores and may be more significant. Specimens agreeing essentially with Cramer's description of *Botryophora Conquerantii* have been collected by the writer at Key West, Florida (*no. 1531*).

Neomeris Cokeri sp. nov.

Plants subcylindrical or clavate, 7–14 mm. long, 1.5–2.5 mm. thick, dark green in upper third or fifth, becoming grayish white below, apex rounded-obtuse or subtruncate, often exhibiting a delicate, translucent apiculum formed of the mantle-caps: * number of successive whorls of branches mostly 60–120; number of branches in a whorl 12–56: hairs of two forms in separate zones, those of one form consisting of a single, clavate, often curved or somewhat hooked cell rich in chlorophyl and having a maximum diameter about equal to that of the supporting cell, the apex acute, obtuse, or more often apiculate; those of the second form consisting of a somewhat similar though slightly narrower basal cell bearing at its apex one or two earlier caducous, more slender branches, these in turn each bearing 2–4 branches; unicellular hairs or basal cells of the multicellular persisting in the upper third or fifth of the plant, the surface after their fall appearing somewhat shaggy or minutely and irregularly punctate, a cortex scarcely developed: branches of the first order lightly calcified, scarcely coherent; branches of the second order more strongly calcified, irregularly and imperfectly coherent, subfusiform, often somewhat curved or gibbous, broadest (100–150 μ) a little above the middle, tapering to a conico-truncate apex 22–34 μ broad at the insertion of the hair: sporangia strongly calcified, free or coherent in short rows of 2–8, pyriform-obovoid, 180–206 μ long (decalcified and including stalk), 90–102 μ in maximum width, calcareous capsule 25–40 μ thick; spores obovoid, 140–156 μ × 82–94 μ. (PLATE 6, FIGURES 3–12.)

Opposite Current Town, Eleuthera, July 5, 1903. The material collected consists of about thirty individuals.

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* "Kappentheile oder Mantelkappen" of Cramer, Neue Denkschr. Schweiz. Naturf. Ges. **32**: 12. 1890.

Neomeris Cokeri constitutes the third known species of the genus, all of which occur in the West Indian region. The principal diagnostic characters of the three species may be arranged as follows:

- Hairs homogeneous; ends of the branches of the second order forming a cortex with distinct facets.
  - Plant reaching a height of 3.5 cm.; sporangia spherical or nearly so, strongly calcified but free. 1. *N. dumetosa.*[*]
  - Plant reaching a height of 2 cm.; sporangia obovoid-oblong or pyriform-obovoid, about twice as long as broad (not including stalk), strongly coherent laterally by their calcareous capsules, so that the plant in the lower fertile parts appears transversely annulate. 2. *N. annulata.*[†]
- Hairs dimorphous, the two forms in different zones; branches of the second order subfusiform, scarcely forming a cortex, surface of the plant after the fall of the hairs somewhat shaggy or minutely and irregularly punctate; sporangia free or coherent in short rows of 2–8. 3. *N. Cokeri.*

Neomeris annulata is not especially uncommon in the West Indian region. The writer has collected specimens in Bermuda, Key West, Florida (two stations) and Porto Rico (three stations). Of what appears to be the true *N. dumetosa*, we have seen only

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[*] NEOMERIS DUMETOSA Lamour. Hist. Polyp. 243. *pl. 7. f. 8.* 1816. Sonder, Alg. Trop. Austral. *pl. 5. f. 8–13.* 1871. J. Ag. Till. Alg. Syst. 5 : 147–151. *pl. 2. f. 4–7.* 1887. Cramer, Neue Denkschr. Schweiz. Naturf. Ges. 30 : — (10, 38) *pl. 2. f. 13–15 ; pl. 3. f. 3.* 1887. Cramer, *op. cit.* 32 : 19. *pl. 1. f. 13. ; pl. 2. f.* 7, *8.* 1890. De-Toni, Syll. Alg. 1 : 413. 1889. Solms, Ann. Jard. Bot. Buitenzorg, 11 : 70. *pl. 8b. f. 11.* 1893.

[†] NEOMERIS ANNULATA Dickie, Jour. Linn. Soc. 14 : 198. 1874. De-Toni, Syll. Alg. 1 : 414. 1889. Solms, Ann. Jard. Bot. Buitenzorg, 11 : 61–71. *pl. 8. f. 1, 3, 4,* 7, *8, 12, 13,* 17. 1893.

Neomeris Kelleri Cramer, Neue Denkschr. Schweiz. Naturf. Ges. 30 :—(3). *pl. 1 ; pl. 2. f. 1–12 ; pl. 3. f. 1, 2.* 1887. Cramer, *op. cit.* 32 : 9. *pl. 1. f. 1–12 ; pl. 2. f. 1–6 ; pl. 4. f. 15–24.* 1890. De-Toni, Syll. Alg. 1 : 413. 1889.

Neomeris Eruca Farlow; Cramer, Neue Denkschr. Schweiz. Naturf. Ges. 32 : 9, 18, 19. 1890.

The names *Dactylopora Eruca*, *D. digitata*, and *D. Annulus* of Parker and Jones (Ann. and Mag. Nat. Hist. III. 5 : 473, 474. 1860), quoted by Cramer in the synonymy of his *Neomeris Kelleri*, were originally applied simply to calcified spore-masses and fragments of a *Neomeris* from the "East Indian and other tropical seas," and cannot, in our opinion — especially since the discovery of *Neomeris Cokeri* with its peculiar hairs — be safely identified with any definite species, though as between *Neomeris dumetosa* and *N. annulata*, *Dactylopora Eruca* and *D. Annulus* clearly belong with the latter type. The name *Neomeris Eruca* Farlow apparently was first published by Hauck in Engler's Bot. Jahrb. (9 : 469. 1888) but this, so far as the technicalities of publication are concerned, rests on the *Dactylopora Eruca* synonym alone, and is therefore, we believe, of uncertain application.

one specimen — the one from Hawaii distributed as *Neomeris dumetosa* by Miss Tilden in American Algae, *no. 445. No. 668* of the Phycotheca Boreali-Americana (St. Thomas, *Börgesen,* Jan. 1896) distributed as *Neomeris dumetosa* has, in the two copies seen, the characters of *N. annulata.* The original description of *Neomeris dumetosa,* as given by Lamouroux, with its "bulles conoïdes ou pédiculées, se touchant entre elles tant elles sont nombreuses, mais sans être coalescentes," combined with Cramer's redescription of the original material (collected in the Antilles by Richard) can leave little doubt as to what *Neomeris dumetosa* really is. The type of *Neomeris annulata* came from Mauritius, where it was collected by Colonel Nicolas Pike. The species is not represented in Colonel Pike's herbarium, now in the possession of the New York Botanical Garden, but Count Solms has seen * the original material preserved in the British Museum and his figures drawn from Mauritius specimens would apply very well to the specimens from Bermuda, Porto Rico, and St. Thomas, alluded to above. Solms-Laubach refers Porto Rican material to this species, using the name *Neomeris annulata,* and Cramer refers to the same both Porto Rican and Bermudian specimens, preferring, however, the name *Neomeris Kelleri.*

CYSTOSEIRA MYRICA (Gmel.) Ag.

Gregory Town, Eleuthera.

LIAGORA ANNULATA J. Ag.

Gregory Town, Eleuthera.

Somewhat resembling *Liagora valida* in habit, but clearly distinct — firmer, beautifully annulate from near the base to the partially calcified apices; the apices are rounded-obtuse in fluid-preserved material, but often become attenuate-acuminate on drying. The annulations appear to be due to unequal calcification in well-defined alternating zones.

NEW YORK BOTANICAL GARDEN.

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* Ann. Jard. Bot. Buitenzorg, **11**: 61. 1893.

Explanation of plate 6

Figs. 1 and 2. *Coccocladus occidentalis laxus;* 3–12, *Neomeris Cokeri*.

1. One of the whorled branches of *Coccocladus occidentalis laxus*, with sporangia, × 12.

2. A single sporangium, × 40.

3. *Neomeris Cokeri*, natural size.

4. A single plant, × 8. At the apex, in this individual, is a zone of multicellular hairs, surrounding and concealing the apiculum formed of the mantle-caps; below, are the unicellular hairs, and farther downward, the lime-coated sporangia, isolated, or coherent in short rows.

5. Apical portion of another plant, × 12. The hairs in the apical region are here of the unicellular kind and the apiculum formed of the mantle-caps is conspicuous; below is a zone of multicellular hairs.

6. A fertile primary branch, with branches of the second order, each, in this case, bearing a unicellular hair, × 40. (Decalcified.)

7. A similar fertile primary branch, × 40. (Decalcified.)

8. A fertile primary branch, with branches of the second order, each, in this case, bearing a multicellular hair, × 40. (Decalcified.)

9. The conditions in this figure are similar to those represented in Fig. 8, except that only the basal cells of the multicellular hairs now persist. Scars remain indicating the places of insertion of the hair-segments which have fallen. In this stage the two forms of hairs sometimes resemble each other, but the persisting bases of the multicellular may be recognized by the presence of these scars, which are always entirely wanting on hairs of the unicellular kind.

10. Part of a primary whorl, with sporangia and branches of the second order, × 40, with calcareous coating.

11. A single primary branch, with sporangium and branches of second order, with calcareous coating, × 37.

12. A mature spore, within the sporangium, decalcified, × 53.

The drawings have been made by the writer, with some assistance from Mr. A. Mariolle in preparing them for reproduction.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1901-1903)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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Ames, O. *Lobelia* × *syphilitico-cardinalis*. Rhodora, **5**: 284–286. *pl. 49*. 22 D 1903.

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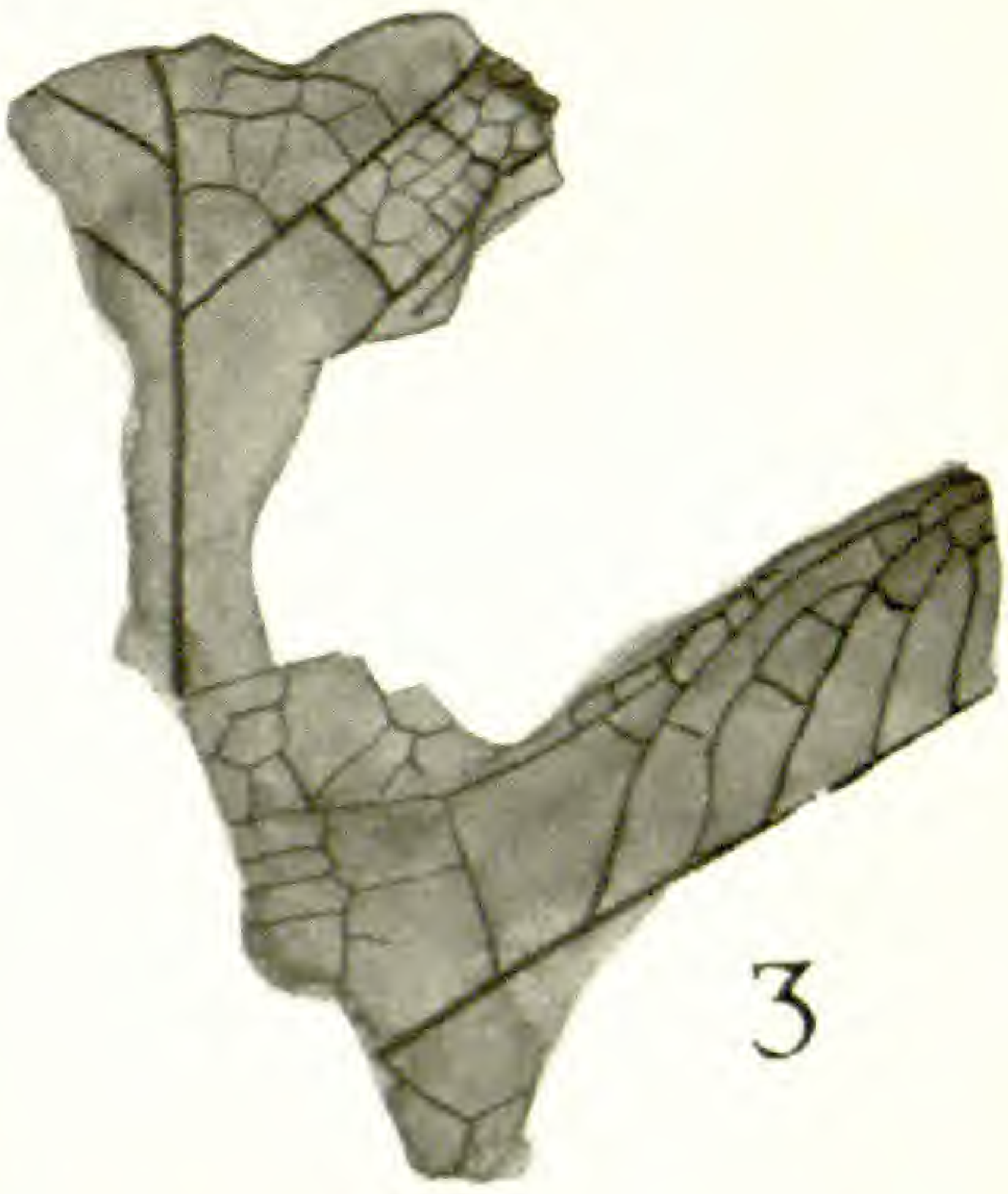

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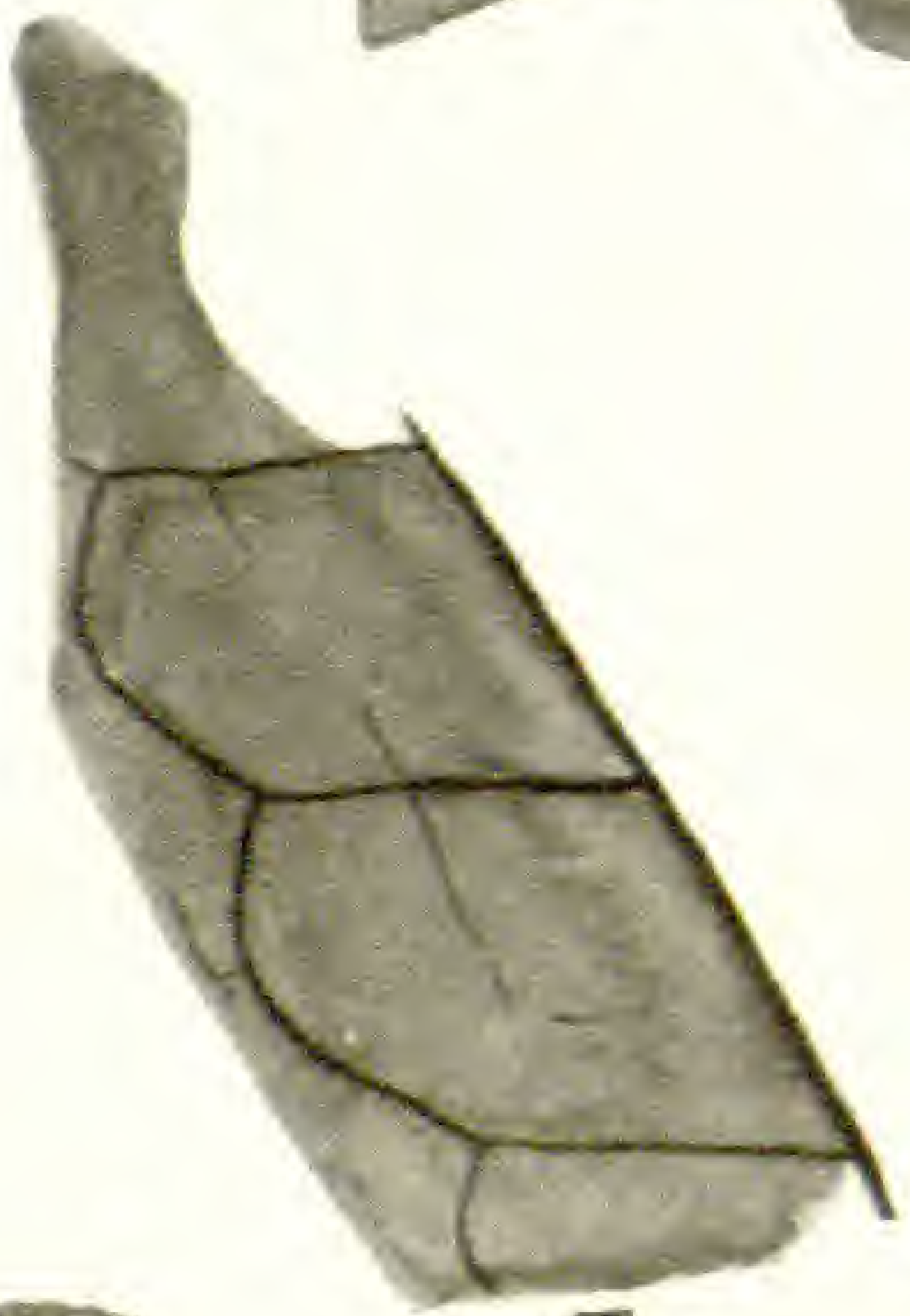

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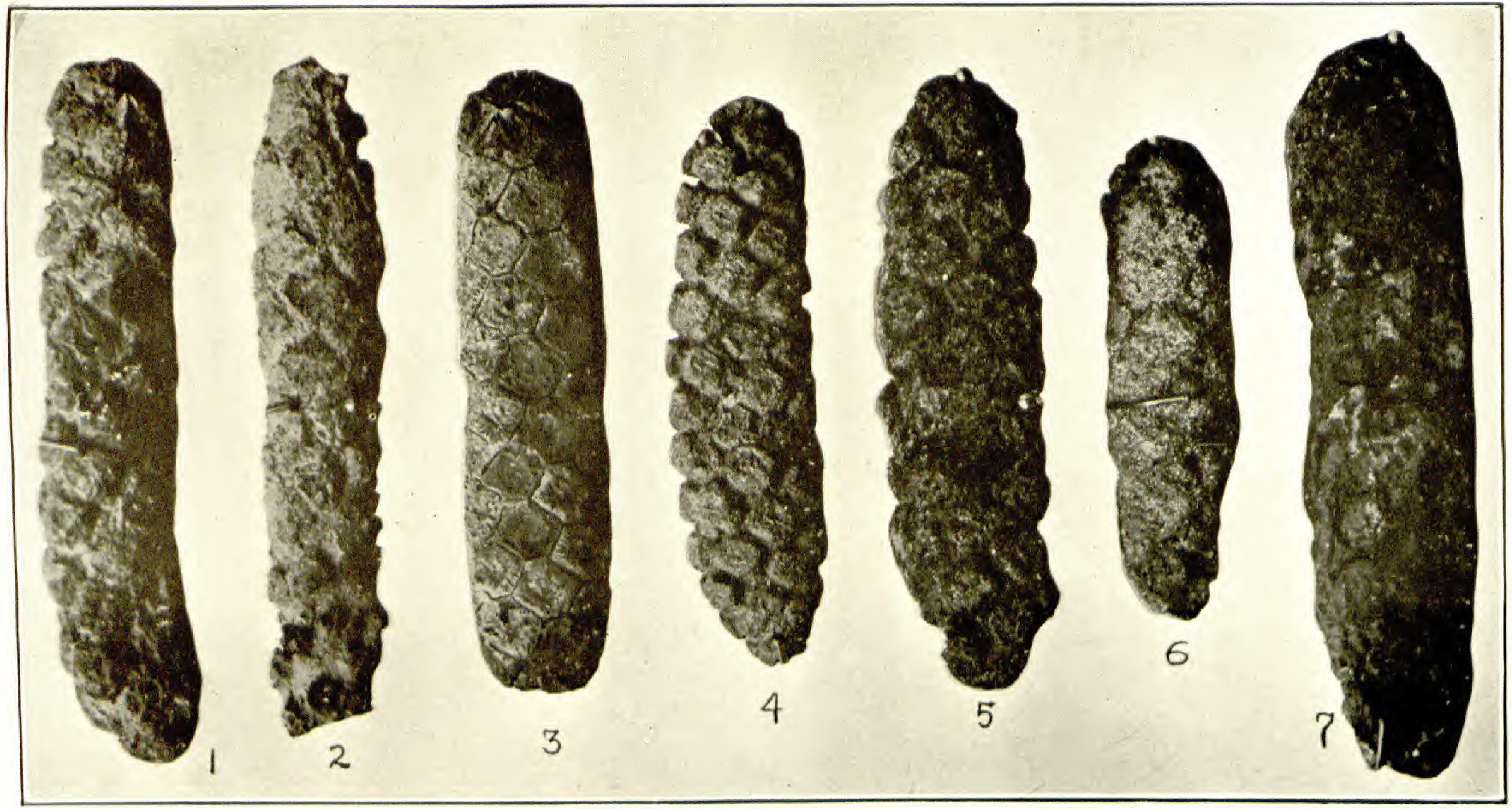

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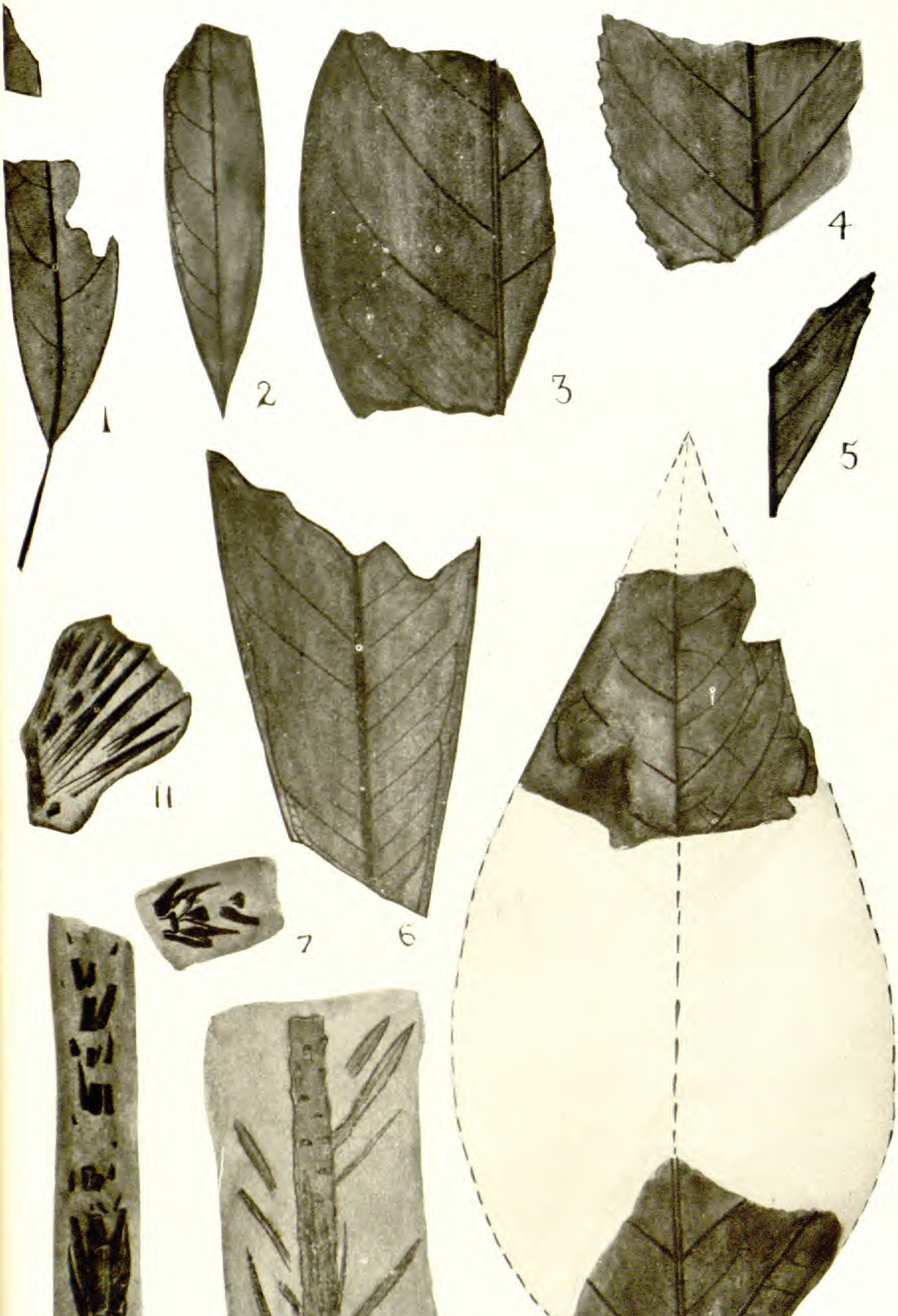

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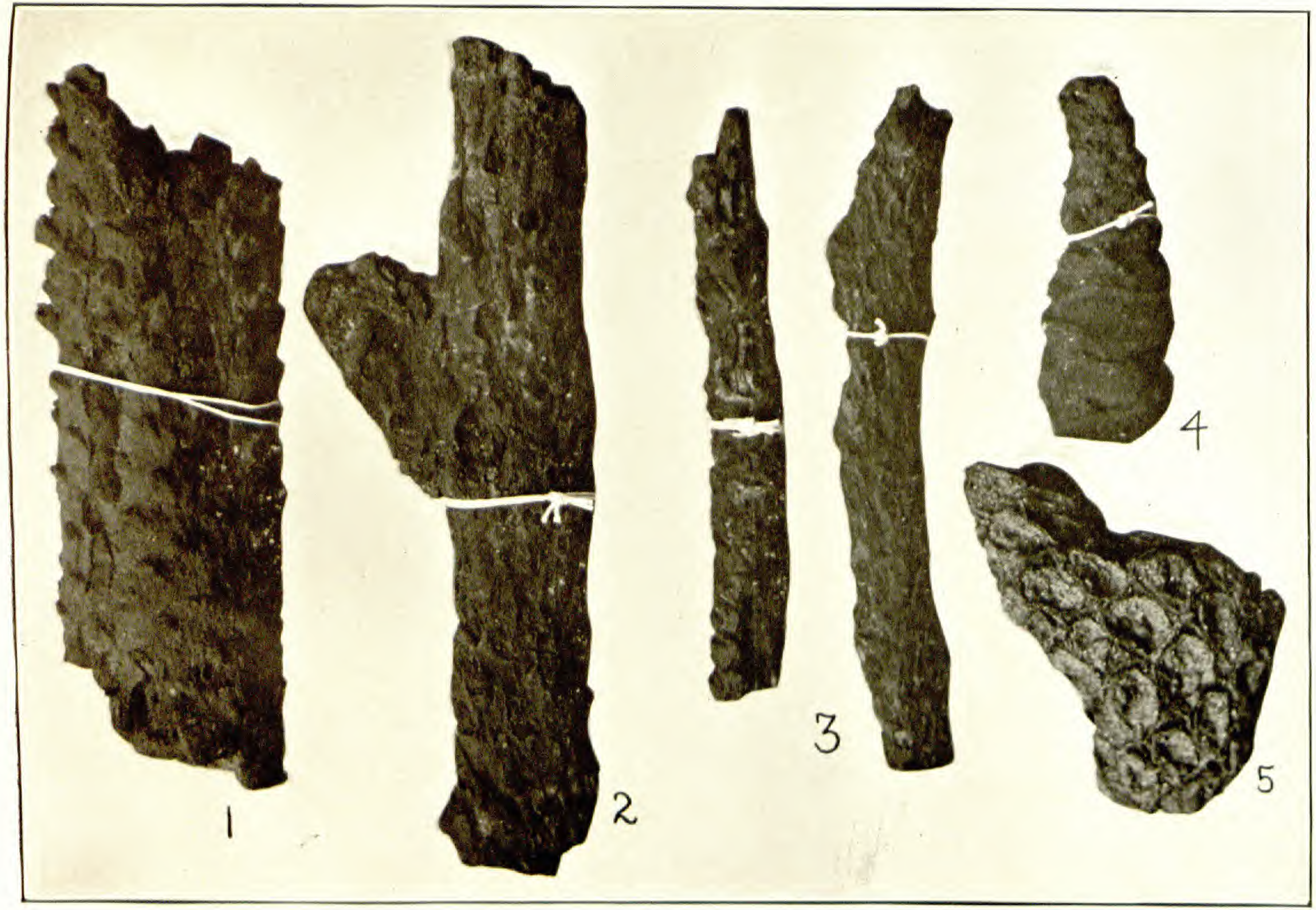

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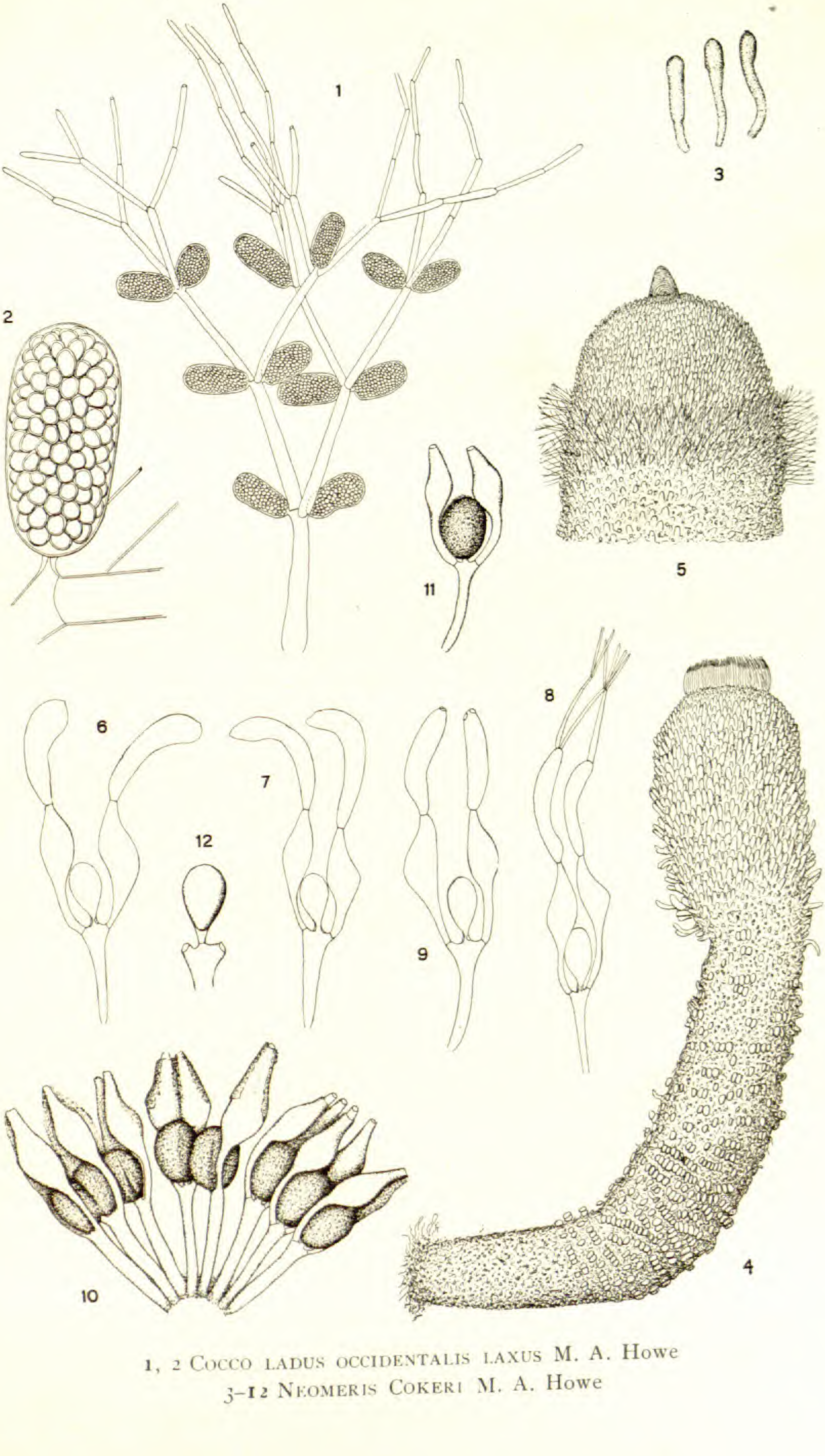

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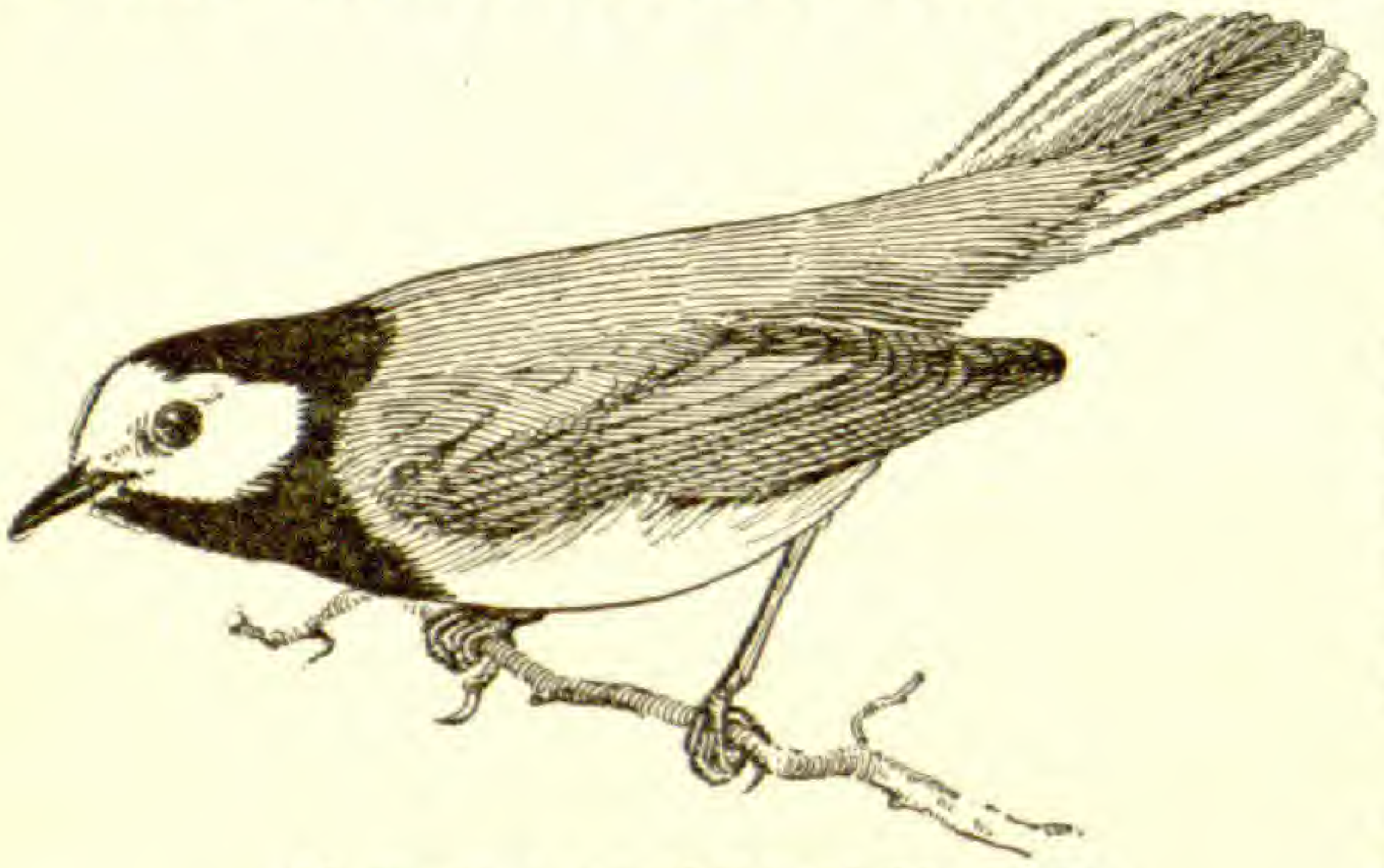

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MARCH, 1904

Taxonomic importance of the spermogonium*

J. C. Arthur

It is as well at the outset to disclaim all intention of treating the subject from any real knowledge of the true nature of the spermogonium. The name implies a sexual function, either active or obsolete. The similarity in structure to the pycnidia of lichens has induced many attempts to discover a similarity in function, but wholly without success. So far as known, the spermatia, which are discharged abundantly from the spermogonium, have no connection with the further development of the fungus. They may be induced to grow somewhat and bud, when placed in a nutrient solution, but no permanent structure has ever been obtained, and no parasitic connection has ever been established. So far as present knowledge extends, the spermogonium is an isolated organ with functions not yet conjectured, or whose original functions have been lost through modifications, possibly induced by parasitism.

Cytological evidence shows very distinctly that the spermogonium is an organ in no wise comparable with the uredosorus or aecidium. The spermatia, which are discharged abundantly from the spermogonium, contain each but a single nucleus, which arises by division of the nucleus in the spermatiophore from which the spermatium is abstricted, according to the researches of Sappin-Trouffy. In what manner this single nucleus is derived from the paired nuclei of the vegetative mycelium is not clear, although

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* Read before the American Association for the Advancement of Science, St. Louis, December 30, 1903.

[The preceding number of the Bulletin, Vol. 31, No. 2, for February, 1904 (31 : 57–112, *pl. 1–6*) was issued 11 F 1904.]

Sappin-Trouffy regards the uninucleated condition as suggestive of senility.

Waiving this inference, observe that both aecidiospores and uredospores are binucleated, and that the nuclei arise from the binucleated mycelium in the usual vegetative manner characteristic of the rusts. Both spore-forms are therefore conidia, and serve the purpose of rapid propagation of the species, being purely asexual in origin and function. This, of course, has always been assumed for the uredospores, but often denied for the aecidiospores. The work of a number of eminent cytologists no longer leaves the slightest doubt regarding the correctness of this view, and whatever degree of sexuality has been assumed for the aecidium must henceforth be abandoned.

Turning to the teleutospore we find that each cell contains two nuclei when young, but that they soon fuse in a manner highly suggestive of a sexual function. The explanation of this nuclear fusion as a genuine sexual act was first proposed by Dangeard and Sappin-Trouffy nearly ten years ago, and quite recently reaffirmed by Harper, and again very recently by Holden and Harper in an important contribution to the nuclear phenomena in *Coleosporium*. During germination the single nucleus of the teleutospore moves into the promycelium, and by dividing twice furnishes a nucleus for each of the four sporidia. In the sporidium the nucleus once more divides, but this time the process is unaccompanied by division of the cell, and thus the vegetative binucleated condition is again established, which is maintained throughout the life-cycle until the teleutospore is again reached, unless the spermogonium may be considered as introducing an interruption. However, as the uninucleated spermatia are discharged into the air and come to naught, and as the mycelium bearing the spermogonium continues the cycle by developing potentially active spores, aecidiospores for example, it is evidently permissible for our present purpose to ignore the spermogonium in tracing the nuclear cycle.

Although our knowledge of the nuclear history is not complete, yet enough has been established to permit of a reasonable inference regarding the nuclear cycle, which may be stated in brief, as follows: A fusion takes place in the teleutospore, having the physiological effect of a sexual act, and establishing the beginning of the nuclear cycle. During germination the one nucleus divides into four, one for each of the four sporidia. By the time the sporidium is ready to form myçelium, its nucleus has separated into two, lying side by side, and henceforth these paired nuclei maintain an independent existence. When a new cell of the mycelium or a conidiospore is formed, each of the paired nuclei divides, half of each remaining in the old cell and half going to the new one. Thus the two associated nuclei have an independent line of descent from the time of leaving the sporidium of the germinating teleutospore until they arrive in a teleutospore again.

This account of nuclear phenomena has been given to show that the life-cycle of a rust begins with the germinating teleutospore, that is, the sporidium; that the spermogonium is a problematical organ quite *sui generis;* and that all other sorts of rust spores are of a conidial or asexual character.

The spore-forms of the rusts and the spore-bearing structures present an endless diversity, which is one of the charms of the study, and at the same time is a source of perplexing difficulties. There are, however, but two types of uredineal conidia; the aecidium and the uredo. These have received different names when presenting different aspects, and it may be well to mention the more common of these appellations. When the aecidial peridium is elongated and dehisces by numerous longitudinal slits the aecidium is called a roestelia, a form found on pomaceous hosts; when the peridium is extended and breaks irregularly we have a peridermium, which occurs on coniferous hosts; when the peridium is wanting the aecidium is called a caeoma. The uredo, when it assumes a resting state, has spores with indurated, brown walls and persistent pedicels, which are called amphispores. But throughout all the variety of forms, the aecidiospore and the uredospore retain their conidial character.

It is not always easy to decide whether a certain spore-structure is an aecidium or a uredo, and it would not be difficult to point out many instances where they are confused in the recent writings of some of the most eminent uredinologists, were it not both ungracious and uncalled for to do so. In general they may be distinguished by the spores of the aecidium always being produced in chains, and those of the uredo being produced singly on evident pedicels, except in case of the genera of the *Coleosporieae* and *Chrysomyxeae*, where they as well as the aecidiospores are in chains. In all cases the aecidium is developed before the uredo in point of time.

This brings us to a consideration of the succession of spore-forms in the cycle of development. In the first place it may be said that the order is invariable. The germinating teleutospore gives rise to the sporidium, from the mycelium of which is produced first the spermogonium, then the aecidium, and later comes the uredo, and then the teleutospore completing the cycle. Either the aecidium or the uredo may be omitted from the cycle of development, or both may be omitted, as occurs in many species, but the spermogonium is rarely omitted, and the teleutospore with its sporidium never. The developmental order and the suppression of spore-forms may be represented in four series. By using the Roman numerals I, II and III for aecidia, uredo and teleutospore respectively, the cipher for the spermogonium, and the letter *y* for the sporidium, the series may be shown in tabular form, or they may be represented diagrammatically. By far the largest number of species are illustrated by the first series, having all spore-forms present; a much smaller number by the second series, having the uredo suppressed; and a still less number by the third series, having the aecidium suppressed. The fourth series, with both conidial forms suppressed, claims many species, however, and possibly more than either the second or third. In each of the four series the spermogonium is sometimes suppressed. Very little attention has been given to the presence or absence of the spermogonium, however, and the recorded data bearing upon the matter are extremely meager. At present it is unwise to venture an opinion whether the non-appearance of this structure in any

SUCCESSION OF SPORE-FORMS

A. Complete series.	B. Uredo wanting.	C. Aecidia wanting	D. No uredo or aecidia.
y	*y*	*y*	*y*
0	0	0	0
I	I	—	—
II	—	II	—
III	III	III	III

species is due to conditions of growth, to adaptations extending over a long period, to reduction as the result of parasitism, or to specific variation. All that can be said is that it seems probable that in some species the spermogonium is wholly wanting, but that in the great majority of species it is present.

The general conception of the spermogonium is, I venture to say, that of a minute structure necessarily accompanying the aecidium, although in some exceptional cases it may occur in connection with the other spores. This view is the outgrowth of the teaching of DeBary. The spermogonium was first described by Tulasne in 1851, and believed to be the male organ of reproduction. In 1866 DeBary published his epoch-making work on the morphology and physiology of the fungi, and in this he says

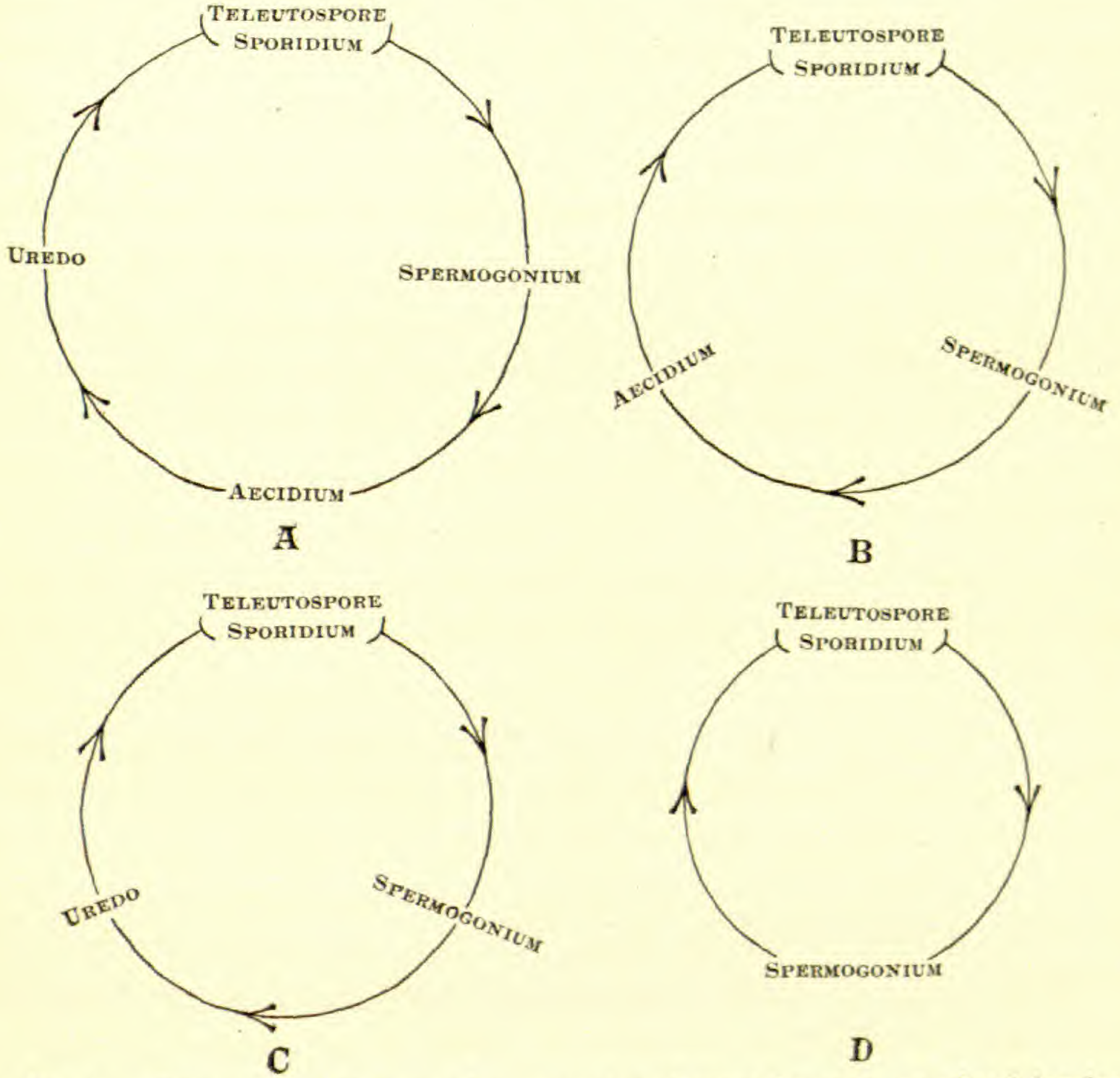

FIG. 1. Diagrams to illustrate the succession of spore-forms in a cycle of development; **A**, all spore-forms present; **B**, uredo-stage suppressed; **C**, aecidium-stage suppressed; **D**, both uredo and aecidium suppressed. The suppression of spore-forms sometimes extends also to the spermogonium.

that with a few exceptions the spermogonia are the constant accompaniment and precursors of the aecidia, and that this points to a sexual relation between them (page 169). In the second edition of the work in 1865 this statement is elaborated, and has been made familiar to English-speaking botanists through the translation of 1887 (page 276). As exceptions DeBary recorded in his earlier work that in cultures of *Endophyllum Sempervivi*, which usually produces spermogonia, repeated generations of aecidia occurred without a trace of spermogonia. In 1879 Schröter observed that aecidia of *Uromyces* on *Ervum* and of *Puccinia* on *Galium Aparine* are produced throughout the warm months, but that only the first generation in springtime is accompanied by spermogonia. In 1891 Barclay made observations upon a *Uromyces* on *Jasminum sempervivum* in India which produced aecidia accompanied by spermogonia when sporidia from germinating teleutospores were sown, but which produced aecidia unaccompanied by spermogonia when aecidiospores were sown. In 1895, in an article on rust-fungi with repeated formation of aecidia, Dietel added to the number of such species, coming to the conclusion that, in those species of *Uromyces* and *Puccinia* which form aecidia and teleutospores but no uredospores, the aecidiospores have the power again to bring forth aecidia, provided the mycelium is not perennial in the host. He called the aecidia arising directly from germination of teleutospores "primary aecidia," and those arising from germination of aecidiospores "secondary aecidia," and noted that spermogonia were usually absent from the latter. The same descriptive method has since been employed with the uredo; the primary uredospores being those which arise first accompanied by spermogonia; and the secondary uredospores, often of a different size and appearance, being those which come later without spermogonia.

Going back to the statement of DeBary, which is also the accepted view of every subsequent writer, that usually the spermogonia are the accompaniment and precursors of the aecidia, or in a few cases, we may add, of the uredo, we are now in a position to point out that the statement is only true in a superficial way, and in reality is misleading. Every one who has made cultures of the rusts knows that, in about a week after sowing the germinating teleutospores, there will appear spermogonia, without any regard to the kind of spore that is to follow. The spermogonium is clearly the first fruiting structure to arise in the cycle of development, that is, the first to follow nuclear fusion, which we may assume to be the sexual act. If we are, therefore, to regard the spermogonium as having any necessary association with other spore-forms, it must be with what precedes, that is, with the sporidium of the teleutospore, rather than with the conidia which follow. That this is physiologically as well as morphologically true is shown by the fact that the conidia closely following the spermogonia are usually larger and in many ways more vigorous than those conidia which arise from the germination of conidia, and thus are further removed from the reinvigoration of nuclear fusion. In some species with primary and secondary uredo, as for example, *Puccinia suaveolens*, and *Phragmidium Potentillae* on *Potentilla Canadensis*, the primary uredo when fresh can be told at a glance by the richer coloration and the larger and more compact sorus. It may be argued that the reason why the primary uredo is larger and stronger is because of its association with the spermogonium, which may be true, but if so, the explanation of it can not now be shown or even clearly conjectured. It is evident, however, that assuming the nuclear fusion in the teleutospore to be an invigorating process, and that position seems fairly unassailable, the effect of the fusion must be most marked in the earliest fruiting-bodies, and grow less and less the greater the number of removes, and hence the difference between the primary and secondary uredo.

Before reaching the chief feature of this paper there is one more phase of cyclar development that should be presented. It is the relation of the repeating conidia to the succession of spore-forms. The incompleteness of knowledge of full life-histories is especially felt in making generalizations regarding this feature of development. All that can be claimed is probable correctness. Both tabular and diagrammatic methods of illustration may be employed as before. When the uredo occurs in the series, the uredospores by germination give rise to a mycelium that at once produces more uredospores, and these may repeat the process, and so on indefinitely, or until the favorable season for growth draws to a close, in this manner widely distributing the species. If no uredo occurs in the series, the aecidiospores often possess the power of repetition; and if neither uredo nor aecidia occur, the teleutospores may act in the same way, as in the numerous species of the *Lepto-Uredineae.*

It is worthy of note that in a complete series of spore-forms there is but one generation of aecidia, and that the mycelium bearing the aecidia does not continue, as a rule, to live and produce uredospores, but comes to an end with the fruiting of the aecidia. The fungus is then re-established by aecidial germination. Thus the development is thrown into two hemicycles. One may incidentally observe that, except as an aid to heteroecism, there appears no evident advantage to the fungus in possessing two conidial spore-forms. All the work of dissemination is equally well done by either one of the two forms, acting alone.

SUCCESSION OF SPORE-FORMS.

A. Complete series	B. Uredo wanting.	C. Aecidia wanting.	D. No uredo or aecidia.
y	*y*	*y*	*y*
o	o	o	o
I	**I**	—	—
II	—	**II**	—
III	III	III	**III**

The repeating spore-forms are in heavy type.

An observation more pertinent to our inquiry is, that the spermogonium occurs but once in the cycle, not being repeated with each generation of repeating aecidia or uredo. In case the teleutospore takes on the conidial function it is uncertain whether the spermogonium is repeated with each summer generation or not. In *Puccinia Malvacearum*, and similar *Lepto-Uredineae*, the spermogonium seems to be wholly suppressed, even with the first generation in spring. It is unnecessary, however, for the purposes of this paper either to decide or to discuss this doubtful point.

After this rather tedious exordium I am prepared to make the first of two statements regarding the taxonomic value of the spermogonium: to record its presence, and the spore-generation with which it is associated, gives valuable information regarding the probable length of the cycle. By referring to the last diagrams it will be clear at a glance, that if spermogonia and uredospores are found arising from the same mycelium, aecidia do not occur in the cycle; and if spermogonia and teleutospores are found arising from the same mycelium, there are neither uredo nor aecidia in the cycle. If we read a diagnosis in which only teleutospores are

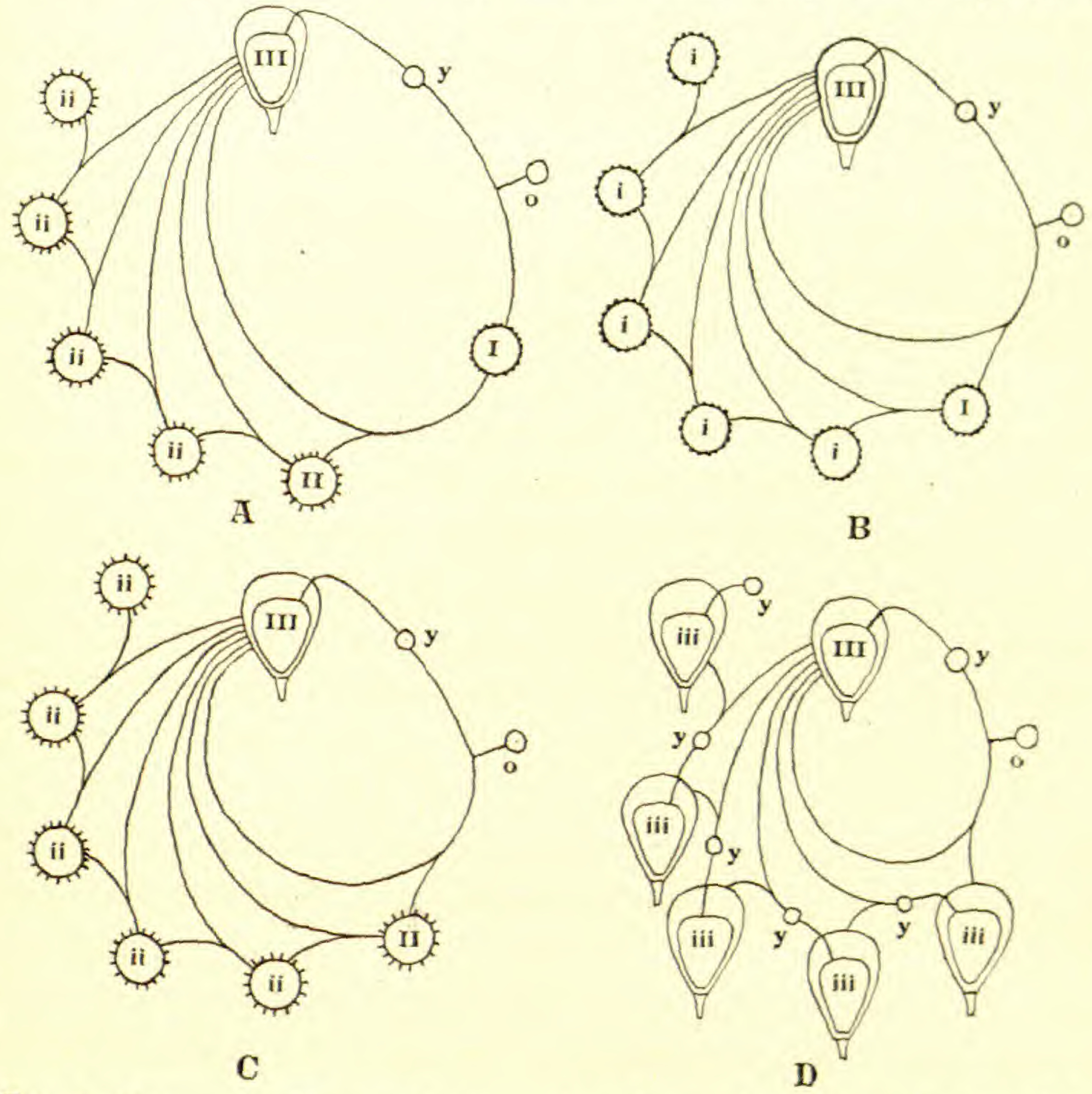

FIG. 2. Diagrams to illustrate the succession of spore-forms, the continuity of the mycelium, and the repeating generation, within a cycle of development.

Curved lines represent mycelium; when the lines branch, two kinds of spores are borne by the same mycelium, usually one succeeding the other in point of time; **III**, primary teleutospores; **iii**, secondary or repeating teleutospores; **I**, primary aecidia; **i**, secondary or repeating aecidia; **II**, primary uredo; **ii**, secondary or repeating uredo; **y**, sporidia; **o**, spermogonia.

A, complete cycle of development, the repeating generation being the uredo; **B**, cycle with the uredo suppressed, the aecidium being the repeating generation; **C**, cycle with the aecidium suppressed, the uredo being the repeating generation; **D**, cycle with both aecidium and uredo suppressed, the teleutospore being the repeating generation.

mentioned, there is no way of judging whether the rust also possesses aecidia and uredo or not, unless it is stated that the teleutospores germinate immediately upon maturity, when usually, although not invariably, other spore-forms are absent. To mention that spermogonia are directly associated with the teleutospores sets the matter at rest. The same is true when they are associated with the uredo. But when they are associated with the aecidia, the case is somewhat different. Only in instances where teleutospores and aecidia arise from the same mycelium, and immediately adjoining, can it be told from a specimen in hand that the cycle is without uredospores.

It should be mentioned, that it is not to be inferred that when spore-forms are suppressed, all trace of them is lost. On the contrary, when the uredo-form is suppressed, a few uredospores are often found intermixed with the teleutospores; and when both aedicia and uredo are suppressed, a few peridial cells and uredospores may occur in the teleutosori, reminders of two lost conidial generations.

My second statement regarding the taxonomic value of the spermogonium is, that position, form, color and size, are characters worth recording, but have only minor value, as the range of variation is slight. The spermogonium is usually a flask-shaped body, averaging 100–150 μ in diameter, formed immediately beneath the epidermis. The narrow neck protrudes through the epidermis, in order to discharge the spermatia into the air. Sometimes, especially in certain species of rusts parasitic upon *Ranunculaceae*, *Anacardiaceae*, *Rosaceae* and *Caesalpiniaceae*, the spermogonium is formed in the upper epidermal wall, just beneath the cuticle, and is then more or less hemispherical or conical. Intermediate forms sometimes occur, but the variation is usually inconsiderable. The position of the spermogonia in relation to the accompanying spore-form is also worth noting. The two structures are usually upon opposite sides of the leaf bearing them, but occasionally both are on the same side. The spermogonia sometimes occupy a small limited area, with the conidiosori on the opposite side of the leaf, or encircling them on the same side; or they may be scattered thickly or sparsely over large areas intermixed with the conidiosori, or opposite them.

The purpose of the paper has now been attained, if the twofold value of including information about the spermogonium in every descriptive account of a rust has been made clear. Spermogonial characters probably have little or no generic value, but their specific value is considerable, first as an indication of the nature of the life-cycle, and secondly in furnishing positive characters for identification. Incidentally it has been explained that the common conception of the spermogonium as an accompaniment of the aecidium, or other spore-forms, is incorrect and misleading. The spermogonium should rather be considered a fixed structure accompanied by some other spore-form as a rule, but in no wise dependent upon the same.

PURDUE UNIVERSITY.

A phyto-geographic sketch of extreme southeastern Pennsylvania

JOHN W. HARSHBERGER

TOPOGRAPHY

The area considered in this phyto-geographic survey comprises the region of Pennsylvania drained by Wissahickon creek, lower Schuylkill river, Cobbs creek, Darby creek, Crum creek, Ridley creek and Chester creek, extending to the divide between Chester creek and the lower Brandywine. It is part of the well-characterized Piedmont plateau in the Atlantic drainage system, and comprises the district situated south and southeast of the range of hills formed by the Laurentian syenites. All of the streams mentioned, with the exception of the Wissahickon, the Brandywine, which heads in the low limestone of the Chester valley, and the Schuylkill, which rises in the mountains, take their rise to the east and southeast of the divide formed by the range of hills that owe their origin to the resistance of the Laurentian syenite rocks to erosion, from the earliest geologic time. The Wissahickon, the Schuylkill and the Brandywine flow from the low limestone Chester valley and through gneiss gorges on their way to the Delaware river. In the case of the Wissahickon, the act is startlingly bold, because accomplished by a small stream.

It may be stated here briefly that when the gorges of the Wissahickon, the Schuylkill and the Brandywine were made, Chester valley was at a much higher level. Its soft limestone rocks were dissolved faster than the gneiss, hence the width of the Chester valley and other limestone valleys compared with the narrow valleys cut in the harder gneissic rock. Cobbs, Darby, Crum, Ridley and Chester creeks rise upon, or on the eastern slopes of the Laurentian ridge which extends in a general southwestern direction from beyond the Delaware at Trenton to West Chester, Chester county, Pennsylvania. This ridge, reaching a general elevation of 300–500 feet, marks the boundary of the limestone Chester and Whitemarsh valleys, crosses the Schuylkill below Norristown and widens in Chester county into a confused range of hills. The streams, just mentioned, flow generally southeastward into the

Delaware river, striking across several geologic formations. The Laurentian syenites are cut into by the headwater tributaries of these streams, which make gorges in the newer gneissic rocks of the region, finally flowing across the alluvial plain found along the Delaware river.

The shorter streams with less volume of water have not cut across the Laurentian divide, but they are and have been constantly at work widening and deepening their gorges, so that in the last few miles of their courses they often run practically at base-level, as indicated by the sluggishness of their flow. During their existence, these creeks, as well as the master-streams mentioned above, have been subjected to various vicissitudes through oscillations of the earth's surface. Several times their lower stretches have been subjected to depression and elevation. During periods of depression, their mouths have been drowned by the encroachment of the sea upon the preceding land-surface, the Delaware river becoming an estuary of the Atlantic ocean, with the deposit of sediments in the form of mud, sand and gravels. Nevertheless the streams of the region have been constantly at work reducing the country to a peneplain, eating away the sand and gravel deposited during submergence and leaving undisturbed patches to tell the tale of their former existence. During periods of subsidence, erosion has been less active, but during long periods of elevation the streams have been reawakened and started afresh into active earth-leveling.

The Piedmont plateau and the alluvial coastal strip in southeast Pennsylvania were, with the similar region in New Jersey, subjected to movements of the earth's surface. The following may be recognized as of importance in the consideration of the region from a phyto-geographic aspect:

1. The post-Triassic uplift and the subsequent development of the Schooley peneplain.
2. The Cretaceous subsidence and deposition.
3. The post-Cretaceous uplift.
4. The Miocene submergence and the deposition of the Miocene beds.
5. The post-Beacon-Hill submergence and the development of the pre-Pensauken peneplain.

6. The Pensauken submergence and the deposition of the Pensauken formation.

7. The post-Pensauken uplift and the erosion accomplished between this uplift and the last glacial epoch.

8. The last glacial epoch.

During the Pensauken submergence the land was depressed to such an extent as to drown the Delaware river at its lower end, allowing the sea to pass up its valley and over the peneplain which had been developed during the previous cycle of erosion, so that a broad sound was formed which connected Raritan bay with Delaware bay. The Delaware river entered the Pensauken sound at Trenton, and the Schuylkill river, Cobbs, Darby, Crum, Ridley and Chester creeks emptied into this sound, having their lower portions drowned through this submergence.

The mouth of the Delaware river during the post-Pensauken uplift was transferred to Delaware bay, the creeks above mentioned assumed their old relationship to the country and began again actively to erode their basins. This cycle of erosion lasted until the ice of the last glacial epoch invaded the northern portion of the state. The topography of the region under consideration was changed but little and what changes were brought about were due to the deposition of drift, which was far from uniform.*

These topographic and geologic facts have been mentioned somewhat at length, because they have strikingly influenced the vegetation of the country since Cretaceous times, when we have a great and sudden inswarming of the higher plants of modern types, at the close of the lower Cretaceous. The great feature of this period was its dicotyledonous forests. Thus the following genera of trees found in southeast Pennsylvania to-day date from the Cretaceous period: *Fagus, Liquidambar, Liriodendron, Salix, Quercus, Castanea, Betula, Alnus, Platanus, Sassafras, Diospyros, Juglans* and *Hicoria*. The botanical character of the Amboy clays of coastal New Jersey, influenced by the changes of elevation described above, will be seen from the following brief synopsis.†

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* *Cf.* Salisbury, R. D. The physical geography of New Jersey. Geol. Surv. N. J. 4: — 1898. — Heilprin, A. Town geology. — Leslie, P. Final report, Pa. Geol. Surv. I. — Rand, T. D. Notes on the geology of southeastern Pennsylvania. Proc. Acad. Nat. Sci. Phila. 1900: 160–338. 1900.

† Dawson, J. W. The geological history of plants. 204.

The angiosperms form about seventy species, which include three of *Magnolia*, four of *Liriodendron*, three or four of *Salix*, three of *Celastrophyllum*, one of *Celastrus*, four or five of *Aralia*, two of *Sassafras*, one of *Cinnamomum*, one of *Hedera* (with leaves that are apparently identical with those described by Heer as belonging to *Andromeda*), *Cissites*, *Cornus*, *Diospyros*, *Eucalyptus*, *Ficus*, *Ilex*, *Juglans*, *Laurus*, *Menispermites*, *Myrica*, *Myrsine*, *Prunus*, *Rhamnus* and others.*

A statement of the above facts is proof that during the Tertiary period and up to its close a dense forest existed in north temperate and arctic latitudes. The northern portion of this forest and the tenderer species unable to withstand the nipping frosts were exterminated with the advance of the glaciers. South of the great terminal moraine, which reaches as far south as the Ohio river, but separated from it by a zone tenanted by arctic-alpine plants and other boreal species now found on mountain-tops and in the Hudsonian and Arctic belts of North America, the original Tertiary forest, minus such genera as *Eucalyptus*, *Ficus*, *Cinnamomum*, etc., persisted, reaching its greatest denseness in the region drained by the Tennessee river and its tributaries. One tongue of this forest of less denseness probably reached in a northeastward direction, as far north as a line following the windings of the west branch of the Susquehanna river to the Blue Ridge, thence along the Blue Ridge to the Schuylkill river, thence across to the southeast side of Great Valley and following the hills on the south side of Great Valley to the Delaware river.

Arbitrarily considered, all of the territory above this line and between it and the terminal moraine was a country influenced by the glacial cold. All of the country south of it, protected by the Allegheny mountains, the Blue Ridge and other ranges of hills to the eastward of the Schuylkill river, was covered by a forest composed in the main of those species of trees, not destroyed by the glacial cold, that had existed in this region, and also in the far north prior to the advent of the last glacial epoch. Comparing the northern remnant of the magnificent Tertiary forest with the southern remnant of this forest in the region drained by the Tennessee

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* Knowlton, F. H. A catalogue of the Cretaceous and Tertiary plants of North America. Bull. U. S. Geol. Surv. No. 152. 1898.

river, and in the southern Appalachian mountains, generally speaking, it lacks many of the peculiar arboreous and herbaceous species which characterize the flora of the south and which have their nearest living representatives in the flora of eastern China and Japan.

With the retreat of the great ice-sheet, the region once covered by the ice was restocked by trees and herbs derived from three main sources of supply: (1) Scandinavia, (2) Hudsonian zone of the Glacial period, (3) Appalachian forests (north and south). The Scandinavian plants migrated eastward during the inter-glacial period and tenanted the moraines, nunataks and arctic strip of territory throughout the later glacial epoch. With the retreat of the glaciers, they migrated northward with the ice sheet, or they persisted on the tops of high mountains which existed as nunataks during the ice age, or they remained as boreal islands in sphagnum-bogs, or in cold and shaded ravines. A northward migration of Hudsonian species and of Appalachian species in concentric waves also took place at the close of the Glacial period.*

The action of the several uplifts and depressions of the earth's surface described was most profound upon this forest, the history of which has been traced. With every submergence of the lower portions of the creeks of the region and of the Delaware river, the forest in the area of submergence was destroyed, or if existing on the higher grounds, was subjected to such extensive changes of level, as to highly modify its character and the distribution of the component species. Many species were crowded together by the change of level and the wearing away of the strata to which they had become adapted, for "if we suppose the earlier Mesozoic uplands to be the seat of the existing dicotyledons, then by the lowering of the surface by gradual consumption of the interstream areas, these forms must have been brought into conflict with the flora of the lowlands and thereby forced into a contest for supremacy."†

Xerophytes of the hillsides and rock exposures (such as ser-

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* *Cf.* Adams, C. C. Post-Glacial origin and migrations of the life of the north-eastern United States. Jour. Geol. 1 : 303. S 1903.

† Woodworth, J. B. The relation between baseleveling and organic evolution. Am. Geol. 14 : 231. O 1894.

pentine)* are replaced by mesophytes, which thrive in rich alluvial soils ; mesophytes, by the wearing away of the soil and the formation of cliffs, by xerophytes, such as exist on the serpentine barrens of southeast Pennsylvania ; hydrophytes replace mesophytes, when an area becomes too wet for the tenancy of ordinary plants. Thus, if we apply such principles to the study of our region, southeastern Pennsylvania, the dry ground formed by the post-Cretaceous uplift was the seat of a dense mesophytic forest, by erosion mesophytes of the plain were replaced by xerophytes of the hillside, and by a still more pronounced base-leveling process, the xerophytes were again replaced by mesophytes. When the submergence occurred and the forest was drowned, a series of hydrophytes filled the tidal estuaries to be replaced by terrestial plants at the next uplift.

Shull † gives an interesting case in point. The distribution of *Isoetes saccharata* Engelm. along Chesapeake bay is explained by the geomorphic movements of the coastal plain. The present elevation of land is such that the water of the bay is fresh about ten kilometers below the mouth of the Susquehanna river. During periods of greater elevation the water was fresh farther to the south. When the land was so elevated that the water was fresh at the mouth of the Potomac river, favorable habitats along the shore of the bay must have been occupied by the progenitors of the colonies of *Isoetes saccharata* which now occur in the upper estuarine portion of the tributary rivers. As the land sank and the rivers were ponded farther and farther from their mouths, new areas became adapted to the growth of *Isoetes*, and new colonies were formed. Simultaneously the colonies furthest down stream were destroyed by the advance of salt water. In this way there came to be, instead of a single colony or group of colonies at the head of Chesapeake bay, as many distinct colonies as there were ponded tributaries. So long as the land continued to sink, the successful reproduction was on the up-stream side, and destruction followed *pari-passu* on the down-stream side until the present con-

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* Harshberger, J. W. Flora of the serpentine barrens of southeast Pennsylvania. Science, II. 18 : 339–343. 11 S 1903.

† Shull, G. H. Geographic distribution of *Isoetes saccharata*. Bot. Gaz. 36 : 199. S 1903.

dition of widely separated colonies was brought about. In periods of elevation the reverse process must have taken place, and the many distinct areas must have been merged again into one. As we find *Isoetes saccharata* Engelm. nowhere else than in Chesapeake bay and *Isoetes riparia* Engelm. nowhere else than in Delaware bay, it seems fair to assume that the physiographic changes mentioned above as controlling the distribution of the former species have influenced the distribution of *Isoetes riparia* along Delaware bay in a somewhat similar manner.

We can picture to ourselves the manner in which the area uplifted from the water was tenanted by various species of dry-land plants. The process may have been gradual, permitting the gradual adjustment of the newly implanted vegetal covering, or it may have been sudden, followed by an inrush of species. Lange * describes an interesting case, illustrating the latter process.

The establishment of vegetation upon the flood-plain of the Delaware river may best be studied on islands formed by the deposition of silt about some obstacle in the river. A bar originates. The first vegetation consists largely of annuals, then come willows, and finally a characteristic flood-plain forest. The red maple (*Acer rubrum*) appears, then poplars and the ash (*Fraxinus Americana*). Gradually the plain becomes dry enough to permit the development of a true mesophytic forest. Some such stages were passed through by the vegetation of southeastern Pennsylvania with each uplift following a process of depression. The same forces are at work now that were active in past geologic time, and the same laws are in operation which then controlled the distribution of plants.

The history of the upland plant associations is somewhat different from that of the lowland. In tracing the genetic development of these associations, we must consider especially the vegetation of the creek ravines. Cowles † has described the origin of the vegetation of clay ravines. None of this class of ravines are found typically developed in southeastern Pennsylvania. Rock-gorges are common and are occupied by all of the streams that drain the region under consideration. The physical nature of the gneissic

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* Lange, D. Revegetation of Trestle Island. Minn. Bot. Stud. 2: 621. 1901.

† Cowles, H. C. The physiographic ecology of Chicago and vicinity. Bot. Gaz. 31: 88. 1901.

and syenitic rocks excludes landslide action and lateral cutting is relatively slow, as compared with ravines formed in clay. Thus the conditions are much more favorable for the growth of plants in a rock-gorge than in a clay ravine. Rock-gorges are shady and often the rocks drip with water and are, therefore, carpeted with mosses, ferns and liverworts. Shade-loving plants abound, whose leaves are broad and thin. The stages of development pass more slowly in rock-gorges. With the gradual widening of the cañon, however, the character of the flora undergoes a slow change, so that the vegetal covering is never stable, but constantly shifting, now of one appearance and with the lapse of time and change of physiographic conditions of another.

The character of the soil conditions, therefore, influences the particular kind of vegetation, so that we may have with the same exposure of light, heat and moisture a different flora, if the superficial soil deposits are different. Recent work * appears to show that, contrary to opinions that have long been held, there is no obvious relation between the chemical composition of the soil as determined by methods of analysis used and the yield of crops, but that the chief factor determining yield is the physical condition of the soil under suitable climatic conditions. The rainfall determines the productiveness of a country. Temperature and rainfall together are one of the most important natural resources of a country.

Clearly, therefore, the distribution of species does not depend so much upon the chemical character of two different strata,† but it is because one geologic area has advanced further in its life history than the other. The vegetation, for example, of a clay hill to-day will be seen on a sand hill in the future. The laws that control changes in the plant covering of a country are, therefore, plainly physiographic. Wherever hills are being eroded, valleys widened, rivers deepened, waterfalls eliminated, lakes filled, or coastal plains enlarged, there must be a constant change in the plant societies, or a succession in definite order of plant groups.

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* Whitney, M. and Cameron, F. K. The chemistry of the soil as related to crop production. U. S. Dept. Agric. Bureau Soils, Bull. 22 : — 1903.

† Cowles, H. C. The influence of the underlying rocks on the character of the vegetation. Bull. Am. Bureau Geog., Je–D 1901.

PLANT FORMATIONS AND ASSOCIATIONS

Southeastern Pennsylvania is a region of hills, of valleys, of meadows and of rocky ravines sloping down in general from the Laurentide hills to the Delaware river.

It represents an original table-land whose general elevation was about 500 feet above tide-level. Originally the surface, hills as well as river-plain above the fresh-water marshes which line the Delaware river, was covered by a dense forest of trees. Since the settlement of the country the most desirable land has been under cultivation, and many flourishing manufacturing towns, as Philadelphia, Chester, Conshohocken and Norristown, are found partly on the river-plain and partly situated on the rolling hills formed by the newer gneissic rocks. Culturally speaking, several kinds of land may be distinguished, such as river-land, marsh-land, city- and town-land, farm- and cultivated land, uncultivated woodland, uncultivated barren land, and abandoned farm-land.

Botanically considered, the following ecologic plant formations and associations may be distinguished, and these are determined approximately by the character of the areas above mentioned.

A. UNCULTIVATED.

AQUATIC-PLANT FORMATION.—The rivers and creeks of our region, especially in their lower courses, have smooth stretches of water in which grow a number of aquatic species. These species in the tidal estuaries are usually of the larger sort and are well adapted to grow in water where there is a change of level between low and high tide of about three feet. In many of the streams, the tidal flow is of considerable strength and the current established, therefore, influences the distribution of the vegetation to a marked extent. Where the flow is less strong and swift, there the material in the form of mud and silt is deposited and upon this alluvial material aquatic plants take root and gradually raise the level of these areas by catching and holding fresh deposits of silt. The result is a tidal marsh intersected by numerous meandering channels through which the tidal water ebbs and flows.

In the Schuylkill river above the dam at Fairmount is such a deposit of silt. *Vallisneria spiralis* L. forms a pure association of such extent as seriously to interfere with the navigation of the river by pleasure craft (*Vallisneria* association). In some of the smaller streams and in ponds formed in artificial depressions, *Philotria Canadensis* (Michx.) Britton (*Elodea Canadensis* Michx.) abounds. A fine growth of this plant, the water-weed, is found in an abandoned quarry-hole at Leiperville, Pa., and another in a small stream near Horticultural Hall, Fairmount Park (*Elodea* association). The spatterdock, *Nymphaea advena* Soland. (*Nuphar advena* Ait. f.) is probably the commonest aquatic plant that grows in the tidal portions of the streams of southeast Pennsylvania. It covers acres of mud ground and stretches as a pure association for miles along the Delaware and Schuylkill rivers (*Nuphar* association). Associated with it in shallower water the pickerel-weed, *Pontederia cordata* L., abounds, forming in places pure associations. This interesting plant with trimorphic flowers is most abundant on the New Jersey side of the Delaware river (*Pontederia* association). The duckweeds are found in the ditches and ponds of the region. This is true especially of the district in South Philadelphia known as the Neck. The agricultural land, kept in a high state of fertility by the application of city manurial waste, is intersected by numerous ditches where abound *Spirodela polyrhiza* (L.) Schleid., *Lemna minor* L., *Wolffia Brasiliensis* Wedd., and *Wolffia Columbiana* Karst. (*Lemna* association). *Orontium aquaticum* L., the goldenclub, is also a plant that forms in places ecologic groups (*Orontium* association). The water-chinquapin, *Nelumbo lutea* (Willd.) Pers., twenty-five years ago existed in the region of the "Neck." With the spread of the city southwest, the plant was destroyed.

POND-PLANT FORMATION. — There are no ponds or lakes of any size natural to southeastern Pennsylvania; all that now exist are artificial. Some of them occupy depressions from which clay has been taken for bricks; others occupy the bottoms of rock quarries, while still others have been formed by the damming of streams. The only natural ponds are of small size and are rather pools formed in a depression near some perennial spring. The ecologist finds in such natural pools, or along their edges, a collection of species that seem to give character to them, such as *Chrysosplenium Americanum* Schwein. (*Chrysosplenium* association), *Veronica Americana* Schwein., *Typha latifolia*

L., *Philotria Canadensis* (Michx.) Britton, *Acorus Calamus* L., *Iris versicolor* L., *Myriophyllum verticillatum* L., *Spirodela polyrhiza* (L.) Schleid., *Cardamine bulbosa* (Schreb.) B. S. P. (*C. rhomboidea* DC.), *C. rotundifolia* Michx., *Caltha palustris* L., *Myosotis palustris* (L.) Lam., *Roripa palustris* (L). Bess. (*Nasturtium palustre* DC.), *Roripa Nasturtium* (L.) Rusby (*Nasturtium officinale* R. Br.) (*Nasturtium* association), *Isnardia palustris* L. (*Ludwigia palustris* Ell.) and various algae, viz., *Spirogyra, Hydrodictyon, Conferva, Nitella, Oedogonium, Volvox, Euglena* and *Mesocarpus.*

TIDAL-MARSH-PLANT FORMATION. — This formation was studied along the Delaware and at the mouths of the Schuylkill river, Crum and Darby creeks. The most satisfactory place to study the ecologic disposition of the plants is at the mouth of Crum creek, where the botanist can take advantage of a wooden footbridge (two thousand feet long) constructed to connect a lighthouse with the mainland (FIG. 1). The tidal marshes have been formed by a variety of contributing forces. Material brought down by the rivers has been sorted and distributed over the tidal areas by the tides and currents of the streams that meet here. The location of these deposits and their superficial extent has depended upon the character, force and direction of the currents. Elaborate plans are in existence showing the currents of all the navigable streams in southeastern Pennsylvania. These may be consulted at the office of the United States engineer in charge of harbor improvements. The material is too abundant and the details too specialized to present in a paper of this character.

The banks of the streams influenced by tidal action are lined by thickets composed of *Platanus occidentalis* L., *Gleditsia triacanthos* L., *Alnus rugosa* (Du Roi) K. Koch, (*Alnus serrulata* Willd.), *Acer rubrum* L., *Salix alba* L., *Liquidambar Styraciflua* L., *Fraxinus Americana* L., *Sambucus Canadensis* L., *Cephalanthus occidentalis* L., *Rosa lucida* Ehrh. with *Parthenocissus quinquefolia* (L.) Planch. (*Ampelopsis quinquefolia* Michx.) and *Rubus nigrobaccus* Bailey. The herbaceous associations of the woody plants mentioned are in this rich alluvial soil *Thalictrum polygamum* Muhl., *Heracleum lanatum* Michx., *Agrimonia parviflora* Soland., *Allium vineale* L., *Ambrosia trifida* L., *Impatiens biflora* Walt. (*I. fulva* Nutt). In mud near the bank, associations of the rose mallow, *Hibiscus Moscheutos* L., occur, with occasional patches of the sensitive fern, *Onoclea sensibilis* L. Along the edges of the stream-banks in the shallow water grow *Clinopodium vulgare* L. (*Calamintha Clinopodium* Benth.), *Jussiaea diffusa* Forsk. (*J. repens* Sw.), *Sagittaria latifolia* Willd. (*S. variabilis* Engelm.), *Cicuta maculata* L., *Ludwigia alternifolia* L., *Stachys palustris* L. and *Asclepias incarnata* L. In the deeper water fringing the shore of the creeks, strips of wild rice, *Zizania aquatica* L. (*Zizania* association) and of *Nymphaea advena* Soland. (*Nuphar* association) are found.

The tidal marshes of the rivers Delaware and Schuylkill are extensive and may be in places one half a mile wide (FIG. 1). Several well-marked zonal areas of marsh vegetation are noticeable in making an ecologic survey. Some of the marshes have been diked. Others at high tide are flooded with water, and yet the ecologist can distinguish relative depths of water by the character of the vegetation alone (FIGS. 2, 3, 4). If one begins with the open channels of the creeks and ditches that intersect the marshes, the following zonal areas can be distinguished. In the deeper water along the channel, the reed-grass, *Zizania aquatica* (*Zizania* association) forms the outer fringe of vegetation (FIGS. 2, 3, 4, *A*, *AA*) and where it does not occur *Nymphaea advena* replaces it and forms a pure growth (*Nuphar* association) (FIGS. 2, 3, *E*). In July two colors of reed-grass are noticeable: a dark green mature form in deep water (FIGS. 2, 3, 4, *A*) and a light green immature growth of reed-grass inside of the dark green area (FIGS. 3, 4, *AA*). In the shallower water behind the reed-grass and spatterdock several associations of plants are seen. One area (FIG. 2, *J*) is characterized by the commingling of *Sagittaria latifolia*, *Impatiens biflora*, *Ambrosia trifida*, *Nymphaea advena*, with an occasional association of *Hibiscus Moscheutos* (FIG. 2, *H*) and on the drier area *Sambucus Canadensis* (FIG. 2, *KKK*, *KKKK*), *Cephalanthus occidentalis*, *Parthenocissus quinquefolia*, *Rubus nigrobaccus* and a few willows, *Salix alba* (FIGS. 2, 4, *W*). In other areas (FIG. 2, *O*) *Impatiens biflora*, *Rudbeckia laciniata* and *Sagittaria latifolia* occur, and on drier soil (FIG. 2, *M*) *Thalictrum polygamum* and *Heracleum lanatum*. As shown in FIG. 3, *D*, *Typha latifolia* forms a pure association (*Typha* association) surrounded by

Ambrosia trifida and *Sagittaria latifolia* (FIG. 3, *BBB*), in other areas this forms pure associations (FIGS. 3, 4, *B*) and in still other situations it is mixed with *Cicuta maculata* (*Sagittaria-Cicuta* association) (FIG. 3, *F*). *Cephalanthus occidentalis* always occurs in the drier soil of the tidal marshes and in a number of places with it grow *Cornus Amomum* Mill. (*Cornus sericea* L.), *Sambucus Canadensis* L. (FIG. 2, *S*), *Stachys palustris* L. and *Convolvulus sepium* L. (*Calystegia Sepium* L.) (FIG. 3, *K*). Alluvial islands occur in the channels of the streams. These are at first covered by the spatterdock, and as the soil becomes drier through the building action of these plants, the spatterdock is replaced by other plants,

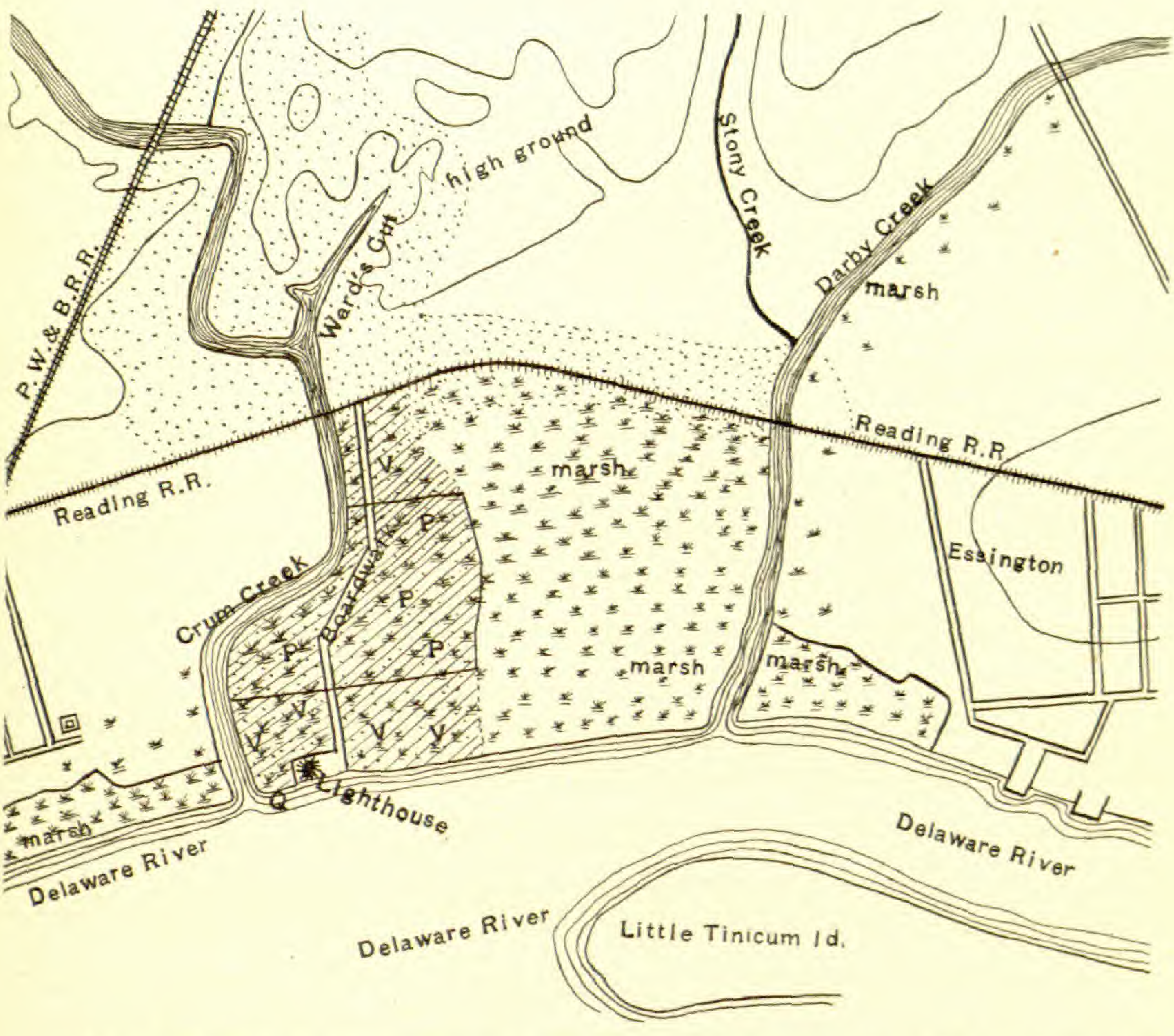

FIG. 1. Map showing position of tidal-marsh region surveyed. The area traversed is represented as the dotted portion of the map. The area surveyed ecologically is represented by the portion designated by the oblique lines (*V*). The area of the marsh (*P*) enlarged in figures 2, 3, and 4 is inclosed by the heavy lines. The position of the *Scirpus* association is shown at *Q*. The open river marsh (not diked) is indicated, as also the location of the high ground.

until the island becomes dry enough to support tree vegetation. The disposition of the several associations of plants can be studied best by reference to the graphic representations of plant distribution accompanying the text. The marshes have been drained in many cases sufficiently to raise marsh-grass for hay. The ditches of such converted marshes afford many interesting plants, such as *Spirodela polyrhiza* (L.) Schleid., *Lemna minor* L., *Wolffia Brasiliensis* Wedd., *W. Columbiana* Karst. (*Lemna* association), *Pontederia cordata* L. (FIG. 4, *C*), *Asclepias incarnata* L., *Typha latifolia* L., *Sagittaria subulata* (L.) Buchenau (*S. pusilla* Nutt.), *S. rigida* Pursh (*S. heterophylla* Pursh), *S. latifolia* Willd., *Zizania aquatica*

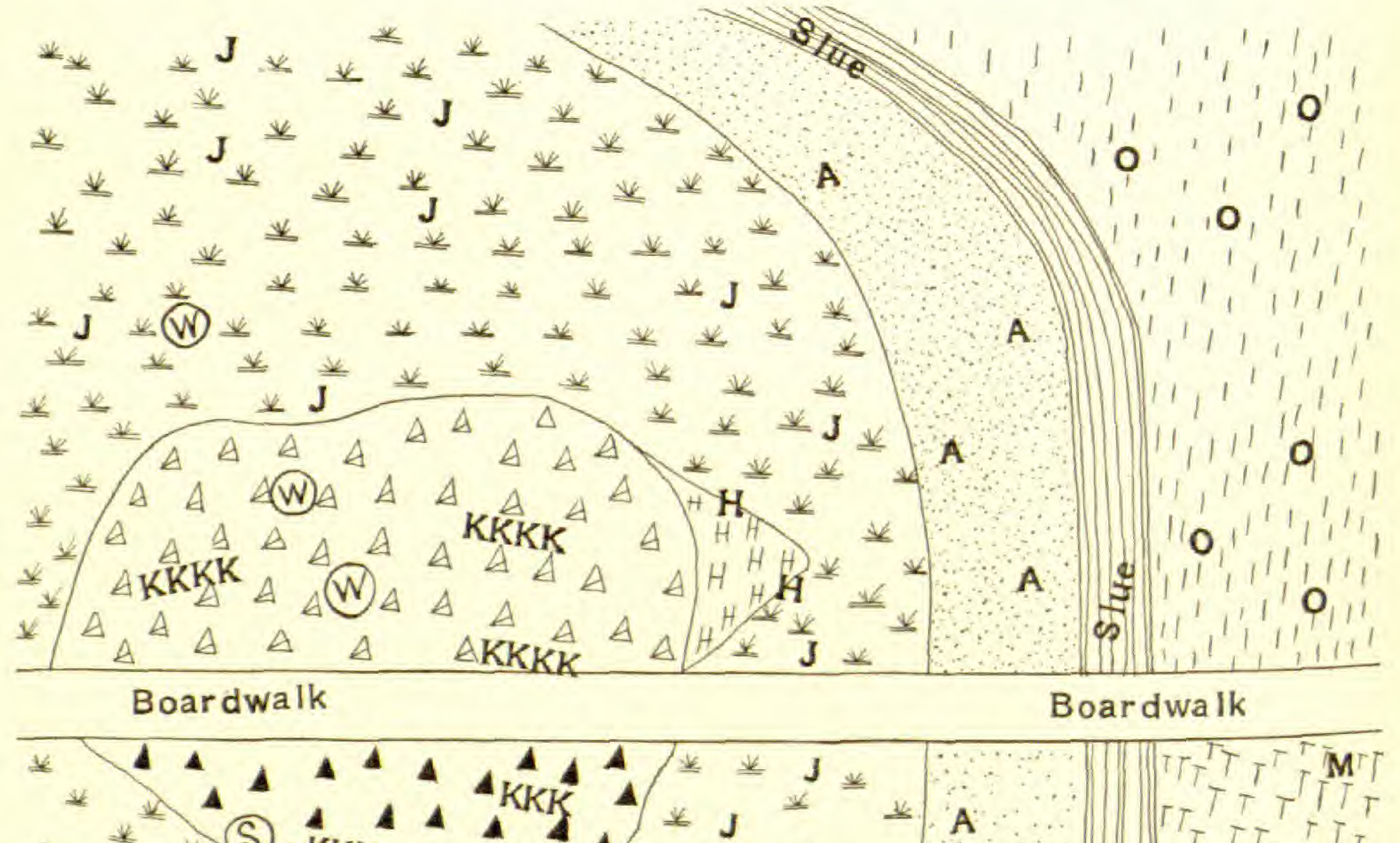

FIG. 2. Portion of tidal-marsh-plant formation shown in Fig. 1. *A*, area of *Zizania aquatica* L.; *E*, *Nuphar* association; *J*, *Sagittaria latifolia* Willd. and *Ambrosia trifida* L.; *KKK*, *Sambucus Canadensis* L., *Cephalanthus occidentalis* L. and *Rubus nigrobaccus* Bailey; *KKKK*, area occupied by willows, *W*, and *Sambucus Canadensis* L.; *H*, *Hibiscus Moscheutos* L.; *O*, *Impatiens biflora* Walt., *Rudbeckia latifolia* Willd. and *Sagittaria latifolia* Willd.; *M*, *Thalictrum polygamum Muhl.* and *Heracleum lanatum* Michx.

L. and *Hibiscus Moscheutos* L. Outside of these associations and growing in the deeper water along the banks of the Delaware River is an association of *Scirpus lacustris* L. (*Scirpus* association) (FIG. 1, *Q*, near lighthouse).

SWAMP-PLANT FORMATION. — The swamps of the region under consideration are of three kinds, as determined by their origin: (1) Swamps that owe their origin to a stream flowing over a low, flat area of country; (2) swamps due to underground springs; (3) swamps due to the collection of the drainage water of an area into a natural basin-shaped depression. True sphagnum bogs are not represented in southeastern Pennsylvania. This

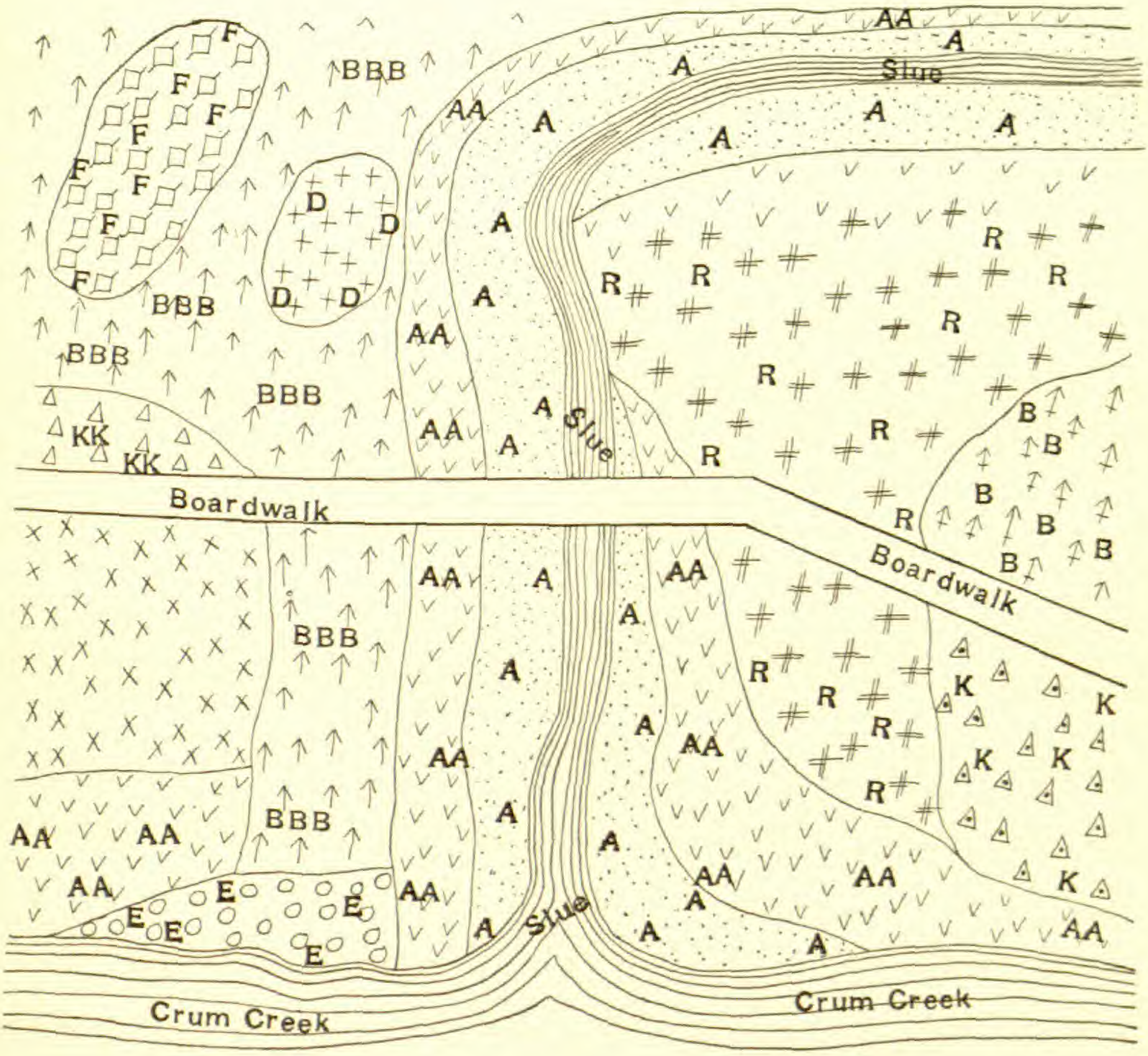

FIG. 3. Portion of the tidal-marsh-plant formation shown in Fig. 1. *A*, dark green *Zizania aquatica* L.; *AA*, light green *Zizania aquatica* L.; *E*, *Nuphar* association; *B*, *Sagittaria* association; *BBB*, *Sagittaria latifolia* Willd. and *Ambrosia trifida* L.; *D*, *Typha* association; *F*, *Cicuta-Sagittaria* association; *K*, *Convolvulus Sepium* L., *Sambucus Canadensis* L., *Cornus amomum* Mill. and *Cephalanthus occidentalis* L.; *R*, *Sagittaria latifolia* Willd. and *Rudbeckia laciniata* L.

does not exclude sphagnum mosses from the category of swamp plants, but bogs which owe their character to them are absent, and peaty deposits such as one finds associated with the sphagnum are entirely wanting. The swamp plants characteristic of the region may be enumerated in the following list: *Carex*, *Scirpus* and *Cyperus*, several species, *Onoclea sensibilis* L., *Osmunda regalis* L., *O. Claytoniana* L., *O. cinnamomea* L., *Spathyema foetida* (L.) Raf., *Acorus Calamus* L., *Typha latifolia* L., *T. angustifolia* L., *Iris versicolor* L., *Carex squarrosa* L., *Veratrum viride* Ait., *Thalictrum polygamum* Muhl., *Impatiens biflora* Walt., *I.*

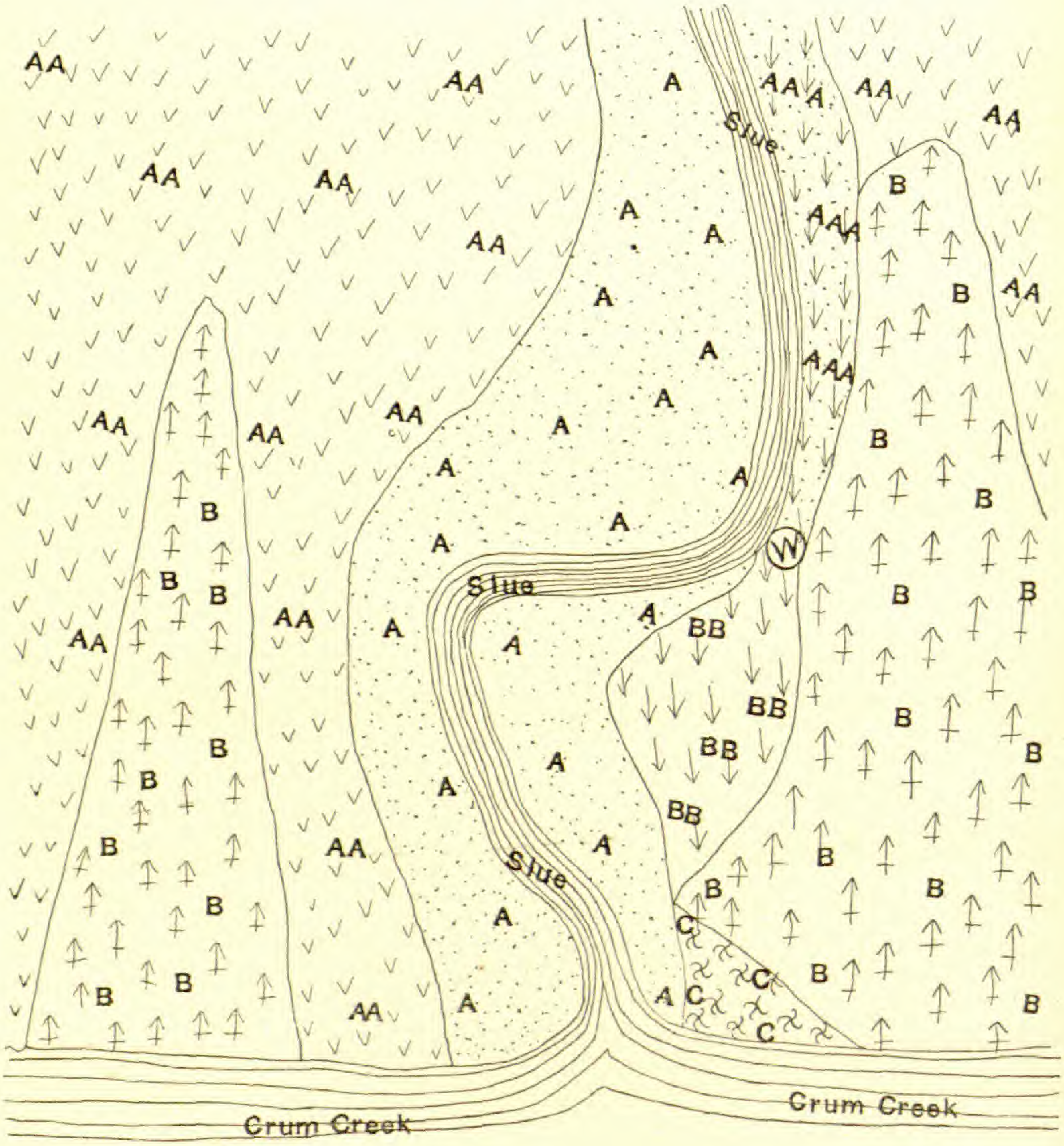

FIG. 4. Portion of tidal-marsh-plant formation shown in Fig. 1. *A*, dark green *Zizania aquatica* L.; *AA*, light green *Zizania aquatica* L.; *B*, *Sagittaria latifolia* Willd.; *BB*, *Sagittaria latifolia* Willd., a form with narrower leaves; *AAA*, dark and light green *Zizania aquatica* L., mixed; *W*, *Salix alba* L.; *C*, *Pontederia cordata* L.

aurea Muhl., *Cardamine bulbosa* (Schreb.) B. S. P., *Drosera rotundifolia* L., *D. intermedia* Hayne, *Sarracenia purpurea* L., *Myosotis palustris* Withering, *Mimulus ringens* L., *Cicuta maculata* L., *Heracleum lanatum* Michx., *Lobelia syphilitica* L., *L. cardinalis* L., *Bidens laevis* (L.) B. S. P., *B. bipinnata* L., *B. frondosa* L., *Rudbeckia laciniata* L., *Eupatorium purpureum* L., *Heliopsis helianthoides* (L.) B. S. P., *Stachys palustris* L., *Alnus rugosa* (DuRoi) K. Koch, *Benzoin Benzoin* (L.) Coult., *Sambucus Canadensis* L., *Ilex verticillata* (L.) A. Gray.

The plants mentioned in the list fall naturally into several ecologic associations. Thus, we have the *Symplocarpus* association, consisting of *Spathyema foetida*, *Osmunda regalis*, *O. Claytoniana*, *O. cinnamomea*, *Cardamine bulbosa* and *Onoclea sensibilis*. The *Iris*, *Typha* and *Acorus* associations are clearly demarcated. *Heracleum lanatum* forms in swampy places a pure growth, as do also *Veratrum viride* and *Eupatorium purpureum* (*Heracleum*, *Veratrum*, *Eupatorium* associations). *Heliopsis helianthoides*, *Rudbeckia laciniata*, *Commelina Virginica*, *Polygonum sagittatum*, *Mentha spicata* and *Vernonia Noveboracensis* are usually together in alluvial bottom lands at the mouths of streams where the soil is wet (*Heliopsis-Rudbeckia* association). In similar situations grow *Solidago rugosa* Mill., *Hydrocotyle umbellata* L., *Carduus lanceolatus* Hoffm. and *Lobelia syphilitica* L.

MIXED-DECIDUOUS-FOREST FORMATION. — Originally the forest covered most of the surface of southeast Pennsylvania. In some places, notably on the Wissahickon creek within the confines of Fairmount Park and in areas on Crum creek, the primeval forest still remains. Mr. J. Howard Lewis, Sr., and his progenitors have preserved inviolate a large tract of timber along Crum creek, while the surrounding country settled by patent in 1681 and 1682 has been cleared of its timber for many years. A study of such preserves shows the character of the original forest. The dominant and secondary forest trees grow on precipitous rocks, on declivitous hillsides, on the plateau surfaces left as a remnant of a former peneplain, on the creek bottoms of the region, where the trees reach their largest size, and on the Delaware river plain down to where the forest formation merges with the river marsh plant formation. All of the areas occupied by the cultivated-plant formations recognized in this paper, as well as the roadside-plant formation, the pasture-field-plant formation, the ruderal-plant formation, part of the barren-plant formations and alluvial-soil-plant formations were covered by the original forest. This fact is mentioned because it illustrates how man has altered the character of the original plant formations. By the removal of the original forest, by the introduction of various cultivated plants and weeds, the long-established balance produced by the competition of the native species is rudely disturbed and exotic species come into conflict with the resident species and even the character of the undisturbed formations is altered by the injection of new species into them. However, enough of the virgin forest remains to permit a phyto-geographic survey. The original forest was a mesophytic one. It probably passed through various vicissitudes dependent upon the topographic changes, so that the xerophytic forest of the hillside was gradually replaced by a mesophytic forest. The tendency has been in the entire region to the culmination of the forest in the mesophytic type. The forest, of great original density, may be looked upon as the northeastern extension of the forest found developed in its highest character in the region drained by the Tennessee river and its tributaries and by streams arising in the southern Allegheny mountains and flowing eastward into the Atlantic. Arbitrarily, a line drawn from a point where the Ohio joins the Mississippi river, east to the Cumberland mountains and thence along the Allegheny mountains to the west branch of the Susquehanna river in Pennsylvania, then to the Blue Ridge and along it to the Schuylkill river, following the hills on the south side of the Great Valley to the Delaware river, represents the northern limit during glacial times of the forest which during the Miocene period extend north into the Arctic regions.

The northeastern extension of the forest of glacial times was much poorer in species than the mixed deciduous forest farther south. This was probably due to the killing of the less hardy species by the glacial cold. Only those species remained in the area mentioned that were hardy. These hardy species, therefore, represent the main constituent species of the present-day forest with the possible introduction of a few additional species that migrated north from the denser forest that clothed the valleys and slopes of the southern Allegheny mountains.

The dominant trees of the forest that covered and still covers in patches southeastern Pennsylvania is composed of the following species: Tulip-poplar, *Liriodendron Tulipifera* L.; chestnut, *Castanea dentata* (Marsh.) Borkh. (*Castanea sativa Americana* Gray); black walnut, *Juglans nigra* L.; red oak, *Quercus rubra* L.; white oak, *Q. alba* L.; scarlet oak, *Q. coccinea* Wang.; chestnut oak, *Q. Prinos* L.; Spanish oak, *Q. digitata* (Marsh.) Sudw. (*Q. falcata* Michx.); beech, *Fagus Americana* Sweet (*F. ferruginea* Ait.); *Hicoria ovata* (Mill.) Britton (*Carya alba* Nutt.); hackberry, *Celtis occidentalis* L.; butternut, *Juglans cinerea* L.; sweet gum, *Liquidambar Styraciflua* L.; persimmon, *Diospyros Virginiana* L.; white elm, *Ulmus Americana* L.; white ash, *Fraxinus Americana* L.; wild red cherry, *Prunus Pennsylvanica* L.f.; pignut, *Hicoria glabra* (Mill.) Britton (*Carya porcina* Nutt.); silver maple, *Acer saccharinum* L. (*Acer dasycarpum* Ehrh.); sugar maple, *Acer saccharum* Marsh. (*Acer saccharinum* Wang.); red maple, *Acer rubrum* L., buttonwood, *Platanus occidentalis* L.; small-fruited hickory, *Hicoria microcarpa* (Nutt.) Britton (*Carya microcarpa* Nutt.); and ironwood, *Ostrya Virginiana* (Mill.) Willd. These trees are found on a great variety of soils, but reach their greatest size on the dry alluvial soils of the creek and river bottoms. Thus the black walnut, tulip-poplar, white elm, buttonwood, red maple and silver maple reach their best development on such soils. The white oak, white ash, chestnut, etc., seem to grow equally well in the drier upland soils. The red cedar, *Juniperus Virginiana* L., on the other hand, seems to be confined to barren places and to rocky outcrops, while the trees that grow along the banks of the streams within the region comprise the red maple, *Acer rubrum* L.; the hornbeam, *Carpinus Caroliniana* Walt.; swamp oak, *Quercus palustris* DuRoi; buttonwood, *Platanus occidentalis* L.; box-elder, *Acer Negundo* L. (*Negundo aceroides* Moench); beech, *Fagus Americana* Sweet; *Sassafras Sassafras* (L.) Karst. (S. *officinale* Nees), and several birches and willows.

These trees form a dense canopy, and shade the forest floor, so that the secondary species,' shrubs, sapling trees and herbs, must be tolerant of such dense shade. The dominant trees reached great size in the primeval forest, for some are left which attest this. Thus are found white oaks six to eight feet in diameter, buttonwood trees six feet across, white pine five feet in diameter, beeches four feet, black walnut trees four to five feet, tulip-poplars six feet, sassafras trees two feet and a half. The secondary species tolerant of the shade are the dogwood, *Cornus florida* L., red mulberry, *Morus rubra* L., service berry, *Amelanchier Canadensis* (L.) Medic, bladdernut, *Staphylea trifolia* L., Judas-tree, *Cercis Canadensis* L., hazel, *Corylus Americana* Walt., witch hazel, *Hamamelis Virginiana* L., and striped maple, *Acer Pennsylvanicum* L., while as shrubs occur smooth alder, *Alnus rugosa* (Du Roi) K. Koch, spice-bush, *Benzoin Benzoin* (L.) Coulter, dockmackie, *Viburnum acerifolium* L., arrowwood, *Viburnum dentatum* L., stagbush, *Viburnum prunifolium* L., strawberry bush, *Euonymus Americanus* L., wahoo, *Euonymus atropurpureus* Jacq., and pinxter flower, *Azalea nudiflora L.* (*Rhododendron nudiflorum* Torr.); *Sambucus Canadensis*, the elder, also occurs in the region and at present is found usually in open places with alluvial soil forming thickets of some denseness. The laurel, *Kalmia latifolia* L., high-bush huckleberry, *Gaylussacia resinosa* (Ait.) Torr. & Gray and deerberry, *Polycodium stamineum* (L.) Greene (*Vaccinium stamineum* L.), are found in the drier forest soils throughout the region. The lianes which grow upon the dominant and secondary forest trees are several grape-vines, *Vitis cordifolia* Michx., *V. labrusca* L., *V. aestivalis* Michx., *V. vulpina* L. (*V. riparia* Michx.), Virginia creeper, *Parthenocissus quinquefolia* (L.) Planch., poison ivy, *Rhus radicans* L., and several species of the genus *Smilax*. The climbing bittersweet, *Celastrus scandens* L., moonseed, *Menispermum Canadense* L., *Sicyos angulatus* L., wild-yam, *Dioscorea villosa* L., and wild balsam apple, *Micrampelis lobata* (Michx.) Greene (*Echinocystis lobata* Torr. & Gray) are climbing plants found along the courses of streams.

A peculiar type of this mixed deciduous forest is found on the serpentine rock formations of the region under consideration. The botanist can identify the serpentine areas, by the vegetation alone, for the species which are character-plants, although occurring elsewhere in the region, are here grouped together in such a manner and in such number, as to sharply delimit these areas from the surrounding country. The dominant trees on the serpentine barrens are *Quercus alba* L., *Q. stellata* Wang., *Quercus Marylandica* Muench, *Acer rubrum L.*, *Liriodendron Tulipifera* L., *Nyssa sylvatica* Marsh., *Juniperus Virginiana* L., *Castanea dentata* (Marsh.) Borkh., *Fagus Americana* Sweet, *Quercus rubra* L. and *Prunus serotina* Ehrh., while associated with these trees are *Sassafras Sassafras* (L.) Karst. *Rhus glabra* L., *Kalmia latifolia* L., *Salix tristis* Ait., *Cornus florida* L., *Viburnum dentatum* L., *Polycodium stamineum* (L.) Greene, *Gaylussacia resinosa* (Ait.) Torr. & Gray, *Viburnum acerifolium* L. and *Benzoin Benzoin* (L.) Coult. The lianes are *Vitis aestivalis* Michx., *Parthenocissus quinquefolia* (L.) Planch., *Rhus radicans* L., *Smilax rotundifolia* L. and *S. glauca* Walt.

The herbaceous plants of the forest floor are found in pure association, or they occur sparingly distributed along with other herbs that form together a mixed vegetation. The habitats of the different herbaceous associations are controlled by photic and edaphic conditions. Thus in the deep shade of the dominant trees, the botanist finds the following plants forming pure associations and each association may be distinguished by the generic name of the plant:

April. — *Asarum Canadense* L., *Bicuculla cucullaria* (L.) Millsp. (*Dicentra cucullaria* DC.), *Erythronium Americanum* Ker, *Claytonia Virginica* L., *Pedicularis Canadensis* L., *Epigaea repens* Lam., *Thalictrum dioicum* L.

May. — *Cubelium concolor* (Forst.) Raf. (*Solea concolor* Ging.), *Podophyllum peltatum* L., *Triosteum perfoliatum* L., *Tradescantia Virginiana* L., *Mertensia Virginica* (L.) DC., *Caulophyllum thalictroides* (L.) Michx., *Hydrophyllum Virginicum* L.

July. — *Gaultheria procumbens* L.

The following ferns are also found in pure association in the forest: *Adiantum pedatum* L., *Dryopteris spinulosa* (Retz) Kuntze, (*Aspidium spinulosum* Swartz), *Dryopteris marginalis* (L.) A. Gray (*Aspidium marginale* Swartz), *Dryopteris acrostichoides* (Michx.) Kuntze (*Aspidium acrostichoides* Sw.) and *Phegopteris Phegopteris* (L.) Underw. (*P. polypodioides* Fée).

Along the woodland streams, growing in the damp loamy soil of such situations and controlled by the amount of soil-moisture present are a number of associations characterized by a single plant, as follows:

April. — *Floerkea proserpinacoides* Willd.

May. — *Polemonium reptans* L., *Valerianella chenopodifolia* (Pursh.) D.C., *Ornithogalum umbellatum* L., *Heracleum lanatum* Michx.

June. — *Lysimachia nummularia* L.

July. — *Impatiens biflora* Walt., *I. aurea* Muhl., *Thalictrum polygamum* Muhl., *Adicea pumila* (L.) Raf. (*Pilea pumila* Gray).

August. — *Leptamnium Virginianum* (L.) Raf. (*Epiphegus Virginiana* Bart.), *Lobelia cardinalis* L., *Commelina nudiflora* L. *C. Virginica* L.

September. — *Eupatorium purpureum* L.

The rocky outcrops in the woods consisting either of ledges or of angular boulders formed by frost action are covered by several well-characterized associations formed by pure growths of the following species:

Camptosorus rhizophyllus (L.) Link, *Polypodium vulgare* L.

April. — *Saxifraga Virginiensis* Michx., *Aquilegia Canadensis* L.

May. — *Heuchera Americana* L.

The herbaceous flora of the woods found on the serpentine areas of southeastern Pennsylvania has been discussed in a paper by the writer entitled "The flora of the serpentine barrens of southeast Pennsylvania." * As the facts have been presented there in some detail, it is hardly necessary to repeat the observations so recently published. The student is referred to that paper for an account of the distribution of the serpentine plants.

Besides these pure associations of plants found in the woods of southeast Pennsylvania occur a large number of species, rich in number of individuals, but scattered on the forest floor, separated from each other by spaces filled up with other characteristic woodland species, likewise isolated. These plants, therefore, form a mixed vegetation which covers the ground except where the pure associations of single species occur and give character to the herbaceous flora of such woodland areas. The following species may be included in this category. They are arranged, because of

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* Science, II. 18: 339–343. 11 S 1903.

what follows, according to the months in which they appear in flower.

Botrychium Virginianum (L.) Swartz, *Asplenium Filixfoemina* (L.) Bernh.

April. — *Dentaria laciniata* Muhl., *Viola palmata* L., *Ranunculus abortivus* L., *Geranium maculatum* L., *Arisaema triphyllum* (L.) Torr., *Erigeron pulchellus* Michx. (*E. bellidifolium* Muhl.), *Sanguinaria Canadensis* L., *Hepatica Hepatica* (L.) Karst. (*H. triloba* Chaix.), *Syndesmon thalictroides* (L.) Morong (*Anemonella thalictroides* Spach), *Panax trifolia* L. (*Aralia trifolia* Decsne & Planch.), *Mitella diphylla* L., *Viola Labradorica* Schrank (*V. canina Muhlenbergii* Gray), *V. blanda* Willd., *V. villosa* Walt., *V. pedata* L., *Carex Pennsylvanica* Lam., *Barbarea Barbarea* (L.) MacM. (*B. vulgaris* R. Br., *Ranunculus fascicularis* Muhl.

May. — *Washingtonia longistylis* (Torr.) Britton (*Osmorrhiza longistylis* DC.), *Vagnera racemosa* (L.) Morong (*Smilacina racemosa* Desf.), *Viola pubescens* Ait., *Thalesia uniflora* (L.) Britton (*Aphyllon uniflorum* Gray), *Oxalis stricta* L. (*O. corniculata stricta* Sav.), *Uvularia sessilifolia* L. (*Oakesia sessilifolia* Watson), *Trientalis Americana* (Pers.) Pursh, *Salomonia commutata* (R. & S.) Britton (*Polygonatum giganteum* Dietr.), *Medeola Virginica* L., *Galeorchis spectabilis* (L.) Rydb. (*Orchis spectabilis* L.), *Hypoxis hirsuta* (L.) Coville (*H. erecta* L.), *Tiarella cordifolia* L., *Hydrastis Canadensis* L., *Thaspium trifoliatum aureum* (Nutt.) Britton (*T. aureum* Nutt.), *Aralia nudicaulis* L., *Cypripedium acaule* Ait., *Allium tricoccum* Ait., *Arisaema Dracontium* (L.) Schott, *Hieracium venosum* L., *Oxalis violacea* L., *Uvularia perfoliata* L., *Smilax herbacea* L., *Geranium maculatum* L., *Juncoides campestre* (L.) Kuntze (*Luzula campestris* DC.), *Ficaria Ficaria* (L.) Karst. (*Ranunculus Ficaria* L.).

June. — *Pyrola rotundifolia* L., *Galium triflorum* Michx., *Cynoglossum Virginicum* L., *Corallorhiza odontorhiza* Nutt., *Uvularia grandiflora* Smith, *Scutellaria serrata* Andrews, *Leptorchis liliifolia* (L.) Kuntze (*Liparis liliifolia* Richard), *Cypripedium hirsutum* Mill. (*C. pubescens* Willd.), *Cypripedium parviflorum* Salisb., *Hieracium Gronovii* L., *H. scabrum* Michx., *Chimaphila maculata* (L.) Pursh, *Galium aparine* L.

July. — *Cimicifuga racemosa* (L.) Nutt., *Urticastrum divarica-*

tum (L.) Kuntze (*Laportea Canadensis* Gaud.), *Chelone glabra* L., *Panicum dichotomum* L., *Lilium Canadense* L., *Monotropa uniflora* L., *Prunella vulgaris* L., *Silene stellata* Ait., *Phryma leptostachya* L.

August. — *Lobelia syphilitica* L., *Solidago bicolor* L., *Aster macrophyllus* L., *Panicum microcarpon* Muhl.

September. — *Aster laevis* L., *Solidago caesia* L., *Collinsonia Canadensis* L.

All of these species are not found in a single wooded area. They are distributed in different combinations in southeastern Pennsylvania. Thus such local plants as *Cypripedium parviflorum*, *C. hirsutum*, *Camptosorus rhizophyllus*, *Galeorchis spectabilis*, *Hydrastis Canadensis* and *Leptorchis liliifolia* occur only in a few places in the region, but they are mentioned because they are plants which grow best in the deep shade formed by the crown of the dominant forest trees. The vegetal covering of the forest floor also differs with the season of the year, so that the spring flora is distinct from that of the summer flora, and the summer flora is distinct from the autumn flora. In the lists above this succession of floras is displayed, as far as the phenologic data at command will permit. The woodland species are most numerous in the spring, because the conditions are most favorable for their growth. Such plants as the bloodroot, wild ginger, May apple, windflower and lady's slipper abound. The summer flora of the woods is poorer in the number of species. Such plants as touch-me-not, cardinal lobelia, boneset, all-heal, etc., are found with a number of funguses, such as *Russula*, etc. The autumn flora of the forest consists of asters, golden-rods, mints, and a large number of toadstools and mushrooms, which feed saprophytically upon the humus of the soil composed of leaf-mold and rotted wood. The phenologic distribution of the woodland species is, therefore, quite as marked as their geographic habitat and controls associations of species in a most intimate manner. The seasonal sequence of species is one of the controlling factors in the struggle for existence. With the exception of the rivalry of the root and underground stem systems for ground-space, the spring plant may be said not to come into competition with the summer- and- autumn flowering species and conversely.

The mutual aid which plants show is quite as important in the grouping of associations, as the struggle for light and soil room. The beech-drop for example is dependent on the beech, and hence it is only found where the beech is an element of the forest. The Indian-pipe occurs only in woods where there is abundant humus, as also the majority of ericaceous plants provided with mycorhiza. Certain funguses are dependent upon the material formed by the decay of certain other plants and they, therefore, abound only where this material is found. The fungous flora of a particular forest area comes and goes in an inexplicable manner. One season there will be an abundance of a particular species and during another season that species cannot be found, but will be replaced by some other form. The character of the rainfall, whether light, heavy or frequent is a determining factor in the appearance of plants. With a heavy downpour most of the water which has fallen runs off the surface and does very little good. On the other hand, gentle rains which come frequently soften the ground, and thus furnish some water to the lower strata, or at least preserve the supply which is already there. The writer believes that there is a delicate balance of some kind established between fungi and the climatic and edaphic conditions of any neighborhood. It is only when the climatic and edaphic conditions are suitable that the fungus species again appears.* The conditions, therefore, which control the character of the vegetal covering of a mesophytic forest are most complex and intricate.

HEMLOCK FORMATION. — This formation occurs on the sloping hillsides and precipitous banks of streams and is developed notably on Wissahickon and Crum creeks. It is found generally along the Wissahickon creek and at the ox-bow of Crum creek below the Springfield water works on the north and west banks of the stream at this point. The forest of hemlocks consists in a few places of a pure growth without the admixture of any other tree species, but usually associated with the hemlock, *Tsuga Canadensis* (L.) Carr. the botanist finds the beech, *Fagus Americana* and red maple, *Acer rubrum*. These trees are tolerant of the dense shade of the hemlocks. Where the forest floor has not been dis-

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* *Cf.* Whitney, M. & Cameron, F. K. The chemistry of the soil as related to crop production. U. S. Dep. Agr. Bureau Soils Bull. 22 : 47–55. 1903.

turbed, sapling hemlocks, beeches and red maples are present ready to replace the dominant trees when they have succumbed to the wind. On the floor of the forest in places *Lycopodium lucidulum* Michx. forms an association (*Lycopodium* association). The laurel, *Kalmia latifolia* L., occurs in the drier soils and forms a thicket (*Kalmia* association). *Mitchella repens* L. carpets the ground (*Mitchella* association) and *Viola rotundifolia* Michx. is a character-plant with which grows *Peramium pubescens* (Willd.) MacM., *Cinna latifolia* (Trev.) Griseb., *Hieracium paniculatum* L., and in late summer *Aster divaricatus* L. In many places, the hemlock, *Tsuga Canadensis,* forms an element in the mixed-deciduous-forest formation. When such is the case, it is found in isolated patches usually of a few trees near the water-courses on steep hillsides. It forms then an association (*Tsuga* association) and with *Lycopodium lucidulum* are found three other species, viz., *Lycopodium annotinum* L., *L. clavatum* L., and *L. obscurum* L. (*L. dendroideum* Michx.), which grow near the hemlocks. Two alternative hypotheses may be adduced for this. Either an original hemlock forest has been replaced by a deciduous one, or occasional hemlock trees have been under certain edaphic conditions developed amidst the component species of the deciduous forest.

SERPENTINE-BARREN TREELESS FORMATION.—The details concerning this formation will not be given here, as an account has been given elsewhere of the character of the vegetation of the serpentine barrens.* The herbs found upon the broken-down serpentine rock are *Phlox subulata* L. (*Phlox* association), *Trifolium aureum* L. (*T. agrarium* L.), *Pteridium aquilinum* (L.) Karst. (*Pteris aquilina* L.), *Verbascum Blattaria* L., *Panicum latifolium* L., *Potentilla Canadensis* L., *Cerastium oblongifolium* Torr. (*Cerastium* association), *Senecio Balsamitae* Muhl. (*Senecio aureus Balsamitae* Torr. & Gray), *Castilleia coccinea* (L.) Spreng., *Arenaria stricta* Michx., *Talinum teretifolium* Pursh, *Ixophorus glaucus* (L.) Nash (*Setaria glauca* Beauv.), *Aster ericoides depauperatus* Porter, *Polygonum tenue* Michx., *Lespedeza Virginica* (L.) Britton, *Andropogon scoparius* Michx., *Solidaga puberula* Nutt., *Eupatorium aromaticum* L., *Panicum dichotomum* L., *Koellia flexuosa* (Walt.) MacM.

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* Harshberger, J. W. The flora of the serpentine barrens of southeast Pennsylvania. Science, II. 18 : 339–343. 11 S 1903.

(*Pycnanthemum linifolium* Pursh) and in wet places *Cyperus inflexus* Muhl. and *Fimbristylis laxa* Vahl.

MEADOW-PASTURE-FIELD-PLANT FORMATION.* — From early historic accounts of the region, the original forest was interspersed with open glades and natural meadows where for some edaphic reason the trees did not grow. These areas (such as we have left in the "Indian clearing" near Lima, Delaware County, and in the Playwicky clearing in Bucks County) were settled upon first, and with the exception of the areas above mentioned we have no natural openings that have not been altered by the hand of man. The botanist, therefore, has no data upon which to base a statement of the plant covering of such open, treeless areas.

Several kinds of fields may be distinguished. A classification of the plants according to the character of the inclosed areas might be made, but it would be too minute for a general phyto-geographic survey, such as this paper is intended to be. The uncultivated fields of southeastern Pennsylvania may be classified as follows:

1. Fields formed by clearing of the original timber.
2. Wet fields that may be called meadows, usually level and situated in low ground.
3. Barren fields characterized by the shallowness or poor character of the soil.
4. Dry fields that are fertile, but lack abundant water, the rain draining off after it falls. These fields are situated usually on hillsides.
5. Fields with rich soil that have been fallow, and that are used as pastures.
6. Abandoned fields in which weeds have been allowed to grow rampant and in which trees are beginning to appear.

Fields of the first class, formed by the clearing away of the original timber, are usually at once cultivated by plowing and sowing between the stumps; occasionally, however, they are left uncultivated and they become veritable weed patches. Most of the herbaceous weeds, mentioned as growing in cultivated areas, appear and occupy the ground. Some of the original woodland

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* For a list of plants peculiar to this formation on Darby Creek, the writer is under obligations to Miss Lydia P. Borden, of Manoa, Delaware County, Pa.

species, such as *Podophyllum peltatum* L., etc., remain as a characteristic plant growth. If permitted to relapse again to natural conditions, fields of the first class become fields of the sixth class in three or four years time.

Meadow-land (2) may be defined as that which has been reclaimed from a too wet condition by ditch or tile drainage. Compared with other field-areas meadows are relatively better supplied with ground water. Meadow-land merges into a swamp on the one hand or a cultivated field on the other. Plants growing in meadow-land are, therefore, not subjected to the vicissitudes of cultivation, but they are trodden down and browsed upon by cattle turned into such areas. Associations of species are not always clearly marked in meadows and no attempt is made to group the plants together naturally. A list of meadow plants is given by way of calling attention to the plants of the region which grow in such localities.

Anthoxanthum odoratum L., *Dactylis glomerata* L., *Lolium perenne* L., *Andropogon Virginicus* L., *Phleum pratense* L., *Alopecurus geniculatus* L., *Agrostis alba* L., *Poa annua* L., *P. compressa* L., *P. pratensis* L., *P. trivialis* L., *Cyperus strigosus* L., *Carex* (various species), *Juncus* (several species), *Scirpus* (several species), *Trifolium pratense* L., *T. repens* L., *T. agrarium* L., *T. procumbens* L., *T. hybridum* L., *Melilotus alba* Desv., *Muscari botryoides* (L.) Mill., *Daucus Carota* L., *Hedeoma pulegioides* Pers., *Hypericum perforatum* L., *Polygonum Pennsylvanicum* L., *P. scandens* L. (*P. dumetorum scandens* Gray), *Eupatorium perfoliatum* L., *E. ageratoides* L., *E. purpureum* L., *Prunella vulgaris* L., *Chrysanthemum Leucanthemum* L., *Achillea Millefolium* L., *Lappula Virginiana* (L.) Greene (*Echinospermum Virginicum* Lehm.), *Strophostyles angulosa* Ell., *Glechoma hederacea* L. (*Nepeta Glechoma* Benth.), *Nepeta Cataria* L., *Potentilla Canadensis* L., *Salvia lyrata* L., *Specularia perfoliata* (L.) A. DC., *Ranunculus bulbosus* L., *R. abortivus* L., *R. septentrionalis* Poir., *Bursa Bursa-pastoris* (L.) Britton (*Capsella Bursa-pastoris* Moench), *Barbarea Barbarea* (L.) MacM. (*B. vulgaris* R. Br.), *Taraxacum Taraxacum* (L.) Karst. (*T. officinale* Weber), *Alsine media* L.

Growing in the wetter portions of the meadows near the streams that frequently run through such areas, the botanist finds

Spathyema foetida, Heracleum lanatum, Rudbeckia laciniata, Impatiens biflora, I. aurea, Lobelia syphilitica, L. cardinalis, Bidens laevis, B. bipinnata, B. frondosa, Cicuta maculata, Thalictrum polygamum, Lilium superbum, Monarda fistulosa, Sium cicutaefolium, Lobelia Nuttallii, Mimulus ringens, Myosotis palustris, Iris versicolor, Stellaria longifolia, Mentha spicata, Lysimachia quadrifolia, Veratrum viride and *Scutellaria integrifolia.*

Many of these plants have remained after the removal of the timber and some of them have advanced into the meadows from the adjacent forest. This is especially true of the species enumerated below. They are woodland species that have adapted themselves to growing in the open. *Erythronium Americanum* Ker., *Valerianella chenopodifolia* (Pursh) DC., *Cardamine bulbosa* (Schreb.) B. S. P., *Polemonium reptans* Michx., *Senecio aureus* L., *Ornithogalum umbellatum* L., *Tradescantia Virginiana* L., *Geranium maculatum* L., *Podophyllum peltatum* L., *Steironema ciliatum* (L.) Raf., *Lilium superbum* L., *Monarda fistulosa* L., *Bicuculla cucullaria* (L.) Millsp., *Arisaema triphyllum* (L.) Torr., *Phytolacca decandra* L., *Salomonia commutata* (R. & S.) Britton, *Clematis Virginiana* L. along the fences, *Vagnera racemosa* (L.) Morong, *Hydrophyllum Virginicum* L., *Salvia lyrata* L., *Origanum vulgare* L., *Thaspium trifoliatum aureum* (Nutt.) Britton, *Viola* (several species), *Uvularia perfoliata* L., *Cimicifuga racemosa* (L.) Nutt., *Mentha* (several species), *Commelina nudiflora* L., *Scutellaria integrifolia* L.

The pasture-fields of categories 3, 4, 5 supply a number of plants which are not found in the meadow-land proper. Most of the aforementioned grasses are encountered and also a large number of woodland species, that have been introduced since the timber was removed, as well as the majority of the introduced weeds mentioned above.

The plants listed below usually grow in drier soil than the meadows afford.

Helianthus giganteus L., *Rudbeckia hirta* L., *Vernonia Noveboracensis* Willd., *Solidago serotina* Ait., *S. nemoralis* Ait., *S. rugosa* Mill., *S. caesia* L., *Aster ericoides* L., *A. puniceus* L., *Ambrosia artemisiaefolia* L., *Bidens discoides* (T. & G.) Britton (*Coreopsis discoidea* Torr. & Gray), *Heliopsis helianthoides* (L.) B. S. P. (*Heliopsis laevis* Pers.), *Arctium Lappa* L., *Asclepias Syriaca L.* (*A.*

Cornuti Decaisne), *A. purpurascens* L., *Apocynum androsaemifolium* L., *Clinopodium vulgare*, *Hypericum perforatum* L., *Dianthus prolifera* L., *Onagra biennis* (L.) Scop. (*Oenothera biennis* L.), *Chenopodium album* L., *Cunila origanoides* (L.) Britton (*C. Mariana* L.) *Potentilla Canadensis* L., *Houstonia caerulea* L., *Linaria Linaria* (L.) Karst. (*L. vulgaris* Mill.), *Specularia perfoliata* (L.) A. DC.

The soil of fields, which may be designated as sandy loam, supports a number of additional species.

Parsonsia petiolata (L.) Rusby (*Cuphea viscosissima* Jacq.), *Veronica officinalis* L., *V. serpyllifolia* L., *Antennaria plantaginifolia* Hook, *Potentilla Canadensis* L., *Fragaria Virginica* Mill., *Lepidium Virginicum* L., *Rumex acetosella* L., *Rubus Canadensis* L., *Sisyrynchium anceps* Cav., *Penstemon pubescens* Solander, *Plantago lanceolata* L., *P. Virginica* L., *P. major* L., *Trichostema dichotomum* L., *Lobelia inflata* L. , *Verbascum Thapsus* L., *V. Blattaria* L., *Abutilon Abutilon* (L.) Rusby (*A. Avicennae* Gaertn.), *Lycopus Virginicus* L., *L. sessilifolius* Gray, *Anaphalis margaritacea* Benth. & Hook., *Nabalus altissima* (L.) Hook. (*Prenanthes altissima* L.), *N. albus* (L.) Hook. (*Prenanthes alba* L.), *Galinsoga parviflora* Cav., *Euphorbia corollata* L., *Leonurus Cardiaca* L., *Convolvulus Sepium* L., *Leptilon Canadense* (L.) Britton (*Erigeron Canadensis* L.), *Agrimonia Eupatoria* L., *Potentilla Norvegica* L., *Matricaria inodora* L., *Trifolium pratense* L., *T. repens* L., *T. agrarium* L , *T. procumbens* L., *Oxalis stricta* L. (*O. corniculata stricta* Sav.), *Malva rotundifolia* L., *Rhus radicans* L. (along fences and stone heaps), *Saponaria officinalis* L., *Lysimachia nummularia* L., *Andropogon scoparius* Michx., *A. Virginicus* L., *Paspalum setaceum* Michx., *Syntherisma sanguinalis* (L.) Nash. (*Panicum sanguinale* L.), *Panicum nitidum* Lam., *P. capillare* L., *Ixophorus glaucus* (L.) Nash (*Setaria glauca* Beauv.), *I. viridis* (L.) Nash (*S. viridis* Beauv.), *Anthoxanthum odoratum* L., *Phleum pratense* L., *Alopecurus geniculatus* L., *Agrostis alba* L., *Holcus lanatus* L., *Avena fatua* L., *Capriola Dactylon* (L.) Kuntze (*Cynodon Dactylon* Pers.), *Eleusine Indica* (L.) Gaertn., *Sieglingia sesleroides* (Michx.) Scribn. (*Triodia cuprea* J. F. Jacq.), *Dactylis glomerata* L., *Poa annua* L., *P. pratensis* L., *P. trivialis* L., *P. compressa* L., *Festuca ovina* L., *Agropyron repens* (L.) Beauv., *Panicum rostratum* Muhl. (*P. anceps* Michx.).

Fields (6) that are abandoned after a long period of cultivation and in which weeds have been permitted to grow rampant and in which trees begin to appear, show some interesting changes in the flora which are not mentioned in connection with fields of the first category. In such fields, trees appear not from the stump, but as chance seedlings, that grow from seeds carried by the winds or animals. The predominant weeds noticed on an old dam site along Crum creek were *Eupatorium purpureum* L., *Aster* (several species), *Solidago* (several species), *Rubus* (several species), *Chelone glabra* L., *Ambrosia trifida* L., *Rudbeckia laciniata* L., etc. These were surrounded by small trees of the following species: *Betula lenta* L., *Liriodendron Tulipifera* L., *Acer rubrum* L., *Ulmus Americana* L. and *Fraxinus Americana* L. All of these trees have winged fruits and without doubt the trees grew from seeds wafted to the open dam site by the wind.

ROADSIDE-PLANT FORMATION. — The flora of a roadside is peculiar. Along the highways we find a miscellaneous assortment of plants, mostly weeds, with an admixture of native plants that are able to compete with foreign introductions and that have adapted themselves to growing under the more trying conditions of the open, shadeless, dust-laden environment. The weeds of the roadsides in southeastern Pennsylvania have been derived from two main sources, viz., Europe, and eastern North America. The European weeds seem to get the upper hand in the struggle for existence for several reasons: (1) Because they have been longer associated with man and his methods of cultivation; (2) because they have adapted themselves during a thousand years, since Europe was a forest wilderness, to living in the open, in fields along roadsides, and in garden patches; (3) because in migrating to a new country they have been removed from their competitors by whom they were held in subjection through the struggle for existence; (4) because in eastern North America they come into competition with native species mostly derived from the forests and that have not had sufficient time to adapt themselves to the changed conditions produced by the destruction of the forests, the cultivation of the soil and growth in open places subjected to the full force of the sunlight.

Western American weeds, seem to have an advantage, because derived from an open prairie country, where, with frequent fires and the roaming of herds of buffaloes and antelopes, they have been subjected to environmental conditions very similar to those which are met with in the more highly cultivated districts of our eastern states.

Plants derived from the native flora can hardly be looked upon as weeds ("plants out of place"). Only a few of our troublesome weeds are native. The native plants have usually persisted in the soil when a road has been constructed, and in many places they are found in greatest abundance along the highways in rich arable land, because they have been left in undisturbed possession of the stretches of land on either side of the roadway, while the same species have been exterminated in the cultivated fields. In other cases native plants have migrated from the woods and natural meadows to the roadside and have implanted themselves there, especially in those districts of our country cut off from the railroad and other lines of cross-country travel. The plants in the following list are arranged according to their source:

Europe. — *Linaria Linaria* (L.) Karst., *Daucus Carota* L., *Phleum pratense* L., *Hypericum perforatum* L., *Rumex crispus* L., *R. obtusifolius* L., *R. Acetosella* L., *Verbascum Thapsus* L., *V. Blattaria* L., *Plantago lanceolata* L., *Allium vineale* L., *Trifolium pratense* L., *T. arvense* L., *Chrysanthemum Leucanthemum* L., *Arctium lappa* L., *Xanthium glabratum* (DC.) Britton (*X. strumarium* L.), *Anthemis Cotula* DC., *A. arvensis* L., *Taraxacum Taraxacum* (L.) Karst., *Cerastium vulgatum* L., *Lactuca scariola* L., *Asparagus officinalis* L., *Saponaria officinalis* L., *Melilotus alba* L., *Mollugo verticillata* L., *Carduus lanceolatus* L., *C. arvensis* (L.) Robs. (*Cnicus arvensis* Hoffm.), *Datura Stramonium* L., *D. Tatula* L., *Syntherisma sanguinalis* (L.) Nash (*Panicum sanguinale* L.), *Chaetochloa glauca* (L.) Scribn. (*Setaria glauca* Beauv.), *Eleusine Indica* (L.) Gaertn., *Polygonum Persicaria* L., *Chenopodium album* L., *C. anthelminthicum* L. (*C. ambrosioides anthelminthicum* Gray), *Atriplex hastata* L., *Amaranthus spinosus* L., *Portulacca oleracea* L., *Cerastium viscosum* L., *Euphorbia Cyparissias* L., *Convolvulus arvensis* L., *Cichorium Intybus* L.

Eastern North America. — *Erigeron annuus* (L.) Pers., *Achillea Millefolium* L., *Plantago Rugelii* Decaisne, *Barbarea Barbarea* (L.)

MacM., *Trifolium repens* L., *Lepidium Virginicum* L., *Equisetum arvense* L., *Ambrosia trifida* L., *Rhus glabra* L., *Phytolacca decandra* L., *Nabalus altissimus* (L.) Hook., *Asclepias Syriaca* L., *Oxalis stricta* L., *Onagra biennis* (L.) Scop., *Ambrosia artemisiaefolia* L., *Rhus radicans* L., *Bidens bipinnata L.*, *B. connata* Muhl., *Verbena hastata* L., *Solanum Carolinense* L., *Panicum capillare* L., *Agropyron repens* (L.) Beauv. *Polygonum aviculare* L., *P. Pennsylvanicum* L., *Amaranthus graecizans* L. (*A. albus* L.), *Convolvulus Sepium* L., *Commelina Virginica* L.

Western North America. — *Helianthus annuus* L., *Rudbeckia hirta* L.

India. — *Abutilon Abutilon* (L.) Rusby.

RUDERAL-PLANT FORMATION. — It is a difficult matter to distinguish clearly between the roadside plant formation and the ruderal plant formation, because near our large cities the conditions influencing vegetation are nearly similar along the much frequented highways and the neglected waste areas, or rubbish heaps. Ruderal areas are distinguished rather by the absence of certain plants found by the roadside and by the numerical frequency of the species, than by a difference in the component plants. The ruderal plant formation may be said to consist of those plants which will grow on rubbish heaps, or on made ground formed by ashes and other dry material representing the waste of a large city, or town. Such dumping places are found usually near the outskirts, and the material, as it settles down, is first covered with a rank growth of weeds and other coarse plants. Later such areas are divided into building lots. All of our large cities afford examples of such waste heaps and fields. The association of species depends largely on chance. It is determined by the way in which seeds, roots and other plant material are heaped together in the waste. Near Philadelphia the following plants are most abundant in the ruderal formation :

Plantago Rugelii, *Linaria Linaria*, *Daucus Carota*, *Rumex crispus*, *R. obtusifolius*, *Verbascum Thapsus*, *Arctium Lappa*, *Xanthium glabratum*, *Lactuca scariola*, *Melilotus alba*, *Carduus lanceolatus*, *Datura Stramonium*, *Datura Tatula*, *Syntherisma sanguinalis*, *Chaetochloa glauca*, *Atriplex hastata*, *Chenopodium album*, *C. anthelminthicum*, *Amaranthus spinosus*, *Cichorium Intybus*, *Melilotus officinalis*, *Trifolium hybridum*, *Lepidium Virginicum*, *Ambrosia artemisiaefolia*, *Bidens connata*, *Panicum capillare*, *Amaranthus graecizans*, *Solidago* (several species), *Aster* (several species), *Populus alba*, *Helianthus annuus*, *Citrullus vulgaris*, *Onagra biennis*.

The list of weeds that grow in waste places near Philadelphia and other large manufacturing towns of our region is not exhausted with the above enumeration. Only the commonest plants have been mentioned. In general, it may be said that the plants of the ruderal formation are coarse, tall, much-branched weeds of an ill smell and producing an abundance of easily distributed fruits and seeds. These weeds owe their presence in such abundance to the perfect means of distribution which they possess, as hooks, wings, tufts of hair, or other contrivances.

BALLAST-PLANT FORMATION. — Ballast-ground may be defined as a place where the material used to steady ships at sea, such as sand, gravel, stone, rubble and the like, is unloaded from vessels and piled up in heaps along the water's edge. The material composing ballast has been gathered from a great number of sources in a great many parts of the world, South America, Australia, Europe and India, from whence the ships have cleared. The result is that roots, stems, fruits and seeds of a heterogeneous assemblage of plants are mixed up in the ballast stuff, and when this lies exposed for some time the roots begin to grow and the seeds to germinate, until the ballast heap is covered by plants native to diverse parts of the globe. Some of these plants will appear but once. Others will remain and become adventitious.

B. CULTIVATED.

Southeastern Pennsylvania is preëminently an agricultural country. It is a country of well-kept, carefully cultivated farms. Now, however, many of the finest farms have been converted into suburban demesnes, where, dictated by the wealth and culture of the owners, large sums have been expended upon buildings and landscape improvements. For convenience and because the classification is a natural one the cultivated plant formation may be divided into the following areas:

1. Cereal-rootcrop-clover area.
2. Orchard area.

3. Vegetable-garden area, (a) Kitchen-gardens, (b) Truck-gardens.

4. Nursery area.

5. House- and garden-plant area.

6. Botanic-garden area.

These must be dismissed because an accurate and detailed description is not possible here. They are mentioned because the natural vegetation of the region has been modified and influenced by the establishment of farms, gardens and suburban parks. If a phyto-geographic chart of the region was to be constructed, such as Robert Smith has done for Scotland, all of these areas would have to be surveyed and located upon the map. In closing, the writer believes that enough has been given in this sketch to serve as an introduction to the plant geography of a region of considerable botanical interest, historic and otherwise.

UNIVERSITY OF PENNSYLVANIA.

Desmids from southwestern Colorado

JOSEPH A. CUSHMAN

(WITH PLATE 7)

The material in which the desmid forms here noted were contained was collected in July, 1903, by Mr. Walter S. Tower. The amount of material was small and not at all rich. It was from moss growing at the edge of a small lake about a hundred yards wide, at the head of Tank Creek. This stream is a tributary of the Animas and runs into the river about six miles below Needleton, Colorado. The altitude of the lake was 3,540 meters. At this altitude, where vegetation was not at all abundant, several genera of desmids were found. None of the filamentous forms were noted, however. Several of the forms are not typical and differ from the described varieties. The following species were noted (the numbers given with each species, H. C. *no. 422*, etc., have reference to the numbered slides in the author's herbarium):

PENIUM DIGITUS (Ehrenb.) Bréb. in Ralfs, Brit. Desm. 150. *pl. 25. f. 3.* 1848. (PLATE 7, FIGURE 1.)

Long. 215 μ; lat. 65 μ. A truncate from very much like that figured by Wolle, Desm. U. S. ed. 2. *pl. 64. f. 1.* (H. C. *no. 428.*)

Penium closterioides spirogranatum var. nov. (PLATE 7, FIGURE 2.)

Long. 138 μ; lat. 33 μ. Apices granulate, middle portion with an irregular granular spiral band connecting the apical portions. (H. C. *no. 426.*)

CYLINDROCYSTIS AMERICANA W. & G. S. West, Jour. Linn. Soc. Bot. **33**: 281. *pl. 18. f. 5, 6.* 1898. (PLATE 7, FIGURE 3.)

Long. 53 μ; lat. 25 μ. The specimen in every way fits the description and figure. The original specimen was from Ithaca, N. Y. (H. C. *no. 426.*)

CLOSTERIUM STRIOLATUM ERECTUM forma β Klebs, Schrift. Phys.-Oekon. Gesells. Königsberg, **22**: 14, *pl. 2. f. 10.* 1879.

Long. 330 μ; lat. 30 μ; lat. apic. 15 μ. (H. C. *no. 426.*)

PLEUROTAENIUM TRABECULA (Ehrenb.) Naeg. Einz. Alg. 104. *pl. 6. f. A.* 1849. (PLATE 7, FIGURE 4.)

Long, 512 μ; lat. ad bas. semicell. 31 μ; lat. apic. 21 μ; lat. ad. inflat. 34.5 μ. (H. C. *no. 426.*)

COSMARIUM MARGARITIFERUM Menegh. Linnaea, **14**: 219. 1840.

Long. 47 μ; lat. 42 μ; lat. isthm. 15 μ. (H. C. *no. 426.*) Frequent.

COSMARIUM BOTRYTIS Menegh. Linnaea, **14**: 220. 1840.

Long. 70 μ; lat. 59 μ; lat. apic. 19.5 μ; lat. isthm. 23 μ. (H. C. *no. 426.*)

COSMARIUM LAEVE SEPTENTRIONALE Wille, Öfv. Vet.-Akad. Förh. **1879**: 43. *pl. 12. f. 34.* 1879.

Long. 18 μ; lat. 15 μ; lat. isthm. 4.5–5 μ. (H. C. *no. 422.*) Common.

COSMARIUM MENEGHINII BRAUNII (Reinsch) Hansg. Arch. Naturw. Landesd. Böhm. **6**^{6}: 195. 1888.

Long. 27 μ; lat. 21 μ; lat. isthm. 6 μ. Very similar to Wolle, Desm. U. S. ed. 2. *pl. 48. f. 28.* 1892. (H. C. *no. 422.*)

Cosmarium balteum Coloradense var. nov. (PLATE 7, FIGURE 5.)

Long. 77.5 μ; lat. 56 μ; lat. apic. 19 μ; lat. isthm. 18 μ. Differs from the species (*C. balteum* W. &. G. S. West, Trans. Linn. Soc. Bot. II. **5**: 249. *pl. 15. f. 1.* 1896) by its smaller size, and with the central basal series represented by a single subcentral granule. (H. C. *no. 454.*)

EUASTRUM VERRUCOSUM Ehrenb. Abh. Akad. Wiss. Berlin, **1833**: 247. 1835; var. (PLATE 7, FIGURE 6.)

Long. 102 μ; lat. 76 μ; lat. lob. pol. 32 μ; lat. isthm. 25 μ. (H. C. *no. 422.*) Common.

EUASTRUM DIDELTA Ralfs, Ann. Nat. Hist. **14**: 190. *pl. 7. f. 2.* 1844; var. (PLATE 7, FIGURE 7.)

Long. 110–116 μ; lat. 43 μ; lat. lob. pol. 25 μ; lat. isthm. 15 μ. Very much like the smaller variety figured by Wolle (Desm. U. S. ed. 2. *pl. 33. f. 9*), but the polar lobe is much broader. In Wolle's figure the ratio of the polar lobe to the diameter is 1 to 2.5, in the Colorado specimens 1–1.7. (H. C. *nos. 426, 451,* etc.) Very common.

XANTHIDIUM HASTIFERUM JOHNSONI W. &. G. S. West, Jour. Linn. Soc. Bot. **33**: 299. *pl. 17. f. 1.* 1898; forma **longispinum** form. nov. (PLATE 7, FIGURE 8.)

Spines much longer and stouter than in the typical variety as figured by Johnson (Bull. Torrey Club, **22**: 295. *pl. 293. f. 10.* 1895). Often with several additional granules below the usual row. Long. s. spin. 56 μ; long. c. spin. 87 μ; lat. s. spin. 50 μ; lat. c. spin. 96 μ; lat. isthm. 14 μ. (H. C. *no. 454.*) Common.

Xanthidium hastiferum Toweri var. nov. (PLATE 7, FIGURE 9.)

Long. s. spin. 57 μ; long. c. spin. 71 μ; lat. s. spin. 46.5 μ; lat. c. spin. 102 μ; long. spin. 23 μ; lat. isthm. 12 μ; crass. 34 μ. Variety with longer spines than usual, the apical spines usually entirely wanting. Membrane smooth and without thickenings. Close to var. *inevolutum* as figured by Nordstedt (Sv. Vet.-Acad. Handl. **22**^{8}: *pl. 4. f. 24.* 1888), but the spines are longer and stouter and the membrane is not thickened or colored in any way in the middle of the semicells, as in that variety.

This tends toward certain varieties of *X. antilopeum* but specimens were found with a trace of a rudimentary spine in the position where it would be found in typical *X. hastiferum*. The variety is named for the collector, Mr. W. S. Tower.

MICRASTERIAS ROTATA (Grev.) Ralfs, Ann. Nat. Hist. **14**: 259. *pl. 6. f. 1.* 1844.

Long, 270 μ; lat. 226 μ; lat. lob. pol. 60 μ; lat. isthm. 55 μ. Close to the form figured by Wolle, Desm. U. S. ed. 2. *pl. 38. f. 2.* (H. C. *no. 422.*)

STAURASTRUM ECHINATUM Bréb. in Ralfs, Brit. Desm. 215. *pl. 35. f. 24.* 1848.

Lat. 31 μ. (H. C. *no. 422.*)

Staurastrum Johnsoni Coloradense var. nov. (PLATE 7, FIGURE 10.)

Differs from the species (*S. Johnsoni* W. & G. S. West, Trans. Linn. Soc. Bot. II. **5**: 266. *pl. 17. f. 16.* 1896), in being somewhat larger, with the lower side of the processes fully as rough as the upper. In this respect it is more like *S. leptocladum* Nordst., but it has the form of processes of *S. Johnsoni*, and the apices are tridentate. Long. 51 μ; lat. 96 μ; lat. isthm. 10 μ. (H. C. *no. 422.*)

BOSTON SOCIETY OF NATURAL HISTORY.

Explanation of plate 7

All figures × 450.

FIG. 1. *Penium Digitus* (Ehrenb.) Bréb.
FIG. 2. *P. closterioides spirogranatum* var. nov.
FIG. 3. *Cylindrocystis Americana* W. & G. S. West.
FIG. 4. *Pleurotaenium Trabecula* (Ehrenb.) Naeg.
FIG. 5. *Cosmarium balteum Coloradense* var. nov.
FIG. 6. *Euastrum verrucosum* Ehrenb., var.
FIG. 7. *a*, *E. Didelta* Ralfs, var.; *b*, end view.
FIG. 8. *Xanthidium hastiferum Johnsoni* W. & G. S. West, forma *longispinum* form. nov.
FIG. 9. *X. hastiferum Toweri* var. nov.
FIG. 10. *Staurastrum Johnsoni Coloradense* var. nov.

Four new North American birches

N. L. BRITTON

Betula Utahensis sp. nov.

Young twigs densely resinous-glandular, greenish-brown, becoming bright brown and shining. Young leaves hairy on both sides, the older ones glabrous, except for a few hairs on the veins beneath, ovate to ovate-orbicular, sharply dentate with abruptly tipped teeth, acute, 5 cm. long or less and sometimes as wide as long, narrowed or truncate at the base, the upper surface dull green ; staminate catkins 5 cm. long or longer ; strobiles cylindric, stout, 3–4 cm. long, more than 1 cm. thick, borne on stalks about 6 mm. long, their scales nearly as wide as long, finely pubescent and ciliate, the lateral lobes obliquely-ovate, widely spreading and about as long as the triangular-lanceolate, pointed, middle one ; nut obovate, 2 mm. long, narrower than its wings.

Type specimens collected in City Creek Cañon, Salt Lake City, by S. G. Stokes.

This appears to differ markedly from *Betula fontinalis* by its very thick strobiles and the widely spreading lateral lobes of their scales.

Betula Piperi sp. nov.

This tree is described by Professor Piper as attaining a height of 15 m. and being slender and graceful, with drooping branches, and dark bronze bark which does not peel off readily. The young twigs are very slender, green and glandular ; leaves ovate, thin, sharply irregularly serrate, acute, 5 cm. long or less, broadly to narrowly cuneate at the base, pubescent when young, glabrous or nearly so and shining on the upper surface when mature ; petioles 1–2 cm. long ; stipules ovate, about 5 mm. long ; staminate catkins 6–8 cm. long ; strobiles narrowly-cylindric, 3–5 cm. long, about 8 mm. thick, stalked, their scales about 6 mm. long, rather longer than wide, 3-lobed at the top, puberulent and ciliate, the lateral lobes widely spreading and obtuse, about as long as the narrower, acute, middle one, the stalk-like base of the scale cuneate ; nut 1.5–2 mm. long, obovate to oblong, wider than its wing.

Type collected by Professor C. V. Piper, July 9, 1901, nine miles south of Pullman, Washington.

Betula Sandbergi sp. nov.

Young twigs loosely pubescent, green, becoming brown. Leaves rhombic-ovate, acute, rather evenly serrate, dark green and strongly netted-veined on the upper side, light green, very glandular and slightly pubescent on the veins beneath, 6 cm. long or less, cuneate at the base; petioles glabrous, 1.5 cm. long or less; staminate catkins 6 cm. long or more; strobiles slender-stalked, cylindric, 2–2.5 cm. long, about 6 mm. thick, their scales about 4 mm. long, pubescent, 3-lobed at the apex, the middle lobe a little longer than the blunt ascending lateral ones, all the lobes blunt; nut oval to obovate, 1.5 mm. long, rather narrower than its wings.

Type collected by J. H. Sandberg in swamps, Hennepin County, Minnesota, June, 1890, and distributed as *Betula nigra.*

Betula Alleghaniensis sp. nov.

Resembling *B. lenta* and *B. lutea,* attaining about the same size as the former but smaller than the latter. Bark either close and furrowed, or peeling off in thin yellowish gray layers; young twigs long-pubescent, becoming brown and shiny; leaves ovate to ovate-oblong, usually gradually acuminate, 12 cm. long or less, rather coarsely and sharply serrate, mostly cordate at the base but sometimes rounded, dark green and glabrous above, yellow-green and more or less pubescent on the veins beneath when mature; petioles pubescent, about 1 cm. long; staminate catkins 6 cm. long or more, their scales broadly ovate and obtusish; strobiles oblong-cylindric, 2–3 cm. long, very short-stalked or sessile, their scales 4–6 mm. long, pubescent, nearly or quite as wide as long, 3-lobed above the middle, the wedge-shaped part below the lobes short, the margins ciliate; nut narrowly obovate to oblong, 2–3 mm. long, mostly narrower than its wings.

Type specimen distributed by the Biltmore Herbarium, *no. 1619,* collected on the upper slopes of Mt. Pisgah, western North Carolina, September 21, 1897.

This tree has been confused with both the cherry birch and the yellow birch. Its range as known to me is from Massachusetts to Quebec and northern Michigan, south to southern New York, Pennsylvania, and in the mountains to Georgia.

NEW YORK BOTANICAL GARDEN.

The influence of carbon monoxide and other gases upon plants

H. M. Richards and D. T. MacDougal

A correction

By reason of direct misinformation imparted by the Chemiker-Kalender of R. Biedermann (pages 348–349 in the 1904 edition), it is necessary to introduce a correction in the estimates of the CO content of the illuminating gas mixtures used in the experiments described under the above title in the February issue of the Bulletin of the Torrey Botanical Club. It is categorically stated in the above-mentioned Chemiker-Kalender that ethylene and the two higher hydrocarbons of the same series (all of which may be present in considerable quantities in illuminating gas) are *not* absorbed by an ammoniacal solution of cuprous chloride. Such, however, has been since found to be incorrect; these hydrocarbons may be so absorbed, at least as far as the first named is concerned.

Consequently the approximate CO content of the gas in question is uncertain, but was probably nearer 25 per cent., and therefore on page 58, line 14, and page 66, line 20, Vol. 31, of the Bulletin of the Torrey Botanical Club, the numeral 40 should be striken out and the numeral 25 substituted.

This does not invalidate, but rather strengthens the conclusion that the greater toxic effect of illuminating gas over CO alone, on the plants experimented with, is due to other gases than the CO itself.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1901-1903)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers, at the rate of one cent for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card-issue should be addressed to the Treasurer of the Torrey Botanical Club.

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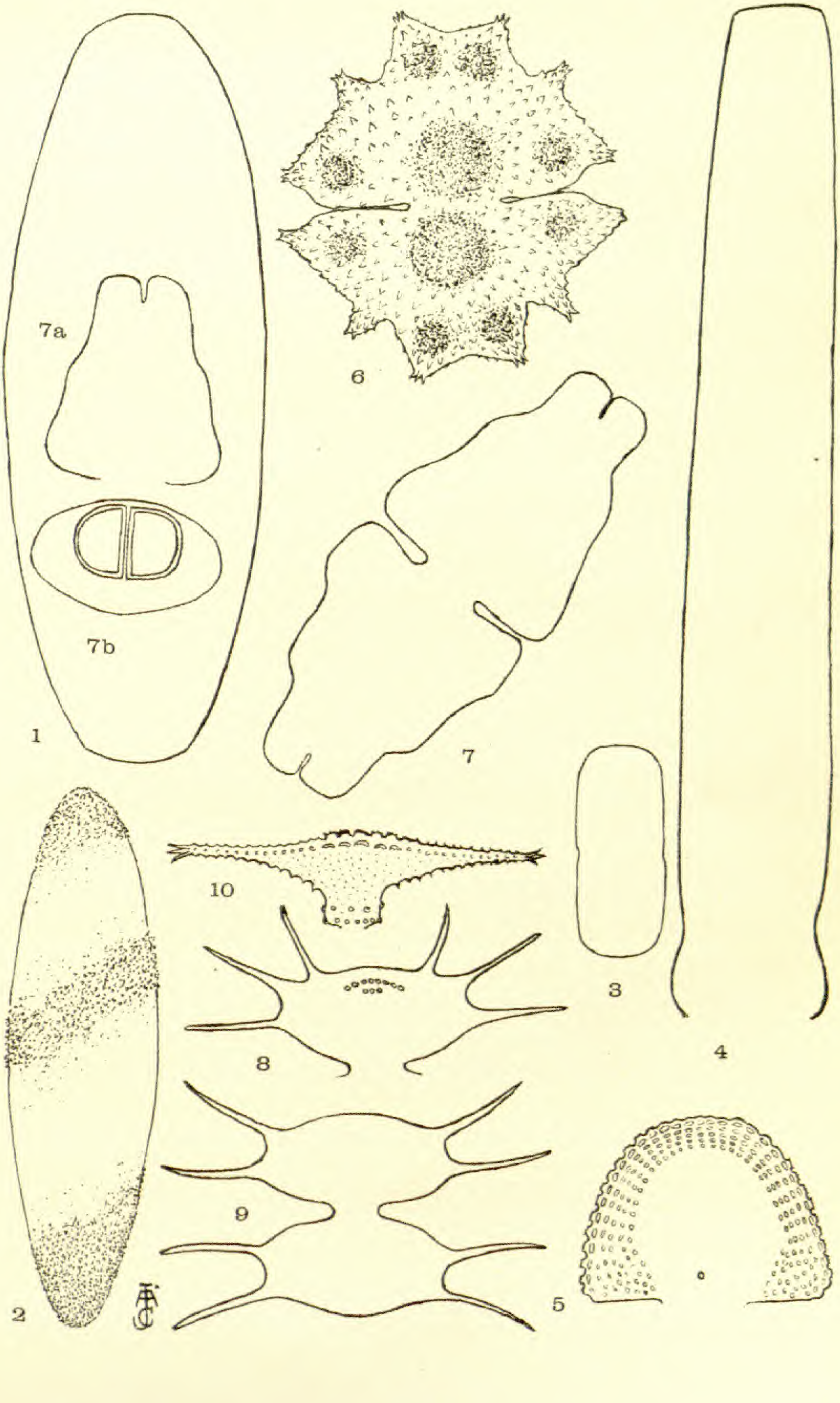

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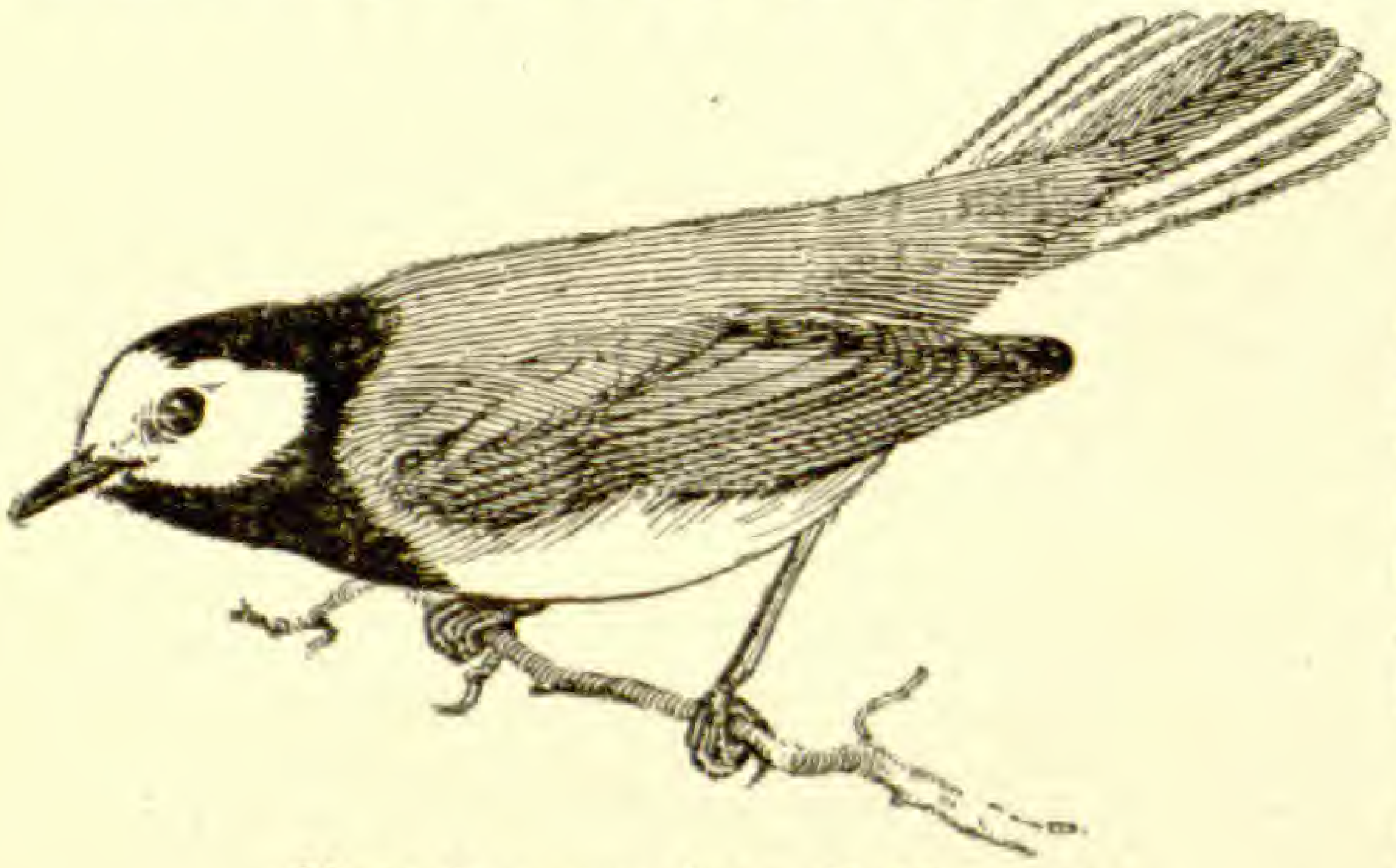

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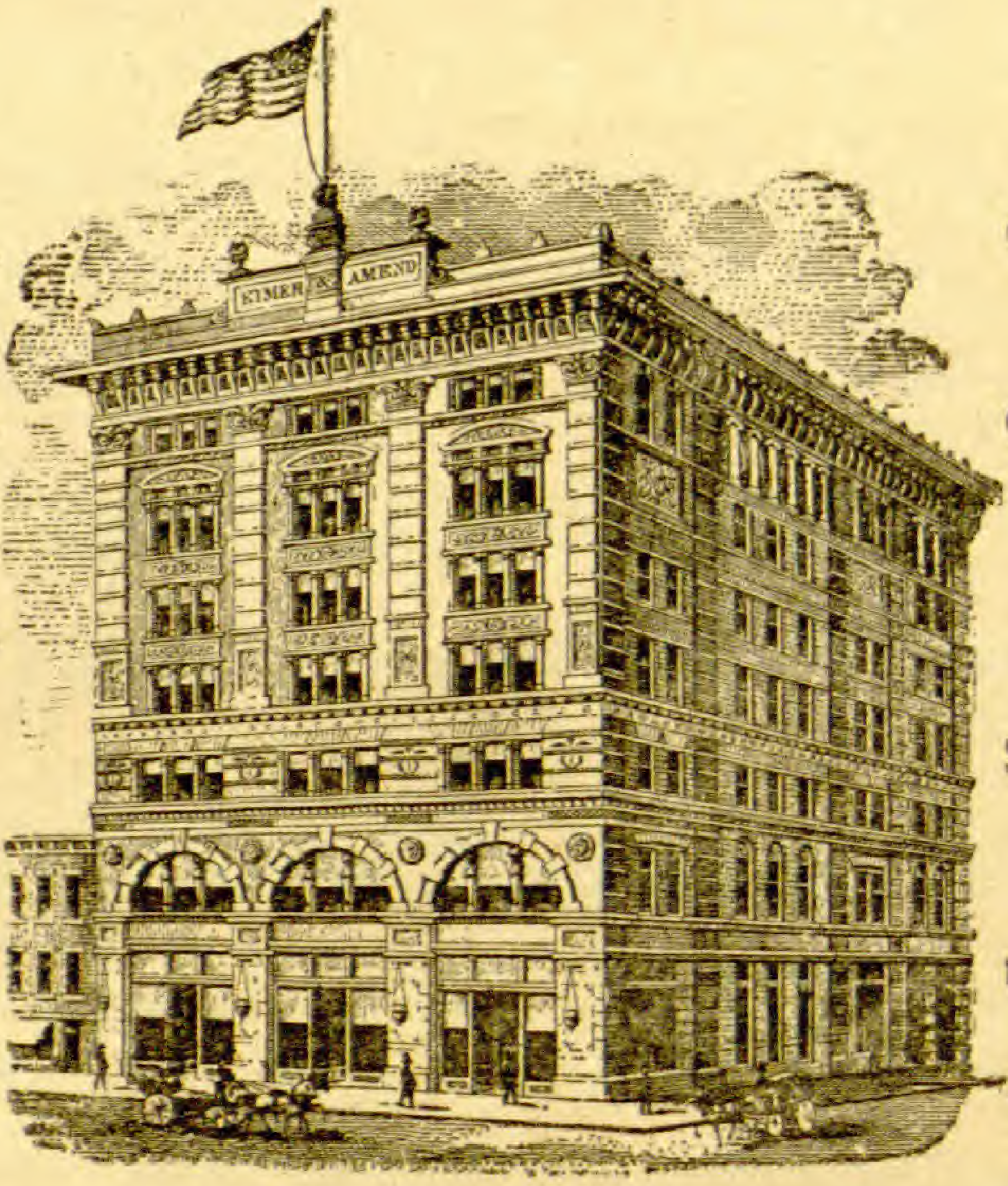

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APRIL, 1904

New species of Fungi

CHARLES H. PECK

Lepiota brunnescens

Pileus thin, convex or nearly plane, obtuse or umbonate, whitish, the cuticle soon cracking and forming brownish granules or squamules except in the center, sometimes radiately rimose on the margin, flesh white, taste sweet; lamellae close, ventricose, free, white; stem equal or slightly thickened toward the base, hollow, fibrous, white, with a slight but subpersistent annulus near the middle; spores elliptic, 6–8 μ long, 4–5 μ broad.

Pileus 2–3 cm. broad; stems 3–5 cm. long, 2–4 mm. thick.

Open woods and grassy places, near St. Louis, Mo. July and August. N. M. Glatfelter.

This singular species, when fresh, resembles *Lepiota cristata*, but in drying, the whole plant changes color. The stem below the annulus at first becomes reddish brown, but soon changes to brown and in 12–24 hours the whole plant becomes brown. Bruises also cause a change of color.

Lepiota Glatfelteri

Pileus thin, convex or nearly plane, obtuse or slightly umbonate, slightly and innately fibrillose, gray, grayish brown or brown, sometimes tinged with purple, the center usually darker, sometimes radiately rimose on the margin, flesh white; lamellae close, lanceolate, free, white or whitish; stem equal or nearly so, firm, stuffed or hollow, white, the annulus slight, persistent; spores broadly elliptic, 6–8 μ long, 4–5 μ broad.

Pileus 2.5–5 cm. broad; stem 4–5 cm. long, 2–4 mm. thick.

Ground in woods, near St. Louis. July, August. N. M. Glatfelter.

[The preceding number of the BULLETIN, Vol. 31, No. 3, for March, 1904 (31 : 113–176, *pl.* 7) was issued 12 Mr 1904.]

A rare but peculiar species belonging to the section Clypeolaria, but distinct and easily recognized by the dark but somewhat variable color of the pileus, of which the cuticle does not form scales but sometimes becomes radiately rimose on the margin.

Tricholoma viscosum

Pileus fleshy, convex, the irregular or wavy margin often turned upward when old, even, glutinous, shining when dry, yellowish tawny, darker or reddish brown in the center, flesh white, odor slight but unpleasant; lamellae narrow, close, nearly free, white; stem firm, equal, brittle, solid, flexuous, glutinous, white above, brown below; spores minute, subglobose, 3–4 μ long.

Pileus 2–5 cm. broad; stem 2.5–4 cm. long, 4–5 cm. thick.

Low ground near St. Louis. August and September. N. M. Glatfelter.

Clitocybe piceina

Pileus fleshy, firm, convex or nearly plane, dry, white or whitish, tinged with gray when young, flesh compact, white, taste pungent, odor strong, disagreeable; lamellae close, decurrent or sometimes strongly decurrent in lines running down on the stem, creamy white; stem equal or nearly so, firm, stout, solid, subfibrous, commonly striate at the top with raised longitudinal lines; spores globose, 5–6 μ in diameter.

Pileus 6–10 cm. broad; stem 5–7 cm. long, 12–18 mm. thick.

Under spruce trees near Chicago. September. W. S. Moffat and L. H. Watson.

In the dried specimens the pileus sometimes assumes a yellowish tint. The species is closely allied to *C. cerussata* and *C. albissima*. From the former it may be separated by its larger globose spores and from the latter by its whitish color being less clear and persistent. From both it differs in the more strongly decurrent lamellae, pungent taste and disagreeable odor.

Collybia umbonata

Pileus thin, conic becoming convex or nearly plane with deflexed margin, prominently umbonate, glabrous, bay red or chestnut color, sometimes darker in the center than on the margin; lamellae numerous, subdistant, narrowed toward the stem, nearly free, whitish; stem rather long, glabrous, equal or slightly tapering upward, hollow, radicating, colored like or a little paler than the pileus; spores minute, elliptic, 6–8 μ long, 4–5 μ broad.

Pileus 2–3 cm broad; stem 5–15 cm. long, 4–6 mm. thick.

On and about old redwood stumps. California. December. W. R. Dudley and E. B. Copeland. The color of this species is similar to that of some forms of *C. dryophila*, but in structure it is more closely related to *C. radicata*. The underground part of the stem is sometimes as long as the part above ground.

Russula luteobasis

Pileus convex, becoming nearly plane, even or slightly and indistinctly striate on the margin, rosy red or pink, becoming paler or yellowish either wholly or in the center only, the cuticle separable, flesh white or whitish ; lamellae adnate or adnexed, equal, creamy yellow or whitish, becoming dingy with age or in drying ; stem nearly equal, slightly furfuraceous, stuffed, white, yellow at the base ; spores subglobose, 8 μ long, sometimes only 7 μ broad.

Pileus 2.5–7 cm. broad ; stem 2.5–5 cm. long, 4–12 mm. thick.

Near St. Louis, Mo. June to August. N. M. Glatfelter. A species well marked by the change of color in the pileus and the yellow base of the stem.

Clitopilus sphaerosporus

Pileus fleshy but thin, nearly plane, with the margin involute or decurved, umbonate or slightly depressed in the center, dry, minutely tomentose pubescent, dark gray or blackish-brown, flesh white ; lamellae thin, narrow, close, unequal, slightly decurrent, whitish, faintly tinged with pink ; stem equal or slightly tapering upward, solid, firm, colored like the pileus, with a white mycelioid tomentum at the base ; spores pale pink, globose, uninucleate, 5–6 μ in diameter.

Pileus 1–2.5 cm. broad ; stem 2–4 cm. long, 2–4 mm. thick.

Among fallen leaves in ravines. Near St. Louis, Mo. August and September. Rare. N. M. Glatfelter. The pink tint of the lamellae and spores is so faint that by careless observation the fungus is liable to be mistaken for a clitocybe.

Flammula eccentrica

Pileus thin, broadly convex, obtuse or slightly umbilicate, dry, minutely squamulose, tawny, yellowish or reddish ferruginous, flesh whitish ; lamellae rather broad, close, somewhat sinuate adnate, dingy, ochraceous, becoming ferruginous : stem equal or slightly tapering upward, commonly eccentric, solid, fibrillose, yellowish or dingy ochraceous, becoming brownish without and within ; spores bright ferruginous, elliptic, (15–16 μ long, about 8 μ broad.) ?? 5–6 x 7–8 u in type material

L. O. O. 191

Pileus 2.5–3.5 cm. broad; stem 2–3 cm. long, 4–8 mm. thick, often curved.

Decaying wood. Near St. Louis, Mo. September and October. N. M. Glatfelter.

Flammula Braendlei

Pileus convex becoming nearly plane with incurved margin, sometimes irregular, fibrillose squamulose, especially in the center, slightly viscid, purplish when young, soon yellowish or yellowish white, sometimes with bluish green stains, flesh whitish; lamellae thin, close, adnate or slightly decurrent, bright ferruginous when mature; stem equal or slightly tapering upward, fibrillose, hollow, whitish streaked with brown, veil webby, sometimes forming a silky zone on the stem and becoming conspicuous by the spores lodging on it; spores elliptic, 6–8 μ long, 4–5 μ broad.

Pileus 2.5–5 cm. broad; stem 2.5–5 cm. long, 4–8 mm. thick.

Single or cespitose on decaying trunks. September to November. Near Washington. F. J. Braendle. Near St. Louis N. M. Glatfelter.

This species is quite attractive by reason of the bright ferruginous color of the mature lamellae and the spores. It belongs to the section *Sericellae*. Sometimes the pileus is slightly umbilicate.

Agaricus solidipes

Pileus fleshy, firm, convex, squamose or rimose squamose, white or whitish, involute on the margin, flesh white, unchangeable, taste sweet, agreeable; lamellae close, free, dull pink changing to dull sepia, finally brownish black; stem very short, equal or tapering upward or downward, glabrous, solid, white or whitish, the white veil slight, often adhering entirely to the margin of the pileus; spores elliptic, 8–10 μ long, 5–6 μ broad.

Pileus 2–7 cm. broad; stem 2–4 cm. long, 6–10 mm. thick.

Prairie pastures. Colorado. June. E. B. Sterling.

A species well marked by its squamose pileus, involute or incurved, often appendiculate margin and by its short solid stem.

Agaricus rutilescens

Pileus fleshy, firm, convex with incurved margin, becoming nearly plane, even or sometimes rimose and minutely fibrillose, dingy white, becoming ferruginous, reddish-brown or bay in drying, flesh whitish changing to reddish where cut or broken; lamellae close, narrow, free, reddish becoming blackish-brown; stem equal or nearly so, firm, stuffed, silky, white, changing to reddish where wounded, often abruptly bulbous at the base, veil white, often adhering partly to the margin of the pileus and partly to the stem ; spores broadly elliptic, 7–8 µ long, 5–6 µ broad.

Pileus 2.5–6 cm. broad ; stem 5–10 cm. long, 6–10 mm thick.

Manured ground in pasture. Denver, Colorado. June. E. B. Sterling.

This differs from *Agaricus compester rufescens* in having its pileus minutely fibrillose, in its flesh becoming reddish where wounded, not bright red, and in its gills being at first reddish instead of white. It resembles *Ag. maritimus* in some respects but differs in its assumed color and in the absence of a seaside odor.

Agaricus sphaerosporus

Pileus fleshy, firm, broadly convex, sometimes slightly depressed in the center, glabrous, whitish, the cuticle sometimes rimose, and the incurved young margin occasionally wavy or irregular when mature, flesh white, unchangeable ; lamellae thin, close, rounded behind, reaching the stem, but free from it, rosy red, becoming blackish-brown ; stem nearly equal, thick, firm, solid, straight or curved, whitish, the thin white veil rupturing and adhering partly to the margin of the pileus and partly to the stem, forming a slight, fringed soon evanescent annulus ; spores globose or nearly so, 7.5–8 µ long, 6–7.5 µ broad.

Pileus 7–12 cm. broad ; stem 3–10 cm. long, 2–3 cm. thick.

Rich soil. Denver, Colorado. June. E. B. Sterling. This species closely resembles large forms of the common mushroom, from which it may be separated by its glabrous pileus, solid stem and nearly globose spores. Mr. Sterling has eaten it freely without harm and considers it a good edible mushroom.

Agaricus cothurnatus

Pileus fleshy, convex with involute margin, dry, glabrous or minutely pulverulent on the margin, chalky white, flesh white ; lamellae close, free, chocolate color becoming black ; stem nearly equal, white, with dense radicular fibers at the base, sheathed below by the white veil which forms a cup-like annulus with lacerated margin above ; spores subglobose, 8–9 µ long, 7–8 µ broad.

Pileus 5–7.5 cm. broad ; stem 3–5 cm. long, 10–12 mm. thick.

Rich soil along roadsides and paths. Denver, Colorado. March. E. B. Sterling.

The chocolate color of the young gills and the sheathed base of the stem are notable distinguishing characters of this species.

Marasmius Copelandi

Pileus thin, tough, broadly convex, glabrous, tawny, taste and odor strong, unpleasant; lamellae few, unequal, distant, adnate, pallid; stem slender, tough, hollow, velvety pubescent and brown below, paler and less densely pubescent above; spores subfusiform, more sharply pointed at one end, 12–15 μ long, 4 μ broad.

Pileus 1–2 cm. broad; stem 4–6 cm. long, 1–2 mm. thick.

On dead leaves of *Quercus densiflora.* Woodside, California. December. E. B. Copeland.

It is related to *M. perforans.*

Clavaria myceliosa

Stem slender, solid, irregularly branched above, tawny, with an abundant mycelium which forms whitish, branching strands among decaying leaves and twigs; branches short, divergent or wide spreading with few branchlets, colored like the stem, the ultimate branchlets mostly acute, whitish; spores subglobose, 4 μ long. Scattered or gregarious, 1–2.5 cm. tall, stems about .5 mm. thick.

Among fallen leaves and twigs under redwood trees. Mountains near Stanford University, California. December. E. B. Copeland.

The abundant rhizomorphoid mycelium is a marked feature of this species. The plant is inodorous but has a slight peppery taste. It is allied to our eastern *C. pusilla*, but it is a smaller, more slender plant with the slender stem branched above only, and with the few short branches more widely spreading.

Helvella Stevensii

Pileus somewhat saddle-shaped, the two lobes deflexed, suborbicular, free, white, becoming yellowish or creamy yellow with age and brown in drying, under surface persistently white, even, pruinose velvety; stem terete, even, solid or stuffed, occasionally hollow in large specimens, pure white, pruinose velvety above; asci cylindric; spores even, broadly elliptic, 20 μ long, 12 μ broad, usually containing a single large nucleus; paraphyses filiform, clavate at the apex, colorless.

Plant 4–5 cm. tall; pileus 10–20 mm. broad.

Open woods of oak and hickory. Oakland co., Mich. June. R. H. Stevens.

Related to *H. gracilis* and *H. Panormitana*, but differing from both in the pure white color of the young fresh plant.

NEW YORK STATE MUSEUM.

Hepaticae of Puerto Rico

IV. ODONTOLEJEUNEA, CYCLOLEJEUNEA AND PRIONOLEJEUNEA

ALEXANDER W. EVANS

(WITH PLATES 8–12)

ODONTOLEJEUNEA

In his subgenus *Odonto-Lejeunea*, Spruce * grouped together a number of *Lejeuneae Holostipae* in which dentate or spinose leaves were borne on a prostrate axis, the latter being closely adherent to the substratum by means of radicelliferous discs develdope on the underleaves. In the other subgenera of this group, in which dentate or spinose leaves also occurred, as, for example, *Thysano-Lejeunea* and *Dicrano-Lejeunea*, the leafy axes were pendulous or ascending from a prostrate caudex and were almost or quite destitute of rhizoids. *Odonto-Lejeunea* was further characterized by a strongly flattened perianth more or less toothed along the sharp lateral keels and emarginate at the apex. Although classed among the *Holostipae*, Spruce included in his subgenus certain species, such as *Lejeunea Peruviana* Lehm. & Lindenb., in which the majority of the underleaves were bifid, and others, such as *L. convexistipa* Lehm. & Lindenb., in which a tendency toward the development of bifid underleaves might sometimes be observed. Schiffner's genus *Odontolejeunea* † has the same limits as Spruce's subgenus, but Stephani understands the genus in a somewhat more extended sense and includes in it at least one species, *L. accedens* Gottsche, ‡ which Spruce referred to *Priono-Lejeunea* (under the name *L. leptocardia* Spruce). In this species, as well as in certain others recently described by Stephani, § the underleaves are invariably bifid. Although in many respects a natural group, the genus *Odontolejeunea* as understood by Stephani or even by Schiffner is more comprehensive than is usual among the

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* Hep. Amaz. et And. 142. 1884.

† Engler & Prantl, Nat. Pflanzenfam. 1^3: 127. 1893.

‡ Hedwigia, 27: 284. 1888.

§ *L. c.* 35: 120. 1896.

Lejeuneae and includes an almost continuous series of species connecting the very different genera *Dicranolejeunea* and *Prionolejeunea.* In fact, such a species as *O. lunulata* (Web.) Schiffn., which may be considered the type of the genus, is much more closely related to certain *Dicranolejeuneae* than it is to *L. accedens* or even to *L. convexistipa;* and *L. accedens*, on the other hand, is hardly to be separated generically from such a *Prionolejeunea* as *P. microdonta* (Gottsche) Steph.

Fortunately the series may be divided into two clearly defined groups or genera. The first of these is composed entirely of species with undivided underleaves and includes the first four of the species described by Spruce under *Odonto-Lejeunea.* For this genus the name *Odontolejeunea* may be retained. In the second genus, which may be designated *Cyclolejeunea*, some of the species have undivided underleaves and others have bifid underleaves. This genus includes most if not all of the remaining species described by Spruce. The slight difference in the underleaves, which by itself would be of but little moment, is supported by the much more important generic characters noted below.

The genus *Odontolejeunea* in its restricted sense is composed entirely of tropical species. The type of the genus, *O. lunulata*, is found in both America and Africa, but the remaining species, so far as known, are exclusively American. Although occasionally found on bark, the species are most at home on living leaves and include some of the largest and most conspicuous of our epiphyllous hepatics. The plants are usually olive green in color, varying to brownish or yellowish, but are apparently never pale green or whitish. In spite of the prostrate habit of the plants, the leaves are not closely appressed to the substratum. When dry they are irregularly crispate and wrinkled; when moist they are convex and strongly revolute along the postical margin. The lobes of the leaves spread widely from the axis and are commonly broad and rounded at the apex. On well-developed leaves the margin is sharply and irregularly dentate, the teeth being scattered and consisting of from one to a considerable number of cells. The lobule of normal leaves encloses a distinct water-sac and the free margin is appressed to the lobe (PLATE 8, FIGURE 2). Along the margin are found from two to four scattered teeth, but the hyaline papilla instead of being marginal is situated on the antical surface of the lobule at some little distance from the margin (FIGURE 6), very much as Leitgeb describes for "*Phragmicoma*."* A somewhat similar lobule is found in *Brachiolejeunea* and also in some of the species of *Marcehesinia*, but it is very different from that found in *Cyclolejeunea* and *Prionolejeunea*. The leaf-cells in *Odontolejeunea* are plane or nearly so and their thin walls are firm and frequently pigmented. Trigones and intermediate thickenings, although small, are everywhere conspicuous (FIGURE 3), but there are no ocelli.

The underleaves in *Odontolejeunea* are approximately orbicular in shape and are commonly described as auriculate at the base. The latter character, however, does not accurately portray the true conditions, because in reality the strongly auriculate appearance is due to the peculiar way in which the underleaves are attached to the axis. The line of insertion is long and sharply arched, and the basal part of the underleaf broadens out so abruptly from this line that it becomes folded upon itself, the fold forming what is apparently the inner edge of a large basal auricle (FIGURE 2). In many cases the lower margin of the underleaf does not extend at all beyond the line of insertion, and of course under these circumstances there is no true auricle whatever; in other cases a slight auricle is developed. The margins of the underleaves are more or less toothed. The radicelliferous discs are highly developed and normally give rise to rhizoids not only from their margins but also from their postical surface. On ordinary underleaves the marginal rhizoids are in a single layer and are more or less palmately branched at their extremities. All of the rhizoids secrete an abundant supply of a tenacious jelly-like substance, a peculiarity possessed by the majority of epiphyllous *Lejeuneae*.

The position of the ♀ inflorescence is variable even in the same species, being sometimes borne on a leading branch and sometimes on a short branch. The inflorescence innovates on one side and frequently the innovation itself is repeatedly floriferous. The lobules of the bracts are represented by minute basal folds (FIGURES 8, 9) and the bracteole is undivided (FIGURE 10). The

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* Unters. über Lebermoose, 2 : 14. 1875. Apparently the species studied was *P. Mackaii* (Hook.) Dumort. (= *Marchesinia Mackaii* S. F. Gray).

essential characters of the perianth have already been noted, but it may be added that the lateral keels are distinctly winged and that the teeth are borne on the margins of the wings (FIGURE 1). The ♂ inflorescence consists of a long spike with closely imbricated diandrous bracts, and the corresponding bracteoles are developed throughout its entire length. So far as known the vegetative reproduction is entirely by means of leafy propagula occupying the position of normal branches and comparable with those found in *Leptolejeunea* and *Drepanolejeunea*.

Two species of *Odontolejeunea* are now known from Puerto Rico and each has apparently been collected but a single time. The first of these, *O. lunulata*, was found many years ago by the Italian botanist Balbis, whose specimens are listed in the Synopsis Hepaticarum under *L. tortuosa* Lehm. & Lindenb. These specimens have been examined by Stephani * and also by Schiffner † and are referred by both to *O. lunulata*, of which *L. tortuosa* is now considered a synonym. The other species is *O. Sieberiana* (Gottsche) Schiffn., recently collected by the writer. Since the specimens of Balbis have not been readily accessible, the following description of *O. lunulata* is based largely on Jamaican specimens.

ODONTOLEJEUNEA LUNULATA (Web.) Schiffn.

Jungermannia lunulata Web. Hist. Musc. Hepat. Prodr. 33. 1815.

Jungermannia tortuosa Lehm. & Lindenb.; Lehmann, Pug. Plant. **4**: 50. 1832.

Lejeunea lunulata Nees; G. L. & N. Syn. Hep. 326. 1845.

Lejeunea tortuosa Lehm. & Lindenb.; G. L. & N. Syn. Hep. 327. 1845.

Jungermannia phyllogenides Brid.; G. L. & N. Syn. Hep. 327. 1845 (as synonym).

Lejeunea Martinicensis Lindenb.; G. L. & N. Syn. Hep. 328. 1845.

Lejeunea (*Odonto-Lejeunea*) *lunulata* Spruce, Hep. Amaz. et And. 145. 1884.

Odontolejeunea lunulata Schiffn.; Engler & Prantl, Nat. Pflanzenfam. **1**^{3}: 128. 1893.

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* Hedwigia, **27**: 287. 1888.

† Bot. Jahrb. **23**: 596. 1897.

Brownish or yellowish green, scattered or loosely caespitose, often mixed with other *Lejeuneae:* stems 0.17 mm. in diameter, irregularly branched, the branches widely spreading: leaves imbricated, the lobe widely spreading, convex and more or less revolute along postical margin, falcate-ovate, 1.7 mm. long, 1 mm. wide, attached by an almost longitudinal line of insertion, antical margin arching across or just beyond the axis and strongly curved from base to apex, postical margin approximately straight, apex broad and rounded, whole margin sharply dentate, the teeth scattered, each consisting usually of a cell with a strongly thickened outer wall arising from a base two cells wide, postical margin with two teeth much larger than the others and separated from each other by a broad lunulate sinus; lobule suborbicular in outline, 0.35 mm. long, the strongly inflated inner half lying parallel with the axis and bulging beyond the free margin, outer half appressed to lobe, free margin curved from base to end of keel, usually bearing three scattered teeth, two side by side at about the middle of the margin, the other midway between these and end of keel, the teeth blunt, commonly two or three cells long and one or two cells wide at the base, often curved toward the lobe; cells of lobe plane or nearly so, averaging 18 μ at the margin and 30 μ in median and basal regions, walls thin but firm, trigones triangular, rarely confluent, intermediate thickenings numerous, oval: underleaves contiguous or slightly imbricated, broadly orbicular, 0.7 mm. long, 0.85 mm. wide, attached by a narrowly arched line of insertion and apparently strongly biauriculate at base, the auricles subquadrate in form; apex broad and rounded, often revolute; margin sharply denticulate, the majority of the teeth minute and consisting of single projecting cells, one or two teeth in the basal region often larger than the others and broadly triangular in outline: inflorescence dioicous: ♀ inflorescence sometimes on a leading branch, more frequently on a short branch, innovating on one or on both sides, the innovation usually floriferous and sometimes repeatedly so; bracts obliquely spreading, slightly plicate at the very base, ovate to oblong, 0.95 mm. long, 0.6 mm. wide, apex rounded to subacute, margin sharply dentate as in normal leaves; bracteole free, orbicular-obovate, 0.75 mm. long, 0.7 mm. wide, middle portion convex postically with a plane or revolute border, margin irregularly denticulate or dentate with scattered teeth; perianth obovate in outline, 1.25 mm. long, 0.95 mm. wide, cuneate toward base, broad and truncate or slightly retuse at the apex with a distinct beak, antical face plane, postical face with a distinct keel, broad and rounded below, narrow and sharp above, lateral wings extending to or below the middle of the perianth, two or three cells broad, each bearing about twelve sharp and usually unicellular teeth: ♂ inflorescence terminal on a leading branch or occupying a short branch; bracts in about twelve pairs, imbricated, the lobe ovate, subacute, with three to seven marginal teeth, lobule about half as long as lobe, ovoid, keel arched, free margin involute, the marginal teeth blunt or obsolete; bracteoles imbricated, similar to the underleaves but more shortly inserted, margin varying from entire to minutely crenulate or denticulate: mature sporophyte not seen (PLATE 8, FIGURES 1–15).

On living leaves. Puerto Rico, *Balbis*; these specimens, growing on orange leaves, were probably collected near the coast. Weber describes the type locality of the species as follows: e regionibus tropicis in foliis *Musae*. Although not so stated, his specimens doubtless came from the American tropics where the species is widely distributed. "Oware,"* the type locality for *Jungermannia tortuosa*, is the only known African station for the plant.

ODONTOLEJEUNEA SIEBERIANA (Gottsche) Schiffn.

Lejeunea Sieberiana Gottsche; G. L. & N. Syn. Hep. 328. 1845.

Lejeunea (*Odonto-Lejeunea*) *Sieberiana* Spruce, Hep. Amaz. et And. 143. 1884.

Lejeunea (*Odonto-Lejeunea*) *chaerophylla* Spruce, *l. c.* 147. *pl. 21.* 1884.

Odontolejeunea Sieberiana Schiffn.; Engler & Prantl, Nat. Pflanzenfam. **1**^{3}: 127. 1893.

Similar in color and in general appearance to *O. lunulata*: stems about 0.12 mm. in diameter, irregularly branched: leaves imbricated, the lobe widely spreading, convex and more or less revolute along postical margin, falcate-ovate, 1.7 mm. long, 1.2 mm. wide, attached by an almost longitudinal line of insertion, antical margin arching across or just beyond the axis, nearly straight near base, then strongly curved to apex, postical margin approximately straight, apex broad and rounded, whole margin sharply dentate with about twenty scattered teeth, each tooth consisting usually of a cell with a strongly thickened outer wall arising from a base two cells wide, teeth along postical margin somewhat larger than the others but not so discrepant in size as in *O. lunulata;* lobule suborbicular in outline, 0.35 mm. long, inner half inflated but less so than in the previous species, outer half appressed to lobe, free margin curved from base to end of keel,

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* "Oware" is apparently the modern "Wari," near the mouth of the Niger.

usually with three or four scattered and equidistant teeth in outer portion, the teeth as in *O. lunulata;* cells of lobe plane or nearly so, averaging 16 μ at the margin, 23 μ in the middle and 30 μ at the base, thin-walled, the triangular trigones and oval intermediate thickenings a little smaller than in the previous species: underleaves distant, 0.6 mm. long, 0.5 mm. wide, obovate, plane or nearly so, apex broad, the apparent basal auricles rounded, margin commonly entire below and varying above from entire to sharply denticulate, the teeth sometimes conspicuous: inflorescence autoicous: ♀ inflorescence borne on a leading branch or on a short branch, innovating on one side, the innovation often floriferous; bracts obliquely spreading, slightly complicate at base, unsymmetrically obovate, 0.95 mm. long, 0.7 mm. wide, margin more sharply dentate than in the leaves, antical margin strongly curved, postical margin nearly straight, apex broad and rounded; bracteole free, orbicular to oblong, about as large as the bracts, margin plane, varying from entire to sharply denticulate; perianth obovate in outline, 1.35 mm. long, 1 mm. wide, broadly cuneate toward base, broad and shortly obcordate at apex with a short beak, antical face plane or nearly so, postical face with a distinct keel sometimes bearing a few short teeth in the upper portion, lateral wings extending almost to the base, two to five cells broad, each about twelve-dentate, the teeth sharp, two to five cells long and usually two cells wide at the base: ♂ inflorescence occupying a short branch; bracts in three to six pairs, imbricated, the lobe ovate, rounded or subacute and apiculate, margin entire or nearly so; lobule as in *O. lunulata*; bracteoles contiguous, oblong to obovate, margin entire: mature sporophyte not seen.

On living leaves. El Yunque, *Evans* (*182*). Also known from the following localities: Andes of Peru and Ecuador, *Spruce;* Mexico, *Liebmann;* Brazil, *Beyrich, Beske, Lindman;* Cuba, *Wright;* Jamaica, *Maxon, Evans;* Dominica and St. Vincent, *Elliott;* Costa Rica, *Pittier.* The type-specimens are said to have been collected on the island of Mauritius, but Stephani looks upon this statement as an error due to the mixing of labels and concludes that Sieber's specimens also came from tropical America. At all events the species has not recently been collected in Africa.

Lejeunea chaerophylla Spruce is here reduced to *O. Sieberiana* on the authority of Schiffner,* who is supported in his statements by Stephani.† Both of these writers examined Sieber's type.

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* Nova Acta Acad. Caes.-Leop. **60**: 230. 1893; also Bot. Jahrb. **23**: 588. 1897.

† Hedwigia, **34**: 238. 1895.

According to Stephani, Spruce himself at one time acquiesced in the reduction, but apparently he changed his mind later because in his "Hepaticae Elliottianae," published shortly after his death, it is maintained that both species are distinct.* The specimens of *Lejeunea chaerophylla*, distributed in *Hepaticae Spruceanae*, have entire underleaves and perichaetial bracteoles, and to this extent differ from many of the West Indian forms of *O. Sieberiana*, but as the denticulation of these parts is always variable, this slight difference can hardly be considered sufficient to separate the species.

It will be seen from the descriptions given above that *O. lunulata* and *O. Sieberiana* are very closely related species. The most important difference between them is in the inflorescence, which is monoicous in one and dioicous in the other. Since the plants are rarely sterile this difference can usually be demonstrated. The characters derived from the vegetative organs are subject to so much variation that they must be used with caution in separating the species, and yet, supported by the inflorescence, they are of some importance. The postical margin of the lobe, for example, in *O. Sieberiana* is more regularly dentate than in *O. lunulata* and fails to show the deep and conspicuous sinus between its two middle teeth. The lobule also, in the monoicous species, is less strongly inflated and more regularly denticulate along its free margin, and the leaf-cells have smaller trigones and intermediate thickenings. The underleaves afford differential characters which are a little more reliable than those drawn from the leaves ; in *O. Sieberiana* they are rounded and entire in the basal portion, and, if they are dentate at all, the teeth increase in size toward the plane apex ; in *O. lunulata* the basal portions often project outward as sharp teeth, while the revolute apex is very minutely denticulate. So far as the writer's experience goes, *O. Sieberiana* is found at rather high altitudes (2,000 feet and above), while *O. lunulata* occurs in the plains ; and apparently this difference in habitat has been noted by other observers.

Under the name *Lejeunea* (*Odonto-Lejeunea*) *calcarata*, Spruce† describes a plant from the Amazon to which he doubtfully refers the old *Phragmicoma calcarata* Mont.‡ This species was long

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* Jour. Linn. Soc. Bot. **30** : 336. 1894.

† Hep. Amaz. et And. 146. 1884.

‡ Ann. Sci. Nat. Bot. II. **19** : 261. 1843.

ago reduced by Gottsche * to a synonym of *O. lunulata* and was afterwards so regarded by Montagne himself.† Spruce separates his plant on account of the acuminate spurs into which the basal angles of the underleaves are said to be produced. In the specimens distributed in *Hepaticae Spruceanae* this peculiarity is not very clearly exhibited, and many of the underleaves are no more spurred than is usual in *O. lunulata;* it is therefore difficult to form a definite opinion as to the validity of Spruce's species. Judging from the distributed specimens alone the plant is hardly worthy of specific rank.

VEGETATIVE REPRODUCTION IN ODONTOLEJEUNEA

Leafy propagula have been observed by the writer in *O. lunulata* and also in *O. Sieberiana* and are essentially alike in the two species. They are much less abundant than in certain species of *Leptolejeunea* and *Drepanolejeunea* and are apparently never borne on specialized microphyllous branches as is so often the case in those genera. Germinating propagula may readily be found in the vicinity of an older plant, but so far only three cases have been noted in which the propagulum was still attached to the parent axis. In one of these it grew out just behind an ordinary branch-leaf at some distance from the apex of the branch (PLATE 8, FIGURE 12); in the other two cases it occupied a similar position with respect to a bract in the middle of a long antheridial spike. In all three cases the empty sheaths of older propagula could also be demonstrated, and these were always larger and more conspicuous than the basal sheaths of ordinary leafy branches. In two of the cases noted the propagulum arched forward across the axis in such a way as to turn its morphologically postical surface upward, very much as in *Leptolejeunea exocellata;* in the third case the propagulum spread widely from the axis and turned its postical surface downward as in a normal branch.

The first leaf of a propagulum is smaller than the first leaf of an ordinary branch and is obovate in shape (FIGURE 13); it is moreover strongly reflexed and its lobule is practically obsolete, being represented merely by a hyaline papilla. The second leaf

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* Syn. Hep. 326. 1845.

† Sylloge, 72. 1856.

is also strongly reflexed but bears a rudimentary lobule; the third and succeeding leaves are similar to ordinary leaves, gradually increasing in size and acquiring normal lobules. The first underleaf is similar to that found at the base of an ordinary branch; it is small and flat, oblong in outline without any indication of basal auricles, and is entire on its margin; it apparently possesses no rhizoid-initials and is attached by a short straight line of insertion. The second underleaf is the most remarkable feature of the propagulum and shows very striking modifications. It is orbicular in shape and is also entire on the margin, but the base is deeply and truly auriculate, the region of insertion being short and at about the middle of the underleaf. The axis-cells, by which the attachment is effected, become elongated and push the underleaf away from the axis, forming as it were a kind of stalk (FIGURE 15). At the top of this stalk the disc is developed and eventually becomes larger than the underleaf itself. The disc consists of two layers of cells, those in the middle being at first small and polygonal in outline and forming a patch about six cells across. The marginal cells, which are really rhizoids, are likewise in two layers and very soon become long and narrow, radiating out in all directions. Instead of remaining distinct, as rhizoids commonly do, they are united except at their tips and thus form, around the middle of the disc, a broad and continuous border crenulated on the edge (FIGURE 14). These rhizoids possess in a marked degree the property of secreting slime. After a propagulum has established itself, the middle cells of the disc may also develop rhizoids. The third and succeeding underleaves of the propagulum are similar to ordinary underleaves and develop radicelliferous discs of the usual type.

CYCLOLEJEUNEA

The genus *Cyclolejeunea* as here understood has four representatives in Puerto Rico. The first of these, *C. Chitonia*, is known from British Guiana and from several of the Lesser Antilles; the second and third, *C. convexistipa* and *C. accedens*, have already been listed from the island * and have a wide distribution in South America; the fourth, *C. angulistipa*, is apparently restricted to

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* Hedwigia, 27: 281, 284. 1888.

the West Indies. Even as it stands the extremes of the genus are rather more diverse than is usual in the *Lejeuneae*, and it is possible that it should be still further subdivided; for the present, however, it seems wisest to leave it intact. All of the species of *Cyclolejeunea*, so far as known, are confined to the American tropics and are found on living leaves or on the bark of trees. The genus may be characterized as follows:

Cyclolejeunea gen. nov.

Lejeunea p. p. G. L. & N. Syn. Hep. 1845.

Lejeunea subgenus *Odonto-Lejeunea p. p.* Spruce, Hep. Amaz. et And. 1884.

Lejeunea subgenus *Priono-Lejeunea p. min. p.* Spruce, *l. c.*

Odontolejeunea p. p. Schiffn.; Engler & Prantl, Nat. Pflanzenfam. 1893.

Plants medium-sized to large, sometimes delicate in texture sometimes more robust, varying in color from pale green or whitish to brownish or olive green: stems prostrate and adherent to the substratum, sparingly to copiously branched: leaves contiguous to densely imbricated, the lobe widely spreading, plane or slightly convex, not revolute along the postical margin, falcate-ovate, broad at the apex and usually rounded or apiculate but never acute, margin varying from entire to coarsely and irregularly dentate; lobule inflated and forming a distinct water-sac, keel more or less arched, free margin involute, tipped at the apex by a single cell bearing a marginal hyaline papilla at its proximal base; leaf-cells sometimes delicate and scarcely thickened at the angles, sometimes with distinct trigones and intermediate thickenings; ocelli usually but not invariably present: underleaves approximately orbicular in form, sometimes undivided, sometimes regularly bifid, sometimes undivided or bifid in the same species, attached by a short and scarcely arched line of insertion: inflorescence usually dioicous: ♀ inflorescence borne on a more or less abbreviated branch or on a leading branch, innovating on one side, the innovation sometimes floriferous; bracts unequally bifid, about as large as the leaves, lobule small but usually distinct; perianth strongly flattened but with a distinct postical keel, broad and emarginate above, lateral keels more or less toothed, sometimes winged: ♂ inflorescence occupying a shorter or longer branch; bracts imbricated, diandrous: vegetative reproduction by means of disc-like gemmae borne on the margins of the leaves. (Name from *κυκλὸς*, a disc, and *Lejeunea*, in allusion to the gemmae).

The most important of the characters which separate the genus just described from *Odontolejeunea* are drawn from the vegetative organs and concern both leaves and underleaves. The margin of the lobe, for example, in *Cyclolejeunea*, is extremely variable with respect to its dentation; in some species it is minutely and regularly crenulate or denticulate from projecting cells (PLATE 10, FIGURES 2, 4); in others it varies from entire to coarsely dentate on the same individual (PLATE 8, FIGURE 16); in *Odontolejeunea* the margin of the lobe is always sharply dentate. The lobule in *Cyclolejeunea* bears a single tooth on the free margin, and the hyaline papilla is also marginal, being borne at the proximal base of this tooth (PLATE 8, FIGURE 22; PLATE 9, FIGURES 10, 17); in *Odontolejeunea* the free margin of the lobule bears several teeth and the papilla is displaced from the margin. The underleaves in the two genera are very different with respect to their method of attachment to the axis, the line of insertion in *Cyclolejeunea* being short and scarcely arched (PLATE 8, FIGURES 16, 17) instead of long and sharply arched as in the other genus. Radicelliferous discs are found in both genera but are not a constant feature in *Cyclolejeunea*, the underleaves in certain species giving rise directly to rhizoids. Other differences in the underleaves, relating to the presence or absence of an apical sinus, have already been alluded to. The perichaetial bracts of *Odontolejeunea* are characterized by being practically elobulate, while those of the new genus have well developed lobules (PLATE 8, FIGURE 23). In the vegetative reproduction, finally, we find a very striking difference which is probably to be considered generic; in *Odontolejeunea* this is carried on by means of the leafy propagula already described; in *Cyclolejeunea* the vegetative reproduction is by means of peculiar marginal gemmae in the form of discs, similar in some respects to those found in *Cololejeunea* and its allies, but differing from them in the details of development and germination. These gemmae will be discussed after the description of species.

Cyclolejeunea Chitonia (Tayl.)

Lejeunea Chitonia Tayl.; Lehmann, Pug. Plant. **8**: 27. 1844 (misprinted "*L. Clitonia*").

Odontolejeunea subbifida Steph. Hedwigia, **35**: 117. 1896.

Brownish or olive green, sometimes varying to pale green or yellowish, densely tufted : stems 0.3 mm. in diameter, copiously and irregularly branched, the branches widely spreading, often ascending : leaves densely imbricated, the lobe more or less convex, broadly falcate-ovate, 1.25 mm. long, 1 mm. wide, attached by an almost longitudinal line of insertion, antical margin arching across or just beyond axis, slightly incurved near base, then strongly outwardly curved to apex, postical margin straight or nearly so, often with a blunt fold near end of keel, apex rounded or obtuse, often apiculate, margin varying from entire to sharply dentate, the teeth in extreme cases reaching a length of four cells and a width of two cells at the base, each tooth tipped with a sharp cell having a strongly thickened outer wall ; lobule narrowly ovoid, 0.5 mm. long, 0.2 mm. wide, tapering and more or less curved toward end of keel, strongly inflated, keel slightly roughened from projecting cells, free margin involute to beyond apex, then passing by a shallow and long sinus to end of keel, apical tooth short and somewhat pointed, strongly curved ; cells of lobe convex, averaging 18 μ at the margin, 35 μ in the middle and 45 μ at the base, rather thick-walled with large triradiate trigones separated by narrow pits or sometimes by an oval intermediate thickening between two pits ; ocelli 80 μ long, 35 μ wide, commonly in a group of three, situated at the base of the lobe but separated from the line of insertion by one or two rows of cells : underleaves imbricated, broadly orbicular, 0.7 mm. long, 0.9 mm. wide, cuneate or subauriculate at the base, shortly bifid at the apex with obtuse or rounded sinus and broad rounded or apiculate lobes, margin varying from entire to sharply and irregularly denticulate in the upper part : inflorescence dioicous : ♀ inflorescence on a short branch, innovating on one side, the innovation commonly floriferous ; bracts obliquely spreading, the lobe obovate, 1.25 mm. long, 0.95 mm. wide, margin entire to dentate, the keel sometimes narrowly winged in the lower part, lobule oblong, 0.6 mm. long, 0.25 mm. wide, rounded to acute at the apex, margin entire ; bracteole free, obovate, 0.85 mm. long, 0.6 mm. wide, shortly bifid at the apex with connivent obtuse or rounded lobes and narrow sinus, margin entire or nearly so ; perianth almost hidden by the bracts, cuneiform in outline with slightly bulging sides, 1.25 mm. long, 0.95 mm. wide, antical face plane, postical keel low and rounded, apex broad and emarginate with an indistinct beak, lateral keels sharp, extended upward as broad, rounded or truncate auricles, entire or minutely and irregularly denticulate in the upper part and often apiculate at the outer angles, sometimes bordered by one or two interrupted and very narrow wings : ♂ inflorescence and mature sporophyte not seen (PLATE 8, FIGURES 16–23).

On bark of trees, more rarely on rotten logs. North slope of the Luquillo Mountains, *Heller* (*1133, 4736 p. p.*). El Yunque, *Evans* (*28, 75, 82, 160*). The species is also known, in sterile condition, from British Guiana, *Greville*, the type-locality, from St. Vincent (collector not named), and from Martinique and Guadeloupe, *Duss*.*

C. Chitonia is closely related to **C. Peruviana** (Lehm. & Lindenb.) comb. nov.†, a widely distributed epiphyllous species which is also to be expected in Puerto Rico. In fact the two species are so closely allied that both Spruce ‡ and Stephani § considered them synonymous. The type-specimen of *Lejeunea Chitonia* in the Taylor herbarium is sterile aud rather fragmentary but is clearly the same as the variable plant described above. It would be difficult, however, to gain an accurate idea of the species from the type-specimen alone. *Odontolejeunea subbifida* is a robust and sterile form in which the foliar teeth are less pronounced than usual. The Puerto Rico specimens show all gradations between forms of this type and those in which the leaves are sharply dentate, and in some cases variations of this character are exhibited by an individual plant (FIGURE 16). The striking variability in the teeth seems to be due, at least in part, to differences in the external conditions under which development takes place. When a stem or a branch has plenty of room for growth its leaves become large and the margin tends to be entire or minutely denticulate; when a branch is crowded or limited in its growth for any other reason the leaves are smaller and the margin is more likely to be dentate. The production of gemmae is also correlated with an increase in the size of the teeth. The variability in the teeth affects not only

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*Cf. Stephani; Urban, Symb. Ant. 3: 277. 1902.

† = *Jungermannia Peruviana* Lehm. & Lindenb.; Lehmann, Pug. Plant. 5: 18. 1832. *Lejeunea Peruviana* Lehm. & Lindenb.; G. L. & N. Syn. Hep. 339. 1845. *Lejeunea* (*Odonto-Lejeunea*) *Peruviana* Spruce, Hep. Amaz. et And. 151. 1884. *Odontolejeunea Peruviana* Schiffn.; Engler & Prantl, Nat. Pflanzenfam. 1^3: 128. 1893.

‡ Hep. Amaz. et And. 152. 1884.

§ Hedwigia, 29: 70. 1890. Spruce reduced not only *L. Chitonia* to synonymy but also *L. foliorum* Nees (Syn. Hep. 326), and Stephani added *L. adglutinata* Tayl. (Lond. Jour. Bot. 5: 389. 1846) and *L. epitheta* Tayl. (*l. c.* 395). The type-specimens of the last two species show that while *L. adglutinata* is doubtless the same as *C. Peruviana*, *L. epitheta* is a synonym of *Drepanolejeunea inchoata*, as since pointed out by Stephani himself (Hedwigia, 35: 83. 1896).

the ordinary leaves but also the underleaves, the lobes of the perichaetial bracts and the lateral keels of the perianth. The development of trigones in the leaf-cells is likewise subject to a great deal of variation. What may be considered a typical condition is described above and figured on the plate (FIGURE 19), but in many cases the trigones are poorly developed and difficult to demonstrate and the walls appear as if they were uniformly thickened. Between these two extremes are all possible gradations.

Aside from its difference in habitat *C. Chitonia* is a more robust plant than *C. Peruviana* and has more densely imbricated leaves and underleaves. The lobe is broad and the lobule narrows gradually toward the end of the keel, the apical sinus being long and very shallow. In *C. Peruviana* the lobe is narrower and usually more gradually pointed, and the lobule narrows more abruptly,.the apical sinus being shorter and deeper; in the majority of the leaves there is a distinct angle between the end of the keel and the postical margin of the lobe, and in many cases the outer part of the lobule is curved abruptly backward and forms a sort of tooth at its junction with the lobe, as already described by Spruce. The apical tooth of the lobule in *C. Peruviana* is shorter than in *C. Chitonia* and is scarcely curved. Ocelli are found in both species and the leaf-cells are very much alike, but the walls in *C. Chitonia* tend to be more strongly thickened. The underleaves of *C. Peruviana* are extremely variable, being sometimes undivided and sometimes more or less bifid; and their margins, although usually sharply dentate, are occasionally entire. They tend, however, to be much more toothed than in *C. Chitonia* and when bifid often show acute divisions. On the smaller branches the underleaves are commonly revolute on both sides, a peculiarity rarely seen in the larger species. Spruce describes the perichaetial bracts of *C. Peruviana* as being much smaller than the leaves; this is true of the inner bract only (that next the innovation), the outer bract being of about the same size as the leaves. The same marked inequality occurs also in *C. Chitonia* (FIGURE 23), but the bracteal lobes are broader and the bracteole has blunt instead of acute divisions and seems to be invariably entire. The perianths in the two species are very much alike.

In his original description of *Odontolejeunea subbifida,* Stephani calls attention to the strong resemblance which it bears in size, color and general appearance to certain members of the genus *Platylejeunea.* He discerned, however, even from his sterile specimens, that this resemblance was merely superficial and that the true alliance of the species was elsewhere, a view which the fertile specimens from Puerto Rico amply confirms. It differs from *Platylejeunea* more especially in its more or less dentate leaves, in its larger and differently constructed lobules, in its bifid underleaves with their short line of attachment, and in its longer ♀ branch with much larger bracts and bracteoles.

Cyclolejeunea convexistipa (Lehm. & Lindenb.)

Jungermannia convexistipa Lehm. & Lindenb.; Lehmann, Pug. Plant. **6**: 43. 1834.

Phragmicoma Surinamensis Mont. Ann. Sci. Nat. Bot. II. **16**: 110. 1842.

Lejeunea convexistipa Lehm. & Lindenb.; G. L. & N. Syn. Hep. 328. 1845.

Jungermannia patinfera Tayl.; G. L. & N. Syn. Hep. 329. 1845 (as synonym).

Lejeunea Surinamensis Mont.; G. L. & N. Syn. Hep. 329. 1845.

Lejeunea Mougeotii Lindenb. & Gottsche; G. L. & N. Syn. Hep. 329. 1845.

Lejeunea (*Odonto-Lejeunea*) *Surinamensis* Spruce, Hep. Amaz. et And. 149. 1884.

Lejeunea (*Odonto-Lejeunea*) *stachyclada* Spruce, *l. c.* 150. 1884.

Lejeunea (*Odontolejeunea*) *convexistipa* Steph. Hedwigia, **27**: 284. 1888.

Odontolejeunea convexistipa Schiffn. Bot. Jahrb. **23**: 583. 1897.

Pale or bright green, growing in thin and intricate mats, often in company with other *Lejeuneae;* stems 0.09 mm. in diameter, copiously and irregularly branched, the branches obliquely or widely spreading, often ascending, usually with smaller leaves than the stem: leaves contiguous or loosely imbricated, the lobe plane or slightly convex, falcate-ovate, 0.75 mm. long, 0.45 mm. wide, attached by an almost longitudinal line of insertion but decurrent at the antical base by a single cell, antical margin arching across or just beyond axis, slightly incurved near base, then strongly outwardly curved to apex, postical margin straight or nearly so, sometimes continuous with the keel but usually with a slight indentation near junction, apex broad, rounded to subacute, often apiculate by a single sharp cell, margin varying from entire to irregularly crenulate, denticulate or serrulate, each tooth consisting of a single cell ; lobule ovoid, 0.17 mm. long, 0.12 mm. wide, strongly inflated, keel more or less arched, smooth or slightly roughened from projecting cells, free margin involute to apex or beyond, sinus lunulate, apical tooth sharp and slightly curved ; cells of lobe plane or slightly convex, averaging 16 μ at the margin, 21 μ in the middle and 35 × 21 μ at the base, thin-walled and with small trigones ; ocelli commonly two, measuring 45 × 28 μ, situated side by side near the base of the lobe and separated from the line of insertion by a single row of cells : underleaves distant, broadly orbicular, 0.17 mm. long, 0.25 mm. wide, abruptly cuneate at the base, apex broad, rounded or slightly retuse, margin normally entire : inflorescence dioicous : ♀ inflorescence borne on a short branch, innovating on one side, the innovation commonly short and sterile, rarely floriferous ; bracts obliquely spreading, the lobe ovate to obovate, 0.65 mm. long, 0.4 mm. wide, margin sharply denticulate, lobule oblong, 0.25 mm. long, 0.1 mm. wide, rounded to subacute at the apex, margin entire ; bracteole free, orbicular, 0.4 mm. long, cuneate toward base, margin entire ; perianth about half exserted, cuneiform in outline with slightly bulging sides, 0.95 mm. long, 0.7 mm. wide, antical face plane, postical keel broad and rounded, apex broad and emarginate with a short beak, lateral keels sharp, smooth or somewhat roughened from projecting cells, not winged, extended upward as broad, rounded or truncate auricles, usually more or less denticulate in the upper part : ♂ inflorescence usually occupying a long branch ; bracts in many pairs (6–22), loosely imbricated, strongly inflated, shortly bifid, the lobe obtuse, often apiculate, margin entire, lobule obtuse, keel strongly arched and often with a crenulate wing one cell broad ; bracteoles found throughout spike, distant, oblong, commonly entire : mature sporophyte not seen (PLATE 9, FIGURES 1–16).

On living leaves and on the bark of trees. North slope of the Luquillo mountains, *Heller* (*4326, 4329*). El Yunque, *Evans* (*7, 19, 22, 55, 142, 162*). First collected in Puerto Rico by *Schwanecke* and afterwards found there by *Sintenis* (*4, 97*). The species is very widely distributed in the American tropics, and two type-localities, St. Vincent and Barbadoes, are recorded by the original authors.

The description of the leaves and underleaves as given above is drawn from those which are normally developed. In many cases, however, the normal branches are largely replaced by short gemmiparous branches, on which the leaves and underleaves differ materially from those described (FIGURE 4). On these modified branches the leaves are ligulate in form and are not falcate, the two margins being approximately straight and parallel; the apex of the lobe is rounded or truncate and the outer portion is much more coarsely dentate than on ordinary leaves. The cells of the lobe are of about the same size throughout (FIGURE 9). The lobules of these modified leaves become more and more rudimentary on passing from the base of the branch toward the apex and are finally reduced to minute and indistinct basal folds. The underleaves on the gemmiparous branches are close together and more or less squarrose; they are, moreover, strongly convex, and it is probable that the species derived its name from underleaves of this type. The margin in the broad apical region is frequently denticulate, and sometimes the two teeth nearest the middle are larger than the others, thus giving the appearance of a shortly bifid underleaf with a shallow apical sinus. The complicated synonymy of *C. convexistipa* is due largely to the occurrence of these peculiar branches, which sometimes completely mask the true characters of the species; it has been ably elucidated by Stephani.*

The perianth of *C. convexistipa* is also subject to considerable variation, although the form described may be considered typical. In some cases the postical keel is extended upward as a distinct auricle or horn, and in rarer instances an antical keel, also with a horn, makes its appearance. Usually these supplementary horns are shorter than the lateral, but in one observed case they were fully as long and gave rise to a four-horned perianth. The position of the horns, however, was different from what we find in *Ceratolejeunea*, where two of the horns are developed from the upper angles of the postical keel. In other cases the floral leaves, which normally unite to form the perianth, fail to do so properly and leave an incomplete organ. Occasionally the abnormal union expresses itself in the development of irregular wings growing out from the surface of the perianth.

It is not difficult to distinguish *C. Chitonia* from the species just described, although the two are rather closely related. *C. convexistipa* is a smaller plant, much more delicate in texture and usually of a paler color. It differs further in its less crowded leaves and

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* Hedwigia, 27: 284. 1888.

underleaves and in the fact that the latter are normally undivided. In the floral organs the differences are not very marked, but the broader perichaetial bracts of *C. Chitonia* and the shortly bifid bracteole may be alluded to in this connection.

Cyclolejeunea accedens (Gottsche)

Lejunea accedens Gottsche; G. L. & N. Syn. Hep. 339. 1845.

Lejeunea (*Priono-Lejunea*) *leptocardia* Spruce, Hep. Amaz. et And. 159. 1884.

Lejeunea (*Odontolejeunea*) *accedens* Steph. Hedwigia, **27**: 281. *pl. 14, f. 34–38.* 1888.

Pale green, growing in thin loose mats, often in company with other hepatics: stems 0.1 mm. in diameter, sparingly and irregularly branched, the branches widely spreading, usually with smaller leaves than the stem: leaves imbricated, the lobe widely spreading, plane or nearly so, falcate-ovate, 1.4 mm. long and 1.1 mm. wide on the main stem, attached by an almost longitudinal line of insertion but decurrent at the antical base by a single cell, antical margin nearly straight near base, then strongly curved to apex, postical margin straight or slightly incurved, usually forming a continuous line with keel, apex broad and rounded on stem-leaves, varying to obtuse or subacute on small branches, margin sometimes entire or subcrenulate but usually sharply crenulate or denticulate from projecting cells; lobule ovoid, 0.3 mm. long, 0.2 mm. wide, strongly inflated, keel more or less arched, roughened from projecting cells, free margin strongly involute to beyond apex, sinus short and lunulate, apical tooth blunt and slightly curved; cells of lobe convex except in basal region, averaging 24 μ at the margin, 35 μ in the middle and 45 × 35 μ at the base, each cell bearing a blunt median wart, representing a local thickening of the outer wall, walls otherwise thin, trigones and intermediate thickenings wanting or minute and indistinct; ocelli none: underleaves broadly orbicular, 0.28 mm. long, 0.3 mm. wide, bifid about one half (to within three or four cells of the rudimentary basal disc), with triangular, straight or slightly connivent, acute lobes and obtuse or rounded sinus, margin crenulate or obtusely denticulate from projecting cells: inflorescence autoicous: ♀ inflorescence borne on a leading branch or on a short branch, innovating on one side, the innovation usually sterile or a male flower, more rarely a second female flower; bracts obliquely spreading, the lobe obovate, 0.7 mm. long, 0.37 mm. wide, obtuse or subacute, margin denticulate, lobule oblong, 0.17 mm. long, 0.07 mm. wide, usually blunt, sometimes poorly developed; bracteole ovate, 0.35 mm. long, 0.25 mm. wide, bifid one third to one half with acute, erect lobes and narrow sinus; perianth projecting slightly beyond the bracts, triangular-obovate in outline, 0.75 mm. long, 0.5 mm. wide, antical face plane, postical keel low and broad, apex emarginate and with a very indistinct beak, lateral keels sharp, extended upward as rounded auricles, lateral wings extending to or below the middle of the perianth, two to six cells broad, denticulate or serrulate on the margin from projecting cells, surface of perianth smooth or somewhat roughened near wings: ♂ inflorescence terminal or occupying a shorter or longer branch; bracts in about six pairs, sometimes more numerous: mature sporophyte not seen (PLATE 9, FIGURES 17–23).

On living leaves. El Yunque, *Evans* (*21 p. p.*). Also collected by *Schwanecke*. Other stations for the species are the following: St. Kitts, *Breutel*, the type-locality; Guadeloupe, *Husnot;* Dominica and St. Vincent, *Elliott;* Peruvian Andes, *Spruce;* Bolivia, *Rusby*.

The identity of *Lejeunea leptocardia* with *C. accedens* was provisionally acknowledged by Spruce when he distributed his exsiccatae, and was afterward affirmed more positively by Stephani.[*] There is certainly no essential difference between the specimens in the *Hepaticae Spruceanae* and those collected on El Yunque. The generic position of the species is a little uncertain, because it approaches *Prionolejeunea* so closely, as has already been noted. It is here separated from *Prionolejeunea* and placed in *Cyclolejeunea* on account of its prostrate habit, the rounded lobes of its leaves, the different cell-structure, the longer female branch and the marginal discoid gemmae.

The cell-walls of *C. accedens* are so transparent that it is sometimes difficult to demonstrate the tubercles on the leaf-cells except along the margin. In doubtful cases staining with methyl-blue will show whether they are present or not. The occurrence of these tubercles is of course a somewhat aberrant character for the genus and would be equally aberrant for either *Prionolejeunea* or *Odontolejeunea;* it indicates a certain relationship with *Trachylejeunea*, to which, however, *C. accedens* cannot belong on account of its flattened, emarginate perianth.

There is no Puerto Rico species except the following with which *C. accedens* is likely to be confused. From *C. convexistipa*,

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[*] Hedwigia, 35: 120. 1896.

which it resembles in size and color and in the nature of its gemmae, it may at once be distinguished by its exocellate leaves, by its regularly bifid underleaves, by its autoicous inflorescence and by its winged perianth. Most of these characters will also separate it from the much more robust *C. Chitonia*.

Cyclolejeunea angulistipa (Steph.)

Lejeunea angulistipa Steph. Hedwigia, **29**: 69. 1890.

Prionolejeunea angulistipa Steph. *l. c.* **35**: 118. 1896.

Pale yellowish or whitish green, becoming brownish upon drying, loosely tufted : stems 0.09 mm. in diameter, less closely adherent to the substratum than in the other members of the genus, sparingly and irregularly branched, the branches widely spreading : leaves loosely imbricated, the lobe abruptly dilated from a narrow base, widely spreading (in outer part), broadly falcate-ovate, 0.5 mm. long, 0.45 mm. wide, attached by an almost longitudinal line of insertion, but decurrent at the antical base by a single cell, antical margin straight or slightly incurved near base, then strongly outwardly curved to apex, postical margin straight or somewhat outwardly curved, forming an angle of 90° or more with keel, apex broad, rounded to obtuse, margin minutely and regularly crenulate or denticulate from projecting cells, except close to the antical base ; lobule ovoid, 0.17 mm. long, 0.1 mm. wide, much inflated, keel strongly arched, more or less roughened from projecting cells, free margin strongly involute to apex, sinus broad and lunulate, apical tooth curved and rather sharp; cells of lobe slightly convex, averaging 16 μ at the margin, 25 μ in the middle and 32 × 25 μ at the base, rather thick-walled, the triangular trigones and the occasional intermediate thickenings large and conspicuous ; ocelli when present one to four in number, measuring 50 × 35 μ, situated near the base of the lobe, but separated from the line of insertion by one or two rows of cells : underleaves distant, orbicular or rhombic-orbicular, 0.14 mm. long, bifid about one half (to within two or three cells of the radicelliferous region) with triangular, acute and erect lobes separated by an acute to obtuse sinus, margin entire or subcrenulate, often angular-dentate on the sides : inflorescence dioicous : ♀ inflorescence borne on a leading branch, more rarely on a short branch, innovating on one side, the innovation commonly branched and sometimes floriferous ; bracts obliquely spreading, the lobe obovate, unsymmetrical, 0.45 mm. long, 0.3 mm. wide, rounded at the apex, entire or subcrenulate, lobule oblong to lanceolate, 0.2 mm. long, 0.08 mm. wide, margin as in lobe ; bracteole free, obovate from a narrow base, 0.45 mm. long, 0.3

mm. wide, bifid from one third to one half with triangular, erect or connivent, acute to obtuse lobes separated by a narrow sinus, margin as in bracts; perianth about half exserted, cuneiform in outline with nearly straight sides, 0.85 mm. long, 0.7 mm. wide, antical face plane, postical keel low and broad, apex slightly emarginate and with a short beak, lateral keels sharp, extended upward as rounded, very narrowly bialate auricles, the wings sharply denticulate with unicellular teeth: ♂ inflorescence occupying a short branch or terminal on a longer one, sometimes proliferating from the apex; bracts in six pairs or less, contiguous or loosely imbricated, strongly inflated and slightly bifid, the lobe more or less pointed and slightly denticulate, the lobule blunt and entire, keel strongly arched and narrowly winged in outer part, the wing crenulate and composed of a single row of cells; bracteoles present in the lower part of the spike, similar to the underleaves, but smaller: mature sporophyte not seen (PLATE 10, FIGURES 1–17).

On bark of trees and on logs. North slope of the Luquillo Mountains, *Heller* (*4716*, *4738*, *4743 p. p.*). Also known from Martinique, *Perrottet*, and recently collected by the writer in Jamaica. The type-locality is not definitely indicated by Stephani.

C. angulistipa is about as close to *Prionolejeunea* as the preceding species and is placed in *Cyclolejeunea* for essentially the same reasons. The cell-structure, however, in the present species would hardly separate it from *Prionolejeunea*, and the female branch, although normally long, is sometimes much abbreviated. The leaves, on the other hand, are usually conspicuously ocellate, and the marginal gemmae are very abundantly produced, being found occasionally even on the perichaetial bracts; both of these peculiarities indicate an alliance with *C. convexistipa*, although the gemmae are somewhat different in the two species. As in other species of doubtful generic affinity, the position of *C. angulistipa* must be determined from a combination of characters rather than from a single generic difference, and another writer might decide in favor of *Prionolejeunea* without violating the natural relationships of the plant.

C. angulistipa is a smaller plānt than *C. accedens* but is at the same time more robust on account of its thicker cell-walls and conspicuous trigones. The leaves are further distinguished by being ocellate and by the fact that their cells, although convex, lack the peculiar tubercles found in *C. accedens*. In the inflorescence and floral organs there are also important differences, *C. accedens* being autoicous instead of dioicous and developing much broader wings on the lateral keels of the perianth. The two species differ finally in place of growth, *C. angulistipa* being found on bark while *C. accedens* prefers living leaves.

Among the species of *Prionolejeunea*, *P. microdonta*, which has not yet been reported from Puerto Rico, resembles *C. angulistipa* in its general appearance, in its blunt leaves, in its subfloral innovations, and in the characters of its perianth. The leaves of *P. microdonta*, however, are more delicate in texture, more sharply denticulate and are usually exocellate, although Spruce apparently attributes ocelli to the species.* It differs further in its autoicous inflorescence and in its normally abbreviated female branch, as well as in its lack of gemmae.

VEGETATIVE REPRODUCTION IN CYCLOLEJEUNEA †

According to Cavers,‡ discoid gemmae have been recorded in *Radula*, *Porella*, *Frullania* and the following genera of the *Lejeuneae: Metzgeriopsis*, *Cololejeunea*, *Cololejeunea*, *Lejeunea* and *Odontolejeunea*. To these *Diplasiolejeunea* may be added, and it is probable that further study will lengthen the list still more. Under the genus *Odontolejeunea* the only species mentioned is *O. mirabilis* Steph. ms., which we know merely from one of Goebel's figures representing a single gemma.§ Judging from this figure alone the species should be referred to *Cyclolejeunea* rather than to *Odontolejeunea*, the method of attachment of this gemma being the same as in *C. Peruviana*. The source of most of our information on these interesting reproductive bodies is Goebel's paper on "epiphytische Farne und Muscineen," || which was based largely on specimens collected in Java.

In the species of *Cyclolejeunea*, studied by the writer, the gemmae are all composed of a single layer of cells. Each gemma is borne on a marginal leaf-cell, which projects slightly beyond the

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* Hep. Amaz. et And. 158. 1884.

† A short account of the vegetative production in *Cyclolejeunea* was read before the Society of Plant Morphology and Physiology, Philadelphia, December, 1903. Abstract in Science, II. 19 : 415. 1904. The undescribed species referred to is C *angulistipa*.

‡ New Phytol. 2 : (15)–(20). 1903.

§ Organographie der Pflanzen, 277. *f. 175, I.* 1898.

|| Ann. Jard. Buitenzorg, 7 : 1–73. *pl. 1–9.* 1887.

other cells and functions as a stalk. The gemma is attached to the stalk-cell by two basal cells which can usually be distinguished by their greater length. The separation of the gemmae is by a schizolytic process, which leaves intact both the stalk-cell and the two basal cells of the gemma. The development, structure and germination of the gemmae differs somewhat in the various species and will be described in considerable detail.

In *Cyclolejeunea accedens*, which will be taken up first, the gemmae arise normally from the antical margin of an unmodified leaf. One of the pointed marginal cells bulges slightly beyond its neighbors and becomes enlarged at its extremity. The enlarged portion is then cut off by a wall and forms the mother-cell of the future gemma (PLATE 9, FIGURE 18). The wall cutting off the mother-cell is not at right angles to the surface of the leaf but is oblique to it and lies in such a way that the cell cut off partly overlaps the stalk-cell when looked at from above. The mother-cell then divides into two unequal cells by a second oblique wall and this is cut by a third oblique wall. The young gemma now consists of three cells: two of these, the basal cells, connect the gemma with the stalk-cell and apparently undergo no further divisions; the third is a wedge-shaped cell, entirely free from the stalk-cell and beginning at once to function as an apical cell. As the development of the gemma continues, the basal cells lengthen and grow back over the surface of the leaf, in this way displacing the region of attachment to the stalk-cell until it comes to lie at some little distance from the margin of the gemma on its ventral surface (FIGURES 19, 20). While these changes are going on in the basal cells, the apical cell is undergoing a series of rapid divisions and soon gives rise to a circular cell-layer composed of a considerable number of small cells. In the subsequent growth of the gemma these cells increase markedly in size, but their growth is apparently unaccompanied by further cell divisions, the apical cell itself eventually becoming indistinguishable from the other marginal cells (FIGURE 21).

The adult gemma is not flat but is shaped very much like a watch-glass and lies with its convex surface turned toward the leaf. The cells composing it show very little differentiation, but the marginal cells are a little smaller than the others and their walls are more delicate. Two of the marginal cells, during the development of the gemma, lengthen out into unbranched rhizoid-like structures, which ultimately become a little longer than its radius. These cells lie, one on each side, about midway between the apical cell and the base of the gemma, and their outgrowths are more or less closely appressed to its convex lower surface (FIGURE 21). Apparently none of the marginal cells are modified into the curious organs of attachment, which Goebel describes and figures for *Cololejeunea Goebelii.*

When a gemma becomes detached it must fasten itself firmly to the substratum before further development can take place. This is done by means of radiately branched rhizoids, which spring from the marginal cells and secrete an abundant supply of slime. Apparently all of the marginal cells are able to develop rhizoids of this character, but many of them fail to do so. The number and position of the rhizoids varies accordingly on different gemmae (FIGURES 22, 23). In all cases observed, where a gemma had established itself firmly, it had first of all been turned over and had thus been enabled to present its concave surface to the substratum ; but whether or not this is an absolutely necessary proceeding could only be proved by experiment. In any case the gemma would be in a most unstable position if it lay with its convex surface turned toward the substratum, and this instability would be increased rather than diminished by the two long rhizoid-like outgrowths above described. By turning the concave surface downward, on the other hand, the gemma is able to present its entire circumference to the substratum and at the same time to enclose a capillary space where water can be temporarily retained. Through the inversion of the gemma the surface which was originally ventral becomes dorsal, and apparently the two outgrowths, which are now turned away from the substratum, undergo no further development. These structures, therefore, although without doubt morphologically rhizoids, do not assume the function of holding the gemma in place.

The established gemma does not give rise at once to a leafy axis but develops instead a protonemal structure in the form of a flat oblong or ligulate thallus, closely appressed to the substratum (FIGURES 22, 23). Its behavior, therefore, is very much like that of the two Javan species of *Radula*, *R. Hedingeri* and *R. Tjibodensis*, described by Goebel.* In order to distinguish a protonemal structure of this type from the similar protonemata sometimes found in spore-germination, Schiffner † proposes the term "Brutknospenvorkeim" or "gemmothallium," which well expresses the facts in the case. In the gemmae of *C. accedens* the gemmothallia may apparently arise from any part of the margin. In the majority of cases, however, the apical region is favored, and it is possible under these circumstances that the old apical cell reassumes its function of dividing and becomes the apical cell of the gemmothallium. Next to the apical region one of the two basal cells seems to be the favorite starting-point for the new structure, and in some cases two or more gemmothallia may be found on a single gemma (FIGURE 23). From whatever region it arises the gemmothallium grows by means of a two-sided apical cell and finally equals or surpasses in size the original gemma. It affixes itself to the substratum by means of rhizoids like those found on the gemma, but owing to its flat character these rhizoids are not confined to the margin but can grow out from any part of the ventral surface. The apical cell of the gemmothallium eventually becomes the apical cell of the leafy shoot. This gives rise at first to two very rudimentary leaves unaccompanied by an underleaf; the third and fourth leaves, however, begin to show the foliar characters of the species and are accompanied by an underleaf in the ordinary way.

The gemmae of *C. convexistipa* are very similar to those of *C. accedens* and are attached to the leaf by two basal cells in the same way. They are, however, larger and commonly bear three or four unbranched marginal rhizoids instead of two. They are distinguished further by a persistent apical cell which can be readily demonstrated in a mature gemma (FIGURE 14). Here again the gemma is normally inverted before it germinates; it also affixes itself to the sustratum by means of rhizoids springing from its marginal cells. These rhizoids, however, do not arise from the ventral surface of the marginal cells as in *C. accedens* but from the outer edges, and are usually less branched (FIGURE 16). The gemmae of *C. convexistipa* do not develop gemmothallia but

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* Ann. Jard. Buitenzorg, 7: 51–54. *pl. 6, 7. f. 60–67.* 1887.

† Oesterr. Bot. Zeits. 43: 207. 1893.

grow at once into leafy shoots, the two-sided apical cell of a gemma becoming directly the tetrahedral apical cell of a new axis (FIGURE 15). Apparently a gemma never develops more than one leafy shoot. In their structure and germination the gemmae just described bear much resemblance to those of *Radula complanata*, of which we have an account by Cavers.* In both *Radula* and *Cyclolejeunea*, therefore, the gemmae of certain species produce gemmothallia, while those of other species fail to develop these remarkable structures. In *C. Chitonia* the gemmae are essentially like those of *C. convexistipa* and consequently retain their apical cells; in many cases, however, they lack the unbranched marginal rhizoids. Germination in this species has not been observed. In *C. Peruviana* the gemmae also retain their apical cells, but the region of attachment, through the division of the basal cells, is displaced toward the center of the gemma instead of being marginal.

The gemmae of *C. angulistipa* differ in several important respects from those found in other species of *Cyclolejeunea*. As in *C. accedens* one of the marginal cells of a leaf projects beyond its neighbors (PLATE 10, FIGURE 10) and is divided by a wall into a stalk-cell and the mother-cell of the future gemma. The dividing wall, however, is at right angles to the surface of the leaf. The mother-cell then divides by a longitudinal wall into two equal cells situated side by side (FIGURE 11). In each of these cells the succeeding divisions go on independently. The cell first divides into an inner and outer cell by a wall at right angles to the longitudinal wall (FIGURE 12). The inner cell may or may not undergo a few irregular divisions. The outer cell behaves at once like an apical cell and continues to cut off segments for a considerable time (FIGURES 13, 14). The adult gemma is flat and ligulate in form, lying in the same plane as the leaf and parallel with its margin (FIGURES 9, 15). The stalk-cell is attached at the bottom of a distinct depression, and the two basal cells are indistinguishable except by their position. If a plane is passed through the stalk-cell and at right angles to the surface of the leaf, it will cut the gemma into symmetrical halves, each of which has developed from one of the two cells resulting from the original division of the mother-cell. The marginal cells are scarcely different from the others, but a few of them give rise to long spreading rhizoids lying

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* New Phytol. **2**: (18). 1903.

in the plane of the gemma. The two apical cells, which are of course marginal cells as well, are persistent and can easily be distinguished at the ends of the gemma. Occasionally an unsymmetrical gemma may be observed, and this is usually caused by the arrested development of one of the apical cells. There is at present no evidence whatever that the adult gemmae are dorsiventral, a condition which is apparently found in *C. accedens* and *C. convexistipa*.

Owing to the habitat of *C. angulistipa* — on rough bark — the marginal rhizoids are usually sufficient to hold the gemmae in place when they become separated from the parent plant; sometimes, however, a few supplementary rhizoids are produced. The germination does not always follow the same type. In cases which may be considered the more typical, one of the apical cells gives rise at once to a leafy shoot without the interpolation of a gemmothallium (FIGURE 16). In other cases a long strap-shaped gemmothallium is developed, which may or may not produce other structures of the same sort by proliferation (FIGURE 17). The growth of the gemmothallium is by means of a two-sided apical cell, and this is probably directly derived from the similar cell of the original gemma. When proliferation takes place the secondary gemmothallia may grow out from the apex of the primary one or from other parts of its margin. In *C. angulistipa*, therefore, the two types of germination which are described above are both exhibited.

The processes of vegetative reproduction in this species may be still further complicated. The gemmothallium, for example, may itself give rise to gemmae of the ordinary type, resembling in this respect the highly developed protonema or gemmothallium of *Metzgeriopsis*.* In other cases a leaf-cell may grow out into a thalloid structure with a single apical cell, from which a leafy shoot eventually develops. This is doubtless an example of a protonema growing directly from a vegetative cell instead of from a spore and resembles the cases described and figured by Goebel.† A protonema of this type is scarcely to be distinguished by its appearance from a gemmothallium.

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* Cf. Goebel, Ann. Jard. Buitenzorg, 7: 55. *pl. 7. f. 72.* 1887; also Schiffner, Oesterr. Bot. Zeits. 43: 121. *pl 7. f 1.* 1893.

† Flora, 72: 17. *pl. 1, f. 19.* 1889.

PRIONOLEJEUNEA

The genus *Prionolejeunea* comprises a group of closely related species, all of which are found in moist tropical forests. It attains its highest development in America, but a few species from western Africa have recently been described. No species are known with certainty from Asia or from the islands of the Pacific. In their choice of a substratum the species are much less particular than in either *Odontolejeunea* or *Cyclolejeunea*. Some of them occur on rocks, others on rotten logs or on trees, still others on the roots and bases of tree ferns; in some cases the same form may be found on various substrata. Nearly all of them show a tendency to creep over tufts of larger mosses and hepatics, and it is most unusual to find a patch composed of a single species free from admixture of any sort.

The species are all small and delicate and are pale green or yellowish in color. The characters derived from the leaves are extremely uniform throughout the genus. The lobe spreads widely from the axis and is attached, very much as in *Harpalejeunea*, by an almost longitudinal line of insertion decurrent by a single cell. Just beyond the lobule the lobe is abruptly dilated into a broadly ovate or orbicular expansion (PLATE 11, FIGURES 2, 19), the margins both antical and postical being more or less rounded. At the apex it is usually abruptly acute or apiculate but is sometimes obtuse or even rounded, and there is often considerable variation in these respects even in a single specimen. The middle part of the lobe is convex but the margin is plane and appressed to the substratum, thus leaving a small capillary space underneath the lobe. Except in a single species the margin of the lobe is distinctly crenulate or denticulate. Each tooth is commonly a single projecting cell (PLATE 10, FIGURE 22; PLATE 11, FIGURE 21); in some cases every marginal cell forms a tooth of this character, in other cases the teeth are separated from one another by cells which do not project: sometimes a few of the teeth will be larger than the others and composed of two or three cells apiece. The denticulation of the leaves is subject to a great deal of variation even on a single individual, and the characters derived from the marginal teeth must therefore be used with the utmost caution in distinguishing between near allies.

The leaf-cells also exhibit considerable uniformity. The outer wall of each cell is usually more or less convex, making the surface of the leaf slightly roughened and approaching in this respect the genus *Trachylejeunea*; but the convex wall is not thickened except sometimes on the marginal teeth. Trigones and intermediate thickenings, although varying greatly in size, can almost always be demonstrated (PLATE 10, FIGURE 21). Ocelli are absent from all the Puerto Rico species and it is doubtful if they occur anywhere in the genus.

The lobule is built up on essentially the same principle as in *Harpalejeunea* and *Cyclolejeunea*. It has a strongly arched keel, more or less roughened throughout, and the free margin is tipped with a single curved cell (PLATE 10, FIGURE 24), which is normally appressed to the lobe and thus assists in forming the opening into the well-developed water-sac. The hyaline papilla is proximal in position, but the depression in which it is situated is very shallow or even entirely obsolete. The papilla itself is conspicuous and lies parallel with the free margin, very much as in *Hygrolejeunea* and *Taxilejeunea*. Sometimes a lobule is poorly developed and fails to show some of the characters just enumerated.

The underleaves, which are very much like those of *Trachylejeunea*, are usually small and distinct and vary in shape from broadly ovate to orbicular. They are deeply bifid with triangular lobes separated by a broad sinus. The rhizoids when present grow out from a definite patch of thin-walled cells at the base of the underleaf (PLATE 11, FIGURE 9), and sometimes an extremely rudimentary disc is developed. The radicelliferous region is separated from the base of the sinus by from one to three cells and is bounded on each side by a single large cell. The line of insertion is short and scarcely arched. The margin of the underleaf is usually entire or crenulate but is sometimes angular-dentate on the sides.

In the majority of the species the inflorescence is autoicous but in a few it is dioicous. The female branch is extremely short and rarely bears more than a single rudimentary leaf and a single underleaf in addition to the involucre and perianth. Occasionally a single pair of normal leaves with their underleaf is interpolated between the rudimentary leaf and the bracts (PLATE 11, FIGURE 18), but this condition seems to be unusual and is limited to certain species. In most of the species the female branch is simple; in a few it is subtended by a short sterile or male innovation; and a very few species have been described in which both conditions are found.

One of the most characteristic features of the genus is the perianth, which, however, finds its counterpart in *Odontolejeunea*, in *Cyclolejeunea* and in certain species of *Cololejeunea*. This organ broadens out gradually from a narrow base and varies at the apex from truncate to emarginate. The apical beak is short or obsolete. The perianth in most of the species is strongly compressed with sharp lateral keels and a broad and rounded postical keel. The lateral keels are usually provided in the upper part with two narrow and interrupted, denticulate to laciniate wings. The characters derived from the floral organs are the most reliable in distinguishing the species of this difficult genus, and it is rarely advisable to attempt the determination of material which is wholly sterile.

Taking the genus as a whole it shows a close relationship with *Cyclolejeunea* and *Trachylejeunea*. From the first of these it differs in its general habit, in its invariably short female branch, and in its lack of gemmae. In fact, so far as is known at present, no species of *Prionolejeunea* exhibits specialized organs of vegetative reproduction, although in one or two cases flat protonemata have been observed growing out from ordinary leaf-cells. The absence of ocelli will also separate the present genus from most of the species of *Cyclolejeunea*. When compared with *Trachylejeunea* the resemblance in leaves and underleaves is at once apparent, even the lobules being built up on the same type in the two genera; but *Trachylejeuneā* is amply distinct in its inflated, five-keeled perianth.

Only one species of *Prionolejeunea*, *P. denticulata* (Web.) Schiffn.,* has been recorded from Puerto Rico. This was found in the collection of Schwanecke, and the old determination of Hampe and Gottsche † has recently been confirmed by Schiffner.‡ Unfortunately the original *Jungermannia denticulata* of Weber § is shrouded in so much mystery that it is impossible to state definitely just which modern species or group of species it represents. The original description does not help at all; it merely gives a

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* Engler & Prantl, Nat. Pflanzenfam. 1^3: 127. 1893.

† Linnaea, 25: 354. 1852.

‡ Bot. Jahrb. 23: 585. 1897.

§ Hist. Musc. Hepat. Prodr. 30. 1815.

very brief characterization of the leaves and underleaves and would apply to almost any species of *Prionolejeunea* or even to species of other genera of the *Lejeuneae*. Weber's description of the type-locality is also indefinite; it is given as follows: ad *Trichom. rigidum* ill. Sprengel. observavit, et absque nomine olim communicavit. Later references to Weber's type-specimens are both vague and confusing. Under *Lejeunea denticulata* Nees, in the Synopsis Hepaticarum, the first specimen quoted is from the following locality: ad *Trichomanes radicans* Jamaicae (Spreng. in Hb. Web.); this is the only specimen noted from the Weber herbarium and also the only one under which reference is made to Sprengel. It was presumably determined by Weber himself even if it did not represent a part of his type-material. In Stephani's paper on "Die Gattung *Lejeunea* im Herbarium Lindenberg," two specimens are quoted under *L. denticulata*,* either of which might be a part of Weber's type, although no definite statement to this effect is made. The first of these is No. 6277, "ad. *Trichom. rigid.*"; the second is No. 6278, "Patria? Sprengel." According to Stephani neither of these is the true *L. denticulata* as he understands the species: the first becomes the type of his new *L. angulistipa*; the second is sterile and indeterminable, but is also distinct. Whether he studied the Jamaican specimen referred to in the Synopsis does not appear from his writings, and there are apparently no later references of any sort to Weber's specimens. The only fact to be learned from the evidence just submitted is that *Jungermania denticulata* was probably an aggregate and that it may have included other forms than those mentioned by Stephani. Under the circumstances it seems wisest to allow the name to disappear from the literature. This conclusion is supported by the fact that recent writers have applied the name *L. denticulata* to entirely distinct species. The plant described † and distributed by Spruce, for example, is destitute of subfloral innovations, while in a specimen from Guadeloupe, determined by Gottsche and kindly communicated by Stephani, innovations are present and the leaves present a different cell-structure. The specimens collected by Schwanecke have not been examined by the writer.

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* Hedwigia, 29: 69. 1890.

† Hep. Amaz. et And. 156. 1884.

In the following pages five species of *Prionolejeunea* from Puerto Rico are described. One of these is *P. aemula* (Gottsche), already known from two of the Lesser Antilles; the others are apparently new. It is probable that further exploration of the island would increase the list of species very materially, since several sterile and indeterminable forms occur in the collections already made. It is also probable that the geographical distribution of one or more of the new species will eventually be found to extend into the neighboring islands.

Prionolejeunea innovota sp. nov.

Dull yellowish green, becoming brownish upon drying, loosely and intricately caespitose: stems 0.09 mm. in diameter, prostrate and loosely adherent to the substratum, sparingly branched, the branches obliquely to widely spreading: leaves contiguous or subimbricated, the lobe widely spreading, more or less convex, falcate, 0.35 mm. long, 0.3 mm. wide, outer part ovate-orbicular, abruptly dilated from a narrow basal region, antical margin straight or slightly incurved near base then strongly outwardly curved to apex, postical margin also strongly curved, apex broad, apiculate or abruptly acute, whole margin (except close to the antical base) sharply denticulate from projecting cells, the teeth regular except in the apical region; lobule ovoid, 0.15 mm. long, 0.1 mm. wide, inflated throughout, keel arched, forming a distinct angle of 90° or more with postical margin of lobe, free margin involute to beyond apex, sinus short and lunulate, apical tooth rather sharp and distinctly curved; cells of lobe slightly convex, averaging 14 × 16 μ at the margin, 28 μ in the middle and 35 × 23 μ at the base, walls rather thin, the trigones and the occasional intermediate thickenings small and sometimes indistinct; underleaves distant, orbicular, 0.15 mm. long, bifid one half to two thirds (to within two or three cells of the radicelliferous portion) with erect, triangular and acute lobes separated by a broad, acute to lunulate sinus, margin usually with one or two short angular teeth on each side, otherwise entire: inflorescence autoicous: ♀ inflorescence on a very short branch, innovating on one side, the innovation sometimes short and sterile, sometimes an antheridial spike; ♀ bracts widely spreading, the lobe obovate, 0.5 mm. long, 0.3 mm. wide, rounded, apiculate or acute at the apex, margin almost as in the leaves but the teeth sometimes a little more irregular, lobule oblong to lanceolate, 0.2 mm. long, 0.12 mm. wide, blunt or acute at the apex, margin entire or slightly denticulate; bracteole free, broadly ovate or orbicular-ovate, 0.35 mm. long, 0.3 mm. wide, bifid about one half with acute, erect or connivent lobes and narrow sinus, margin slightly and irregularly crenulate or denticulate from projecting cells; perianth well exserted, broadly triangular in outline with nearly straight sides, 0.75 mm. long, 0.55–0.65 mm. wide, postical keel low and broad, apex slightly but distinctly emarginate with a very indistinct beak, lateral keels extended upward as rounded auricles, bearing above the middle two narrow and interrupted wings, sharply and irregularly denticulate to laciniate on the margin, the teeth one to four cells long and one to three cells broad at the base, surface of perianth smooth or a little roughened from projecting cells, the postical keel sometimes more markedly scabrous in the upper part: ♂ inflorescence occupying a short branch; bracts in two to six pairs: mature sporophyte not seen (PLATE 10, FIGURES 18–27).

On roots of a tree fern. North slope of the Luquillo Mountains, *Heller (4637)*.

The perianth of *P. innovata* varies considerably in width and is sometimes quite a little broader than in the specimen figured. It is further remarkable for the distinct teeth which are often to be observed in the upper part of the postical keel; in one case noted the keel was obscurely two-angled and the teeth were arranged along the angles.

So far as is known at present this is the only species on the island in which subfloral innovations are developed. Its immediate allies, therefore, must be sought among species from other regions. Apparently the closest of these is *Lejeunea (Priono-Lejeunea) macrocardia* Spruce,* from the Peruvian Andes, in which the inflorescence is also autoicous. In this species, however, the leaves are blunter and are sometimes obtuse or even rounded, the marginal denticulations are less prominent, the underleaves are entire except for the apical sinus, the margins of the bracts are no more sharply toothed than in the leaves, and the perianth is more deeply and narrowly emarginate. No other described species seem to be very close. *P. microdonta*, *P. subobscura* Spruce † and *P. validiuscula* Spruce † have subfloral innovations and are also autoicous, but all three species are more robust than *P. innovata*, their leaves are usually even blunter than in *L. macrocardia* and their underleaves are also destitute of marginal teeth. These three plants were originally described from South American specimens, but *P. microdonta* has been recorded from St. Vincent and *P. validiuscula* from

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* Hep. Amaz. et And. 158. 1884.

† Stephani, Hedwigia, 35: 119. 1896.

the same island and also from Dominica ; their discovery therefore may be expected in Puerto Rico. Judging from the description alone, another species from St. Vincent, *Prionolejeunea vagans* (Spruce) Schiffn.,* resembles *P. innovata* rather closely in the form and denticulation of its leaves and also agrees with it in the possession of a subfloral innovation. It differs, however, in the more conspicuous trigones of its leaves, in its dioicous inflorescence and in its indistinctly winged perianth, the wings being merely setulose or erose and never laciniate.

There will be little difficulty in distinguishing *P. innovata* from *Cyclolejeunea angulistipa*, although in both species the underleaves are commonly toothed on the sides. The *Cyclolejeunea* is more robust in all its parts, the cell-walls being firmer and their local thickenings much more pronounced, the leaves are blunt and usually ocellate, the inflorescence is dioicous, the female branch is variable in length and the wings of the perianth are narrower and more shortly denticulate. Of course the remarkable gemmae afford a further character of much importance and these can usually be demonstrated without difficulty.

Prionolejeunea aequitexta sp. nov.

Dull yellowish green, becoming brownish upon drying, loosely and intricately caespitose, often mixed with other hepatics : stems 0.09 mm. in diameter, prostrate and loosely adherent to the substratum, sparingly branched, the branches obliquely to widely spreading : leaves contiguous to loosely imbricated, the lobe widely spreading, plane to convex, falcate, 0.5 mm. long, 0.4 mm. wide, outer part ovate-orbicular, dilated from a narrower basal region, antical margin straight or slightly incurved near base, then strongly outwardly curved to apex, postical margin also strongly outwardly curved, forming an angle of 90° or less with the keel, apex broad, abruptly acute or apiculate, rarely reflexed, whole margin (except close to the antical base and near keel) closely and often regularly denticulate or serrulate from projecting cells ; lobule inflated throughout, ovoid, 0.17 mm. long, 0.1 mm. wide, keel strongly arched, free margin straight or nearly so, involute to beyond apex, sinus lunulate, apical tooth rather sharp and slightly curved ; cells of lobe convex, averaging 15 μ at the margin, 19 μ in the middle and $30 \times 19\,\mu$ at the base, rather thin-walled but with conspicuous trigones and intermediate thickenings : underleaves

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[*] Bot. Jahrb. 23 : 590. 1897 (= *Lejeunea vagans* Spruce, Jour. Linn. Soc. Bot. 30 : 339. 1894).

distant, orbicular, 0.15 mm. long, bifid about two thirds with erect triangular and acute lobes separated by a narrow sinus, margin entire or repand, rarely indistinctly crenulate from projecting cells: inflorescence autoicous: ♀ inflorescence borne on a very short branch without innovation; bracts widely spreading, the lobe ovate, 0.7 mm. long, 0.45 mm. wide, apex broad but usually apiculate, margin as in the leaves, lobule oblong to lanceolate, 0.35 mm. long, 0.12 mm. wide, rounded to acute at the apex, margin entire; bracteole free, ovate-orbicular, 0.5 mm. long, 0.4 mm. wide, bifid about one third with erect, acute or obtuse, triangular lobes and narrow sinus, margin slightly and irregularly denticulate from projecting cells; perianth triangular in outline with nearly straight sides, 0.85 mm. long, 0.7 mm. wide in broadest part, postical keel broad and rounded, apex obcordate with a short but distinct beak, lateral keels extended upward as rounded auricles and bearing above the middle two narrow and interrupted, denticulate or shortly spinulose wings, surface of perianth slightly roughened from projecting cells: ♂ inflorescence usually occupying a short branch but sometimes terminal on a longer branch; bracts in two to four pairs: mature sporophyte not seen (PLATE 11, FIGURES 1–17).

On shaded rocks. El Yunque, *Evans* (*129, 169*). *No. 169* may be designated as the type.

The species described above agrees in many respects with Spruce's *Lejeunea denticulata*, as represented by the specimens distributed in the *Hepaticae Spruceanae*. It differs very considerably, therefore, from the *Lejeunea denticulata* of Stephani and Gottsche. Stephani (*in litt.*) refers *P. aequitexta* with some question to a manuscript species of Gottsche and calls attention to the slight variation in the size of the leaf-cells. As however this determination is not altogether certain, and as Gottsche's species has never been published even as a *nomen nudum*, it seems advisable to give the Puerto Rico plant a different name.

Spruce compared his *Lejeunea denticulata* with *L. decora* Tayl.,* originally collected on the island of Dominica, but threw doubt on the validity of the latter species. Later, however, he referred to it provisionally a plant collected by Elliott on St. Vincent.† According to Bescherelle the species has also been found on Guadeloupe by L'Herminier.‡ The type-specimen of *L. decora*

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* Lond. Jour. Bot. 5: 393. 1846.

† Jour. Linn. Soc. Bot. 30: 338. 1894.

‡ Jour. de Bot. 7: 177. 1893.

in the Taylor herbarium is exceedingly fragmentary but is sufficient to show that the species is distinct not only from Spruce's *L. denticulata* but also from *P. aequitexta*. It is characterized by its narrower and more gradually acute leaves, by its smaller underleaves which are relatively broader and less deeply bifid, by its narrower bracteole with entire or subentire margin, and by its perianth which has a very rudimentary beak and sharply laciniate wings. Its inflorescence is apparently dioicous. Judging from the type-specimen, *P. bicristata* Steph.,* also collected by L'Herminier on Guadeloupe, is a synonym of *L. decora*, although this could hardly be determined from Taylor's very incomplete description.

Prionolejeunea aemula (Gottsche)

Lejeunea aemula Gottsche; G. L. & N. Syn. Hep. 338. 1845.

Lejeunea (*Priono-Lejeunea*) *aemula* Steph. Hedwigia, **29**: 69. 1890.

Lejeunea (*Prionolejeunea*) *vulcanica* Spruce, Jour. Linn. Soc. Bot. **30**: *337. pl. 21. f. 1–3.* 1894.

Prionolejeunea vulcanica Schiffn. Bot. Jahrb. **23**: 590. 1897.

Dull pale green, becoming brownish upon drying, loosely tufted and often mixed with other hepatics: stems 0.09 mm. in diameter, prostrate and loosely adherent to the substratum, sparingly branched, the branches obliquely to widely spreading: leaves slightly imbricated (or sometimes distant on small-leaved branches), the lobe obliquely spreading, convex, scarcely falcate, 0.5 mm. long, 0.45 mm. wide, outer part ovate to orbicular, very abruptly dilated from a narrow and contracted basal region, antical margin strongly incurved near the base then strongly outwardly curved to apex, postical margin also strongly outwardly curved, forming an angle of 90° or less with the keel, apex broad but usually abruptly apiculate or short-acuminate, whole margin (except close to the antical base) densely and regularly denticulate from projecting cells; lobule inflated throughout, ovoid, 0.17 mm. long, 0.12 mm. wide, keel strongly arched, free margin curved, involute to apex but usually appressed to lobe, sinus broad and lunulate, apical tooth slightly curved; cells of lobe slightly convex, averaging 20 μ at the margin, 24 μ in the middle and 35 × 24 μ at the base, rather thin-walled, trigones and intermediate thickenings small but distinct: underleaves distant, orbicular, 0.2 mm. long, bifid about one half (to within two or three cells of the radicelliferous region) with erect triangular lobes, acute or obtuse or even

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* Hedwigia, 35: 118. 1896.

rounded at the apex, and a broad obtuse to lunulate sinus, margin subentire to crenulate from projecting cells, sometimes angular-unidentate on the sides: inflorescence autoicous: ♀ inflorescence borne on a very short branch without innovation, the leaves of the branch being usually reduced to a rudimentary leaf and underleaf but sometimes with a pair of normal leaves interpolated between the rudimentary leaf and the involucre; bracts widely spreading, the lobe obovate, 0.6 mm. long, 0.35 mm. wide, rounded to subacute at the apex, margin as in the leaves, lobule oblong, usually blunt, 0.35 mm. long, 0.12 mm. wide, margin subentire; bracteole free, ovate, 0.6 mm. long, 0.35 mm. wide, bifid about one half with acute lobes and a narrow sinus, margin as in the leaves but with rather more irregular teeth; perianth triangular in outline with nearly straight sides, 0.75 mm. long, 0.6 mm. wide in broadest part, postical keel broad and rounded, apex truncate, slightly indented in the middle, beak obsolete, lateral keels extended upward as rounded auricles and bearing above the middle two interrupted and very narrow, denticulate wings, each tooth one or two cells long, surface of perianth smooth or nearly so: ♂ inflorescence occupying a short branch; bracts in one to three pairs: mature sporophyte not seen (PLATE 11, FIGURES 18–28).

On a rotten log, *Evans* (*103 p. p.*). Originally collected by *Breutel* on St. Kitts, the type-locality, and recently found by *Britton* and *Cowell* on the same island. Also known from Dominica, *Elliott.*

The most striking character of *P. aemula* is the very abrupt dilation of the lobe just beyond the lobule; this is sometimes so marked that a distinct passage-way is left between the base of the lobe and the axis (FIGURE 19), giving the plant a most peculiar appearance. The marginal teeth or crenulations of the underleaves, although not constant, should also be especially noted. In the female inflorescence the denticulate bracteole and the slightly retuse perianth with obsolete beak are perhaps the most important features, when comparing *P. aemula* with its immediate allies. Certain of these peculiarities are not clearly shown in the figures published by Spruce.

According to Gottsche, the leaves of *P. aemula* are coarsely serrate and the lateral keels of the perianth are sometimes minutely and sparingly ciliate and sometimes nearly entire. In his description of *L. vulcanica*, Spruce calls attention to its close relationship with Gottsche's species but separates it because its leaves are minutely crenulate or serrulate and its perianth is subdenticulate. A careful comparison of the types of these two species shows, however, that they are not distinct and that the differential characters upon which Spruce relied are not apparent. In all probability he based his decision on Gottsche's description alone and had no opportunity of consulting the type-specimens. The leaf-cells of *L. vulcanica* are described as being destitute of trigones, but these are represented in the published figure and the type-specimen shows them almost everywhere. They are smaller than is usual in the species but vary markedly in size even on the same plant and are sometimes fully as large as in the typical material of the species.

Among the Puerto Rico species of *Prionolejeunea*, the closest ally of *P. aemula* is perhaps *P. aequitexta*, the two species agreeing in their general appearance, in their autoicous inflorescence and in their lack of subfloral innovations. *P. aemula*, however, is clearly distinct in the very abrupt dilation of its leaf-lobes, in its more sharply denticulate leaves, bracts and bracteoles, in its smaller underleaves with variable margins, and in its nearly beakless perianth. Another close ally is *Lejeunea serrulata* Mont., of Cuba.* This species is still known from the original specimens only, which are destitute of perianths. It is dioicous, and the female branch, although usually simple, sometimes innovates. The species is further remarkable for its distinctly crenulate underleaves, the teeth being found along the inside of the sinus as well as elsewhere. The leaf-margins of *L. serrulata* are very much as in *P. aequitexta.*

Prionolejeunea Helleri sp. nov.

Dull yellowish green, becoming brownish upon drying, loosely and intricately caespitose: stems 0.09 mm. in diameter, prostrate and loosely adherent to the substratum, sparingly branched, the branches obliquely to widely spreading: leaves contiguous or slightly imbricated, the lobe obliquely spreading, plane or somewhat convex, more or less falcate, 0.4 mm. long, 0.35 mm. wide, outer part broadly ovate to orbicular, dilated from a narrow basal region, antical margin straight or slightly incurved near base, then strongly outwardly curved to apex, postical margin also more or less outwardly curved, forming a rather blunt angle, 90° or more, with the keel in well-developed leaves, apex broad but usually abruptly apiculate, whole margin (except close to the antical base)

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* Ramon de la Sagra, Hist. phys. pol. et natur. de Cuba, 9: 479. *pl. 18. f. 3.* 1845.

sharply and irregularly denticulate or serrulate from projecting cells, the teeth along the postical margin a little blunter than elsewhere ; lobule inflated throughout, ovoid, 0.15 mm. long, 0.1 mm. wide, keel strongly arched, free margin straight or nearly so, involute to beyond apex but usually appressed to lobe, sinus lunulate, apical tooth rather sharp and slightly curved ; cells of lobe slightly convex, averaging 15 μ at the margin, 21 μ in the middle and 25 × 21 μ at the base, rather thin-walled, with small but distinct trigones and occasional intermediate thickenings : underleaves distant, broadly orbicular, 0.14 mm. long, 0.15 mm. wide, bifid about two thirds (to within a single cell of the radicelliferous region) with triangular acute lobes separated by a broad acute to lunulate sinus, margin usually with a distinct angular tooth on each side, otherwise entire : inflorescence autoicous : ♀ inflorescence borne on a very short branch without innovation ; bracts widely spreading, the lobe falcate-obovate, 0.5 mm. long, 0.35 mm. wide, apex apiculate or acute, margin as in the leaves but with rather more conspicuous and irregular teeth, lobule oblong to lanceolate, 0.18 mm. long. 0.05 mm. wide, apex blunt to sharp, margin entire ; bracteole free, ovate, 0.35 mm. long, 0.2 mm. wide, bifid one third to one half with erect or connivent, acute to acuminate lobes and a narrow sinus, margin usually entire, sometimes with a single tooth on one or both sides ; perianth triangular in outline with straight or somewhat incurved sides, 0.75 mm. long, 0.65 mm. wide, postical keel low and broad, apex deeply obcordate and with a short beak, lateral keels extended upward as rounded auricles, each developing in the upper part two distinct and deeply laciniate wings, the laciniae one to five cells long and one to four cells wide at the base, surface of perianth smooth or slightly roughened from projecting cells : ♂ inflorescence occupying a short branch ; bracts in one to six pairs, strongly inflated and shortly bifid, the lobe acute and slightly denticulate, the lobule blunt and entire, keel strongly arched, narrowly winged in the outer part, the wing composed of a single row of crenulate cells ; bracteoles in lower part of spike, similar to the underleaves but smaller : mature sporophyte not seen (PLATE 12, FIGURES 1–13).

On roots of tree ferns. North slope of the Luquillo Mountains, *Heller* (*4633*). El Yunque, *Evans* (*148*). *No. 148* may be designated the type.

In the perianth of *P. Helleri* the sides are sometimes nearly straight instead of being strongly incurved as in the figured specimen ; the conspicuous wings, however, seem to be a constant feature although the laciniae vary considerably in length. Perhaps the most striking peculiarities of the species, aside from these wings and the short but distinct beak of the perianth, are the small and deeply bifid underleaves, which are usually unidentate on the sides, and the narrow bracteoles, which are destitute of marginal denticulations.

Among the other Puerto Rico species of *Prionolejeunea*, *P. innovata* and *P. aemula* bear some resemblance to the species just described. In *P. innovata*, however, the underleaves are larger and less deeply bifid, the female branch bears a subfloral innovation, the bracteole is broader and is crenulate or denticulate on the margin, the perianth is less deeply emarginate and the apical beak is obsolete. In *P. aemula* the lobes of the leaves are much more abruptly dilated, the margins are more regularly denticulate, the underleaves have blunter divisions and are usually crenulate on their margins, the bracteole is distinctly denticulate, the beak of the perianth is obsolete, and the wings are less conspicuously toothed.

Prionolejeunea exauriculata sp. nov.

Dull yellowish green, becoming brownish upon drying, growing in depressed and intricate mats: stems 0.09 mm. in diameter, prostrate, sparingly branched, the branches widely spreading: leaves contiguous or loosely imbricated, the lobe obliquely spreading, plane or slightly convex, sometimes reflexed at the apex, somewhat falcate, 0.5 mm. long, 0.4 mm. wide, outer part varying from ovate or obovate to orbicular, dilated from a narrow basal region, antical margin slightly incurved near base, then strongly outwardly curved to apex, postical margin also strongly outwardly curved, forming a sharp angle, 90° or less, with the keel on well-developed leaves, apex broad, usually abruptly apiculate, more rarely acute, obtuse or even rounded, whole margin (except close to antical base) minutely and irregularly crenulate or bluntly denticulate from projecting cells; lobule inflated throughout, ovoid, 0.17 mm. long, 0.1 mm. wide, keel strongly arched, free margin involute to beyond apex, sinus lunulate, apical tooth curved and rather sharp; cells of lobe slightly convex, averaging 16 μ at the margin, 20 μ in the middle and 32 × 20 μ at the base, walls rather thin, with small but distinct trigones and occasional intermediate thickenings: underleaves distant, broadly orbicular, 0.18 mm. long, 0.2 mm. wide, bifid about one half (to within two or three cells of the apical region), with erect, triangular, acute lobes separated by a broad, acute to rounded sinus, margin entire or vaguely crenulate from projecting cells, rarely unidentate on the sides: inflorescence dioicous: ♀ inflorescence borne on a very short branch without innovation; bracts obliquely spreading, the lobe obovate, 0.6 mm. long, 0.45 mm. wide, rounded or apiculate, margin irregularly denticulate, lobule oblong to lanceolate, 0.35 mm. long, 0.1 mm. wide, blunt or pointed, margin entire or slightly crenulate; bracteole free, ovate to oblong, 0.5 mm. long, 0.3 mm. wide, bifid about one half with narrowly triangular, erect and acute lobes separated by a narrow sinus, margin irregularly crenulate as in the leaves, especially in the upper part, rarely unidentate on the sides; perianth oblong in outline from a somewhat narrowed base, 0.9 mm. long, 0.4 mm. wide, somewhat flattened but with rounded lateral keels, apex truncate or rounded, abruptly contracted into a very short beak, surface roughened from convex or rarely conical cells especially along the lateral keels: ♂ inflorescence and mature sporophyte unknown (PLATE 12, FIGURES 14–28).

On shaded rocks. El Yunque, *Evans* (*179*).

The generic position of this distinct little species is not altogether certain. Its leaves and underleaves are clearly those of a *Prionolejeunea*, and in sterile condition there is little to distinguish it from such species as *P. Helleri*, *L. decora* and *L. macrocardia.* In its abbreviated female branch it also shows a clear relationship with this same genus. Its aberrant character is shown in its perianth, which, although somewhat flattened, entirely lacks the conspicuous auricles found in all other known species. It hardly seems advisable, however, to make it the type of a distinct genus on this account alone, and there is certainly no other established genus with which it shows so many points in common as with *Prionolejeunea.*

Aside from its peculiar perianth, *P. exauriculata* differs from the other species found in Puerto Rico in its dioicous inflorescence and in the less prominent crenulations of its leaves and bracts. The lobules, leaf-cells and underleaves offer few additional points of difference. From *P. Helleri* and from *L. decora* it may be further distinguished by its blunter or even rounded leaves, and from *L. macrocardia* by its dioicous inflorescence and by its lack of a subfloral innovation.

In the preparation of this paper the writer has received assistance from Mr. M. B. Slater, Professor W. G. Farlow, Dr. G. Lindau and Herr F. Stephani. In fact, the discussion of the difficult genus *Prionolejeunea* would hardly have been possible had it not been for their kind coöperation.

YALE UNIVERSITY.

Explanation of plates 8-12

As in the previous papers of this series, the figures were drawn by the writer and prepared for publication by Miss Hyatt.

PLATE 8

Odontolejeunea lunulata (Web.) Schiffn. 1. Branch with perianth, postical view, × 19. 2. Part of stem with two underleaves dissected away, postical view, × 14. 3. Cells from middle of lobe, × 265. 4. Cells from antical margin of lobe, × 190. 5. Teeth from inner part of the free margin of lobule, × 190. 6. Tooth from outer part of the free margin, showing also the hyaline papilla, × 190. 7. Teeth from apex of underleaf, × 190. 8, 9. Bracts, × 19. 10. Bracteole, × 19. 11. Tooth from wing of perianth, × 190. 12. Branch with attached propagulum, × 19. 13. Germinating propagulum, × 19. 14. A part of the second underleaf of a germinating propagulum, × 190. 15. Longitudinal section through same, × 190. The figures were all drawn from Jamaican specimens collected by the writer (*319*).

Cyclolejeunea Chitonia (Tayl.) Evans. 16. Branch with two perianths, postical view, × 195. 17. Part of stem, postical view, × 219. 18. Leaf, antical view, × 190. 19. Cells from middle of lobe, × 265. 20. Cells from antical margin of lobe, × 190. 21. Same from another leaf, × 190. 22. Apex of lobule, × 190. 23. Bracts and bracteole, × 19. The figures were all drawn from specimens collected by the writer (*75*, *82*).

PLATE 9

Cyclolejeunea convexistipa (Lehm. & Lindenb.) Evans. 1. Part of stem with two female branches, postical view, × 35. 2. Branch with perianth, postical view, × 35. 3. Two leaves, antical view, × 35. 4. Modified branch, postical view, × 35. 5. Cells from middle of lobe, × 310. 6. Cells from antical margin of lobe, × 220. 7, 8. Apices of normal leaves, × 220. 9. Apex of leaf from modified branch, × 220. 10. Apex of lobule, × 220. 11, 12. Bracts, × 35. 13. Bracteole, × 35. 14. Apical region of mature gemma, showing apical cell, × 220. 15. Germinating gemma, showing the two basal cells, the rhizoids and the young leafy shoot, × 50. 16. Rhizoids of germinating gemma, × 220. The figures were all drawn from specimens collected by the writer (*19*, *162*).

Cyclolejeunea accedens (Gottsche) Evans. 17. Apex of lobule, × 220. 18–20. Developing gemmae, × 220: in fig. 18 the mother-cell has just divided by an oblique wall; in fig. 19 the apical cell is well established and the two basal cells can be clearly distinguished; in fig. 20 the cell-division is practically ended but the apical cell is still distinct. These three figures show the antical aspect of the attached gemmae, and in fig. 20 the two young marginal rhizoids can be indistinctly seen through the cells. 21. Adult gemma seen from below, × 220: the apical cell is no longer to be distinguished, the basal cells show the region of attachment to the stalk-cell and the rhizoids have attained their full development. 22. Germinating gemma, antical view, showing a gemmothallium growing out from one of the basal cells and producing a young leafy shoot at its apical end, × 50. 23. Germinating gemma, postical view, showing a gemmothallium with a leafy shoot growing out from the apical region and a second gemmothallium without a leafy shoot growing out from one of the basal cells, × 50. The figures were all drawn from specimens collected by the writer (*20 p. p*).

PLATE 10

Cyclolejeunea angulistipa (Steph.) Evans. 1. Part of plant with perianth, postical view, × 35. 2. Part of stem, postical view, × 35. 3. Cells from middle of lobe, × 310. 4. Apex of lobe, × 220. 5. Apex of lobule, × 220. 6. Underleaf, × 220. 7. Bract, × 35. 8. Bracteole, × 35. 9. Leaves with gemmae, antical view, × 25. 10–14. Developing gemmae, × 220 : in fig. 10 the mother-cell has not yet been cut off from the stalk-cell ; in fig. 11 this division has taken place and the mother-cell has divided by a longitudinal wall; in fig. 12 the two basal cells and the two apical cells may be seen ; in figs. 13 and 14 a series of segments have been cut off by the apical cells. 15. Part of adult gemma, showing the still active apical cell, the basal depression where the stalk-cell is attached and three marginal rhizoids, × 220. 16. Germinating gemma with a young leafy shoot growing from one of its apical regions, × 50. 17. Proliferating gemma, × 35. The figures were all drawn from specimens collected by A. A. Heller (*4716*, *4738*).

Prionolejeunea innovata Evans. 18. Branch with perianth and antheridial spike, postical view, × 35. 19. Part of stem, postical view, × 35. 20. Leaf, antical view, × 35. 21. Cells from middle of lobe, × 310. 22. Cells from antical margin of lobe, × 220. 23. Apex of lobe, × 220. 24. Apex of lobule, × 220. 25. Part of underleaf, × 220. 26. Bract, × 50. 27. Bracteole, × 50. The figures were all drawn from the type-specimens.

PLATE 11

Prionolejeunea aequitexta Evans. 1. Part of plant with perianth, postical view. × 35. 2. Leaf, antical view, × 35. 3. Cells from middle of lobe, × 310. 4, Cells from antical margin of lobe, × 220. 5–7. Apices of lobes, × 220. 8. Apex of lobule, × 220. 9. Basal part of underleaf, × 220. 10–12. Apices of underleaf-divisions, × 220. 13, 14. Bracts, × 35. 15, 16. Bracteoles, × 35. 17. Cross-section of perianth, × 35. The figures were all drawn from the type-specimens.

Prionolejeunea aemula (Gottsche) Evans. 18. Part of plant with perianth and unfertilized female inflorescence, postical view, × 35. 19. Two leaves, antical view, × 35. 20. Cells from middle of lobe, × 310. 21. Cells from antical margin of lobe, × 220. 22. Apex of lobe, × 220. 23. Apex of lobule, × 220. 24. Part of underleaf, × 220. 25. Lateral tooth of underleaf, × 220. 26, 27. Bracts, × 35. 28. Bracteole, × 35. The figures were all drawn from specimens collected by the writer (*103 p. p.*).

PLATE 12

Prionolejeunea Helleri Evans. 1. Part of plant with perianth and male inflorescence, postical view, × 35. 2. Part of stem, postical view, × 35. 3. Leaf, antical view, × 35. 4. Cells from middle of lobe, × 310. 5. Cells from antical margin of lobe, × 220. 6. Apex of lobe, × 220. 7. Apex of lobule, × 220. 8. Underleaf, × 220. 9–11. Bracts, × 50. 12, 13. Bracteoles, × 50. The figures were all drawn from the type-specimens.

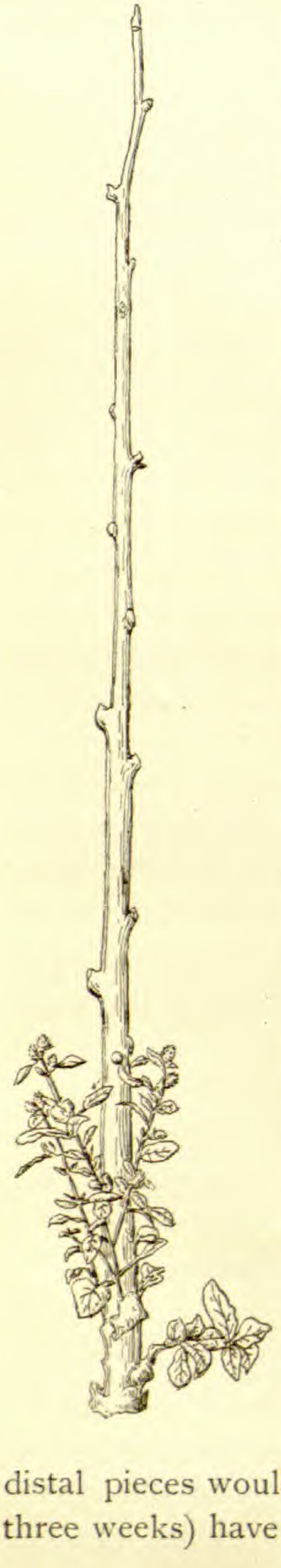
Prionolejeunea exauriculata Evans. 14. Part of plant with perianth, postical view, × 35. 15. Leaf, antical view, × 35. 16. Cells from middle of lobe, × 310. 17. Cells from antical margin of lobe, × 220. 18, 19. Apices of lobes, × 220. 20. Apex of lobule, × 220. 21. Part of underleaf, × 220. 22. Apex of underleaf-division, × 220. 23–25. Bracts, × 35. 26, 27. Bracteoles, × 35. 28. Cross-section of perianth, × 35. The figures were all drawn from the type-specimens.

Polarity and regeneration in plants

T. H. Morgan

The earlier and greater development of the buds that stand at the distal end of a piece of a willow than of those that stand nearer to the base of the piece bears a certain general resemblance to the phenomenon of polarity in animals, and has led, in fact, to the use of the same word for both processes. This comparison needs, I think, to be more critically examined. During the past summer I have kept pieces of several plants, from which the leaves were removed, in a moist chamber with the lower end of the pieces in water, and have watched the development of the buds. In most cases, as in the willow, the more distal, *though not necessarily the most distal*, buds are the first to develop, and it could be easily seen that those that unfolded first were, as a rule, the largest and most advanced buds present on the piece when it was removed from the plant. In other words, the relative strength of the buds determines which develop first, and it seems most plausible that in consequence of this development the other buds might be kept from unfolding because those that got the start used up all the available food substances that were present, or were being manufactured in the piece. It appears, therefore, that the result is not so much the outcome of the polarity of the piece, acting at the time of regeneration, as of preexisting conditions in the piece at the time of its removal from the plant. These determine which buds shall be the first to unfold. Whether or not this difference in the condition of the buds of the original piece has itself been regulated by polar relations in the growing point is a question for further consideration, but in any case it is one that does not involve the immediate question of the regeneration of the isolated piece.

In one of the plants that I examined, the proximal and not the distal buds of the piece were the first to develop. It is this case that I wish more especially to discuss in connection with the problem of polarity in plants. The plant was the common burdock, *Arctium Lappa* (*Lappa officinalis*). The leaves and the lateral branches were cut off from half a dozen vigorous plants, and the denuded stalk was left standing in place in connection with its original roots. In the course of about ten days new buds began to grow out near the base of the stalk. They unfolded rapidly and at the end of about two weeks had reached the condition shown in the figure. The new shoots arose in or near the angles between the main stem and the lateral branches (which had been cut off). These branches stand in the axils of the lower leaves. No shoots at all appeared in the upper regions of the stem, although the latter remained green and in good condition. It may appear that the results in this case are connected with the attachment of the stem to the old roots. The fact that large branches arise near the base of the main stem may be interpreted to mean that these parts receive a large share of the substances that come up from the roots. In order to see if this suggestion had any value I cut off other stems from their roots, stripped them of their leaves and branches, and placed the lower ends in dishes of water. In these cases also the lower buds alone unfolded and none appeared in the upper parts of the stem.



To determine whether the result is due to the better development of the buds at the base rather than due to the movement towards the base of food or of so-called formative substances, I cut a few of the stems into three pieces. In those in which any development took place this occurred in the basal pieces, and in one case in the lower part of the second piece as well, but no buds developed in the distal pieces, although to all appearances these remained in good condition. Whether these distal pieces would after a much longer time (I kept them nearly three weeks) have developed buds, I do not know.

This last experiment, while not satisfactory in all respects, yet suffices to show that the development of the basal buds in the long pieces is not due to the polarity localizing, as it were, the development at the base, nor to the flow of substances downward, but is due to the stronger buds being present in the basal region.

These results recall the cases of *Lilium candidum* and *Lachenalia luteola*. These plants do not set seed, but produce bulblets at the base. This formation of basal bulblets is attributed by Goebel to the flow of food substances in the plants towards the base which causes the bulblets to develop in this region, and at the same time deprives the seeds of the necessary material for their development. The explanation appears to me to be exactly the reverse. The buds that give rise to the bulblets in these plants are so vigorous that they utilize all of the food substances that are present, and thus deprive the seeds of food material that they might possibly make use of if the bulbs did not develop. It is not, I think, the flow of food substances downwards that causes the bulblets at the base to develop, but the vigorous bulblets in this region draw into themselves so much of the available food substances that not enough is left for the seeds.

It might be claimed in the case of the burdock, that when the stalk, deprived of its leaves, is left attached to the old roots, material from the roots rising up into the stem will affect the basal buds first; or it might be claimed that since there are large fibrovascular bundles that go to the basal nodes these bring to this region materials from the roots that cause the buds to develop, but that this is not the real explanation was shown above by the experiment of removing the stem from the roots. The result appears to be due rather to the more vigorous condition of the basal buds. Whether, as I have said, this condition of the plant is itself to be thought of as ultimately the outcome of its polarity, is a question that I do not think we can profitably discuss as yet. If it is, then the polarity in the growing point has already acted and determined the relative development of the buds in the different regions. When the piece containing these buds is removed, their further development is first determined by the stage that they are already in, or by their greater vigor, which may, in most cases, mean the same thing. In the second place certain buds having gotten a start use up all or most of the available food materials and thus check the further development of the other buds.

In the light of these facts and conclusions certain of the statements that I made in my book on "Regeneration" in regard to the cause of the development of the apical buds in a piece of the willow must be recast. The development of the apical buds of the willow, and of other similar plants, and of the basal buds in the burdock appear both to be due, not to a dynamic relation (polarity) between the two ends of the piece, but to a static condition already existing in the piece before its removal, namely, the relative state of development of its buds.

From this point of view Sachs' theory of formative stuffs plays no directive part in the regeneration of pieces of the plants. The presence of food stuffs enters into the problem only in so far as certain parts are supposed to be able to draw on that which is present, while other parts (the less developed buds) are not so able to make use of the common supply. The flow of these food stuffs through the plant appears from this point of view not to be due to the stuffs tending to flow of themselves in certain directions, or as the result of the action of some outside agent, as gravity, but their flow may be simply a question of diffusion from those places where they exist in larger amounts to other places where there is not so much of the substance present. If the more vigorous and somewhat older parts can make use of this material more rapidly than can the less well-developed parts, there will be a steady flow of soluble food substances towards the growing parts, because in these regions the material is being more rapidly used up, and hence the region is relatively poorer in these materials. The flow is then a purely physical problem. This assumption is, of course, not different from that usually employed by botanists to account for the flow of soluble substances from one part of a plant to other parts.

It appears, therefore, that polarity in the plant is not the cause of the flow of substances through the plant, as Goebel seems to imply in certain parts of a recent article,* nor does polarity appear to regulate the development of certain buds and hold others in check.† Possibly some such factor may determine in the growing regions of the plant the relative rate of development of certain buds, but even this is not certain and remains to be further examined.

BRYN MAWR COLLEGE.

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* Goebel. Bull. Torrey Club, 30: 197–205. 1903. Also Biolog. Centralbl. 22: 385–397, 417–438, 481–505. 1902.

† Morgan. Bull. Torrey Club, 30: 206–213. 1903.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1904)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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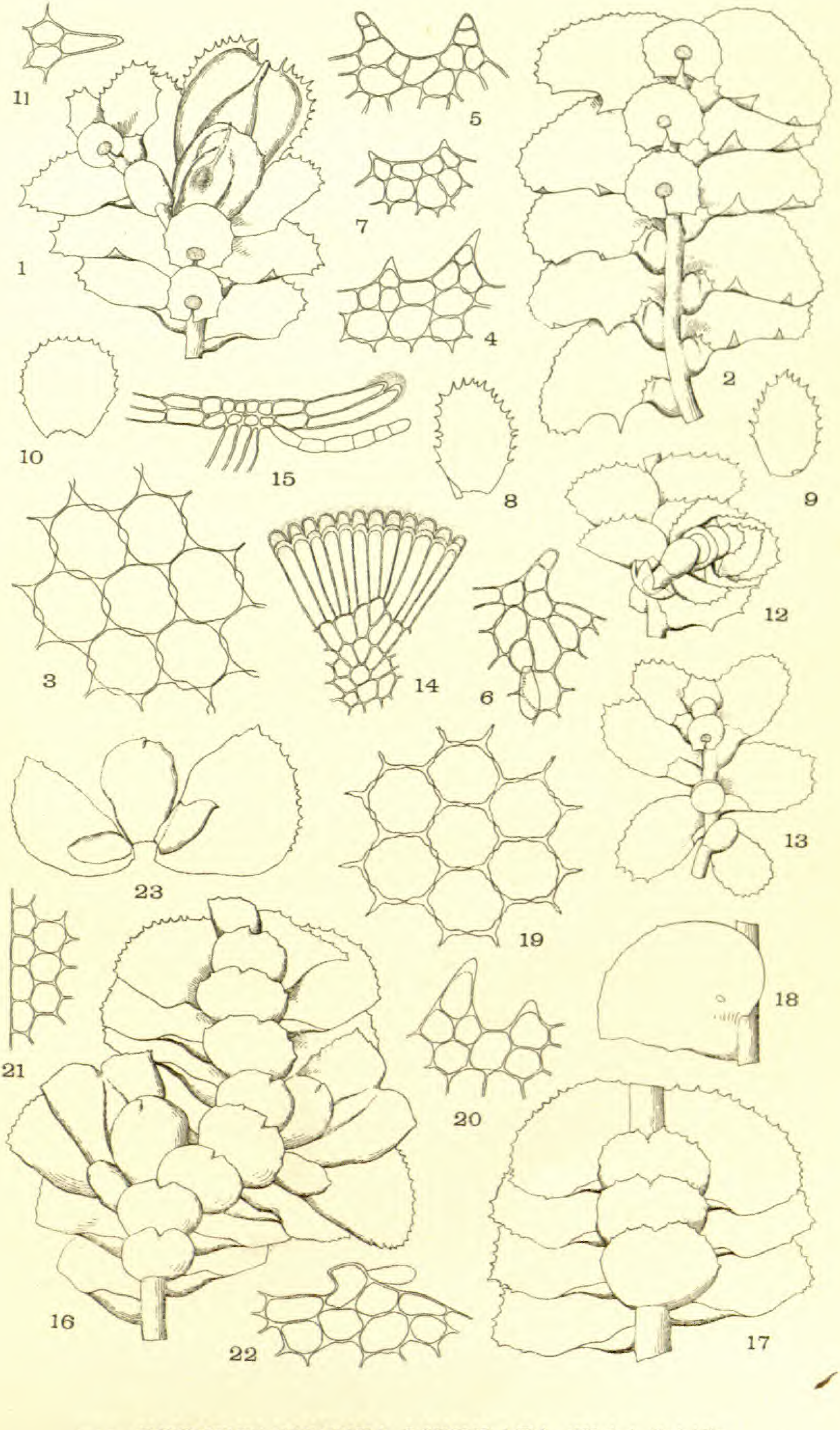

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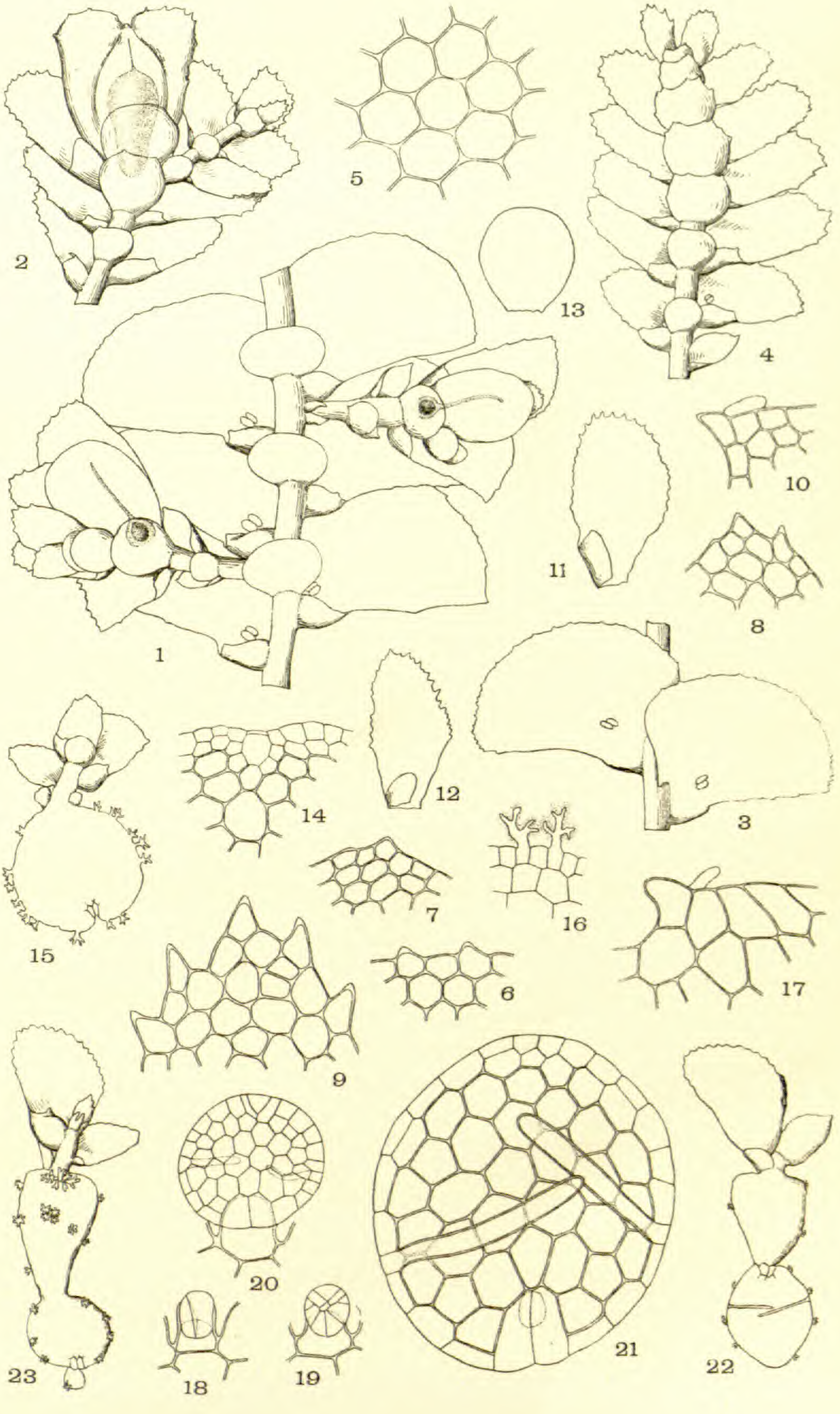

1-16. CYCLOLEJEUNEA CONVEXISTIPA (Lehm. & Lindenb.) Evans.
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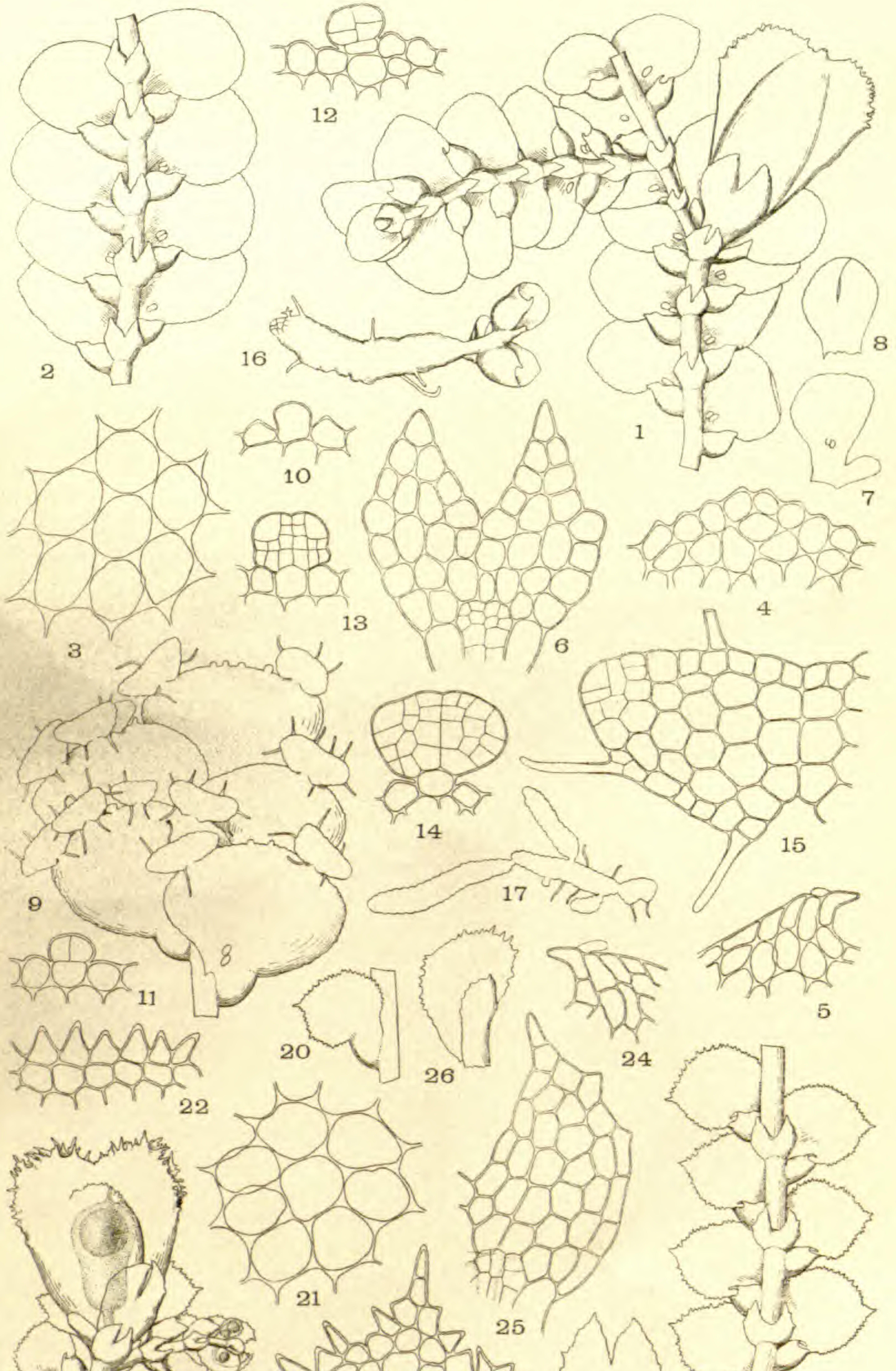

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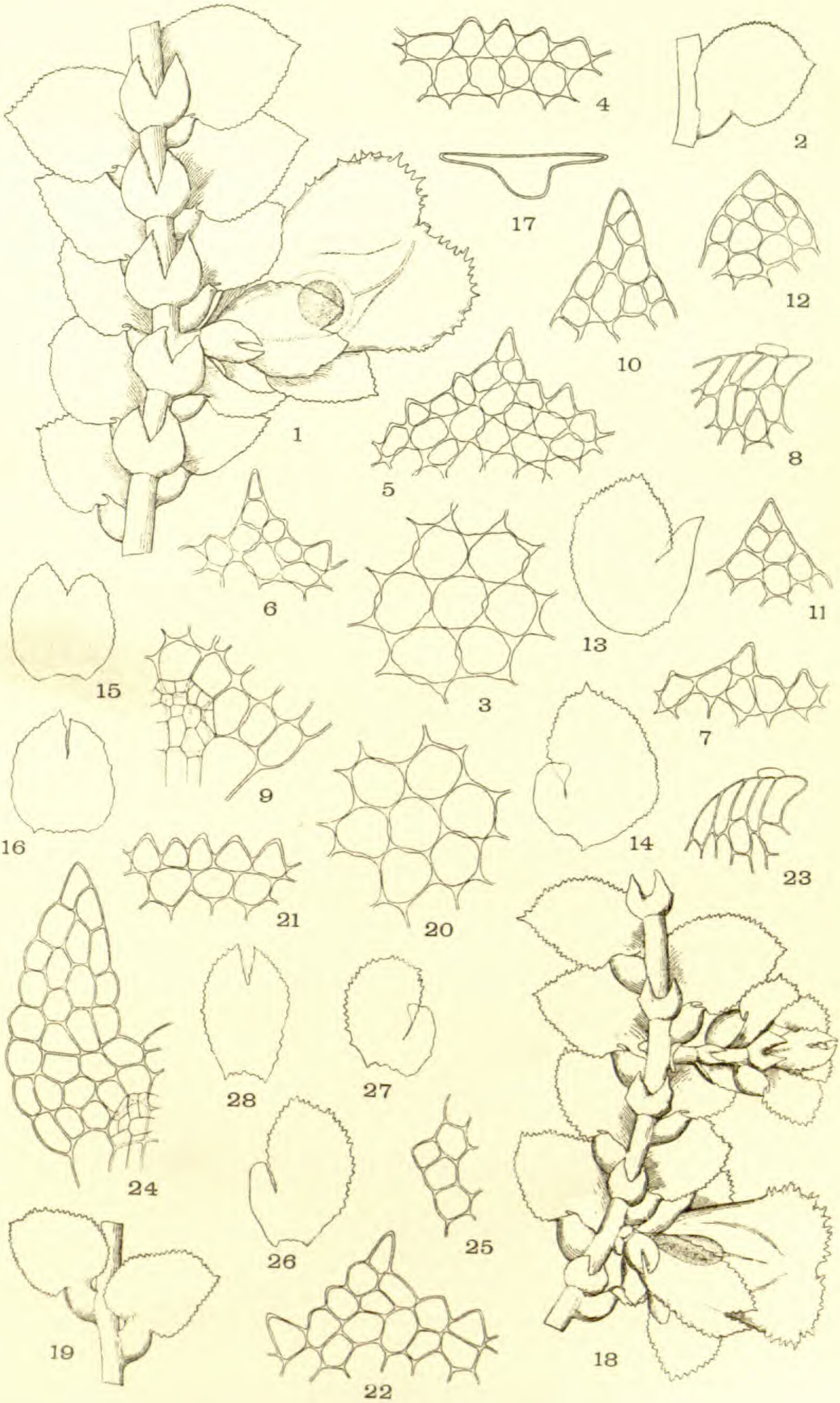

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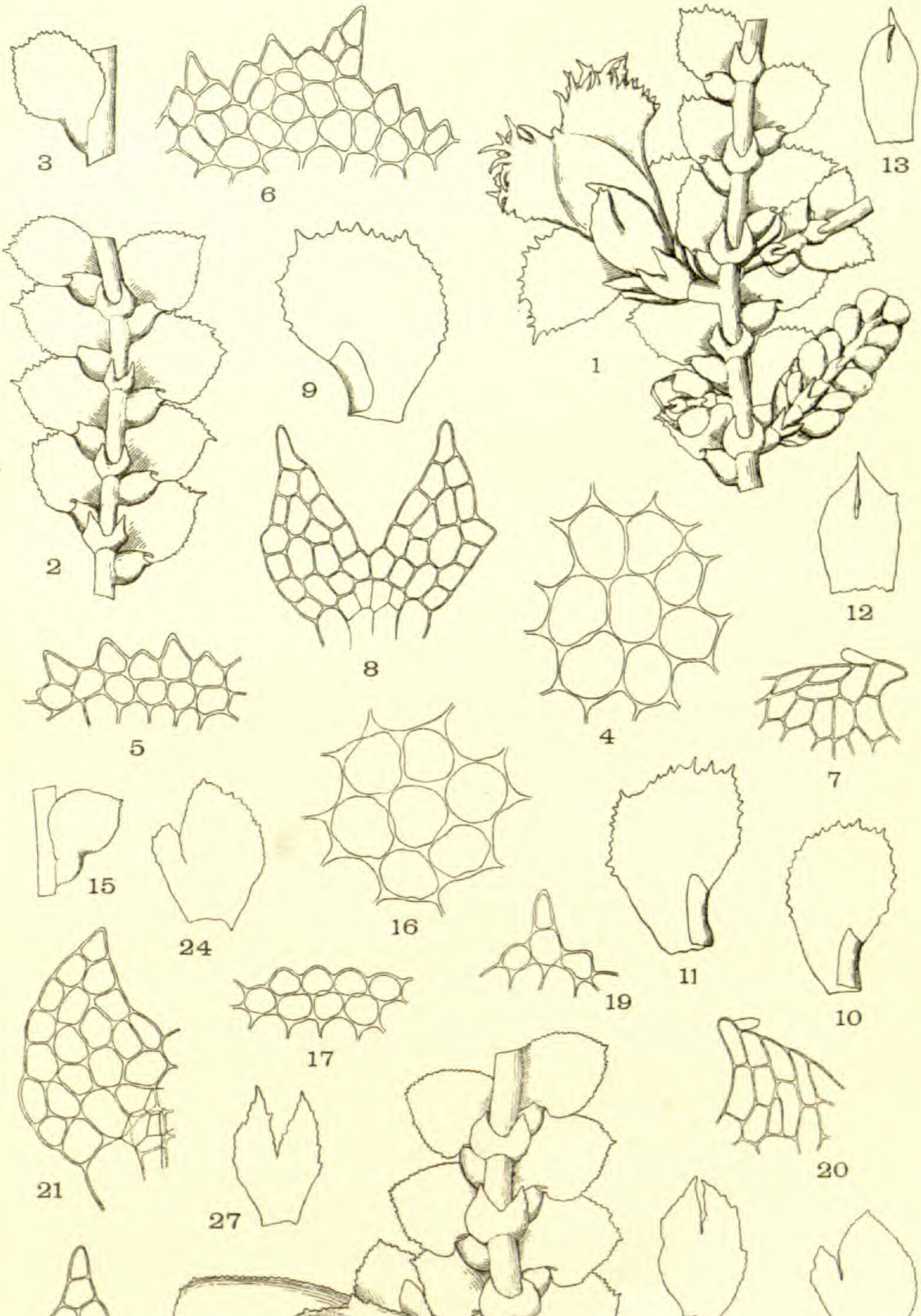

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

MAY, 1904

New plants from Wyoming, XV

AVEN NELSON

Eriogonum vegetius (T. & G.)

Perennial, the root woody, ragged, more or less branched at the summit and clothed by the dead leaf-bases : stems scapose, at first white-tomentose, becoming denuded and green, 1–3 dm. high, moderately stout : leaves basal, from nearly oval to spatulate or narrowly lance-oblong, 2–5 cm. long, white-tomentose, tending to become green and glabrate above ; the petioles short or sometimes as long as the blade : inflorescence highly characteristic as follows : — a single large sessile (or short-peduncled) involucre at the summit of the scape, from the base of which arise a pair of peduncles (very variable in length), at the summit of which is another involucre and another pair of proliferating peduncles, — such proliferation sometimes occurring a third or even a fourth time with constantly shortening rays : floral bracts large and quite similar to the lower leaves : involucres several- to many-flowered : perianths yellow, more or less silky-villous, on rather long but variable pedicels ; the inner segments distinctly longer than the outer, all spatulate or obovate : akene angled by a firm narrow wing-like margin.

This is the *E. Jamesii flavescens* of Watson's Revision (Proc. Am. Acad. **12** : 255) and *E. flavum vegetius* T. & G. Proc. Am. Acad. **8** : 156.

So far as I am aware no one has heretofore taken up the earlier name of this plant, which is most characteristically distinct, though allied to *E. Jamesii* as placed by Watson rather than to *E. flavum*. Since previously very briefly described, a fuller characterization

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[The preceding number of the BULLETIN, Vol. 31, No. 4, for April, 1904 (31 : 177–238, *pl. 8–12*) was issued 28 Ap 1904.]

may be of service. It occurs from southern Wyoming to New Mexico and specimens of it are not rare. Excellent ones were secured at Sherman, Wyoming, in August, 1901, *no. 8574*.

Eriogonum salinum sp. nov.

Perennial, from a low freely-branched woody base or caudex, with dry shreddy bark: herbaceous stems simple, erect, leafy, 1–2 dm. long, terminating in a short naked peduncle: leaves narrowly lanceolate, rather crowded, mostly erect, subsucculent, white with a fine closely-felted tomentum below (as are also the stems, and inflorescence), short-petioled, glabrous above but very pale, 2–3 cm. long: inflorescence a short broad-topped crowded irregular cyme (not more than 8 cm. high and usually much less), the branching mostly trichotomous but often with some smaller accessory rays; the lower bracts 1 cm. long or less, linear, the others greatly reduced: involucres narrowly turbinate, subsessile, several-flowered, their teeth seemingly obtuse but when divested of their tomentum sharply acute: perianth small, white, its segments obtuse, often apiculate; the outer oblong-elliptic; the inner longer than the outer, obovate: stamens and style-branches included; ovary glabrous.

Allied to *E. microthecum* Nutt., and to *E. effusum* Nutt., but quite distinct from either. The season's branches are simple and permanently leafy. The tomentum is of a different character from that of the allied species and the leaves on the upper surface have in the dried state a somewhat glistening or unctuous appearance. The short inflorescence, forming so small a part of the whole height of the plant, is in sharp contrast to the ample inflorescence of its allies. In this respect it suggests *E. Jonesii* Watson.

This species is an inhabitant of strongly saline soils, as its appearance would suggest. The type was secured on Salt Wells Creek, Sweetwater Co., July 17, 1897, and is *no. 3753*. It was distributed as *E. effusum* Nutt.

Chenopodium aridum nom. nov.

Chenopodium Wolfii Rydb. Bull. Torrey Club, **30**: 248; not *C. Wolfii* Simk. Flora Austro-Hungarica, a species founded upon specimens by G. & J. Wolff, from Transylvania; nor *C. Wolffii* Simk. Termész. Füzetek, **3**: 164. 1879.

Physaria didymocarpa lanata var. nov.

Habit and size of the species; basal leaves more inclined to be irregularly toothed, but the variety mainly distinguished by its copious pubescence as follows: white throughout with long-branched stellate hairs and a more copious simpler pubescence, giving the plant a tomentose appearance especially upon the bases of the crowded crown-leaves and to a lesser degree in the inflorescence: the fruits large, thin and papery.

Collected by L. N. Goodding in the Big Horn Mountains, on steep slopes at the head of the middle fork of Powder river, July 19, 1901, *no. 326.*

Linum compactum sp. nov.

Apparently perennial, from slender rhizomes having somewhat enlarged crowns at the surface of the ground: murky-green, with a scabrous puberulence throughout, seemingly also subglutinous: stems crowded on the crowns, short (about 1 dm. long), each freely short-branched, thus forming plants of subspherical aspect, striate but not all wing-angled: leaves very numerous especially below, divaricate or the lower widely spreading, linear, scarcely exceeding 1 cm. in length, mucronate, the midnerve obscure, the margins slightly cartilaginous-thickened, often with a few minute stipitate glands on the margin near the base; no stipular glands; flowers numerous, on terete or sometimes wing-angled pedicels scarcely longer than the sepals: sepals lanceolate, obscurely 1–3 nerved, short-cuspidate, glandular-ciliate on the scarious margin, 5–6 mm. long, hardly surpassing the mature fruit: petals yellow, wholly glabrous, less than 1 cm. long: filaments linear, not enlarged at base; anthers oval, large, attached near the base: styles free for one third of their length: capsule ovoid, obtuse, about 4 mm. long.

This species is allied to *L. puberulum* (Engelm.) Heller and to *L. Arkansanum* G. E. Osterh. The former differs from this species in its glaucous hue, and in having stipular glands, filaments triangular-ovate at base, and styles united to the summit. The latter differs in having longer leaves, sepals twice as long, and styles united to the summit. Both differ from the species now described in habit, being corymbosely branched from the base up, and in having much larger orange-colored flowers, the petals of which are pubescent at base. The type is *no. 8291*, secured on the North Platte River near the eastern border of Wyoming, Torrington, June 28, 1901, when it was in full fruit almost past blossoming.

Anogra violacea sp. nov.*

Biennial or possibly more enduring, from a vertical, semi-woody taproot: stems several to many, erect with a decumbent base, 2–3 dm. high, violet or purplish throughout (or at least broadly splotched), appearing smooth but puberulent under a lens: crown-leaves rather small, linear-oblanceolate, entire or toothed, few if any of them surviving the first season: stem-leaves puberulent, dark green, numerous, 4–8 cm. long, linear-oblong or narrowly oblanceolate, coarsely sinuate dentate and some of them deeply pinnatifid, the lobes acute, triangular to oblong: flowers axillary, congested at the summit of the stems: buds drooping, oblong or slightly enlarged towards the obtusish tip, pubescent with flat crinkled hairs which are densest at the apex: calyx-lobes a little more than half as long as the tube, tips free: petals triangular-obcordate, sinus broad and shallow, 1–20 mm. long, scarcely longer than the calyx-lobes, white, drying pink: young capsule largest near the base, tapering gradually to a slender apex, subangulate, sinuate-tubercled on the margins, sparsely hispid-ciliate, about as long as the calyx-lobes.

This species probably finds its nearest ally in *A. albicaulis* (Pursh) Britt., from which its numerous, erect, violet stems, its glabrous aspect, its smaller flowers and its divaricate capsule easily separate it.

It occurs in the greatest profusion in sandy draws in south-central Wyoming. Type specimen *no. 3075*, Point of Rocks, June 1, 1897.

Pachylophus glabra sp. nov.

Acaulescent and completely glabrous throughout: perennial (possibly short-lived), from a thick deep-set semi-fleshy root which is caespitosely branched at summit; the enlarged crowns rough with the old dead petioles: leaves crowded on the crowns, nearly linear, 7–12 cm. long, remotely and irregularly toothed on the margins, tapering to both ends, acute at apex, at base passing gradually into the slender petiole which is about half as long as the blade: flowers not equalling the leaves; the calyx-tube slender, only slightly enlarged at the throat, 1 dm. or less long; calyx-lobes about 2 cm. long: petals somewhat inequilateral, broad, deeply cleft-cordate, about 2 cm. long, white, turning pink in fading: the versatile anthers and the filaments subequal, about

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* The description of this species was prepared some years since but was withheld from publication. Dr. Rydberg now kindly writes me that he has received it in good fruit. "The fruit is narrowly linear-cylindric, standing out at right angles to the stem and therefore in (sharp) contrast to *A. albicaulis*."

12 mm. long: the stigmas surpassing the petals when the latter are closed: fruits small, 12–15 mm., strictly basal, not tubercled and but slightly angled.

If one accepts the current descriptions of *P. caespitosa* (Nutt.) Raimann as really applying to the *Oenothera caespitosa* of Nuttall, there can then be no doubt about the validity of the species now described. In Nuttall's Genera he uses the word "smooth" of the leaves and "cespitose" of the crowns which is just the case in the now proposed *P. glabra*. But he also speaks of the large size of the flowers and the tuberculate capsule which are characters of the pubescent plant we have so long recognized as Nuttall's. Whatever, then, Nuttall's plant may prove to be, the present one seems distinct and is readily known by its wholly glabrous condition, narrow leaves which surpass the much smaller flower, and the capsule which is not tubercled but which has four rounded veins.

The type specimens were collected on the Platte River bottoms, near Badger, Wyoming (Laramie County), June 1, 1901, *no. 8340.*

Lavauxia flava sp. nov.

Stemless, perennial (probably short-lived) from somewhat fleshy roots, nearly glabrous, only a little pubescence on the margins of the leaves: leaves crowded on the crown, oblong-lanceolate in outline, gradually narrowed to the margined base, deeply and irregularly runcinate-pinnatifid, 15–25 cm. long (including petiole): flowers much shorter than the leaves; calyx-tube 4–7 cm. long, its lobes about 2 cm. long: petals yellow, invariably turning pink with age and in drying, obovate, attached by a broad base, entire and broadly rounded at summit: stamens shorter than the petals, the filaments rather broad, the anthers attached about one third of their length from the base: capsule oblong, narrowly wing-angled, 2–3 cm. long, one third as broad: seeds numerous, cuneate-obovate, slightly concave with a carinate ridge on the ventral side, and with a narrow crest-like margin around the obtuse summit.

At least some of the plants from the Rocky Mountains which have passed as *Lavauxia triloba* (Nutt.) Spach are distinct from that species, whether we consider the Nuttallian plant from the Red river country (Arkansas) or that one in literature which is said to have white flowers. Nuttall's plant was described as having large membranaceous leaves, somewhat trilobed petals (hence the name), and ovoid capsules with broad reticulated wings. None of these characters apply to *L. flava*. It has a capsule both relatively and actually longer than that of the other, with narrow wings and not very evident reticulation. In the seeds we find further evidence of the distinctness of the two since *L. flava* does not possess the tubercle on the inner upper face nor the broad tooth at the apex.

Dr. Watson seems to be the only one who has called attention to the yellow flowers of this western form, which he has done in two instances, viz., Bot. King's Rep. 107, and Fl. Calif. **1** : 224; and in both cases he was, of course, dealing with the western plants.

I do not venture to say that all the plants of the west that have heretofore been called *L. triloba* belong to *L. flava*. That can only be determined by finding whether they have the characters of the latter. Hence I name a type, my *no. 219*, Laramie, June, 1894, and as illustrative of it all of my numbers, distributed from time to time, under the name *Lavauxia* (*Oenothera*) *triloba*.

Gentiana monantha sp. nov.

An alpine annual, mostly much less than 1 dm. high: stem simple or with one or two branchlets from the base, very short, of few internodes, only 1–3 cm. high, terminated by a slender naked one-flowered peduncle very much longer than the stem; the accessory branchlets (if any) tardily developed and with a shorter peduncle: leaves oblong to spatulate, 5–10 mm. long: calyx one fourth shorter than the corolla and somewhat exceeding its tube; sepals 4, equal, oblong-lanceolate, subacute, distinct nearly to the base: corolla about 12 mm. long, its tube twice as long as the 4 lance-ovate subacute lobes; the fimbriae of the crown rather coarse and short: stamens shorter than the corolla-tube.

This is *G. tenella*, in so far as the plant of the southern Rocky Mountains is concerned. Seemingly very rare and probably not well represented in the herbaria. Most of what has been distributed as *G. tenella*, in so far as my own specimens are concerned, belongs to other species (*G. acuta*, *G. heterosepala*, etc.). The true *G. tenella* Rottb. is an arctic plant with 5-merous flowers, the obtuse corolla-lobes as long as its tube; the calyx only half as long as the corolla and with unequal sepals.

The best example I have seen of *G. monantha* is Dr. Clements' *no. 456*, Mirror Lake (altitude 3500 m.), Colorado, Sept. 6, 1901; I name this as the type.

Chondrophylla gen. nov.

Small biennials (?) from a few cm. to 1 dm. high, the stems single or several from the slender root. Leaves numerous, small, opposite, seemingly imbricated below because of the short internodes, the margins white and scarious or cartilaginous. Flowers solitary and terminal. Calyx narrow, 4- or 5-toothed. Corolla salver-form when expanded, plicate at the sinuses with broad emarginate lobes or plates, without crown or glands. Anthers cordate, versatile. Seeds oblong, with a close coat.

The two species following, which have long stood as a section of *Gentiana*, are so completely out of harmony with the other sections of that genus that it would certainly tend toward simplicity to elevate the section to generic rank. In doing so I have used the sectional name of Bunge and Grisebach. The minute cartilage-margined leaves, the solitary terminal flowers, the versatile anthers are generic characters separating these plants from *Gentiana*.

Chondrophylla Fremontii (Torr.)

Gentiana humilis of Gray, Syn. Fl. **2**^{1}: 120; Engelm. Trans. Acad. St. Louis, **2**: 217, *pl. 9; G. Fremontii* Torr. in Frém. Rep. 94; probably *G. humilis* Stev. Act. Mosq. **3**: 258. 1812; Griseb. Gent. 251: not *G. humilis* Salisb. Prodr. 137. 1796.

Since the specific name so long in use is not available, I take up Torrey's name.

Chondrophylla Americana (Engelm.)

Gentiana prostrata Americana Engelm. Trans. Acad. St. Louis, **2**: 217, *pl. 9*, 1862; probably not *Gentiana prostrata* Haenke; Jacq. Coll. **2**: 66, nor of later authors.

The Rocky Mountain plant seems to be distinguishable from the arctic and European forms, so Engelmann's name is adopted.

Hedeoma ovata sp. nov.

Perennial, the slender branches of the caudex widely divaricate from the summit of the taproot; stems slender, branched, 12–20 cm. high, puberulent with recurved hairs: leaves entire, oval, from broadly to narrowly so, 7–15 mm. long, glabrous above, nearly so below, crowded and more bract-like upward: flowers small, cymulose in the axils, short-pedicelled and bracteolate: calyx about 5 mm. long, its lower teeth surpassing the upper, somewhat hispid-pubescent on the tube and teeth: corolla inconspicuous, barely surpassing the longer calyx-teeth, the upper lip 2-lobed; staminodia wanting.

Not closely allied to any of the northern species. The type number, collected by the writer, on Pole Creek, June 30, 1895, was distributed as *H. Reverchoni*, to which it may be most nearly allied.

Castilleja pilifera sp. nov.

Perennial, more or less finely pilose throughout; stems several from the crown of a caudex, slender and erect from a somewhat decumbent base, 15–25 cm. high: leaves numerous, flaccid, nearly linear, entire or with one or more linear divergent lobes, 3–6 cm. long: calyx a little shorter than the bracts, equally cleft above and below to the middle; the lobes linear and rarely more than bidentate at apex: corolla about 2 cm. long (shorter than the calyx), tubular; the lip as long as the galea and about one fourth as long as the tube, its linear teeth as long as the obscurely saccate base.

It is strongly to be suspected that most if not all the plants of the Rocky Mountains that have heretofore been called *C. pilosa* (*Orthocarpus pilosus*) are not that species at all. That species was founded on very limited material, but the original description by Watson, in Bot. King's Rep., 231, calls attention to the calyx, "cleft nearly to the base anteriorly, 4-lobed to the middle and shorter than the corolla." The description in Flora of California may cover this species alone, but that of Gray, Syn. Fl., undoubtedly is more inclusive though too brief to indicate that fact clearly. *C. pilosa* probably belongs in the Sierra Nevada and northwestward.

The type of *C. pilifera* is *no. 5878*, A. & E. Nelson, Soda Butte, Yellowstone Park, July 15, 1899. It was distributed as *C. pilosa.*

Symphoricarpos Tetonensis sp. nov.

Wholly glabrous; branches dark brown, with smooth bark (not shreddy); the young twigs light brown; leaves green, somewhat lighter beneath and subglaucous, narrowly elliptic and tapering somewhat cuneately from the middle to the acute ends, 3–4 cm. long, entire or with a few irregular acute teeth, the veins conspicuous and the margin slightly thickened-revolute; petioles slender, 4–6 mm. long, dilated and somewhat connate at base: flowers in the upper axils, mostly twin, drooping, on short pedicels: calyx minute, less than 2 mm. long, acetabuliform, its lobes about as long as the shallow cup: ovary oblong, 3–4 mm. long, about twice as long as the lanceolate bracts at its base, which in turn are about as long as the pedicels — all of these structures purplish-blue as if with bloom: corolla ochroleucous tinged with pink, gradually dilated-tubular, less than 1 cm. long, its rounded lobes half as long as the tube, nearly glabrous within, only a few inconspicuous hairs near the middle of the tube, glandular from the hairs down: filaments shorter than the anthers; style glabrous, half as long as the corolla; fruit not known.

This is a member of the *S. oreophilus* group, which now contains several species. Among them, however, there is no species so wholly glabrous, nor with leaves like those of the species now proposed. The floral characters, while characteristic, are less noticeable.

The type is *no. 1025*, by Merrill and Wilcox, Teton Mountains, Wyoming, July 26, 1901. Paratypes (probably) in the National and in the New York Botanical Garden herbaria.

UNIVERSITY OF WYOMING.

CODE OF BOTANICAL NOMENCLATURE

A Nomenclature Commission was appointed by the Botanical Club of the American Association for the Advancement of Science at a meeting held in Washington, D. C., January 2, 1903. At this meeting a series of rules for nomenclature was presented and referred to the Commission, which has carefully considered all the principles involved, and has tested the application of the principles to all kinds of cases. The Commission has found that, for purposes of more exact statement, and to reach more satisfactory results, some rearrangement and modification of the rules as proposed at this Washington meeting are advisable. The principles have been carefully compared with those advanced in the Laws for Nomenclature adopted at the Paris Botanical Congress in 1867, and at the Botanical Congress held in Genoa in 1892, together with propositions advanced by various groups of botanists, and by individuals, during the past few years, and the methods pursued by zoologists have also been studied; all with the plan of obtaining a code of nomenclature which will best satisfy all interests involved. The action of the International Botanical Congress, held in Paris in 1900, by which the subject of nomenclature is to be brought before the International Congress to be held at Vienna in 1905, has been considered, and the decision there reached to base a new set of rules upon those adopted by the Paris Congress of 1867 has had our careful attention. This action contemplates the modification of the Paris Laws of 1867 by amendment, abandonment, or substitution of its various articles. We have found, however, that the Paris Laws of 1867 are not satisfactorily adaptable to precisely this consideration, for the reasons that their arrangement is not philosophical in the light of modern experience and knowledge, that many important principles are either not recognized, or else given altogether too meager consideration, and that there is a want of definite and exact statement, which leads to ambiguity. We therefore recommend, and propose also to move in the Vienna Congress of 1905, that, in accordance with the provisions of the committee on organization of the Congress of 1905, the code of laws of 1867 be amended by the abandonment of all its articles and the substitution of the appended code.

J. C. ARTHUR, *Professor of Plant Physiology and Pathology, Purdue University.*

JOHN HENDLEY BARNHART, *Editor, Torrey Botanical Club.*

N. L. BRITTON, *Director-in-Chief, New York Botanical Garden.*

STEWARDSON BROWN, *Conservator, Botanical Section, Academy of Natural Sciences of Philadelphia.*

FREDERIC E. CLEMENTS, *Assistant Professor of Botany, State University of Nebraska.*

O. F. COOK, *Botanist in charge of Investigations in Tropical Agriculture, United States Department of Agriculture; Assistant Curator (Cryptogamia), United States National Herbarium.*

JOHN M. COULTER, *Professor of Botany, University of Chicago; Editor, Botanical Gazette.*

FREDERICK V. COVILLE, *Chief Botanist, United States Department of Agriculture; Curator, United States National Herbarium.*

F. S. EARLE, *Director, Estación Agronómica Central de Cuba.*

ALEXANDER W. EVANS, *AssistantProfessor of Botany, Yale University.*

TRACY E. HAZEN, *Tutor in Botany, Barnard College, Columbia University.*

ARTHUR HOLLICK, *Assistant Curator (Palaeobotany), New York Botanical Garden.*

MARSHALL A. HOWE, *Assistant Curator (Algae), New York Botanical Garden; Editor, Torreya.*

F. H. KNOWLTON, *United States Geological Survey; Custodian (Mesozoic Plants), United States National Museum.*

GEORGE T. MOORE, *Physiologist, in charge of Laboratory of Plant Physiology, United States Department of Agriculture; Custodian (Algae), United States National Herbarium.*

E. L. MORRIS, *Head of the Department of Biology, Washington (D. C.) High Schools.*

WILLIAM ALPHONSO MURRILL, *New York Botanical Garden.*

H. H. RUSBY, *Professor of Physiology, Botany and Materia Medica, and Dean of the Faculty, College of Pharmacy of the City of New York.*

C. L. SHEAR, *Plant Pathologist, United States Department of Agriculture.*

WILLIAM TRELEASE, *Director, Missouri Botanical Garden.*

LUCIEN M. UNDERWOOD, *Professor of Botany, Columbia University.*

DAVID WHITE, *United States Geological Survey; Custodian (Palaeozoic Plants), United States National Museum.*

WILLIAM F. WIGHT, *Assistant, Geographic Botany, United States Department of Agriculture.*

MEMBERS AND ALTERNATES OF THE NOMENCLATURE COMMISSION

CODE OF BOTANICAL NOMENCLATURE

PART I. PRINCIPLES.

1. The primary object of formal nomenclature in systematic biology is to secure stability, uniformity and convenience in the designation of plants and animals.
2. Botanical nomenclature is treated as beginning with the general application of binomial names of plants (Linnaeus' Species Plantarum, 1753).
3. Priority of publication is a fundamental principle of botanical nomenclature. Two groups of the same category cannot bear the same name.

   NOTE.—Previous use of a name in zoology does not preclude its use in botany.

4. The application of a name is determined by reference to its nomenclatorial type.

PART II. CANONS.

Section I. Categories of Classification.

CANON 1. Connected or coherent groups of individuals are termed species.

CANON 2. Species are grouped into genera; genera into tribes; tribes into families; families into orders; orders into classes; classes into phyla.

NOTE.—Order is preferable to cohort and phylum to division, conforming to zoological usage.

CANON 3. When additional categories are necessary for the convenient presentation of relationships, they are to be obtained by the recognition of intermediate groups, the names of which are formed by prefixing sub- to the names of the above principal categories.

EXAMPLES.—Subspecies, subgenus, subfamily, suborder.

CANON 4. Other terms, such as group, section, series, division, and branch, may be used for more convenient temporary arrangement under the above categories, but their names are to have no validity in formal taxonomy.

NOTE.—The term variety is relegated to horticultural usage.

Section II. Formation of Names.

CANON 5. Specific and subspecific names consist of Latin or Latinized adjectives or substantives, the latter being either nominatives in apposition or genitives.

EXAMPLES.—*Hookerianus ; europaeus ; vulgaris ; heterophyllus ; malvicola ; Tulipifera ; Tuna ; Engelmanni ; Sonorae ; Trifolii.*

CANON 6. Generic and subgeneric names consist of Latin or Latinized substantives, or equivalent terms.

EXAMPLES.—*Rosa ; Convolvulus ; Hedysarum ; Bartramia ; Liquidambar ; Couroupita ; Tsuga ; Gloriosa ; Impatiens ; Manihot.*

CANON 7. Names for subtribes, orders, and intervening groups, are formed from names of component genera.

(*a*) For names of tribes add -eae, of families -aceae, of orders -ales, to the stem of the generic name.

EXAMPLES.—*Roseae ; Rosaceae ; Rosales.*

(*b*) For names of subtribes add -anae, of subfamilies -atae, of suborders -ares, to the stem of the generic name.

EXAMPLES.—*Rosanae ; Rosatae ; Rosares.*

CANON 8. Names for subclasses and higher groups consist of plural Latin or Latinized substantives.

EXAMPLES.—*Monocotyledones ; Angiospermae ; Pteridophyta.*

Section III. Publication of Names.

CANON 9. A specific or subspecific name is published when it has been printed and distributed with a description (or in palaeobotany a figure), or with a reference to a previously published description.

EXAMPLES.—*Coursetia arborea* Griseb. Fl. Brit. W. Ind. 183 (1859), is published with a description ; *Cynanchum nivale* Nym. Syll. Fl. Eur. 108 (1855), is published with a reference to the previously described *Vincetoxicum nivale* Boiss. & Heldr. ; *Pterospermites Whitei* Ward, Ann. Rep. U. S. Geol. Surv. **6** : 556. *pl. 56, f. 5, 6* (1885), a fossil species, is published with a figure, but without a description.

(*a*) Names published for primary subdivisions of species are treated as subspecific names, however designated by their authors.

EXAMPLES.—*Juglans alba minima* Marsh. Arb. Am. 68 (1785) ; *Scirpus maritimus β fluviatilis* Torr. Ann. Lyc. N. Y. **3** : 324 (1836) ; *Zizia aurea* var. *Bebbii* Coult. & Rose, Bot. Gaz. **12** : 138 (1887) ; these are primary divisions of species, which are recognizable as subspecies.

(*b*) In the transfer of a species from one genus to another the original specific name is retained, unless the resulting binomial has been previously published.

EXAMPLES.—*Bromus giganteus* L. Sp. Pl. 77, is *Festuca gigantea* (L.) Vill. Hist. Pl. Dauph. **2**: 110 (1787); *Arum triphyllum* L. Sp. Pl. 965, is to be known as *Arisaema triphyllum* (L.) Torr. Fl. N. Y. **2**: 239 (1843), not as *Arisaema atrorubens* Blume, Rumphia, **1**: 97 (1835); *Laurus Sassafras* L. Sp. Pl. 371, is to be known as *Sassafras Sassafras* (L.) Karst. Deutsch. Fl. 505 (1881), not as *Sassafras officinale* Nees & Eberm. Handb. Med.-pharm. Bot. **2**: 418 (1831); however, *Schoenus pusillus* Sw. Nov. Gen. & Sp. Pl. 20 (1788), when transferred to *Rynchospora*, is not to be known as *Rynchospora pusilla* (Sw.) Griseb. Kar. 123 (1857), because prior to 1857 the same binomial had been used for another species, *Rynchospora pusilla* Chapm. (1849).

(*c*) A subspecies elevated to specific rank retains the same name, unless the resulting binomial has been previously published.

EXAMPLES.—*Sparganium simplex androcladum* Engelm. in A. Gray, Man. ed. 5, 481 (1867), if regarded as a distinct species, becomes *Sparganium androcladum* (Engelm.) Morong, Bull. Torrey Club, **15**: 78 (1888); however, *Juncus acuminatus robustus* Engelm. Trans. Acad. Sci. St. Louis, **2**: 463 (1868), does not become *Juncus robustus* (Engelm.) Coville in Britt. & Brown, Ill. Fl. **1**: 395 (1896), because prior to 1896 the binomial had been used for another species, *Juncus robustus* S. Wats. Proc. Am. Acad. **14**: 302 (1879).

CANON 10. A generic or subgeneric name is published when it has been printed and distributed (1) with a generic or specific description (or in palaeobotany a figure) and a binomial specific name, (2) with a generic and specific name and the citation of a previously published description, or (3) with a reference to a specific description, which is associable by citation with a previously published binomial species.

EXAMPLES.—*Pachysandra* Michx. Fl. Bor. Am. **2**: 177 (1803), is published with a generic and specific description and a binomial specific name; *Brasenia* Schreb. ex Gmel. Syst. **2**: 853 (1791), is published with a generic description and a binomial specific name; *Silphium* L. Sp. Pl. 919 (1753), is published with a specific description and a binomial specific name; *Poacites* Schloth. Petrefact. 416. *pl. 26, f. 1, 2* (1820), a fossil genus, is published with figures and a binomial specific name, but without a description; *Nyssa* L. Sp. Pl. 1058 (1753), is published with a generic and specific name and the citation of previously published descriptions; *Dryopteris* Adans. Fam. Pl. **2**: 20 (1763), is published with a reference to a specific description associable by citation with the previously published *Polypodium Filix-mas* L. Sp. Pl. 1090 (1753), inasmuch as both Adanson and Linnaeus cite *Filix mas* of Fuchs.

CANON 11. Names of subtribes, orders, and intervening groups are published when they have been printed and distributed with direct or indirect citations of component genera.

EXAMPLES.—*Moraceae* Lindl. Veg. Kingd. 266 (1847), is published with the citation of component genera; *Ophioglossales* Engler, Syll. ed. 2, 63 (1898), is published with the citation of component genera.

CANON 12. A name is not published by its citation in synonymy, or by incidental mention.

EXAMPLES.—*Echeveria spicata*, cited by De Candolle, Prodr. **3**: 349 (1828), as a synonym of *Fouquiera formosa*, is not published, and does not invalidate *Echeveria* DC. published on page 401 of the same volume; *Acrostichum Plumieri* "Desv. herb.," cited as a synonym of *A. viscosum* in Fée, Mém. Fam. Foug. **2**: 46 (1845), is not published, and does not invalidate *Acrostichum Plumieri* Fée, published as a species on page 50 of the same work; *Hormisus opuntioides* Targ., cited by Bertoloni, Amoen. Ital. 316 (1819), as a synonym of *Fucus Sertolara* Bertol. (= *Halimeda Tuna*), is not thereby published.

CANON 13. Of names published in the same work and at the same time, those having precedence of position are to be regarded as having priority.

EXAMPLES.—*Alsine* L. Sp. Pl. 272, is to be regarded as having priority over *Stellaria* L. Sp. Pl. 421; *Aira spicata* L. Sp. Pl. 63, is to be regarded as having priority over *Aira spicata* L. Sp. Pl. 64; *Hibiscus Moscheutos* L. Sp. Pl. 693, is to be regarded as having priority over *H. palustris*, which it precedes on the same page.

Section IV. Application of Names.

CANON 14. The nomenclatorial type of a species or subspecies is the specimen to which the describer originally applied the name in publication.

EXAMPLES.—*Polypodium marginale* L. Sp. Pl. 1091, is typified by the designation of a specimen collected in Canada by Kalm; *Stachys arenicola* Britton, Man. 792 (1901), is typified by the designation of a specimen from Staten Island, New York; *Carex intumescens Fernaldii* Bailey, Bull. Torrey Club, **20**: 418 (1893), is typified by a specimen collected at Cedar Swamp, Aroostook County, Maine, by M. L. Fernald.

(*a*) When more than one specimen was originally cited, the type or group of specimens in which the type is included may be indicated by the derivation of the name from that of the collector, locality or host.

EXAMPLES.—*Eriogonum Porteri* Small, Bull. Torrey Club, **25**: 41 (1898), is based on several specimens, of which the one collected by T. C. Porter is the type; *Gaillardia arizonica* A. Gray, Syn. Fl. N. Am. **1**^{2}:

353 (1884), is based on several specimens, of which the one collected by Palmer in Arizona is the type; *Cuscuta Cephalanthi* Engelm. Am. Jour. Sci. 43: 336 (1842), is based on specimens from several hosts, of which the one from *Cephalanthus* is the type.

(*b*) Among specimens equally eligible, the type is that first figured with the original description, or in default of a figure the first mentioned.

EXAMPLES.—*Calyptridium roseum* S. Wats. Bot. King's Exp. 44. *pl. 6, f. 6–8* (1871), is based on at least three specimens, of which the one figured is the type; *Arnica cordifolia* Hook. Fl. Bor. Am. 1 : 331 (1833), is based on two specimens, neither of which is figured, and the one first mentioned, which was collected by Drummond in alpine woods of the Rocky Mountains, is the type.

(*c*) In default of an original specimen, that represented by the identifiable figure or (in default of a figure) description first cited or subsequently published, serves as the type.

EXAMPLES.—*Trillium sessile* L. Sp. Pl. 340, is based on three citations, of which the second is the type, being accompanied by a figure; *Centaurea Scabiosa* L. Sp. Pl. 913, is based on a number of citations, of which the first mentioned is the type, as no figures are cited.

CANON 15. The nomenclatorial type of a genus or subgenus is the species originally named or designated by the author of the name. If no species was designated, the type is the first binomial species in order eligible under the following provisions:

(*a*) The type is to be selected from a subgenus, section or other list of species originally designated as typical.

EXAMPLES.—*Psilogramme* Kuhn, Festschr. 50-Jähr. Jub. Königs. Realschule zu Berlin, 332 (1882), is typified by the first mentioned species of the second section *Eupsilogramme*, and not from species included in the first section *Jamesonia*, which is based on a generic name previously published; *Phania* DC. Prodr. 5 : 114 (1826), is typified by *P. multicaulis* DC., the only species of the section *Euphania*.

(*b*) A figured species is to be selected rather than an unfigured species in the same work; or, in the absence of a figure, preference is to be given to a species accompanied by the citation of a figure.

EXAMPLES.—*Lespedeza* Michx. Fl. Bor. Am. 2 : 70 (1803), is typified by *L. procumbens* Michx. *loc. cit. pl. 39*, the species first figured; *Basanacantha* Hook. f. in Benth. & Hook. Gen. Pl. 2 : 82 (1873), is typified by *Randia tetracantha* (Cav.) DC., the second species cited, as this had been figured by Cavanilles, whereas *Randia Humboldtiana* DC., the species first mentioned by Hooker, had not been figured.

(*c*) The types of genera adopted through citations of nonbinomial literature (with or without change of name), are to be selected from those of the original species which receive names in the first binomial publication. The genera of Linnaeus' Species Plantarum (1753) are to be typified through the citations given in his Genera Plantarum (1754).

NOTE.—The Species Plantarum contains no generic references, but the 1754 edition of the Genera Plantarum was evidently prepared at the same time and was in effect a complementary volume of the same work. It accords much more nearly than other editions with the treatment followed in the Species Plantarum, and thus makes it possible to retain more of the Linnaean generic names in their current application.

EXAMPLES.—*Cypripedium* L. Sp. Pl. 951, a genus adopted from Tournefort with a change of his name *Calceolus*, is typified by *Cypripedium Calceolus*, the only species common to both authors; *Seseli* L. Sp. Pl. 259, a genus adopted from Boerhaave, is typified by the second species of Linnaeus, *Seseli montanum*, which is the first in Linnaeus of the species common to both authors; *Silene* L. Sp. Pl. 416, a genus adopted from Dillenius with a change of his name *Viscago*, is typified by *Silene anglica*, the first in Linnaeus of the thirteen species figured by Dillenius; *Fritillaria* L. Sp. Pl. 303, a genus adopted from Tournefort, is typified by the fifth species of Linnaeus, *Fritillaria Meleagris*, which is one of the three species included in *Fritillaria* by both authors, and is selected from these three because it is the one figured by Tournefort.

(*d*) When a prebinomial generic name is displaced by the publication of a generic name within binomial usage, the application of the displaced name to a species under the new generic name designates the type.

EXAMPLE.—*Dianthus* L. Sp. Pl. 409, a genus adopted from Tournefort with a change of his name *Caryophyllus*, is typified by *Dianthus Caryophyllus*, one of the fifteen original species of Linnaeus.

(*e*) The application to a genus of a former specific name of one of the included species, designates the type.

EXAMPLES.—*Amsonia* Walt. Fl. Car. 98 (1788), is typified by *Tabernaemontana Amsonia* L., one of its two original species; *Sordaria* Ces. & DeN. Comm. Soc. Critt. Ital. 1: 225 (1863), is typified by *Sphaeria Sordaria* Fr., one of its twelve original species.

(*f*) To avoid change in the current application of a Linnaean generic name, a well-known economic species may be selected as the type, in accordance with the principle stated by Linnaeus (Phil. Bot. 197. 1751): "Si genus receptum, secundum jus naturae et artis, in plura dirimi debet, tum nomen antea commune manebit vulgatissimae et officinali plantae."

EXAMPLES.—*Poa* L. Sp. Pl. 67, is typified by *P. pratensis* L., the commonest of its original species; *Mollugo* L. Sp. Pl. 89, is typified by *M. verticillata* L., the commonest of its original species.

Section V. Rejection of Names.

CANON 16. A name is rejected when preoccupied (homonym).

(*a*) A specific or subspecific name is a homonym when it has been published for another species under the same generic name. Two subspecies of the same genus shall not retain the same name.

EXAMPLES.—*Acer saccharinum* Wang. Amer. 36. *pl. 2, f. 26* (1787), is a homonym of *Acer saccharinum* L. Sp. Pl. 1055 (1753); *Vaccinium myrtilloides* Hook. Fl. Bor. Am. **2**: 32 (1834), is a homonym of *Vaccinium myrtilloides* Michx. Fl. Bor. Am. **1**: 234 (1803), and is rejected whether the latter species is regarded as distinct or not; *Juncus nodosus megacephalus* Torr. Fl. N. Y. **2**: 326 (1843), is a homonym of *Juncus megacephalus* M. A. Curtis, Boston Jour. Nat. Hist. **1**: 132 (1835); *Chrysopsis pilosa* (Walt.) Britton, Mem. Torrey Club, **5**: 316 (1894), is a homonym of *Chrysopsis pilosa* Nutt. Jour. Acad. Nat. Sci. Phila. **7**: 66 (1834), and is to be rejected, notwithstanding the fact that *Erigeron pilosum* Walt. was published in 1788; *Carex scoparia moniliformis* Tuckerm. Enum. Meth. Car. 17 (1843), and *Carex straminea moniliformis* Tuckerm. *loc. cit.*, can not both be maintained.

(*b*) A generic or subgeneric name is a homonym when previously published, or proposed in print, for another genus.

EXAMPLES.—*Torreya* Arn. Ann. Nat. Hist. **1**: 130 (1838), is a homonym of *Torreya* Raf. Am. Mo. Mag. **3**: 356 (1818), of *Torreya* Raf. Jour. Phys. **89**: 105 (1819), of *Torreya* Spreng. Neue Entdeck. **2**: 121 (1821), and of *Torreya* Eat. Man. ed. 5, 420 (1829); *Rivularia* Ag. Syn. Alg. Scand. xxxviii (1817), is a homonym of *Rivularia* Roth, Cat. **1**: 212 (1797); *Nesaea* Lamour. Nouv. Bull. Soc. Philom. **3**: 185 (1812), is a homonym of *Nesaea* Commers. ex Juss. Gen. Pl. 332 (1789); *Bulliarda* DC. Bull. Soc. Philom. 3^{49}: 1 (1801), is a homonym of *Bulliarda* Neck. Elem. **2**: 321 (1790).

(*c*) Similar names are to be treated as homonyms only when they are mere variations in the spelling of the same word; or in the case of specific and subspecific names, when they differ only in adjective or genitive termination.

EXAMPLES.—*Penicillus* and *Penicillium*, *Callitriche* and *Calothrix*, *Nemastylis* and *Nematostylis*, *Pterigophyllum* and *Pteridophyllum*, may be maintained; *Cyathophora* and *Cyathophorum*, *Asterocarpus* and *Astrocarpus* can not be maintained. *Greenei* and *Greenii*, named for different persons, Greene and Green, may be maintained in the same genus; *virginicus*, *virginianus* and *virginiensis*, *oreganus* and *oregonensis*, *Hookeri* and *Hookerianus*, can not be maintained in the same genus.

CANON 17. A name is rejected when there is an older valid name based on another member of the same group (metonym).

EXAMPLES.—*Meibomia* Heist. ex Adans. Fam. Pl. **2**: 509 (1763), is based on *Hedysarum canadense* L. Sp. Pl. 748, and *Desmodium* Desv. Jour. de Bot. II. **1**: 122 (1813), is typified by *Hedysarum asperum* Poir. Encycl. Suppl. **6**: 408 (1804), consequently if these species are regarded as congeneric the name *Desmodium* is to be rejected; *Boletopsis* P. Henn. Nat. Pflanzenf. 1¹**: 194 (1899), cannot stand as a genus to include a section bearing the name *Boletinus* Kalchb., the latter having been established as a genus in 1877; *Sisymbrium altissimum* L. Sp. Pl. 659 (1753), *Sisymbrium Sinapistrum* Crantz, Stirp. Austr. ed. 2, 52 (1769), and *Sisymbrium pannonicum* Jacq. Coll. **1**: 70 (1786), have different types, but if these are regarded as belonging to the same species, the two later names are metonyms of that of Linnaeus.

CANON 18. A name is rejected when there is an older valid name based on the same type (typonym).

EXAMPLES.—*Miegia* Pers. Syn. **1**: 101 (1805), is a typonym of *Arundinaria* Michx. Fl. Bor. Am. **1**: 73 (1803), both being based on the same species; *Asplenium Vincentis* Christ, Bot. Jahrb. **24**: 109 (1897), is a typonym of *A. Guildingii* Jenm. Gard. Chron. III. **15**: 70 (1894), both being based on H. H. Smith's *no. 1346* from St. Vincent.

CANON 19. A name is rejected when the natural group to which it applies is undetermined (hyponym).

(*a*) A specific or subspecific name is a hyponym when it has not been connected with a description identifiable by diagnostic characters or by reference to a type specimen, figure or locality.

EXAMPLES.—*Gentiana hybrida* Raf. Med. Rep. II. **5**: 353 (1808), is a hyponym, as no diagnosis is published; *Lechea furfuracea* Raf. New Fl. Am. **1**: 92 (1836), is a hyponym, as its description is not identifiable.

(*b*) A generic or subgeneric name is a hyponym, when it is not associable, at least by specific citation, with a binomial species previously or simultaneously published; or when its type species is not identified.

EXAMPLES.—*Adodendrum* Necker, Elem. **1**: 214 (1790), and *Calesiam* Adans. Fam. Pl. **2**: 446 (1763), are hyponyms, because their authors neither named a binomial species nor cited a species which had previously received a binomial name; *Nudilus* Raf. Atl. Jour. 176 (1833), is a hyponym, as its type species, *N. paradoxus*, has not been identified.

PART III. ORTHOGRAPHY AND CITATION.

Section I. Orthography.

1. The original orthography of names is to be maintained, except in the following cases; the change not to affect priority.

(*a*) Manifest typographical errors may be corrected.

EXAMPLES.—*Scoria* Raf. is a misprint for *Hicoria; Rumhora* Raddi is a misprint for *Rumohra*, named for K. von Rumohr.

(*b*) Adjectival names of species and subspecies agree in gender with the generic name with which they are associated.

EXAMPLES.—*Polygonum articulatum* L. = *Polygonella articulata* (L.) Meissn.; *Sisymbrium amphibium palustre* L. = *Roripa palustris* (L.) Bess.

(*c*) Generic names derived from personal names should be feminine, and if originally of other forms should be corrected.

EXAMPLES.—*Lippius* S. F. Gray, *Kantius* S. F. Gray, *Pallavicinius* S. F. Gray, should be changed to *Lippia*, *Kantia*, and *Pallavicinia* and yet date from 1821 when originally published.

(*d*) In the case of names proposed in works in which v and j were used as vowels or u and i as consonants they should be corrected to agree with modern usage.

EXAMPLES.—*Euonymus*, not *Evonymus; Naias*, not *Najas; Neuropteris*, not *Nevropteris; Rivularia*, not *Riuularia* (*Rivvlaria*); *Jungia*, not *Iungia*.

2. Generic names should be written with initial capital letters.

EXAMPLES.—*Desfontainea*, not *desFontainea; Durvillaea* not *d'Urvillaea.*

3. If capital letters are to be used for specific names they should be employed only for substantives and for adjectives derived from personal names.

EXAMPLES.—*Asplenium Trichomanes* L.; *Uromyces Trifolii* (Hedw.) Lév.; *Trichomanes Smithii* Hook.; *Galium Boryanum* Walp.

4. The publication of names of bilingual derivation should be avoided, but published names are not to be rejected on account of such derivation.

EXAMPLES. — *Liquidambar* is Latin-Arabic; *Fimbristylis* is Latin-Greek; *Actiniceps* is Greek-Latin.

5. The names of hybrids may be written as follows:

(*a*) A hybrid may be named by placing the names of the parent species or subspecies in alphabetical order, connected by the sign × ; but in hybrids experimentally produced, or in which the sex of the parents is known, the female parent is to be written first, and the sex indicated by the signs ♀, ♂.

EXAMPLES. — *Carex debilis* × *virescens ; Digitalis lutea* ♀ × *purpurea* ♂.

(*b*) A hybrid may be named when desirable like a species or subspecies, provided the binomial or trinomial is preceded by the sign ×, designating it as a hybrid.

EXAMPLE. — × *Salix capreola* Kern.

(*c*) A hybrid between species of different genera may be named by attaching the specific name to the generic name of the female parent, or, if the sex of the parents is unknown, to the generic name coming first in alphabetical order.

EXAMPLE. — × *Ammophila baltica* Link = *Ammophila arenaria* × *Calamagrostis Epigeios.*

(*d*) A hybrid derived from parents one or both of which are of hybrid origin, may be named by including the name of the hybrid parent in parentheses.

EXAMPLE. — *Salix* (*aurita* × *repens*) × *cinerea.*

(*e*) Preponderance of one parent over the other may be designated by the signs >, <.

EXAMPLES. — *Mentha longifolia* > × *rotundifolia ; Mentha longifolia* × < *rotundifolia.*

Section II. Citation of authors.

1. An author-citation following a name refers to the author by whom the name was first published ; the author's name may be abbreviated, but never in such a manner as to result in ambiguity.

EXAMPLES. — Spreng. for Sprengel, not Spr., to distinguish from Spruce and others; Michx. for Michaux, not Mich., to distinguish from Micheli ; S. Wats. for Sereno Watson, to distinguish from H. C. Watson.

2. In the following cases the name of the original author should appear in parentheses, followed by that of the author who first published the name in its accepted form and application.

(*a*) A specific name originally combined with a different generic name, or a subspecific name originally combined with a different binomial.

EXAMPLES.—*Moneses uniflora* (L.) A. Gray, for the plant originally described as *Pyrola uniflora* by Linnaeus and subsequently first published as *Moneses uniflora* by Asa Gray; *Chondrophora nauseosa glabrata* (A. Gray) Rydberg for *Bigelovia graveolens* var. *glabrata* A. Gray.

(*b*) A generic name adopted through citation from a publication issued prior to the first edition of Linnaeus' Species Plantarum (1753).

EXAMPLES.—*Linnaea* (Gronov.) L.; *Anthoceros* (Mich.) L.; *Valerianella* (Tourn.) Poll.

(*c*) A name applied to a category different from that in which it was first proposed.

EXAMPLES.—*Salix cordata angustata* (Pursh) Anders., originally *Salix angustata* Pursh; *Actaea rubra* (Ait.) Willd., originally *Actaea spicata* var. *rubra* Ait.; *Ardisia* subg. *Pickeringia* (Nutt.) Mez, originally genus *Pickeringia* Nutt.; *Raphidostegium* (Br. & Sch.) De Not., originally *Rhynchostegium* subg. *Raphidostegium* Br. & Sch.

3. A comma between the name of the plant and the name of the author is undesirable.

EXAMPLES.—*Rumex* L., not *Rumex*, L.; *Phacelia congesta* Hook., not *Phacelia congesta*, Hook.; *Ilysanthes dubia* (L.) Barnhart, not *Ilysanthes dubia*, (L.), Barnhart.

CODE DE LA NOMENCLATURE BOTANIQUE

Une Commission de Nomenclature fut nommée par le Club Botanique de l'Association Américaine pour l'Avancement des Sciences, dans une réunion tenue à Washington, D. C., le 2 Janvier, 1903. Dans cette réunion une série de règles de nomenclature était présentée et renvoyée à la Commission, qui a examiné soigneusement tous les principes en jeu, et a essayé l'application de ces principes à toutes sortes de cas. La Commission a trouvé que, dans le but d'obtenir des données plus exactes, et pour arriver à des résultats plus satisfaisants, un nouvel arrangement et quelques modifications aux règles proposées à cette réunion de Washington étaient jugés convenables. Les principes ont été soigneusement comparés à ceux qui ont été énoncés dans les Lois de la Nomenclature adoptées au Congrès de Botanique de Paris en 1867, et au Congrès de Botanique réuni à Gênes en 1892, ainsi qu'aux propositions faites par divers groupes de botanistes et par des particuliers, pendant les quelques années passées ; les méthodes suivies par les zoologistes ont été également étudiées ; le tout, en vue d'obtenir un code de nomenclature qui puisse satisfaire aussi bien que possible tous les interêts en jeu. L'action du Congrès international de Botanique tenu à Paris en 1900, d'après laquelle le sujet de la nomenclature doit être soumis au Congrès international devant avoir lieu à Vienne en 1905, a été prise en considération, et la décision prise à ce Congrès de baser un nouveau système de règles sur celles qui avaient été adoptées par le Congrès de Paris en 1867, a reçu notre attention toute spéciale. Cette action projette la modification des Lois de Paris de 1867, dans ses différents articles, par amendement, suppression ou substitution. Nous avons trouvé, d'ailleurs, que les Lois de Paris de 1867 ne peuvent s'adapter d'une manière satisfaisante à la modification ci-dessus indiquée, pour les raisons suivantes : que leur disposition n'est pas philosophique à en juger par l'expérience et les connaissances modernes ; que beaucoup de principes importants n'y sont pas reconnus ou y reçoivent en somme une considération trop restreinte ; et qu'il s'y rencontre un manque d'exposé exact et défini, lequel conduit à l'équivoque. Nous recommandons donc, et avons l'intention de proposer au Congrès de Vienne en 1905, que conformément aux dispositions du comité d'organisation du Congrès de 1905, le code de lois de 1867 soit amendé par la suppression de tous ses articles et la substitution du code ci-joint.

J. C. ARTHUR, *professeur de physiologie et pathologie végétale, Purdue University.*

JOHN HENDLEY BARNHART, *rédacteur, Torrey Botanical Club.*

N. L. BRITTON, *directeur, New York Botanical Garden.*

STEWARDSON BROWN, *conservateur des collections botaniques, Academy of Natural Sciences of Philadelphia.*

FREDERIC E. CLEMENTS, *professeur-adjoint de botanique, State University of Nebraska.*

O. F. COOK, *botaniste chargé d'investigations d'agriculture tropicale, United States Department of Agriculture; conservateur-adjoint (cryptogamie), United States National Museum.*

JOHN M. COULTER, *professeur de botanique, University of Chicago; rédacteur, Botanical Gazette.*

FREDERICK V. COVILLE, *botaniste en chef, United States Department of Agriculture; conservateur, United States National Herbarium.*

F. S. EARLE, *directeur, Estación Agronómica Central de Cuba.*

ALEXANDER W. EVANS, *professeur-adjoint de botanique, Yale University.*

TRACY E. HAZEN, *répétiteur de botanique, Barnard College, Columbia University.*

ARTHUR HOLLICK, *conservateur-adjoint (paléobotanique), New York Botanical Garden.*

MARSHALL A. HOWE, *conservateur-adjoint (algues), New York Botanical Garden; rédacteur, Torreya.*

F. H. KNOWLTON, *United States Geological Survey; conservateur (plante mésozoiques), United States National Museum.*

GEORGE T. MOORE, *physiologiste chargé du Laboratoire de physiologie végétale, United States Department of Agriculture; conservateur (algues), United States National Herbarium.*

E. L. MORRIS, *chef du departement de biologie des Écoles supérieures de Washington (D. C.).*

WILLIAM ALPHONSO MURRILL, *New York Botanical Garden.*

H. H. RUSBY, *professeur de physiologie, botanique et matière médicale, et doyen de la Faculté, College of Pharmacy of the City of New York.*

C. L. SHEAR, *phytopathologiste, United States Department of Agriculture.*

WILLIAM TRELEASE, *directeur, Missouri Botanical Garden.*

LUCIEN M. UNDERWOOD, *professeur de botanique, Columbia University.*

DAVID WHITE, *United States Geological Survey; conservateur (plantes paléozoiques), United States National Museum.*

WILLIAM F. WIGHT, *assistant, botanique géographique, United States Department of Agriculture.*

MEMBRES ET SUBSTITUTS DE LA COMMISSION DE NOMENCLATURE.

CODE DE LA NOMENCLATURE BOTANIQUE

PARTIE I. PRINCIPES.

1. Le but principal d'une nomenclature formelle en biologie systématique est d'obtenir la stabilité, l'uniformité et la facilité dans la désignation des plantes et des animaux.
2. La nomenclature botanique est considérée comme commençant avec l'application générale de noms binaires aux plantes (Linné, Species Plantarum, 1753).
3. La priorité de publication est un principe fondamental de nomenclature botanique. Deux groupes de la même catégorie ne peuvent pas avoir le même nom.

   NOTE. — L'emploi antérieur d'un nom en zoologie n'exclut pas son emploi en botanique.

4. L'application d'un nom est déterminée par rapport à son type de nomenclature.

PARTIE II. CANONS.

Section I. Catégories de Classification.

CANON 1. Groupes alliés ou cohérents d' individus se nomment espèces.

CANON 2. Les espèces sont groupées en genres ; les genres en tribus ; les tribus en familles ; les familles en ordres ; les ordres en classes ; les classes en phyla.

NOTE. — Ordre est préférable à cohorte, et phylum à division, conformément à l'usage zoologique.

CANON 3. Lorsque des catégories additionnelles sont nécessaires pour la présentation commode des relations, on les obtient en reconnaissant des groupes intermédiaires dont les noms se forment en ajoutant le préfixe sous- aux noms des catégories principales ci-dessus.

EXEMPLES. — Sous-espèce, sous-genre, sous-famille, sous-ordre.

CANON 4. D'autres expressions telles que groupe, section, série, division et embranchement, peuvent être employées pour un arrangement temporaire plus commode subordonné aux catégories ci-dessus, mais leurs noms ne peuvent être valides en taxinomie formelle.

NOTE. — L'expression variété est reléguée à l'usage horticole.

Section II. Formation des Noms.

CANON 5. Les noms spécifiques et sous-spécifiques consistent en adjectifs ou substantifs latins, ou latinisés, ces derniers étant soit des nominatifs en apposition, ou des génitifs.

EXEMPLES. — *Hookerianus ; europaeus ; vulgaris ; heterophyllus; malvicola; Tulipifera ; Tuna ; Engelmanni ; Sonorae ; Trifolii.*

CANON 6. Les noms génériques et sous-génériques consistent en substantifs latins ou latinisés, ou en mots équivalents.

EXEMPLES. — *Rosa ; Convolvulus ; Hedysarum ; Bartramia ; Liquidambar ; Couroupita ; Tsuga ; Gloriosa ; Impatiens ; Manihot.*

CANON 7. Les noms des sous-tribus, ordres, et groupes intermédiaires sont formés des noms des genres constituants.

(*a*) Pour les noms de tribus ajouter -eae, de familles -aceae, d'ordres -ales, au thème du nom générique.

EXEMPLES. — *Roseae ; Rosaceae ; Rosales.*

(*b*) Pour les noms de sous-tribus ajouter -anae, de sous-familles -atae, de sous-ordres -ares, au thème du nom générique.

EXEMPLES. — *Rosanae ; Rosatae; Rosares.*

CANON 8. Les noms des sous-classes et groupes plus élevés consistent en substantifs latins ou latinisés, au pluriel.

EXEMPLES. — *Monocotyledones ; Angiospermae ; Pteridophyta.*

Section III. Publication des Noms.

CANON 9. Un nom spécifique ou sous-spécifique est considéré comme publié quand il a été imprimé et distribué avec une description (ou en paléobotanique une figure), ou bien avec un renvoi à une description publiée antérieurement.

EXEMPLES. — *Coursetia arborea* Griseb. Fl. Brit. W. Ind. 183 (1859), est publié avec une description ; *Cynanchum nivale* Nym. Syll. Fl. Eur. 108 (1855), est publié avec un renvoi à *Vincetoxicum nivale* Boiss. & Heldr., publié antérieurement ; *Pterospermites Whitei* Ward, Ann. Rep. U. S. Geol. Surv. **6** : 556. *pl. 56, f. 5, 6* (1885), une espèce fossile, est publiée avec figure, mais sans description.

(*a*) Les noms publiés pour des subdivisions primaires d'espèces sont considérés comme des noms sous-spécifiques, de quelque manière qu'ils aient été désignés par leur auteur.

EXEMPLES. — *Juglans alba minima* Marsh. Arb. Am. 68 (1785) ; *Scirpus maritimus β fluviatilis* Torr. Ann. Lyc. N. Y. **3** : 324 (1836) ; *Zizia aurea* var. *Bebbii* Coult. & Rose, Bot. Gaz. **12** : 138 (1887) ; ces exemples montrent des divisions primaires d'espèces qu'on peut reconnaître comme sous-espèces.

(*b*) Dans le transfert d'une espèce d'un genre dans un autre, on maintient le nom princeps spécifique à moins que le nom binaire résultant n'ait été publié antérieurement.

EXEMPLES. — *Bromus giganteus* L. Sp. Pl. 77, est *Festuca gigantea* (L.) Vill. Hist. Pl. Dauph. **2** : 110 (1787) ; *Arum triphyllum* L. Sp. Pl. 965, doit être connu sous le nom de *Arisaema triphyllum* (L.) Torr. Fl. N. Y. **2** : 239 (1843), et non de *Arisaema atrorubens* Blume, Rumphia, **1** : 97 (1835) ; *Laurus Sassafras* L. Sp. Pl. 371, doit être connu sous le nom de *Sassafras Sassafras* (L.) Karst. Deutsch. Fl. 505 (1881), et non de *Sassafras officinale* Nees & Eberm. Handb. Med.-pharm. Bot. **2** : 418 (1831) ; cependant, *Schoenus pusillus* Sw. Nov. Gen. & Sp. Pl. 20 (1788), quand on le transfère à *Rynchospora*, ne doit pas être connu sous le nom de *Rynchospora pusilla* (Sw.) Griseb. Kar. 123 (1857), parce que avant 1857, le même nom binaire avait été employé pour une autre espèce, *Rynchospora pusilla* Chapm. (1849).

(*c*) Une sous-espèce élevée au rang d'espèce conserve le même nom à moins que le nom binaire résultant n'ait été publié antérieurement.

EXEMPLES. — *Sparganium simplex androcladum* Engelm. in A. Gray, Man. ed. 5, 481 (1867), si on le considère comme une espèce distincte, devient *Sparganium androcladum* (Engelm.) Morong, Bull. Torrey Club, **15** : 78 (1888) ; cependant, *Juncus acuminatus robustus* Engelm. Trans. Acad. Sci. St. Louis, **2** : 463 (1868), ne devient pas *Juncus robustus* (Engelm.) Coville in Britt. & Brown, Ill. Fl. **1** : 395 (1896), parce que avant 1896, le nom binaire avait été employé pour une autre espèce, *Juncus robustus* S. Wats. Proc. Am. Acad. **14** : 302 (1879).

CANON 10. Un nom générique ou sous-générique est considere comme publié quand il a été imprimé et distribué (1) avec une description générique ou spécifique (ou en paléobotanique une figure) et un nom binaire spécifique, (2) avec un nom générique et spécifique et la citation d'une description publiée antérieurement, ou (3) avec un renvoi à une description spécifique, qu'on peut associer par citation à une espèce binaire publiée antérieurement.

EXEMPLES. — *Pachysandra* Michx. Fl. Bor. Am. **2** : 177 (1803), est publié avec une description générique et spécifique et un nom binaire spécifique ; *Brasenia* Schreb. ex Gmel. Syst. **2** : 853 (1791), est publié avec une description générique et un nom binaire spécifique ; *Silphium* L. Sp. Pl. 919 (1753), est publié avec une description spécifique et un nom binaire spécifique ; *Poacites* Schloth. Petrefact. 416. *pl. 26, f. 1, 2* (1820), un genre fossile, est publié avec figures et un nom binaire spécifique, mais sans description ; *Nyssa* L. Sp. Pl. 1058 (1753), est publié avec un nom générique et spécifique et la citation d'une description publiée antérieurement ; *Dryopteris* Adans. Fam. Pl. **2** : 20 (1763), est publié avec renvoi à une description spécifique qu'on peut associer par citation avec *Polypodium Filix-mas* L. Sp. Pl. 1090 (1753), publié antérieurement, puisque Adanson et Linné citent tous deux *Filix mas* de Fuchs.

CANON 11. Les noms de sous-tribus, ordres et groupes intermédiaires sont considérés comme publiés quand ils ont été imprimés et distribués avec citation directe ou indirecte des genres constituants.

EXEMPLES. — *Moraceae* Lindl. Veg. Kingd. 266 (1847), est publié avec citation des genres constituants ; *Ophioglossales* Engler, Syll. ed. 2, 63 (1898), est publié avec citation des genres constituants.

CANON 12. Un nom n'est pas considéré comme publié par sa seule citation en synonymie, ou par une mention casuelle.

EXEMPLES. — *Echeveria spicata*, cité par DeCandolle, Prodr. 3 : 349 (1828), comme synonyme de *Fouquiera formosa*, n'est pas publié, et ne rend pas invalide *Echeveria* DC., publié à la page 401 du même volume ; *Acrostichum Plumieri* "Desv. herb.", cité comme synonyme de *A. viscosum* dans Fée, Mém. Fam. Foug. **2** : 46 (1845), n'est pas publié, et ne rend pas invalide *Acrostichum Plumieri* Fée, publié comme espèce à la page 50 du même ouvrage ; *Hormisus opuntioides* Targ., cité par Bertoloni, Amoen. Ital. 316 (1819), comme synonyme de *Fucus Sertolara* Bertol. (= *Halimeda Tuna*), n'est pas publié par ce seul fait.

CANON 13. Parmi les noms publiés dans le même ouvrage et en même temps, ceux qui ont la précédence de position seront considérés comme ayant la priorité.

EXEMPLES. — *Alsine* L. Sp. Pl. 272, doit être considéré comme ayant la priorité sur *Stellaria* L. Sp. Pl. 421 ; *Aira spicata* L. Sp. Pl. 63, doit être considéré comme ayant la priorité sur *Aira spicata* L. Sp. Pl. 64 ; *Hibiscus Moscheutos* L. Sp. Pl. 693, doit être considéré comme ayant la priorité sur *H. palustris*, qu'il précède à la même page.

Section IV. Application des Noms.

CANON 14. Le type de nomenclature d'une espèce ou sous-espèce est le spécimen auquel l'auteur de la description a appliqué le nom originellement, lors de la publication.

EXEMPLES. — *Polypodium marginale* L. Sp. Pl. 1091, est typifié par la désignation d'un spécimen recueilli au Canada par Kalm ; *Stachys arenicola* Britton, Man. 792 (1901), est typifié par la désignation d'un spécimen venant de Staten Island, New York ; *Carex intumescens Fernaldii* Bailey, Bull. Torrey Club, **20** : 418 (1893), est typifié par un spécimen recueilli à Cedar Swamp, Aroostook County, Maine, par M. L. Fernald.

(*a*) Lorsque plus d'un spécimen ont été cités originairement, le type ou groupe de spécimens dans lequel le type est compris peut être indiqué par la dérivation du nom de celui du collecteur, de la localité ou de l'hôte.

EXEMPLES. — *Eriogonum Porteri* Small, Bull. Torrey Club, **25** : 41 (1898), est basé sur plusieurs spécimens, dont le type est celui qui a été recueilli par T. C. Porter; *Gaillardia arizonica* A. Gray, Syn. Fl. N. Am. 1^2 : 353 (1884), est basé sur plusieurs spécimens, dont le type est celui qui a été recueilli dans l'Arizona par Palmer; *Cuscuta Cephalanthi* Engelm. Am. Jour. Sci. 43 : 336 (1842), est basé sur des spécimens provenant de plusieurs hôtes, dont le type est celui qui provient de *Cephalanthus*.

(*b*) Entre les spécimens éligibles au même degré, le type est celui figuré avec la description originale, ou à défaut de figure le premier mentionné.

EXEMPLES. — *Calyptridium roseum* S. Wats. Bot. King's Exp. 44. *pl. 6, f. 6–8* (1871), est basé sur au moins trois spécimens dont celui qui est figuré est le type ; *Arnica cordifolia* Hook. Fl. Bor. Am. **1** : 331 (1833), est basé sur deux spécimens, ni l'un ni l'autre figurés, et le premier mentionné, celui qui a été recueilli par Drummond dans les bois alpins des Montagnes Rocheuses, est le type.

(*c*) À défaut de spécimen original, celui qui est représenté par la première figure citée, dont on peut prouver l'identité, ou à défaut de figure, par la première description citée, ou publiée postérieurement, sert de type.

EXEMPLES. — *Trillium sessile* L. Sp. Pl. 340, est basé sur trois citations, dont la seconde typifie l'espèce, étant accompagnée d'une figure ; *Centaurea Scabiosa* L. Sp. Pl. 913, est basé sur un nombre de citations, dont la première mentionnée est le type, puisque on ne cite pas de figure.

CANON 15. Le type de nomenclature d'un genre ou sous-genre est l'espèce nommée ou désignée originellement par l'auteur du nom. Si aucune espèce n'a été désignée, le type est la première espèce binaire après l'application des conditions suivantes :

(*a*) Le type doit être choisi dans un sous-genre, une section, ou autre liste d'espèces désignées originellement comme typiques.

EXEMPLES. — *Psilogramme* Kuhn, Festschr. 50-Jähr. Jub. Königs. Realschule zu Berlin, 332 (1882), est typifié par l'espèce mentionnée en premier lieu dans la seconde section *Eupsilogramme*, et non d'après des espèces comprises dans la première section *Jamesonia*, qui est basée sur un nom générique publié antérieurement; *Phania* DC. Prodr. **5** : 114

(1826), est typifié par *P. multicaulis* DC., la seule espèce de la section *Euphania*.

(*b*) Une espèce figurée doit être choisie plutôt qu'une espèce sans figure, dans le même ouvrage ; ou bien en cas d'absence de figure, on doit donner la préférence à une espèce accompagnée par la citation d'une figure.

EXEMPLES. — *Lespedeza* Michx. Fl. Bor. Am. 2 : 70 (1803), est typifié par *L. procumbens* Michx. *loc. cit. pl. 39*, l'espèce figurée en premier lieu ; *Basanacantha* Hook. f. in Benth. & Hook. Gen. Pl. 2 : 82 (1873), est typifié par *Randia tetracantha* (Cav.) DC., la seconde espèce citée, car cette espèce a été figurée par Cavanilles, tandis que *Randia Humboldtiana* DC., l'espèce mentionnée la première par Hooker, n'avait pas été figurée.

(*c*) Les types de genres adoptés au moyen de citations de textes nonbinaires (avec ou sans changement de nom) doivent être choisis parmi ceux des espèces originales qui reçoivent des noms dans la première publication binaire. Les genres du Species Plantarum de Linné (1753) doivent être typifiés au moyen des citations données dans son Genera Plantarum (1754).

NOTE. — Le Species Plantarum ne contient aucune référence générique, tandis que l'édition de 1754 du Genera Plantarum était évidemment préparée en même temps et était en effet un volume complémentaire de l'ouvrage précédent. Le dernier ouvrage s'accorde beaucoup mieux que d'autres éditions avec le traitement suivi dans le Species Plantarum, et permet ainsi de conserver, un plus grand nombre des noms génériques de Linné dans leur application courante.

EXEMPLES. — *Cypripedium* L. Sp. Pl. 951, un genre adopté d'après Tournefort, avec changement du nom *Calceolus* qu'il emploie, est typifié par *Cypripedium Calceolus*, la seule espèce commune aux deux auteurs ; *Seseli* L. Sp. Pl. 259, un genre adopté d'après Boerhaave typifié par la seconde espèce de Linné, *Seseli montanum*, qui est la première des espèces de Linné commune aux deux auteurs ; *Silene* L. Sp. Pl. 416, un genre adopté d'après Dillenius, avec changement du nom *Viscago* qu'il emploie, est typifié par *Silene anglica*, qui est la première de Linné des treize espèces figurées par Dillenius ; *Fritillaria* L. Sp. Pl. 303, un genre adopté d'après Tournefort, est typifié par la quinquième espèce de Linné, *Fritillaria Meleagris*, qui est une des trois espèces de *Fritillaria* communes aux deux auteurs, et elle est choisie parce qu'elle est l'espèce figurée par Tournefort.

(*d*) Quand un nom générique pré-binaire est déplacé par la publication d'un nom générique compris dans l'usage binaire, l'application du nom déplacé à une espèce sous le nouveau nom générique désigne le type.

EXEMPLE. — *Dianthus* L. Sp. Pl. 409, un genre adopté d'après Tournefort avec changement du nom *Caryophyllus* qu'il emploie, est typifié par *Dianthus Caryophyllus*, une des quinze espèces originales de Linné.

(*e*) L'application à un genre d'un ancien nom spécifique d'une des espèces comprises, désigne le type.

EXEMPLES. — *Amsonia* Walt. Fl. Car. 98 (1788), est typifié par *Tabernaemontana Amsonia* L., une de ses deux espèces originales; *Sordaria* Ces. & DeN. Comm. Soc. Critt. Ital. 1 : 225 (1863), est typifié par *Sphaeria Sordaria* Fr., une de ses douze espèces originales.

(*f*) Pour éviter le changement dans l'application courante d'un nom générique de Linné, une espèce utile bien connue peut être choisie comme type selon le principe énoncé par Linné (Phil. Bot. 197. 1751): "Si genus receptum, secundum jus naturae et artis, in plura dirimi debet, tum nomen antea commune manebit vulgatissimae et officinali plantae."

EXEMPLES. — *Poa* L. Sp. Pl. 67, est typifié par *P. pratensis* L., la plus commune des espèces originales; *Mollugo* L. Sp. Pl. 89, est typifié par *M. verticillata* L., la plus commune des espèces originales.

Section V. Rejet des Noms.

CANON 16. Un nom est rejeté quand il a été employé antérieurement (homonyme).

(*a*) Un nom spécifique ou sous-spécifique est un homonyme quand il a été publié pour une autre espèce sous le même nom générique. Deux sous-espèces du même genre ne doivent pas conserver le même nom.

EXEMPLES. — *Acer saccharinum* Wang. Amer. 36. *pl. 2, f. 26* (1787), est l'homonyme de *Acer saccharinum* L. Sp. Pl. 1055 (1753); *Vaccinium myrtilloides* Hook. Fl. Bor. Am. 2 : 32 (1834), est l'homonyme de *Vaccinium myrtilloides* Michx. Fl. Bor. Am. 1 : 234 (1803), et doit être rejeté, que l'on considère cette dernière espèce comme distincte ou non; *Juncus nodosus megacephalus* Torr. Fl. N. Y. 2 : 326 (1843), est l'homonyme de *Juncus megacephalus* M. A. Curtis, Boston Jour. Nat. Hist. 1 : 132 (1835); *Chrysopsis pilosa* (Walt.) Britton, Mem. Torrey Club, 5 : 316 (1894), est l'homonyme de *Chrysopsis pilosa* Nutt. Jour. Acad. Nat. Sci. Phila. 7 : 66 (1834), et doit être rejeté, malgré le fait que *Erigeron pilosum* Walt. fut publié en 1788; *Carex scoparia moniliformis* Tuckerm. Enum. Meth. Car. 17 (1843), et *Carex straminea moniliformis* Tuckerm. *loc. cit.*, ne peuvent être conservés tous deux.

(*b*) Un nom générique ou sous-générique est un homonyme quand il a été publié antérieurement, ou proposé dans un texte imprimé, pour un autre genre.

EXEMPLES. — *Torreya* Arn. Ann. Nat. Hist. **1** : 130 (1838), est l'homonyme de *Torreya* Raf. Am. Mo. Mag. **3** : 356 (1818), de *Torreya* Raf. Jour. de Phys. **89** : 105 (1819), de *Torreya* Spreng. Neue Entdeck. **2** : 121 (1821), et de *Torreya* Eat. Man. ed. 5, 420 (1829) ; *Rivularia* Ag. Syn. Alg. Scand. xxxviii (1817), est l'homonyme de *Rivularia* Roth, Cat. **1** : 212 (1797) ; *Nesaea* Lamour. Nouv. Bull. Soc. Philom. **3** : 185 (1812), est l'homonyme de *Nesaea* Commers. ex Juss. Gen. Pl. 332 (1789) ; *Bulliarda* DC. Bull. Soc. Philom. **3**^{49} : 1 (1801), est l'homonyme de *Bulliarda* Neck. Elem. **2** : 321 (1790).

(*c*) Des noms semblables ne seront pas considerés comme homonymes excepté quand ils ne sont que de simples variations de l'orthographe du même mot ; ou bien dans le cas de noms spécifiques et sous-spécifiques quand ils ne diffèrent que par la désinence adjective ou génitive.

EXEMPLES. — *Penicillus* et *Penicillium*, *Callitriche* et *Calothrix*, *Nemastylis* et *Nematostylis*, *Pterigophyllum* et *Pteridophyllum*, peuvent être conservés ; *Cyathophora* et *Cyathophorum*, *Asterocarpus* et *Astrocarpus*, ne peuvent être conservés. *Greenei* et *Greenii*, dé rivés denoms d'hommes différents, Greene et Green, peuvent être conservés dans le même genre ; *virginicus*, *virginianus* et *virginiensis*, *oreganus* et *oregonensis*, *Hookeri* et *Hookerianus*, ne peuvent être conservés dans le même genre.

CANON 17. Un nom est rejeté quand il y a un nom valable plus ancien, basé sur un autre membre du même groupe (métonyme).

EXEMPLES. — *Meibomia* Heist. ex Adans. Fam. Pl. **2** : 509 (1763), est basé sur *Hedysarum canadense* L. Sp. Pl. 748, et *Desmodium* Desv. Jour. de Bot. II. **1** : 122 (1813), est typifié par *Hedysarum asperum* Poir. Encycl. Suppl. **6** : 408 (1804), par conséquent si ces espèces sont considérées comme congénériques le nom *Desmodium* doit être rejeté ; *Boletopsis* P. Henn. Nat. Pflanzenf. **1**** : 194 (1899), ne peut être maintenu comme genre, une section portant le nom *Boletinus* Kalchb., ce dernier ayant été établi comme genre en 1877 ; *Sisymbrium altissimum* L. Sp. Pl. 659 (1753), *Sisymbrium Sinapistrum* Crantz, Stirp. Aüstr. ed. 2, 52 (1769), et *Sisymbrium pannonicum* Jacq. Coll. **1** : 70 (1786), ont des types différents, mais si ceux-ci sont considérés comme appartenant à la même espèce, les deux derniers noms sont des métonymes de celui de Linné.

CANON 18. Un nom est rejeté quand il y a un nom valable plus ancien basé sur le même type (typonyme).

EXEMPLES. — *Miegia* Pers. Syn. **1** : 101 (1805), est le typonyme de *Arundinaria* Michx. Fl. Bor. Am. **1** : 73 (1803), tous deux étant basés sur la même espèce ; *Asplenium Vincentis* Christ, Bot. Jahrb. **24** : 109 (1897), est le typonyme de *A. Guildingii* Jenm. Gard. Chron. III. **15** : 70 (1894), tous deux étant basés sur le *no. 1346* de H. H. Smith, provenant de St. Vincent.

CANON 19. Un nom est rejeté quand le groupe naturel auquel le nom applique est indéterminé (hyponyme).

(*a*) Un nom spécifique ou sous-spécifique est un hyponyme quand il n'a pas été rattaché à une description qui peut être identifiée par des caractères diagnostiques ou par renvoi à un spécimen, à une figure ou à une localité typique.

EXEMPLES. — *Gentiana hybrida* Raf. Med. Rep. II. 5 : 353 (1808), est un hyponyme, car aucun diagnose n'en est publié ; *Lechea furfuracea* Raf. New Fl. Am. 1 : 92 (1836), est un hyponyme, car on ne peut en identifier la description.

(*b*) Un nom générique ou sous-générique est un hyponyme quand on ne peut le rattacher, tout au moins par une citation spécifique, à une espèce binaire publiée antérieurement ou simultanément ; ou bien quand son espèce typique n'est pas identifiée.

EXEMPLES. — *Adodendrum* Necker, Elem. 1 : 214 (1790), et *Calesiam* Adans. Fam. Pl. 2 : 446 (1763), sont hyponymes, car leurs auteurs n'ont ni nommé d'espèce binaire, ni cité d'espèce qui ait reçu antérieurement un nom binaire ; *Nudilus* Raf. Atl. Jour. 176 (1833), est un hyponyme, car son espèce typique, *N. paradoxus*, n'a pas été identifiée.

PARTIE III. ORTHOGRAPHE ET CITATION.

Section I. Orthographe.

1. L'orthographe originale des noms doit être maintenue excepté dans les cas suivants ; le changement ne devant en aucun cas porter atteinte à la priorité.

(*a*) Les erreurs typographiques évidentes peuvent être corrigées.

EXEMPLES. — *Scoria* Raf. est une faute d'impression au lieu de *Hicoria ; Rumhora* Raddi est une faute d'impression pour *Rumohra*, nommé d'après K. von Rumohr.

(*b*) Noms de forme adjective d'espèces et de sous-espèces s'accordent en genre avec le nom générique auquel ils sont associés.

EXEMPLES. — *Polygonum articulatum* L. = *Polygonella articulata* (L.) Meissn.; *Sisymbrium amphibium palustre* L. = *Roripa palustris* (L.) Bess.

(*c*) Les noms génériques dérivés de noms de personnes doivent être féminins, et s'ils ont une autre forme primitive doivent être corrigés.

EXEMPLES. — *Lippius* S. F. Gray, *Kantius* S. F. Gray, *Pallavicinius* S. F. Gray, devraient être changés en *Lippia*, *Kantia*, et *Pallavicinia*, et néanmoins conserver la date de 1821, quand ils furent d'abord publiés.

(*d*) Dans le cas de noms proposés dans des ouvrages ou le v et le j sont employés comme voyelles, ou l'u et l'i comme consonnes, on doit les corriger pour les faire accorder avec l'usage moderne.

EXEMPLES. — *Euonymus* et non *Evonymus ; Naias* et non *Najas ; Neuropteris* et non *Nevropteris ; Rivularia* et non *Riuularia* (*Rivvlaria*); *Jungia* et non *Iungia.*

2 Les noms génériques doivent toujours commencer par des majuscules.

EXEMPLES. — *Desfontainea* et non *desFontainea ; Durvillaea* et non *d'Urvillaea.*

3. Si les majuscules doivent être employées pour les noms spécifiques, on doit les employer seulement pour les substantifs ou pour les adjectifs dérivés de noms d'hommes.

EXEMPLES. — *Asplenium Trichomanes* L. ; *Uromyces Trifolii* (Hedw.) Lév. ; *Trichomanes Smithii* Hook. ; *Galium Boryanum* Walp.

4. On devrait éviter la publication de noms dérivés de deux langues, mais des noms déjà publiés ne seront pas rejetés à cause d'une telle dérivation.

EXEMPLES. — *Liquidambar* est Latin-Arabe ; *Fimbristylis* est Latin-Grec ; *Actiniceps* est Grec-Latin.

5. Les noms d'hybrides peuvent être écrits comme il suit :

(*a*) Un hybride peut être désigné en plaçant les noms des espèces parentes par ordre alphabétique et en réunissant par le signe × ; mais dans les hybrides d'origine expérimentale, ou dans lesquels le sexe des parents est connu, le parent femelle doit être écrit le premier, et le sexe indiqué par les signes ♀, ♂.

EXEMPLES. — *Carex debilis* × *virescens ; Digitalis lutea* ♀ × *purpurea* ♂.

(*b*) Un hybride peut être désigné, si l'on veut, comme une espèce ou sous-espèce, pourvu que le nom binaire ou trinaire soit précédé du signe ×, pour indiquer que c'est un hybride.

EXEMPLE. — × *Salix capreola* Kern.

(*c*) Un hybride entre des espèces de genres différents peut être désigné en ajoutant le nom spécifique au nom générique qui précède l'autre dans l'ordre alphabétique.

EXEMPLE. — × *Ammophila baltica* Link = *Ammophila arenaria* × *Calamagrostis Epigeios*.

(*d*) Un hybride provenant de parents dont un ou tous deux sont hybrides d'origine, peut être désigné en intercalant le nom du parent hybride entre parenthèses.

EXEMPLE. — *Salix* (*aurita* × *repens*) × *cinerea*.

(*e*) La prépondérance de l'un ou de l'autre parent peut être indiquée par les signes >, <.

EXEMPLES. — *Mentha longifolia* >× *rotundifolia*; *Mentha longifolia* ×< *rotundifolia*.

Section II. Citation d'auteurs.

1. Une citation d'auteur suivant un nom indique l'auteur par qui le nom a été publié le premier ; le nom de l'auteur peut être abrégé mais jamais de manière à causer une équivoque.

EXEMPLES. — Spreng. pour Sprengel, et non Spr., afin de distinguer de Spruce et d'autres ; Michx. pour Michaux, et non Mich., afin de distinguer de Micheli ; S. Wats. pour Sereno Watson, afin de distinguer de H. C. Watson.

2. Dans les cas suivants le nom de l'auteur primitif doit être cité entre parenthèses, suivi par celui de l'auteur qui le premier a publié le nom sous sa forme et application acceptées.

(*a*) Dans le cas d'un nom spécifique combiné d'abord avec un nom générique différent, ou un nom sous-spécifique combiné d'abord avec un nom binaire différent.

EXEMPLES. — *Moneses uniflora* (L.) A. Gray, pour la plante originairement décrite comme *Pyrola uniflora* par Linné et ensuite publiée pour la première fois comme *Moneses uniflora* par Asa Gray ; *Chondrophora nauseosa glabrata* (A. Gray) Rydberg, pour *Bigelovia graveolens* var. *glabrata* A. Gray.

(*b*) Dans le cas d'un nom générique adopté par citation d'après un ouvrage publié avant la première édition du Species Plantarum de Linné (1753).

EXEMPLES. — *Linnaea* (Gronov.) L.; *Anthoceros* (Mich.) L.; *Valerianella* (Tourn.) Poll.

(*c*) Dans le cas d'un nom appliqué à une catégorie différente de celle dans laquelle il a été proposé d'abord.

EXEMPLES. — *Salix cordata angustata* (Pursh) Anders., originairement *Salix angustata* Pursh ; *Actaea rubra* (Ait.) Willd., originairement *Actaea spicata* var. *rubra* Ait.; *Ardisia* subg. *Pickeringia* (Nutt.) Mez originairement genre *Pickeringia* Nutt.; *Raphidostegium* (Br. & Sch.) De Not., originairement *Rhynchostegium* subg. *Raphidostegium* Br. & Sch.

3. Une virgule entre le nom de la plante et le nom de l'auteur n'est pas à désirer.

EXEMPLES. — *Rumex* L., et non *Rumex*, L.; *Phacelia congesta* Hook., et non *Phacelia congesta*, Hook.; *Ilysanthes dubia* (L.) Barnhart, et non *Ilysanthes dubia*, (L.), Barnhart.

KODEX DER BOTANISCHEN NOMENKLATUR

In der Versammlung des botanischen Clubs der amerikanischen Gesellschaft zur Beförderung der Wissenschaften, gehalten am 2ten Januar, 1903, zu Washington, D. C., wurde eine Kommission für Nomenklatur ernannt. In dieser Versammlung wurde eine Reihe von Regeln vorgeschlagen und an dieser Kommission verwiesen, welche alle in Betracht kommenden Prinzipien und die Anwendung derselben in jeder Richtung einer sorgfältigen Prüfung unterzogen hat. Zum Zwecke einer mehr präcisen Formulation und um zu einem befriedigenden Resultate zu gelangen fand diese Kommission dass eine neue Anordnung und eine Modification der auf der in Washington gehaltenen Versammlung vorgeschlagenen Regeln anzurathen sei. Diese Prinzipien wurden sorgfältig verglichen mit denen enthalten in den Regeln der Nomenklatur angenommen auf den botanischen Kongressen in 1867 in Paris und in 1892 in Genua, ebenso mit Vorschlagen wie sie von verschiedenen Gruppen von Botanikern sowol wie von Einzelnen während der letzten Jahre gemacht waren; auch wurden die Methoden der Zoologen einem sorgfältigen Studium unterworfen — alles dieses für den alleinigen Zweck, um einen Kodex der Nomenklatur auszuarbeiten, der im Interesse aller Theile möglichst zufriendenstellend ist. Der Beschluss des Internationalen Kongresses zu Paris in 1900, nachdem die Nomenklatur auf den in 1905 in Wien abzuhaltenden Kongress aufgenommen werden sollte, wurde von der Kommission besonders in Erwägung gezogen und der damals angenommene Beschluss auf den vom Pariser Kongress von 1867 adoptirten Regeln neue Gesetze zu bauen wurde gleichfalls sorgfältigst erwogen. Dieser Beschluss bedingt eine Modification der Pariser Gesetze durch Verbesserung, Abschaffung oder Substitution verschiedener Artikel. Wir haben jedoch gefunden dass die Pariser Gesetze von 1867, genau genommen, sich den vorgeschlagenen Aenderungen nicht anbequemen, da deren Anordnung im Lichte der neueren Erfahrungen und neueren Wissens nicht rational ist, und weil viele wichtige Prinzipien entweder nicht anerkannt oder in zu oberflächlicher Erwägung gezogen sind; und endlich, da ein Mangel von klarer Präcision viele in Zweifel lässt. Wir befürworten daher und beabsichtigen auf dem Wiener Kongress von 1905 den Vorschlag zu machen dass der Kodex von 1867, in Uebereinstimmung mit den Verfügungen des Kommittees für Organisation des Kongresses von 1905, dahin verbessert werde dass alle seine Artikel gestrichen und der beigefügte Kodex substituirt werde.

J. C. ARTHUR, *Professor der Pflanzen-Physiologie und Pathologie, Purdue University.*

JOHN HENDLEY BARNHART, *Redacteur des Torrey Botanical Club.*

N. L. BRITTON, *Direktor, New York Botanical Garden.*

STEWARDSON BROWN, *Konservator der Botanischen Abtheilung, Academy of Natural Sciences of Philadelphia.*

FREDERIC E. CLEMENTS, *Hilfs-Professor der Botanik, University of Nebraska.*

O. F. COOK, *Chef der Abtheilung für Botanische Untersuchungen in tropischer Agrikultur, U. S. Department of Agriculture; Hilfs-Kurator (Kryptogamen), U. S. National Herbarium.*

JOHN M. COULTER, *Professor der Botanik, University of Chicago; Redacteur der Botanical Gazette.*

FREDERICK V. COVILLE, *Chef der Botanischen Abtheilung, U. S. Department of Agriculture; Kurator, U. S. National Herbarium.*

F. S. EARLE, *Direktor, Estación Agronómica Central de Cuba.*

ALEXANDER W. EVANS, *Hilfs-Professor der Botanik, Yale University.*

TRACY E. HAZEN, *Lehrer der Botanik, Columbia University.*

ARTHUR HOLLICK, *Hilfs-Kurator (Paläobotanik), New York Botanical Garden.*

MARSHALL A. HOWE, *Hilfs-Kurator (Algen), New York Botanical Garden; Redacteur der Torreya.*

F. H. KNOWLTON, *U. S. Geological Survey; Kustos (Mesozoische Pflanzen), U. S. National Museum.*

GEORGE T. MOORE, *Chef des Laboratoriums für Pflanzen-Physiologie, U. S. Department of Agriculture; Kustos (Algen), U. S. National Museum.*

E. L. MORRIS, *Chef der Biologischen Abtheilung an den Hochschulen zu Washington, D. C.*

WILLIAM ALPHONSO MURRILL, *New York Botanical Garden.*

H. H. RUSBY, *Professor der Physiologie, Botanik und Materia Medica, und Dekan der Facultät, College of Pharmacy of the City of New York.*

C. L. SHEAR, *Pflanzen-Pathologe, U. S. Department of Agriculture.*

WILLIAM TRELEASE, *Direktor, Missouri Botanical Garden.*

LUCIEN M. UNDERWOOD, *Professor der Botanik, Columbia University.*

DAVID WHITE, *U. S. Geological Survey; Kustos (Paläozoische Pflanzen), U. S. National Museum.*

WILLIAM F. WIGHT, *Botanische Abtheilung (Geographische Botanik), U. S. Department of Agriculture.*

MITGLIEDER UND STELLVERTRETER DER KOMMISSION FÜR NOMENKLATUR.

KODEX DER BOTANISCHEN NOMENKLATUR

TEIL I. PRINZIPIEN.

1. Dauerhaftigkeit, Einheitlichkeit, und Bequemlichkeit in der Benennung von Pflanzen und Tieren zu sichern ist der Hauptzweck formeller Nomenklatur in systematischer Biologie.
2. Die allgemeine Anwendung von binären Namen zur Bezeichnung von Pflanzen (Linné's Species Plantarum, 1753) wird als der Anfangspunkt botanischer Nomenklatur betrachtet.
3. Publikationspriorität ist ein Grundprinzip botanischer Nomenklatur. Zwei Gruppen ein und derselben Kategorie können nicht denselben Namen tragen.

   ANMERKUNG. — Der vorhergehende Gebrauch eines Namens in der Zoologie schliesst dessen Gebrauch in der Botanik nicht aus.

4. Die Anwendung eines Namens ist durch Hinweis auf den nomenklatorischen Typus bestimmt.

TEIL II. REGELN.

Sektion I. Kategorien der Klassifikation.

REGEL 1. Verbundene oder zusammenhängende Gruppen von Individuen werden als Arten bezeichnet.

REGEL 2. Arten werden in Gattungen gruppirt; Gattungen in Tribus; Tribus in Familien; Familien in Ordnungen; Ordnungen in Klassen; Klassen in Phyla.

ANMERKUNG. — Dem zoologischem Gebrauch gemäss ist Ordnung dem Namen Kohorte vorzuziehen, und Phylum dem Namen Division vorzuziehen.

REGEL 3. Wenn noch weitere Kategorien zur bequemlichen Bezeichnung von Verwandtschaftsverhältnissen notwendig sind, dann sind dieselben durch die Anerkennung von Zwischengruppen deren Namen durch die Hinzufügung des Präfixes "unter" zu den Namen der oben benannten Hauptkategorien gebildet werden zu erlangen.

BEISPIELE. — Unterart, Untergattung, Unterfamilie, Unterordnung.

REGEL 4. Andere Bezeichnungen, wie Gruppe, Sektion, Reihe, Division, und Abteilung können zur bequemeren temporären Anordnung in den oben benannten Kategorien angewandt werden aber diese Namen haben in formeller Systematik keine Gültigkeit.

ANMERKUNG. — Die Bezeichnung Varietät ist auf den Gebrauch in Gartenkunst verwiesen.

Sektion II. Bildung der Namen.

REGEL 5. Arten- und Unterartennamen bestehen aus lateinischen oder latinisierten Adjektiven oder Substantiven, die letzteren entweder als Nominative in Apposition oder als Genitive.

BEISPIELE. — *Hookerianus; europaeus; vulgaris; heterophyllus; malvicola; Tulipifera; Tuna; Engelmanni; Sonorae; Trifolii.*

REGEL 6. Gattungs- und Untergattungsnamen bestehen aus lateinischen oder latinisierten Substantiven oder gleichwertigen Bezeichnungen.

BEISPIELE. — *Rosa; Convolvulus; Hedysarum; Bartramia; Liquidambar; Couroupita; Tsuga; Gloriosa; Impatiens; Manihot.*

REGEL 7. Die Namen der Untertribus, Ordnungen und Zwischengruppen werden nach einer Gattung derselben Gruppe gebildet.

(*a*) Für die Namen der Tribus fügt man -eae, der Familien -aceae, und der Ordnungen -ales zum Wortstamme des Gattungsnamen.

BEISPIELE. — *Roseae; Rosaceae; Rosales.*

(*b*) Für die Namen der Untertribus fügt man -anae, der Unterfamilien -atae, und der Unterordnungen -ares zum Wortstamme des Gattungsnamens.

BEISPIELE. — *Rosanae; Rosatae; Rosares.*

REGEL 8. Die Namen der Unterklassen und höheren Gruppen bestehen aus pluralen lateinischen oder latinisierten Substantiven.

BEISPIELE. — *Monocotyledones; Angiospermae; Pteridophyta.*

Sektion III. Publikation der Namen.

REGEL 9. Ein Arten- oder Unterartenname gilt als publiziert wenn derselbe in Druckschriften in Verbindung mit einer Beschreibung (in der Paläobotanik mit einer Abbildung) oder mit Hinweis auf eine schon früher publizierte Beschreibung verteilt worden ist.

BEISPIELE. — *Coursetia arborea* Griseb. Fl. Brit. W. Ind. 183 (1859), ist mit einer Beschreibung publiziert; *Cynanchum nivale* Nym. Syll. Fl. Eur. 108 (1855), ist mit Hinweis auf das früher beschriebene *Vincetoxicum nivale* Boiss. & Heldr. publiziert; *Pterospermites Whitei* Ward, Ann. Rep. U. S. Geol. Surv. **6**; 556. *pl. 56, f. 5, 6* (1885), eine fossile Art, ist mit einer Abbildung publiziert, aber ohne Beschreibung.

(*a*) Die für primäre Unterabteilungen von Arten publizierten Benennungen werden als Unterartennamen behandelt wie auch immer dieselben von ihren Autoren betrachtet worden sein mögen.

BEISPIELE. — *Juglans alba minima* Marsh. Arb. Am. 68 (1785); *Scirpus maritimus β fluviatilis* Torr. Ann. Lyc. N. Y. 3 : 324 (1836); *Zizia aurea* var. *Bebbii* Coult. & Rose, Bot. Gaz. 12 : 138 (1887); diese sind primäre Divisionen der Arten, anerkennbar als Unterarten.

(*b*) Wird eine Art von einer Gattung in eine andere versetzt so wird der ursprüngliche Artenname beibehalten, wenn das resultierende Binom nicht schon vorher publiziert worden ist.

BEISPIELE. — *Bromus giganteus* L. Sp. Pl. 77, ist *Festuca gigantea* (L.) Vill. Hist. Pl. Dauph. 2 : 110 (1787); *Arum triphyllum* L. Sp. Pl. 965, muss *Arisaema triphyllum* (L.) Torr. Fl. N. Y. 2 : 239 (1843), genannt werden, nicht *Arisaema atrorubens* Blume, Rumphia, 1 : 97 (1835); *Laurus Sassafras* L. Sp. Pl. 371, muss *Sassafras Sassafras* (L.) Karst. Deutsch. Fl. 505 (1881), heissen, nicht *Sassafras officinale* Nees & Eberm. Handb. Med.-pharm. Bot. 2 : 418 (1831); *Schoenus pusillus* Sw. Nov. Gen. & Sp. Pl. 20 (1788), indessen, zu *Rynchospora* versetzt, wird nicht *Rynchospora pusilla* (Sw.) Griseb. Kar. 123 (1857), genannt, da vor dem Jahre 1857 dasselbe Binom für eine andere Art, *Rynchospora pusilla* Chapm. (1849), publiziert wurde.

(*c*) Eine zum Artenrange erhobene Unterart behält denselben Namen, wenn das resultierende Binom nicht schon vorher publiziert worden ist.

BEISPIELE. — *Sparganium simplex androcladum* Engelm. in A. Gray Man. Ed. 5, 481 (1867), wenn als gute Art angesehen, muss die Benennung *Sparganium androcladum* (Engelm.) Morong, Bull. Torrey Club, 15 ; 78 (1888), erhalten; *Juncus acuminatus robustus* Engelm. Trans. Acad. Sci. St. Louis, 2 : 463 (1868), indessen, wird nicht *Juncus robustus* (Engelm.) Coville in Britt. & Brown, Ill. Fl. 1 : 395 (1896), genannt, da vor dem Jahre 1896 dieses Binom für eine andere Art, *Juncus robustus* S. Wats. Proc. Am. Acad. 14 : 302 (1879), gebraucht wurde.

REGEL 10. Ein Gattungs- oder Untergattungsname gilt als publiziert wenn derselbe in Druckschriften verteilt worden ist (1) mit einer Gattungs- oder Artenbeschreibung (oder in der Paläobotanik mit einer Abbildung) und mit einem binären Artennamen; (2) mit einem Gattungs- und Artennamen und mit dem Citate einer schon früher publizierten Beschreibung; oder (3) mit Hinweis auf eine Artenbeschreibung, welche durch Citat mit einer schon früher mit binären Namen publizierten Art in Verbindung gebracht werden kann.

BEISPIELE. — *Pachysandra* Michx. Fl. Bor. Am. 2 : 177 (1803), ist mit einer Beschreibung der Gattung und Art und einem binomischen Artennamen publiziert; *Brasenia* Schreb. ex Gmel. Syst. 2 : 853 (1791), ist mit einer Beschreibung der Gattung und einen binomischen Artennamen publiziert; *Silphium* L. Sp. Pl. 919 (1753), ist mit einer Beschreibung der Art und einen binomischen Artennamen publiziert; *Poacites* Schloth. Petrefact. 416. *pl. 26, f. 1, 2* (1820), eine fossile Gattung, ist mit Abbildungen und einem binomischen Artennamen publiziert, aber ohne Beschreibung; *Nyssa* L. Sp. Pl. 1058 (1753), ist mit einem Gattungs- und Artennamen und dem Citate früheren veröffentlichten Beschreibungen publiziert; *Dryopteris* Adans. Fam. Pl. 2 : 20 (1763) ist publiziert mit Hinweis auf die Beschreibung einer Art welche durch Citat mit dem früher publizierten *Polypodium Filix-mas* L. Sp. Pl. 1090 (1753), in Verbindung gebracht werden kann, indem Adanson sowie Linné *Filix mas* von Fuchs citiren.

REGEL 11. Namen der Untertribus, Ordnungen und Zwischengruppen gelten als publiziert wenn dieselben in Druckschriften mit direkten oder indirekten Citaten einer Gattung der gleichen Gruppe verteilt worden sind.

BEISPIELE. — *Moraceae* Lindl. Veg. Kingd. 266 (1847), ist mit dem Citate der dazu gehörenden Gattungen publiziert; *Ophioglossales* Engler, Syll. Ed. 2, 63 (1898), ist mit dem Citate der dazu gehörenden Gattungen publiziert.

REGEL 12. Ein Name wird weder durch dessen Citation in der Synonymik noch durch zufälligen Gebrauch als gültig publiziert betrachtet.

BEISPIELE. — *Echeveria spicata*, von De Candolle citirt, Prodr. 3 : 349 (1828), als Synonym von *Fouquiera formosa*, ist nicht publiziert, und *Echeveria* DC., auf Seite 401 desselben Bandes publiziert, ist daher nicht ungültig; *Acrostichum Plumieri* "Desv. herb.," als Synonym von *A. viscosum* in Fée, Mém. Fam. Foug. 2 : 46 (1845), citirt, ist nicht publiziert, und *Acrostichum Plumieri* Fée, auf Seite 50 desselben Werkes als Art publiziert, ist daher nicht ungültig; *Hormisus opuntioides* Targ., citirt von Bertoloni, Amoen. Ital. 316 (1819), als Synonym von *Fucus Sertolara* Bertol. (= *Halimeda Tuna*), wird dadurch als nicht publiziert betrachtet.

REGEL 13. Von den gleichzeitig in demselben Werke publizierten Namen sind diejenigen welche Platzpriorität haben als prioritätsberechtigt anzuerkennen.

BEISPIELE. — *Alsine* L. Sp. Pl. 272, besitzt Prioritätsrecht über *Stellaria* L. Sp. Pl. 421; *Aira spicata* L. Sp. Pl. 63, besitzt Prioritätsrecht über *Aira spicata* L. Sp. Pl. 64; *Hibiscus Moscheutos* L. Sp. Pl. 693, besitzt Prioritätsrecht über *H. palustris*, da dieser Name auf derselben Seite zuerst erscheint.

Sektion IV. Anwendung der Namen.

REGEL 14. Der nomenklatorische Typus einer Art oder Unterart ist dasjenige Exemplar welches vom beschreibenden Autor in der ursprünglichen Publikation mit dem Namen belegt wurde.

BEISPIELE. — *Polypodium marginale* L. Sp. Pl. 1091, ist als Typus dargestellt durch die Bezeichnung eines Exemplars welches von Kalm in Canada gesammelt wurde; *Stachys arenicola* Britton, Man. 792 (1901), ist als Typus dargestellt durch die Bezeichnung eines Exemplars aus Staten Island, N. Y.; *Carex intumescens Fernaldii* Bailey, Bull. Torrey Club, **20**: 418 (1893), its als Typus dargestellt durch die Bezeichnung eines Exemplars welches in Cedar Swamp, Aroostook County, Maine, von M. L. Fernald gesammelt wurde.

(*a*) Wenn mehr als ein Exemplar ursprünglich citirt wurde, dann kann der Typus oder die diesen miteinschliessende Gruppe durch die Benennung nach den Sammler, der Lokalität, oder der Wirtpflanze angedeutet werden.

BEISPIELE. — *Eriogonum Porteri* Small, Bull. Torrey Club, **25**: 41 (1898), ist von mehreren Exemplaren beschrieben, von welchen das von T. C. Porter gesammelte den Typus vorstellt; *Gaillardia arizonica* A. Gray, Syn. Fl. N. Am. 1^2: 353 (1884), ist von mehreren Exemplaren beschrieben, von welchen das von Palmer in Arizona gesammelte den Typus vorstellt; *Cuscuta Cephalanthi* Engelm. Am. Jour. Sci. 43: 336 (1842), ist auf verschiedene Wirtpflanzen Exemplare basirt, von welchen das auf *Cephalanthus* vorkommende den Typus vorstellt.

(*b*) Zwischen gleichwertigen Exemplaren gilt dasjenige als Typus welches mit der ursprünglichen Beschreibung zuerst abgebildet, oder im Falle dass die Abbildung fehlt, zuerst genannt wurde.

BEISPIELE. — *Calyptridium roseum* S. Wats. Bot. King's Exp. 44. *pl. 6, f. 6–8* (1871), ist auf wenigstens drei Exemplare basirt, von welchen dasjenige als Typus betrachtet wird welches abgebildet war; *Arnica cordifolia* Hook. Fl. Bor. Am. 1: 331 (1833), ist auf zwei Exemplare basirt, von welchen keine Abbildungen vorhanden waren, und das erstgenannte, von Drummond im Alpengehölz den Felsengebirgen gesammelt, gilt als Typus.

(*c*) Fehlt ein Originalexemplar dann dient dasjenige als Typus welches in erkennbarer Abbildung dargestellt ist oder (wenn keine Abbildung da ist) durch die zuerst citirte oder nachher veröffentlichte Beschreibung repräsentirt ist.

BEISPIELE. — *Trillium sessile* L. Sp. Pl. 340, ist auf drei Citate basirt, von welchen das zweite als Typus betrachtet wird, da es mit einer Abbildung repräsentirt ist; *Centaurea Scabiosa* L. Sp. Pl. 913, ist auf mehrere Citate basirt, von welchen das erste als Typus dient, da keine Abbildungen citirt sind.

REGEL 15. Der nomenklatorische Typus einer Gattung oder einer Untergattung ist diejenige Art welche ursprünglich vom Autor des Namens als Typus benannt oder bezeichnet wurde.

In Falle dass keine Art als Typus bezeichnet worden ist dann dient die erste in der Reihenfolge unter den folgenden Bedingungen dazu berechtigte binomische Art als Typus :

(*a*) Der Typus ist aus einer ursprünglich als typisch bezeichneten Untergattung, Sektion, oder Liste von Arten zu wählen.

BEISPIELE. — *Psilogramme* Kuhn, Festschr. 50-Jähr. Jub. Königs. Realschule zu Berlin, 332 (1882), ist als Typus dargestellt durch die erstgenannte Art der zweiten Sektion *Eupsilogramme*, und nicht durch Arten der ersten Sektion *Jamesonia*, welche auf einen früher publizierten Gattungsnamen basirt ist; *Phania* DC. Prodr. **5**: 114 (1826), ist als Typus dargestellt durch *P. multicaulis* DC., die einzige Art in der Sektion *Euphania*.

(*b*) Eine abgebildete Art ist einer nichtabgebildeten in derselben Publikation vorzuziehen, wenn aber zu der Zeit keine Abbildung vorhanden war dann erhält eine von einem Citate einer Abbildung begleitete Art den Vorzug.

BEISPIELE. – *Lespedeza* Michx. Fl. Bor. Am. **2**: 70 (1803), ist als Typus dargestellt durch *L. procumbens* Michx. *loc. cit. pl. 39*, die zuerst abgebildete Art; *Basanacantha* Hook. f. in Benth. & Hook. Gen. Pl. **2**: 82 (1873), ist als Typus dargestellt durch die zweitgenannte Art, *Randia tetracantha* (Cav.) DC., welche von Cavanilles abgebildet war, während *Randia Humboldtiana* DC., die von Hooker zuerst genannte Art, nicht abgebildet war.

(*c*) Die Typen der durch Citate nichtbinärer Literatur adoptirten Gattungen (mit oder ohne Namensänderung) sind von denjenigen der ursprünglichen Arten zu wählen die Namen in der ersten binären Publikation der Gattung erhielten. Die Typen der Gattungen von Linné's Species Plantarum (1753) sind durch die in seiner Genera Plantarum (1754) angegebenen Citate zu bestimmen.

ANMERKUNG. — Linné's Species Plantarum enthalten keine Hinweise auf Gattungen, aber die Ausgabe der Genera Plantarum des Jahres 1754 war offenbar zur selben Zeit in Bearbeitung und wirklich ein ergänzender Band desselben Werkes. Es stimmt mit der Behandlungsweise welche in Species Plantarum befolgt wird mehr überein als die anderen Ausgaben, und macht es daher möglich mehr Linneische Gattungsnamen in ihrer jetzigen Anwendung beizubehalten.

BEISPIELE. — *Cypripedium* L. Sp. Pl. 951, eine Gattung aus Tournefort adoptirt mit einer Veränderung seiner Benennung *Calceolus*, ist als Typus dargestellt durch *Cypripedium Calceolus*, die einzige Art welche von beiden Autoren gemeinschaftlich gebraucht wurde ; *Seseli* L. Sp. Pl. 259, eine Gattung aus Boerhaave adoptirt, ist als Typus dargestellt durch die zweite Linneische Art, *Seseli montanum*, welches in Linné die erste Art ist welche von beiden Autoren gemeinschaftlich gebraucht wurde; *Silene* L. Sp. Pl. 416, eine Gattung aus Dillenius adoptirt mit einer Veränderung seiner Benennung *Viscago*, ist als Typus dargestellt durch *Silene anglica*, die erste der dreizehn Arten von Dillenius abgebildet in Linné; *Fritillaria* L. Sp. Pl. 303, eine Gattung aus Tournefort adoptirt, ist als Typus dargestellt durch die fünfte Linneische Art, *Fritillaria Meleagris*, eine der drei Arten in *Fritillaria* eingeschlossen von beiden Autoren, und ist von den drei Arten gewählt worden da es diejenige ist welche Tournefort abbildete.

(*d*) Wird ein präbinärer Gattungsname durch die Publikation eines binären Gattungsnamens verdrängt, dann deutet die Anwendung dieses verdrängten Namens als Benennung einer unter dem neuen Gattungsnamen eingereihten Art den Typus an.

BEISPIEL.—*Dianthus* L. Sp. Pl. 409, eine aus Tournefort adoptirte Gattung mit einer Veränderung dessen Benennung *Caryophyllus*, ist durch *Dianthus Caryophyllus*, eine der 15 ursprünglichen Linneischen Arten, als Typus dargestellt.

(*e*) Wird ein ehemaliger Artenname einer miteingeschlossenen Art zum Namen der Gattung angewandt, dann deutet dieser den Typus an.

BEISPIELE.—*Amsonia* Walt. Fl. Car. 98 (1788), ist als Typus dargestellt durch *Tabernaemontana Amsonia* L., eine der zwei urpsrünglichen Arten; *Sordaria* Ces. & DeN. Comm. Soc. Critt. Ital. 1 : 225 (1863), ist als Typus dargestellt durch *Sphaeria Sordaria* Fr., eine der 12 ursprünglichen Arten.

(*f*) Um Veränderungen im gegenwärtigen Gebrauche eines Linneischen Gattungsnamens zu verhüten kann eine allgemein bekannte und wirtschaftlich wichtige Art, in Uebereinstimmung mit dem folgenden von Linné niedergelegten Grundsatze, als Typus gewählt werden: (Phil. Bot. 197. 1751) "Si genus receptum, secundum jus naturae et artis, in plura dirimi debet, tum nomen antea commune manebit vulgatissimae et officinali plantae."

BEISPIELE.—*Poa* L. Sp. Pl. 67, ist als Typus dargestellt durch *P. pratensis* L., die gewöhnlichste der ursprünglichen Arten; *Mollugo* L. Sp. Pl. 89, ist als Typus dargestellt durch *M. verticillata* L., die gewöhnlichste der ursprünglichen Arten.

Sektion V. Verwerfung der Namen.

REGEL 16. Ein Name wird verworfen wenn derselbe präoccupirt ist (Homonym).

(*a*) Ein Arten- oder Unterartenname ist Homonym wenn derselbe als Name einer anderen Art unter demselben Gattungsnamen schon publiziert worden ist. Zwei Unterarten derselben Gattung können denselben Namen nicht behalten.

BEISPIELE. — *Acer saccharinum* Wang. Amer. 36. *pl. 2, f. 26* (1787), ist als Homonym zu betrachten von *Acer saccharinum* L. Sp. Pl. 1055 (1753); *Vaccinium myrtilloides* Hook. Fl. Bor. Am. **2**: 32 (1834), ist ein Homonym von *Vaccinium myrtilloides* Michx. Fl. Bor. Am. **1**: 234 (1803), und ist verwerflich ob das letztere als bestimmte Art betrachtet wird oder nicht; *Juncus nodosus megacephalus* Torr. Fl. N. Y. **2**: 326 (1843), ist ein Homonym von *Juncus megacephalus* M. A. Curtis, Boston Jour. Nat. Hist. **1**: 132 (1835); *Chrysopsis pilosa* (Walt.) Britton, Mem. Torrey Club, **5**: 316 (1894), ist ein Homonym von *Chrysopsis pilosa* Nutt. Jour. Acad. Nat. Sci. Phila. **7**: 66 (1834), und ist verwerflich, obgleich *Erigeron pilosum* Walt. im Jahre 1788 publiziert war; *Carex scoparia moniliformis* Tuckerm. Enum. Meth. Car. 17 (1843), und *Carex straminea moniliformis* Tuckerm. *loc. cit.*, können nicht beide beibehalten werden.

(*b*) Ein Gattungs- oder Untergattungsname ist Homonym wenn derselbe schon vorher als Name einer anderen Gattung publiziert oder im Druck vorgeschlagen wurde.

BEISPIELE. — *Torreya* Arn. Ann. Nat. Hist. **1**. 130 (1838), ist ein Homonym von *Torreya* Raf. Am. Mo. Mag. **3**: 356 (1818), von *Torreya* Raf. Jour. Phys. **89**: 105 (1819), von *Torreya* Spreng. Neue Entdeck. **2**: 121 (1821), und von *Torreya* Eat. Man. Ed. 5, 420 (1829); *Rivularia* Ag. Syn. Alg. Scand. xxxviii (1817), ist ein Homonym von *Rivularia* Roth, Cat. **1**: 212 (1797); *Nesaea* Lamour. Nouv. Bull. Soc. Philom. **3**: 185 (1812), ist ein Homonym von *Nesaea* Commers. ex Juss. Gen. Pl. 332 (1789); *Bulliarda* DC. Bull. Soc. Philom. **3**^{49}: **1** (1801), ist ein Homonym von *Bulliarda* Neck. Elem. **2**: 321 (1790).

(*c*) Aehnliche Namen werden als Homonyme behandelt nur wenn dieselben ungleiche Schreibweisen desselben Wortes vorstellen, oder im Falle von Arten- oder Unterartennamen wenn dieselben nur in den adjektivischen oder genitivischen Endungen verschieden sind.

BEISPIELE. — *Penicillus* und *Penicillium*, *Callitriche* und *Calothrix*, *Nemastylis* und *Nematostylis*, *Pterigophyllum* und *Pteridophyllum*, können beibehalten werden; *Cyathophora* und *Cyathophorum*, *Asterocarpus* und *Astrocarpus* können nicht beibehalten werden. *Greenei* und *Greenii*, nach verschiedenen Personen benannt, Greene und Green, können in derselben Gattung beibehalten werden; *virginicus*, *virginianus* und *virginiensis*, *oreganus* und *oregonensis*, *Hookeri* und *Hookerianus*, können nicht in derselben Gattung beibehalten werden.

Regel 17. Ein Name wird verworfen wenn ein älterer gültiger auf ein anderes Bestandteil derselben Gruppe basirter Name (Metonym) vorhanden ist.

Beispiele. — *Meibomia* Heist. ex Adans. Fam. Pl. **2** : 509 (1763) ist auf *Hedysarum canadense* L. Sp. Pl. 748, basirt, und *Desmodium* Desv. Jour. de Bot. II. **1** : 122 (1813), ist als typus dargestellt durch *Hedysarum asperum* Poir. Encycl. Suppl. **6** : 408 (1804), folglich, wenn diese Arten als zur selben Gattung gehörend betrachtet werden, ist der Name *Desmodium* verwerflich ; *Boletopsis* P. Henn. Nat. Pflanzenf. 1^{1**} : 194 (1899), kann nicht als eine Gattung anerkannt werden mit Einschluss einer Sektion den Namen *Boletinus* Kalchb. tragend, da diese in 1877 als eine Gattung eingesetzt wurde ; *Sisymbrium altissimum* L. Sp. Pl. 659 (1753), *Sisymbrium Sinapistrum* Crantz, Stirp. Austr. Ed. 2, 52 (1769), und *Sisymbrium pannonicum* Jacq. Coll. **1** : 70 (1786), haben verschiedene Typen, aber wenn diese als zu derselben Art gehörend betrachtet werden, so sind die zwei späteren Namen Metonymen von den Linneischen.

Regel 18. Ein Name wird verworfen wenn ein älterer gültiger auf denselben Typus basirter Name (Typonym) vorhanden ist.

Beispiele.—*Miegia* Pers. Syn. **1** : 101 (1805), ist ein Typonym von *Arundinaria* Michx. Fl. Bor. Am. **1** : 73 (1803), da beide auf dieselbe Art basirt sind ; *Asplenium Vincentis* Christ, Bot. Jahrb. **24** : 109 (1897), ist ein Typonym von *A. Guildingii* Jenm. Gard. Chron. III. **15** : 70 (1894), da beide basirt sind auf H. H. Smith's *No. 1346* aus St. Vincent.

Regel 19. Ein Name wird verworfen so lange die natürliche Gruppe zu deren Benennung der Name dient unbestimmt ist (Hyponym).

(*a*) Ein Arten- oder Unterartenname ist Hyponym wenn derselbe nicht in Verbindung mit einer durch diagnostische Merkmale oder durch Hinweis auf ein Typus-Exemplar, eine Abbildung oder eine Lokalität identifizierbare Beschreibung gebraucht worden ist.

Beispiele.—*Gentiana hybrida* Raf. Med. Rep. II. **5** : 353 (1808), ist ein Hyponym, da keine Diagnose publiziert ist ; *Lechea furfuracea* Raf. New Fl. Am. **1** : 92 (1836), ist ein Hyponym, da die Beschreibung nicht identifizierbar ist.

(*b*) Ein Gattungs- oder Untergattungsname ist Hyponym wenn derselbe durch spezifisches Citat mit einer vorher oder gleichzeitig publizierten binomischen Art nicht associierbar ist ; oder wenn die Typus-Art noch nicht identifiziert ist.

Beispiele.—*Adodendrum* Necker, Elem. **1** : 214 (1790), und *Calesiam* Adans. Fam. Pl. **2** : 446 (1763), sind Hyponyme, da ihre Autoren keine binomische Art oder eine Art welche vorher einen Binom erhalten hatte, citirten ; *Nudilus* Raf. Atl. Jour. 176 (1833), ist ein Hyponym, da die Typus-Art, *N. paradoxus*, noch nicht identifiziert ist.

TEIL III. RECHTSCHREIBUNG UND CITATION.

Sektion I. Rechtschreibung.

1. Die ursprüngliche Schreibweise ist mit Ausnahme der folgenden Fälle beizubehalten. Die Aenderungen bleiben ohne Einfluss auf Priorität.

(*a*) Offenbar typographische Fehler können corrigirt werden.

BEISPIELE.—*Scoria* Raf. ist ein Druckfehler, für *Hicoria*; *Rumhora* Raddi, ist ein Druckfehler für *Rumohra*, nach K. von Rumohr genannt.

(*b*) Adjektivische Arten- und Unterartennamen stimmen im Geschlechte mit dem associierten Gattungsnamen überein.

BEISPIELE.—*Polygonum articulatum* L. = *Polygonella articulata* (L.) Meissn.; *Sisymbrium amphibium palustre* L. = *Roripa palustris* (L.) Bess.

(*c*) Nach Personen gebildete Gattungsnamen sind Feminina und sind, wenn urspünglich in anderen Formen, zu ändern.

BEISPIELE.—*Lippius* S. F. Gray, *Kantius* S. F. Gray, *Pallavicinius* S. F. Gray, sollen verändert werden zu *Lippia*, *Kantia*, und *Pallavicinia*, und doch datiren von 1821, dem Jahre in welchem sie ursprünglich publiziert sind.

(*d*) Die Schreibweise von Namen in Werken vorgeschlagen in welchen v und j als Vokale und u und i als Konsonante vorkommen ist zu modernisieren.

BEISPIELE.—*Euonymus*, nicht *Evonymus*; *Naias*, nicht *Najas*; *Neuropteris*, nicht *Nevropteris*; *Rivularia*, nicht *Riuularia* (*Rivvlaria*); *Jungia*, nicht *Iungia*.

2. Gattungsnamen werden mit grossen Anfangsbuchstaben geschrieben.

BEISPIELE.—*Desfontainea*, nicht *des Fontainea*; *Durvillaea*, nicht *d' Urvillaea*.

3. Artennamen werden nur dann mit grossen Anfangsbuchstaben geschrieben wenn dieselben Substantive oder von Personennamen abgeleitete Adjektive sind.

BEISPIELE.—*Asplenium Trichomanes* L.; *Uromyces Trifolii* (Hedw.) Lév.; *Trichomanes Smithii* Hook.; *Galium Boryanum* Walp.

4. Die Publikation zweisprachiger Namen ist zu vermeiden, aber publizierte Namen sind aus diesem Grunde nicht zu verwerfen.

BEISPIELE.—*Liquidambar* ist Lateinisch-Arabisch; *Fimbristylis* ist Lateinisch-Griechisch; *Actiniceps* ist Griechisch-Lateinisch.

5. Die Namen der Hybriden sind wie folgt zu schreiben:

(*a*) Ein Bastard wird durch die Namen der elterlichen Art oder Unterart in alphabetischer Ordnung und mit dem Zeichen × verbunden bezeichnet; aber in experimentalisch produzirten Bastarden, oder wenn das Geschlecht der Eltern bekannt ist, wird der Name der Mutter zuerst geschrieben und das Geschlecht durch die Zeichen ♀, ♂, gekennzeichnet.

BEISPIELE. — *Carex debilis* × *virescens; Digitalis lutea* ♀ × *purpurea* ♂.

(*b*) Wenn wünschenswert kann ein Bastard wie eine Art oder Unterart benannt werden, vorausgesetzt dass die Hybridität durch die Anbringung eines × vor dem Binom oder Trinom ausgedrückt wird.

BEISPIEL. — × *Salix capreola* Kern.

(*c*) Ein Bastard zweier Arten verschiedener Gattungen kann durch die Hinzufügung des Artennamens zum Gattungsnamen der Mutter, oder wenn das Geschlecht der Eltern unbekannt, zum nach alphabetischer Ordnung erststehenden Gattungsnamen bezogen werden.

BEISPIEL. — × *Ammophila baltica* Link = *Ammophila arenaria* × *Calamagrostis Epigeios.*

(*d*) Ein Bastard mit einer oder auch beiden der Elternpflanzen von hybridischer Abstammung kann durch die Anführung des Namens der hybridischer Elternpflanze in runde Klammern gesetzt werden.

BEISPIEL. — *Salix* (*aurita* × *repens*) × *cinerea.*

(*e*) Die grössere Bedeutung der einen Elternpflanze der anderen gegenüber kann durch die Zeichen >, < ausgedrückt werden.

BEISPIELE. — *Mentha longifolia* > × *rotundifolia; Mentha longifolia* × < *rotundifolia.*

Sektion II. Autorcitation.

1. Eine nach dem Namen stehende Autorcitation bezieht sich auf den Autor der den Namen zuerst publizierte; der Name des Autors kann abgekürzt werden, aber nie in solcher Weise dass Zweideutigkeit dadurch entsteht.

BEISPIELE. — Spreng. für Sprengel, nicht Spr., zum Unterscheiden von

Spruce und anderen; Michx. für Michaux, nicht Mich., zum Unterscheiden von Micheli; S. Wats. für Sereno Watson, zum Unterscheiden von H. C. Watson.

2. In den folgenden Fällen ist der Name des ursprünglichen Autors in runde Klammern zusetzen, und der Name des Autors der die Benennung in ihrer acceptirten Form und Anwendung zuerst publizierte ist demselben nachzusetzen.

(*a*) Ein Artenname ursprünglich mit einem anderen Gattungsnamen oder ein Unterartenname ursprünglich mit einem anderen Binom verbunden.

BEISPIELE. — *Moneses uniflora* (L.) A. Gray, für die Pflanze ursprünglich von Linné beschrieben als *Pyrola uniflora*, und nachher zuerst publiziert als *Moneses uniflora* von Asa Gray; *Chondrophora nauseosa glabrata* (A. Gray) Rydberg für *Bigelovia graveolens* var. *glabrata* A. Gray.

(*b*) Ein Gattungsname adoptirt durch Citate aus Werken die vor der ersten Ausgabe von Linné's Species Plantarum (1753) erschienen sind.

BEISPIELE. — *Linnaea* (Gronov.) L.; *Anthoceros* (Mich.) L.; *Valerianella* (Tourn.) Poll.

(*c*) Ein Name der für eine Kategorie angewandt wird aber ursprünglich für eine andere vorgeschlagen wurde.

BEISPIELE. — *Salix cordata angustata* (Pursh) Anders., ursprünglich *Salix angustata* Pursh; *Actaea rubra* (Ait.) Willd., ursprünglich *Actaea spicata* var. *rubra* Ait.; *Ardisia* Unterg. *Pickeringia* (Nutt.) Mez, ursprünglich die Gattung *Pickeringia* Nutt; *Raphidostegium* (Br. & Sch.) De Not., ursprünglich *Rhynchostegium* Unterg. *Raphidostegium* Br. & Sch.

3. Ein Komma zwischen dem Namen der Pflanze und dem des Autors ist nicht wünschenswert.

BEISPIELE. — *Rumex* L., nicht *Rumex*, L.; *Phacelia congesta* Hook., nicht *Phacelia congesta*, Hook.; *Ilysanthes dubia* (L.) Barnhart, nicht *Ilysanthes dubia*, (L.), Barnhart.

The effect of chemical irritation on the respiration of fungi

ADA WATTERSON

The effect of chemical irritation upon the growth of fungi has been the subject of considerable study for a number of years past. The results obtained by Raulin,[*] Richards,[†] Ono,[‡] Hattori,[§] and others have gone to prove that certain metallic salts, in small quantities, stimulate the metabolic activity of various fungi and thereby induce a more rapid growth than is normal. This action is interpreted by Richards[||] as being a means by which the plant is enabled to dispose more economically of the sugar or other source of the carbohydrates required in growth.

The fungi used by Richards in his experiments were *Sterigmatocystis* (*Aspergillus*) *niger*, *Penicillium glaucum*, and *Botrytis*, and the substances which served as irritants were zinc, iron, cobalt and nickel sulphates, NaFl, LiCl, Na_2SiO_3, cocaine, morphine and amygdalin. Ono made use of the same irritants with the addition of $HgCl_2$. Hattori experimented with $CuSO_4$; Yasuda[¶] with certain alkaloids; Hueppe[**] found the activities of bacteria stimulated by certain poisons. Schultz[††] likewise observed an acceleration of fermentation in yeast following the addition of small quantities of poisonous substances, but whether this was due to a more

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[*] Raulin, J. Études chimiques sur la végétation; deuxième partie. Ann. Sci. Nat. Bot. V. **11**: 190–299. 1869.

[†] Richards, H. M. Die Beeinflussung des Wachsthums einiger Pilze durch chemische Reize. Jahrb. Wiss. Bot. **30**: 665–688. 1897.

[‡] Ono, N. Ueber die Wachsthumsbeschleunigung einiger Algen und Pilze durch chemische Reize. Jour. Coll. Sci. Imp. Univ. Tokyo, **13**: 141–186. 1900.

[§] Hattori, H. Studien über die Einwirkung des Kupfersulfats auf einige Pflanzen. Jour. Coll. Sci. Imp. Univ. Tokyo, **15**: 371–394. 1901.

[||] Richards, H. M. The effect of chemical irritation on the economic coefficient of sugar. Bull. Torrey Club, **26**: 463–479. 1899.

[¶] Yasuda, A. On the effect of alkaloids upon some moulds. Bot. Mag. Tokyo, **15**: 79–83. 1901.

[**] Hueppe, F. Naturwissenschaftliche Einführung in die Bakteriologie, 55. Wiesbaden, 1896. (Not seen.)

[††] Schultz, H. Pflüger's Archiv, **42**: —. 1888. (Reference in Bot. Zeitung, **46**: 610. 1888.)

rapid growth and division, or to greater activity of the individual cells, has not been determined.

Experiments were likewise performed by Ono on algae with like results except that the optimum concentration of the stimulants was much smaller. Similar work has been done on the phanerogams by Copeland and Kahlenberg * using pure metals as stimulants, by Townsend † with ether and HCl, and by Kahlenberg and True. ‡ Chapin § also found an increase in the growth of certain seedlings due to the presence in the atmosphere of small amounts of CO_2, larger quantities of which acted as a poison.

In all of these cases the amount of stimulation is indicated by the increase in the plant body, as shown by dry weight in the case of the fungi and algae, and by the increased surface of the organs of phanerogams. It is well known, however, ‖ that only a part of the nutrient material absorbed by the plant is used to build up its living substance ; a part is continually being oxidized to provide the necessary energy for carrying on life-processes. Fully to determine, therefore, the relation between the plant and its food-supply, one would have to take into account both the amount of the latter which is used as constructive material, measured by the increased weight or size of the plant, and that which undergoes katabolic changes during which CO_2 and other waste products are liberated.

Richards' experiments were concerned with the first factor, that is, the amount of dry substance produced and its relation to the amount of sugar used, or the economic coefficient. Ono confirmed his results, and in addition he determined the relative quantities of oxalic acid produced by fungi under normal conditions and under stimulation, finding a decrease in the latter case with all substances tried except $NiSO_4$. To account for this Ono suggests

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* Copeland, E. B., and Kahlenberg, L. The influence of the presence of pure metals upon plants. Trans. Wisc. Acad. **12** : 454–474. 1899.

† Townsend, C. O. The correlation of growth under the influence of injuries. Ann. Bot. **11** : 509–532. 1897. — The effect of hydrocyanic acid gas upon grains and other seeds. Bot. Gaz. **31** : 241–264. 1901.

‡ Kahlenberg, L., and True, R. H. On the toxic action of dissolved salts and their electrolytic dissociation. Bot. Gaz. **22** : 81–124. 1896.

§ Chapin, P. Einfluss der Kohlensäure auf das Wachsthum. Flora, **91** : 348–379. 1902.

‖ Pfeffer, W. Physiology of plants, ed. 2, **1** : 287, 523. 1900.

that the carbohydrate which during normal growth is decomposed, in the processes of metabolism, to form oxalic acid, is not so transformed during the accelerated growth resulting from stimulation, but is immediately changed into constructive material for the plant body. Of this, the decrease in the economic coefficient (*i. e.*, ratio of dry weight to sugar used) of the stimulated cultures seems an indication. Oxalic acid is not, however, the only waste product of metabolism. Since, according to Pfeffer,[*] "a decreased formation of oxalic or other organic acids is accompanied by an increase in the ratio of CO_2 exhaled to the oxygen absorbed," the amount of CO_2 given off under the varying conditions must also be reckoned with; it must be determined, that is, whether all the additional carbohydrate normally used to produce oxalic acid is now transformed into formative substance, or whether part of it may be wholly oxidized to produce larger quantities of CO_2. This ratio of the dry substance produced to the amount of CO_2 exhaled, or the respiratory quotient, was found by Kunstmann[†] to vary with changing conditions, decreasing with a rise of temperature or with higher concentrations of the nutrient solution. The effect of chemical stimulation was not included among the conditions.

The effect of such stimulation upon respiration alone without regard to the possible acceleration of growth ensuing was studied by Jacobi,[†] who obtained an increase in amount of CO_2 produced by certain phanerogams, due to the influence of KCl, NaCl, KNO_3, iodine, chinin, antipyrin, oxalic acid and various organic substances. Copeland[‡] obtained similar results; and likewise Kosinski[§] in the case of fungi. Morkowin[||] found a decided

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[*] Pfeffer, W. Physiology of plants, ed. 2, 1: 527. 1900.

[†] Kunstmann, H. Ueber das Verhältnis zwischen Pilzernte und verbrauchter Nahrung. Leipzig. 1895. [Inaug. Diss.]

[‡] Jacobi, B. Ueber den Einfluss verschiedener Substanzen auf die Athmung und Assimilation submerser Pflanzen. Flora, **86**: 289–327. 1899.

[§] Copeland, Bot. Gaz. **35**: 81–98, 160–183. 1903.

[||] Kosinski, I. Die Athmung bei Hungerzuständen und unter Einwirkung von mechanischen und chemischen Reizmittteln bei *Aspergillus niger*. Jahrb. Wiss. Bot. **37**: 137–204. 1901.

[¶] Morkowin, N. Recherches sur l'influence des anesthésiques sur la respiration des plantes. Revue Gén. de Bot. **11**: 289–303, 341–352. 1899. — Ueber den Einfluss der Reizwirkunzen auf die intramoleculare Athmung der Pflanzen. Ber. Deut. Bot. Ges. **21**: 72. 1903.

increase in the intensity of respiration, both normal and intramolecular, of etiolated leaves and shoots under the influence of ether, alcohol and various alkaloids. Pfeffer states * that according to Elfving and Lauren adult parts of higher plants, where stimulation is unaccompanied by growth, react in the same manner to a short treatment with ether and chloroform ; he notes however that Detmer and also Bonnier and Mangin found no such reaction.

Summarizing then, the results quoted, we find that small quantities of certain poisonous substances act as stimulants, increasing the growth of certain plants ; they also increase respiration, but what relation the latter increase bears to the former is not determined. Since, however, in the case of fungi, it has been found that stimulation raises the economic coefficient of the sugar, *i. e.*, allows the plant to make use of the sugar to form a greater amount of dry substance in a given time, the question of the amount of CO_2 which is produced at the same time becomes one of interest.

This problem was suggested to me by Dr. H. M. Richards, to whom I wish to express my gratitude for his interest and valuable assistanee. The work was done in the botanical laboratory of Barnard College during the winters of 1901–1902 and 1902–1903.

Two kinds of apparatus have been employed in carrying on this work, one that of Godlewski described by Kunstmann † the other a modification of the Pfeffer-Pettenkofer apparatus. In all the experiments, however, the fungi used were *Sterigmatocystis nigra* and *Penicillium glaucum.* The formula for the nutrient solution was that given by Richards : ‡

KH_2PO_4	0.05g.
$MgSO_4$	0.25g.
NH_4NO_3	1.00g.
$FeSO_4$	trace.
Sugar	5.00g.
Water	100 cm.

Only the purest chemicals and sugar obtainable were used,

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* Pfeffer, W. Physiology of plants, Ed. 2, 1 : 564. 1900.

† Kunstmann, *l. c.* 10. 1895.

‡ Richards. Jahrb. Wiss. Bot. **30** : 667. 1897.

and the water was twice distilled. The dishes and flasks in which the cultures were grown were rinsed with dilute HCl, carefully washed with double-distilled water and dried in a dry sterilizer. The spores were sown by rubbing small pieces of glass rod, exactly equal in size, upon the dry stock supply, and then transferring them to the dishes by means of glass tipped forceps. It was found convenient to keep a supply of the concentrated nutrient solution on hand, containing all the ingredients except sugar. The necessary amount was diluted and the sugar added when the series was set up.

At first the Godlewski apparatus used by Kunstmann was employed. This consisted, in brief, of a bell-jar enclosing two crystallizing dishes; the smaller of these held the fungus growing on 75 c.c. of the nutrient solution, and rested upon a glass strip placed across the larger dish which contained 150 c.c. of a 10 per cent. solution of KOH. The mouth of the jar was closed with a rubber cork provided with two holes through one of which passed a thermometer, and through the other a glass tube leading to a mercury valve, with which, in turn, was connected a KOH tube in such a way that air could pass into the jar, but could not escape from it. The bell-jar was sealed to a ground glass plate by means of vaseline and the joining was then painted with two coats of shellac to make it water tight. Three jars were used, one to serve as a control, and two for the experiment; the results given are, unless otherwise stated, the average of the two grown at the same time and under the same conditions. The greatest difficulty was experienced in keeping the cultures at an even temperature, approximately near the optimum for *Sterigmatocystis*, which is 30–34° C. The plan finally followed was to place all three jars in a zinc trough partly filled with water, the temperature of which would change more slowly than that of the air, and then to enclose the whole in a wooden box placed near a steam radiator. Under these conditions the temperature was raised to the neighborhood of 30° C., and varied not more than three or four degrees during any one experiment.

At the close of the experiment the fungus was killed with formalin as soon as the jar was opened, washed with distilled water, collected in weighed filter papers, dried in an oven at a temperature of 70° C., and after cooling in a dessicator was carefully weighed. The KOH was diluted to 250 c.c.; the CO_2 was precipitated out of it by an equal quantity of barium hydrate, and the alkalinity of the remaining KOH was determined by titrating in the usual way with HCl of such strength that 1 c.c. of the acid = 1 mg. of CO_2. The result was then subtracted from that obtained by treating a certain amount of the stock KOH in the same way, and thus the amount of CO_2 given off by the fungus was obtained. The results are given in milligrams both for the weight of the fungus and the amount of CO_2 given off.

At the same time a series of experiments was carried on with a form of the Pfeffer-Pettenkofer respiration apparatus. The particular object in using this was to determine the rate of respiration during short intervals of time. Certain practical difficulties made this impossible, however, at that time, and the attempt was abandoned. Later, the same apparatus was started again in a slightly different way; *i. e.*, a strong solution of KOH was used and the same experiment was continued for a week at a time. It was set up in the dark room, which, being small and kept carefully closed, could be maintained at a comparatively even temperature in the neighborhood of 24° C.

The air in entering the apparatus passed through three U-tubes filled with pumice stone wet with a strong solution of KOH which was frequently renewed. A $Ba(OH)_2$ test-bottle was placed in the course to prove that no CO_2 passed over to the cultures, and the air was then distributed to these, four in number, by means of a T-tube and two Y-tubes. The cultures were grown in Erbenmeyer flasks of about 250 c.c. capacity, in which only 75 c.c. of the nutrient solution was used. This brought the film of mycelium at the level of the widest diameter of the flask and the flasks were all as nearly as possible of the same diameter. Between the culture flasks and the Pettenkofer tubes were interposed large test-tubes to prevent any possible backward flow of the KOH into the culture flasks; 150 c.c. of a 10 per cent. solution of KOH was introduced into the absorption tubes by means of a large pipette; the stock solution was kept in a tightly stoppered bottle sealed with vaseline. At the exit end of the tubes were placed screw pinch-cocks to regulate the amount of air drawn through the apparatus, which was measured by the size and rate of flow of the bubbles of air in the tubes. Any slight difference in the rate of flow would be of no importance when the length of time during which the experiment ran — six to nine days — is taken into consideration. Between the tubes and the aspirator were inserted $Ba(OH)_2$ test-bottles. The aspirator was a simple one fastened to the water faucet.

At the close of the experiment the aspirator was shut off, the stop-cocks closed, the cultures immediately killed with formalin, and the contents of the tubes quickly emptied into bottles which were tightly corked. The amount of CO_2 absorbed was obtained by titration as before.

The metallic salts used as irritants in these experiments were $ZnSO_4$, $FeSO_4$ and LiCl. In each case such a concentration was used as had been found by Richards to be most favorable for an increased growth of the fungus. A 1 per cent. stock solution of anhydrous $ZnSO_4$ was made carefully; of this, .3 c.c. was used for 75 c.c. of the nutrient solution, giving thus a .004 per cent. solution or, expressed in terms of a normal (gram equivalent) solution,* .00049; of the $FeSO_4$, a .082 per cent. solution was used, or .01078 normal; and of LiCl, a .162 per cent. solution or .03822 normal.

In the following tables the results of the experiments are presented. In the first are given five series carried on with the Kunstmann apparatus, for three or four days at a temperature of 28°–31° C. The irritant was $ZnSO_4$. In the first column are given the dry weights of the cultures, both normal and irritated; in the second the amount of CO_2 given off by each, expressed in millegrams; and in the third the ratio of the weight to the CO_2. On examination of these figures it is evident that the addition of the zinc has caused an increase in the growth of the fungus and there has been likewise an increase in the amount of CO_2 respired. The amount of CO_2 respired is sometimes less than the corresponding weight of the culture, sometimes more, but when one compares the ratios of the two cultures in any one series, one finds very little difference between them; that is, the increase in respiration has been correspondingly great in both, with perhaps

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* Livingston, B. E. The role of diffusion and osmotic pressure in plants, 22. 1903.

a slight advantage on the side of the irritated fungus. There is one exception to this, the fourth series, where the difference is unaccountably great, owing to an unusually large evolution of CO_2 from the stimulated culture. The increase in the amount of CO_2 given off is therefore but little greater than might naturally be expected from the increased respiratory surface due to the greater growth of the fungus.

The second table shows the results of five experiments performed with the Pettenkofer apparatus; the cultures, being grown at a lower temperature, 20–24° C., were allowed to run for a longer time: five, six, or seven days. In these, the figures for the irritated fungus represent the average of three cultures, grown under precisely similar conditions. Here too the ratios are very near one another. It is noticeable however that the difference, such as it is, is reversed in the second table, in all but one case, and the respiration of the normal grown in the Pettenkofer apparatus is therefore apparently a little greater, relatively, than that of the irritated fungus. The cause of this reversal of the ratios obtained by the two methods I have not been able to determine, but the difference is too slight to be of any importance. In Tables IX and X are given the same figures as in I and II, but the averages are found for the weights, CO_2, and ratios of each set of series; that is, for the series obtained by the Kunstmann method (Table IX), the average ratio of weight to CO_2 for the normal is .98, for the stimulated culture is 1.18; for those in the Pettenkofer apparatus (Table X) the average is 1.16 for the control as against .94 for the stimulated fungus.

Bearing these figures in mind, let us refer again to Ono's experiments in determining the amount of oxalic acid produced by fungi during growth under stimulation. With all the irritants used, with the exception of $NiSO_4$, he found a more or less marked decrease in the production of oxalic acid, a decrease shown (to quote some of his figures) * by the difference between 2.58 acid for every gram of dry weight of the normal, and 0.428 for the culture to which has been added .003 per cent $ZnSO_4$. The duration of this experiment was twenty-seven days and the temperature 16–20° C. Ono suggests three possible explanations for this de-

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* Ono, *l. c.* 174. 1900.

crease:* (1) Although oxalic acid is a normal product of metabolism of the fungus, it is to be regarded nevertheless as a product of incomplete oxidation, and if the metabolic activity were increased, more CO_2 might be produced and therefore less oxalic acid. (2) The same result would occur in case the acid should disappear through a further "working-over" on the part of the fungus. Thereby it could be taken up again as building material or be decomposed without being useful to the fungus. Yet, as shown by Wehmer,† oxalic acid is poor food stuff for *Aspergillus*, and in the presence of a plentiful supply of sugar would probably remain intact. (3) Those materials (carbohydrates, etc.) which in normal growth are, by metabolism, transformed in part into oxalic acid, in consequence of increase in growth due to the stimulation are not separated out in that form, but are changed directly into the fungus body, in short, are applied as formative material.

Of these three possibilities, Ono concludes from his experiments that the third is the true explanation, since in every case the economic coefficient was much greater in the control than in the stimulated fungus. "Dieses Verhältnis deutet also an, das die Pilze bei Anvesenheit von Zinksulfat veranlasst wurden, mit einem verhältnismässig kleinen Verbrauch von Zucker eine bedeutend grössere körpersubstanz aufbauen zu können." ‡ This was also the conclusion reached previously by Richards. §

Further support is now given to this explanation by the results presented here, since Ono's first suggestion is thereby eliminated; that is, the present figures show that an amount of CO_2 is produced by the stimulated fungus which varies a little, being either more or less relatively to the weight of the fungus than that produced by the normal, but still remains comparatively close to the latter. The increase in metabolic activity has, therefore, not increased (relatively) the production of CO_2 although the formation of oxalic acid under similar conditions was materially checked, and the carbohydrates formerly used in the manufacture of the latter must consequently be devoted to the building up of new substance in the plant.

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* *Idem*, 157. 1900.

† Wehmer, Bot. Zeitung, **49**: 553. 1891.

‡ Ono, *l. c.* 160. 1900.

§ Richards, H. M. The effect of chemical irritation on the economic coefficient of sugar. Bull. Torrey Club. **26**: 463–479. 1899.

In Table III two series are shown, in which glycerine was used instead of sugar as the source of the carbohydrate. All of the figures here are rather low, owing to the slower growth of *Sterigmatocystis* in such a nutrient medium; the ratios, however, bear much the same relation to one another as in the preceding series, .61 and .69 (normal) to .77 and .68 (stimulated), respectively.

In the experiments recorded in Table IV, .082 per cent. (.01078 normal) $FeSO_4$ was used as the stimulant, since this concentration is near that which caused the greatest increase in growth in Richards' experiments. A .162 per cent. (.0381 normal) solution of LiCl was also tried (Tables V and VI), and although the increase in growth was not as great as might have been expected from Richards' results, yet the evolution of CO_2 bears much the same relation to it as in the preceding cases.

A few experiments were likewise made with *Penicillium glaucum.* Though *Penicillium* grows well at a lower temperature than does *Sterigmatocystis*, yet it grows slowly, and the total weight of the normal is seldom as great as is that of *Sterigmatocystis* in the majority of cases. The evolution of CO_2 is nevertheless very active, and the number of milligrams of CO_2 given off exceeds that of the dry weight of the fungus. Several of these cultures were raised on the usual nutrient medium (Table VII), and one (Table VIII) on a solution in which .5 gr. asparagin replaced the NH_4NO_3 as the source of nitrogen. The weight of the irritated fungus in the latter case was much greater than that of the normal, but the evolution of CO_2 kept pace with it to such an extent that the ratio is 1.22 as compared with 1.26 in the normal.

In reviewing, then, the results recorded here, it is evident that the addition of small quantities of $ZnSO_4$, $FeSO_4$ and LiCl has increased the rate of growth of *Sterigmatocystis* and *Penicillium* so that a larger amount of dry substance is produced within a given time than in normal cultures; that at the same time there has been an increase in the production of CO_2, an increase not too great, however, to be accounted for by the enlarged area of the plant. The ratio of dry weight to CO_2 of the irritated fungus is therefore approximately equal to that of the normal. Taking into account previous results which show that the effect of the addition of such poisons is to enable the plant to make more economical use of the carbohydrates supplied to it, we can interpret this action as a stimulus which causes the fungus to transform more of the food material into its own substance, and less into waste products such as oxalic acid, while at the same time the respiration remains relatively unchanged.

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TABLE I.

Kunstmann apparatus.

Sterigmatocystis nigra. 5 per cent. sugar solution.

A = Normal. B = average of two cultures to which .004 per cent.[*] or .00049 normal (gram equivalent) $ZnSO_4$ has been added. Temperature 28–30°C.

		Weight of Fungus.	CO_2	Ratio.	Time.
I.	A	335.2	155	.46	3 days.
	B	597.6	392.5	.67	
II.	A	398.5	455	1.13	3 "
	B	607.1	755	1.27	
III.	A	479.7	705	1.46	4 "
	B	805.1	1185	1.47	
IV.	A	480.8	415	.86	4 "
	B	783.7	1230	1.56	
V.	A	533.6	465	.87	4 "
	B	875.6	780	.89	

TABLE II.

Pettenkofer apparatus.

Same as in Table I, except that B = average of *three* cultures to which .004 per cent.,[*] (.00049 normal) $ZnSO_4$ has been added. Temperature 20–24° C.

		Weight of Fungus.	CO_2	Ratio.	Time.
VI.	A	600	420	.70	7 days
	B	1138.1	987	.86	
VII.	A	673.6	768	1.14	7 "
	B	888.0	888	1.00	
VIII.	A	885.5	1173	1.32	7 "
	B	1086.6	1143	1.05	
IX.	A	1056.0	978	.92	6 "
	B	1237.2	1036	.83	
X.	A	715	936	1.30	5 "
	B	1327	1263	.95	

[*] Calculated as anhydrous salt.

TABLE III.

Pettenkofer apparatus.

Nutrient solution a 5 per cent. glycerine instead of sugar; otherwise as in Table II. B = .004 per cent.* (.00049 normal) $ZnSO_4$.

		Weight.	CO_2	Ratio.	Time.	Temp.
XI.	A	489	300	.61	7 days.	23–25°
	B	1194.7	920	.77		
XII.	A	358.5	249	.69	7 "	20–24°
	B	724.3	498	.68		

TABLE IV.

Pettenkofer apparatus.

Same as in Table II, but B = .082 per cent.* (.01078 normal) $FeSO_4$.

		Weight.	CO_2	Ratio.	Time.	Temp.
XIII.	A	1142.5	867	.75	6 days.	26–29°
	B	1691	1513	.89		
XIV.	A	687	180	.26	6 "	
	B	1449.4	830	.57		

TABLE V.

Kunstmann apparatus.

Same as in Table I, but B = .162 per cent.* (.0381 normal) LiCl.

B here was not an average of two, but a single culture. Temperature 19–28° C.

		Weight of Fungus.	CO_2	Ratio.	Time.
XV.	A	615.5	514	.83	11 days
	B	775.5	814	1.04	

TABLE VI.

Pettenkofer apparatus.

Same as in Table II, but B = .162 per cent.* (.0381 normal) LiCl.

		Wght. Fungus.	CO_2	Ratio.	Time	Temp.
XVI.	A	1434	1110	.78	7 days	25°C.
	B	1501.1	1311	.87		
XVII.	A	679	645	.94	8 "	22°–27°C.
	B	723.7	747	1.03		

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* Calculated as anhydrous salt.

TABLE VII.

Pettenkofer apparatus.

Penicillium glaucum. Otherwise as in Table II. B = .004 per cent.* (.00049 normal) $ZnSO_4$.

		Wght. Fungus.	CO_2	Ratio.	Time.	Temp.
XVIII.	A	489.50	705	1.43	7 days	18–22°C.
	B	525.75	739.5	1.40		
XIX.	A	438.5	729	1.66	9 "	19–22°C.
	B	539.33	991	1.66		

TABLE VIII.

Pettenkofer apparatus.

Penicillium glaucum.

Same as in Table VII., but .5 grams asparagin used in place of NH_4NO_3. B = .004 per cent.* (.00049 normal) $ZnSO_4$.

		Weight.	CO_2	Ratio.	Time.	Temp.
XX.	A	354.5	450	1.26	9 days.	17.5–20°
	B	932.16	1145	1.22		

TABLE IX.

Kunstmann apparatus. Average of five series shown in Table I. .004 per cent.* (.00049 normal) $ZnSO_4$.

	Normal.			Average of 2.		
	Weight.	CO_2	Ratio.	Weight.	CO_2	Ratio.
I.	335.2	155	.46	597.6	392.5	.67
II.	398.5	455	1.13	607.1	755	1.27
III.	479.7	705	1.46	805.1	1185	1.47
IV.	480.8	415	.86	783.7	1230	1.56
V.	533.6	465	.87	875.6	780	.89
Average.	445.56	439	.98	733.8	868.5	1.18

TABLE X.

Pettenkofer apparatus. Average of five series shown in Table II .004 per cent.* (.00049 normal) $ZnSO_4$.

	Normal.			Average of 3.		
	Weight.	CO_2	Ratio.	Weight.	CO_2	Ratio.
VI.	600	420	.70	1138.1	987	.86
VII.	673.6	768	1.14	888.0	888	1.00
VIII.	885.5	1173	1.32	1086.6	1143	1.05
IX.	1056.0	978	.92	1237.2	1036	.83
X.	715	936	1.30	1327.0	1263	.95
Average.	759.4	885.37	1.16	1207.23	1138.2	.94

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* Calculated as anhydrous salt.

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(1904)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

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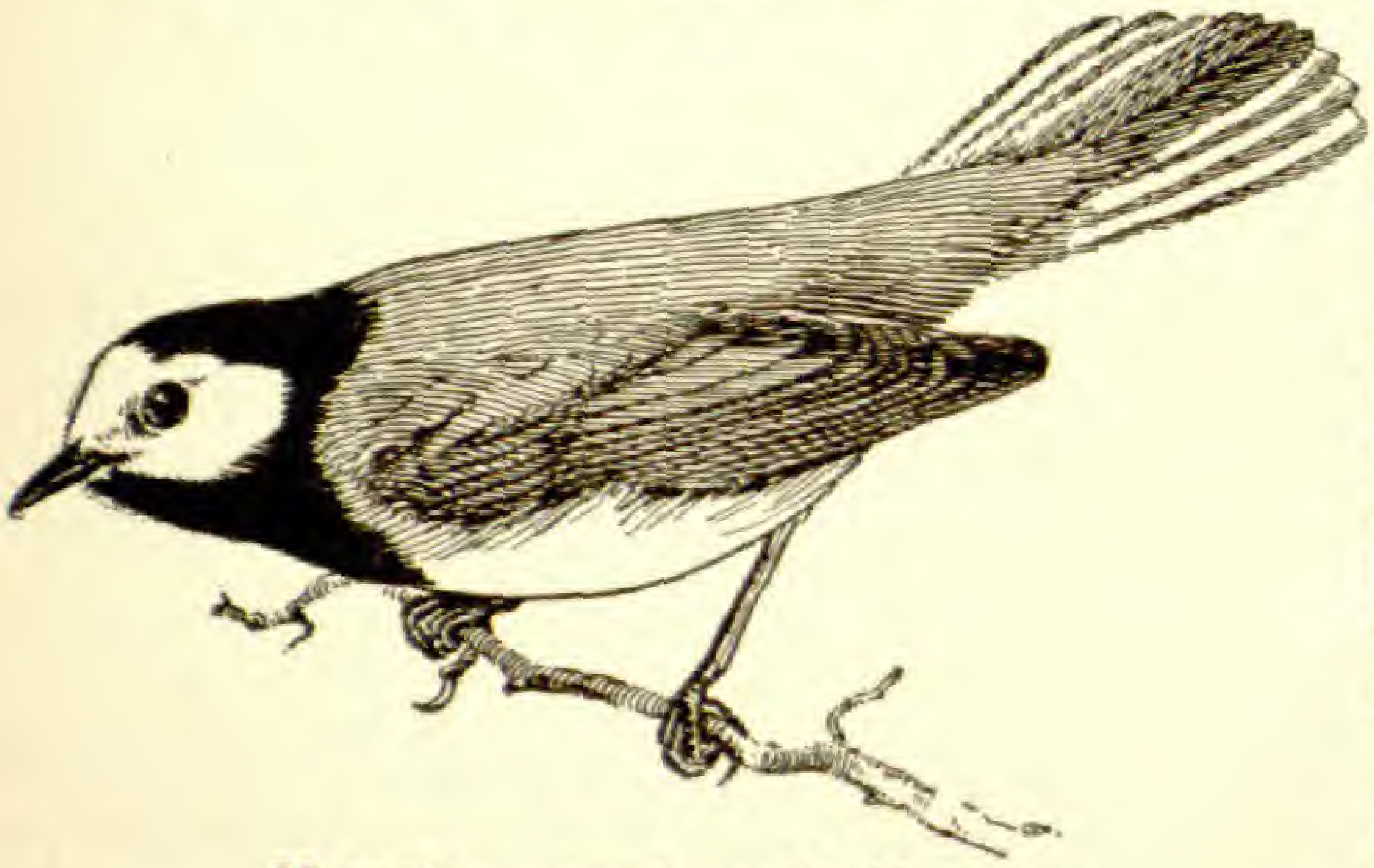

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JUNE, 1904

A revision of some species of Ectropothecium

ERNEST S. SALMON

(WITH PLATES 13 AND 14)

Whilst studying lately some West Indian examples of the genus *Ectropothecium* Mitt., received from the New York Botanical Garden, U. S. A., it became necessary to examine the type-specimens of the following plants — *E. vesiculare* (Schwaegr.) Mitt., *E. rutilans* (Brid.) Mitt., *E. malachiticum* (C. Müll.) Paris, *E. Poeppigianum* (Hampe) Jaeger, *E. conostegum* (C. Müll.) Mitt., *E. flavoviride* Mitt., *E. crassicaule* Mitt., *Hookeria praelonga* W. Arnott and the plant sent out under the name *Hypnum Montagnei* Schimp. in Wright's Cuban Mosses, number *120*. The result of the study and comparison of type specimens and authentic examples of the above plants has enabled me to make the following revision.

Bridels' *Leskia rutilans* (1827) from St. Domingo proves to be identical with Schwaegrichen's *Hypnum vesiculare* (1827) from Jamaica; and Müller's *Vesicularia malachitica* (1898) from Porto Rico is also the same species. A specimen in Mitten's herbarium labeled "Brazil" is also to be referred to *E. vesiculare*.

Hampe's *Hookeria Poeppigiana* (1844), from Peru, which has been sunk in *E. vesiculare*, proves to be a well marked variety of that species, and to be identical with Müller's *Hypnum conostegum* (1851) from Cuba and St. Domingo. Mitten's *E. flavoviride* (1869) from Cuba is a form of this same variety *Poeppigianum*.

E. crassicaule Mitt. (1869) from Cuba appears distinct from all the above mentioned plants.

[The preceding number of the BULLETIN, Vol. 31, No. 5, for May, 1904 (31: 239–308) was issued 18 My 1904.]

Hookeria praelonga W. Arnott, from Rio de Janeiro, which has been referred to *E. vesiculare*, proves to be a species of *Ectropothecium* allied to, if not identical with, *E. amphibolum* Spruce.

As regards "*Hypnum Montagnei* Schimp." the following plants have been sent out under the number *120* in Wright's Cuban Mosses. In Mitten's herbarium and in the Kew herbarium three distinct plants appear under the number *120*, viz., *E. vesiculare* (Schwaegr.), *E. vesiculare Poeppigianum* (Hampe), and *E. crassicaule* Mitt. In Müller's herbarium both *E. vesiculare* and the variety *Poeppigianum* are found under the number *120*. The plant quoted by Mitten, "Wright, inter 120," as belonging to *E. amphibolum* Spruce proves to be *E. vesiculare*. The plant, "n. 120 ex parte" in Mitten's herbarium, on which Mitten founded his *E. flavoviride* is a form of the variety *Poeppigianum*; while *E. crassicaule* Mitt. founded also on "n. 120 ex parte" proves, as mentioned above, to be a distinct species. It may be mentioned here that from Montagne's original description of "*H. Montagnei*" the plant appears to be *E. vesiculare Poeppigianum*; specimens from Montagne's herbarium, however, are *E. vesiculare* type.

The result of the above investigations shows how necessary it is in the first place, in describing the moss-flora of any country, to examine types and historical specimens in herbaria in order to remove the errors which have accumulated round certain species.

My sincere thanks are due to the authorities at the Berlin Museum and the Herbier Boissier for kindly allowing me to see specimens from, respectively, Müller's and Schwaegrichen's herbaria; to Mr. William Mitten, A.L.S., for kindly sending me a large number of specimens of *Ectropothecium* from his herbarium; and to Professor F. O. Bower, F.R.S., for allowing me to examine a specimen from Walker-Arnott's herbarium.

I give below diagnoses drawn up from the examination of the type and authentic specimens, and the revised synonymy and distribution. In the study of the species of this difficult genus *Ectropothecium* the shape and areolation of the *ventral branch-leaves* afford important specific characters. By paying attention to these points the two species *E. vesiculare* (Schwaegr.) and *E. amphibolum* Spruce, which are both variable species and often closely resemble each other, can be at once separated.

ECTROPOTHECIUM VESICULARE (Schwaegr.) Mitt.

Hypnum vesiculare Schwaegr. Sp. Musc. Frond. Suppl. **2**: 167, *pl. 199.* 1827; C. Müll. Syn. **2**: 235 (sect. *Omalia* subsect. *Vesicularia*) (syn. *Hookeria praelonga* Walk. Arnott excl.) 1851.

Leskia (*Omalia*) *rutilans* Brid. Bryol. Univ **2**: 332 (var. *portoricensis* excl.) 1827.

Hypnum rutilans (Brid.) C. Müll. Syn. **2**: 234 (sect. *Omalia* subsect. *Vesicularia*) (habitat. quibusdam probabiliter excl.) 1851.

Ectropothecium vesiculare (Schwaegr.) Mitt. Musc. Austr.-Amer. 518 (synon. et habitat. peruvianis excl.) 1869; Jaeger, Adumbr. **2**: 534 (habitat. peruv. excl.) 1879; Paris, Index Bryol. 89 (syn. et habitat. quibusdam excl.) 1895.

E. rutilans (Brid.) Mitt. Musc. Austr.-Amer. 519 (habitat. quibusdam probabil. excl.) 1869; Jaeger, Adumbr. **2**: 538 (habitat. quibusdam prob. excl.) 1879; Paris, Index Bryol. 86 (habitat. quibusdam prob. excl.) 1895.

Vesicularia malachitica C. Müll. Hedwigia, **37**: 251. 1898.

Ectropothecium malachiticum (C. Müll.) Paris, Index Bryol. Suppl. **1**: 136. 1900.

Tenellum depresse caespitosum laete viride vel aeruginoso-viride raro flavo-viride monoicum; caule tenui interdum subelongato repente hic illic cortici radicularum ope brunnearum fasciculatarum adhaerente ramis distichis depressis saepe alternis interrupte pinnatim ramoso, ramis subcomplanatis approximatis patentissimis saepe per totam longitudinem arcuatis simplicibus vel raro ramulis brevibus perpaucis ramosis brevibus 2–4 mm. longis latitudinem cum foliis 0.80–1 mm. latis interdum elongatioribus ad 8 mm. longis latitudine cum foliis 1.5 mm. latis, foliis caulinis dorsalibus et lateralibus patentibus siccitate imbricatis erecto-patentibus late subtriangularibus et late ovatis acuminatis acumine interdum subrecurvo margine integro vel in folii apice minutissime denticulato cellulis laxis pellucidis superioribus hexagonis circ. 30–40 × 22–25 μ, foliis caulinis ventralibus minoribus e basi lata oblonga vel subquadrata concava acuminatis acumine plus minus recurvo tenerius areolatis, foliis rameis dorsalibus et lateralibus confertis subdistichis planiuscule compressis patentibus siccitate plus minus crispulis ovatis vel late ovatis interdum rotundato-ovatis breviter et abrupte acuminatis interdum apiculato-acuminatis basi saepe inaequalibus praeter apicem summum minutissime denticulatum integris nervis binis brevissimis interdum indistinctis cellulis laxis pellucidis late et breviter hexagonis et subhexagonis circ. 20 × 25–30 μ basin versus gradatim longioribus, foliis rameis ventralibus multo minoribus et tenerioribus e basi lata ovata concava breviter acuminatis interdum subtriangularibus cellulis laxis hexagonis et subhexagonis circ. 15–20 × 40–50 μ, foliis perichaetialibus erectis apice interdum flexuoso-patentibus superioribus caulinis majoribus circ. 1.5 mm. longis e basi ovata vel oblonga tenuiter filiformi-acuminatis enervibus cellulis superioribus longis augustioribus margine integro vel apicem versus minutissime subdenticulato, capsula in pedunculo 1–1.5 cm. longo gracili erecto purpureo laevi apice incurvo breviter et turgide oblonga vel urceolata macrostoma maturitate infra orificium contracta badia horizontali tandem nutante parvula 0.75–1 mm. × 0.50–0.60 mm. raro 1.25 × 1 mm. leptodermatica basi ima stomatibus superificialibus paucis instructis exothecii cellulis prominentibus subquadratis 25–30 μ latis ad capsulae orificium subito minoribus, operculo e basi majore convexa plus minus longe apiculato humore vero conico-acuminato, peristomii externi dentibus lineari-lanceolatis basin versus dense striato-trabeculatis badiis apice albidis papillosis interni magnis quandoque emergentibus lanceolatis carinatis lacunis dorsalibus plus minus distinctis ciliis 2–3 vel apice in unum coalitis nodulosis longis interpositis, membrana basilari alta fere ad peristomii externi dentium medium producto, calyptra subulata latere fissa pallide virente; floribus masculis minutis pluribus in caule prope flores femineos positis, foliis perigonialibus ovatis breviter acuminatis integris cellulis laxis hexagonis, antheridiis paraphysibus filiformibus immixtis.

Hab. Ind. occid: Jamaica, ad rupes et fontes prope plantationem Richmond, c. fr., leg. D. Reider (in herb. Schwaegr.)! St. Domingo (Hispaniola), c. fr. (in herb. Bridel.)! Cuba, ad truncos putridos in sylvis, c. fr., C. Wright, *no. 120*, partim, sub *Hypno Montagnei*, (Kew, Brit. Mus. et in herb. Mitten., etiam in herb. Müller., sub *Hypno conostego*, partim)! Porto Rico, Sierra de Lares, ad arbores, c. fr., Feb. 3, 1887, leg. Sintenis (in herb. Müller., sub *Vesicularia malachitica*)!

Amer. austr: Brazil, c. fr. (in herb. Mitten.)!

Schwaegrichen's *Hypnum vesiculare* was published in 1827, a good description of the species, together with figures, being given. The type-specimens collected in Jamaica, and preserved in Schwaegrichen's herbarium, represent a rather small state of the species, with branches 3.5 mm. long, which, with the leaves, measure a little under 1 mm. wide. Very rarely indeed a branch occurs which bears a very short branchlet. The dorsal and lateral branch-leaves are entire, or minutely denticulate at the extreme apex; they commonly approach roundish-ovate in shape, with the apex shortly and often abruptly apiculato-acuminate. These leaves do not exceed 0.75 mm. in length.

In the same year (1827) Bridel published a moss, from St. Domingo, as a new species under the name *Leskia* (*Omalia*) *rutilans*. I have seen the type of this in Bridel's herbarium. The sheet containing it bears two labels; on one is written "*Pterigophyllum rutilans* N. *Leskia rutilans* N. *L. Omalia rutilans* Bryol. Univ. Saint Domingo. Balbis. Lyon. 1820." There are examples of two mosses pasted down above this label, one being the type of Bridel's species, while the other is a species of the genus *Hookeria.* Over the first moss has been written in Müller's handwriting, "*Om. rutilans*;" over the second, "*Alia species.*"

Now this type-specimen of Bridel's "*L. rutilans*" agrees exactly with Schwaegrichen's type-specimen of "*H. vesiculare.*" One indeed was prepared for the fact of the identity of the two plants on reading Bridel's description of his plant ("Laete virens, complanata, simpliciter pinnato-ramosa, ramis brevibus parallelis. Folia duplici serie disticha, subrotundo-ovata, subintegerrima, laete viridia, laxissime ovato-areolata, diaphana") and comparing it with the description and figures given by Schwaegrichen.

It is most probably the erroneous statement made by authors with regard to the inflorescence of *E. rutilans* which has caused the two plants to be regarded as distinct species up to the present day. Bridel in his diagnosis makes no mention at all of the inflorescence. In Müller's "Synopsis," however, Bridel's plant is described as "dioicum?" In Mitten's "Musci Austro-Amer." we find *E. rutilans* separated as being dioicous from the monoicous species *E. vesiculare*, *E. amphibolum*, etc. As a matter of fact Bridel's plant is monoicous, and the type-specimens bear abundant male and female flowers. Müller in his "Synopsis" compares "*H. rutilans*" with *H. subdenticulatum*, *H. conostegum*, and *H. Poeppigianum*, but not with *H. vesiculare;* we may infer from this that it is most probable that Müller had not seen at the time Schwaegrichen's plant.

Bridel published his species from the single locality, "In Hispaniolâ unde missam Balbisius habuit et communicavit, in arboribus habitat." Müller, however, in describing the plant in the "Synopsis" does not mention this locality, but gives, apparently by a mistake, the habitat "Portorico: Bertero." For the following reason it seems possible that this mistake arose through some error of copying. As mentioned above, there are two labels on the sheet of "*L. rutilans*" in Bridel's herbarium. On one label is written "*Leskia capillaris*, ad saxa locis udis Portorico" in one handwriting, and to this is added, in Bridel's handwriting, "Balbis Lyon 1820." Over the plant to which this label belongs Müller has written "*Omalia rutilans* Brid." It is to be noted, however, that Bridel himself has not in any way identified this moss as belonging to his "*L. rutilans*." An examination of this plant from Porto Rico shows that it belongs to a small form of *Ectropothecium amphibolum* Spruce — agreeing exactly with the plant sent out in Spruce Musc. Amazon. et And. *no. 1145*, from the Andes of Peru, and also with examples from Cuba (collected by Liebmann) in the Kew Herbarium. It may be questioned, perhaps, if the other localities given by Müller, viz., "Venezuela, Cumbre de Valenzia, alt. 3,000′: Wagner 1848," and "Insula St. Catharina Brasiliae, loc. umbrosis pr. Destero, Jan. et Febr. 1847: Pabst" really belong to the present species.

The example named "*E. rutilans*" by Mitten, in the Kew Herbarium, from Rio de Janeiro (comm. A. Glaziou, *no. 7453*) belongs to *E. amphibolum* Spruce; the inflorescence is monoicous.

Since Schwaegrichen's and Bridel's names date from the same year, we are at liberty to choose either for the present species. Schwaegrichen's name is, however, preferable on every ground, both for the reason that a clear description, indicating the inflorescence, together with a good figure, is given of *H. vesiculare*, and that Bridel included under *L. rutilans* a variety "*portoricensis*," which proves to be specifically distinct.

The plant from Rio de Janeiro (collected by Jameson) published in 1824 as a new species under the name of *Hookeria praelonga* by Walker-Arnott (Mem. Wernerian Nat. Hist. Soc. **5**: 203) was referred to by Wilson (London Jour. Bot. **7**: 278. 1848) in a note on "*Hypnum scaturigenum* Schwaegr." as follows:

"This moss may be the same species as *Hookeria praelonga* Arnott, and possibly, also, *Hypnum vesiculare* Schwaegr." This remark of Wilson's was somewhat altered by Müller, who stated in the "Synopsis," under *Hypnum vesiculare*, "*Hookeria praelonga* W. Arn. ex animadv. Wilsoni in Lond. Journ. of bot. 1848. p. 278, huc pertinere dicitur." Mitten, also (Musci Austro-Amer. 518), quotes *Hookeria praelonga* "W. Arn. ex obs. Wils." as a synonym of *Hypnum vesiculare*. I have been able to examine the type-specimens of *Hookeria praelonga* in Arnott's herbarium at the University of Glasgow, and find that this plant is quite distinct specifically from *E. vesiculare*; it is a species of *Ectropothecium* allied to *E. amphibolum*, or is possibly a form of that species.

"*Hypnum Montagnei*," from Cuba, belongs in part to *E. vesiculare* type, and in part to the var. *Poeppigianum* described below. There is a specimen in the Kew Herbarium, labelled in Montagne's handwriting "*Pterygophyllum Montagnei* Belang. Voy. Ind. Or. Cuba," which is undoubtedly specifically identical with Schwaegrichen's plant. The specimen consists of portions of two fruiting stems, and in the small size and general habit of the plant, as well as in the shape of stem- and branch-leaves, areolation, etc., this Cuban plant agrees exactly with the type-specimen of *E. vesiculare* (from Jamaica) in Schwaegrichen's herbarium. In a few instances, however, the branches reach a length of 5 mm., and measure, with their leaves, about 1 mm. wide. The same plant, in a slightly more robust state, was sent out, under the name *Hypnum Montagnei* Schimp., as part of *no. 120* in Wright's Cuban Mosses,—at least as regards the examples under this number in the Kew, British Museum, and Mitten's herbaria. These specimens, whilst certainly belonging to Schwaegrichen's species, represent a larger, more luxuriant state. Some of the branches attain a length of 8 mm., and sometimes, though rarely, bear a short branchlet. The branches with their leaves are about 1.5 mm. wide.

In the example in Müller's herbarium labeled "*Hypnum conostegum* C. Müll., Cuba, decayed logs in forests. Wright n. 120 = *H. Montagnei* Sch. ex C. M.," some of the specimens are clearly the same as the plant from Cuba (collected by Döring) described by Müller as *H. conostegum* — a plant which, as mentioned below, I cannot separate from the var. *Poeppigianum* of *E.*

vesiculare. Mixed with these, however, are plants which are clearly referable to *H. vesiculare* type, agreeing perfectly in the habit, the small size, the short branches, and small roundly ovate apiculate-acuminate branch-leaves.

The plant figured natural size under the name *H. Montagnei* Schimp., by Montagne in La Sagra, Hist. Cuba, Crypt. *pl. 20. f. 1*, has the more robust habit and regular pinnate branching of the var. *Poeppigianum* described below.

Mitten quotes (Musci Austro-Amer. 519) under *E. amphibolum*, Cuba, "Wright, inter n. 120," but the plant referred to belongs — as the specimen in Mitten's herbarium shows — to *E. vesiculare.* Mitten quotes (*l. c.* 518) also a plant collected by Spruce in the Andes of Peru (Spruce, Musc. Amazon. et And. *no. 1145*) as belonging to *E. vesiculare.* In the examples under this number in Mitten's herbarium, and in the herbaria at Kew and the British Museum, however, the plant is not *E. vesiculare*, but *E. amphibolum*, showing clearly the more denticulate dorsal and lateral branch-leaves, and the characteristic shape and areolation of the ventral branch-leaves of the latter species. The same is also the case with specimens in the Kew Herbarium, from Rio de Janeiro (collected by Glaziou), which have been referred to *E. vesiculare* by Mitten.

In Mitten's herbarium there is a small specimen consisting of part of a stem bearing one seta (without a capsule) labelled "Brazil." This moss unquestionably belongs to true *E. vesiculare.*

Unless careful attention is paid to certain points the present species is very liable to be confused with *E. amphibolum. E. vesiculare* type may usually be known by its smaller size, and more compact habit, with the branches more complanate, spreading at right angles, and more or less arcuate ; it is, however, by certain characters shown invariably by the branch-leaves that the two species are best distinguished. In *E. vesiculare* the ventral branch-leaves are broadly ovate-acuminate, and the areolation is lax, with hexagonal and subhexagonal cells, measuring $15–20 \times 40–50\,\mu$. In *E. amphibolum* the ventral branch-leaves are more longly acuminate from a narrower ovate base, or are sometimes ovate-lanceolate ; the areolation is narrow, with subprosenchymatous cells measuring $15 \times 80–100\,\mu$. The dorsal and lateral branch-leaves, also, of the two species show constant differences. In *E. vesiculare* the leaves are subentire, the margin being minutely denticulate only at the extreme apex; and the areolation of the leaf in the upper half is remarkably lax, with the marginal cells wide. In *E. amphibolum* the margin is more evidently denticulate for a greater distance below the apex; the areolation is decidedly less lax, and the marginal cells are distinctly narrower than the rest, often forming a kind of indistinct border, which is most evident when the leaf is viewed under a low magnification.

Müller has recently (Hedwigia, **37**: 251 *1898*) described a moss from Portorico under the name *Vesicularia malachitica*, with the characters, "monoica; cespites latissime expansi planissimi aeruginosi teneri; folia e cellulis pro foliolo majusculis laxis chlorophyllosis utriculo primordiali repletis breviusculis reticulata, integerrima. . . . E minutissimis Vesiculariis, minutie partium omnium et colore malachitico primo visu distinguenda." Müller quotes the synonym "*Hypnum Montagnei* Hpe. in Musc. Portoricens. Schwaneckianis no. 41" for his plant. I have seen the type-specimens of *V. malachitica* in Müller's herbarium, labelled "Puerto Rico, Sierra de Lares, ad arbores, Feb. 3, 1887, Leg. Sintenis." The moss is certainly *E. vesiculare* Schwaegr., and is identical in the aeruginose color, habit, etc., with the plant sent out as part of number *120* in Wright's Cuban mosses, under the name *Hypnum Montagnei* Schimp., and which Mitten (Musci Austro-Amer.) has wrongly referred to *E. amphibolum.*

I have not seen the calyptra of the present species, and have therefore in the diagnosis given above repeated Schwaegrichen's description. Montagne (in La Sagra, Hist. Cuba, Bot. 532) says of the calyptra of "*Hypnum Montagnei*" "Calyptra mature decidua longe subulata, pallide viridis, stylo residuo coronata, basi hinc breviter fissa."

Ectropothecium vesiculare Poeppigianum (Hampe).

Hypnum Montagnei Schimp. ex Mont. in La Sagra, Hist. Cuba, Bot. 530 (partim). 1842; et in La Sagra. Fl. Cub. **1**: 315. *pl. 20. fig. 1* (partim). 1853.

Hookeria Poeppigiana Hampe, Icon. Musc. *pl. 4.* 1844.

Hypnum Poeppigianum Hampe ex C. Müll. Syn. **2**: 235 (sect. *Omalia*, subsect. *Vesicularia*) 1851.

H. conostegum C. Müll., *l. c.* 242 (sect. *Omalia*, subsect. *Vesicularia*) (synon. et habitat. portoric. excl.) 1851.

Ectropothecium flavoviride Mitt. Musc. Austr.-Amer. 518. 1869; Jaeger, Adumbr. **2**: 534. 1879; Paris, Index Bryolog. 81. 1895.

E. conostegum (C. Müll.) Mitt. Musc. Austr.-Amer. 519. 1869; Jaeger, Adumbr. **2**: 537 (Brideli syn. et habitat portoric. excl.) 1879; Paris, Index Bryolog. 79 (Brideli syn. et habitat. portoric. excl.) 1895.

E. Poeppigianum (Hampe) Jaeger, Adumbr. **2**: 534. (Mitteni syn. et Lindigi planta excl.). 1879.

Vesicularia conostega C. Müll. Hedwigia, **37**: 252. 1898.

Monoicum, fusco- vel flavo-viride, laxe et depresse caespitosum, caespitibus intricatis mollibus, caule repente praelongo flexuoso inferne radiculoso irregulariter pinnato vel raro hic illic subbipinnato, ramis inaequalibus ad 7 mm. longis simplicibus vel raro parce et vage ramosis patulis vel patentibus distichis haud complanatis cum foliis circ. 1.5 mm. latis, foliis caulinis erecto-patentibus imbricatis saepe apice parum uncinatis vix compressis siccitate inflectentibus dorsalibus et lateralibus oblongo- vel ovato-acuminatis circ. 1.5 mm. longis acumine longo tenui flexuoso saepe recurvo lateralibus basi inaequalibus cellulis firmiusculis superioribus hexagonis et subhexagonis 50 — 70 × 12 — 15 μ inferne longioribus rectangulo-subhexagonis utriculo primordiali contracto repletis margine nisi in acumine minutissime subdenticulato integerrimo interdum ad folii medium recurvo nervis binis brevibus plerumque inaequilongis, foliis caulinis ventralibus minoribus circ. 1 mm. longis e basi late ovali vel subquadrata abruptius tenuiter acuminatis tenerius areolatis cellulis hexagonis et elliptico-subhexagonis 40 — 70 × 13 — 15 μ, foliis rameis haud complanatis multiseriatis vix compressis erecto-patentibus imbricatis saepe plus minus uncinatis dorsalibus et lateralibus circ. 1 mm. longis ovatis vel oblongis sensim acuminatis lateralibus angustioribus ovato-lanceolatis basi saepe inaequalibus, acumine fragili plus minus longe producto, margine in folii summo apice minutissime denticulato alibi integro cellulis superioribus firmiusculis hexagonis et subhexagonis 45 — 60 × 12 — 15 μ marginalibus in folii parte superiore latis omnibus utriculo primordiali contracto repletis nervis binis brevibus distinctis, foliis rameis ventralibus minoribus nunc e basi concava oblonga vel ovata lanceolatis nunc oblongis vel ovatis plus minus longe acuminatis (in rami parte inferiore saepe subulato-acuminatis acumine curvato) margine subintegro tenerius areolatis cellulis hexagonis et subhexagonis circ.

40 – 60 × 13 – 15 μ nervis binis brevibus, foliis perichaetialibus erectis superioribus apice flexuosis e basi oblongo-ovata truncata filiformi-acuminatis laxe reticulatis margine integro vel subintegro, capsula in pedunculo gracili subflexuoso purpureo glabro 1.5 cm. alto apice incurvo parvula 1.25 × 0.75 mm. badia suburceolata pendula, operculo turgide conico acutiusculo, "peristomii dentibus interni ciliis binis."

Hab. — *Amer. austr.* — Peruvia; sylvae primaevae, Cuchera, c. fr. (leg. Poeppig, 1829), Poeppig, Musci frondosi *no. 12* (Herb. Hamp.)! Andes peruvianae (Spruce)!

Ind. occid. — Cuba, ad truncos putridos in sylvis (Wright, *no. 120*, sub *Hypno Montagnei* Schimp., partim, = *E. flavoviride* Mitt. in herb. Mitten. et = *Hypnum conostegum* C. Müll. in herb Müller). Cuba, Döring in Hb. Kunzeano. Sept. 25, 1843 (sub. *Hypno conostego* C. Müll. in herb. Müller). St. Domingo, in monte "Isabel de la torre," 600 m. alt., June 3, 1887, leg. Eggers (sub *H. conostego* C. Müll. in herb. Müller).

Hampe in 1844 described the present plant, from examples collected by Poeppig in Peru, as *Hookeria Poeppigiana.* Müller in the "Synopsis" placed the moss in the genus *Hypnum* — section *Omalia*, subsection *Vesicularia* — between *H. rutilans* and *H. vesiculare*, and contrasted it with the latter species. In 1869 Mitten (Musci Austro-Amer. 518) without seeing specimens of Hampe's plant, quoted "*Hookeria Poeppigiana*" as a synonym of *Ectropothecium vesiculare*, and since this date authors have, almost without exception, followed Mitten in referring Hampe's plant from Peru to Schwaegrichen's species, *E. vesiculare*, from Jamaica. Jaeger (Adumbr. **2**: 534), who maintains Hampe's species and who was the first to place it in *Ectropothecium*, gives the reference "*Ectropothecium vesiculare* forma Mitt. Musc. Austr. Amer. p. 518," this, however, is incorrect, the word "forma" not occurring in the place cited. Jaeger quotes as a locality for the species "Nova Granada, in silvis ad flumen Magdalenae (*A. Lindig*)." There are examples of this plant in Hampe's herbarium, labelled in Hampe's handwriting, "*Hypnum Poeppigianum*," from "Nova Granata, ad flum. Magdalenae, December, 1862 in sylvis leg. A. Lindig." This moss, however, is certainly not the same species as is represented by Hampe's type-specimens from Peru, but belongs clearly to *E. amphibolum* Spruce. The same is the case with another moss in Hampe's herbarium labelled "*Hypnum callidum* Mont.

Chile; Huallagua super in arboribus ad Missionem Tocache Jul. 1830 Poeppig." On the label has been written in Müller's handwriting "= *Hookeria Poeppigiana* Hampe," and "= *Leskea rutilans* Brid. nach Originalexempl."

Further, there is a moss in Hampe's herbarium labelled "Musc. Andini Amazonici 1155 zu 1144. *Hypnum glaucosum* C. Müll. n. sp. *Ectropothecium subdenticulatum* Mitt. non C. Müll. Andes Peruvianae." An examination of the specimen, which consists of a few stems only, shows that there is a mixture of two species here, one being Hampe's *Hookeria Poeppigiana* — the plant agreeing in every way with Hampe's type; while the other is *E. amphibolum* Spruce.

In 1851 Müller published as a new species, in the section *Omalia*, subsection *Vesicularia*, of *Hypnum*, a plant from Cuba, (collected by Döring) under the name of *H. conostegum*, placing it, with the single species *H. subdenticulatum* in the section "Folia denticulata, longe acuminata," whilst *H. Poeppigianum* was placed in the section "Folia integerrima, breviter acuminata." The following description was given: "*monoicum; H. subdenticulato* simillimum, sed *irregulariter* pinnatum, ramis *siccitate distincte curvatis flexuosis tenerioribus subcontortis lutescentibus hic illic fuscidulis,* humore patentibus; folia obsolete denticulata saepe integerrima; pedunculus, theca et peristomium *H. Pöppigiani;* operculum *turgide conicum acutum.*" I have seen the type-specimen, labelled "*Hypnum conostegum* n. sp. Cuba: Döring in Hb. Kunzeano 25.9.1843," in Müller's herbarium. It is clearly the same plant as Hampe's *Hookeria Poeppigiana*, agreeing perfectly in habit, color, areolation and other leaf-characters.

These Cuban examples agree with certain specimens of the var. *Poeppigianum* in Bescherelle's herbarium, labelled "Peruv. Andes; Cocheras, Poeppig," in showing a variation in the shape of some of the branch-leaves which point out clearly the passage to *E. vesiculare* type. In Hampe's plant, as well as in Müller's type-specimens of *H. conostegum*, the dorsal and lateral leaves of some branches are more or less long-acuminate, while in other branches *of the same stem* these leaves (in the upper part of the branch) are broadly ovate and short- and abrupt-acuminate,— or even apiculate-acuminate, with slightly laxer areolation.

Two other examples of "*H. conostegum*" occur in Müller's herbarium. The first, which is labelled "*Hypnum conostegum* C. M. Cuba, decayed logs in forests, Wright n. 120 = *H. Montagnei* Sch. ex C. M.," quite agrees with the plant collected in Cuba by Döring, and, like that, often shows an approach in the shape of the branch-leaves to *E. vesiculare* type. It is of interest to note, however, that the main stem of some of these specimens is often thick, especially towards the apex, and that the apex of the branches is often incurved, and also that the points of the dorsal and lateral leaves of both stem and branches are slightly decurved, so that the stems have a very different appearance viewed from above and below.

The second example is labeled "*H. conostegum* m. St. Domingo in monte 'Isabel de la torre,' 600 m. alt. 3.7.87 leg. Eggers." This also has rather thick stems, with the points of the leaves decurved. It is, however, like the other example, clearly the same plant as Hampe's *Hookeria Poeppigiana,* in the type-specimen of which the same leaf-characters are sometimes observable.

With regard to the shape of the operculum — "operculum *turgide conicum acutum*"— advanced by Müller as a distinguishing character, it may be noted here that, as Montagne (in La Sagra, Hist. Cuba, Bot. 532) has already pointed out, the operculum of the present plant is *in the dry state* apiculate or mucronate, but becomes conical acuminate *on being moistened* ('operculum in statu sicco plus minus longe apiculatum vel mucronatum, humecto vero conico-acuminatum'). The FIGURES 19 and 20 which I have given on PLATE 14 show the change which takes place in the shape of the operculum.

It must be noted here that Müller quotes in the Synopsis, under *H. conostegum* the locality "Portorico: Bertero," and remarks "*Leskea* (*Omalia*) *rutilans β Portoricensis* Brid. II, p. 332 e spec. imperfectis Hb. Brid. forma flaccidior videtur." I have seen the type of Bridel's plant above referred to; — the sheet bears the label, in Bridel's handwriting, "*L. Omalia rutilans β Portoricensis* Bryol. Univ. *Pterigophyllum pendulum* N. *L. Omalia Portoricensis* Bryol. Univ. In Porto Ricco ad saxa et arbor. Balbis Lyon 1820." On the sheet, above the specimens, Müller has written "*Acosta conostega* mihi videtur." Now this plant of Bridel's from Porto Rico, of which a fair, fruiting example still exists in his herbarium, is certainly not Müller's *H. conostegum*, but it is identical with *E. amphibolum* Spruce.

Mitten, in 1869, in Musc. Austr.-Amer. 518, published, as a new species "*Ectropothecium flavoviride.* Ins. Cuba, Wright, n. 120, ex parte." I have examined the type in Mitten's herbarium, and find that it agrees well with Hampe's *H. Poeppigiana.* Whilst clearly belonging, in my opinion, to this, it is somewhat marked in possessing long-acuminate and rather narrow leaves, and in having the margin of the dorsal branch-leaves recurved at the middle of the leaf. The ventral branch-leaves in Mitten's type are frequently subulate-acuminate. In some of the branches of the type-specimens of *H. Poeppigiana*, however, the ventral branch-leaves are of exactly the same shape (while on other branches they are simply acuminate), and occasionally, also, the margins of the dorsal branch-leaves are recurved.

Part of the specimen in the Kew Herbarium under the *no. 120* in Wright's Cuban Mosses is the same plant as Mitten's *E. flavoviride.*

The present plant, described by Hampe as *Hookeria Poeppigiana*, certainly presents characteristics which might lead us at first sight to suppose that it was specifically distinct from *E. vesiculare.* These characteristics are the more robust habit (shown in Hampe's figure), the pale color, the longer stems with less patulous branches which sometimes bear secondary branchlets, and especially the different shape and arrangement of the branch-leaves. In the present plant the dorsal and lateral branch-leaves are usually longer, narrower, more acuminate and with firmer areolation than in *E. vesiculare*, and the branch-leaves are more crowded and arranged in many rows, so that the branches present a very different appearance from the complanate branches of *E. vesiculare* type, with their marked subdistichous arrangement of dorsal and lateral branch-leaves. As pointed out above, however, we find both in authentic specimens of *Hookeria Poeppigiana* from Peru, and of *Hypnum conostegum* from Cuba, some stems showing characters which clearly point to too close an affinity with *E. vesiculare* to allow of the present plant being given more than a varietal rank.

From all forms of the variable *E. amphibolum*, Spruce, *E. vesiculare Poeppigianum* may be at once distinguished by the less denticulate dorsal and ventral branch-leaves, with wider marginal cells towards the apex of the leaf, and by the wider areolation of the ventral branch-leaves. I have not seen the peristome of the present plant, and have therefore, in the diagnosis given above, copied the description given by Hampe in Müller's Synopsis.

It would appear from the figure given by Montagne that the Cuban "*Hypnum Montagnei*" is *E. vesiculare Poeppigianum*, although the specimen in the Kew Herbarium, from Montagne's herbarium, is certainly *E. vesiculare* type (see above). It may be noted that Paris (Index Bryolog. 84) cites wrongly the reference "Mont. in Hist. Cuba, Crypt. p. 530, t. 20, f. 1" for the true *E. Montagnei* (Bel.) Jaeger. The latter species, from authentic specimens I have seen, is distinct from *E. vesiculare* — although evidently closely allied — in the more robust habit, the branches with more densely arranged leaves, and in the branch-leaves being of a different shape, hamate at the apex, and with different areolation; the ventral branch-leaves, also, are wider and more suddenly acuminate.

E. crassicaule Mitt. is — as the type-specimen in Mitten's herbarium shows — different from all the plants described above, and presents the following characters. The plant is straw-colored, with here and there branches showing a rich fuscous tinge of color; the stem is closely pinnate, with branches of unequal length which are usually curved at the apex. The stem-leaves are very crowded, and seen from the dorsal side of the stem are imbricate in several rows. They are gradually long-acuminate from a truncate broadly ovate or oblong base, the acumen is long, fine and flexuous, the margin is entire (with the marginal cells very distinct) except in the acumen, where it is obscurely and minutely denticulate, or subentire. The areolation is lax, with hexagonal or elongate-subhexagonal cells, the walls of which become subporose. The ventral stem-leaves are smaller and wider, and the cells have thinner walls. They are suddenly acuminate from a subquadrate or broadly oblong truncate base; the acumen is long and usually filiform, and is often flexuously contorted. The points of all the stem-leaves are regularly hamate, being curved towards the ground. The branch-leaves are crowded, and strongly hamate; the dorsal branch-leaves are lanceolate and ovate-lanceolate, attenuated to a fine acumen; the margin is entire below, minutely denticulate above; the cells are lax, and hexagonal in shape. The ventral branch-leaves are smaller, and more abruptly acuminate from a broadly oblong or subquadrate base; the cells are more delicate, hexagonal in shape, but longer; the acumen is long and fine. Seta about 2 cm. long; capsule pendulous. The habit is very *hypnoid* (as in other species of *Ectropothecium*), and in the regularly hamate leaves, all turned in one direction (so that the dorsal surface of the stem and branches has a smooth or almost glossy appearance, while viewed from below the stem and especially the branches bristle with the flexuose arcuate points of the leaves) the plant recalls such a species as *Hypnum cupressiforme*.

Mitten's type is labeled "120 *Hypnum Montagnei* Schimp. in Mont. Crypt. Cub. p. 530, t. 20. Hab. decayed logs in forests. Cuba, Wright, ex parte."

In the Kew Herbarium part of the specimens under the *no. 120* in Wright's Cuban Mosses belongs to *E. crassicaule* Mitt., and agrees with the type in every way except that many of the dorsal branch-leaves are a little broader, being ovate-acumiate instead of lanceolate.

Explanation of plates 13 and 14

PLATE 13

FIG. 1. *Ectropothecium vesiculare* (Schwaegr.) Mitt., ventral branch leaf, × 68. FIG. 2. Areolation of same at ⅓ from the apex, × 400. FIG. 3. Areolation of a dorsal branch-leaf at ⅓ from the apex, × 400. (*Figs. 1–3* drawn from the plant in Wright's Cuban Mosses, *no. 120*, in the Kew Herbarium.)

FIG. 4. *E. amphibolum* Spruce, ventral branch-leaf, × 68. FIG. 5. Areolation of same at ⅓ from the apex, × 400. FIG. 6. Areolation of a dorsal branch-leaf at ⅓ from the apex, × 400. (*Figs. 4–6* drawn from the plant in Spruce, Musc. Amazon. et And., *no. 1145*.)

FIG. 7. *E. vesiculare* (Schwaegr.) Mitt., apex of a dorsal branch-leaf, × 255. FIG. 8. A ventral branch-leaf, towards the base of the branch, × 52. FIG. 9. Perichaetial leaf, × 25. (*Figs. 7–9* drawn from the type in Schwaegrichen's herbarium.)

PLATE 14

FIGS. 10, 11. *E. vesiculare* (Schwaegr.) Mitt., a dorsal and a lateral branch-leaf, × 52. FIG. 12. Areolation of the apical part of the same dorsal branch-leaf, × 400. (*Figs. 10–12* drawn from the type in Schwaegrichen's herbarium.)

FIG. 13. *E. amphibolum* Spruce; marginal areolation of a lateral branch-leaf at ¼ from the apex of the leaf, × 255 (drawn from the plant in Spruce Musc. Amazon. et And., *no. 1148*.)

FIGS. 14, 15. *E. vesiculare Poeppigianum* (Hampe), a dorsal and a lateral branch-leaf, × 52. FIG. 16. Marginal areolation of a dorsal branch-leaf at ¼ from the apex of the leaf, × 255. (*Figs. 14–16* drawn from the type in Hampe's herbarium.)

FIGS. 17–22. *E. vesiculare* (Schwaegr.) Mitt.; 17, 18, two stem-leaves, from the superior side of the stem, × 52; 19, capsule, in moistened state, × 25; 20, operculum, dry, × 25; 21, part of inner peristome, × 150; 22, cilia of same, × 255. (*Fig. 19* drawn from the plant in Wright's Cuban Mosses, *no. 120*, in the Kew Herbarium; *figs. 17, 18, 20–22* from the type in Schwaegrichen's herbarium.)

The Polyporaceae of North America — VII. The genera Hexagona, Grifola, Romellia, Coltricia and Coltriciella

William Alphonso Murrill

In the last article of this series (Bull. Torrey Club, **31** : 29–44. 1904), the tough, wood-loving, central-stemmed polypores were discussed under the genus *Polyporus*. The genus *Hexagona* is in general readily distinguished from *Polyporus* by its lateral stem and peculiar pores, but the two genera approach very near to one another in some of their forms. Species of *Grifola* are large, fleshy to tough and much branched, usually growing at the bases of trees or arising from buried wood. The genera *Romellia*, *Coltricia* and *Coltriciella*, although belonging to the brown-fleshed section, are conveniently introduced here because their species are stipitate and are ordinarily associated with the stipitate forms already discussed. This latter group, moreover, is indirectly related to *Grifola* through the genus *Romellia*, with its hyaline spores, large, irregular pileus and thick, rather fleshy substance.

HEXAGONA Poll. Pl. Nov. 35. *pl. 2, 3.* 1816.

This genus was founded upon *Hexagona Mori*. The genus *Favolus* was based on *Favolus hirtus*. Both genera are monotypic in origin. Unfortunately the two were interchanged by Fries, who was unfamiliar with the species, and they have been improperly used ever since. In the Systema, Fries followed Beauvais and included *Hexagona* under the subgenus *Favolus* of *Polyporus*. In the Epicrisis, Fries includes *F. hirtus*, Beauvais' type, in the genus *Hexagona* and follows it with *H. Mori*, Pollini's type. He then begins his genus *Favolus* with *F. europaeus*, a synonym of *H. Mori*.

The genus *Hexagona* comprises species with radially elongated pores having normally six angles. In some species, the usual form of the pores is not so evident, but general appearance and habit serve to indicate generic limits. The line of demarcation between this genus and *Polyporus* is difficult to draw. Most of the species of *Hexagona* are laterally stipitate or almost sessile, but some of them vary to centrally stipitate forms and a few species are regularly mesopous. All grow upon dead wood and agree closely in habit and host plants. One American species is common also in Europe, the others are limited to either temperate or to tropical regions of America. Many of them are very imperfectly known.

Synopsis of the North American species

1. Tubes unequally hexagonal, the radial walls longer. 2.
   Tubes equally hexagonal 15.

2. Pileus white or nearly so. 3.
   Pileus purple or brown. 12.

3. Surface of pileus glabrous or minutely hairy or fibrillose, not distinctly hispid or tomentose. 4.
   Surface of pileus distinctly hispid or tomentose. 9.

4. Pileus reniform at maturity, stipe usually much reduced; species not tropical. 5.
   Pileus flabelliform, stipe usually very distinct, equalling the pileus at times in length; species tropical. 6.

5. Tubes large, surface of pileus decorated with imbricated reddish-brown fibrils, which disappear with age. 1. *H. alveolaris.*
   Tubes much smaller, the mouths rarely over 1 mm. long and 0.5 mm. broad, surface of pileus glabrous. 2. *H. micropora.*

6. Tubes of medium size; pileus large and tough, margin not ciliate. 3. *H. daedalea.*
   Tubes large, mouths 1–2 mm. broad and 3–5 mm. long. 7.

7. Margin much lobed and fissured at maturity. 4. *H. Wilsonii.*
   Margin entire. 8.

8. Pileus small, 5 cm. in breadth. 5. *H. hispidula.*
   Pileus large, 10 cm. in breadth. 6. *H. princeps.*

9. Surface not tessellated. 10.
   Surface tessellated. 11.

10. Tubes large, the mouths 1 x 4 mm., becoming radially confluent and gill-like; context only partially translucent. 7. *H. fragilis.*
    Tubes small, the mouths about half as large as in the preceding and not becoming confluent; context thinner, wholly translucent. 8. *H. floridana.*

11. Pileus small, thin and fragile, the surface minutely checkered. 9. *H. tessellatula.*
    Pileus large, thick and firm, the surface coarsely checkered. 10. *H. caperata.*

12. Pileus purple or purplish-brown, stipe lateral or excentric. 13.
    Pileus brown, stipe distinctly central. 14.

13. Tubes merulioid. 11. *H. brunneola.*
    Tubes of normal length. 12. *H. purpurascens.*

14. Margin entire. 13. *H. portoricensis.*
    Margin ciliate. 14. *H. hondurensis.*

15. Pileus purple.	15. *H. indurata.*
Pileus yellow or brown.	16.
16. Margin papulose.	16. *H. cucullata.*
Margin not papulose.	17. *H. Taxodii.*

1. **Hexagona alveolaris** (DC.).

Merulius alveolaris DC. Fl. Fr. **6**: 43. 1815.
Hexagona Mori Poll. Pl. Nov. 35. *pl. 2, 3.* 1816.
Boletus arcularius Schw. Syn. Car. 69. 1818.
Cantharellus alveolaris Fr. Syst. Myc. **1**: 322. 1821.
Favolus canadensis Kl. Linnaea, **7**: 197. 1832.
Favolus europaeus Fr. Epicrisis, 498. 1838.
Favolus ohiensis Berk & Mont. Syll. Crypt. 171. 1856.
Favolus alveolaris Quél. Enchiridion, 185. 1886.—Fairman, Proc. Rochester Acad. Sci. **2**: 162. 1895.

This common and widely distributed species has been several times described, the earliest name having been assigned to specimens from Europe. No mention is made of the American plant in the description of *M. alveolaris* from southern France. The plant was apparently known to Fries under its earliest name in 1821, but in 1838 he redescribed it under the name *Favolus europaeus*, even the genus being different. *F. canadensis* was described from a single specimen in Hooker's herbarium. The excellent description of *F. ohiensis* was drawn from several specimens sent from Columbus, Ohio, by Sullivant. In addition to the names listed above, the species has been reported under several others, notably *F. Boucheanus* Kl. (Linnaea, **8**: 316. *pl. 5. f. 2.* 1833) and *F. alutaceus* Berk. & Mont. (Ann. Sci. Nat. Bot. III. **11**: 240. 1849). The former was originally collected by Bouché on dead trunks of birch at Lankwitz near Berlin. The latter was described from Bahia, Brazil, and probably does not extend even into tropical America. Faded specimens of *H. alveolaris*, collected especially in the South during late autumn or winter, resemble the Brazilian species in some ways, but authentic plants show them to be very distinct. Var. *peponinus* B. & C. of *F. Boucheanus* was doubtless based on these same faded forms of our common species.

In the exsiccati listed, only American material is considered. The species grows upon dead wood, usually fallen limbs, of various deciduous trees. In New York it appears to be most common on species of hickory: Canada, *Dearness, Macoun;* New Hampshire. *Lobenstine;* Connecticut, *White, Earle;* New York, *Underwood, Clinton, Brown, Murrill, Overacker, Earle;* Pennsylvania, *Haines, Everhart;* New Jersey, *Ellis;* Ohio, *James, Morgan;* Virginia, *Murrill;* Georgia, *Ravenel;* Alabama, *Earle;* Michigan, *Hicks, Johnson;* Wisconsin, *Calkins;* Montana, *Anderson.*

2. **Hexagona micropora** sp. nov.

Pileus flabelliform to reniform, convex, usually umbilicate or depressed behind, 2–4 × 2.5 × 0.2–0.4 cm.; surface smooth, glabrous, straw-colored to cream-colored, margin acute, undulate or slightly lobed, rarely reflexed, irregularly denticulate, dark brown, as if scorched: context white, 1–2 mm. thick; tubes decurrent, ochraceous, 1–2 mm. long, mouths 4–6 angled, 0.3–0.5 × 0.6–1 mm., edges rather firm, beset with small, sharp teeth; spores ellipsoidal, smooth, hyaline, 3 × 9 μ; stipe lateral to excentric, slightly enlarged below, concolorous, minutely tomentose to subglabrous, 1–7 mm. long, 3–5 mm. thick.

The type plants of this species were collected by Miss V. S. White on a dead birch tree at Bar Harbor, Maine, August 4, 1901. Other collections are at hand from Ohio, *Kelsey;* New York, *Britton;* New Jersey, *Ellis;* Wisconsin, *Baker.* Specimens were also found in the Fries herbarium at Upsala sent from New York by Peck. In habit and general appearance it resembles *H. alveolaris*, but it is much rarer and seems confined to the northern states, while the glabrous surface and very much smaller tubes easily distinguish it from that species.

3. **Hexagona daedalea** (Link)

Merulius daedaleus Link, Disser. **1**: 37. 1795.
Daedalea braziliensis Fr. Syst. Myc. **1**: 332. 1821.
Favolus braziliensis Fr. Elench. Fung. 44. 1828; Linnaea, **5**: 511. *pl. 11. f. 1.* 1830.

This species was originally described from Brazil, but it extends as far north as Florida and is quite abundant in tropical America on fallen trunks and other decayed timber. Besides the synonyms cited above, there are doubtless several more recent ones assigned by those who have worked over South American material. On the other hand, some species have been treated as forms of this one which are really distinct. *Favolus tessellatus* Mont. (Ann. Sc. Nat. II. Bot. **20** : 365. 1843), a good Brazilian species, was at first determined as *F. braziliensis* by Montagne and later separated because of its distinctly tessellated or checkered surface and regularly hexagonal pores. Cuban specimens called *F. tessellatus* are plainly *F. braziliensis*, and are so determined at Kew by Montagne.

Exsiccatae : Texas, *Wright ;* Louisiana, *Hale, Langlois ;* Cuba, *Underwood & Earle ;* San Domingo, *Wright ;* Brazil, *Telinck.*

4. **Hexagona Wilsonii** sp. nov.

Pileus flabelliform, applanate, 4–7 × 4–9 × 0.05–0.2 cm. ; surface radiate-striate, slightly hispid, partially tessellate, pure white, becoming cream-colored on drying ; margin at maturity very thin, usually much lobed and fissured, beset with short, fugacious hairs : context fleshy-tough, membranous, white, partially or wholly translucent ; tubes decurrent, white, 1–2 mm. long, 4–6 angled, mouths 1.5 × 5 mm., smaller near the margin, edges very thin, splitting into irregular teeth ; spores ellipsoidal, smooth, hyaline, 5 × 10 μ ; stipe exactly lateral, equal, concolorous, hispid, 0.5–1 cm. long, 2.5–5 mm. thick, often umbilicate above where it expands into the pileus.

This elegant species was collected by Percy Wilson (*no. 317*) in July, 1902, in the Luquillo mountains, Porto Rico, three miles from the coast. Decaying logs along a mountain stream were found covered with the fruit-bodies.

5. **Hexagona hispidula** (B. & C.)

Favolus hispidulus B. & C. Jour. Linn. Soc. Bot. **10** : 321. 1868.

Collected on trunks in Cuba by Wright.

6. **Hexagona princeps** (B. & C.)

Favolus princeps B. & C. Jour. Linn. Soc. Bot. **10** : 321. 1868.

Collected on dead wood in Cuba by Wright. The type is at Kew. It is a large, handsome species.

7. **Hexagona fragilis** sp. nov.

Pileus flabelliform, convex, depressed behind, 2–3 × 2–4 × 0.1–0.3 cm.; surface densely hispid, especially behind, faintly radiate-striate, pure white, becoming straw-colored in drying ; margin quite thick for the genus, nearly regular in outline, usually inflexed when dry, partly hygrophanous at times, beset with short, fimbriate, fugacious hairs: context thin, white, partially translucent, quite fragile when dry; tubes decurrent, white, 2–3 mm. long, 4–6 angled, mouths 1 × 4 mm., becoming radially confluent and gill-like, edges thin, lacerate, the divisions fimbriate; spores ellipsoidal, smooth, hyaline, 4–5 × 10 μ; stipe lateral, subequal, concolorous, hispid, short, 5 mm. long, 2.5 mm. thick, rarely umbilicate above.

About twenty specimens of this plant were collected by Earle (*no. 585*) during a recent visit to Jamaica. They were found on fence-posts made of "star-apple" (*Chrysophyllum*).

8. **Hexagona floridana** sp. nov.

Pileus flabelliform, applanate, depressed behind, 2 × 2.5–3 × 0.2 cm.; surface finely hispid, pure white becoming straw-colored on drying, faintly radiate-striate; margin slightly undulate, tessellate at times, fringed with numerous slender cilia: context very thin, white, membranous, wholly translucent; tubes decurrent, white, becoming ochraceous, 1.5–2 mm. long, normally hexagonal, mouths 0.5–1 × 2–3 mm., not radially confluent, edges thin, fimbriate; spores ellipsoidal, smooth, hyaline, 9 × 4 μ; stipe lateral, subequal, scutate at the base, concolorous, hispid, 2–5 mm. long, 1–2 mm. thick, always umbilicate above.

This species was collected by Small & Wilson near Miami, Florida, May, 1904. About thirty sporophores in various stages of development were taken from an old decaying log in rich shady woods.

9. **Hexagona tessellatula** sp. nov.

Pileus flabelliform, convex, depressed behind, 1–3 × 2–4 × 0.2 cm.; surface delicately and closely tessellate, finely hispid, becoming glabrous, white, yellowish when dry; margin thin, denticulate, slightly incurved when dry, frequently brown and hygrophanous: context white, membranous, translucent; tubes decurrent, white, 2 mm. long, 4–6 angled, mouths 1 × 3 mm., at length radially confluent, edges thin, lacerate; spores ellipsoidal, smooth, hyaline, 2-guttulate, 3 × 10 μ; stipe lateral, short, slightly enlarged below, concolorous, hispid, 3–5 mm. long, 2–3 mm. thick, usually umbilicate above.

This species was recently collected on dead wood in Cuba by Underwood and Earle (*no. 1212*). About twenty fruit-bodies were preserved.

10. **Hexagona caperata** (Pat.)

Favolus caperatus Pat. Bull. Soc. Myc. **18**: 171. 1902.

Described from Guadeloupe collections. Easily recognized by the abundant villosity which covers the cap. Plants recently collected by Earle at Port Antonio, Jamaica, agree well with the description.

11. **Hexagona brunneola** (B. & C.)

Favolus brunneolus B. & C. Jour. Linn. Soc. Bot. **10**: 321. 1868.

Collected on dead wood in Cuba by Wright. One small specimen is at Kew. The tubes are merulioid in their brevity, the dissepiments being mere lines. I was at first inclined to consider the species an undeveloped stage of *H. purpurascens*, but the two species were originally described at the same time and declared by their authors to be most distinct.

12. **Hexagona purpurascens** (B. & C.)

Favolus purpurascens B. & C. Jour. Linn. Soc. Bot. **10**: 321. 1868.

Collected by Wright on trunks in Cuba. Easily distinguished from most other species by its purple color.

13. **Hexagona portoricensis** sp. nov.

Pileus centrally stipitate, circular, deeply umbilicate, × 4 0.3 cm.; surface subglabrous, umbrinous, the centre concolorous; margin entire, not very thin, much inflexed when dry: context white, fibrous, 1 mm. thick, opaque; tubes somewhat decurrent, white, 2 mm. long, 4–6 angled, mouths 1 × 3 mm., smaller and more regular near the margin, edges thin, fimbriatulate; spores ellipsoidal, smooth, hyaline, 2-guttulate, 3–5 × 8–10 μ; stipe central, compressed, slightly tapering downward, subconcolorous, minutely tomentose, 2 cm. long, 4 mm. thick.

The above description is based on *no. 145* of Earle's Porto Rican collections. The plant was found upon decaying wood in the mountains at an altitude of 2,000 feet. It has many characters in common with *H. hondurensis*.

14. **Hexagona hondurensis** sp. nov.

Pileus centrally stipitate, circular, slightly umbilicate, 2–4 × 0.05 cm.; surface faintly radiate-striate, subglabrous, fulvous, the center fuliginous; margin thin, regular, tessellate, inflexed when dry, fringed with numerous short, fugacious cilia: context white, fibrous, 0.25 mm. thick, translucent near the margin; tubes adnate, white, 0.3 mm. long, hexagonal, radially elongated, mouths 1 × 2 mm., much smaller near the margin, edges thin, subentire; spores ellipsoidal, smooth, hyaline, 3.5 × 9 μ; stipe central, equal, concolorous, pruinose to glabrous, 2–3 cm. long, 2 mm. thick.

This species is described from plants collected in Honduras by Percy Wilson (*no. 640*) March, 1903. They grew on dead logs by the shore of a lagoon not far from the coast. All stages are represented.

15. **Hexagona indurata** (Berk.)

Favolus induratus Berk. Ann. Nat. Hist. II. **9**: 198. 1852.

Collected on wood in San Domingo. The type plants are at Kew. If the tubes alone were considered, this species would belong rather with *Favolus*. It differs from *H. cucullata* in having larger tubes, and being purple in color.

16. **Hexagona cucullata** (Mont.)

Favolus cucullatus Mont. Pl. Cell. Cuba, 378. *pl. 14. f. 2.* 1842.

Montagne's type from Cuba is well described and figured in the work cited. Although the tubes are regularly hexagonal, it seems best to place the species in *Hexagona* because of general appearance, structure and habit. Berkeley considered *Favolus curtipes* B. & C. (Kew Misc. **1**: 234. 1849) a synonym of Montagne's species, remarking that plants collected in San Domingo exactly connect the Cuban species with that described from South Carolina.

17. **Hexagona Taxodii** sp. nov.

Pileus reniform, applanate, umbonate-sessile, 3–6 × 6–8 × 0.2 cm.; surface glabrous, radiate-striate, cream-colored to ochraceous, marked with two or three broad undulations from center to margin, which is thin, entire, irregularly undulate or lobed and deflexed when dry: context tough, white, homogeneous, 0.5 mm. thick; tubes dark fulvous, hexagonal, not radially elongated, 1.5 mm. long, 1 mm. wide, edges thin, finely denticulate; spores ellipsoidal, smooth, hyaline, 14 × 7 μ, copious; stipe a mere scutate disk nearly a centimeter in breadth.

The type collection of this species was made by Small & Wilson near Miami, Florida, May, 1904. The sporophores were found a few feet from the ground on a decaying standing trunk of cypress (*Taxodium distichum*) in damp rich woods near the Miami river. Other plants were collected near the type locality by Mr. McCullough of the Miami Experiment Station.

SPECIES INQUIRENDAE

Favolus Friesii B. & C. Jour. Linn. Soc. Bot. **10** : 321. 1868. First collected on decayed wood at San José, Costa Rica, and called *Favolus lacerus* by Fries, who later (Nov. Symb. 104. 1851) assigned it to *F. flaccidus* Fr. (Linnaea, **5** : 511. 1830), a species collected in Brazil by Beyrich, in whose herbarium it was called *Cantharellus aequinoctialis* Link. The original name was changed by Berkeley and Curtis because of *Favolus lacerus* Lév., described from Java. The Cuban plant at Kew seems only a form of *H. daedalea*, but it is very likely that the one from Costa Rica is different.

Favolus curtipes B. & C. Hook. Jour. Bot. **1** : 234. 1849. "Pileus reniform, two inches broad, one and one-half inches long, quite smooth, rigid, and tawny when dry. Stem extremely short, disciform. Pores one-thirty-sixth of an inch broad, pale, undulated, and crisped; edge white." Said by the authors to differ from *F. cucullatus* Mont. in having less rigid and smaller pores and more fleshy substance.

Favolus guadalupensis Lév. Ann. Sc. Nat. III. Bot. **5** : 144. 1846. Collected on trunks in Guadeloupe by L'Herminier. Infundibuliform specimens of *H. daedalea* agree fairly well with the description of this species.

Favolus velutipes Fr. Nov. Symb. 104. 1851. Collected by Oersted at San José, Costa Rica. Pileus fan-shaped, smooth, ferruginous; stipe very short, pubescent.

GRIFOLA S. F. Gray, Nat. Arr. Brit. Pl. **1** : 643. 1821.

Polypilus Karst. Rev. Myc. **3** : 17. 1881.

Meripilus Karst. Bidr. Finlands Nat. och Folk. **37** : 33. 1882.

Cladomeris Quél. Enchiridion, 167. 1886.

The genus *Grifola* was founded on *Grifola frondosa* and five other species with lateral stem and semicircular cap, *i. e.*, *G. platypora*, *G. cristata*, *G. lucida*, *G. badia* and *G. varia*. Of these last only *G. cristata* is congeneric with the type, the others belonging to *Polyporus* and *Ganoderma.* In Karsten's arrangement of the group, *P. frondosus* with *P. confluens* and *P. sulfureus* form the basis of a new genus, *Polypilus*, Gray's genus *Grifola* not being considered. So, again, Quélet establishes his genus *Cladomeris* on *P. umbellatus* and sixteen other species, ignoring the work of both Karsten and Gray.

The plants of the genus *Grifola* are large and striking in appearance and sometimes attractive in coloring. They are intricately branched or irregularly lobed, fleshy or fleshy-tough in substance, with white context and spores and large, irregular tubes, which become friable or laciniate with age. They are usually found on or near dead wood in some form, either attached to buried sticks or roots or growing close to the base of a tree trunk. This latter habitat is a favorite one for at least four members of the genus, and the tree is usually an oak.

The distribution of members of this genus is quite general. Two of our species occur also in the Eastern hemisphere and two others are represented there by nearly related plants. *G. frondosa* may be said to be abundant, *G. poripes* and *G. Berkeleyi* are fairly well known and the remaining three are rare, *G. ramosissima* being more common, however, in Europe than in America.

Owing to the difficulty of handling such large forms and the changes which they undergo in drying, many mistakes are current concerning these plants. It is not easy to gain a just conception of an entire plant from one of its minute divisions, and in this, as well as in other groups, form and habit of growth count for much. If some of the existing errors have been eradicated by these studies, there is yet much to learn with regard to known species and more concerning those whose standing is still in doubt.

Synopsis of the North American species

1. Hymenium ochraceous, becoming dirty-yellow with age, plants terrestrial, irregularly confluent, olivaceous to greenish-yellow. 1. *G. poripes.*
   Hymenium at first fuliginous, becoming paler. 2. *G. Sumstinei.*
   Hymenium white or pallid from the first. 2.

2. Surface of pileus gray or grayish-brown to coffee-colored, stipe intricately branched, pileoli very numerous and small. 3.
   Surface of pileus pallid or alutaceus, stipe not intricately branched, lobes usually few in number and comparatively large. 4.

3. Pileoli lateral, spatulate or dimidiate. 3. *G. frondosa.*
Pileoli centrally attached, circular and umbilicate. 4. *G. ramosissima.*

4. Sporophore of immense size, 20–60 cm. in diameter, spores echinulate, 8–9 μ. 5. *G. Berkeleyi.*
Sporophore small for the genus, only 8 cm. or less in diameter, spores smooth, ovoid, much smaller. 6. *G. fractipes.*

1. **Grifola poripes** (Fr.)

Polyporus poripes Fr. Nov. Symb. 48. 1851.
Polyporus flavovirens B. & Rav. Grevillea, **1**: 38. 1872.

Small plants of this species from the collections of Curtis were described by Fries in 1851. Somewhat older plants were later renamed by Berkeley and Ravenel, the name referring to the very characteristic mixture of yellow and green in the plant as it develops. Most of the herbarium specimens of this species are young and do not properly show the systematic position of the plant, its relationship clearly being with *Grifola* instead of *Scutiger*. It occurs on the ground in woods, rising from a tubercle and spreading broadly in irregular lobes. The substance is eaten by insect larvae. Specimens have been examined from Massachusetts, *Blake, Ricker;* Canada, *Dearness;* New York, *Long;* Delaware, *Commons;* New Jersey, *Ellis;* Ohio, *Morgan;* Pennsylvania, *Everhart;* Virginia, *Murrill;* and Carolina, *Ravenel.* It is fairly common and always eagerly picked by collectors. A good description of it may be found in the Journal of Mycology for January, 1886. Ellis there makes some corrections in the original description of Berkeley and Ravenel.

2. **Grifola Sumstinei** sp. nov.

A very large plant resembling *G. frondosa* in habit and general appearance, but with fewer and broader pileoli, darker surface and darker hymenium. Pileus imbricate-multiplex, 20 × 30 cm., pileoli flabelliform to spatulate, 6–8 × 6–8 × 0.3–0.5 cm.; surface radiate-rugose, finely tomentose, light to dark brown; margin very thin, fissured and strongly inflexed when dry: context white, fibrous, fleshy-tough to almost leathery, 0.3 cm. thick; tubes 0.2 cm. long, 7 to a mm., at first fuliginous, becoming pallid at maturity, polygonal, irregular, edges very thin and fragile, becoming lacerate; spores globose, smooth, hyaline, thin-walled, copious, 5 μ: stipe tubercular, woody, blackish below, connate-ramose, lighter-colored, passing insensibly into the pileoli above.

This species is found about old stumps and trunks during the autumn. It has been collected three times in as many different states. Morgan determined it as *P. giganteus* Pers., a European species which it resembles in habit and coloring. His specimen from Ohio is rather small and undeveloped. A still smaller plant, only 4 cm. high, is in the Langlois collection from Louisiana. The type plants of the species, however, were sent this year to the New York Botanical Garden from Pennsylvania by Professor D. R. Sumstine. They are large and well developed and show both the immature and the mature hymenium in a highly satisfactory manner. I take pleasure in dedicating the species to Professor Sumstine.

3. GRIFOLA FRONDOSA (Dicks.) S. F. Gray

Boletus frondosus Dicks. Crypt. Brit. **1**: 18. 1785.
Polyporus frondosus Fr. Syst. **1**: 355. 1821.
Grifola frondosa S. F. Gray, Nat. Arr. Brit. Pl. **1**: 643. 1821.
Polypilus frondosus Karst. Rev. Myc. **3**: 17. 1881.

This species is commonly found at the base of oak trees. It is very large, intricately branched, fleshy to tough, and usually grayish in color. It varies considerably and has several names. The European and American forms do not appear to differ very much, and I have also been unable to distinguish it in herbarium material from such species as *P. intybaceus* and *P. anax*, the shape of the spores being rather variable and uncertain in this group. Quite a full description of the present species is given in the Journal of Mycology for January, 1886. Exsiccati are very abundant. Most European collectors have distributed it and it has been reported from nearly every state in this country, *e. g.*, Iowa, *Macbride*, *Fitzpatrick*; Ohio, *Morgan*, *Lloyd*; District of Columbia, *James*; Pennsylvania, *Everhart*; Louisiana, *Langlois*; Canada, *Dearness*. Atkinson, in his Studies of American Fungi, discusses the species at length and gives two illustrations of it from original photographs.

4. **Grifola ramosissima** (Scop.)

Boletus ramosissimus Scop. Carn. ed. 2. **2**: 470. 1772. — Schaeff. Fung. *pl. 111.* 1763.

Boletus umbellatus Pers. Syn. 519. 1801.
Polyporus umbellatus Fr. Syst. **1**: 354. 1821.
Cladomeris umbellata Quél. Enchiridion, 167. 1886.
Cladomeris ramosissima Murrill, Jour. Myc. **9**: 95. 1903.

This species closely resembles *G. frondosa* in size, habit and general structure, but the pileoli are centrally attached and circular in form instead of dimidiate and spatulate. It is likewise much rarer than *G. frondosa* both in this country and in Europe. Persoon's name seems a very appropriate one, but it is antedated by that of Scopoli. Quélet used this species in establishing his genus *Cladomeris*, a synonym of *Grifola*. In America, the plant is reported but rarely. Atkinson found it at Ithaca and refers to it in his Studies of American Fungi. Specimens are at hand from Pennsylvania, *Everhart;* Connecticut, *Underwood & Earle;* and Ohio, *Lloyd;* the last accompanied by a fine protogravure of the entire living plant.

5. **Grifola Berkeleyi** (Fr.)

Polyporus Berkeleyi Fr. Nov. Symb. 56. 1851.
Polyporus subgiganteus Berk. & Curt. Grevillea, **1**: 49. 1872.
Polyporus Beatiei Peck, Rept. N. Y. State Mus. Nat. Hist. **30**: 36. 1878.

This species was described from a single pileolus sent to Fries from Curtis' North Carolina collections. It fully warrants the expression used by Fries in describing it: "Nobilissimus inter omnes mihi cognitos Polyporos." I have seen plants two feet in width and over a foot high, with several lobes six to nine inches in diameter. They usually grow under oak trees, often between the enlarged bases of the main roots, and are in close connection with some supply of humus, either from buried wood or very rich leaf-mould. The surface of the pileus is light yellowish-brown, darker toward the center, the tubes irregular, light yellowish-brown, fragile and somewhat toothed. It is easily distinguished from its American allies by the size, color and breadth of its lobes. *Polyporus Beatiei* Peck and *Polyporus subgiganteus* B. & C. are not specifically distinct. The former was collected in Maryland and well described in manuscript by Miss Banning; the latter is represented at Kew by a single pileolus collected by Wright in Connecticut.

Specimens are at hand from Massachusetts, *Banker;* Canada, *Dearness;* Missouri, *Demetrio;* Ohio, *James, Lloyd;* West Virginia, *Nuttall;* Pennsylvania, *Everhart;* New York, *Banker;* Virginia, *Murrill.* Lloyd's photogravures 23 and 24 exhibit the appearance and habit of the living plant most accurately and beautifully. It seems fitting that this magnificent plant should be so well represented. It is also appropriate that it should bear the name of a man who has done so much for American mycology.

6. **Grifola fractipes** (B. & C.)

Polyporus fractipes B. & C. Grevillea, **1**: 38. 1872.

Little is known of this species beyond the collections of Curtis and Ravenel in South Carolina and an occasional plant reported from adjoining states. The specimens at hand are better developed than those at Kew, with older and larger pores, and show a close relationship rather with species of *Grifola* than *Polyporus.* Although the stipe is not branched in these specimens, it is distorted and tubercular at the base as though united with other pilei that were as yet immature. So far as the general structure of context and hymenium goes the species exhibits very close similarity with typical *Grifola* forms.

SPECIES INQUIRENDAE

Polyporus anax Berk. Grevillea, **12**: 37. 1883. Described from Ohio. Apparently not specificially distinct from *G. frondosa.*

Polyporus lactifluus Peck, Bull. Torrey Club, **8**: 51. 1881. Described from dried material and notes sent by Miss Banning from Maryland. It seems different from *G. Berkeleyi* only in having milky juice, a character possessed by other members of this genus and probably present in *G.. Berkeleyi* in its young stages.

Romellia gen. nov.

Hymenophore large, irregular, annual, spongy to corky, epixylous; stipe simple, variously attached, surface of pileus anoderm, hispid; context ferruginous, tubes irregular, thin-walled, spores ellipsoidal, smooth, hyaline, cystidia none.

The type of this genus is *Boletus sistotremoides* Alb. & Schw., better known as *Polyporus Schweinitzii* Fr. The plant is a large and striking one, quite common in Europe and America, and has figured under several genera since it was first described as a *Boletus*. Soon after being transferred to *Polyporus*, it was assigned to *Daedalea* because of its irregular pores, then to *Polystictus* because it seemed nearly allied to *P. perennis*. Quélet, however, overlooked this relationship and classified it under *Cladomeris* with *Polyporus frondosus*, *P. imberbis*, etc., largely on account of its hyaline spores. The species may be easily confused in some of its forms with *Polyporus hispidus*, but its normal form is stipitate, while *P. hispidus* is always dimidiate and the spores of the former are hyaline while those of the latter are of a deep golden hue. From the genus *Coltricia*, apparently its nearest ally, it differs in having hyaline spores, a more spongy context, differently colored tubes and a very variable stipe.

I take pleasure in dedicating this genus to my friend Lars Romell, the distinguished mycologist of Stockholm, Sweden.

Romellia sistotremoides (Alb. & Schw.)

Boletus sistotremoides Alb. & Schw. Conspec. Fung. 243. 1805.
Polyporus Schweinitzii Fr. Syst. Myc. **1**: 351. 1821. Icon. *pl. 179. f. 3.* 1870.
Daedalea epigaea Lenz, Schwäm. 62. 1831.
Polyporus tabulaeformis Berk. Lond. Jour. Bot. **4**: 302. 1845.
Polyporus spectabilis Fr. Nov. Symb. 48. 1851.
Polyporus hispidioides Peck, Rept. N. Y. State Mus. Nat. Hist. **33**: 21. 1880.
Polystictus Schweinitzii Karst. Rev. Myc. **3**: 18. 1881.
Cladomeris Schweinitzii Quél. Enchiridion, 169. 1886.

The description of this fungus as given by the original authors is sufficiently clear and complete and the plant is so well known as to require little comment upon its appearance and structure. On account of its exceeding variability, well-known mycologists, such as Fries, Berkeley and Peck, have been led to rename it in certain of its forms. *P. tabulaeformis*, for example, is an old plant of *P. Schweinitzii* from Augusta, Georgia, sent to Berkeley by Wray, while a similar specimen sent by Curtis from North Carolina to Fries received the name *P. spectabilis*, the type of which still exists at Upsala. Fries was deceived by the firm, corky substance and very changed aspect of the plant in its older stages.

Peck was led to separate the rather rare dimidiate form of this species found on the trunks of trees under the name *P. hispidioides*, because of its resemblance to *P. hispidus*.

All of these forms and others which have received no distinct names seem to grade imperceptibly into one another, so that their separation would seem impossible even if desirable. The plant is an illustration of one of those unsettled types found more than once in this family which are blessed with overflowing exuberance of vitality and have several ways of expressing it. Thus, for example, while it usually attacks coniferous trees it may also be found on deciduous wood; while occurring commonly on the roots or at the base of its host, it may ascend to a height of fifty feet on the trunk, and while usually central-stemmed, the stipe may be lateral or even wanting. It is a very fine, large, highly-colored plant, well-known for its destructive effects upon coniferous trees both in Europe and America. Specimens nearly two feet in diameter were collected the past summer on the roots of larch trees at Mendel Pass in the Italian Tyrol.

According to Schrenk, who has studied the species in New England, the fruit bodies appear in July and August and are greedily devoured by beetles soon after the spores are matured. During the discharge of the spores, drops of a yellow liquid were collected by him from the hymenium, which were found to contain certain fungous sugars. It is probable that these sugars have something to do with the distribution of the spores among the roots of new host plants.

Some of the localities where this widely distributed fungus has been collected are given below. It is not rare in Asia and Europe and seems even more abundant in North America: Finland, *Karsten;* England, *Plowright;* Tyrol, *Bresadola & Murrill;* Newfoundland, *Waghorne;* Canada, *Macoun;* Vermont, *Burt;* Connecticut, *White;* New York, *Earle, Peck;* New Jersey, *Ellis;* Delaware, *Commons;* Oregon, *Carpenter;* Washington, *Macbride;* South Carolina, *Shear;* Louisiana, *Langlois;* Alabama, *Earle & Baker;* Mexico, *Smith.*

COLTRICIA S. F. Gray, Nat. Arr. Brit. Pl. **1**: 644. 1821.

Strilia S. F. Gray, Nat. Arr. Brit. Pl. **1**: 645. 1821.

Polystictus Fr. Nov. Symb. 70. 1851.

Pelloporus Quél. Enchiridion, 166. 1886.
Mucronoporus Ell. & Ever. Jour. Myc. **5**: 28. *pl. 8.* 1889.
Onnia Karst. Finlands Basidsv. 326. 1889.
Xanthochrous Pat. Cat. Tun. 51. 1897.

The genus *Coltricia* was established by S. F. Gray in 1821 upon three species, *C. connata*, *C. nummularia* and *C. leptocephala*. The first, which is considered the type of the genus, is the *Boletus perennis* of Linnaeus, a well-known plant of wide distribution, placed under the genus *Polystictus* in Saccardo's Sylloge. The other two are typical species of the genus *Polyporus* in the narrowest sense. Gray placed them in *Coltricia* because they had the "stem central, cap orbicular, umbilicate, membranaceous," while important differences in structure were disregarded. The genus *Strilia*, based on *S. cinnamomea* (Jacq.), has no claim to distinction and was evidently erected through error or lack of proper material.

The genus *Polystictus*, separated as an experiment by Fries in 1851, is based on *Polystictus parvulus*, a close ally of *P. perennis*, and must therefore stand as a synonym of *Coltricia*.

The genus *Pelloporus* included *P. perennis*, *P. tomentosus* and other allied species with corky or coriaceous context, ferruginous substance and spores and terrestrial habits. The first species listed is *P. triqueter*, a wood-loving form of *P. circinatus*, in which the stipe has become lateral and rudimentary. In a former article (Jour. Myc. **8**: 95. 1903), *P. triqueter* was considered more nearly related to *P. radiatus*, which also has a spiny hymenium and grows on tree-trunks, and the genus *Pelloporus* was there treated as a synonym of *Inonotus* Karst. Since the proper position of *P. triqueter* is determined *Pelloporus* must now be considered synonymous with *Coltricia*.

The genus *Mucronoporus* was based on *M. circinatus*, *M. dualis*, *M. tomentosus* and nine other species quite different in structure from the three mentioned, but resembling them in having a spiny hymenium, which was the distinguishing feature of the genus. In observing this feature exclusively, a number of other species, as varied an assortment as the family affords, have been since added to the original twelve. The genus *Onnia*, with the same distinctive character as *Mucronoporus*, was established later in the same year upon *Onnia circinata* and *Onnia tomentosa* and is therefore a synonym of *Mucronoporus* and *Coltricia*. As to the standing of such genera as *Hymenochaete* and *Mucronoporus*, based solely on the presence of cystidia, opinion has been divided, but a brief study of various forms will show that this character is possessed exclusively by no one group of fungi and that it varies abundantly even within the limits of a single species. It often affords a convenient clue to the identification of species, but should be accompanied by stronger and more permanent characters in the separation of genera.

The species of the present genus are terrestrial or wood-loving plants found in dry soil in woods or attached to decayed sticks or roots beneath the ground or growing at times upon much-decayed logs and stumps. Some of the species have a peculiar fondness for places where fires have been built; others are able to adapt themselves to very varied localities, growing now upon rich soil and again upon dead standing tree-trunks. In appearance, they are usually circular, central stemmed, brownish plants with rusty context and spores and a brown hymenium, which is covered with a yellowish or whitish powder when young. Cystidia are rarely present. The consistency of the pileus varies from coriaceous to spongy and the surface from concentrically zonate to smooth. As to distribution, the members of the genus are about equally divided, half of them being cosmopolitan and the other half local. The smallest plant of the group is *C. cinnamomea*, the largest *C. Memmingeri*, a new species known from one locality only.

Synopsis of the North American species

1\. Pileus concentrically zonate, context thin. 2.
Pileus azonate, context rather thick and spongy. 4.

2\. Pileus shining cinnamon, strigose, striate, thin, flexible, slightly depressed, the margin often fimbriate or pseudo-ciliate. 1. *C. cinnamomea.*
Pileus dull rusty cinnamon to hoary, velvety to glabrous, deeply depressed, the margin thicker and less fimbriate. 3.

3\. Tubes small, 0.5 mm. or less in diameter. 2. *C. perennis.*
Tubes large, 1 mm. in diameter. 3. *C. parvula*

4\. Context homogeneous, hymenium free from spines. 5.
Context duplex, soft above and woody below, hymenium beset with spines. 4. *C. tomentosa.*

5\. Pileus ferruginous to fulvous, 5 cm. in diameter, surface finely tomentose, stipe swollen and soft at the base. 5. *C. obesa.*
Pileus darker, fulvous to chocolate-colored, 10 cm. in diameter, surface rough and shaggy, stipe scutate and firm at the base. 6. *C. Memmingeri.*

1. **Coltricia cinnamomea** (Jacq.)

Boletus cinnamomeus Jacq. Collect. **1**: 116. *pl. 2.* 1786.

Strilia cinnamomea S. F. Gray, Nat. Arr. Brit. Pl. **1**: 645. 1821.

Polyporus oblectans Berk. Lond. Jour. Bot. **4**: 51. 1845.

Polyporus splendens Peck, Rept. N. Y. State Mus. Nat. Hist. **26**: 68. 1874.

Polyporus subsericeus Peck, Rept. N. Y. State Mus. Nat. Hist. **33**: 37. 1880.

Polystictus cinnamomeus (Jacq.) Sacc. Michelia, **1**: 362. 1878.— Atkinson, Stud. Amer. Fungi, 192. *f. 182.* 1900.

This species appears to be truly cosmopolitan, being found in both hemispheres in tropical as well as in temperate regions. In habitat it differs from its nearest American allies in growing more commonly on mossy soil or much-decayed wood and rather sparingly on sandy soil, thus showing a preference for almost pure humus rather than for sterile soil very poor in humus. In appearance it is small, slightly depressed, silky and shining, well deserving the name, *P. splendens*, assigned to it by Peck. Its first name, however, refers to its cinnamon color and dates back to the days of Jacquin, who received it from Westhofen in the month of September. His description plainly refers to our plant:

> "Totus cinnamomeus, etiam in substantia interna. Stipes solidus, teres, villosulus, plus minus uncialis, erectus, calamo gracilior. Pileus in centro infundibuliformis, in limbo planus, lineam unam alteramve crassus, diametri uncialis, supra sericeus nitidus et ad tactum holoserici adinstar mollis, subtus poris angulatis totus refertus. Sponte exiccatus colorem servat, nec putrefecit, fragilis dumtaxit evadit, et parumper limbo crispatur. Crescit inter muscas in humo udo."

Only two characters in this description need comment. While the species is usually slightly depressed, it is sometimes more or less infundibuliform, as our own plants show, and Jacquin seems to have got some of the latter kind. The term *fragilis* seems to have been incorrectly or rather freely used. Fries questions its correctness, while S. F. Gray stumbles over it into erecting the genus *Strilia*, which differs from *Coltricia* only in being fleshy instead of membranaceous.

P. oblectans was described from Australian material. Berkeley's description, though unusually complete, does not differ materially from that of Jacquin and the type plants cannot be distinguished from American specimens. Soon after Peck named the

American plant Cooke referred it to *P. oblectans*, while Peck soon discovered that *P. splendens* was preoccupied by a Brazilian species and changed the name to *P. subsericeus*.

The following American exsiccati are in the New York Botanical Garden herbarium: Canada, *Dearness;* Iowa, *Holway;* Maine, *White;* Connecticut, *Underwood & Earle;* New York, *Peck, Lobenstine, Earle, Gerard;* New Jersey, *Ellis;* Pennsylvania, *Everhart, Barbour;* Ohio, *Morgan;* West Virginia, *Nuttall;* Georgia, *Underwood, Stevenson;* Alabama, *Earle;* Colorado, *Underwood & Selby.*

2. COLTRICIA PERENNIS (L.) Murrill, Jour. Myc. 9: 91. 1903.

Boletus perennis L. Sp. Pl. 1177. 1753.—Sowerby, Eng. Fung. *pl. 192.* 1799.
Boletus coriaceus Scop. Fl. Carn. ed. 2. **2**: 465. 1772.—Bull. Herb. France, *pl. 28.* 1780.
Boletus subtomentosus Bolt. Hist. Fung. **2**: 87. *pl. 87.* 1788.
Boletus confluens Schum. Saell. **2**: 378. 1803.
Polyporus perennis Fr. Syst. Myc. **1**: 350. 1821.
Coltricia connata S. F. Gray, Nat. Arr. Brit. Pl. **1**: 644. 1821.
Polystictus perennis Karst. Rev. Myc. **3**: 18. 1881.
Pelloporus perennis Quél. Enchiridion, 166. 1886.

This species appears to be common throughout the northern hemisphere in temperate regions, occurring in woods on dry exposed soil, especially where fires have been kindled, or rarely in moss or leaves. When young, it is ferruginous-cinnamon in color with punctiform tubes and thin substance; as it grows older the pileus becomes more depressed, the tubes longer and more decurrent, the sterile marginal band disappears and the whole plant appears thicker and firmer; in age the color becomes hoary, the zones are more marked, much of the tomentum disappears and the tubes and margin become more or less fimbriate. These changes often appear very marked when collections made in autumn are placed beside those of midsummer.

The present species is at once distinguished from *C. parvula* by its much smaller tubes and from *C. cinnamomea* by its larger size, more deeply depressed center and less shining surface. Specimens have been examined for the principal herbaria and published exsiccati, among which the following will indicate the distribution of the species: Finland, *Karsten;* Sweden, *Starbäck;* Saxony, *Krieger;* Hungary, *Linhart;* Belgium, *Westendorp & Wallays;* France, *Fautrey;* England, *Massee, Plowright;* Canada, *Macoun;* Maine, *Blake, Harvey, Ricker, Macdougal;* Massachusetts, *Fursten;* Washington, *Macbride;* Wisconsin, *Calkins;* Michigan, *Minns;* Minnesota, *Holway;* New York, *Shear, Peck;* New Jersey, *Ellis.*

3. **Coltricia parvula** (Kl.)

Polyporus parvulus Kl. Linnaea, **8**: 483. 1833.
Polyporus connatus Schw. Trans. Am. Phil. Soc. **4**: 154. 1834.
Polystictus parvulus Fr. Nov. Symb. 70. 1851.
Polyporus focicola B. & C. Jour. Linn. Soc. Bot. **10**: 305. 1868.

This species was described from plants in the Hooker herbarium collected by Dr. Richardson in America. Klotsch had hardly published his description before Schweinitz described the same plant under the name *Polyporus connatus.* When Fries established the genus *Polystictus,* this species was listed first, thus becoming its nomenclatorial type. Later it was renamed *P. focicola* by Berkeley and Curtis, the reason not being assigned. The plant occurs only in North America and is confined, so far as is known, to the states south of Massachusetts. As with *C. perennis,* it usually grows on earth mixed with ashes and charcoal from fires built in woods.

There is no difficulty in distinguishing it from *C. perennis* except in middle ground occupied by both species, where they have a tendency to approach each other in varieties. There can be no doubt that the two species are intimately related in origin and the inference is that *C. parvula* is an offspring of the cosmopolitan species induced by conditions existing at one time in the more southern parts of North America. They are at present, however, so distinct that a plant collected in Georgia may with little hesitation be called *C. parvula,* while one from Canada may with equal certainty be labeled *C. perennis.* The following collections of *C. parvula* are at hand: North Carolina, *Curtis;* South Carolina, *Ravenel;* Georgia, *Harper;* Alabama, *Earle;* Delaware, *Commons;* Pennsylvania, *Everhart, Jeffries & Haines.* In every instance the collection was made on soil where fires had been built.

4. **Coltricia tomentosa** (Fr.)

Polyporus tomentosus Fr. Syst. Myc. **1**: 351. 1821.

Polyporus dualis Peck, Rept. N. Y. State Mus. Nat. Hist. **30**: 44. 1878.

Pelloporus tomentosus Quél. Enchiridion, 166. 1886.

Macronoporus tomentosus Ell. & Ever. Journ. Myc. **5**: 28. 1889.

Onnia tomentosa Karst. Finlands Basidv. 326. 1889.

Xanthochrous tomentosus Pat. Cat. Tun. 52. 1897.

This species has frequently been collected by North American mycologists, but has rarely been correctly determined by them. Some European botanists are no less confused by the two Friesian species, *P. tomentosus*, described in 1821 and *P. circinatus*, described in 1848. At Upsala there is no type specimen of the latter species, while types of *P. tomentosus* correspond in all respects with our common species, the hymenium bearing the same kind of spines and the context being dual instead of homogeneous. Indeed, I have seen nothing in any foreign herbarium to indicate that *P. circinatus* is specifically distinct from *P. tomentosus*.

This fungus usually grows on or near the ground beneath pines, spruces and other coniferous trees. Collections are at hand from Bavaria, *Allescher;* Sweden, *Romell;* Canada, *Macoun;* Maine, *Curtis;* New Hampshire, *Minns;* Vermont, *Burt;* Massachusetts, *Clarke;* Pennsylvania, *Stevenson;* New York, *Peck;* New Jersey, *Ellis;* West Virginia, *Nuttall;* Colorado, *Underwood & Selby*.

5. **Coltricia obesa** (Ell. & Ever.)

Polystictus obesus Ell. & Ever. Bull. Torrey Club, **24**: 125. 1897.

This species was collected at Newfield, New Jersey, and at Philadelphia, Pennsylvania, growing on buried pine branches. It is thick and spongy in texture, depressed, rusty cinnamon, azonate, with dark cinnamon stipe, which is central and usually much enlarged below. The spores are elliptical, ferruginous, $7–8 \times 4–5\ \mu$. No spines are present. The plant resembles *Coltricia perennis* in color, but is larger, thicker, more fragile and entirely free from zones. From *C. tomentosa*, it differs in being darker in color, homogeneous in texture and free from cystidia. Type specimens are now in the herbarium of the New York Botanical Garden.

6. **Coltricia Memmingeri** sp. nov.

A large dark brown plant with rough shaggy surface and short thick stipe much dilated at the base. Pileus very irregular, circular to dimidiate, convex to plane or depressed, 10 × 1 cm.; surface fulvous to dark seal brown, ornamented with long imbricated scales of the same color, margin alutaceous, pubescent, sterile, subacute, undulate: cortex corky, fragile, azonate, 0.5–1 cm. thick, thinner towards the margin, concolorous; tubes adnate, 1–4 mm. long, 1–3 to a mm., umbrinous, apparently blackening with age, mouths circular and whitish when young, becoming angular, irregular and concolorous or darker with age, dissepiments entire to dentate: spores ovoid, smooth, light ferruginous, usually 2-guttulate, 4 × 7 μ; hyphae golden-yellow; cystidia none; stipe central or excentric, at times confluent, very short, thick, angular or flattened, dilated at the base to twice its thickness above, resembling the pileus in color, surface and substance, 1–3 × 3–5 cm.

The above description was made from specimens collected at Blowing Rock, North Carolina, by Mr. E. R. Memminger, September 1, 1901, and sent to the Underwood herbarium. According to the accompanying field notes, it is a rare species and one of peculiar habits, being found on steep clay banks with its short stipe broadly spreading at the base, reminding one of a sea-anemone, and its pileus irregular and deformed by the steepness of its habitat and soaked with moisture from the wet clay soil and the surface water that trickles past it. In some ways it suggests forms of *P. Schweinitzii*, but differs widely in the color of its tubes and spores as well as in its shaggy surface and peculiar stipe. In many ways it forms a climax to the series which begins with *C. cinnamomea* and ends with *C. obesa*, the plants increasing in size, thickness, irregularity, variability and roughness as one proceeds.

I take pleasure in dedicating the species to its discoverer, Mr. Memminger. The type plants are now in the herbarium of the New York Botanical Garden.

SPECIES INQUIRENDÆ

Polyporus simillimus Peck, Rept. N. Y. State Mus. Nat. Hist. **32**: 34. 1879. This species was based on plants collected at Brewerton, New York, on burnt soil where *C. parvula* grew. It is said to closely resemble *C. parvula* when looked at from above, but to have much smaller tubes and slightly longer spores, which are tinged with red at times. It is also very close to old plants of *C. perennis* collected in autumn. Additional collections should decide whether it is a good species or only a variety, as it was first considered by Peck.

Coltriciella gen. nov.

Hymenophore small, annual, tough, epixylous; stipe attached to the vertex of the pileus; surface of the pileus anoderm, zonate; context spongy, fibrous, ferruginous, tubes angular, one-layered, dissepiments thin; spores ellipsoidal, smooth, ferruginous.

The type of this genus is *Polyporus dependens* B. & C., a very rare plant found thus far only on dead pine logs in South Carolina and New Jersey. In some ways it resembles the genus *Porodiscus*, the species of both being small and epixylous with vertically attached stipes, but the two genera are very distinct as regards more important characters, such as the structure of the context and spores. From *Coltricia*, its nearest ally, the present genus differs chiefly in being uniformily epixylous and in having a pendant vertically-attached pileus. The name I have chosen refers to its general resemblance to *Coltricia*, this resemblance being best seen in *Coltricia cinnamomea*, which grows very frequently on wood in a state of advanced decay. Only one species is known.

Coltriciella dependens (B. & C.)

Polyporus dependens B. & C. Ann. Nat. Hist. II. **12**: no. 44. 1853. Grevillea, **1**: 37. 1872.

Polystictus dependens Sacc. Sylloge Fung. **6**: 213. 1888.

This very rare and interesting little fungus was first collected by Curtis in South Carolina on decorticated pine wood lying on the ground. It has since been found at Newfield, New Jersey, once under a decaying oak log and twice on a dead pine. The first of these collections on pine seems to have been quite abundant, since there are still in the Ellis collection about twenty-five specimens of it. Ellis says that they grew from the upper surface of the hollow in a rotten log, where they were found on July 30, 1883. On April 21, 1890, Dr. F. W. Anderson discovered a few plants growing on a rotten pine knot near Newfield. I am inclined to think that the collection made under the dead oak log was really growing on chips or sticks of pine.

The nomenclature of the royal palms

O. F. Cook

In two previous discussions of botanical nomenclature * the royal palms and their relatives have served as instances of the prevailing taxonomic confusion. The West Indian species which in general practice for many years past have constituted the genus *Oreodoxa* are, in all probability, generically distinct from either of the two Venezuelan species placed under *Oreodoxa* when that genus was first described by Willdenow in 1804.† Detailed reasons for this view were included in a "Synopsis of the palms of Porto Rico," ‡ where a new royal palm found in that island was described under the name *Roystonea borinquena*. In a recent fascicle of the *Symbolae Antillanae*,§ the important work on West Indian botany now being issued by Professor Urban of Berlin, the royal palm of Porto Rico is admitted to be distinct from that of Cuba, but is given the name *Oreodoxa caribaea.*

Unsystematic methods of systematic study have resulted in endless nomenclatorial complications which should not be discussed, perhaps, outside technical monographs. The royal palms, however, are among the most conspicuous members of the vegetable world, and the errors which have been made in dealing with them are not without practical interest as samples of the confusion which could be avoided by adherence to the more simple and practical system of nomenclatorial procedure sometimes termed the "method of types."

Like many of his contemporaries, Martius, the great German palm specialist of the first half of the last century, largely disregarded the work of his predecessors, in the sense that he "emended" generic descriptions with the greatest freedom and did not hesitate to apply generic names to groups of species not

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* The method of types in botanical nomenclature. Science, II. 12 : 475. 1900. Types and synonyms. Science, II. 15 : 648. 1902.

† Mem. Acad. Roy. Berlin, 1804 : 37. 1807.

‡ Bull. Torrey Club, 28 : 552. 1901.

§ Dammer, U., and Urban, I. *Palmae.* Symbolae Antillanae, 4 : 126. 1903.

related to those for which they were originally proposed. Martius seems to have had no personal acquaintance with either of Willdenow's two original species of *Oreodoxa* from Venezuela. The first he left nominally in the genus and the second he referred to *Iriartea*, but the centre of gravity, as it were, was shifted to the West Indian species unknown to Willdenow. Wendland, whose knowledge of the palms of the Caribbean region advanced far beyond that of Martius, did not show any corresponding improvement of nomenclatorial policy. He completed the removal of both the original species from *Oreodoxa*, assigning the first (*O. acuminata*) to *Euterpe*, and the second (*O. praemorsa*) to a new genus *Catoblastus*, leaving the West Indian royal palms in full possession of the name *Oreodoxa*, though with no defensible title. There seems to be no reason for setting aside Wendland's opinion that *O. acuminata* is a *Euterpe* rather than an *Oreodoxa*, in the Martian sense, but the name *Euterpe* is not available for any American palm,[*] and a new name would be required for the group to which *O. acuminata* belongs unless *Oreodoxa* be restored to its original place in the system.

Messrs. Dammer and Urban rejected Wendland's idea of the affinities of *Oreodoxa acuminata* and consider it congeneric with the West Indian royal palms because seedlings supposed to belong to *O. acuminata* [†] have the primary leaves of the germinating plant simple and entire, while those which follow have the apex bifid and long-produced. It is not explained why similarities of the seedlings should be supposed to cancel differences of the adult palm, and such an argument would prove too much in the present case, because *Acrista*, and probably several other genera, related and unrelated, have primary leaves of the character described.

Generic diagnoses of palms have commonly taken into account only floral characters. Perhaps the use of the seedlings may lead in time to an appreciation of other vegetative features. The cespitose, "stoloniferous" habit of *Oreodoxa acuminata*, for example, furnishes as important evidence of relationship as the seedling, and this supports the association of the type of *Oreodoxa*

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[*] See page 351.

[†] No indication of the origin of these seedlings is given, nor of the manner in which they were specifically identified as belonging to *Oreodoxa acuminata*.

with the many other slender cespitose "stoloniferous" "*Euterpe*" palms of the South American continent, rather than with any of the insular types. This indication of alliance is strengthened, moreover, by the remainder of Willdenow's description, especially the tripartite style and globose longitudinally sulcate seed. The gamosepalous calyx, and the large woody spathe, are also characters of the related continental genus *Oenocarpus*. Kunth described in 1815 additional species of *Oreodoxa* from Colombia (*O. Sancona* and *O. frigida*) with a tubular three-lobed calyx and three styles, so that these characters of *Oreodoxa* can scarcely be ignored as errors on the part of Willdenow.

The genus *Roystonea*, to which the West Indian royal palms belong, is unique in the possession of a spherical or ovoid rudimentary pistil in the staminate flowers, while all the other related genera retain the more primitive character of a conical or columnar pistillode three-lobed at the apex. According to Willdenow and Kunth the true *Oreodoxa* of the mountains of South America is peculiar in having the flowers bisexual, which would represent a still more backward stage of development. If these authorities were in error they were deceived, evidently, by large three-styled pistillodes of the staminate flowers which would, however, be even more significant of the probability that the affinities of *Oreodoxa* do not lie with *Roystonea*, whatever be its relationships with *Oenocarpus* and other continental genera.

There are thus many indications favoring, and none opposing, the opinion of Wendland, that *Oreodoxa acuminata* is a "*Euterpe*," or, to speak with more nomenclatorial circumspection, that it is a genus of the considerable series of American palms to which the name *Euterpe* was applied by Martius, Wendland, and others. It would, in other words, have been more nearly correct to have applied the name *Oreodoxa* to the mountain palm of Porto Rico (*Acrista*) than to have made it supplant *Roystonea*, *Acrista* being obviously nearer to the cespitose continental species of "*Euterpe*" than are the robust and otherwise rather specialized royal palms.

The use of the name *Euterpe* in the above discussion is an apparently necessary concession to history, though an unfortunate one, since it has been shown elsewhere that *Euterpe* has no true place in American botany, having been proposed originally for an unrelated East Indian palm.* In *Die natürlichen Pflanzenfamilien*, Professor Drude recognizes six genera of American palms of the group in which *Euterpe* and *Oreodoxa* are placed, though he distributes them among three separate series of Old World genera, from the Malay region and the islands of the Pacific and Indian Oceans. They seem, however, to constitute a compact natural group, as coherent in their characters as they are in their geographical distribution, and worthy of taxonomic recognition as a distinct tribe.

The genera of the tribe *Acristeae* may be separated by the following diagnostic characters:

1. Staminate flowers with spherical or ovoid pistillodes and sessile stigmas; pistillate flowers with staminodes united into a six-toothed cup. Genus ROYSTONEA Cook; type, *R. regia* (H. B. K.) Cook; Cuba.
Staminate flowers with conical or columnar pistillodes 3-parted at apex; stamens and staminodes free. 2.

2. Ripe fruit with stigma-scar basal. Genus HYOSPATHE, Martius; type, *H. elegans* Martius, Brazil.
Ripe fruit with stigma-scar lateral or apical. 3.

3. Leaves pinnately divided below, entire above, ending in a large simple bifurcate blade. Genus PRESTOEA Hook. f.; type, *P. pubigera* (Griseb. & Wendl.) Hook. f., Trinidad.
Leaves divided throughout into equal or graded narrow pinnae. 4.

4. Stamens 9–20; inflorescence interfoliar. Genus JESSENIA, Karsten; type, *J. polycarpa* Karsten, Brazil.
Stamens 6; inflorescence distinctly infrafoliar. 5.

5. Internodes short, leaf-bases not long-sheathing. Genus OENOCARPUS Martius; type, *O. distichus* Martius, Brazil.
Internodes long, leaves with long sheathing bases. 6.

6. Calyx of staminate (or bisexual?) flowers with sepals united at base. Genus OREODOXA Willd.; type, *O. acuminata* Willd., Venezuela.
Calyx with three distinct broadly imbricate sepals. 7.

7. Trunk attenuate, increasing in thickness with age; spathes ensiform, flat; branches of spadix subtended by large spathe-like bracts; seeds with uniform albumen. Genus PLECTIS; † type, *P. Oweniana* sp. nov., Guatemala.

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* Bull. Torrey Club, **28**: 556. 1901.

† **Plectis** gen. nov.

Trunk solitary, very tall, slender and tapering, the diameter increasing with age. Leaves long-sheathing at base; petiole short; pinnae very numerous, narrowly linear, horizontal or drooping.

Spathes numerous, coriaceous, but thin and flexible; outer spathes short; two long ensiform complete spathes; a large lanceolate-ligulate incomplete spathe subtending the lowest branch of the spadix; a small ligulate spathe or bract subtends each of the other branches.

Trunk columnar; spathes fusiform or subcylindric; branches of spadix with bracts rudimentary or wanting; seed deeply ruminate. 8.

8. Stigma of ripe fruit lateral; embryo basal; solitary, not stoloniferous. Genus ACRISTA Cook; type, *A. monticola* Cook, Porto Rico.

Stigma of ripe fruit subapical; embryo lateral; stoloniferous, cespitose. Genus CATIS Cook; type, *C. Martiana* Cook (*Euterpe oleracea* Martius), Brazil.

A similar history of nomenclatorial lawlessness is concealed behind the exclamation point of certainty with which Messrs. Dammer and Urban associate the specific name *caribaea* and the royal palm of Porto Rico. Jacquin described from the Carib Islands in 1763 an *Areca oleracea*, which Martius assigned to the genus *Euterpe*, but he disregarded the priority of Jacquin's specific name *oleracea* and made a new *Euterpe oleracea* of his own from Brazil. When Sprengel undertook the revision of Linnaeus' *Systema Vegetabilium*, published in 1825, he found both these *oleracea* species claiming entry under *Euterpe*, and renamed Jacquin's plant *Euterpe caribaea.* Martius himself placed *Euterpe caribaea* Sprengel as a synonym under *Oreodoxa oleracea* in the third volume of his *Historia Naturalis Palmarum* (page 166), after he had come to look upon the royal palms as generically distinct from *Euterpe.*

It seems certain, moreover, that Sprengel and Martius were dealing with a single palm. How Messrs. Dammer and Urban have brought the two species into the *oleracea-caribaea* complication appears utterly mysterious, unless it be that they have disre-

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Fruits small, subglobose, with a very prominent subapical stigmatic scar; pericarp thin, firmly fleshy; a layer of coalesced fibres adhering to the smooth seed; albumen uniform; embryo basal.

Plectis Oweniana sp. nov.

Trunk smooth, ringed with leaf-scars, 25 meters and upwards; diameter at base 25–30 cm.; at apex 10 cm. or less; supported on a conical mass of thick roots with large fibrous root-caps.

Leaf-sheaths over 150 cm. long; petiole 37–47 cm. long by 2.7 wide at apex; rachis 267 cm. tapering more or less and produced into a slender fiber as long as the terminal pinnae; total length of leaf 481 cm., basal pinnae 67 cm. by 1.1 cm., middle pinnae 81–93 cm. by 3.5 cm., terminal pinnae 37 cm. by 1.2 cm. or less, generally split with age into narrow grass-like shreds 5 mm. or less in width. Upper surface of rachis flat at base but gradually narrowed upward, the cross-section becoming subtriangular.

Habitat: steep slopes and summits of mountains in the vicinity of Senahu, Alta Vera Paz, Guatemala, at an elevation of 600–900 meters. It is said not to occur in the Coban district further west.

Native name in the Kekchi language "*halaute*"; also called "*ternera*" by the ladino population of Alta Vera Paz.

garded the above history and relied entirely upon the finding in Sprengel's herbarium of a specimen of the Porto Rican royal palm erroneously identified as *Euterpe caribaea*.* They do not, however, give any reason for believing that Sprengel had this specimen in hand or in mind while revising the *Systema*, and there are several points of internal evidence which forbid such a supposition. The name *caribaea* was not proposed for a new species; the name for which it was substituted being given at the end of the description "(*Areca oleracea* Jacq.)." There is no mention of Porto Rico, the only locality given being that of Jacquin, "*Ins. Carib.*" a term which seems not to have included Porto Rico, Jamaica and the other larger Antilles, which were frequently mentioned by name. Sprengel shows care and discrimination in the indication of localities, and wrote "*Ind. occ.*" and "*Ins. Antill. minor*" when plants were known from different islands of the West Indies. Finally the description of *Euterpe caribaea* definitely excludes the royal palm of Porto Rico by stating that the fruit is somewhat curved, "*fructibus oblongis subincurvis*," a peculiarity mentioned by Jacquin in the same words, and known to exist only in the royal palm of the southern islands of the lesser Antilles.†

With these facts in view it seems apparent that the discovery of Sprengel's mislabeled specimen does not bring his *Euterpe caribaea* any nearer to Porto Rico than before, nor does it alter three-quarters of a century of botanical history in which this name has remained in oblivion as a synonym of *Oreodoxa oleracea*, a period of disuse which under a consistent application of the Berlin fifty year rule would have rendered its resuscitation impossible, whatever its original merits.

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* The Caribbean royal palm, *Roystonea oleracea*, formerly called *Oreodoxa oleracea*, has been reported from Porto Rico more than once, but its occurrence is not authenticated. The Porto Rican specimens distributed from Berlin as *Oreodoxa oleracea* (Sintenis *no. 1525*), stated to have been identified by Professor Drude, do not belong to this genus, but represent *Acrista monticola*.

† Some botanists may hold that Sprengel should be followed in changing the name of Jacquin's *oleracea*, on the ground that the Brazilian *oleracea* of Martius had priority as a species of *Euterpe*, but if the name *caribaea* is to be taken away from Jacquin's *oleracea* of the Carib Islands and used for the royal palm of Porto Rico (to supplant *borinquena*), it is evident that the older and more southern species would still be in need of a name, so that even the motive of economy is lacking as a justification for the arbitrary change proposed at Berlin.

The few readers, if any, who may have had the curiosity to follow along this barren path of unnecessary error may be the better able at least, to understand why systematic study has come to be looked upon, more and more, as an unproductive part of the biological field. The history of the nomenclatorial vicissitudes of the royal palm is no unique instance, and is not brought forward as an indication of any special carelessness or perversity on the part of Professor Urban or Dr. Dammer. It is a fair and typical example of the taxonomic methods, or lack of methods, which still render much of the systematic work of even the larger botanical centers a waste of the time, not merely of the specialists now writing, but also of their successors who must some time unravel the skeins so industriously tangled. The method of types, requiring the fixed and definite application of names, is as essential for taxonomy as the multiplication table for mathematics, dates for history, or latitude and longitude for geography. It is so axiomatic, indeed, that it escaped formulation by DeCandolle and other eminent taxonomists, and is evidently still unconsidered by European botanists. The recent announcement of a botanical congress, to be held in Vienna in 1905, provides that all proposals of nomenclatorial reform must be based on DeCandolle's Paris Code of 1867. The method of types is more fundamental however, than anything in the Paris Code, and once admitted to the serious consideration of taxonomic workers is soon found to justify a thorough recasting of nomenclatorial legislation. This task is already well advanced in America, though not yet entered upon by our trans-Atlantic colleagues.

The present vast confusion of names and methods has tended, no doubt, to discourage the entrance into systematic biology of those who appreciate that life is short, and that names and classifications are not the final objects of scientific study. Nevertheless, the fact that nine tenths of the difficulties of formal nomenclature can be permanently removed by consistent adherence to a few simple rules will have its effect in time, and biological taxonomy may ultimately serve its original purpose of rendering nature and science more accessible, instead of artificially multiplying labor and confusion.

Notes on Colorado plants

GEORGE E. OSTERHOUT

OREOBROMA TRIPHYLLA (Wats.) Howell

Claytonia triphylla Wats.

This peculiar little plant was collected near timber-line in the mountains east of Steamboat Springs, Routt Co., Colorado, July 15, 1902. In flower it has the appearance of a small *Claytonia*, and the thread-like stem beneath the soil is from a corm similar to the species of that genus. It has been reported only from the mountains much farther west.

OREOBROMA NEVADENSIS (Gray) Howell

Calandrinia nevadensis Gray.

Collected in the valley of the Bear river at Steamboat Springs, Routt Co., Colorado, June 18, 1903. It seems not to have been reported from Colorado or adjacent territory.

CYMOPTERUS PARRYI (C. & R.) Jones.

Mature fruiting specimens of this species were collected at McCoys, Eagle Co., Colorado, June 14, 1903. At first sight it does not differ much from *Cymopterus acaulis* (Pursh) Rydb. but the fruit is considerably larger. I think its collection has been reported only a few times and never before from Colorado.

AGOSERIS AGRESTIS Osterhout, Bull. Torrey Club, **28**: 645.

Further field-study has convinced me that this is not a valid species, but a robust form of the variable *Agoseris glauca* (Pursh) Greene. Separated from the intermediate forms it appears to be a good species but really grades into the older species.

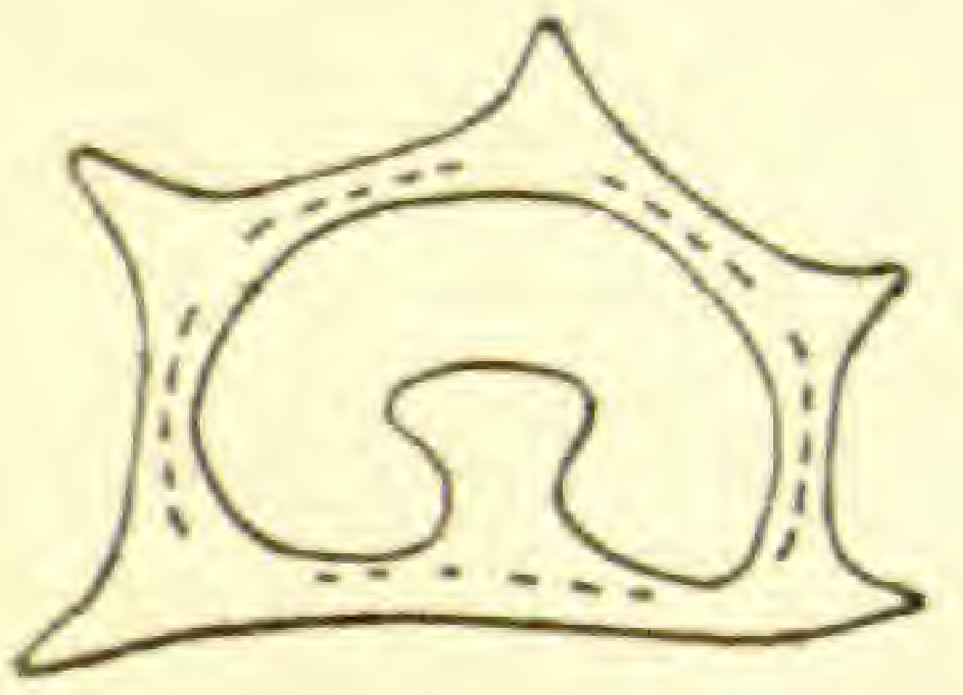
Arabis rugocarpa sp. nov.

A perennial many-stemmed from the root, the stems attaining a length of 1 to 1.5 cm., pubescent below and leafy to the inflorescence, the leaves small and auriculate, but the auricles small; the radical leaves oblanceolate, acuminate, 2 to 3 cm. long including the narrowly winged petiole, pubescent with forked hairs, but not thickly so, and the margins ciliate; the flowers light purple, the calyx-lobes spatulate, scarious-margined, 2 mm. long, and the corolla-lobes 5 mm. long; the pods rugose, about 3 cm. long, reflexed, on pedicels 5 mm. long, the valves one-nerved; the seeds in a single row, nearly round, slightly margined, a little more than 1 mm. in diameter; cotyledons accumbent.

Collected at Malta, a station on the Denver & Rio Grande Railway near Leadville, Colorado, June 20, 1903, *no. 2800.* Collected also at the same place in 1900.

Aulospermum angustum sp. nov.

Perennial from a deep-seated fleshy root; stem naked, crowned with a cluster of leaves and the peduncles, the whole 2 or more dm. in height; leaves narrowly ovate in outline, on short petioles, 0.5 to 0.75 dm. long, bipinnatifid, the segments small and the whole leaf glaucous; the fruiting peduncles much longer than the leaves, 1 to 2 dm. long; the umbel 5 or more rayed; involucre none; involucels of few subulate bractlets; rays about 1 cm. long, pedicels 3 to 4 mm. long; the fruit 6 to 7 mm. long, the 5 carpel-wings narrow and subequal; the oil-tubes 4 to 5 in the intervals (mostly 5) and 6 on the commissure; flowers yellow.



Collected in the valley of the Bear river between Steamboat Springs and Hayden, Routt Co., Colorado, June 17, 1903, *no. 2783.*

Senecio Fendleri lanatus var. nov.

Several-stemmed from the root, usually branched, very leafy to the inflorescence; leaves linear, pectinate pinnatifid, the divisions crenate-toothed, upper leaves reduced and becoming bract-like; the whole plant very lanate to the inflorescence; peduncles short, heads numerous and crowded, almost 1 cm. long, the bracts very nearly glabrous; *rays none.*

Collected along the sides of a dry gulch at Wolcott, Eagle Co., Colorado, July 11, 1902, *no. 2667.*

NEW WINDSOR, COLORADO.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1904)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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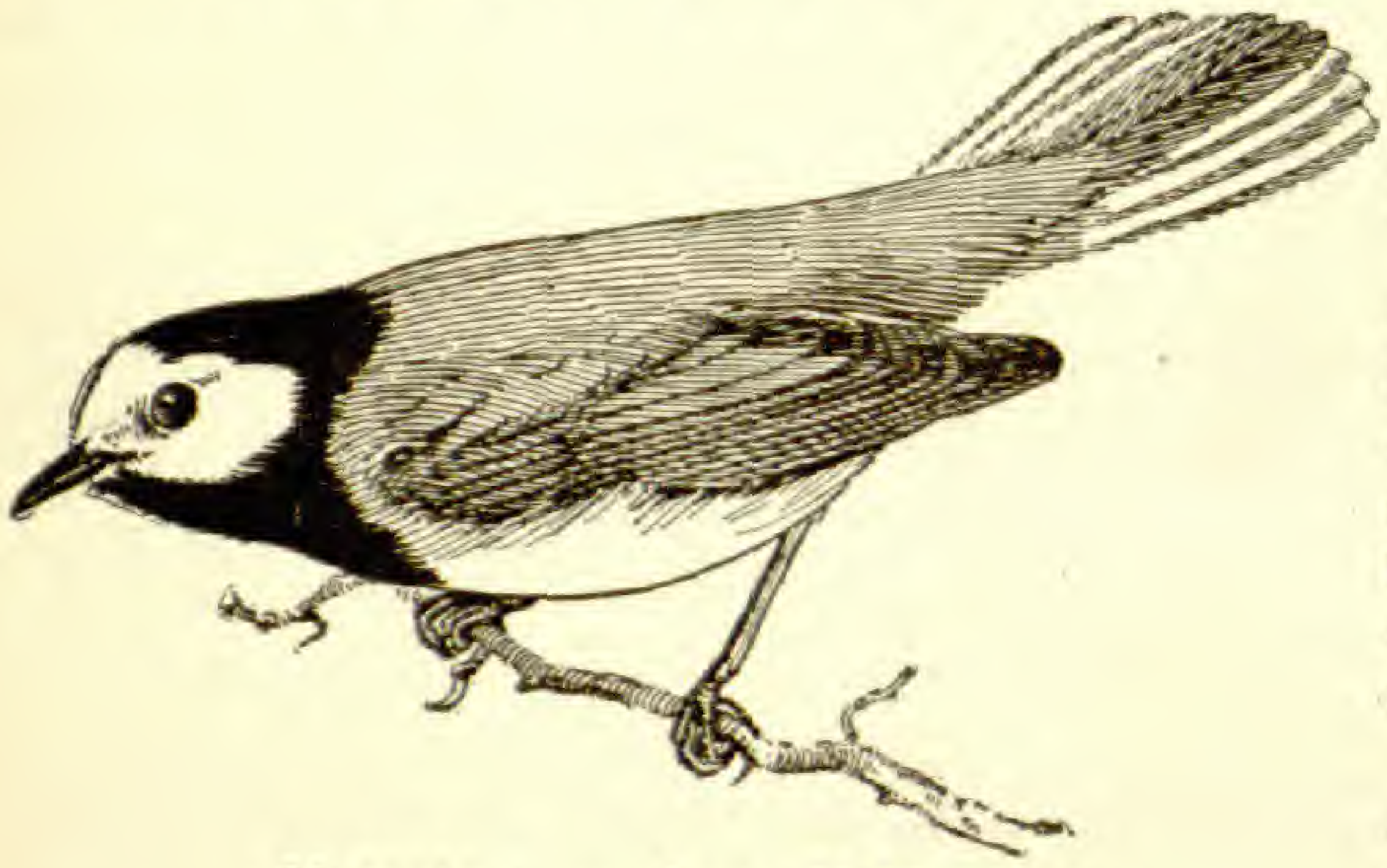

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BULLETIN

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JULY, 1904

Chemical notes on "bastard" logwood[*]

Benjamin C. Gruenberg and William J. Gies

During the past few years the growers of logwood in Jamaica have been greatly disturbed by an apparent increase on their properties of an unmerchantable variety of the plant known as "bastard" logwood.[†] The exportation of this wood along with real logwood has served to condemn all the logwood from the districts which have shipped it.[‡]

"Bastard" logwood differs from the genuine varieties, from the dyer's standpoint, in yielding little or no hematoxylin, but, instead, a yellowish-green pigment which is of no value and which, when admixed with the commercial extract, reduces the characteristic tinctorial properties of the latter. Chips of the "bastard" logwood present a yellow, pale pink, white or even chocolate-colored surface instead of the dark red or deep purple, bronze-tinted color of the best Jamaican or Mexican logwoods of commerce. There appears to be considerable uncertainty, even when the trees are cut down, as to whether a tree is really a "mulatto" ("bastard") tree or not. What is known as a "mulatto" tree is frequently dark enough when first cut to lead one to believe that it is a good redwood tree, but instead of darkening with age as all the good wood does, it remains the same color or becomes lighter rather than darker. The "bastard" tree

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[*] From the New York Botanical Garden, New York. Some of the chemical work was done in the laboratory of physiological chemistry of Columbia University.

[†] Fawcett: Bulletin of the Botanical Department, Jamaica, 3: 179. 1896.

[‡] Clipping from a Kingston, Jamaica, newspaper, sent to Dr. D. T. MacDougal by Hon. William Fawcett (September, 1901).

[The preceding number of the Bulletin, Vol. 31, No. 6, for June, 1904 (31: 309-366, *pl. 13, 14*) was issued 24 June, 1904.]

seems to be perfectly dry, and even when the chips are soaked for a long time in water, they give out no dye.*

Various theories have been advanced to explain the apparent increase in the "bastard" logwood in Jamaica. Professor F. S. Earle, after a thorough study of the situation in Jamaica, came to the following conclusions: †

1. "Logwood is a variable plant showing marked differences in form, color and texture of leaf; time of blooming; form and extent of ribs on the trunk; color of bark and especially in the color and dye-producing quality of the heart-wood. Four well-marked varieties are said to be recognized in Honduras and three are usually recognized in Jamaica, but there are many other intermediate forms."

2. "Bastard" wood is not the result of disease or of any lack of vigor. The trees producing it are perfectly healthy and normal.

3. "It is not the result of soil or climatic conditions, since 'bastard' and normal trees are found growing side by side under absolutely identical conditions."

4. "It is not the result of immaturity. Aged trees may produce 'bastard' wood, while in normal trees the heart-wood, as soon as formed, contains a good percentage of hematoxylin. These facts seem to point to heredity as the probable cause of the trouble. That is, that certain trees produce only 'bastard' wood because they grow from the seed of a 'bastard' tree; or in other words that 'bastard' logwood represents a variety of *Haematoxylon campechianum* that normally produces little or no hematoxylin, just as one Honduras variety has smaller, shorter, thinner and lighter colored leaves."

Some time before Professor Earle made his investigations in Jamaica we began, at Dr. MacDougal's suggestion, a comparative study of logwoods from that island, in the hope of finding definite chemical differences, other than purely tinctorial ones, between "red logwood" and the "bastard" variety. Unfortunately our work in collaboration was soon unavoidably interrupted. We present here very briefly, however, such of our notes in this connection as may be of general interest.

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* Cradwick: Report to the Chairman of the Experiment Station, Kingston, Jamaica, 1902 (April 4).

† Earle: Journal of the New York Botanical Garden, 4: 3. 1903.

ELEMENTARY COMPOSITION OF HEART-WOOD. — Elementary analysis of typical samples of (1) the red logwood of commerce, (2) a "bastard" variety somewhat resembling it and (3) a second specimen of the "bastard" type yielding hardly any pigment to water gave the following results:

TABLE I.

PERCENTAGE ELEMENTARY COMPOSITION OF SUBSTANCE DRIED TO CONSTANT WEIGHT AT 110°C.*

	I.			II.			III.		
	"Red" Logwood.			"Bastard" (medium grade).			"Bastard" (poorest quality).		
	C†	H	Ash.	C†	H	Ash.	C†	H	Ash.
1	51.91	5.98	1.80	51.45	5.83	1.59	51.04	5.67	2.03
2	52.00	5.80	2.06	51.77	6.03	1.68	51.35	5.74	1.86
3	52.12	5.76	1.71	51.45	6.03	—	51.00	5.58	—
Av.	52.01	5.84	1.86	51.56	5.96	1.63	51.13	5.66	1.94

SUMMARY OF AVERAGES.

	I.	II.	III.	General Average.
Carbon,	52.01	51.56	51.13	51.57
Hydrogen,	5.84	5.96	5.66	5.82
Ash,	1.86	1.63	1.94	1.81
Oxygen.‡	42.15	42.48	43.21	42.61

The most significant feature of these results is the decreasing amount of carbon in the "bastard" wood. The differences are too slight to warrant any emphasis, but are such as might be due to a lower percentage of hematoxylin, which is a pigment of high carbon (and low oxygen) content — $C_{16}H_{14}O_6$.

The data of the second series of analyses, given in TABLE II, show that the wood was not decomposed in the process of drying to constant weight at 110° C. (first series) and that, therefore, the previous results were not influenced by that procedure.

GENERAL COMPOSITION OF SEEDLINGS. — In TABLE III we present the results of some analyses of seedlings of "red" logwood

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[*] Only heart-wood was employed in this work. This was converted into sawdust and only such portions as passed through a very fine sieve were taken for analysis. The methods of analysis were those which are now in general use.

[†] The figures for carbon and hydrogen are calculated (from the data of direct analysis), for *ash-free* substance.

[‡] Calculated, by difference, for *ash-free* substance.

TABLE II.

PERCENTAGE ELEMENTARY COMPOSITION OF SUBSTANCE DRIED TO CONSTANT WEIGHT AT 20 C.°

	I.			II.		
	C	H	H_2O	C	H	H_2O
1	46.90	5.40	7.95	46.58	5.28	7.97
2	46.98	5.24	—	46.87	5.45	—
3	47.08	5.20	—	46.58	5.45	—
Average.	46.99	5.28	7.95	46.68	5.39	7.97

and of the "bastard" variety. The condition of the seedlings at the time of analysis is shown in FIGURE I. The outward appearance of the two kinds of seedlings was practically the same. Likewise, the differences among the figures in our table for general chemical composition are too slight to warrant any other conclusion than that the seedling metabolism was, in general, essentially the same in both varieties. The analyses were made 12 months after seeds were planted.

TABLE III.

GENERAL COMPOSITION OF LOGWOOD SEEDLINGS.*

		Water.		Solids.					
				Total.		Organic.		Inorganic	
		Red.	Bastard.	Red.	Bastard.	Red.	Bastard.	Red.	Bastard
Leaves,	*a*	60.33	60.05	39.67	39.95	37.08	36.93	2.59	3.02
		59.89	——	40.11	——	37.70	——	2.41	——
	b	56.27	51.22	43.73	48.78	41.08	45.94	2.65	2.84
	c	63.57	60.68	36.43	39.32	34.72	36.50	1.71	2.82
Upper stem,	*a*	43.77	38.34	56.23	61.66	54.40	58.29	1.83	3.37
	b	39.06	34.01	60.94	65.99	59.08	63.99	1.86	2.00
	c	43.68	45.89	56.32	54.11	54.61	52.50	1.71	1.61
Lower stem,	*a*	43.19	39.99	56.81	60.01	55.62	58.32	1.19	1.69
	b	36.83	32.97	63.17	67.03	61.63	65.24	1.54	1.79
	c	43.39	44.46	56.61	55.54	55.41	54.14	1.20	1.40
Roots,	*a*	67.93	61.66	32.07	38.34	30.52	35.39	1.55	2.95
	b	65.32	70.58	34.68	29.42	33.20	27.70	1.48	1.72
	c	——	49.17	——	50.83	——	46.87	——	3.96

* Analyses were made by the usual drying and incineration methods. The portions subjected to comparative analysis were approximately of the same morphological location in each variety. The most significant differences seem to be the slightly larger proportion of water in the "red" wood and the relatively greater quantity of solids, especially inorganic matter, in the "bastard" samples.

CONCLUSIONS FROM THE GENERAL ANALYTIC DATA. — All of the preceding analytic results make it evident that the chemical differences existing among these logwoods are quantitatively very slight. They also make it appear probable that the variations in the different samples of the wood are chiefly variations in the chemical characteristics of the pigments themselves, which, as is well known, possess as a rule high tinctorial qualities even when they occur in only very small amounts. Our results in this connection would also indicate that there are no striking structural differences among these varieties of logwood. They suggest, likewise, that even

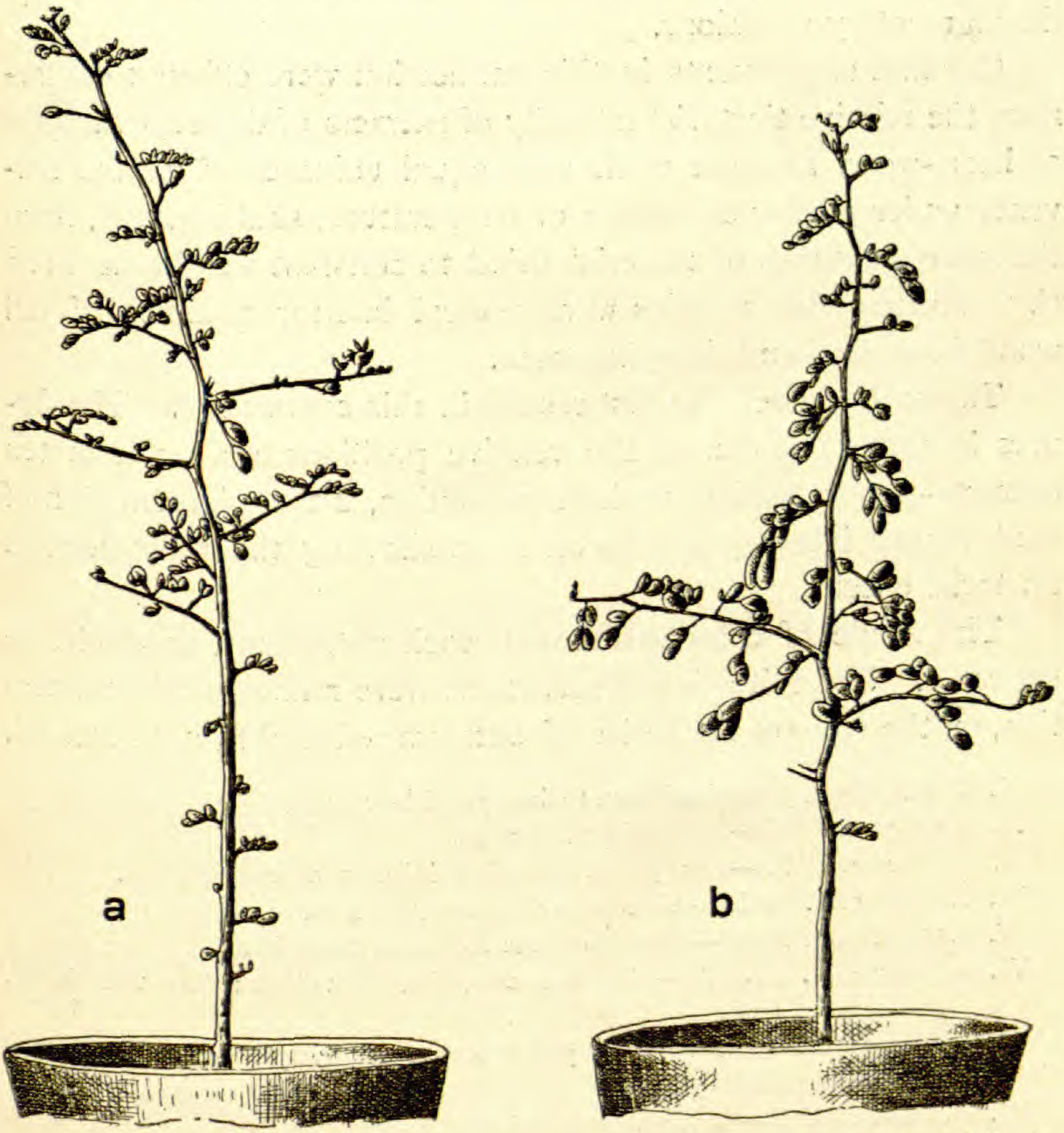

FIGURE I. Seedlings of logwood, one year old. a, "red logwood." b, "bastard logwood." Both grown from seeds obtained from "Old Hope" plantation, Jamaica.

metabolic tendencies in these logwoods are essentially the same, varying only, perhaps, in the course of events which involve relatively slight quantities of pigment.*

TINCTORIAL DIFFERENCES. — The foregoing results having shown that the differences among these logwoods were chiefly if not solely tinctorial, we next endeavored to ascertain the extent of the pigmentary variations.

Our first experiments in this connection were efforts to determine the relative tinctorial intensity of extracts of different samples of heart-wood sawdust made with equal volumes of various solvents under similar conditions of temperature, shaking, etc., from the same quantities of material dried to constant weight at 110° C.† Among the samples were several inferior qualities of red wood from dead and decaying trees.

TABLE IV gives our first results in this connection. The figures in that table denote the relative positions in a series of ten extracts — 1 indicating weakest coloration, 2 the pigmentation of next higher intensity and so on to 10 showing the most decided tinctorial effect.

The shade of color varied with each extractant, as would be expected. The following observations were made in this connection, on the color of the series of extracts referred to in TABLE IV.

I. Water—slight yellowish-brown to deep reddish-brown.‡
II. 0.2 per cent. HCl—faint yellow to orange.
III. 2.0 per cent. HCl—faint yellow through reddish-brown to bright red.
IV. 0.01 per cent. KOH — chocolate coloration throughout.
V. 0.15 per cent. KOH — deep chocolate coloration throughout.
VI. 0.5 per cent. Na_2CO_3 — chocolate coloration throughout; less than in V, greater than in IV.
VII. Saturated borax solution — faint yellow to deep reddish-yellow.
VIII. Ether — faint yellow to orange.
IX. Absolute alcohol — faint yellow to red.
X. Acetone — faint yellow through greenish-yellow to yellowish-red.
XI. Acetic ether — faint yellow to deep reddish-yellow; brighter than in VII.

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* These conclusions are in harmony with those drawn from other standpoints by Professor Earle (quoted on page 368). They were arrived at independently by us and were included in our report, in December, 1902, to the Botanical Society of America, before we were aware of Professor Earle's deductions. Science, II. 17: 338. 1903.

† Drying occurred rapidly and seemed to have no transforming effect on the dust. This fact was noted before in another connection (page 369).

‡ The coloration intensities are indicated progressively from 1 to 10 (see TABLE IV). Individual exceptions are not referred to.

XII. Chloroform — no color in some, faint yellow in others.
XIII. Benzol — no color in any.

TABLE IV.

RELATIVE PIGMENTATION OF VARIOUS KINDS OF LOGWOOD.

Extractant.	*A*	*B*	*C*	*D**	*E*	*F*	*G*	*H*	*I*	*J*
I. Water.	1	2	3	10	4	6	7	5	8	9
II. 0.2 % HCl.	1	2	5	7	6	3	4	10	9	8
III. 2.0 % HCl.	1	2	4	3	5	6	7	8	9	10
IV. 0.01 % KOH.	1	2	4	3	5	6	7	8	9	10
V. 0.15 % KOH.	2	4	1	3	5	7	6	8	9	10
VI. 0.5 % Na_2CO_3.	2	3	1	6	4	5	7	8	9	10
VIII. Ether.	1	2	5	4	8	7	9	6	3	10
IX. Absolute alcohol.	1	2	4	3	6	5	9	7	8	10
X. Acetone.	1	2	4	3	5	9	6	7	10	8
XI. Acetic ether.	1	2	3	4	6	7	5	9	8	10
Average.	1.2	2.3	3.4	4.6	5.4	6.1	6.7	7.6	8.2	9.5

A—"Bastard" (very poor). *B*—"Bastard" (very poor). *C*—Immature wood of varying tints. *D*—"Purple" (from tree on extremely poor marly bank; tree mature, but dead in nearly all parts, including the roots). *E*—Immature wood of varying tints. *F*—"Bastard" (medium grade). *G*—Red (tap root of nearly dead tree). *H*—Red (tree over ripe; wood bored by ants). *I*—Red (from roots of dead tree). *J*—Red (best grade).

More important, however, than the variations in the shades of color in the extracts was the fact, already noted, that the *sequence* of coloration intensity (in extracts made under like conditions in detail in each series) *varied* with each solvent (TABLE IV). This result not only shows that the colors of the woods are not due merely to different amounts of the same pigment but also proves that the pigmentary differences are caused either by varying proportions of at least two pigments, or by the same pigment radical in more than one chemical condition — in combinations, it may be of different solubilities and stoichiometric relationships, and of different dissociable tendencies.

Relative tinctorial differences and variations are further shown in the following sample data, which indicate the quantity of water in c.c. added to 10 c.c. of 0.5 % Na_2CO_3 extract (TABLE IV) in order to make the tinctorial intensity approximately the same throughout the series.†

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* This sample contained several pigments. One of these was purplish and quite unlike any in the other samples. The pigment was especially soluble in water. It was not ordinary hematoxylin.

† Dilution of D with an equal volume of water furnished the basis of coloration for the comparative observations.

TABLE V.

Sample of Logwood.	Water Added.	Sample of Logwood.	Water Added.
A	3.5 c.c.	C	7.5 c.c.
B	3.5	D*	10.0
F	5.5	H	10.9
E	7.1	I	12.2
G	7.1	J	17.8

The letters correspond to those in TABLE IV.

The tinctorial sequence after the above dilution is different from what it was before dilution as may be seen from the following summary: †

TABLE VI.

	1	2	3	4	5	6	7	8	9	10
Before dilution (TABLE IV).	C	A	B	E	F	D	G	H	I	J
After dilution (TABLE V).	A	B	F	E	G	C	D	H	I	J

The above facts are in further harmony with the foregoing conclusions regarding cause of coloration effects and relative differences.

Dilute aqueous extracts of two samples of red logwood and of one medium grade "bastard" wood all showed a similar yellow color, by transmitted light. The shades of color did not differ noticeably except in degree. In stronger extracts of equal concentration the first two appeared more reddish.

Treatment with alkalies, volatile and non-volatile, turned the color of the red logwood extracts to a blood-red, passing into purple, whereas in the "bastard" extract the shade of yellow was merely deepened, passing into the dull brown color of faded oak leaves. Dilute and concentrated mineral acids turned the yellow of the dilute aqueous extracts of the red wood into a color ranging from orange to bright red. In the "bastard" extract no such change was perceptible.

These differences in the behavior of the two sets of aqueous extracts toward acids and alkalies correspond to the differences between the reactions exhibited toward the same reagents by a

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* This color was of the same intensity as the rest, but not the same shade. See footnote, page 373.

† A similar change in sequence of tinctorial intensity after dilution was noted in other extracts, also.

freshly prepared solution of the commercial "extract of logwood," and a solution four weeks old that had faded to a straw-yellow.

The chemical alterations undergone by the aqueous solution of the commercial extract are accompanied by such a decided change in color and in chemical properties that from a comparative study of such extracts we expected to learn something definite regarding the actual differences between the pigments in the heart-wood of "red" logwood and in that of the bastard variety. We were unable, however, to do so.

Experiments were started to determine, if possible, the relations of light and of air to the discoloration of solutions of logwood extracts. In a few weeks all the preparations had been attacked by growths of *Penicillium*, *Rhizopus* and other fungi. After filtration the solutions showed no appreciable differences in shade or color. But on diluting these filtered solutions with two parts of water and eventually with eight parts, differences were readily observed.

The solutions which had been in the light showed no change in color, whereas those kept in the dark had become distinctly yellow. The extracts to which the air had free access manifested the greatest changes.

SOLID MATTER IN LOGWOOD EXTRACTS. — We desired to ascertain, in comparative determinations, the quantities of solid matter in aqueous extracts of the various logwoods under investigation. The absolute amount of solid substance in 100 c.c. of the extract was always small — less than 0.02 gram. In the drying process slight decomposition seemed to result and perfectly constant weights could be obtained only after a long time. Although the absolute changes in weight were only very small, the proportionate variations in quantities so slight were quite large. For these reasons no comparative observations were attempted in this connection. The use of very large volumes of extract, to reduce the comparative effects of the variations referred to, was impracticable.

The general question of the physiology or chemistry of pigment-formation in the heart-wood was not approached at all, nor were the histological characters of the varieties compared.

There can be no doubt that "bastard" logwood is, as Prof. Earle also concludes (see page 368) a distinct variety or subspecies of *Haematoxylon campechianum*, notwithstanding the slight morphological differences that distinguish it from the "red logwood" and "blue logwood." The differences in the floral organs between

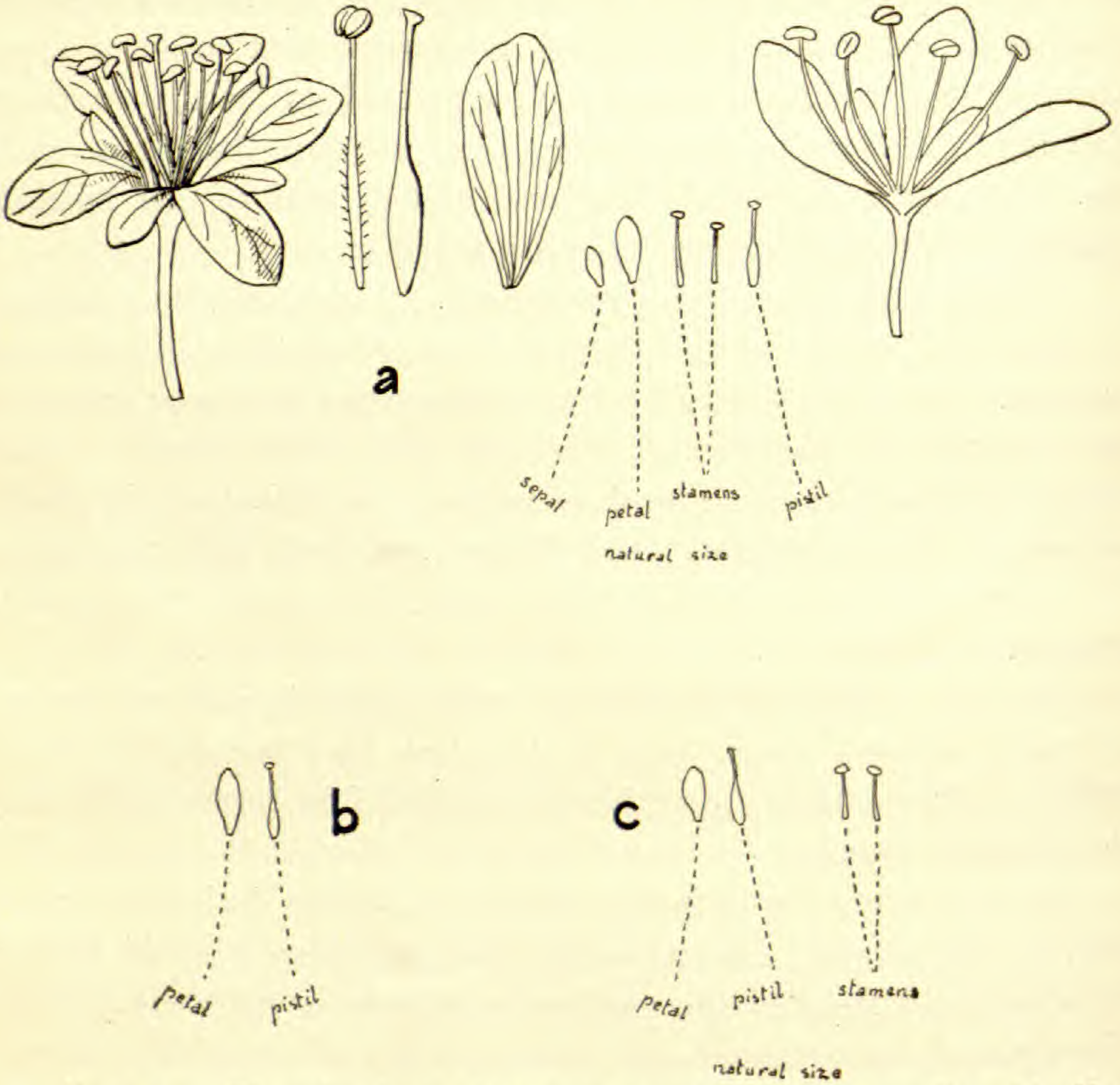

FIGURE 2. These drawings, which were made from specimens collected by Hon. William Fawcett near Morant Bay, Jamaica, show all the morphological differences that have been observed in the flowers of three varieties: *a*, "blue logwood." *b*, "red logwood." *c*, "bastard logwood."

The petals are widest in the blue and narrowest in the bastard.

The pistil of the blue is thicker than that in the red and the bastard. The style in the bastard is slightly curved.

In the bastard the stamens are smaller than in the others, and there is less difference between them.

It does not appear from the data at hand that the differences noted exceed the ordinary individual variations for the species of *Haematoxylon*.

the three varieties are shown in FIGURE 2, which was made from drawings sent by Mr. Fawcett, of the Jamaica Botanical Gardens.

That there are species which are not at all distinguishable from one another externally, but which vary in their physiological properties, is a recognized fact,* and the "bastard" logwood may simply be a new example of the same phenomenon. A parallel case would seem to be furnished by the black locust (*Robinia pseudacacia*), the wood of which is described by Sargent † as being "reddish, greenish-yellow or white, *according to locality*"; but the yellow and white varieties occur side by side in at least one locality.

SUMMARY.

1. The most significant fact shown by elementary analysis of the heartwood of typical specimens of logwood was the lower carbon content of the poorer wood, which may be due to lower pigment content, hematoxylin being a compound containing nearly twice as much carbon as oxygen.

2. No morphological differences are discernible between red logwood and bastard logwood in the young seedlings.

3. Analyses of the various seedlings agreed too closely to warrant any conclusion but that the metabolism of the seedlings was essentially alike in the two varieties.

4. The chemical differences between red logwood and "bastard" logwood are very slight, and are probably due to differences in amount of pigment.

5. Extractions with various solvents gave solutions of different colors, and also of varying orders of intensity in the several series, indicating the presence of at least two pigments in varying proportions, or a pigment radical in different combinations.

6. This was confirmed by the fact that the order of coloration intensity of a series of extracts was altered by diluting with water.

7. Aqueous extracts of the two varieties of logwood gave different reactions to acids, alkalies and other reagents. The differences are parallel to those between a fresh aqueous solution of commercial logwood "extract," and the same solution after it had become discolored on long standing.

8. Attempts to determine the conditions of the discolorations of solutions of commercial "extract," failed to yield definite results, but indicated, in general, that darkness and air are favorable to the change.

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* DeVries: Mutationstheorie, 1: 122. 1901.

† Sargent: Catalogue of the forest trees of North America, 15. Washington, 1880.

Studies in Sisyrinchium — X. The species of California

EUGENE P. BICKNELL

The blue-eyed grasses of California, as shown by the collections which have passed under review in a study of the group, are common in many parts of the state and in nearly all parts are represented by one or more species, forming a noteworthy if not everywhere conspicuous element in the flora.

The widely diversified topographical features and sharply contrasted climatic conditions embraced within the great area of the state might well lead us to expect some striking reflection in so responsive a genus as *Sisyrinchium* occurring throughout, more especially since so many other sections of the United States have been found to possess a more or less characteristic group of species, and yet it has long been commonly supposed that scarcely more than a single species belonged to the California flora. In fact since Dr. Watson, in 1877, separated the most conspicuous California species from its eastern relatives under the name of *Sisyrinchium bellum* this name has been in common use for almost all specimens collected within the boundaries of the state.*

Within these boundaries, however, is an interesting group of species few of which appear to extend far beyond them. How many species make up this group cannot as yet be determined. Six or seven come out clearly enough from the mass of specimens which have been available for study, and others might be proposed on evidence perhaps sufficient yet not altogether convincing. For the present seven species are recognized. Of these *Sisyrinchium bellum*, the most conspicuous, appears also to be the most abundant. It proves, however, to be not at all of general distribution

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* The yellow-flowered species formerly included in *Sisyrinchium* are here excluded from consideration, having already been separately treated under the revised genus *Hydastylus*. (Studies in *Sisyrinchium* — VIII. Bull. Torrey Club, **28**: 570–592. 1901.)

The even more distinct genus *Olsynium* of Rafinesque takes over another plant long accepted as a *Sisyrinchium*, the *Sisyrinchium grandiflorum* Douglas, as already pointed out. (Studies in *Sisyrinchium* — VII. Bull. Torrey Club, **27**: 237. 1900.)

throughout the state, being restricted, or very nearly so, to the coastwise counties, through which it ranges from San Diego, and doubtless Lower California, northward into Mendocino County, from beyond which no specimens have been forthcoming. This species bears the distinction of having flowers of larger maximum size than any other species of the United States, although surpassed in both the size and beauty of its flowers by *Sisyrinchium Macounii* of Vancouver Island.

In the Sierra Nevada region, northward from about the middle of the state, and beyond into Oregon, *Sisyrinchium bellum* is replaced by a slighter and smaller-flowered plant, *Sisyrinchium Greenei* sp. nov., which appears to be generally representative of that region, while in the valleys and mountains of the southern part of the state away from the coast another species, *Sisyrinchium Eastwoodiae* sp. nov., appears to be equally representative. A further, somewhat obscure species from the southwestern ranges nearer the coast is admitted as *Sisyrinchium hesperium* sp. nov. Four species appear from the extreme eastern parts of the state, one very distinct and apparently local species, *Sisyrinchium funereum* sp. nov., in the southeast, and three, *Sisyrinchium halophilum* Greene, *Sisyrinchium leptocaulon* Bicknell and *Sisyrinchium oreophilum* sp. nov., all simple-stemmed plants, mostly in the Sierra Nevada region.

SISYRINCHIUM HALOPHILUM Greene, Pitt. **4**: 34. 1899.

Inyo County, *Bishop;* Owen's Valley, alt. 5,000 ft., May 15, 1897, *M. E. Jones*, Herb. Missouri Bot. Gard. (not U. S. Nat. Herb., as cited in error Bull. Torrey Club, **26**: 451. 1899); Sierra Nevada Mts., 1875, *J. G. Lemmon*, U. S. Nat. Herb.

These specimens are stouter and broader-leaved, with thicker roots and perhaps larger flowers than the type, but are without perfect flowers and fruit and can be referred to no other species at present described.

The range of *S. halophilum* may be extended to Idaho, Wyoming and Colorado. From these states come a series of small, slender plants which, while contrasting markedly with the specimens from California cited above are brought closer to them by somewhat intermediate characters found in the Nevada type. The principal differences from the latter are more slender, less clustered roots, slenderly prolonged outer bract and apparently larger and darker-colored, thinner-walled capsules.

There seems, indeed, good reason to suspect the existence of a group of closely related simple-stemmed species inhabiting nearly the same general region, which on present material it is impossible to disentangle effectually from *S. halophilum* and *S. leptocaulon.*

SISYRINCHIUM LEPTOCAULON Bicknell, Bull. Torrey Club, **26**: 451. 1899.

Sierra Nevada Mts., near Lake Tahoe, *J. Ball*, July 20, 1884, Herb. Acad. Nat. Sci. Phila.

Tuolumne Co.: Soda Springs, Herb. Cal. Acad. Sci.

Lassen Co.: Milford, June 26, 1892, *T. S. Brandegee*, Herb. Cal. Acad. Sci.

The original description of *S. leptocaulon* was drawn from the specimen first above cited together with other material from Nevada and Utah less evidently distinct from *S. halophilum.* Of the additional specimens here recorded, that from Soda Springs, while clearly related to the Lake Tahoe type, shows a greater size for the species and a wider divergence from *S. halophilum* than has hitherto appeared. The stiff, narrowly margined stems are 45–70 cm. tall and about 1.5 mm. wide; the broadest leaves, nearly 2.5 mm. wide, are strongly rather few-nerved and more or less white-glaucous; the bracts are finely close-striate, the outer one stiffly short-pointed, scarcely surpassing the inner, and 2–2.5 cm. long; inner scales crowded, sometimes exceeding the shorter bract; pedicels close-fascicled, somewhat exserted; capsules pale, thick-walled, finely rugulose, 2.5–5 mm. high; seeds 2–3 in a row; a mature seed is nearly 2 mm. in diameter, irregularly compressed-subglobose and very minutely rugulose.

It is impossible to derive a clear understanding of either this species or *S. halophilum* from the scant material so far collected. While extreme examples of each appear obviously distinct, their relationship is confused by certain specimens which cannot be satisfactorily assigned at the present time. As already intimated there is good reason to believe that more than two species enter into the problem.

Sisyrinchium oreophilum sp. nov.

Stems simple, or occasionally developing a single terminal peduncle with subtending leaf, 10–25 cm. high from slender fibrillose roots; pale glaucescent green, showing some discoloration when dry. Leaves about half the height of the stems, firmly erect, becoming rather strongly nerved, 1–3 mm. wide, tapering-acute, the edges smooth; stems .75–1.50 mm. wide, narrowly wing-margined, finely cartilaginous-denticulate to smooth; spathes narrow, the bracts rather prominently but not very closely fine-nerved, the hyaline edges narrow; outer bract 1.5–4 cm. long, narrowly attenuate, abruptly pointed or often obtuse, usually surpassing the inner one 2–10 mm., but sometimes longer, rather closely united-clasping for 5–7 mm. and with sharply keeled edges; inner bract usually abruptly scarious-obtuse and bluntly apiculate; inner scales little more than half the length of the bracts; pedicels erect, slightly exserted, often reddish-purple; flowers violet-purple; perianth 8–10 mm. long, the segments mucronulate-aristulate, slightly if at all emarginate; stamineal column 5 mm. long or less; anthers small, about 1 mm. long; ovary oblong, puberulent; capsule sparsely puberulent, brown, thin-walled, globose or obovoid, 2.5–5 mm. high, many-seeded.

Mariposa County: Yosemite Valley, May–June, 1900, *F. T. Bioletti*, Herb. Cal. Acad. Sci. (type); Yosemite Valley and Mountains, *J. Torrey*, 1865, Herb. Columbia Univ.; Sierra Nevada Mountains, 8,000 ft., south fork of San Joaquin River, July, 1900, *H. M. Hall & H. P. Chandler, no. 652.*

Placer County: Downer Lake, July 25, 1895, *Edward L. Greene*, Herb. E. L. G.

Modoc County: 1894, *M. S. Baker and Frank Nutting*, Herb. E. L. G.

Appearing nearer to *S. angustifolium* than any species seen from west of the Rocky Mountain region, and variously suggestive, as well, of some of the simple-stemmed western species, but showing material differences from each one. It is a smaller plant than *S. angustifolium* with less unequal and more obtuse bracts of somewhat different nervation, smaller flowers with small anthers and more glandular-puberulent ovary, the capsules also more or less sparsely puberulent.

In the relative length of the bracts this species nearly agrees with *S. occidentale*, but it differs notably in much smaller flowers, less acute and differently shaped bracts, especially the narrower inner one, weaker and less narrowly margined, mostly rough-edged stems and more slender roots.

S. segetum is also much larger flowered, as well as taller and more slender, more densely tufted, narrower leaved and with slenderly very acute bracts.

S. halophilum and *S. leptocaulon* both differ essentially from *S. oreophilum* by their thicker roots and smaller, thicker-walled, pale capsules.

The only other simple-stemmed species of any of the Pacific states, *S. idahoense* and *S. sarmentosum*, need no comparison with *S. oreophilum*, the former being a much larger plant in every way, and the latter differing conspicuously by its narrowly prolonged foliaceous bracts, besides narrower and weaker leaves and stems and smaller flowers.

Sisyrinchium Greenei sp. nov.

Mostly 25–45 cm. high, from fibrous, sometimes slightly thickened roots, pale or glaucescent green, often darkening or becoming brownish in drying. Leaves commonly about half the height of the plant and 1–3 mm. wide, sometimes rather thin and soft or becoming firm, varying from linear-attenuate and straight to acuminate and somewhat curved, narrowly acute, the delicate nerves approximate, or becoming well separated on the broader leaves, the edges smooth; stems commonly terminated by one or two, or even three, slender but mostly short peduncles subtended by a usually shorter erect bractal leaf, sometimes bearing a leaf and axillary peduncle lower down, casually simple with terminal spathe, 1–3 mm. wide, narrowly thin-margined or winged, the edges smooth or obscurely denticulate near the node; peduncles 3–10 cm. long, often extremely slender, slightly diverging and mostly a little unequal; spathes often purplish, usually narrow, 15–20 mm. long, the bracts rather firmly fine-nerved, equal, or either one slightly the longer, the outer one mostly acute, sometimes slightly foliaceous and becoming 2.5 cm. long, united-clasping below for .05–.07 mm., the inner one often scarious, obtuse; inner scales mostly about three-fourths the length of the bracts; flowers on slender, slightly exserted pedicels, delicate, pale violet-blue, about 10 mm. long, the segments short-aristulate; stamineal column 5–6 mm. long; ovary glandular-puberulent; capsule subglobose or obovoid, brown, firm-walled, 3–7 mm. high; seeds numerous, apparently medium-sized.

Sierra Nevada Mountains from about midway in the state northward, extending into Oregon, ascending to at least 6,000 feet. Flowering mostly in June and July, although beginning to bloom in May, or even earlier, at lower altitudes. Named in honor of Professor Edward L. Greene.

Siskiyou County: North side of Mount Shasta, 5–9000 feet, June 11–16, 1897, *H. E. Brown, no. 351* (type).

Modoc County: June 14, 1893, *M. S. Baker.*

Plumas County: Near Pratville, Mountain Meadow, 5,500 ft., July 2, 1897, *M. E. Jones;* July, 1896, 1897, 1898, *Mrs. R. M. Austin.*

Butte County: Little Chico Creek, May, 1896, Colby, July, 1896, *Mrs. R. M. Austin.*

Placer County: Applegate, May, 1899, *Mrs. Helen Smith.*

An inhabitant of the mountainous region of the north and northeastern part of the state, there replacing *S. bellum* of the coastwise counties and ascending to high altitudes.

It is ordinarily a smaller, more delicate plant than *S. bellum*, paler green in color and drying paler, and with much smaller flowers. So considerable, however, are the variations shown by the series of specimens at present necessary to refer to this species that little doubt need be entertained that more than one species is involved. Confident segregation, however, must await critical study of more complete material.

The type of *S. Greenei* may be taken as H. E. Brown's *no. 351*, from Mt. Shasta, of which I have seen four good sheets from as many herbaria and which is somewhat intermediate between extremes of the series.

Certain specimens from high elevations in Plumas County, as well as from Klamath Lake, Oregon (July, 1893, *Mrs. R. M. Austin*), are extremely delicate and slender throughout and bear only one or two terminal peduncles; other specimens are considerably stouter with broader and thinner leaves. A few specimens vary suggestively from the type by unusually long peduncles, broad thin leaves and sharply serrulate stems, and appear also to be earlier-flowering, several specimens having been collected in full flower in the month of May.

A particularly notable specimen more than doubtfully associated with the others here assigned is from near Pentz, Butte Co., collected by *Mrs. C. C. Bruce*, April, 1897 (Herb. Cal. Acad. Sci.), in full flower and with some mature fruit, although typical *S. Greenei* appears not to bloom ordinarily until June and July; these specimens are further remarkable for their greatly elongated stems and leaves, some being 70 cm. high, very pale and glaucous, peduncles in clusters of 2–5, and capsules very large, becoming 7 mm. high.

Sisyrinchium Eastwoodiae sp. nov.

Glaucescent green, often brownish-tinged on the herbarium sheet, 20–60 cm. high; roots clustered, becoming slightly thickened towards the base. Leaves firm, with acute hardened tips, sometimes nearly equalling the stem but more often half its height, 1–3 mm. or even 4 mm. wide, firmly striate-nerved, the edges smooth or, in forms, roughened with minute points; stems erect, often flexuously curved, about the width of the leaves, flattened and narrowly winged to subterete and merely margined, the edges smooth or, in forms, bearing close-set, erect or retrorse cartilaginous points; node mostly one, high up, or sometimes two, its leaf shorter than the peduncles, often very short, stiff and bract-like; peduncles one to four, mostly short but sometimes very slender, 3–10 cm. long; spathes narrow, flattened, 1.3–2 cm. long, the bracts finely, but not very closely striate-nerved, the inner one commonly the longer and acuminate or apiculate from a scarious apex, the outer one cuspidate or stiffened to a short corneous tip, united-clasping for 4–8 mm. at base; inner scales equaling the shorter bract or sometimes much shorter; flowers rather numerous, 8–14, on erect or slightly spreading exserted pedicels, rather small; perianth 8–12mm. long, the segments broadly short-aristulate from a usually slightly retuse apex, violet-purple, the yellow eye small; stamineal column about 5 mm. long, ovary loosely glandular puberulent; capsule pale or dark brown, subglobose to obovoid or pyriform, thick-walled, sparsely puberulent, small, 2–4 mm. high; seeds 1–4 in each row, about 1.5 mm. in diameter, rugulose.

Valleys and mountains of Southern California extending into Lower California, not apparently reaching the coast; blooms from early May to July or later. Named in honor of Miss Alice Eastwood.

Kern County: Tehachapi, June 22, 1889, *Prof. E. L. Greene;* San Emidio Cañon, October 2, 1894, *Miss Alice Eastwood.*

San Bernardino County: San Bernardino Valley, in meadows. May, 1886, *S. B. & W. F. Parish, no. 663* (type), also 1889 and 1888, by same collectors; San Bernardino, May 3, 1898, *S. B, Parish,* 1880, *G. R. Vasey;* San Bernardino Mountains and their eastern base, alt. 5,000 ft., June 28, 1894, *S. B. Parish, no. 3045.*

San Diego County: San Ysabel, May, 1893, *H. W. Henshaw;* Cuiamaca Mountains, July 12, 1875, *Edward Palmer, no. 374.*

The above description of *S. Eastwoodiae* has been derived primarily from the plant of the San Bernardino Valley represented mainly by the collections of S. B. and W. F. Parish. This is, apparently, the largest form of the species, frequently developing two leaf-bearing nodes, and with the basal leaves mostly about half the height of the close tufts, becoming even more than 4 mm. wide. This plant shows more or less discoloration on the herbarium sheet. It comes into flower in April and May.

Specimens collected by Professor Greene at Tehachapi, still flowering towards the end of June, are tall, pale in color, with long, slender, narrowly attenuate leaves and somewhat flexuous, very firm, smooth-edged stems with a single node and slender peduncle; the bracts of the spathe are narrow and firm, the shorter primary one with a stiff corneous tip.

Near this form may be placed a small, very different-appearing plant collected by Miss Alice Eastwood in San Emidio Cañon, Kern County, still flowering in October. Its leaves are short, especially the nodal leaf, the stems and peduncles very slender, the bracts mostly under 1.5 cm. in length, and the capsules only 2–2.5 mm. high; the outer bract shows the same hardened nail-like tip seen in the Tehachapi specimens.

In the absence of further material for study there may be referred here, also, Dr. Edward Palmer's *no. 374*, collected on mountains in the southern part of San Diego County in full flower, July 12th. These specimens are noteworthy in several ways, especially by reason of the harshly cartilaginous-ciliolate edges of leaf and stem and the roots which are distinctly woody-thickened toward the base; the bracts also appear to be more membranous than in the more northern plant and are mostly very acute, but without an indurated tip.

Another collection from the San Bernardino mountains must for the present find its place here also, although presenting many points of contrast. The stems are but 6–15 cm. high, many of them simple but others bearing two short peduncles; the leaves are short, relatively broad and mainly obtuse as are the broad short bracts, and both stems and leaves are more or less denticulate or even cartilaginous-ciliolate. This plant was collected by S. B. Parish in flower, June 28th, at an altitude of 5,000 ft., and though strikingly at variance with the valley plant may well be a modified sub-alpine form.

Sisyrinchium funereum sp. nov.

Stiff and erect in scant tufts becoming 50–60 cm. high, pale glaucous-green, not discoloring when dry, the dead leaves and stems of the previous season, bleached to a light straw-color, persisting rigidly amid the fresh growth; roots soft and stout, mostly 2–3 mm. thick towards the base when dried and becoming over 30 cm. long. Leaves somewhat shorter than the stems, very smooth throughout, strongly close-nerved, 2–3.5 mm. wide, narrowly tapering to an acute, hard-pointed apex, their bases broadened and equitant; stems 2–4.5 mm. wide, stiff and straight, narrowly firm-margined and very smooth; node only one, high up, bearing a stiff, erect bracteal leaf 4–10 cm. long, subtending 2–3 longer approximate peduncles; peduncles slender, erect, straight or slightly curved, unequal, 4–12 cm. long; spathes erect or slightly bent, 18–23 mm. long, 2–3 mm. wide; bracts closely approximate, firmly close-nerved, the inner one usually slightly surpassing the outer, its tip white-scarious, obtuse, or even truncate or emarginate and apiculate, sometimes erose-denticulate; outer bract hyaline-margined nearly to the short-pointed apex, broadly so below, united-clasping for 5–7 mm.; inner scales crowded, silvery white, about equaling the bracts in length; flowers numerous, finally 12–18, on slightly exserted puberulent pedicels; perianth-segments violet-blue, 12–14 mm. long, contracted to a mucronate apex; stamineal column about 5.5 mm. high; ovary densely glandular-puberulent; pedicels fascicled, stiff and erect, or somewhat diverging above, the weaker ones sometimes spirally flexuous; capsules light-colored, thick-walled, 3–6 mm. high, oblong-ovoid to broadly ovoid, often truncately contracted above and below, more or less distinctly moulded over the seeds; seeds rather few, 2–4 in a row on slender stipels from central placentae, mostly globose and 1.5 mm. in diameter, black, rugulose, reticulate, not umbilicate.

Furnace creek cañon, Funeral Mountains, January 27, 1891, *Frederick V. Coville & Frederick Funston*, Death Valley Expedition of the U. S. Department of Agriculture, *no. 225*.

A striking species, tall and stiff and very pale in color, with appressed peduncles, rather large flowers and greatly developed root-system. The persistence from one flowering season to another of the dried and rigidly erect leaves and stems is a noteworthy characteristic of the plant. It would appear from the single collection of the species so far made that the seeds of one season were carried over to the succeeding one to be released when the plant came again into flower.

SISYRINCHIUM BELLUM S. Watson, Proc. Am. Acad. **12**: 277. 1877.

Remarkably variable in size and relative proportions; from 6 cm. to over 6 dm. high, mostly 2.5–4 dm., green to glaucescent, subject to slight or to pronounced discoloration on the herbarium sheet, the tufts often fibrillose at base, the roots either slender or somewhat thickened, frequently from an ascending or horizontal, sometimes compound, woody rootstock. Leaves soft and rather thin, or becoming firm, finely many-nerved, sometimes equaling the plant in height but usually shorter, mostly 2–4 mm. wide (1–6 mm.), acute or aculeate, the edges smooth or denticulate; stems erect, stout or slender, 1–4 mm. wide, narrowly firm-margined to narrowly winged, the edges smooth or denticulate; sides of leaves, bracts and stems rarely obscurely roughened with harsh points; primary node supporting from 2–4 peduncles or one or two branches each with 1–2 peduncle-bearing nodes; primary stem-leaf conspicuous, the bracteal leaves usually much reduced; peduncles stout or very slender, straight or curved, divergent or erect, sometimes very short but becoming 18 cm. long; spathes very variable, linear, lanceolate, or short oblong, 1.5–6 mm. wide when pressed, the bracts green or purplish, very acute to obtuse, straight to strongly incurved, subequal or very unequal, when subequal 1.5–3 cm. long, when very unequal foliaceous and reaching a length of 3.5 cm. for the inner and 5.5 cm. for the outer bract; bracts finely many-nerved, the edges often conspicuously white or purplish margined, the outer one united-clasping below for from ¼ to ½ its length; inner scales mostly brownish tinged, sometimes equaling the bracts, but usually much shorter; flowers on slightly or slenderly exserted erect or diverging pedicels, varying in color from blue and violet to lilac, in light and dark shades, in one specimen pure white; segments sharply emarginate or contracted to the mucronate or aristulate apex, 12–20 mm. long; column 5–7 mm. high; ovary glandular-puberulent to glabrous; capsules dark or pale brown, depressed-globose to obovoid or pyriform, in some forms strongly trilobulate, 2–7 mm. long; seeds 1 or 2 to 5–6 in each row, about 1.5 mm. in diameter, dark, pitted, subglobose.

Apparently common in all the coastwise counties from San Diego to Mendocino, extending from the immediate coast back into the mountains, but no evidence has developed of its occurrence in any of the inland counties.

In the southern part of the state the species begins to flower in February and March, and sometimes even in March in the neighborhood of San Francisco. At its northern limit flowering begins in May and June, continuing into July and August.

San Diego County: San Diego, 1850, *C. C. Parry;* May, 1852, *Geo. Thurber;* April, 1866, *Weed;* 1882, *C. G. Pringle;* 1884, *C. R. Orcutt;* 1885, *E. L. Greene;* February 19, 1891, *Alice Eastwood;* Delmar, April 16, 1895, *Belle S. Angier;* Fall Brook, March 17, 1882, *Marcus E. Jones.*

Los Angeles County: Los Angeles, April, 1888, *Dr. H. E. Hasse;* March 14, 1890, *Fritchley;* San Gabriel, March 23, 1854, *Dr. J. M. Bigelow.*

Santa Barbara County: Santa Barbara, 1874, *Miss S. P. Monks.*

Monterey County: Santa Lucia Mountains, August, 1885, *T. S. Brandegee;* April, 1898, and May 20, 1897, *R. A. Plaskett.*

Santa Cruz County: *Horace Davis.*

San Mateo County: Purisima, April, 1898, Blenheim, May 19, 1901, *Alice Eastwood.*

Alameda County: Salinas Plains, March, 1866, *A. Wood;* Berkeley, 1882, 1886, *E. L. Greene;* 1892, *Michener & Bioletti;* Point Isabel, June, 1900, *Alice Eastwood.*

San Francisco County: near San Francisco, *Dr. A. Kellogg,* 1866; March, 1892, *Michener & Bioletti;* May, 1894, *Alice Eastwood.*

Marin County: April, 1895, *Alice Eastwood.*

Solano County: 1866, *A. Wood;* Bernicia, *Rev. J. P. Moore.*

Sonoma County: *E. Samuels;* Bodega Point, July 4, 1900, Hood Mountain, April 27, 1893, Altruria, April 7, 1900, *Alice Eastwood.*

Mendocino County: Long Valley, 1871; May, 1898, June, 1898, *H. E. Brown;* Red Mountain, Strong Mountain, May 21–28, 1902, Fort Bragg, August 9, 1902, *Alice Eastwood.*

Although no specific type of *Sisyrinchium bellum* is cited by Dr. Watson, a number of sheets labeled by his hand are preserved in the Gray Herbarium. Among these are excellent examples of the stout and large-flowered coastwise plant which Dr. Watson's description furthur unmistakably defines. There need be no doubt, therefore, as to the right application of the name *Sisyrinchium bellum,* notwithstanding the existence of several sheets so labelled by Dr. Watson, which, as it now appears, really represent other species.

Even as here delimited, however, *S. bellum* is still quite certainly an aggregate, and certain further lines of subdivision not yet clearly shown may confidently be expected to reveal themselves to careful field observation and the study of ample material.

In the more southern coastwise counties of the state occurs a form commonly more tufted, smaller and more branched than the type, often more fibrillose about the base and usually turning much darker on the herbarium sheet; other comparative differences appear in very slender erect peduncles, smaller spathes with subequal often sharply apiculate or aculeate bracts, smaller flowers and small, dark, trilobulate capsules only 2–4 mm. high.

In marked contrast with this is another form apparently confined also to the southern coastwise counties which discolors less when dry and is tall and stout, with rather short, curved peduncles, short, oval spathes with mostly equal, often obtuse bracts, and apparently larger flowers with broader less slenderly aristulate segments.

Similar to the type, but usually lower and less branched and with shorter peduncles, is a form apparently best developed somewhat northward in the range of the species which is noteworthy for its conspicuously foliaceous and often greatly elongated unequal bracts; in this plant the ovary is sometimes, at least, quite glabrous.

Also from northward in the range of the species, especially from Mendocino County, come a few specimens very slender throughout having mostly two slender approximate peduncles, narrow, very acute bracts, much exserted pedicels, the flowers with narrow segments, and small, subglobose, few-seeded capsules.

Still further rather suggestive indications of other species are afforded by certain imperfect or fragmentary specimens of little use to discuss at the present time.

Sisyrinchium hesperium sp. nov.

Slender, erect or ascending in thin, somewhat open tufts sparsely fibrillose at base, 25–40 cm. high, dull green and glaucescent becoming brownish in drying, the slender roots numerous and densely clustered. Leaves thin and soft or becoming firm, half the height of the stem or less, 1–3 mm. or even 4 mm. wide, usually narrowed towards the base, tapering-acute, straight or slightly falcate, the edges smooth or obscurely denticulate-roughened; stems fragile, 1–2.5 mm. wide, merely margined, or with narrow finely nerved wings, the edges smooth or slightly denticulate; peduncles 1–3, erect or diverging, long and very slender, 5–14 cm. in length; spathes narrow, 15–25 mm. long or the outer bract longer; bracts membranous, narrow, often attenuate, delicately nerved, mostly cuspidate-acute and often narrowly aristulate, distinctly white-margined, the outer one united-clasping below for 5–10 mm., sometimes for half its length; inner scales narrow, attenuate, about three-quarters the length of the bracts; flowers on hair-like exserted pedicels, deep violet-purple, perianth about 10 mm. long; stamineal column about 5 mm. long; capsules often on flexuously spreading pedicels, brown, thin-walled, obovoid-pyriform to subglobose, 3–5 mm. high, slightly puberulent; seeds only 2–4 in each row, large, becoming 1.5 mm. or more in diameter, rugulose.

Near the boundary between Santa Barbara and San Luis Obispo Counties, Dutard's Ranch, May 9, 1896 (type).

Fresno County: Wauthan, May 11, 1893.

Monterey County: Melpitas Ranch, Santa Lucia Mountains, May 1–12, 1899.

All in flower and early fruit and collected by *Miss Alice Eastwood.* In Herb. Cal. Acad. Sci.

A much more slender and delicate species than *S. bellum*, often very fragile, with long, very slender peduncles, smaller, more delicate flowers on hairlike, mostly flexuously exserted pedicels, and smaller, thinner-walled capsules.

Notes on Micrasterias from southeastern Massachusetts

JOSEPH A. CUSHMAN

During the spring and summer of 1903 a number of collections of desmid material were made in various localities of southeastern Massachusetts by the writer. Some of these were exceedingly rich in desmids. As no results of examinations of the desmid flora of this part of the state have ever been published except in a previous short paper by the writer (Desmids of Bridgewater, Mass. Rhodora, **5**: 79–81. Mr 1903) a comparison of the forms found in this area with those reported from other parts of New England may be instructive. The nomenclature as previously used in connection with New England species in many cases needs correcting. As many of the forms found are apparently new, they may best be presented by single genera or groups of genera to allow more ease in working them up. The New England desmid flora is as yet hardly touched upon, and what may be expected in the line of new forms may be seen by a single paper of Lagerheim's on a collection from Tewksbury, Mass., where many new species and varieties were described.

As one would expect from the characters of the genus taken up in the present paper—*Micrasterias*—it has been better worked up than many of the others. The species are of large size and usually very distinct — at least in those found in New England. One thing was apparent in looking over the data obtained — this genus appears to be almost wholly confined to ponds and lakes. Naturally, some are found in the streams, but, as far as can be noted from New England data, not of many species in a locality nor of many individuals. In the case of ponds and lakes the opposite is usually true: there are many species present and usually an abundance of specimens. Of twenty-five collections representing eleven localities, but four had *Micrasterias* represented by more than one species in any abundance. These were all from ponds or lakes. Mr. G. E. Stone, in his list of the desmids of Lake Quinsigamond, near Worcester, Mass., gives twenty-three species and varieties, considerably more than half of those reported from the whole of New England. The following species were found in the collections made in 1903.

MICRASTERIAS RADIOSA Ag.

A typical form of this species was common in Carver's Pond, Bridgewater, but was not noted in any other of the collections. An average specimen measures long. 186 μ, lat. 207 μ, lat. isth. 22 μ, lat. lob. pol. 34 μ.

M. RADIOSA **Wollei** var. nov.

Found at Chilmark, Martha's Vineyard. This variety is that figured by Wolle (Desmids of the U. S. ed. 2. 1892) on *plate 35, figure 3*. It is not as wide as the typical form and is much smaller, with a row of minute granules bordering the edge of the sinuses, not quite as open as the specimen figured by Wolle. In some respects this variety tends toward *M. papillifera*. An average specimen measures long. 152 μ, lat. 146 μ, lat. lob. pol. 28 μ.

M. DENTICULATA Bréb.

Found both in Carver's Pond, Bridgewater, and at Lake Watuppa, Fall River. An average specimen measures long. 234 μ, lat. 195 μ, lat. lob. pol. 72 μ, lat. isth. 25 μ.

M. APICULATA FIMBRIATA (Ralfs) Nordst.

The form described by Ralfs in 1848 as *M. fimbriata* is considered by Nordstedt as a subspecies of *apiculata* published by Ehrenberg several years earlier. Nordstedt includes under this subspecies the forms called by Wolle var. *apiculata*, var. *elephanta*, and var. *nuda* as well as *M. simplex* Wolle of the first edition, 1884, which Wolle called *M. fimbriata* var. *simplex* in the second edition, 1892.

This form was found both in Carver's Pond and Lake Watuppa. Two specimens from the first locality were measured, the first, long. 186 μ, lat. 180 μ, lat. isth. 38 μ, lat. lob. pol. 40 μ; the second, long, 229 μ, lat. 205 μ, lat. lob. pol. 50 μ.

M. FURCATA Ag.

Found both in Carver's Pond and in Lake Watuppa. A specimen from the latter locality measures long. 180 μ, lat. 160 μ, lat. isth. 30 μ, lat. lob. pol. s. proc. 22 μ. The variability of this species is very great, but according to W. and G. S. West this variability is limited to American specimens.

M. AMERICANA (Ehrb.) Ralfs.

The typical form was obtained from a pond at Plainville and also from Carver's Pond, Bridgewater. An average specimen from Plainville measured long. 155 μ, lat. 130 μ, lat. lob. pol. c. proc. 54 μ, lat. isth. 28 μ. One from Bridgewater, long. 158 μ, lat. 133 μ, lat. isth. 22 μ, lat. lob. pol. c. proc. 50 μ.

M. AMERICANA RECTA Wolle.

This variety was noted from Carver's Pond, Bridgewater, but measurements were not obtained.

M. AMERICANA **spinulifera** var. nov.

End lobe short and in general appearance much like var. *Ralfsii* Maskell. Not as spinose as var. *spinosa* Turner and without the "spinose coronet" of that form. Considerably smaller than the typical form and slightly smaller than the var. *spinosa*. Ends of the lobes spinose, also two subcentral spines at the basal margins. Long. 120 μ, lat. 108 μ, lat. isth. 25 μ, lat. lob. pol. c. proc. 57 μ, lat. lob. pol. s. proc. 33 μ. From Stub Pond, three miles northeast of Fall River R. R. Station.

M. LATICEPS forma MAJOR Nordst.

Found both in Carver's Pond and in Lake Watuppa. A specimen from the latter measured long. 150 μ, lat. 165 μ, lat. isth. 37 μ.

M. MAHABULESHWARENSIS COMPACTA, a. AMERICANA Nordst.

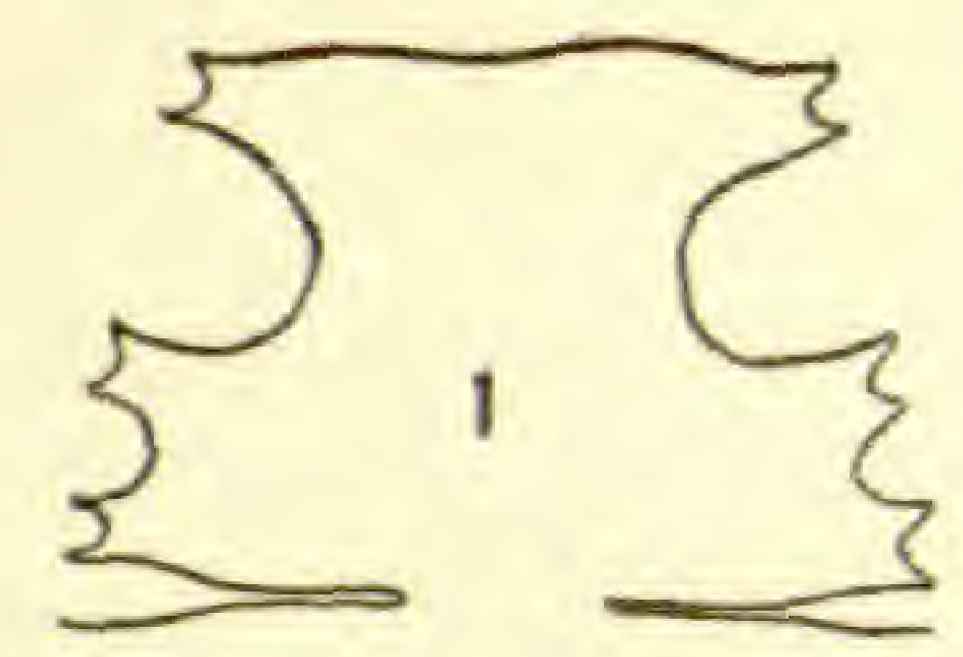
Noted from Carver's Pond, Bridgewater in the previous list.

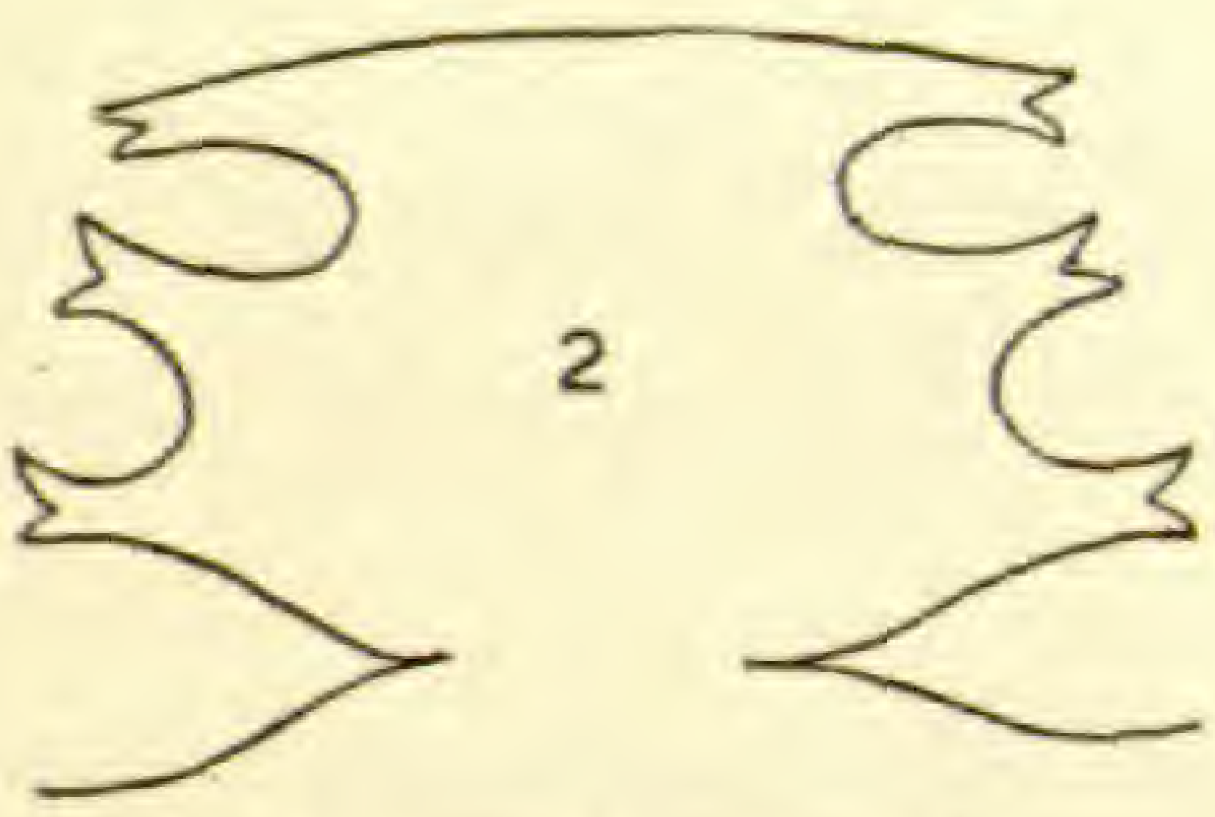
M. TRUNCATA (Corda) Bréb.

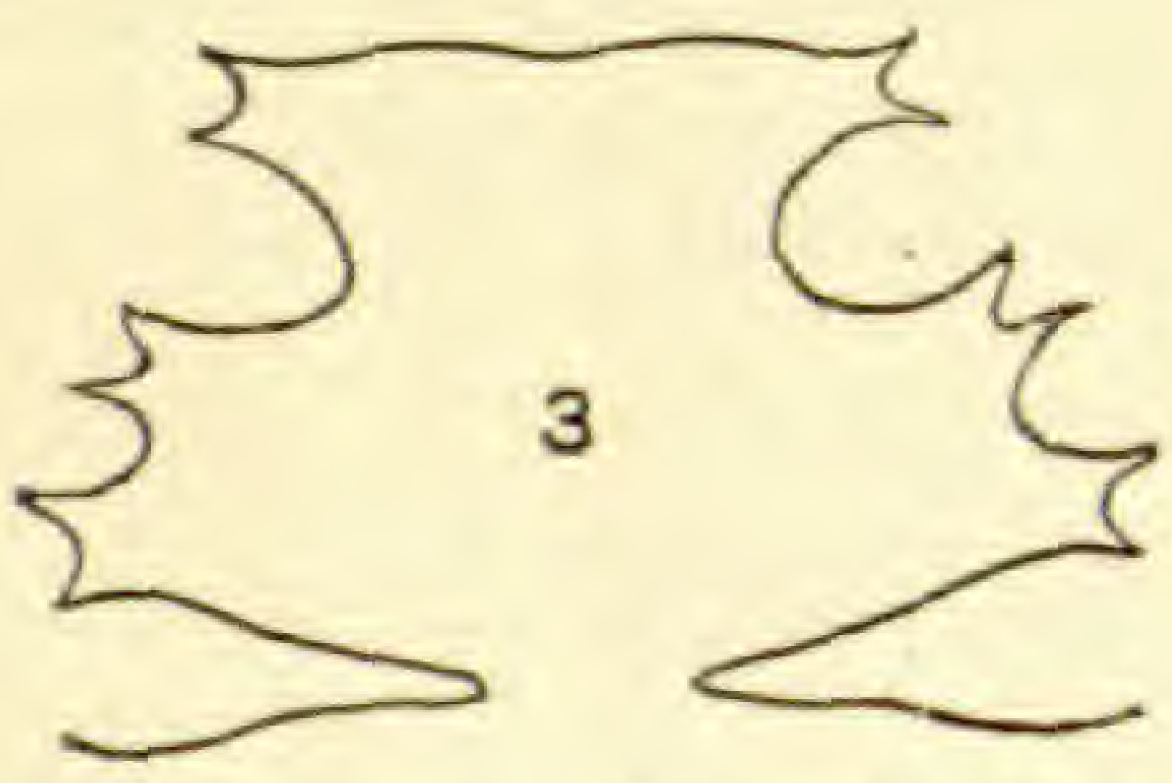
The typical form was found in a pond at Chilmark, Martha's Vineyard and in Lake Watuppa. A specimen from the former locality measured long. 113 μ, lat. 110 μ, lat. lob. pol. 81 μ. A Watuppa specimen, long. 100 μ, lat. 93 μ, lat. lob. pol. 55 μ, lat. isth. 19 μ. Although this species is supposed to be very common it was found in but these two localities.

M. DEPAUPERATA Nordst.

The typical species, FIGURE 1, was described by Nordstedt from Brazil, the measurements of the original, as given by the author, being long. 84–96 μ, lat. 64–78 μ, lat. lob. pol. 48–59 μ, crass. 23 μ.







As noted by Lagerheim, *M. Kitchelii* Wolle is a form of this species. There seem to be two distinct American forms besides the typical form of Nordstedt. They may be separated as follows:

M. DEPAUPERATA KITCHELII Wolle. FIGURE 2.

This name, as suggested by W. and G. S. West, should be retained for the form figured by Wolle (Desm. U. S. *pl. 37, f. 1, 2.* 1884), with the shorter and considerably wider polar lobe. It is much larger than the previous form.

M. DEPAUPERATA **Wollei** var. nov. FIGURE 3.

This name is proposed for the variety figured by Wolle as *M. Kitchelii* var. (Desm. U. S. ed. 2. *pl. 42. f. 2.* 1892) and by W. and G. S. West as *M. depauperata* Nordst. (Trans. Linn. Soc. Lond. II. Bot. **5**: *pl. 14. f. 1*). This is nearer the typical form but is one-half larger, the sinus more open, the apical lobe shorter and the upper portion of the basal lobes considerably narrower than the lower. A typical specimen measures long. 150 μ, lat. 140 μ, lat. lob. pol. 96 μ, lat. isth. 26 μ. Very common in Lake Watuppa.

M. MURICATA (Bailey) Ralfs.

This species was found in but one locality, Carver's Pond, Bridgewater. An average specimen measured long. 161 μ, lat. 127 μ, lat. isth. 31 μ, lat. lob. pol. 78 μ. In the Trans. Linn. Soc. Lond. II. Bot. **5**: 240, *pl. 14, f. 7*, W. and G. S. West give the varietal name *tumida* to a form which "differs from the typical form in having a central protuberance near the base of each semicell." Which should be considered the typical form is somewhat doubtful. In Bailey's original figures a side view and an oblique view are given. In looking over his original drawings and notes several end views were found. Three out of four of these had the basal protuberance, in two cases even more marked than in the figure given by W. and G. S. West. It was a custom of Bailey's to mark the drawing he considered as typical to distinguish it from the rest. This he did by writing the word "standard" close to the particular drawing. In this case it is found with a specimen of the basal view with very decided prominences. It would therefore seem that the original specimens possessed by Bailey and from which he wrote his description were of the form called above var. *tumida* by W. and G. S. West. As this character is very variable in any lot of specimens and as the typical specimens seem to have had this character the value of the varietal name *tumida* is somewhat in doubt.

BOSTON SOCIETY OF NATURAL HISTORY.

Studies on the Rocky Mountain flora — XI.

Per Axel Rydberg

Juncus balticus vallicola var. nov.

Stem from a horizontal rootstock, rather stout, 6–8 dm. high, terete, 2–4 mm. in diameter; sheaths at the base short, dark brown, bladeless; bract 1–2 dm. long; bractlets broadly ovate, scarious, brown, abruptly acuminate; inflorescence open; its branches 4–8 cm. long; sepals narrowly lanceolate, slightly if at all scarious on the margin, attenuate at the apex, about 6 mm. long; petals much broader and shorter with broad scarious margin, about 5 mm. long; anthers about 4 times as long as the filaments; capsules short ovoid, obtusish and mucronate, shorter than the petals.

This variety has the open inflorescence and general habit of var. *litoralis* but the fruit of var. *montanus*. It differs from both, however, in the long-attenuate sepals. It grows in wet ground, both in alkaline and sandy or gravelly soil in the valleys of the Rocky Mountain region.

Wyoming: Point of Rocks, 1901, *E. D. Merrill & E. N. Wilcox, 664* (type)*; Big Sandy River, *730;* Steamboat Mountain, 1900, *Aven Nelson, 7075.*

Colorado: Mancos, 1898, *Baker, Earle & Tracy, 438.*

Utah: Antilope Island, *Stansbury.*

Juncus truncatus sp. nov.

J. alpinus insignis Coult. Man. 358 (in part as to the Colorado specimens). 1885.

Stems slender, 3–5 dm. high, terete or slightly flattened; leaves 1–3 dm. long, slightly flattened laterally or nearly terete, 1–2 mm. in diameter, septate; sheaths with scarious margins which end in rounded auricles, which are 1–1.5 mm. wide; bract 1–3 cm. long, lanceolate or subulate, brown with green back; inflorescence open, 2–5 cm. long, irregularly cymose with 4–10 heads; bractlets ovate, brown, acuminate-cuspidate; heads 6–9 mm. in diameter, 5–10-flowered; petals and sepals lanceolate, dark brown, about 3 mm. long, acuminate, longer than the capsule which at maturity is truncate or slightly emarginate at the apex: seeds not caudate.

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*Unless otherwise stated the types are preserved in the herbarium of the New York Botanical Garden.

This species is most nearly related to *J. nevadensis*, *J. Mertensianus* and *J. Richardsonianus*, with which three it has been confused. It differs from the first in the truncate capsule, from the second in the paniculate inflorescence and not caudate seeds, and from the last in the dark acuminate petals and sepals and the short capsule. It grows in wet meadows at an altitude of 1800–2700 m.

COLORADO: Meadow Height, 1898, *Shear & Bessey, 4323* (type); Elk River, Routt County, 1894, *C. S. Crandall.*

WYOMING: Copperton, 1901, *F. Tweedy, 4335;* North Fork of Clear Creek, Big Horn Mountains, 1898, *T. A. Williams;* Grand Encampment Creek, 1897, *Aven Nelson, 3981.*

Juncus brunnescens sp. nov.

Juncus xiphioides montanus Engelm. Trans. Acad. Sci. St. Louis, **2**: 481 (in part). 1868.

Stem 4–6 dm. high, flattened laterally and more or less winged; leaves 1–2.5 dm. long, 2–5 mm. wide, equitant, laterally flattened, long-attenuate, septate; sheaths with scarious margins, abruptly contracted above, but scarcely auricled; bract linear-lanceolate, 2–5 cm. long, green; panicle open, 5–10 cm. long, with from 10–60 small heads; bractlets ovate-lanceolate or ovate, abruptly acuminate, scarious and light brown; heads 5–12-flowered; petals and sepals subequal, lanceolate, acuminate, about 3 mm. long, light brown with green midrib; stamens usually 6, sometimes 4 or 5; style about equaling the petals; capsule lance-ovoid acute.

This was included in *J. xiphioides montanus* by Engelmann, but the first specimen cited by him belongs to a distinct plant with few, large, dark brown heads. This has received the name *J. saximontanus* by Aven Nelson. Besides the character mentioned, the scarious margins of the leaf-sheaths in the latter nearly always end in small auricles, a character by which it differs from all the species of the group. *J. brunnescens* grows in wet places in the mountains of Colorado, New Mexico and Arizona, while *J. saximontanus* ranges from Alberta and British Columbia to Colorado and California.

COLORADO: Pagosa Springs, 1899, *C. F. Baker, 245* (type).

NEW MEXICO: Bear Mountain and Mangus Springs, *Rusby, 417 C, 417 D* and *417 F.*

ARIZONA: Flagstaff, 1898, *MacDougal, 304;* San Pedro Valley, *J. W. Toumey, 6;* Fort Verde, *E. A. Mearns;* San Francisco Mountains and Clifton, *Rusby, 417 A* and *417 E.*

Juncus parous sp. nov.

Stem 3–6 dm. high, laterally flattened and distinctly winged; leaves equitant, laterally flattened, septate, 2–3 dm. long, 3–5 mm. wide; sheaths with scarious margins that taper upwards and without any indication of an auricle; bracts 1–2 cm. long, green with more or less scarious margins; heads few, 1–8, often clustered, 15–20-flowered; bractlets lanceolate, light brown; petals and sepals lanceolate, sharply acuminate, subequal, light brown or greenish on the back; stamens usually 6; style shorter than the petals; capsule oblong, acute, shorter than the petals; seeds apiculate.

This is still more closely related to *J. saximontanus* than the former, but is easily distinguished by the light-colored heads and the total lack of auricles. It grows in mountain meadows of Colorado and New Mexico.

COLORADO: Fort Garland, 1896, *C. L. Shear, 3666* (type) and *3668;* North Cheyenne Cañon, 1896, and Pike's Peak, 1895, *E. A. Bessey.*

NEW MEXICO: Organ Mountains, 1897, *E. O. Wooton, 615.*

Juncoides subcapitatum sp. nov.

Stem 3–4 dm. high, glabrous; leaf-blades lanceolate, acuminate, glabrous, 4–10 cm. long, 5–10 mm. wide; bracts 2.5–3 cm. long, lanceolate, foliaceous; inflorescence compact, consisting of 6–10 heads, conglomerate and forming an irregular head; bractlets ovate, those subtending the individual flowers about half as long as the sepals; these and the petals subequal, 1.5–2 mm. long, ovate, acuminate, dark brown but lighter on the midrib; capsule broadly obovoid, obtuse, shorter than the petals; seeds about 1 mm. long, ellipsoid, obtuse, dark brown, minutely punctate.

Notwithstanding the capitate inflorescence, the large foliaceous bracts, and the shorter capsule, it is most closely related to *J. parviflorum,* which it resembles in leaves and flowers. The type grew near timber-line on a mountain above Silver Plume.

COLORADO: Silver Plume, 1895, *C. L. Shear, 4611.*

Allium macropetalum sp. nov.

Bulb obovoid, about 4 cm. long and 2 cm. thick, coated with long loose fibers; leaves about 2 cm. long, almost equaling the scapes, 2–4 mm. wide; sheaths very broad, loose and scarious; scapes a little over 2 dm. high, stout, 3–4 mm. thick, often 2 or 3 from the same set of sheaths: umbel many-flowered; bracts usually 3, ovate-lanceolate, acuminate, about 2 cm. long, veined with purple; pedicels stout, about 2 cm. long; the outer in fruit spreading or reflexed; petals and sepals lanceolate, long-attenuate, fully 1 cm. long, white, scarious, with a prominent purple midvein; capsule 5–6 mm. long, with 6 conspicuous oblong crests which are over 1.5 mm. high.

This species is perhaps most nearly related to *A. Geyeri*, but stouter, usually with 2 or 3 scapes, loose sheaths, longer and more attenuate petals and sepals, larger conspicuous crests, and longer bulb with very fibrous coat.

COLORADO: May 14, 1898, *C. S. Crandall.*

Allium Pikeanum sp. nov.

Bulb obliquely ovoid, about 1.5 cm. long and 8–10 cm. thick; coat membranous except the outer layer, which is fibrous-reticulated; scape 8–15 cm. long, almost equaled by the narrowly linear leaves: bracts usually 3, lanceolate, 8–10 mm. long and very soon reflexed; umbels with 10–15 flowers, but no bulblets; pedicels about 1 cm. long; petals and sepals subequal, ovate, acuminate, red-purple; filaments subulate, dilated below, about three-fourths as long as the petals; capsule slightly crested above.

This is most nearly related to *A. reticulatum* and *A. Geyeri*, but distinguished by the small reflexed bracts, the dark flowers and the small bulb with only the outermost layers of the coat fibrous. It grows in the higher mountains of the Pike's Peak region at an altitude of 3,000–3,800 m., while the other species mentioned belong to the plains.

COLORADO: Halfway House, 1896, *C. L. Shear, 3721* (type); South of Pike's Peak and Bald Mountain, 1895 and 1896, *E. A. Bessey;* Peak Valley, 1901, *Clements, 426.*

Corallorrhiza ochroleuca sp. nov.

Whole plant light yellow; stem 2–4 dm. high, not bulbous-thickened at the base; sheaths loose and rounded and mucronate at the apex; raceme 10–15-flowered; flowers 15–20 mm. long, light yellow, unspotted; petals and sepals 7–8 mm. long, oblong-lanceolate, acute, with prominent midvein; lip ovate, sinuate but neither lobed nor toothed; spur small and adnate to the ovary.

In general habit, this resembles a large *C. multiflora*, but differs in the yellow color of the plant, the unspotted flowers and the entire lip. It grows at an altitude of 1400–2500 m.

NEBRASKA: War Bonnet Cañon, 1890, *T. A. Williams, 48* (type).

COLORADO: Echo Cañon, near La Veta, 1900, *F. K. Vreeland, 649.*

Salix pachnophora sp. nov.

A shrub 2–3 m. high or perhaps sometimes higher: stems yellowish; branches dark bluish with a bloom; leaves oblong-lanceolate or oblanceolate, 3–5 cm. long, or on vigorous shoots 1 dm. long, acute at both ends, densely white-silky beneath, glabrous or when young slightly silky above, rather thin, with prominent veins beneath; pistillate aments subsessile, 1–3 cm. long; bracts almost black, ovate or oblong, acutish or obtuse; pistils subsessile; ovary grayish-silky, ovoid, 3–5 mm. long; styles slender, about 1.5 mm. long; stigmas slender, deeply 2-cleft; staminate aments about 1.5 mm. long, subsessile; bracts similar; stamens 2, filaments glabrous, distinct.

This species is evidently most nearly related to *S. bella* and *S. subcoerula*, differing from the former in the smaller aments and capsules and the presence of bloom on the branches and from the latter by the sessile and naked aments. It grows in the mountains at an altitude of 2,300 to 2,500 m.

COLORADO: Chambers lake, 1899, *Agricultural College of Colorado* coll. (type); Rico, Dolores Co., 1899, *Geo. E. Osterhout, 2505;* along Uncompahgre River near Ouray, 1901, *Underwood & Selby, 256.*

NEW MEXICO: Beulah, 1901 & 1902, *T. D. A. Cockerell.*

Atriplex oblanceolata sp. nov.

Suffruticose dioecious perennial with decumbent base and ascending branches, about 2 dm. high; leaves oblanceolate or spatulate, 2–3 cm. long, obtuse or acutish, densely white-scurfy on both sides, entire, short petioled, or sometimes nearly sessile; pistillate flowers in small axillary clusters; fruiting bracts ovate in outline, slightly dentate, tubercled or irregularly crested on the back; staminate flowers brown in small terminal panicles.

This species is most nearly related to *A. Nuttallii* and *A. eremicola.* From the former it differs in the decumbent low habit, the more distinctly petioled leaves and the brown panicled staminate flowers (in *A. Nuttallii* they are yellow and arranged in interrupted spikes). It is more like *A. eremicola,* from which it scarcely differs except in the tubercled or appendaged bracts, which are broadest below instead of above the middle.

COLORADO: Delta, Sept. 3, 1897, *J. H. Cowen* (Agric. Coll. Colo., *no. 4071*) (type), Hotchkiss and Smiths Fork (*no. 4070*).

WYOMING: Gardiner River, 1899, *Aven & Elias Nelson, 5995*; Hams Fork, 1900, *C. C. Curtis*; Fort Steele, 1901, *Tweedy, 4501*.

Atriplex odontoptera sp. nov.

A shrubby dioecious perennial: stems with shining white more or less flaky bark; leaves narrowly oblanceolate, acute or obtusish, 2–4 cm. long, entire, white-scurfy on both sides; pistillate flowers axillary; fruiting bracts united to near the apex; united portion with 4 laciniate dentate wings, 3–4 mm. broad, reticulate and ribbed; free portion subulate, scarcely as long as the width of the wing; staminate plant unknown.

This species is most nearly related to *A. canescens*, differing mainly in the laciniate-toothed wings. It grows on plains at an altitude of 1,000–1,600 m.

WYOMING: Buffalo, 1900, *F. Tweedy, 3302* (type); four miles below U. L. Ranch, 1896, *Knowlton, 160*; Steamboat Lake, 1900, *Osterhout, 2330*, in part.

Coriospermum emarginatum sp. nov.

Annual, perfectly glabrous or with a few hairs on the bracts, branched near the base, 3–4 dm. high: leaves narrowly linear, 2–4 cm. long, 1–2 mm. wide, cuspidate-pointed; bracts except the lowest ovate, 5–7 mm. long, acuminate, scarious-margined, much broader than the fruit; fruit plano-convex, 2.5–3 mm. long and about 2 mm. wide, almost without a trace of a wing-margin.

In habit this species resembles mostly *C. marginale*, but differs in the lack of the wing-margins of the fruit characteristic of that species. In this respect it more resembles *C. villosum*, but is a much more slender plant and glabrous.

WYOMING: Laramie, 1897, *A. Nelson, 4282* (type).

COLORADO: A specimen in the Torrey herbarium without any other data.

Claytonia rosea sp. nov.

Scape about 1 dm. high, slender, from a small corm 10–15 mm. in diameter; basal leaves rare, long-petioled; blade 1–2 cm. long, spatulate; stem-leaves linear or narrowly linear-lanceolate, sessile, 2–5 cm. long, 1-ribbed or faintly 3-ribbed, acute, rather fleshy;

sepals rounded ovate, rounded at the apex, about 5 mm. long, half as long as the pink obovate petals; inflorescence 5–10-flowered, short, little exceeding the leaves, bractlets lanceolate; capsule shorter than the sepals; seeds about 2 mm. long, black and very glossy.

The few specimens of this species that are found in our herbaria bear a variety of names, as *C. caroliniana*, *C. caroliniana lanceolata*, *C. caroliniana sessilifolia* and *C. lanceolata sessilifolia*. The original *C. lanceolata* Pursh is a much larger plant with broad, strongly 3-ribbed stem-leaves, elongated inflorescence and large flowers, the sepals being about 6 mm. long. The type of *C. caroliniana sessilifolia* Torr., is a plant somewhat resembling the present species, but with somewhat broader leaves abruptly contracted at the sessile base and with acutish sepals. Neither in the herbarium of the New York Botanical Garden nor in that of Columbia University is found any other specimen matching the original collected by Bigelow. Most species of *Claytonia* are found near water or in damp places. The type of *C. rosea* was collected on rather dry hills, at an altitude of 2200–2300 m.

COLORADO: La Veta, 1900, *Rydberg & Vreeland, 6300* (type); "Colorado," *G. C. Woolson;* 1875, *W. A. Henry;* Graham's Peak, 1899, *C. F. Baker, 305*.

WYOMING: Pole Creek, 1894, *Aven Nelson, 27*.

Cerastium pulchellum sp. nov.

Low decumbent perennial with horizontal cespitose rootstock: stems 5–10 cm. long, finely viscid pubescent; leaves oblong to oval, obtuse or rarely acutish, about 1 cm. long and 4 mm. wide, subsessile and slightly connate at the base, viscid pubescent on both sides; peduncles 1–1.5 cm. long; inner sepals oblong; outer oval, scarious-margined both on the side and at the rounded apex, about 4 mm. long; petals obcordate, 10–12 mm. long.

This species is nearest related to *C. Earlei* and *C. behringianum*. From the former it differs in the low habit, the very obtuse scarious-tipped sepals and the short blunt leaves; from the latter in the large petals and the scarious-tipped sepals. It grows in the mountains at an altitude of about 3900 m.

COLORADO: Hayden Peak, 1898, *Baker, Earle & Tracy, 573*.

Arenaria polycaulos sp. nov.

Arenaria saxosa Coult. Man. 35, 1885, and Gray, Syn. Fl. **1**^{1}: 240, in part; not A. Gray, Pl. Wright. **2**: 18.

Perennial with a long tap-root, giving rise to numerous prostrate or spreading stems about 1 dm. long, slender, finely scabrous puberulent; leaves ovate or ovate lanceolate, spreading, about 5 mm. long, finely puberulent; pedicels 5–10 mm. long; sepals ovate-lanceolate, short-acuminate, scarious-margined, 3–4 mm. long; petals 5–6 mm. long, obovate, entire.

This plant has generally been known as *A. saxosa*, but the type collected by Wright differs considerably from it, being subligneous at the base, with short erect stems, lanceolate almost erect leaves and narrower sepals. *A. polycaulos* grows on dry hills at an altitude of 2600–3000 m.

COLORADO: Silverton, 1898 (type; collector not given, but specimens received from the Agricultural College of Colorado); 1895, *Tweedy, 173;* Mt. Harvard, 1896, *F. E. Clements, 54;* Gray Back Mining Camps, 1900, *Rydberg & Vreeland, 6288;* La Plata P. O., 1898, *Baker, Earle & Tracy, 444;* Dark Cañon, 1901, *Clements, 115;* Breckenridge, 1896, *Shear, 4558* and *4545*.

ARIZONA: Mt. Humphrey, 1883, *Rusby, 531;* 1897, *R. E. Kunzé;* San Francisco Mts., 1892, *Toumey, 487*.

Arenaria Tweedyi sp. nov.

Perennial, densely cespitose with somewhat ligneous base; leaves fleshy, linear-filiform, 2–3 cm. long, less than 1 mm. wide, somewhat curved; stem usually less than 1 dm. high, glandular puberulent especially on the inflorescence; this an open cyme; bracts lanceolate, scarious-margined; pedicels about 1 cm. long; sepals lanceolate, acute, about 5 mm. long, scarious-margined and decidedly glandular puberulent; petals about 8 mm. long.

This is most nearly related to *A. uintahensis* A. Nelson, differing in the fleshy not pungent leaves and the more glandular puberulent inflorescence. It grows in the mountains at an altitude of about 3600 m.

COLORADO: La Plata Mountains, 1896, *Frank Tweedy*.

Arenaria Eastwoodiae sp. nov.

Perennial with a cespitose base; stems about 2 dm. high, perfectly glabrous; leaves filiform, stiff, pungent, 1–2 cm. long, 0.5 mm. wide, minutely scabrous-ciliolate on the margin below, dilated and somewhat connate at the base; inflorescence elongated; bracts subulate to lanceolate, scarious-margined; pedicels erect, 1–2 cm. long, glabrous; sepals linear-lanceolate, about 6 mm. long, glabrous, long-attenuate, equalling or slightly exceeding the petals.

This is most nearly related to *A. Fendleri* but is more slender and glabrous. It grows on dry hills.

COLORADO: Grand Junction, 1892, *Alice Eastwood.*

Arenaria Fendleri Porteri var. nov.

Like the type but low, 1–2 dm. high, very glandular; leaves short; branches of the inflorescence short and ascending.

It is common on dry mountain ridges of Colorado. As type I take the following:

COLORADO: Gray's Peak, 1878, *M. E. Jones, 716* (type in herb. Columbia University).

Alsinopsis macrantha sp. nov.

Perennial, cespitose, diffusely branched and spreading, perfectly glabrous; branches 1 dm. long or less; leaves subulate-filiform, obtuse, 5–10 mm. long, 0.5 mm. wide, 1-nerved; pedicels 1 cm. or less long; sepals lanceolate, 4–5 mm. long, very acute, scarious-margined, strongly 3-nerved; petals oblong, 7–8 mm. long.

The type sheet is labelled *Arenaria verna* L., which it resembles much in habit, in the sepals and in the lack of pubescence, but it differs in the large petals and the 1-nerved leaves.

COLORADO: Little Kate Basin, La Plata Mts., 1898, *Baker, Earle & Tracy, 678.*

Silene Antirrhina vaccarifolia var. nov.

Stem-leaves broad, lanceolate, elliptic or oblanceolate; stem stouter than in *S. Antirrhina* proper; bracts more or less scarious-margined below; flowers and capsule larger.

In the Rocky Mountain region the typical *S. Antirrhina* is rather rare and evidently an introduced plant found in waste places and fields. It is there represented by two native forms, the present with broad leaves and large flowers and the next with narrow leaves and small flowers.

IDAHO: Lewiston, 1896, *A. A. & E. Gertrude Heller, 3153* (type in herb. Columbia University); Upper Ferry, Clearwater River, 1892, *Sandberg, MacDougal & Heller, 190.*

MONTANA: Big Horn River, 1891, *Tweedy*.

COLORADO: Foothills, Larimer County, 1895, *J. H. Cowen, 82;* near Golden, 1878, *M. E. Jones, 279;* Rist Cañon, 1897, *J. H. Cowen.*

Silene Antirrhina depauperata var. nov.

Like the species but more slender and few-flowered; calyx in fruit very short; petals none or small, not exceeding the calyx-lobes; blade cuneate, truncate or emarginate at the apex.

BRITISH COLUMBIA: Lower Arrow Lake, 1890, *J. M. Macoun* (type).

COLORADO: 1874, *G. C. Woolson.*

ARIZONA: Tucson, 1894, *J. W. Toumey.*

SOUTH DAKOTA: Lead City, 1892, *P. A. Rydberg, 557.*

WASHINGTON: W. Klickitat County, 1891, *W. N. Suksdorf.*

WYOMING: Hartville, 1892, *Aven Nelson, 493.*

NEBRASKA: Dismal River, 1893, *P. A. Rydberg, 1349.*

UTAH: City Creek Cañon, 1880, *M. E. Jones, 1839.*

Lychnis striata sp. nov.

Perennial with more or less cespitose base; stems 3–5 dm. high, finely puberulent and more or less viscid above; basal leaves and lower stem-leaves narrowly oblanceolate, 5–15 cm. long with a more or less distinct petiole; upper stem-leaves sessile and linear-lanceolate; inflorescence narrow with erect branches; calyx densely viscid puberulent, strongly 10-nerved, in fruit somewhat extended by the capsule, 10–12 mm. long and 5 mm. wide; its lobes oblong, obtuse, somewhat scarious-margined; petals exserted, about 15 mm. long; claw long, narrowly cuneate, fully equaling the calyx; blade short, two-cleft, with obtuse lobes.

This species is most nearly related to *L. Drummondii*, but differs in the exserted petals and the more strongly 10-nerved calyx. It grows at an altitude of 2000–3300 m.

COLORADO: Cameron Pass, 1896, *C. F. Baker* (type), also 1899; Silver Plume, 1895, *P. A. Rydberg.*

WYOMING: Battle, 1901, *Tweedy, 4535,* also Headwaters of Tongue River, 1898, *163*; Yellowstone Lake, 1899, *Aven & Elias Nelson, 6634.*

UTAH: Evanston, 1869, *S. Watson, 154.*

Atragene pseudo-alpina diversiloba var. nov.

A peculiar form with merely ternate leaves, the segments of which are more or less cleft or lobed, some rounded at the apex; staminodia conspicuous, spatulate or oblanceolate.

This may be a distinct species, but the material is too scant. The most striking character is the conspicuous staminodia, which in the species are narrowly linear or more often lacking.

COLORADO: Mountains near Denver, 1869, *B. H. Smith* (type herb. Columbia University).

Stanleya glauca sp. nov.

Tall, perfectly glabrous, 4–6 dm. high, bluish green; lower leaves 1–1.5 dm. long, more or less pinnatifid with linear-lanceolate or oblong lobes, the terminal usually much longer than the rest; upper leaves usually entire, linear-lanceolate; racemes 3–4 dm. long, sometimes branched below; sepals and petals lemon-yellow; the former oblong, about 1 cm. long, deciduous; petals of about the same length, long-clawed; claws more or less pubescent, about twice as long as the oblong blades; fruiting pedicels about 1 cm. long, more or less spreading; stipes about 1.5 cm., slender; pod proper about 5 cm. long and 1.5 mm. thick, somewhat arcuate, but neither tortuose nor torulose; seeds oblong, dark brown, minutely pitted.

This species is perhaps most nearly related to *S. integrifolia* James, which, however, differs in the following respects: the stem lower, leaves thicker and broader, oval or broadly oblanceolate; the lower, if lobed, with broad and short lobes; claws of the petals broader at the base, shorter, scarcely longer than the oblong spatulate blades. *S. glauca* grows on the dry hills and table lands at an altitude of 1,200–2,500 m.

COLORADO: Prairie, Entrance Soldier's Cañon to Sulphur Springs, 1895, *J. H. Cowen* (type); McElma Cañon, 1901, *F. K. Vreeland, 871;* plains near Fort Collins, 1896, *C. S. Crandall;* near Badita, 1900, *Rydberg & Vreeland, 6120;* Dixon Cañon, 1899, *W. F. M.;* Mancos, 1898, *Baker, Earle & Tracy, 412;* Pueblo, *10;* Garden of the Gods, 1894, *E. A. Bessey;* Pike's Peak, 1894, *T. F. Allen.*

Schoenocrambe decumbens sp. nov.

Stem slender, decumbent, 2–3 dm. long, as well as the whole plant perfectly glabrous, more or less branched; leaves narrowly linear, 2–6 cm. long, 1–3 mm. wide, 1-nerved, rather thick and more or less glaucous; raceme rather few-flowered, lax; pedicels 3–5 mm. long, ascending; sepals oblong, about 4 mm. long, light yellow; petals yellow, 6–7 mm. long, spatulate or oblanceolate, obtuse, gradually narrowed into a more or less distinct claw; pods 3–4 cm. long, about 0.75 mm. in diameter, usually more or less arcuate, beak (*i. e.*, portion above the end of the valves) about 1 mm. long.

This species is closely related to *S. linifolium*, but differs in the more slender and more branched decumbent stem, usually narrower leaves, smaller flowers, and more slender pods, which are more or less arcuate and with a more distinct beak. It grows on dry plains and hills.

MONTANA: Melrose, 1895, *P. A. Rydberg, 2671* (type); Sheridan, 1895, *L. A. Fitch.*

UTAH: Thistle Junction, 1900, *S. G. Stokes.*

COLORADO: Gypsum, 1894, *C. S. Crandall.*

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(1904)

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Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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The Polyporaceae of North America—VIII. Hapalopilus, Pycnoporus, and new monotypic genera

WILLIAM ALPHONSO MURRILL

HAPALOPILUS Karst. Rev. Myc. 3: 18. 1881

This genus was established upon a single species, *H. nidulans* (Fr.), the chief distinguishing characters being an anoderm surface and fleshy-tough context. In his work on Finland basidiomycetes published in 1889 Karsten reduces *Hapalopilus* to a subdivision of the genus *Inonotus*, throwing white-spored and brown-spored forms together. The forms treated under this genus in the present paper are all white-spored, with anoderm, variously marked surface and corky substance. The prevailing color is some shade of brown, the context usually being ferruginous. All the species are dimidiate, sessile and imbricate and grow upon decaying wood. *H. sublilacinus* differs from the other species in growing upon coniferous instead of deciduous wood.

In distribution the species differ widely. *H. rutilans* occurs rather abundantly in the temperate regions of North America and Europe, *H. gilvus* is exceedingly common throughout North America in both temperate and tropical regions and *H. licnoides* is a common tropical American species. The other three are as yet known only from their type localities, which are southern. A very evident line of division exists between *H. rutilans* and the other species, which latter bear distinct evidence of recent common origin. When the great variability of *H. gilvus* is taken into consideration, it appears to be only a question of a comparatively short time before several new species will be evolved.

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Synopsis of the North American species

1\. Hymenium concolorous, pileus smooth, entirely devoid of zones or furrows, context soft and friable, spores 2.5 × 3.5 μ. 1. *H. rutilans.*
Hymenium differently colored, pileus rarely smooth, context rigid or corky, not friable. 2.

2\. Hymenium lilac-colored, tubes 1 cm. or more in length, pileus concentrically sulcate. 2. *H. sublilacinus.*
Hymenium dark brown, tubes less than 0.5 cm. in length, pileus smooth or zonate. 3.

3\. Context rigid, pileus azonate or with few and indefinite markings. 4.
Context flexible, pileus plainly and definitely multizonate. 3. *H. licnoides.*

4\. Context bright ferruginous, hymenium fulvous to fuliginous, spores elongated, 6 × 2 μ. 4. *H. gilvus.*
Context pallid, hymenium subfulvous, spores subglobose to ovoid, 3–4 μ in diameter. 5. *H. fulvitinctus.*
Context brown, hymenium brownish-gray, pileus reddish-brown, finely hispid behind, spores ovoid, 3 × 3.5 μ. 6. *H. hispidulus.*

1. **Hapalopilus rutilans** (Pers.)

Boletus suberosus Bull. Herb. France, **11**: 354. *pl. 482.* 1791.
Not *B. suberosus* L. Sp. Pl. 1176. 1753.
Boletus rutilans Pers. Icon. et Descrip. 18. *pl. f. 4.* 1798–1900.
Polyporus nidulans Fr. Syst. Myc. **1**: 362. 1821.
Polyporus rutilans Fr. Syst. Myc. **1**: 363. 1821.
Hapalopilus nidulans Karst. Rev. Myc. **3**: 18. 1881.
Inonotus nidulans Karst. Finlands Basidsv. 332. 1889.

This species seems to have been described independently under different names by both Bulliard and Persoon, though the name assigned by the former had been previously used by Linnaeus. When Fries studied the plant he gave it the name *P. nidulans*, following it with Persoon's *P. rutilans*, which, he naïvely remarked, was perhaps a variety of *P. nidulans.* The two species were kept distinct by Berkeley, but he had little and poor material and evidently did not know them very intimately.

The plant appears to grow on most deciduous wood, being found on birch, dogwood, hazelnut, hickory, oak and other deciduous trees, with a preference in this country, perhaps, for hickory. Collections are at hand from Paris, *Patouillard;* Connecticut, *Underwood, Earle, White;* Pennsylvania, *Rau, Stevenson;* New York, *Underwood;* Kansas, *Cragin;* Iowa, *Macbride;* Greenland, *Rostrup;* Austria, *Bresadola.*

2. **Hapalopilus sublilacinus** (Ell. & Ev.)

Mucronoporus sublilacinus Ell. & Ev. Bull. Torrey Club, **27**: 50. 1900.

This species was collected by Langlois on pine logs in Louisiana and very doubtfully and provisionally assigned to *H. gilvus*. In some ways it does resemble that species, but it is larger, with concentrically furrowed surface and long, lilac-colored tubes. The spores are hyaline, but very distinct from those of *H. gilvus*.

3. **Hapalopilus licnoides** (Mont.)

Polyporus licnoides Mont. Pl. Cell. Cuba, 401. *pl. 16. f. 2.* 1842.

Polystictus licnoides Fr. Nov. Symb. 92. 1851.

Polystictus subglaber Ell. & Macbr. Iowa Univ. Bull. Nat. Hist. **3**: 193. 1896.

This well-known fungus is exceedingly common in tropical parts of America, occurring on dead wood of various kinds and presenting a variety of forms according to locality and habitat. The best early description of it is that made by Montagne. Fries may have described the species under *P. crocatus*, but this is not yet well determined. According to Romell, *Polyporus xerophyllaceus* Berk. (Hook. Jour. Bot. **8**: 200. 1856), described from Brazilian collections, is a synonym of the present species. Specimens from Guadaloupe in the Paris herbarium are named *Fomes Khortalsii* Lév., which latter is a Sumatran species. Young plants collected in Nicaragua by C. L. Smith have recently received the name *Polystictus subglaber*, said to differ from *P. licnoides* in having smaller pores and no spines. Resupinate forms from the southern states are usually known as *P. crocatus*, possibly because this species was once so identified from South Carolina.

In many ways *H. licnoides* and *H. gilvus* are strikingly alike and approach very near to each other in some varieties, but they are usually readily distinguished by the numerous concentric zones which ornament the surface of the former species. Spores and cystidia correspond closely. *H. gilvus* extends much farther north, however, and is abundantly collected where *H. licnoides* is never found. Among the numerous collections of this species examined are the following: Jamaica, *Underwood, Earle;* Cuba, *Underwood & Earle;* Mexico, *Smith;* Nicaragua, *Smith;* Louisiana, *Langlois;* Florida, *Martin, Calkins, Lloyd.*

4. **Hapalopilus gilvus** (Schw.)

Boletus gilvus Schw. Syn. Fung. Car. 70. 1818.
Polyporus gilvus Fr. Elench. Fung. 104. 1828.
Polyporus calvescens Berk. Ann. Nat. Hist. **3**: 390. 1839.
Polyporus omalopilus Mont. Pl. Cell. Cuba, 423. 1842.
Polyporus carneofulvus Berk. in Fries, Nov. Symb. 68. 1851.
Polystictus purpureofuscus Cooke, Grevillea, **15**: 24. 1886.

Owing to the abundance and wide distribution of this species in America it has figured in many collections and received several different names. This renaming has been due partly to the ignorance of foreign botanists and partly to the importance which varieties assume when studied apart from abundant representative material. The type specimens grew on maple and sweet gum in the Carolinas, where the plant is still found in great abundance. Old specimens from New Orleans were so changed in appearance that Berkeley described them as *P. calvescens.* The thinner tropical form collected in Cuba was called *P. omalopilus* by Montagne, while the stratified form occasionally assumed under tropical conditions is known as *Polyporus carneofulvus* Berk., or *Polyporus holosclerus* Berk. Still another variation, sulcate, thicker and tinged with purple, was collected on hickory in South Carolina (*Ravenel 3034*) and described by Cooke as *P. purpureofuscus.*

In addition to the above specific names, other names with which we have nothing to do have been assigned to our plant, thus increasing the confusion; as, for example, *P. scruposus* Fr., *P. isioides* Berk. and *P. pruinatus* Berk. & Kl., all applied originally to Indian or African species.

The present species is too well known to American mycologists to require further description. It is found on decayed wood of deciduous trees throughout; and except in the Gulf states and south where *H. licnoides* occurs it need not be confused with other species. Collections are at hand from Canada, *Dearness;* Pennsylvania, *Barbour, Sumstine;* Delaware, *Commons;* New York, *Earle, Burnham, George, Underwood, Murrill;* New Jersey, *Ellis, Murrill;* Missouri, *Demetrio;* Ohio, *Selby, Morgan;* Kansas, *Cragin;* Wisconsin, *Baker;* Nebraska, *Clements, Williams;* Virginia, *Murrill;* Georgia, *Harper, Ricker;* Alabama, *Earle, Baker;* Florida, *Calkins;* Louisiana, *Langlois;* Mexico, *Smith;* Cuba, *Earle, Underwood;* Jamaica, *Earle, Underwood;* Porto Rico, *Earle;* Trinidad, *Lloyd.*

5. **Hapalopilus fulvitinctus** (B. & C.)

Polyporus fulvitinctus B. & C. Jour. Linn. Soc. Bot. **10**: 313. 1868.

This species was collected on dead wood in Cuba by Wright. It differs from *H. gilvus* chiefly in having smaller and more rounded spores and paler substance; while in surface characters and consistency the two species are much alike. I know of no collections of the plant except those at Kew, and our knowledge of its habits and distribution is most meagre.

6. **Hapalopilus hispidulus** (B. & C.)

Polyporus hispidulus B. & C. Jour. Linn. Soc. Bot. **10**: 319. 1868.

Collected on decayed wood in Cuba by Wright. Known only from the rather scanty type collections at Kew. Pileus reddish-brown, finely hispid except near the margin, context brown, hymenium brownish-gray, spores ovoid, smooth, hyaline, 3 × 3.5 μ, immature, hyphae very pale ferruginous.

SPECIES INQUIRENDAE

Polyporus crocatus Fr. Epicr. 477. 1836–1838. Described from Leibman's Mexican collections. Transferred to *Polystictus* in Novae Symbolae, 91. 1851. Probably a form of *P. licnoides* Mont. I hesitate to reduce *P. licnoides* to synonymy, however, without further investigation.

Polyporus sordidus Berk. in Fries, Nov. Symb. 80. 1851. Name changed to *Polyporus sordidulus* in Cooke's enumeration of polypores owing to the discovery of another species bearing the former name.

Polyporus endozonus Fr. Nov. Symb. 54. 1851. Collected by Oersted on trunks in the Island of San Juan. I have not seen the type of this species. It is said to be very thick and narrow, with smooth, rigid pileus, roughly fibrous context and very small short pores, which become dark umber with age. Fries treats it next to *P. scruposus* and it is certainly not far from *H. gilvus*, but the pileus is too thick and the substance too fibrous for this species.

PYCNOPORUS Karst. Rev. Myc. 3: 18. 1881

This genus was founded upon a single species, *Pycnoporus cinnabarinus* (Jacq.), and characterized by its author as follows: "Pileus suberosus, intus floccosus. Pori sat firmi." In North America there are two species of the genus, both of them very attractive, abundant and well known. One occurs chiefly in temperate regions and the other is extremely common in the tropics. In the southern United States the two approach quite near each other in some of their forms so that it is not easy to distiuguish them.

Synopsis of the North American species

Pileus thick smooth, opaque; plant abundant in temperate regions. 1. *P. cinnabarinus.*

Pileus thin, often zonate, brilliant red; plant abundant in the tropics. 2. *P. sanguineus.*

1. PYCNOPORUS CINNABARINUS (Jacq.) Karst. Rev. Myc. 3: 18. 1881

Boletus cinnabarinus Jacq. Fl. Austr. 4: 2. *pl. 304.* 1776.
Boletus coccineus Bull. Herb. France, 364. *pl. 501. f. 1.* 1791.
Polyporus cinnabarinus Fr. Syst. Myc. 1: 371. 1821.
Trametes cinnabarina Fr. Nov. Symb. 98. 1851.

This species was known for some time in Europe before receiving the name assigned to it by Jacquin. The type specimens were sent from Carinthia by Wulfen, and Jacquin states that it is parasitic on trees in subalpine districts of Austria. It is now known to occur on various deciduous trees in Europe, Asia and North America. Bulliard's fine figures were made from plants growing on cultivated cherry. Fries assigned it to his new genus *Trametes* in 1851 and Saccardo has listed it under two genera in his Sylloge. Its nearest ally is *P. sanguineus*, a tropical species, from which it differs in being thicker, more opaque in color, anoderm, and in having larger tubes with thicker dissepiments. There is also no zonate form of *P. cinnabarinus.*

The sporophores appear in this latitude in the latter part of June and mature quickly. In the earlier stages they are very soft, spongy and elastic, light orange in color and clothed with numerous slender delicate hairs which give them a pruinose appearance. Later the hairs disappear, the color becomes darker and the margin thicker. Not infrequently the old sporophores revive and take on an additional stratum of tubes, the new growth extending outward and upward over the former margin so as to entirely conceal it from view.

Exsiccatae: Finland, *Karsten;* New York, *Clinton, Blake, Murrill;* New Jersey, *Anderson;* Pennsylvania, *Barbour, Sumstine, Stevenson;* South Carolina, *Ravenel;* West Virginia, *Nuttall;* Virginia, *Murrill.*

2. **Pycnoporus sanguineus** (L.)

Boletus sanguineus L. Sp. Pl. ed. 2. **2**: 1646. 1762.
Xylometron sanguineum Paul. Icon. Champ. *pl. f. 3, 4.* 1793.
Polyporus sanguineus Mey. Fl. Esseq. 304. 1818.
Polystictus sanguineus Fr. Nov. Symb. 75. 1851.

This highly attractive fungus has been known from ancient times on account of its great abundance and brilliant coloring. The type locality is given by Linnaeus as Surinam, South America, but herbaria are abundantly supplied with it from most tropical regions the world over. Paulet's figure is cited only because of his generic name; no drawing could be poorer than this one, which seems to be only a mechanical design for the corner of his plate, resembling the plant in color but in no other way.

As to habitat and host, this species exhibits little choice, occurring on standing or fallen dead trunks and structural timbers of almost any kind of deciduous or evergreen tree. According to Swartz, it was formerly eaten by the negroes in its young stages; but it is certainly too tough for any ordinary use in this way.

Of the large number of exsiccati examined, I need mention only a few: North Carolina, *Raasloff;* South Carolina, *Ravenel, Du Bois;* Georgia, *Frank, Harper;* Florida, *Lloyd, Small & Carter;* Cuba, *Underwood & Earle, Britton, Shafer;* Jamaica, *Earle;* Porto Rico, *Howe;* Hayti, *Nash;* San Domingo, *Wright;* Bahamas, *Minns;* Trinidad, *Lloyd;* Mexico, *Smith;* Nicaragua, *Smith;* Honduras, *Wilson;* Columbia, *Baker;* Uruguay, *Lorentz;* Paraguay, *Balansa;* Bolivia, *Rusby;* Peru, *Pearce;* Bonin Islands, *Wright.*

Abortiporus gen. nov.

Hymenophore annual, tough, humus-loving; stipe normally central, often obsolete; context yellowish-white, duplex, spongy above, woody below, tubes thin-walled, mouths polygonal; spores subglobose, smooth, hyaline.

The type of this genus is *Boletus distortus* Schw. (Syn. Fung. Car. 71. 1818), a very variable species found about old stumps in various localities in the Eastern United States. The name assigned to the genus refers to the usual aborted form of the fruit body, in which the tubes with their abundant contents appear prematurely before the development of the pileus is complete.

Abortiporus distortus (Schw.).

Boletus distortus Schw. Syn. Fung. Car. 71. 1818.
Polyporus abortivus Peck, Bot. Gaz. **6**: 274. 1881.

The ordinary form of the fruiting body of this species has the appearance of being badly aborted in its development, only a few of the pilei reaching their full size. In its arrested form the pileus is a mass of pores filled with spores. The species has been badly confused with *P. rufescens* of Europe, but a study of that species in the field easily shows a very marked difference. A small specimen of our plant is to be found in the Paris herbarium under the name of *Polyporus pulvillus* Mont., but this name was never published for it so far as I know. The specimen is from South Carolina.

This species occurs about stumps, roots and other dead wood of deciduous trees, such as the oak, maple, *Ailanthus*, etc. Its distribution is quite general throughout the eastern part of North America and it has been found as far west as Wisconsin and Texas.

Exsiccatae: Canada, *Dearness;* Connecticut, *Earle;* Delaware, *Commons;* New Jersey, *Ellis;* Pennsylvania, *Rau*, *Gentry*, *Herbst;* Ohio, *Lloyd*, *Morgan*, *Dawson;* Missouri, *Demetrio;* Wisconsin, *Miss Patterson;* Alabama, *Earle & Baker;* Louisiana, *Langlois;* Texas, *Gentry*.

Cyclomycetella gen. nov.

Hymenophore annual, tough, epixylous, sessile, anoderm, zonate; context thin, fibrous, brown, tubes short, thin-walled, mouths polygonal, becoming concentrically elongated in some species by the splitting of the radial walls; spores ellipsoidal, smooth, ferruginous.

This genus is based upon *Boletus pavonius* Hook. (Kunth, Syn. Pl. **1**: 10. 1822), described from Colombia. Its nearest ally is the old-world genus *Cyclomyces*, erected by Fries in 1830 upon *Cyclomyces fuscus*. In this latter genus the tubes are continuous concentric furrows, while in the species of *Cyclomycetella* which come nearest to *Cyclomyces* the concentric appearance of the hymenium is caused by the partial splitting of the radial walls in age; and the formation of furrows is by no means constant.

Cyclomycetella pavonia (Hook.).

Boletus pavonius Hook. in Kunth, Syn. Pl. **1**: 10. 1822.
Polyporus pavonius Fr. Epicr. 477. 1836–1838.
Polyporus iodinus Mont. Ann. Sci. Nat. II. Bot. **16**: 108. 1841.

The type plants of Hooker's species were collected by Humboldt in Colombia, or New Granada as it was then called, and named for *Ulva pavonia* because of the concentric lines of the pileus. Montagne's types were from Guiana, collected by Leprieur. He first thought that these plants were *P. striatus* (Hook.), but later placed them midway between this species and *P. tabacinus* Mont., making no mention of Hooker's other species, *P. pavonius*, described just before.

Other closely related species are found in South America. *B. striatus* Hook. (Kunth, Syn. Pl. **1**: II. 1822), was described from plants collected by Humboldt in Peru, and has since been found in Venezuela. *P. vespilloneus* Berk. (Hook. Jour. **8**: 1856) was described from Juan Fernandez Island and later reported by Montagne from Chile. All these species show very recent common origin. *P. Hasskarlii*, a Ceylon species, has several times been erroneously reported from Cuba.

Cycloporus gen. nov.

Hymenophore annual, tough, anoderm, terrestrial, orbicular, centrally stipitate; context soft, spongy, ferruginous; pores at first polygonal, soon becoming continuous concentric furrows, dissepiments thin, lamelloid; spores ovoid, smooth, ferruginous.

The type of this genus is *Cyclomyces Greenei* Berk. (Lond. Journ. Bot. **4**: 306. *pl. 11.* 1845), a very rare plant found in temperate regions of North America. The genus *Cycloporus* differs widely from *Cyclomyces* in being terrestrial and stipitate instead of epixylous and sessile.

Cycloporus Greenei (Berk.)

Cyclomyces Greenei Berk. Lond. Jour. Bot. **4**: *pl. 11.* 1845.

This remarkable plant has been eagerly sought for by collectors since its discovery in New England by Greene and still the number of specimens found is hardly a dozen. It may at once be distinguished from all other pore-fungi by its concentric, gill-like tubes and central stem. It grows on the ground in woods. Specimens have been examined from Massachusetts, *Greene*, *Sprague;* New York, *Peck;* Connecticut, *Earle;* New Jersey, *Gentry;* Iowa, *McBride;* West Virginia, *Nuttall;* Vermont, *Farlow*. Five of these collections are in the herbarium of the New York Botanical Garden.

Globifomes gen. nov.

Hymenophore large, woody, encrusted, perennial, epixylous, compound; context ferruginous, punky, tubes cylindrical, thick-walled, stratose: spores ovoid, smooth, ferruginous.

The type of this genus is *Boletus graveolens* Schw. (Syn. Fung. Car. 71. 1818), a rather rare plant first found in Georgia and the Carolinas, but later discovered as far west as Iowa. The genus is readily distinguished among its allies by its compound pileus, which consists of numerous small, closely imbricated pileoli united into a compact rounded mass.

The genus *Xylopilus* of Karsten (Hattsv. **2**: 69. 1882), is also described as having a compound pileus, but *Xylopilus crassus* (Fr.) Karst., its type species, is very probably only an abnormal form of a European species of *Elfvingia;* and even if this type plant were found to be normal the genus *Globifomes* would remain sufficiently distinct.

Globifomes graveolens (Schw.)

Boletus graveolens Schw. Syn. Fung. Car. 71. 1818.
Polyporus conglobatus Berk. Lond. Journ. Bot. **4**: 303. 1845.
Fomes graveolens Cooke, Grevillea, **13**: 118. 1884.

This species was first sent to Schweinitz from Georgia, but was later found in North Carolina. Plants sent from Ohio to Berkeley were thought to differ sufficiently from those growing on oak to justify a new name. The heavy odor of the fruiting plant is thought to be responsible for the common name of "Sweet Knot," by which it is known in some sections.

The most common host of this species is the oak, especially *Quercus nigra*; but it also occurs on beech. The fruit bodies are found on old dead trunks.

Exsiccatae: Rav. Fung. Car. 3: 8; Ell. N. A. Fung. 603; Ohio, *James, Cheney*; Iowa, *Macbride*; Pennsylvania, *Sumstine*.

Nigrofomes gen. nov.

Hymenophore large, perennial, epixylous, sessile; context woody, purple, tubes cylindrical, stratose, thick-walled, black; spores ovoid, smooth, hyaline.

The type of this genus is *Polyporus melanoporus* Mont. (Pl. Cell. Cuba, 422. 1842), found on trunks of trees in tropical America. The genus is readily distinguished from its near allies by its purple context and black tubes.

Nigrofomes melanoporus (Mont.)

Polyporus melanoporus Mont. Pl. Cell. Cuba, 422. 1842.

This species is the darkest-colored of the perennial polypores. It was first described from collections made in Cuba by Ramon de la Sagra. Underwood has also collected it several times in Jamaica and Florida and Smith has found it in Nicaragua. It is probably more or less common throughout tropical America on decaying trunks of various broad-leaved trees.

Poronidulus gen. nov.

Hymenophore annual, tough, sessile, epixylous, at first sterile and cup-like, the fertile portion developing from the sterile; context white, fibrous, tubes short, thin-walled, mouths polygonal; spores ellipsoidal, smooth, hyaline.

The type of this genus is *Boletus conchifer* Schw. (Syn. Fung. Car. 72. 1818), a very common and abundant species on dead elm branches. The development of the fruit-body is peculiar, being in two stages, the first ending with the formation of a cup-shaped sterile body, from which the fruit-body proper later develops. This preliminary pileus begins as a knot of whitish mycelium, which soon ceases to grow at the center, while the hyaline borders continue to grow upward and form a cup resembling species of *Nidularia*. The margin of the cup is thin and entire or undulate and becomes darker like the center when the limit of growth is reached, while the concentric zones within very plainly show the progress of the development. The cup varies from deeply infundibuliform to shallow or even flat at times and the central portion which has ceased to grow is much cracked radially to accommodate itself to the growing exterior.

The pileus proper usually arises from one side of the cup near its base and expands laterally into a reniform, zonate hymenophore considerably larger than the sterile portion. At times the pileus does not develop beyond the surface of the cup and at other times a developed pileus becomes proliferous at several points and give rise to new sterile and fertile portions. Since the formation of the cups continues throughout the growing season, many are overtaken by winter and are found among the new ones the following spring. The old pilei rarely remain over winter, being fragile and readily devoured by insect larvae.

Poronidulus conchifer (Schw.)

Boletus conchifer Schw. Syn. Fung. Car. 72. 1818.
Boletus virgineus Schw. Syn. Fung. Car. 72. 1818.

This species was first described from North Carolina, but it is known to be common in many parts of North America on fallen branches and dead limbs of the elm, its only host. Under the first name Schweinitz described forms that showed the cups attached to the developing pilei; under the second he placed fully developed fruit bodies showing little trace of the sterile part from which they sprang. The plant is confined to North America. Among collections examined are the following: Massachusetts, *King;* Connecticut, *White;* New Hampshire, *Minns;* New York, *Earle*, *Murrill;* New Jersey, *Earle*, *Murrill;* Ohio, *Lloyd;* Virginia, *Murrill;* Alabama, *Earle;* Kansas, *Bartholomew.*

A brief synopsis of the genera treated in articles I–VIII of this series

- Surface of hymenophore covered with reddish-brown varnish, context corky. *Ganoderma.*
- Surface of hymenophore not as above, or, if so, context woody.
  - Hymenophore annual.
    - Tubes hexagonal and radially elongated. *Hexagona.*
    - Tubes not as above.
      - Hymenophore stipitate.
        - Stipe compound. *Grifola.*
        - Stipe simple.
          - Context white.
            - Plants fleshy, terrestrial. *Scutiger.*
            - Plants tough, epixylous.
              - Pileus inverted, erumpent from lenticels. *Porodiscus.*
              - Pileus erect, not erumpent.
                - Context homogeneous, firm. *Polyporus*
                - Context duplex, spongy above, woody below. *Abortiporus.*
          - Context brown.
            - Hymenium concentrically lamelloid. *Cycloporus.*
            - Hymenium poroid.
              - Spores white. *Romellia.*
              - Spores brown.
                - Pileus erect, stipe central. *Coltricia.*
                - Pileus inverted, pendent. *Coltriciella.*
      - Hymenophore sessile.
        - Context white.
          - Tubes at length separating from the context, surface smooth. *Piptoporus.*
          - Tubes not separating from the context, surface zonate. *Poronidulus.*
        - Context red. *Pycnoporus.*
        - Context brown.
          - Spores white. *Hapalopilus.*
          - Spores brown. *Cyclomycetella.*
  - Hymenophore perennial.
    - Context and tubes white or pallid.
      - Hymenium at first concealed by a volva. *Cryptoporus.*
      - Hymenium free from the first. *Fomes.*
    - Context and tubes brown or dark red.
      - Hymenophore subsessile, caespitose, the numerous pileoli arising from a common trunk or tubercle. *Globifomes.*
      - Hymenophore truly sessile, either simple or imbricate.
        - Pileus covered with a horny crust, context punky. *Elfvingia.*
        - Pileus not covered with a horny crust or, if encrusted, context hard and woody. *Pyropolyporus.*
    - Context and tubes dark purple or black. *Nigrofomes.*

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Note on the sexual generation and the development of the seed-coats in certain of the Papaveraceae

CHARLES H. SHAW

(WITH PLATE 15)

During the past two years the writer has mounted and examined material in some quantity of *Sanguinaria*, *Chelidonium* and *Eschscholtzia*. The facts in hand indicate that the embryo-sac phenomena do not widely depart from those described, for instance, in genera of the *Ranunculaceae*. The following are some of the facts observed.

Annual phases of Sanguinaria.—Material of *Sanguinaria* has been gathered at various seasons in order to obtain a complete view of the annual life-cycle. The flowers of the plant begin to be formed nearly a year before they appear, viz., in May of the preceding year, while the seeds of that season are becoming mature. The stamens develop more rapidly than the carpels. By August the anthers are well formed, with four-lobed outline in cross-section, and the sporogenous tissue is beginning to be differentiated from that of the anther-walls. Cell-division proceeds during autumn, the size of the anther as a whole meanwhile increasing. The cells lying toward the periphery of the sporogenous mass begin to degenerate and by November the spore-mother-cells are seen as richly filled cells lying among the more or less disorganized tapetal cells. In this condition the winter is passed. Division of the mother-cells begins very early in the spring. Material killed on February 4, 1903, after several days of very mild weather, shows figures of dividing nuclei. Development of the spores and the final formation of the anther-wall seem, as might be expected, to be somewhat controlled by the weather, but are completed during this period, between the renewal of growth and blooming. The ovules begin to appear about August as undifferentiated outgrowths of the placental tract, but development lags behind that of the anthers. The integuments are not developed till the close of winter, at the time when the microspores are being formed from their mother-cells. No trace of the megaspore mother-cell is visible when growth is renewed in late winter. *Sanguinaria* is therefore in this respect like *Salix* and *Populus*, whereas certain other plants, most definitely *Epigaea* and *Erythronium*, have been observed to reach the mother-cell stage during the preceding season.

The division of the megaspore mother-cells and the formation of the embryo-sac take place during March and early April. Although the development of the microspores has kept far in advance, the flower at blooming is proterogynous. As is well known, the phases from pollination to maturity of seeds occur in April, May and June.

Structure of the pistil.—In *Sanguinaria*, *Chelidonium* and *Eschscholtzia*, an open canal leads from the ovary to the exterior. Hairy outgrowths of a kind with those of the stigma project into the passage but generally do not close it, and continue down the two placental ridges. Thus the hairy outgrowths of the stigma, of the interior of the stylar canal and of the placental ridges form a single continuous tract. This is highly developed in *Sanguinaria*, less so in *Chelidonium* and *Eschscholtzia*, but distinctly in all. The path of the pollen-tubes is among these hairs and the loose superficial cell-layers from which they spring. The tubes pass through the micropyle and penetrate the nucellus in the usual manner.

The embryo-sac.—The embryo-sac exhibits the typical number and arrangement of nuclei (PLATE 15, FIGURES 1 AND 2). The polar nuclei are often met with, lying close together. In the antipodal region are found features of interest. The antipodal cells reach an unusual size, and the nucellar cells in their vicinity acquire thickened walls. In *Eschscholtzia* the antipodals continue to enlarge for a brief period during the early formation of the endosperm nuclei and then decrease and disappear before the endosperm cells are cut out.

In *Chelidonium* (PLATE 15, FIGURE 2), the antipodals are relatively smaller than in *Eschscholtzia* but they persist longer and may be seen after walls have formed about the endosperm cells. For *Sanguinaria* also the statements in regard to *Chelidonium* hold true.

In all three forms the cells in the nucellus adjacent to the antipodals acquire thickened walls (PLATE 15, FIGURE 1). This tissue increases during the enlargement of the sac and the formation of the endosperm. It can scarcely be doubted that to this tract, together with the enlarged antipodals, some nutritive significance attaches.

The size of the nucleoli is noteworthy both in the nuclei of the embryo-sac and those of the surrounding cells. Practically all of the strongly staining substance of the nuclei is included in them. It is difficult to entertain any other idea than that these nucleoli embrace the chromatin.

DEVELOPMENT OF THE SEED-COATS IN SANGUINARIA

The integuments arise shortly after renewal of growth in the spring as two folds growing up around the nucellus. Each consists throughout most of its extent of three cell-layers (PLATE 15, FIGURE 3). Following is a description of the differentiation and destiny of each of these:

(*a*) *The secundine.*—The inner of the three cell-layers undergoes anticlinal division as the ovule enlarges, so that at the time when the egg-apparatus is formed the cells are still nearly isodiametric (PLATE 15, FIGURE 4). At this time they have the appearance of active cells with abundant protoplasm and well-developed nuclei. Very soon, however, their anticlinal division becomes less active and at the same time they are stretched by the expanding embryo-sac. By the time that the endosperm nuclei have spread to the wall of the embryo-sac this layer is losing its organization, and thereafter appears only as an ill-defined rudiment (PLATE 15, FIGURES 5 AND 6).

The middle layer of the secundine has almost from the first less protoplasmic contents. At the time of the completion of the egg-apparatus it appears highly vacuolated with larger cells and degenerating nuclei. This is the first of all the layers to break down, the cells losing their form shortly after fertilization.

The outer layer of the secundine does not become vacuolated to so great a degree as the one last named and it persists somewhat longer. But it shares the fate of the other layers of the secundine, appearing while the endosperm is forming only as a mass of distorted and fragmentary cell-bodies.

(*b*) *The primine.*—The persistent parts of the seed-coats are formed exclusively from this tissue. The inner layer is marked almost from the first by its richer contents of protoplasm and active nuclei (PLATE 15, FIGURE 3). Anticlinal division nearly or quite keeps pace with the swelling of the ovule, so that at the time of the completion of the egg-apparatus (PLATE 15, FIGURE 4) the cells are nearly or quite isodiametric. Shortly after that period a great anticlinal elongation takes place and this layer becomes the first in prominence as it is destined to be in importance of all the cell-layers (PLATE 15, FIGURE 5). From an early date a sort of cuticular layer is formed on its inner surface where it comes in contact with the secundine (PLATE 15, FIGURE 5). The cells continue to be well filled with protoplasm and to have prominent nuclei. About the time when endosperm cells begin to be cut out, crystals of calcium oxalate appear within this layer, and these later accumulate to a considerable degree. While the endosperm is maturing, their layer still further increases in size and becomes greatly indurated. It forms the most important part of the testa, exceeding in thickness all the other layers together (PLATE 15, FIGURE 6).

The middle layer of the primine undergoes both periclinal and anticlinal division so that in the later stages it is several cells deep (PLATE 15, FIGURES 4, 5, 6). All these cells become highly vacuolated, increase in size, and toward the last become compressed by the enlarging inner layer of the primine and almost disappear.

The outer layer of the primine undergoes comparatively few divisions and these are all anticlinal. Although the cells become much enlarged, they are not distorted by pressure nor in any way disorganized, and developing thick walls on every side, they constitute the outer hard and shining coat of the seed (PLATE 15, FIGURE 6). The caruncle arises just outside the vascular tissue of the raphe, and its enormous cells are thin-walled, but by no means poor in contents. Despite the ready ecological explanations advanced, the significance of this caruncle is still, to the writer at least, a mystery.

In *Eschscholtzia* the development of the integuments resembles that in *Sanguinaria*, but with the difference that the principal layer of the testa is composed of smaller cells which have relatively little induration.

In *Chelidonium*, however, a more considerable difference exists. Both primine and secundine persist and take part in the formation of the seed-coat. In fact the outer cell-layer of the secundine is rather the most indurated of the four or five cell-layers which give protection to the endosperm.

SUMMARY

In *Sanguinaria* the microspore mother-cells are formed during the season preceding blooming, but their division and the formation of the ovular integuments and of the embryo-sac occur after renewal of growth in the spring, just before blooming.

In *Sanguinaria*, *Chelidonium* and *Eschscholtzia* an open canal extends from the carpellary cavity to the exterior.

In the above-mentioned forms the antipodal cells are very prominent, especially so in *Eschscholtzia*, and the adjacent nucellar cells are thick-walled and rich in contents.

In *Sanguinaria* and *Eschscholtzia* the secundine eventually disappears and the inner cell-layer of the primine constitutes the most important element of the testa. In *Chelidonium* both primine and secundine persist and take part in the formation of the seed-coat.

Explanation of plate 15

All drawings were made with camera lucida. Figures 3, 4, 5 and 6 are drawn to the same scale.

FIG. 1. Embryo-sac of *Eschscholtzia*.

FIG. 2. Embryo-sac of *Chelidonium*.

FIG. 3. Section through the integuments of *Sanguinaria*, immediately after their formation; *a*, secundine, *b*, primine.

FIG. 4. The same at the time of completion of egg-apparatus. The middle layer of the primine has undergone division.

FIG. 5. The same at the time when endosperm cells are being cut out. The secundine is breaking down.

FIG. 6. The same at maturity of seed, showing the inner layer of the primine greatly enlarged and indurated and containing crystals of calcium oxalate.

Observations on the germination of Phoradendron villosum and P. californicum

W. A. Cannon

A few years since, when in California, I had the opportunity of studying the structure and noting certain physiological peculiarities of *Phoradendron villosum.** The study was confined almost entirely to mature forms, only a few relatively young plants were secured, and no seedlings were seen although I searched diligently for them. Neither was I successful in germinating the seeds. It is with the idea of supplementing that work with some account of the younger stages of the life history of the mistletoe that this sketch is presented.

Among other things I showed in the preceding paper that the spreading of the mistletoe in the host occurs in the cortex only, a fact well known,† and also that this takes place because the haustoria are supplied with secreting cells from which probably exudes a solvent capable of dissolving the cell-walls of the host. It however was noticed that not all of the host-tissues were affected by the haustoria. For instance, their enzymes were apparently incapable of dissolving the suberized walls of the cork as well as the lignified grit-cells in the cortex, and this may account in part for the fact that the haustoria do not penetrate into the woody central portion of the stem. Of course in the latter instance other questions enter, as for instance the necessary change in function of the haustoria to water-absorbing organs, but as regards the grit-cells there can be no doubt. These were frequently noted lying within the tissues of the parasite and completely enclosed by them, which means that at an early stage in the development of the plant the grit-cells, like the other and adjacent cortical cells of the host, came into contact with the solvent secreted by the

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* The anatomy of *Phoradendron villosum* Nutt. Bull. Torrey Club, **28**: 374. 1901.

† Kerner and Oliver. Natural history of plants. **1**: 216. — Peirce. On the structure of the haustoria of some phanerogamic parasites. Ann. Bot. **7**: 317. 1893.

parasite, but they, with lignified walls, unlike the latter whose walls were unmodified, were unaffected by this fluid.

The question at once arises as to whether the seedlings of the mistletoe secrete enzymes which can dissolve suberized, cuticularized or lignified cell-walls, and thereby gain entrance into the host at nearly any point, or, as may be the case in the haustoria of mature plants, only unmodified walls are affected. Of course it may be that cuticularized walls can be dissolved and neither of the other two. I have no evidence to offer in the latter alternative, but it is noticeable that the mistletoe is almost never parasitic on itself* in spite of the fact, which will be given later, that the seedlings often germinate in contact with its own branches. Dr. MacDougal informs me, however, that several instances have been known of the parasitism of one loranth on another in Jamaica. The mistletoe is provided with a cuticularized epidermis with communication to the exterior through stomates only.

In the vicinity of the Desert Botanical Laboratory occur two species of mistletoe, *P. villosum* and *P. californicum.* The former has white berries and broad leaves, the latter has red berries and is nearly devoid of leaves. *P. villosum* occurs here mainly on the native ash and native cottonwood and appears to be quite like the California plant studied by me. The other species has a different habit of growth. It generally hangs from the branches of the host, and is found mainly on the cat-claw (*Acacia Greggii*), and mesquite (*Prosopis juliflora*). I have seen it also on palo verde (*Parkinsonia microphylla*); and I believe that it occurs on the creosote bush (*Covillea tridentata*), but I have not seen it on this plant.

The distribution of the mistletoe from tree to tree is likely always effected by the agency of birds, but its distribution in a tree may be brought about in another manner also, and thus it is frequently accounted for by the position of the older plants. In cases where infection has occurred on the higher branches of the host it frequently happens that numerous younger plants of the parasite will be placed directly under this pioneer, as if they

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* In Kerner and Oliver's work, *l. c.*, it is said that on one occasion mistletoe, probably *Viscum*, was seen growing on *Loranthus*. It, however, is not clear whether the place where the *Viscum* seedling gained an entrance was cuticularized or suberized.

were derived from its seeds. This habit is of much use to the collector, since he has but to mark a tree in which a large bunch of mistletoe is growing in the top, and if there is sufficient growth beneath, he is sure to find at the proper time of the year an abundance of seedlings.

Thus it must frequently happen that the mistletoe seeds germinate without having been first passed through the alimentary tract of birds, and, in fact, although I did not determine more closely the conditions under which they best germinate, these do not appear to be other than that the seeds must be mature. A large amount of heat is not required, and also it may be that germination is not dependent on rains.

In February, March and April germinating seeds of both species of mistletoe were seen in great abundance. The seedlings were found on all portions of the mesquite, including leaves, and on cat-claw and ash. That is, the seeds germinated on the old bark at the base of the tree as well as on last year's growth. I observed them also on dead twigs that were detached from any tree, on mesquite thorns, and even on the mistletoe itself. Also seedlings of *P. californicum* were taken from branches of the ash whither the seeds had been carried by birds. It thus appears questionable whether the character of the substratum has any influence whatever on the germination of the mistletoe seeds.

It is of interest to note that the seeds of the mistletoe are for the most part ripe and fallen by the time the leaves of the host make their appearance. This has one great advantage to the parasite, namely, that of being better able to reach the twigs and branches of the host than would be the case when these members are covered with leaves. As it will be seen later this is especially important in the case of the mesquite and its mistletoe.

Although water may not be a factor in inducing the germination of the seeds, it may assist in their dissemination; however I have made no direct observation on this point. When the seeds fall and become attached to a branch, they are so firmly fastened by means of the adhesion to the branch of their viscid contents, that they are dislodged with difficulty (FIGURE 1). It is quite possible, and here again I have no proof of the truth of the statement, that the firmness of the attachment is of considerable importance to the seedling in permitting it to press the tip of the radicle firmly against the host.

After attachment is secured, the radicle is sent out; it turns in most cases directly toward the host and comes into contact with it, and not until then forms the expanded tip whose distal epithelium functions as the secreting organ. The color, form and size of the hypocotyl in the two species of mistletoe are unlike. The hypocotyl of *P. californicum* is slender, reddish in color and may attain a length of .7 cm. although it is usually shorter. The hypocotyl of the other form is short, rarely much exceeding the seed-coat, stout and greenish in color. The structure of the hypocotyl in both is clearly like that of the mature plants, *i. e.*, the outer epi-

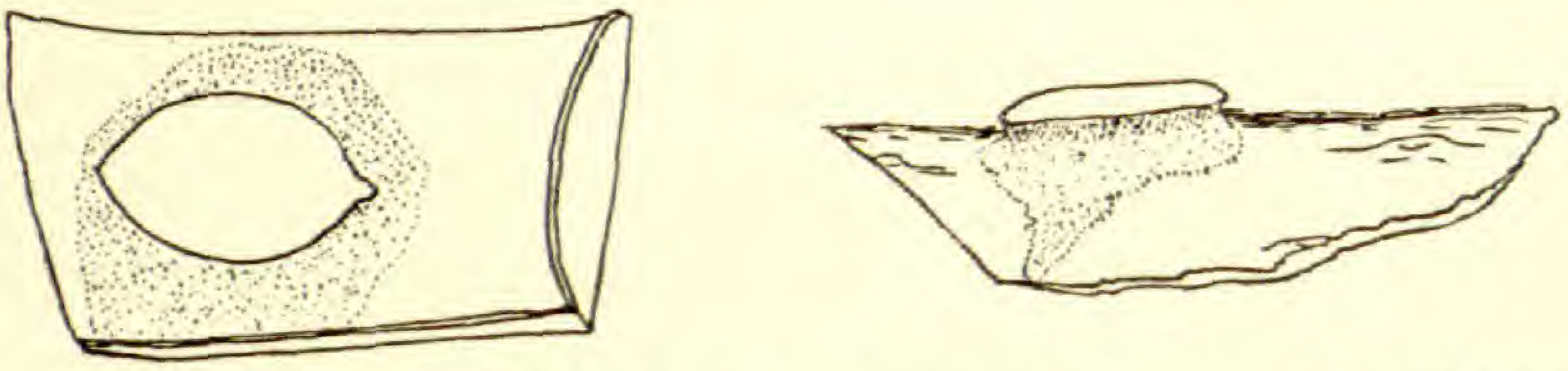

FIGURE 1. Seeds of *P. villosum*, showing manner of attachment to the cottonwood branch. The shaded area represents the viscid substance which glues the seeds to the host.

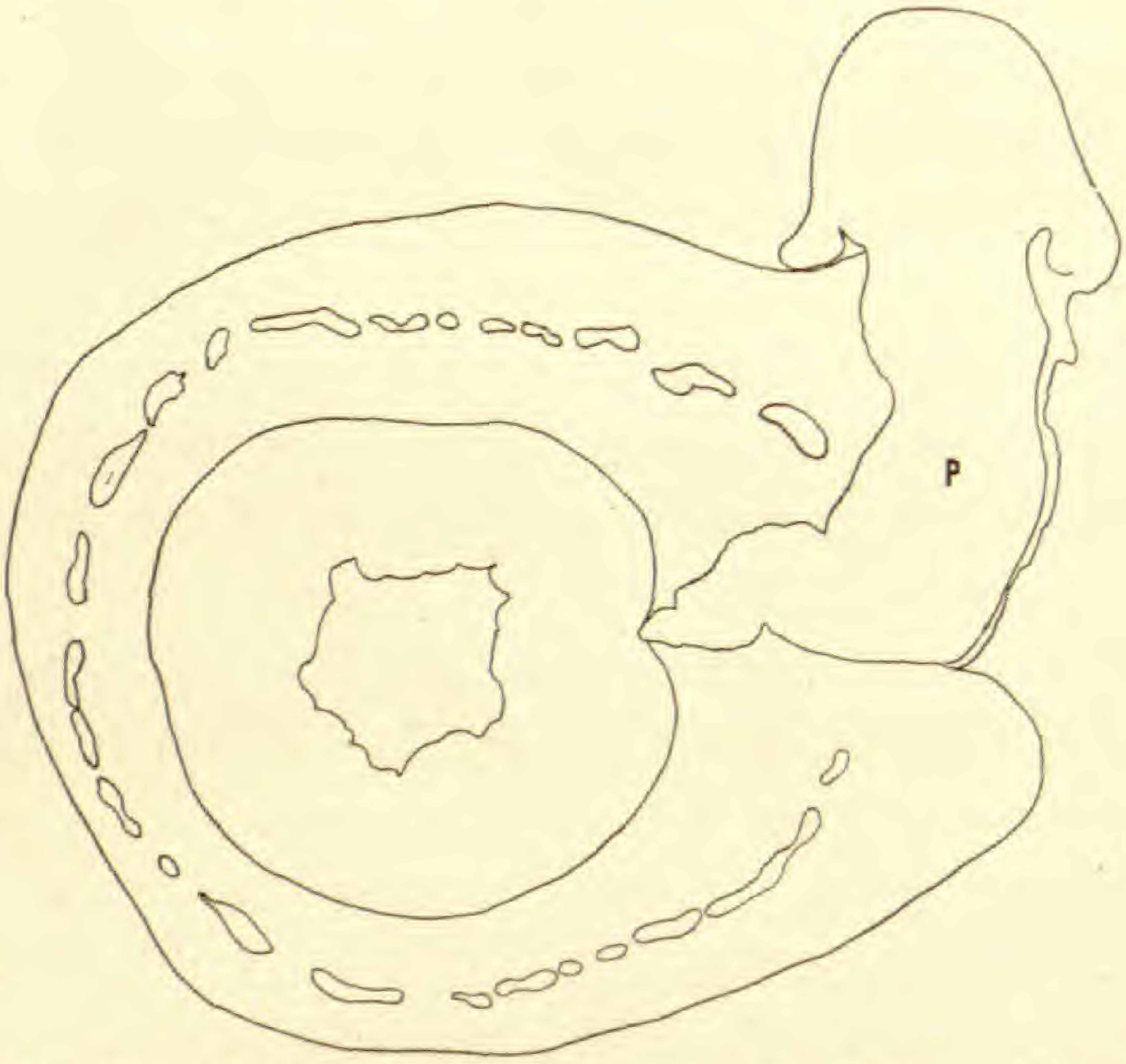

FIGURE 2. Seedling of *P. villosum* on cottonwood. This seedling penetrated last season; the tip of the haustorium is being transformed into a sinker for the absorption of water.

dermal wall is strongly cuticularized, and hence the hypocotyl is xerophytic. This not only ensures against rapid drying out but probably the converse of that, making impossible, perhaps, the absorption of water should it chance to come during the early stages of germination.

The cotyledons probably never emerge from the seed until foothold has been secured by the root, and this may not take place under several months from the time germination commences; they are thus unlike those of *Loranthus*, which appear much more quickly.* FIGURE 2 shows a young plant of *P. villosum* on a cottonwood branch. It was collected in January and the seed presumably was one that ripened and began to germinate the previous season. The seed-leaves, however, had not yet left the seed-coat; they were closely pressed together like the young leaves in old plants.

There are three well-marked periods in the life of the young mistletoe plant: 1, the growth of the hypocotyl and the formation of the disc; 2, penetration; and 3 (probably after the establishment of a connection with a water supply), the erection of the cotyledons.

Some very interesting work is to be done on the causes that influence the radicle to turn towards the host. In *P. villosum* this almost always occurs at once but in the other species the radicle may bend and twist in a variety of ways before the host is touched. However, in the end the tip of the radicle touches the substratum and flattens into a disc-shaped organ, likely as a result of the pressure caused by the resistance of the host.† The young disc was not especially studied; it has been long known that it secretes a substance which aids the penetration of the haustorium. The discs increase in size by the multiplication of cells about the periphery, and in older forms, in which penetration has already taken place, secreting cells of the disc are confined to the outer portion (FIGURE 3). These are as usual elongated, they have dense protoplasmic content and conspicuous nuclei.

Penetration is effected unlike in the two species, and in the instances cited, the manner of penetration is dependent on the

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* Keeble. Loranthaceae of Ceylon. Trans. Linn. Soc. London, II. 5: 91. 1895.

† Compare the account given in Engler & Prantl, Nat. Pflanzenf. 3^1: 160, and by Keeble, *loc. cit. supra*.

structure of the host. I would not say that the mistletoe does not gain entrance in these hosts in any other way, but I have seen nothing that would indicate that it does.

In the case of the ash, the mistletoe seeds, *P. villosum*, falling on the younger and smooth branches send out their hypocotyls and these attach themselves at once to the substratum. The branches are provided with prominent lenticels and if one of these chances to be directly beneath a disc, the epidermal cells of the disc enter it, dissolving or pushing to one side, or both, the cells of the host, and at length find themselves in the cortex. This is not a matter of solution entirely, since the host-cells at the side of the haustoria give evidence of having been subjected to pressure by them, and the walls of such cells, as will appear directly, are suberized. That is, as far as I have been able to determine, and to express the matter in another way, the cell-walls of the host which make up the lenticels and which had been affected by the solvent, were not suberized, as is shown by the following tests. In the section from which FIGURE 4 was sketched, the walls of the host-cells which were immediately in front of the tip of the haustorium, and for a distance back equal to about one third of its length, gave the cellulose reaction with iodine and sulphuric acid; they were colored blue, while the lignified portions of the central

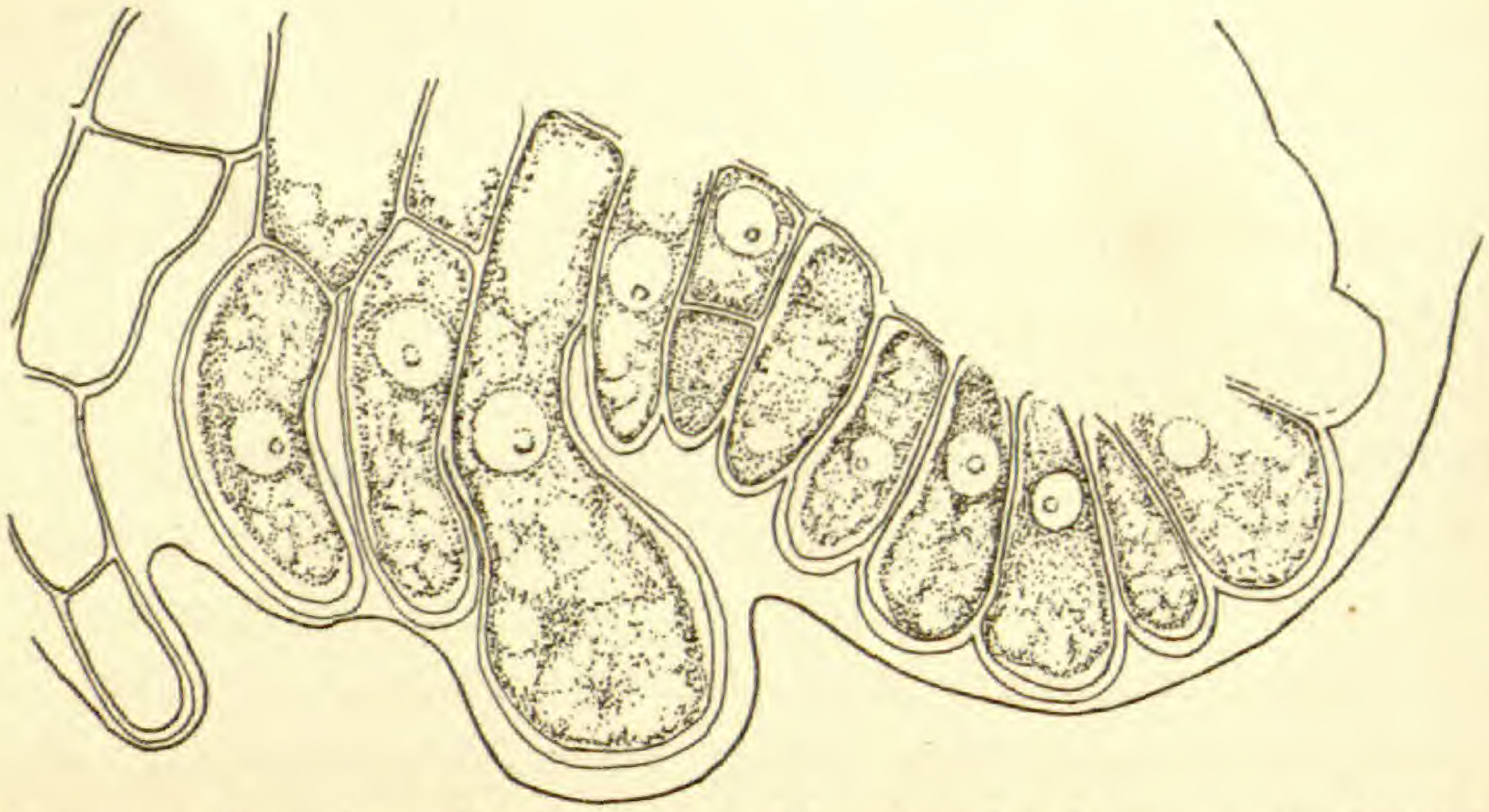

FIGURE 3. Secreting cells at the edge of the disc of such a young mistletoe as that shown in the preceding figure. The cells are evidently active, but a study of the section from which the sketch was made does not show that the host tissues are being dissolved as the sketch would indicate.

cylinder, the hard bast, as well as the suberized cork cell-walls were colored yellowish, the reaction for corky and for lignified tissue. And it was observed that the cell-walls of the host adjacent to the upper two thirds of the haustorium reacted to the test for suberized walls, and these were the cells which were seen to be compressed in a direction parallel to the surface of the haustorium, and which probably somewhat earlier had been moistened with the secretions of the haustorium. Naturally the cells nearer the tip of the haustorium, whose walls were of cellulose, gave no indications of pressure. It appears probable, therefore, that the entrance was made by pressing the loosely constructed tissue of the lenticel to one side, and afterwards, when the deeper cortical cells whose walls were of cellulose were reached, the solvents secreted by the haustorium became for the first time of service to the growing root by making the resistance of the host less, as well as by preparing the host-tissues for absorption.

FIGURE 4. *P. villosum* on ash. The haustorium is making its way between the hard bast of the cortex, but does not dissolve them. *p*, mistletoe; *cam*, cambium.

The general forms of haustoria which have penetrated in the manner above outlined, and on this host, as compared with those of the haustoria on the mesquite, point also to this conclusion. In the former the haustoria are most frequently wedge-shaped, in the latter they may be more or less spread out and brush-formed (FIGURE 4) and in the latter also there were no evidences of pressure exerted by the mistletoe on the host's tissues.

Penetration in the other species, it can thus be seen, takes place in quite another manner. This presumably, in part at least, is due to the differences in the structure of the branch of the two hosts. The axillary buds of the mesquite are closely enwrapped by protecting scales, and the internodal portions of the branch are usually somewhat roughened and appear not to bear lenticels. Therefore the mistletoe seedling that would penetrate the mesquite branch must be able to make its way through the outer cork either by pressure or by dissolving the periderm, or entrance must be gained at some other point, as at the axillary buds. The latter solution of the problem has been made.

Even in older mistletoe plants it frequently happens that one can identify their place of attachment as being axillary, and in the younger ones the host sometimes sends out leaves from the same axillary buds. And I have seen branches of the mesquite on which as many as half-a-dozen successive buds bore mistletoes.

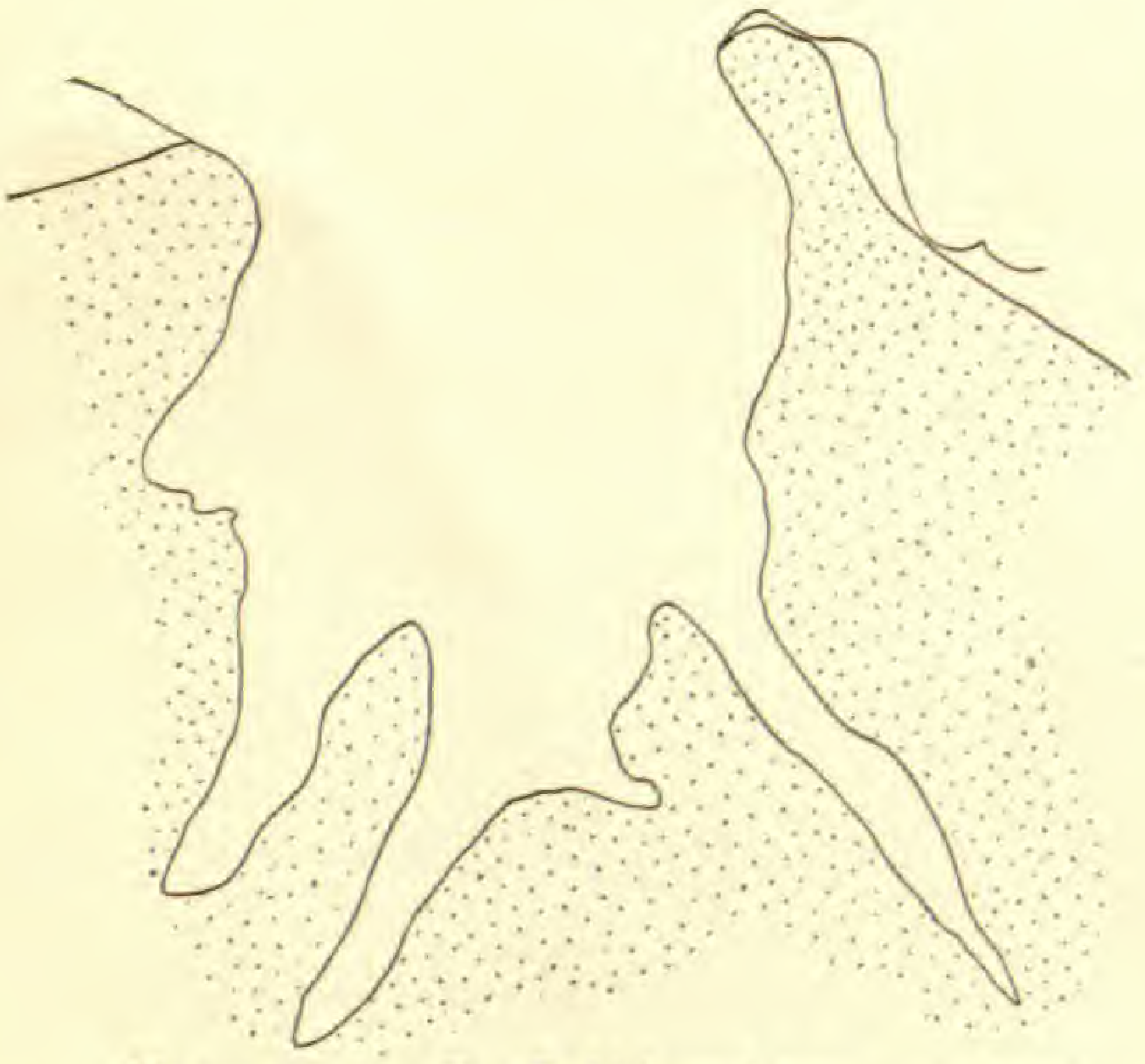

FIGURE 5. *P. Californicum* penetrating the cortex of the mesquite; the branching of the haustorium, which frequently may be seen, is shown.

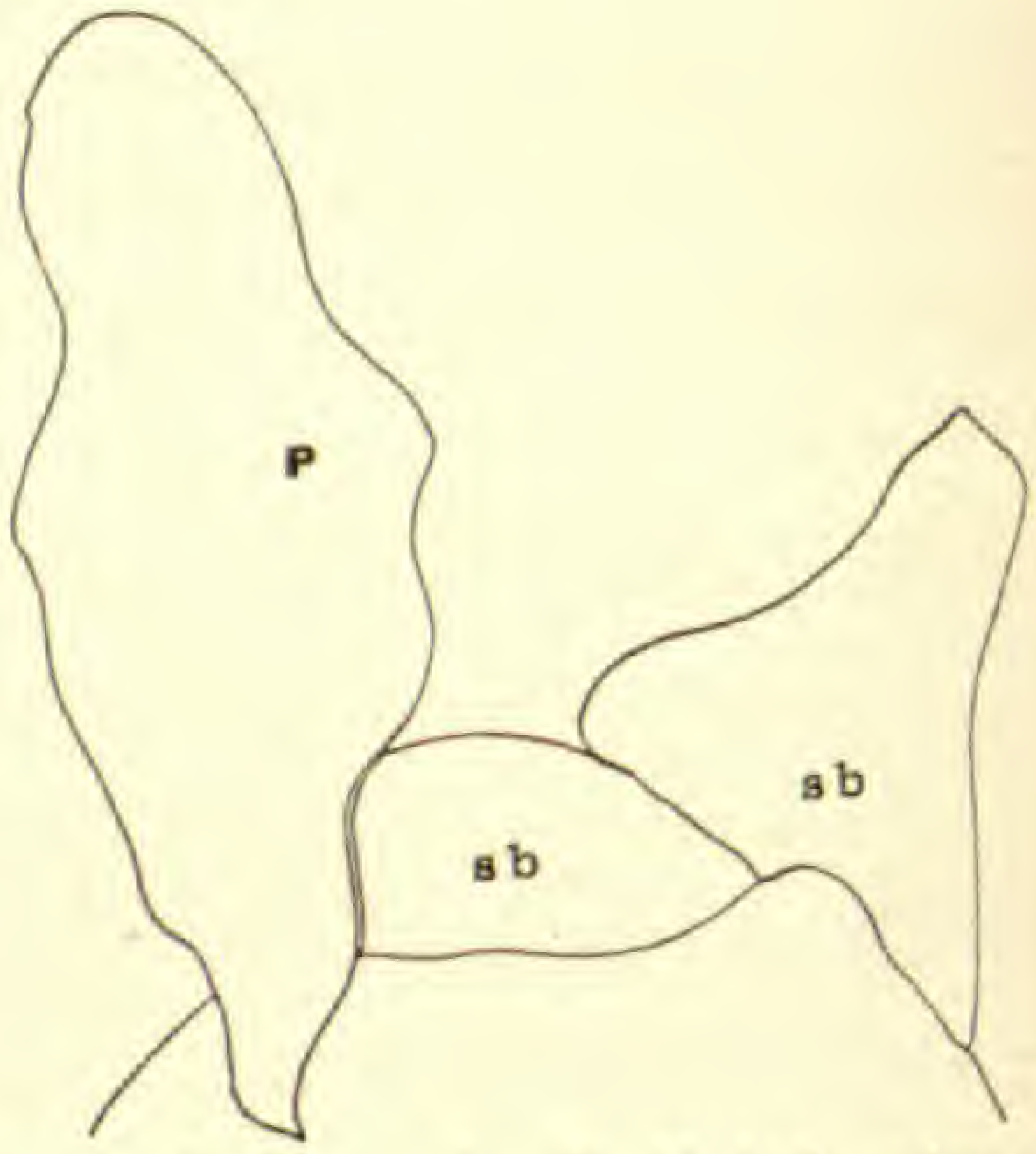

FIGURE 6. *P. Californicum* entering the cortex of the mesquite in the region of the axillary bud. *p*, mistletoe seedling; *sb*, the scale bases.

The manner of infection is as follows: seedlings which are attached to the internodal portion of the branch secrete solvents, as the discoloration of the cork immediately under the discs of the haustoria show, but they do not effect the penetration; such seedlings, however, as are attached either to the buds, or to the branch but close to them, and whose hypocotyls reach the buds, are those which at length gain admission into the sub-cortical host-tissues. The hypocotyls are pushed between the bud-scales to their base, the discs are formed in that position, and the secreting cells are thus brought at once in contact with cellulose cell-walls. These are penetrated without difficulty and, as mentioned above, apparently without exerting any pressure on the host (see FIGURE 5).

Although the method of securing an entrance into the hosts is in the two species of mistletoe and the two kinds of host plants above considered unlike in certain particulars, they agree in this, namely, that the solvents secreted by the haustoria of the parasite do not in either case dissolve suberized cell-walls, and apparently cannot do so. For this reason the points of admission open to the mistletoe are determined solely by the character of the host-substratum, whether its cells are loosely put together, as in the lenticels of the cottonwood, or the place where the parasite seeks admission has cellulose cell-walls.

Finally, it should be stated that the above conclusion is based on anatomical evidence alone, and that the subject should be taken up from the experimental standpoint before the conclusion can be definitely accepted as valid. And this experimental work I hope sooner or later to undertake.

DESERT BOTANICAL LABORATORY,
TUCSON, ARIZONA.

Two new species of American wild bananas with a revision of the generic name

ROBERT F. GRIGGS

At the time of publication of a former paper * I was not aware that antedating Linnaeus's application of the name *Heliconia*, to the plant called by the Indians "*Bihai*," is a description of the same plant under the name of *Bihai* by Adanson (Fam. Pl. **2** : 67. 1763). This necessitates the use of that name instead of *Heliconia*. It will be a matter of some pleasure to those whose sense of justice is gratified when they see the name given by the original describer of a plant retained, that *Bihai*, which was manifestly a generic name as first applied by Plumier, though not used binomially in the technical sense, can now be restored. Otto Kuntze, in his Revisio Generum Plantarum (**2** : 684. 1891), used Plumier's name with an *a* suffixed, probably to latinize it more perfectly ; and applied it to all the species he knew. There were, however, several species which he overlooked, and it seems proper that these, together with a number of others described since his paper was published, should here be transferred from *Heliconia* to the older genus as follows : **Bihai aurantiaca** (Ghiesb.), **Bihai Bihai** (L.), **Bihai borinquena** (Griggs), **Bihai Burchellii** (Baker), **Bihai Champneiana** (Griggs), **Bihai choconiana** (Watson), **Bihai Collinsiana** (Griggs), **Bihai crassa** (Griggs), **Bihai distans** (Griggs), **Bihai elongata** (Griggs), **Bihai episcopalis** (Vell.), **Bihai humilis** (Jacq.), **Bihai latispatha** (Benth.), **Bihai librata** (Griggs), **Bihai lingulata** (Ruiz & Pavon), **Bihai platystachys** (Baker), **Bihai purpurea** (Griggs), **Bihai rostrata** (Ruiz & Pavon), **Bihai rutila** (Griggs), **Bihai spissa** (Griggs), **Bihai tortuosa** (Griggs). Each of these was originally described, with the same specific name, under *Heliconia*, by the author cited in parentheses.

The two species of *Bihai* described below were discovered by Messrs. Cook, Collins and Doyle of the United States Department

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* On some species of *Heliconia*. Bull. Torrey Club, **30** : 641–664. December, 1903.

of Agriculture, in the spring of 1903. The types of both are in the herbarium of the Department of Agriculture at Washington.

Bihai reticulata sp. nov.

Leaf 94 cm. long, 37 cm. broad, petiole and base 70 cm.; blade elliptical, acute at the tip, cuneate at the base, thin, glabrous, not glaucous, main veins about 1 cm. apart, finest veins nearly 1 mm. distant, connected by cross-veinlets forming square meshes (an unusual character, for the veins of most species are so close together as to make the cross-veinlets so short that they are not often noticed even under a glass ; this feature is strikingly brought out by the remarkable coloration of the under surface of the leaf); all the veins from the midrib down, including the cross-veinlets, bright red contrasting strongly with the body of the leaf and giving it a very noticeable screen-like appearance ; inflorescence sessile, upright, about 25 cm. long, nearly if not quite glabrous, of 12–15 bracts ; rachis stiff and straight ; bracts close, overlapping at their middles, ascending at angles of 45–60°, lowest sterile bract 15 cm. long, 8 cm. broad, long-acute, the middle ones suborbicular, 8 cm. long, 10 cm. broad, rounded at the base, with a very short-acuminate tip; flowers large, longer than the branch-bracts, red and yellow (*fide* Cook).

Cook & Collins 149, Buena Vista, Costa Rica ; *photo 5547*. Growing in a deep ravine.

This plant with its broad branch-bracts rather closely packed on the rachis, belongs to the subgenus *Taeniostrobus.* But its sessile inflorescence makes it unusual in that section. It is not close to any of the described species, differing from all either in the absence of a peduncle or in the inflorescence being much narrower with smaller bracts. It seems to be distinct also from all other species of the genus, whether of the same subgenus or not, in the colored venation of the leaves.

Bihai longa sp. nov.

Stem 6 m. long, inclined (*fide* Collins), leaf-surfaces radially disposed ; leaves 1.5–2 m. long, about 50 cm. broad, acute, obliquely cordate at the base, rather thick and firm, glabrous except along the midrib, covered below with a bloom so extremely dense as to be as thick as the body of the leaf itself and to give the under surface a feeling like that of felt ; petiole about 1 m. long ; inflorescence pendulous, nearly 2 m. long, peduncle 25 cm., stout, glabrous ; rachis flexuose, flexible, short-tomentose, internodes 2–6 cm.; bracts many, 27 in the type, all but the last one reflexed, ovate, acute, varying from 7 cm. long at the tip to 16 cm. at the base and from 5–8 cm. wide, tomentose on the outside, at least near the base, and densely ferruginous-pubescent within: flowers almost as long as the branch-bracts except at the base of the inflorescence, flower-bracts triangular, 2 cm. broad, 5 cm. long, densely velvety pubescent on the outside, glabrous within.

El Pez, road from Buena Vista to San Carlos Valley, Costa Rica, *Cook & Collins 47, photo 5459*.

The present species is closely related to *B. Collinsiana*, and probably more closely to *B. pendula*. From the former it is distinct in the hairy inflorescence, twice or three times as long, the stouter rachis, the ovate rather than lanceolate branch-bracts. From *B. pendula* it differs in being fully twice as large, in the very glaucous, not green, leaves, in the hairy not glabrous, broader, branch-bracts.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1901-1903)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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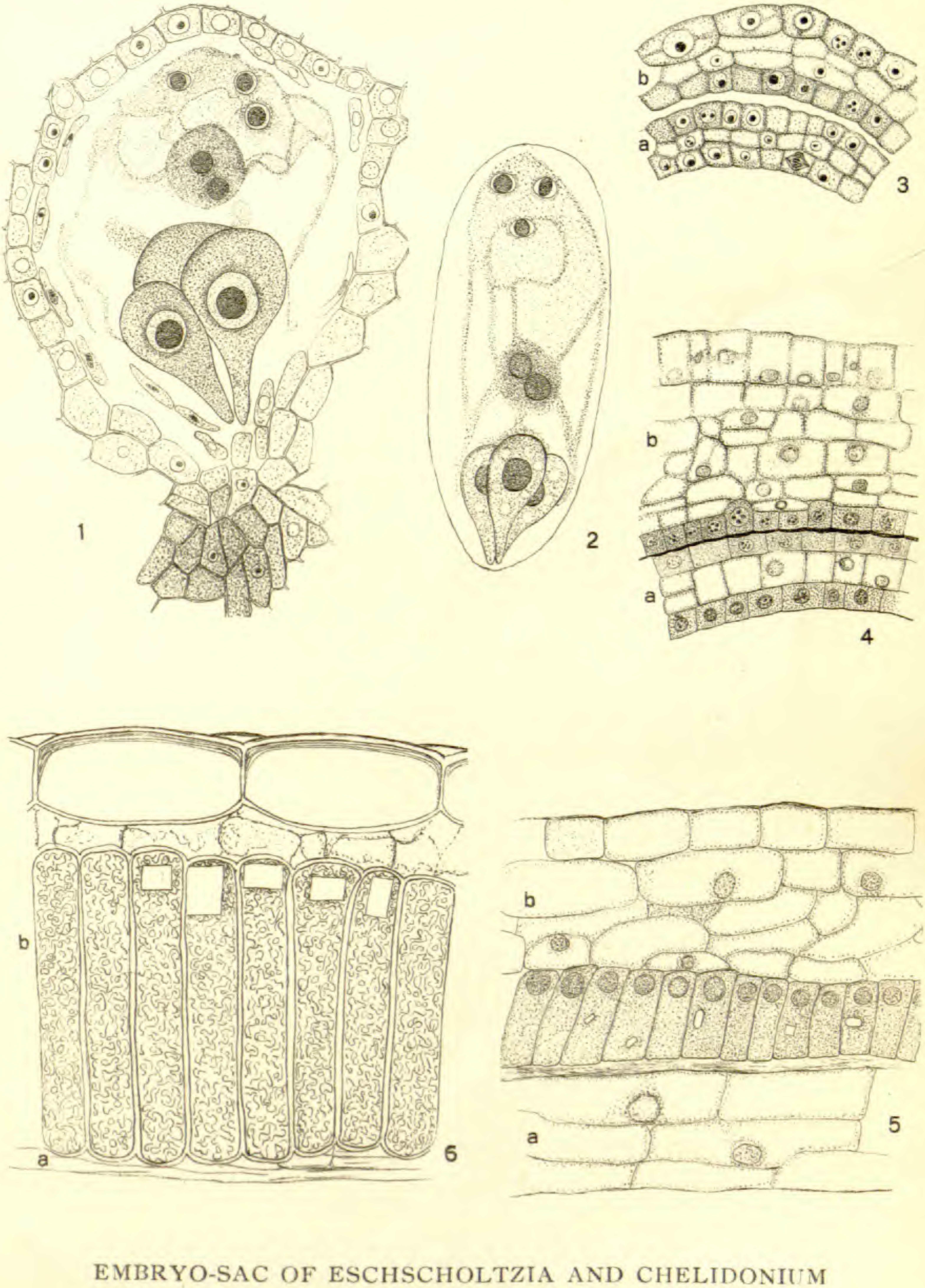

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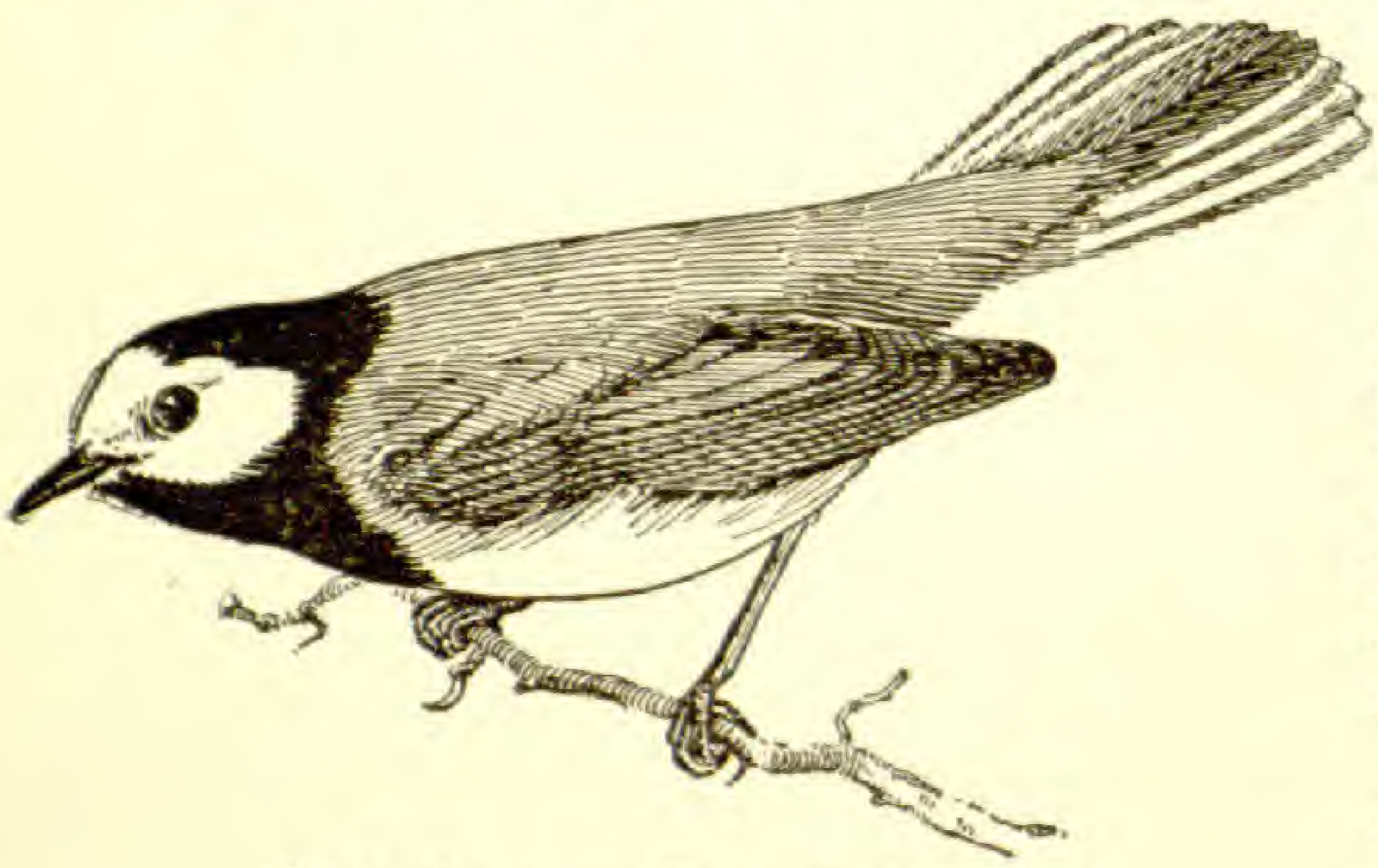

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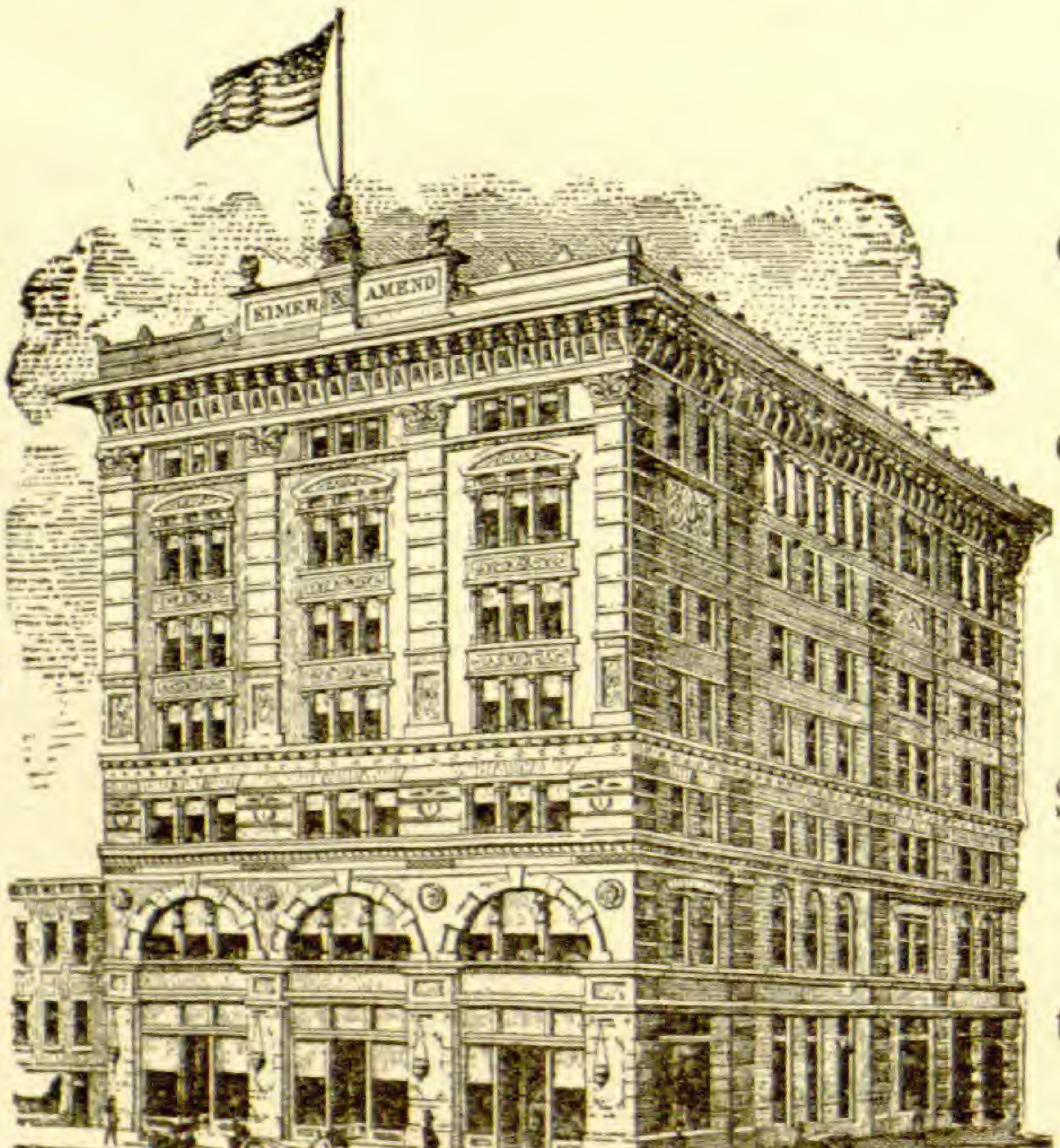
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VOL. 31 No. 9

BULLETIN

OF THE

TORREY BOTANICAL CLUB

SEPTEMBER, 1904

Studies in the Asclepiadaceae — VIII

A NEW SPECIES OF ASCLEPIAS FROM KANSAS AND TWO POSSIBLE HYBRIDS FROM NEW YORK

ANNA MURRAY VAIL

(WITH PLATES 16–19)

Asclepias kansana sp. nov.

Stems erect, very stout, canescently tomentose throughout, 2 dm. (or more ?) high: leaves approximately opposite, short-petioled; basal blades broadly oblong-ovate, truncate and rounded at the base, obtuse and mucronulate or emarginate at the apex, the upper ones elliptical-oblong, also mucronulate or more often emarginate, the lower ones 13–16 cm. or more long, 9–11 cm. wide, the upper ones 9–14 cm. long and 4.5–9 cm. wide, minutely tomentose or becoming glabrate above, densely canescently tomentose beneath, becoming less so with age, the midvein very broad and conspicuous, the primary veins wide-spreading; petioles stout, 1–1.5 cm. long: umbels several, axillary on the upper part of the stem, peduncled, many-flowered; peduncle 3–7 cm. long; pedicels 2–3 cm. long, tomentose: calyx-segments oblong-lanceolate: corolla-segments (pink-purple ?), oblong, 7–8 mm. long, tomentose on the outside; hoods oblong, about 4 mm. long, erect but diverging at the obtuse apex (pinkish ?), the lateral margins infolded with a broad obtuse tooth on each side at about the middle, the tips of which meet under the exserted incurving horn; horn falcate, affixed near the base of the hood, and incurving over the edge of the anthers: follicles erect, on recurved pedicles, 8–10 cm. long, 3–3.5 cm. wide, obtuse at the curved apex, densely white-tomentose, echinate with numerous soft spinose processes that vary in length from 3–10 mm.; seeds 8 mm. long. (PLATE 16, FIGURE 4; PLATE 18.)

[The preceding number of the BULLETIN, Vol. 31, No. 8, for August, 1904 (31: 415-456, *pl. 15*) was issued 26 Au 1904.]

Kansas: Fort Riley, *E. E. Gayle 514*, June 24, 1892; Manhattan, Riley County, *W. A. Kellerman*, 1890; Riley County, *J. B. Norton 762*, 1896 (type, in the Herbarium of the New York Botanical Garden.)

A specimen labelled *A. syriaca* L. from Independence, Mo., *B. F. Bush 355*, June, 1895, might be referred here, the leaf-characters being clearly those of *A. kansana*, but the flowers are in too poor condition to study. A specimen from Osborne County, Kansas, *C. L. Shear 130*, June 22, 1894, also labelled *A. syriaca* L., without flowers, appears to belong here.

Differing from *Asclepias syriaca* L. in its broader oblong-ovate and oblong-elliptical leaves, in the erect-spreading hoods that are narrower at the apex, and in the character and greater number of the processes of the densely tomentose follicles.

Asclepias syriaca L. from the Eastern States has longer, narrower, more acute leaves, shorter, more rounded and erect corolla-hoods and follicles that are much less tomentose and have fewer and much shorter processes. (PLATE 16, FIGURES 1*a* and 1*b*; PLATE 17, FIGURE 1, *a–f*.)

Asclepias Bicknellii sp. nov.

Stems erect, glabrous or strigilose in lines above, glaucous, 3 dm. or more high: leaves opposite, short-petioled; blades oblong or the upper ones elliptical-oblong, 11–16 cm. long, 3.5–8 cm. wide, acute at the apex, truncate or rounded or sometimes subcordate at the base, glabrous or nearly so above, paler, glaucous and sparingly strigilose beneath, undulate on the margins; petioles 2–5 mm. long: umbels terminal and axillary; peduncles 6–9 cm. long, strigilose; pedicels slender, 2–2.5 cm. long, strigose: calyx-segments ovate-lanceolate, acute, glabrate; corolla-segments oblong, 7 mm. long, pale greenish, tinged with purple, glabrous; hoods erect, 4 mm. high, rounded and somewhat pendulous at the saccate base, pale pink, crenately notched or undulate at the apex; horn falcate, flat, arising from the base of the hood, long-exserted over the anthers: follicles not known. (PLATE 19.)

Van Cortlandt Park, New York City, collected by E. P. Bicknell, June 25, 1895. Type in the Herbarium of Columbia University (N. Y. Botanical Garden).

A possible hybrid appearing to be intermediate between *A. syriaca* L. and *A. amplexicaulis* Smith or *A. exaltata* (L.) Muhl. Named in honor of Mr. E. P. Bicknell.

A single plant found growing on a railroad embankment with *A. syriaca* L., "and *A. purpurascens* L. a not distant neighbor" (Bicknell in litt.). Its leaves resemble closely those of *A. purpurascens* L., but with the undulate marginal characters of *A. amplexicaulis* Smith; but the flower and hood characters are nearer those of *A. exaltata* (L.) Muhl. than of any of the other related Northeast American species. The leaves of *A. exaltata* are very thin and acute at each end, those of *A. Bicknellii* being more nearly of the texture of those of *A. syriaca*, but without the canescent pubescence of the latter species. *A. exaltata* was not known to grow in the vicinity.

Asclepias intermedia sp. nov.

Stems erect, glabrous, purplish, not glaucous, 3 dm. or more high: leaves opposite, on very short but distinct petioles, or possibly the lowest sessile; blades oblong-elliptical, thinnish, yellow-green and glabrous above, paler and minutely pubescent beneath, the midvein reddish above, the primary veins wide-spreading, also tinged with red, 8–14 cm. long, 3–7 cm. wide, obtuse or the upper ones subcordate at the base, obtuse and apiculate at the apex, most of the margins undulate; petioles 1–3 mm. long: umbels terminal, 2 or more, short-peduncled, or subtended by an upper leaf, 16–24-flowered; peduncles minutely and sparingly pubescent, 2–8 cm. long; pedicels 2.5–3 cm. long, slender, minutely pubescent: calyx-segments ovate, acute, pubescent, especially toward the apex; corolla green-purple, its segments oblong-lanceolate, 6–8 mm. long; hoods erect, ovate-lanceolate, obtuse, 5–6 mm. long, pinkish purple with a darker red or purplish stripe down the back, the lateral margins incurved, each with an erect tooth somewhat above the middle; horn slender, arising from about the middle of the hood, the tips incurved and meeting over the anthers; follicles not known. (PLATE 16, FIGURE 2; PLATE 17, FIGURE 2, *a–f*.)

Lawrence, Long Island, collected by E. P. Bicknell, July 17, 1904. Type in the Herbarium of the New York Botanical Garden.

A possible hybrid. It appears to be intermediate between *Asclepias syriaca* L. (PLATE 16, FIGURE 1 *a*, 1 *b*; PLATE 17, FIGURE 1, *a–f*) and *A. amplexicaulis* Smith (PLATE 16, FIGURE 3; PLATE 17, FIGURE 3, *a–f*). It differs from the latter in its narrower, brighter green leaves that are distinctly petioled and pubescent beneath, and also somewhat less undulate on the margins. The umbels resemble those of *A. syriaca* in contrast to the long-peduncled terminal umbels of *A. amplexicaulis.* The flowers are intermediate between the two species, with the characteristic distinct stripe down the back of the hood that appears in fresh specimens of *A. amplexicaulis.* The hoods of *A. amplexicaulis* vary very greatly in size, and in the undulations of their apical margins.

NEW YORK BOTANICAL GARDEN.

Explanation of plates 16-19

PLATE 16

1*a*. *Asclepias syriaca* L., follicle. 1*b*. *Asclepias syriaca* L., leaf. 2. *Asclepias intermedia* Vail, leaf. 3. *Asclepias amplexicaulis* Smith, leaf. 4. *Asclepias kansana* Vail, follicle.

Figures 1*a*, 1*b* and 3 were drawn from fresh material; 2, from the fresh type specimen; 4, from specimen collected by W. A. Kellerman, 1890. All figures ⅔ nat. size.

PLATE 17

1. *Asclepias syriaca* L. 2. *Asclepias intermedia* Vail. 3. *Asclepias amplexicaulis* Smith.

Figures 1 and 3 were drawn from fresh material; 2, from type specimen.

In each case *a*, flower, × 2. *b*, calyx-segments, × about 6. *c*, hood, front view, × about 6. *d*, hood, side view, × about 6. *e*, gynostegium, × about 6. *f*, pollinia, × 14.

PLATE 18

Asclepias kansana Vail. *a*, flower. *b*, calyx-segments. *c*, hood, front view. *d*, hood, side view. *e*, gynostegium. *f*, pollinia. *g*, basal leaf. *h*, upper stem leaf. The figures were all drawn from *no. 762*, collected by J. B. Norton, 1896.

PLATE 19

Asclepias Bicknellii Vail. *a*, flower. *b*, calyx-segments. *c*, hood, front view. *d*, hood, side view. *e*, gynostegium. *f*, pollinia. *g*, basal leaf. *h*, stem leaf. The figures were all drawn from the type specimen, when fresh.

The North American species of Hymenoxys

T. D. A. Cockerell

(With plates 20–23)

Much interest has been excited in Colorado by the discovery of the existence of rubber in the roots of the plant recently described as *Picradenia floribunda utilis.* It appears that sheep-herders have for years been in the habit of chewing the roots of this plant, obtaining thereby a product which served for chewing-gum. Mr. F. R. Marsh, of Denver, conceived the idea of turning this substance to commercial use, and at the present time arrangements are being made for its extraction on a large scale. When Mr. Marsh presented the matter to me, asking that it should be investigated, I was naturally quite skeptical; but my wife undertook to make the necessary chemical tests, and obtained the excellent results she has described in *Science* (II. **19**: 314. 19 F 1904).

In Colorado, the plant in question is sometimes referred to as rabbit-weed; but I believe that several *Compositae* are confused under this name. Mr. E. C. Van Diest tells me that the Mexicans call it *pengué*, but here again it may be that two or more things are confused. He states that it is poisonous to sheep in the spring — probably on account of its mechanical rather than its chemical properties.

Finding the plant of so much interest, I undertook a botanical investigation of it and its allies. It soon became apparent that the whole genus required revision, and this paper was accordingly prepared. The possibility of the undertaking has depended entirely upon the kindness with which several botanists responded to my requests for the loan of specimens, Dr. Rose sending all the material of the National Museum, Dr. Trelease that of the Missouri Botanical Garden, Miss Eastwood that of the California Academy of Sciences, Prof. Aven Nelson that of the University of Wyoming, Prof. E. O. Wooton that of the New Mexico Agricultural College, and his own herbarium; and last but not least, Dr. E. L. Greene sent a series of especially interesting and important plants from his collection. To all of these my thanks are due.

Hymenoxys is separated from *Actinella* (which includes our *Picradenia*) in the Genera Plantarum of Bentham & Hooker, but anyone who will compare the description will see that no substantial difference is indicated. Gray in the Synoptical Flora, treats *Hymenoxys* as a synonym of *Actinella*, referable to the section of that genus which includes *Picradenia*. Greene and others, seeing that typical *Hymenoxys* was a rayless plant of South America, felt satisfied that *Picradenia* was distinct, and I had adopted this view without serious misgivings. At Kew Herbarium, however, I have been able to examine species of *Hymenoxys*, and much to my regret (on account of the nomenclatural changes it compels) I am quite unable to separate the South American genus from *Picradenia*. In the herbarium, indeed, *Actinella chrysanthemoides* is placed in the *Hymenoxys*-cover, though it is absolutely congeneric with our plants of Texas, etc. There is nothing in the structure or habit to separate *Hymenoxys* from *Picradenia*, and the absence of rays cannot be considered important, as they may or may not be present in *Gaillardia*, and moreover *Hymenoxys Tweediei* Hook & Arn., from Uruguay, has very well-developed rays. This *H. Tweediei*, in its foliage and manner of growth, closely imitates our *H.* (or *Picradenia*) *Lemmoni*. *Hymenoxys Haenkeana* DC. has heads not unlike those of the Mexican *H. chrysanthemoides*. *Hymenoxys anthemoides* Cass., which is typical of the genus, looks just like our annual plants of the forms intermediate between *chrysanthemoides* and *multiflora*. The material examined has dark red pappus-scales and hairs on the achenes just as in some of our *Picradenia* forms.

The separation of *Tetraneuris*, *Rydbergia* and *Macdougalia** from *Hymenoxys* appears to be justified. *Actinella Palmeri* Gray, 1883, forms still another genus; taking up the subgeneric name proposed by Gray, it becomes **Plateilema Palmeri.** It is not only very distinct in its foliage and manner of growth, but its angular achenes, with ciliate margins, are very distinctive, not to mention the peculiar

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* *Macdougalia* has only one known species, *M. Bigelovii* (Gray) Heller. This is cited in the Synoptical Flora only from New Mexico, but I have examined material (hb. U. S. Nat. Mus.) from San Francisco Mountain (*Jones*), near Flagstaff, 5500 ft. (*MacDougal*), Willow Spring (*Palmer*) and Williams (*Rusby*,) all in Arizona.

bracts. On the other hand, the fibrillose receptacle is not an absolute character to separate *Gaillardia* from *Hymenoxys*. As a matter of fact the broad-receptacled species of *Hymenoxys* do have the lowermost of the achene-hairs attached to the rim of the achene socket, and if the achenes are carefully removed the receptacle seems more or less fibrillose. Moreover there are admitted into the genus *Flaveria* two species (*F. australasica* and *F. repanda*) in which the receptacle is setose, while in the rest of the species it is bare. On other characters, I think *Gaillardia* is quite sufficiently distinct from *Hymenoxys*, but it is difficult to express the peculiarities in a rigid mechanical way. *Phileozera* is no doubt a valid subgenus; with the help of a little imagination, one could almost believe it to have originated independently from some Anthemoid ancestor. I do not suppose, however, that anything of this sort has really taken place; it is possible for Anthemoid characters to arise among the Helenioids, even so as to deceive the very elect. Most assuredly *Leucampyx Newberryi* Gray, placed by its author as the first genus of Anthemideae, is nothing but a rayed *Hymenopappus*; related, of course, to *H. radiatus* Rose. If we are to keep up the genus *Leucampyx*, certainly *H. radiatus* must be included. I have studied both it and *L. Newberryi* in the living state, and they look as much alike as they could without being quite the same.

The more essential characters of *Hymenoxys* are found in the hairy and usually slender achenes; the pappus-scales; the bracts of the involucre in two series, the outer united basally; the strongly punctate foliage, usually linear or divided into linear divisions. The genus is remarkably conservative in regard to these things, and yet in many other respects extremely plastic. The combination of great racial variability with a marked ability to become directly modified by existing conditions makes it unusually hard accurately to define the species and subspecies.

SUMMARY OF THE CLASSIFICATION

Subgenus **Picradenia** (Hook. 1833)

Plants with the aspect of *Gaillardia* or *Helenium*, the stems almost always erect; foliage linear or divided into linear segments, punctate; inner bracts almost always conspicuously different from the outer, and fimbriate; disc-corollas not expanded at the mouth; rays well-developed. Perennials or biennials, never annuals. Type, *H. Richardsoni*.

A. Plants less than 20 cm. high; perennials with large roots, and many stems; inflorescence usually flat-topped, not spreading; pappus-scales long-acuminate or aristate.

1. Pappus-scales not half length of disc-corolla; heads large. (Saskatchewan.) *H. Richardsoni.*

Pappus-scales more than half length of disc-corolla. 2.

2. Plant normally much over 10 cm. high, with large heads. 3.

Plant normally over 10 cm. high, with medium-sized heads; pappus-scales normally about three quarters length of disc-corolla. (Helena, Montana, through middle Wyoming to the extreme north of Colorado.) *H. Richardsoni liguiæflora.*

Plant normally under 10 cm. high, heads medium-sized. 4.

3. Heads up to 2 cm. across, exclusive of rays. (Wyoming.) *H. Richardsoni macrantha Nelsoni.*

Heads 12 to 16 mm. across, exclusive of rays; rays very conspicuous; pappus-scales normally about two thirds length of disc-corolla. (South central Wyoming and the mountains of the northern half of Colorado.) *H. Richardsoni macrantha.*

Heads about 10 mm. across, exclusive of rays; foliage and bracts paler than in the last, and the rays shorter. (Utah.) *H. Richardsoni macrantha Utahensis.*

4. Flowers rather inconspicuous; foliage pale and wiry. (Western Wyoming to the mountains of Southern Utah.) *H. Richardsoni pumila.*

Flowers more conspicuous, with large rays; inner bracts gradually tapering to apex. (Assiniboia.) *H. Richardsoni pumila Macouni.*

B. Plants normally 25 cm. high or more, with straight erect stems, and very numerous medium-sized heads (6 to 8 mm. diam. excl. rays); perennials with large roots.

1. Stems not very numerous, scarcely at all woolly at base; heads rather flat; outer bracts conspicuously tipped with dark green; pappus-scales short-pointed; leaf-segments up to 2.5 mm. broad. (Mancos, Colo.) *H. Earlei.*

Stems usually very numerous, often very woolly at base; heads more convex; leaf-segments very narrow, normally not over 1 mm. broad. 2.

2. Well-developed plants 30 cm. high; stems not very woolly at base; pappus and achene-hairs normally more or less ferruginous, pappus-scales long-pointed. (Southern central Colorado and northern New Mexico.) *H. floribunda.*

Well-developed plants about 26 cm. high; stems very woolly at base; pappus and achene-hairs normally shining silvery-white. (Buena Vista and adjacent parts of Colorado, at 2,280–3,000 m.) *H. floribunda utilis.*

Differs from the last two by the short-pointed pappus-scales; stems not very woolly at base; heads rather large. (San Francisco Mountain region of Arizona.) *H. floribunda arizonica.*

Plant more slender, pale; achene-hairs pale ferruginous; pappus-scales fairly long-pointed, with ferruginous base. (Arizona and New Mexico.) *H. floribunda intermedia.*

C. Plant when well-developed 36 cm. high, similar in mode of growth to the last group; stems and foliage a lively green; basal leaves up to about 7 cm. long, some entire, but always some divided into about five broad-linear segments; bracts light green; rays brilliant orange; pappus scales long-acuminate. (Burro Mountains, New Mexico.) *H. Metcalfei.*

D. Plants of the arid southwest, usually in the mountains, with the pappus-scales always very short, often truncate or subtruncate.

1. Tall and bushy, with very numerous rather small heads; rays inconspicuous, but the disc-florets prominent and bright orange; pappus very short; basal leaves all simple and grass-like. (Southwestern New Mexico, and Arizona.) *H. Rusbyi.*

 Heads usually quite large; plant spreading above; rays conspicuous. 2.

2. Heads (excl. rays) only about 10 mm. broad; outer bracts united about half-way up. (Organ Mountains, New Mexico.) *H. Vaseyi.*

 Heads considerably larger, usually less numerous; plant taller than the last, generally less leafy. 3.

3. Pappus-scales deep ferruginous, with a sort of purplish tint; rays comparatively narrow. (Mohave district of California.) *H. Cooperi.*

 Pappus-scales normally white; rays broad. (Southeastern Arizona.) *H. Cooperi Grayi.*

 Plant with a single rather slender stem, rather like *H. canescens biennis;* pappus silvery-white; rays narrow. (Grand Cañon of the Colorado.) *H. Cooperi argyrea.*

E. Moderate-sized apparently perennial plants, not over 30 cm. high in the material seen; heads fairly large, but not over 13 mm. broad (excl. rays); basal leaves all entire; pappus-scales aristate or long-pointed.

1. Pale and canescent; heads (excl. rays) 10–13 mm. diameter; cauline leaves broader and more lobed than in the next. (Arizona, 2,280 m.) *H. subintegra.*

 Dark olivaceous; heads (excl. rays) 8–10 mm. diameter; pappus-scales not so long as in the last. (New Mexico.) *H. olivacea.*

F. Tall (rarely dwarf) plants with one or few stems, and comparatively large heads; some apparently biennials; pappus-scales at least pointed.

1. Pappus-scales short, not over half length of disc-corolla, not at all aristate. 2.

 Pappus-scales long-pointed or aristate. 3.

2. Stature low, rarely over 20 cm.; plant hoary. (Mountains of Nevada, 2,400–2,700 m.) *H. canescens.*

 Stature and appearance of *H. canescens biennis*, about 75 cm. high; pappus as in *H. canescens.* (Charleston Mountains, Nevada, 1,800–2,100 m.) *H. canescens nevadensis.*

3. A tall xerophytic plant, with much-divided leaves, with linear segments, the foliage divergent from the stem, with a tendency to curl. (Utah, N. Arizona.) *H. canescens biennis.*

 Mesophytic plants, tall and upright, with large heads and comparatively coarse erect foliage. 4.

4. Basal leaves entire to bipartite; leaf-segments very broad. (Colorado.) *H. helenioides.*

 Basal leaves always divided; leaf-segments narrower. 5.

5. Heads larger. (Northern California and western Nevada.) *H. Lemmoni.*
Heads smaller. (Eastern Nevada, Utah and northern Arizona). *H. Lemmoni Greenei.*

Subgenus **Picradenidia** subg. nov.

Cauline leaves elongate-oval, large, entire, pointed apically, strongly punctate ; heads very large, very convex ; rays large and conspicuous ; inner bracts with long pointed tips ; receptacle high-conical ; pappus-scales long-pointed. (Southern California.) Type and only species, *H. latissima*.

Subgenus **Phileozera** (Buckley, 1862)

Annuals (rarely biennials), usually much spreading, with numerous heads ; foliage and growth suggestive of *Anthemis* or *Matricaria ;* inner bracts not very different from outer, not abruptly contracted apically, or copiously fringed ; pappus-scales long-pointed ; disc-corollas distinctly expanded at mouth.

1. Heads very large, up to 15 mm. broad (excl. rays). 2.
Heads much smaller, usually not over 8 mm. broad (excl. rays), often smaller. 3.
2. Heads rather larger ; inner bracts narrow and long-pointed. (Mexican table-land.) *H. chrysanthemoides.*
Heads rather smaller ; bracts broader ; plant of laxer growth and olive-green foliage. (Vicinity of Yuma, Arizona.) *H. chrysanthemoides excurrens.*
3. Biennial. (Arizona.) *H. Davidsonii.*
Annual. 4.
4. Plant large and bushy, often about 45 cm. high, or more ; heads (excl. rays) about 8 mm. diameter, sometimes rather less. 5.
Plant quite small, much less than 20 cm. high ; heads usually smaller. 6.
5. Plant typically larger ; bracts broader. (State of Chihuahua, Mexico, extreme western Texas, southern New Mexico, southern Arizona.) *H. chrysanthemoides juxta.*
Plant typically smaller (about 21 cm. high) ; bracts narrower. (Otero Co., Colorado.) *H. chrysanthemoides Osterhouti.*
6. Plant many-stemmed and densely leafy, about 10 cm. high, heads (excl. rays) about 8 mm. broad, rays broad. (Dog Spring, southern New Mexico.) *H. chrysanthemoides Mearnsi.*
Not nearly so densely tufted, usually upright, with smaller heads. (Texas, except the extreme western part ; plains of eastern New Mexico, Oklahoma, western Kansas.) *H. chrysanthemoides multiflora.*

Subgenus **Picradeniella** subg. nov.

Very small annuals, with some of the stem-leaves broad, with short lateral lobes, such leaves being unique in *Hymenoxys ;* receptacle very high and narrow ; pappus-scales long-pointed ; rays almost undeveloped, minute. Type and only species, *H. texana.*

There is scarcely a species or variety of *Picradenia* which has not at one time or another been labeled "*Actinella Richardsoni*" or "*Picadenia Richardsoni*" by some competent botanist. It is hard to understand why this should be, since typical *H. Richardsoni* does not appear to occur in the United States, and the plants so labeled are many of them extremely different from it, even in superficial appearance. I have even found a species of *Phileozera* labeled *Richardsoni!* Those who could make such identifications ought not to feel very indignant at the way I have "lumped" the northern races under *H. Richardsoni*, and the southern annuals under *H. chrysanthemoides*. When one compares the typical *chrysanthemoides* with typical *multiflora*, the idea of specific unity seems ridiculous to the highest degree, although in the *Anthemideae*, at least, nearly as much difference may sometimes be produced by the direct action of the environment. I confess that I cannot myself contemplate these two plants together without a strong feeling that they constitute a *reductio ad absurdum* of my classification. At the same time, when the whole series of plants is arrayed on a table so as to be directly compared, one does not know where to draw specific lines, and no good structural characters are apparent upon microscopical examination. I have tried consistently to follow the rule that species are not marked by the amount of divergence they exhibit, but by the fact of their discontinuity in nature. Species to me are like islands; sub-species are like peninsulas. A peninsula may be vastly more important and more distinct than the little island off the shores; but nevertheless it remains a peninsula, and the island, however small, is an island. Thus in the *Phileozera* series, *multiflora* and *anthemoides* are great peninsulae, and *Davidsonii* is a little island close to the latter, much nearer to it in characters than it is to the *chrysanthemoides* mainland.

I do not find any distinct evidence of the origin of species by mutation in *Hymenoxys*. On the contrary, the characters of the species are highly adaptive. Differences of environment appear to result in morphological differentiation, but when the environments are intimately connected, as they are in the north and south, not in specific segregation. When we find the plants growing on more or less isolated mountain ranges, as in New Mexico, there appears a strong tendency to form species, closely allied but definitely separated. Thus isolation brings about the *separation* of "species," without (in all probability) having anything to do with their *differentiation*. It is exactly similar to the case of mountain peaks which, submerged in the ocean, become islands, but the ocean had nothing to do with forming the peaks. Of course it will be granted that the matter is not so simple as here pictured; but I think that the facts warrant the suggestion made, admitting various minor qualifications.

Notwithstanding the evident plasticity of the species, they are more nicely adjusted to their surroundings by true racial characters than one would at first suspect. Thus *H. Vaseyi* appears to remain in the Organ Mountains, although the rains must often wash its seeds down to the adjacent lowlands. *H. floribunda utilis* insists upon occupying quite high altitudes in central Colorado, although other *floribunda* forms (in New Mexico and Arizona) give it a precedent for going lower; and what is perhaps more curious, it has not appeared at all on the east side of the front range. Then again, *H. floribunda utilis* ceases abruptly in central Colorado, and going a little north we find abruptly beginning and very abundant the large-headed *H. Richardsoni macrantha.* Now it is difficult on the face of things to say why *macrantha* should not be common as far south as Santa Fé, and *floribunda* as far north as Wyoming.

✓ **Hymenoxys Richardsoni** (Hooker)

Picradenia Richardsoni Hooker, Flora Boreali Americana, **1**: 317. *pl. 108.* 1833.

Actinella Richardsonii Nuttall, Trans. Amer. Phil. Soc. **7**: 379. 1841.

I am greatly indebted to Mr. O. F. Cook for a copy of the original description and a photograph of the plate. The description is as follows:

"*Radix* subfusiformis, lignosa, descendens, ramosa, superne divisa. *Caules* subspithamaei, erecti, rigidi, glabri, striati, superne ramosi. *Folia* 3–4 uncias longa, lineari-filiformia, *caulina* pauca; omnia pinnatifida, laciniis paucis, remotis, rarius iterum divisis, glanduloso-atque pellucido-punctatis, obscure unicostatis. *Pedunculi* terminales, uniflori. *Flos* [*i. e.* caput] majusculus. *Involucrum* hemisphaericum, impresso-punctatum, glandulosum, subpubescens; foliolis oblongis imbricatis, exterioribus inferne coadunatis. *Rachis* (seu *receptaculum*) conica, carnosa, punctata, ebracteata. *Flosculi radii* ligulati, obovato-oblongi, lutei, tubo praecipue glandulosi, apice dentibus 3 grossis; *disci* tubulosi, 5-dentati, flavi, glandulis valde amaris tecti. *Antherae* subexsertae. *Stigmata* inclusa, breviuscula, apice incrassata et hirsuta. *Achenium* oblongum, superne latius, pilosum praecipue apicem versus. *Pappus* paleaceus, paleis 6–7, erectis, ovatis, acuminatissimis, membranaceis.

"HAB. About Carlton House, on the Saskatchawan. *Dr. Richardson.* — Allied to *Hymenoxys* of Cassini, in the nature of the pappus: but very different in the involucre and habit."

The plate shows three rather short, branched stems arising from a thick and evidently perennial root; the basal leaves numerous, with linear divisions; the rather long naked peduncles extending beyond the leaves, the heads large for the size of the plant, and not very numerous; the rays broad and conspicuous, four-nerved, and tridentate apically; the outer bracts united nearly to the middle, the inner similar to the outer, and not or hardly surpassing them; the receptacle obtuse-conical, somewhat broader than high; the achene stout and rather short, hairy; the pappus-scales long-acuminate, but not half the length of the disc-corolla.

This is a plant of the type of *Picradenia macrantha*, "*P. ligulaeflora*" and "*P. pumila*." Comparing it with the type specimens of these three, we find characters as indicated in the table on page 470.

The roots are practically the same in all four. The foliage does not differ in any important respects, but is more wiry, and pallid, in *P. pumila*. According to the figure, the foliage of *P. Richardsoni* is also more wiry than that of *P. macrantha* or *P. ligulaeflora*. The pappus-scales in *P. ligulaeflora* are long-awned, decidedly more produced than in the others.

According to the data on the type sheets, it seems that *P. macrantha* flowers earlier than *P. ligulaeflora*. *P. pumila* occurs on "dry clayey hills" in western Wyoming. *P. ligulaeflora* on dry clayey alkaline ridges or flats on the open plains. *P. macrantha* on open stony slopes. The two extremes of this series are *P. macrantha* and *P. pumila*; *P. ligulaeflora* is fairly intermediate, while *P. Richardsoni* leans towards *P. macrantha*.

The above remarks are based only on the types of the four species named. When one comes to examine specimens from numerous localities, it appears impossible to maintain them as separate species, owing to the existence of various intermediates. This seems strange, considering how totally different *P. macrantha* and *P. pumila* are, and I am not certain that detailed field study might not modify the conclusions here reached; yet with the

P. Richardsoni Hook.	*P. macrantha* A. Nelson.	*P. ligulaeflora* A. Nelson.	*P. pumila* Greene.
Plant about 13 cm. high.	Plant 13 to 18 cm. high.	Plant about 13 cm. high.	Plant about 6 cm. high.
Heads large, rays shorter than in *P. macrantha*.	Heads large, rays up to 15 mm. long, very bright yellow.	Heads medium-sized, rays not so well developed as in *P. Richardsoni*, pale yellow.	Heads about as in *P. ligulaeflora*.
Peduncles evidently extended beyond the leaves.	Peduncles evidently extended beyond the leaves.	Peduncles hardly extended beyond the leaves.	Peduncles hardly extended beyond the leaves.
Outer bracts joined nearly to middle but variable.	Outer bracts variable, perhaps rather less united.	Outer bracts variable, joined to middle or only one-third.	Outer bracts joined to middle or less.
Inner bracts lanceolate, not fimbriate, gradually narrowed to tip. (Thus much as in *P. odorata!*)*	Inner bracts broad, strongly white fimbriate, suddenly narrowed to a green acuminate apex.	Inner bracts as in *P. macrantha* but the apical part shorter, and pale yellowish like the rest of the bract.	Inner bracts practically as *P. ligulaeflora*.
Achenes of disc-florets about half length of their corollas.	Achenes of disc-florets about or hardly over half length of their corollas.	Achenes of disc-florets narrower in proportion to their length, much more than half length of their corollas.	Achenes of disc-florets practically as in *P. ligulaeflora*, not greatly shorter than their corollas.
Receptacle rounded.	Receptacle rounded.	Receptacle low, rather more conical.	Receptacle more conical, or subcylindrical.
?	Hair on achenes tinged with reddish; pappus-scales white reddish at base.	Hair on achenes white; pappus-scales white, or slightly reddish at base.	Achenes reddish, but their hair white, except at base; pappus-scales white.
Pappus-scales not half length of disc-corolla.*	Pappus-scales about ⅔ length of disc-corolla.	Pappus-scales about three-fourths length of disc-corolla.	Pappus-scales hardly two-thirds length of disc-corolla.
Type from Carlton House, Saskatchewan, British America.	Type from Fort Steele, Wyoming, collected by A. Nelson, June 18, 1898.	Type from plains near Laramie Peak, Wyoming, collected by A. Nelson, Aug. 6, 1895.	Type from Rock Creek, Wyoming, collected by E. L. Greene, July 10, 1896.

material in hand I cannot satisfactorily distinguish more than one species with several races. Those who disagree with this conclusion will not feel obliged to follow the nomenclatural changes involved.

It would be possible to go to an opposite extreme, and found a large number of specific names on the various combinations of slight characters of the bracts, pappus, achenes, etc., presented by the different specimens. I should not object at all to naming races on slight characters or combinations of characters, if it were possible to prove that they possessed local constancy; but obviously,

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* But see first footnote on page 472.

only field-study could determine this. Specimens collected at the same locality in Wyoming in different years show differences in the bracts, apparently due to differing meteorological conditions, most probably conditions of drought and moisture. The same causes may have something to do with the differences between specimens of *P. floribunda* collected in different years near Santa Fé, N. M. Prof. K. Pearson, in his recent experiments, has found it hard to separate the effects of different seasons from those dependent on genuine racial differentiation, except after studies extending over considerable periods of time.*

In the Rocky Mountains there often exist in close geographical proximity very different soils, differing in the amount of moisture they contain, in their texture, in their chemical constituents, or in all of these things. It remains to be shown how far these soil differences are the immediate and direct causes of differences in plants, and this can only be done by experiment. Experience suggests that in the main the apparently different plants of, *e. g.*, rocky hillsides and alkaline flats, are really specifically different in the majority of instances, and could not be artificially interchanged. This conclusion is supported by the fact that these plants are often so very different (*e. g.*, generically so) that the idea of their characters being non-hereditary does not suggest itself, and the fact that they do not spread to the contrasted environment is evident. I should, therefore, feel very well disposed to consider *P. macrantha* and *P. ligulaeflora* perfectly distinct species, were it not that I cannot exactly state with the herbarium material before me, where one leaves off and the other begins. Professor Aven Nelson, who knows them in the field, believed them to be distinct.

HYMENOXYS RICHARDSONI (Hooker) typical

The type of this species and of Hooker's genus *Picradenia* came from the most northern locality (about 53° N. Lat.) in which *Hymenoxys* has yet been found. In two particulars the figures indicate a plant differing from anything I have seen, (1) the inner bracts are not fimbriate, (2) the pales of the pappus are remarkably short, not half the length of the disc-corolla. I should be in-

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* Biometrika, 2: 145–165. 1903. In *Ficaria Ficaria*, "the influence of environment and of season are of supreme importance and screen differences due to local race."

clined to attribute these peculiarities to the carelessness of the artist (although the figures seem carefully drawn), were it not that an inscription at the corner of the plate indicates that Sir William Hooker himself made the drawings.*

Hymenoxys Richardsoni pumila (Greene)

Picradenia pumila Greene, Pittonia, **3**: 271. 1898.

Professor Aven Nelson considers this a synonym of his *P. ligulaeflora*, but Dr. Greene (in litt.) states that it has never seemed to him the same. Dr. Greene has very kindly allowed me to study his type specimens, and I think the plant should be separated from subsp. *ligulaeflora*.† The typical specimens of the two plants look very different. *P. ligulaeflora* being taller, with straight erect stems, and greener foliage, exhibiting characters usually regarded as mesophytic. *P. pumila*, on the other hand, is a genuine xerophyte, with short stems, inclined to spread outwards, and pale wiry foliage. *P. ligulaeflora*, as its author states, is a plant of the open plains in Wyoming; the type of *P. pumila* came from Wyoming, but much further west, and as I recognize the plant it is alpine and northern. The following are referred to *H. Richardsoni pumila*:

WYOMING. — Rock Creek, *Greene*.

COLORADO. — North Park, Larimer Co., July 13, 1896, *G. E. Osterhout*. This has the foliage and aspect of subsp. *pumila*, but is taller (about 9 cm.); receptacle quite high, higher than broad, rounded at end; achenes very red; pales of pappus about ⅔ length of disc-corollas.

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* I have now examined the type material of *Picradenia Richardsoni* at Kew; it is abundant (covering two sheets) and in excellent condition. To my surprise the peculiarities noticed in the original figure do not exist. The inner and outer bracts are not alike; the inner are strongly fimbriate as usual in the group, the outer are united quite high up. The pappus-scales are ferruginous, and are long-pointed, reaching far beyond the middle of the corollas. Large, well-developed heads are as much as 31 mm. across, including the rays. In view of all this, I do not think it is practicable to separate *macrantha* from *Richardsoni*.

† Dr. Greene says the type is from Western Wyoming. Professor Nelson writes, "the type of *P. pumila* was the Laramie Plains near Rock Creek, and not far from the type locality of *P. ligulaeflora*." Are there two Rock Creeks? A specimen which Professor Nelson had labeled *pumila* is not that form.

UTAH. — Mt. Ellen, Henry Mts., Garfield Co., Utah, 10,000 ft., July 25, 1894, *M. E. Jones:* top of Salina Pass, 8,200 ft., June 16, 1894, *M. E. Jones.* The Salina Pass material is poor; that from Mt. Ellen is good, and looks very like some specimens of *H. Richardsoni ligulaeflora,* especially those from Montana. However, it has the pale foliage of *pumila,* and the comparatively short pappus-scales, hardly ⅔ length of disc-corolla. The achenes are of the long type.

ASSINIBOIA. — Medicine Hat, June 2, 1894, *John Macoun;* Cypress Hills, August, 1880, *John Macoun;* Wood Mountain, June 6, 1895, *John Macoun.* This was confidently expected to be true *H. Richardsoni,* the material coming from localities about 200 miles (or some less?) south of Carlton House. It resembles *H. Richardsoni* in the conspicuous flowers, with large orange rays, and the inner bracts, though fimbriate, do gradually taper to the apex, as in the figure of *P. Richardsoni.* The foliage much resembles that of subsp. *pumila,* and the stature is about the same, though the largest plants are as much as 10 cm. tall. The Wood Mountain plant is more dwarfed than the others (height 6 to 8 cm.), and has the achenes short (a *Richardsoni*-character), their hair shining pale ferruginous; the pappus-scales are ferruginous basally, and have long linear awns, the whole ¾ length of disc-corolla, as in subsp. *ligulaeflora.* The Medicine Hat plant, with the same conspicuous orange-rayed heads, has the achenes fairly long (considerably over half length of disc-corolla), their hair strongly ferruginous; the pappus-scales are light ferruginous, darker at base, ⅓ length of corolla, the oval portion very large, the apical portion linear and about ⅓ length of the whole. In this plant the achenes are much longer than in true *H. Richardsoni* The Cypress Hills material is poor; the achenes are long, as in subsp. *ligulaeflora,* the pappus-scales also very long; hair of achenes ferruginous.

It will be apparent from the above that the Assiniboia plants are variable and are not exactly *H. Richardsoni* or subsp. *pumila.* Assuming the figures of *P. Richardsoni* to be correct, I cannot refer them there, and on the whole they go best here.

It is difficult to decide how to indicate such puzzling forms in the nomenclature. In the present paper I shall use the term variety as meaning something which appears to possess distinctive racial characters, and yet is not thoroughly established (in human knowledge, not in fact!) as a subspecies. As we know more, some such "varieties" will be reduced to forms, mutations or synonyms, while others will rank as subspecies or even valid species.

Following this plan, the Assiniboia plant (taking the Wood Mountain plant as the type) may stand as var. **Macouni.** The type sheet is in the herbarium of Dr. E. L. Greene. The others are in herb. Mo. Bot. Garden and U. S. Nat. Museum.

Hymenoxys Richardsoni ligulaeflora (A. Nelson)

Hymenopappus ligulaeflorus A. Nelson, Bull. Wyoming Exper. Sta. 28: 135. 1896.

Originally described as *Hymenopappus ligulaeflorus*, this was later transferred to *Picradenia* by its author (*cf.* Bull. Torrey Club, **25**: 378. 1898). Professor Nelson has very kindly allowed me to study the type specimens. The characters of this plant have been set forth above, in the table on page 470; the following material is referred to it:

WYOMING. — Plains near Laramie Peak, *A. Nelson;* North Vermillion Creek, Sweetwater Co., July 17, 1897, *A. Nelson;* Steamboat Lake, July 2, 1896, *G. E. Osterhout;* rolling plains between Sheridan and Buffalo, 3,500–5,000 feet, June 15 to July 15, 1900, *Frank Tweedy;* on clay, saline flats, Antelope Basin, Albany Co., July 8, 1900, *A. Nelson.* These localities are in Albany and Sweetwater counties, southern central Wyoming, except the one between Sheridan and Buffalo, which is in north central Wyoming. The North Vermillion Creek plant has the long achenes, reddish like subspecies *pumila;* pappus awns hardly so long as in type; heads larger than typical. The Steamboat Lake plant agrees with the type. The Tweedy plant is variable in height, 8 to 17 cm., the smaller ones looking like subspecies *pumila;* the achenes are ferruginous, shorter than in the type; foliage rather approaching subspecies *pumila;* inner bracts and pappus-scales as in subspecies *ligulaeflora.* The Antelope Basin plant is like the type, but the rays are more orange; achenes long, their hair silvery white; pappus white, about normal; inner bracts green-tipped.

MONTANA. — Helena, July 27, 1887, *R. S. Williams.* Appearance of subspecies *ligulaeflora;* bracts agree; achenes broad but long, with copious ferruginous hair; pappus-scales ferruginous at base, fairly long-awned; the achene is more like that of the Assiniboia plant than that of typical subspecies *ligulaeflora.* Also collected at Helena by *Rev. F. D. Kelsey*, July 4, 1888.

COLORADO. — Rocky Mts., lat. 40–41°, 1868, *Geo. Vasey.* Rather tall.

It will be observed that it is in northern Wyoming and Montana that subspecies *ligulaeflora* passes into subspecies *pumila*, whereas in southern Wyoming and northern Colorado it passes into subspecies *macrantha.* One of the Helena sheets (*Kelsey*) shows conspicuous rays which seem to have been orange, recalling the plant of Assiniboia. The plant, however, is 15 cm. high.

Hymenoxys Richardsoni macrantha (A. Nelson)

Picradenia macrantha A. Nelson, Bot. Gaz. **28**: 130. 1899.

Professor Nelson says, allied to *P. ligulaeflora*, "from which its larger size, conspicuous rays, longer peduncles, fewer and less resinous heads serve to separate it."

The following material is referred to subspecies *macrantha:*

WYOMING. — Fort Steele, *A. Nelson;* clayey draws, Cooper Lake, Albany Co., June 17, 1901, *Leslie N. Goodding;* Centennial Hills, August 19, 1895, *A. Nelson.**

These localities are all in the southern part of the state. The Centennial Hills plant may be called var. **Nelsoni**; it is remarkable for its gigantic heads, up to 2 cm. across, exclusive of the rays, which appear to have been very pale. Its achenes are broad and reddish, and the shining white pappus-scales are barely two-thirds the length of the disc-corolla. It is in the herbarium of the University of Wyoming. The Cooper Lake plant is labeled *P. ligulaeflora*, and has the stature of that plant, but the large flowers, with conspicuous orange rays, are precisely those of subspecies *macrantha.* The inner bracts are green-tipped; peduncles hardly so long as in typical *macrantha;* achenes rather short;

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* Professor Nelson writes me that the soil at the Centennial Hills is mostly gravelly and free from alkali, while that at Fort Steele where subspecies *macrantha* occurs is a heavy saline clay.

hair of achenes and pappus white; pappus only moderately long. It is this material, and that from Como, Colorado, that seem to me to break down the distinctions between subspecies *macrantha* and *ligulaeflora*.

COLORADO. — Central Colorado, as far south as Park and Lake Counties; further south it is replaced by *H. floribunda*. Como and near Como, Park Co., 9,800 feet, July 23, 1897, *C. S. Crandall;* Twin Lakes, August 7, 1873, *J. M. Coulter;* South Park, 8,500 feet, September 17, 1878, *M. E. Jones;* South Park, July, 1873, *John Wolf;* lat. 39–41°, alpine and sub-alpine, *Hall & Harbour;* South Park, 1891, *Alida Lansing*. As it goes southward, the plant reaches quite high altitudes. One sheet from Como is said to have come from a meadow, showing that the mesophytic appearance of the plant is not wholly illusory. The altitude of this meadow is given as 9,775 feet; the date, August 3, 1895. This appears to be very good *macrantha*, as to general appearance, achenes and pappus; but the sheet from near Como, certainly not a different plant in any important respect, is labelled *P. ligulaeflora* by Professor Nelson. This has the heads nearly as large as in subspecies *macrantha*, but the achenes are of the long type; hair of achenes silvery-white; pappus-scales white, ferruginous at base. The habitat is very different from that normal to subspecies *ligulaeflora*. One sheet of the Hall and Harbour material (herb. Cal. Acad. Sci.) has the heads (excl. rays) only 9 to 10 mm. broad, and is fairly intermediate between *macrantha* and *ligulaeflora*.

The Twin Lakes material has all the appearance of subsp. *macrantha*; but the achenes, though broad as in *macrantha*, are long enough for *ligulaeflora*; hair of achenes ferruginous; pappus-scales rather short, as in *macrantha*. Another sheet from Twin Lakes is marked July 22, and is just coming into flower. The Wolf material from South Park has the achenes short, with deep ferruginous hairs; pappus-scales very strongly ferruginous basally, not very greatly over half length of corolla.

UTAH.— Emery, 7000 ft., June 16, 1894, *M. E. Jones*; near Emery, on clay, June 16, 1894, 7000 ft., *M. E. Jones*; Cannonville, 6000 ft., May 28, 1894, *M. E. Jones*. These plants, from southern Utah, are not typical, the flowers being on the average smaller (heads excluding rays about 10 mm. diam.— 12 to 16 in *macran-*

tha), with pale yellowish, coriaceous, well-keeled bracts, the inner not at all green-tipped; the foliage paler, though the leaf segments are as broad and flat as they are in true *macrantha;* the rays evidently shorter, and apparently more orange-tinted. The achenes are broad, of moderate length, with copious pale ferruginous hairs; the pappus-scales are fairly long, dilute ferruginous, darker basally. The receptacle is quite small. This plant may be designated var. **Utahensis,** the Emery sheet in the National Museum (234968) being taken as typical. Compared with *H. floribunda*, the plant is not so tall, and the heads are larger; the leaves also are longer, and their segments broader. Two other sheets must also be referred to var. *Utahensis*, as follows: Capitol Wash, 7000 ft., evidently in red soil, July 19, 1894, *M. E. Jones.* A plant with longer slender stems, the longest about 25 cm.; foliage pale; achenes more slender, white-haired. This tends towards *floribunda.* Rabbit Valley, 6800 ft., July 23, 1875, *Lester F. Ward.* About 15 cm. high, very leafy at base, the leaf-segments narrower; heads (excluding rays) about 10 to 13 mm. diameter; achenes broad, with ferruginous hair. All these Utah plants appear to be essentially of one type, which in its more extreme forms (*e. g.*, that from Capitol Wash) does not even suggest subsp. *macrantha.*

A good specimen of var. *Utahensis* from near Emery is in the herbarium of the California Academy of Sciences (33875).

Hymenoxys Lemmoni (Greene)

Picradenia Lemmoni Greene, Pittonia, **3**: 272. 1898.

The original description is as follows:

"Evidently perennial, glabrous and strongly punctate, the rather slender stems 1½ feet high, not rosulately nor densely leafy at base; the lowest leaves on rather coarse elongated erect petioles 5 or 6 inches long, the blade only 2 inches, pinnately cut into about 3 pairs of divaricate linear lobes: heads middle-sized in a corymbose cyme; bracts of the involucre subequal, the outer series ovate-lanceolate, the inner oblong, obtuse. Mountains of California, probably northward; collected only by J. G. Lemmon, and by Dr. Gray erroneously referred to his *A. biennis.*"

This plant is easily recognized by its tall upright growth, with large heads and conspicuous rays, and comparatively coarse erect foliage. It has the characters of a mesophyte, and could be derived from the type of *P. macrantha* by the elongation and reduction in number of the stems. The heads (excluding the rays) are about 12 to 17 mm. diameter. The roots are stout (up to 10 mm. diam.), but I do not feel perfectly sure that the plant is more than biennial. The petioles of the basal leaves seem usually to be not over 7.5 cm. long. The species appears to be common in the region about Mt. Shasta, northern California (where it is the only *Picradenia*), and it extends practically unaltered into western Nevada. Further east it is replaced by a distinct subspecies. Its characters separate it sharply from the xerophytic *H. canescens biennis.* Miss Eastwood had recognized it as a new species before the description of *P. Lemmoni* was published. The following material is referred to *H. Lemmoni:*

CALIFORNIA.— North side of Mt. Shasta, Siskiyou Co., 5000–9000 ft., June 11–16, 1897, *H. E. Brown*; Sierra Valley, June, 1879, *J. G. Lemmon;* Sierra Nevada Mts., 1875, *J. G. Lemmon;* near Edgwood, Siskiyou Co., July 28–21, 1892, *Dr. E. Palmer;* on Shasta River, 14 July, 1876, *Edw. L. Greene;* near Yreka, Siskiyou Co., July 14, 1876, *Edw. L. Greene;* journey from Willametta to California, *Capt. Wilkes Expl. Exped.*

NEVADA.— Star valley, July 21, 1876, *Edw. L. Greene.*

The Mt. Shasta plant collected by H. E. Brown is about 3.5 dm. high, perfectly glabrous, the stem pale and shining, the leaves strongly punctate. The lowest leaves are on rather coarse elongated erect petioles 6 to 7 cm. long, the blade 3 to 5.5 cm., pinnately cut into lobes which are about 2 mm. broad and six or seven in number. The heads are ten or eleven in number, close together, 11 to 14 mm. diameter (excluding rays), rays lemon yellow and about 10 mm. long. Bracts pale yellowish green; outer bracts about 10 in number, united beyond the middle, basal two-thirds strongly thickened and subcarinate; inner bracts broad, hardly surpassing outer, pointed-tipped, with more or less fimbriate sides. Pappus pales a little over half length of disc-corolla, long-acuminate but not aristate, pale ferruginous, as also is the hair of the achenes. The Sierra Valley plant has the outer bracts deeply divided, carinate, blunt, without dark green tips; achene-hairs ferruginous; pappus-pales long-pointed, white, ferruginous at extreme base (like the Star Valley plant). Another Sierra Valley sheet (hb. Mo. Bot. Garden) is clearly the same thing, but it has the pappus-pales wholly ferruginous, long-pointed but hardly half length of disc-corolla; leaf-segments narrower; inner bracts often bifid at end. The plant from near Edgwood has the leaf-segments narrower than usual; outer bracts narrow; achene-hairs ferruginous; pappus-pales aristate, white with a ferruginous tinge. The Shasta River plant has the achenes and pappus like the last. The plant from near Yreka has the achene-hairs deep ferruginous; pappus ferruginous. The Star Valley plant (which Dr. Greene in litt. thought might prove distinct) has the appearance of the California ones, with large heads and clear yellow rays; the outer bracts are narrow and deeply divided, 13 in number; hair of achenes quite bright ferruginous; pappus-pales strongly contrasting, pure shining white except the extreme base, which is ferruginous. The plant grows to a height of 3 to 4 dm.

All the above plants seem to me essentially the same. They agree with *H. Richardsoni* in the short pappus-pales, but the much greater height and mesophytic habit are distinctive. I cannot understand how anyone, after a careful study, can doubt the validity of *H. Lemmoni* as a species.

Hymenoxys Lemmoni Greenei subsp. nov.

Picradenia biennis Greene, Pittonia, 3: 272, in part. 1898. (Not *Actinella biennis* Gray.)

This plant is similar to the true *H. Lemmoni*, but the heads are uniformly smaller. The basal leaves, as in *H. Lemmoni*, are always divided; the plant mentioned by Dr. Greene, with simple and linear basal leaves, is to be separated. Dr. Greene says, "probably only a winter annual," but I think the plant is biennial.

I take as typical of this subspecies Palmer's *261*, collected in 1877, "So. Utah, N. Ariz., etc.," in herb. Mo. Botanical Garden. There is a single reddish stem, smooth and striate; foliage abundant and erect, like true *H. Lemmoni;* stem-leaves much as in true *H. Lemmoni*, but broader, the foliage intermediate in breadth between *H. Lemmoni* and *H. helenioides;* basal leaves about 11 cm. long, pinnately divided, with lobes 2–3 mm. broad; heads (excl. rays) 10–13 mm. diameter, averaging smaller than *H. Lemmoni* or *H. helenioides;* rays well developed; outer bracts divided to near base, 9 in number, broad basally, rapidly narrowing to an obtuse point; involucre not woolly, except some loose pubescence on margins of bracts; inner bracts about as long as outer, very broad, with short points, fimbriate; hair of achenes and pappus ferruginous, pappus-pales long-awned. According to Greene, Palmer's *261* is from Rock Creek, Utah. Other material referred here is as follows:

UTAH. — Deep Creek, July 28, 1891, *Marcus E. Jones.* In herb. Mo. Bot. Garden and herb. U. S. Nat. Mus., the two sheets exactly similar. Foliage not quite so broad, pale yellowish-green; two stems from one root; outer bracts about eleven, not rapidly narrowing.

NEVADA. — Huntingdon Valley (Elko Co., about 80 miles W. of Utah line), 6,000 ft., Aug., 1868, *Sereno Watson.* In herb. U. S. Nat. Mus. About 4 dm. tall; outer bracts deeply divided, not at all woolly; pappus-scales long-pointed, over half length of corolla, ferruginous.

ARIZONA. — "Northern Arizona," *Mrs. Thompson*, 1872. In herb. U. S. Nat. Mus. Pappus and hair of achenes ferruginous; pappus-scales very long-awned, in some cases not far short of length of disc-corollas; much woolly hair between outer bracts; upper part of stems hairy; foliage narrower than typical. The outer bracts are numerous, and separated far down. This is perhaps a distinct variety.

Hymenoxys subintegra sp. nov.

An apparently perennial and xerophytic plant, about 2 dm. high, with a stout base. Foliage pale, canescent because minutely hirsute, similar in type to that of *H. Lemmoni Greenei,* but the basal leaves broad-linear and entire; cauline leaves frequently with a couple of lateral lobes. Breadth of leaves or their divisions up to 3 mm. Root about 7 mm. broad; stems three, not very stout; flower-heads about 17, at various heights (inflorescence not at all flat-topped as in the *macrantha* forms, more spreading than in the *Lemmoni* forms); size of head moderate, 10–13 mm. diam. excluding rays; rays deep yellow (not orange as in *H. helenioides*);

stems very slightly reddened; outer bracts 12, deeply divided, basally thickened, apical part dark green and very woolly; inner bracts not or barely surpassing outer; hair of achenes, and pappus-scales, shining but slightly sordid white; pappus-scales extremely large and elongate, ending in a linear tip which is nearly equal to the disc-corolla. (PLATE 22, FIGURE 1.)

Nagle's Ranch, Arizona, 7,600 ft., Sept. 13, 1894, *Marcus E. Jones.* U. S. Nat. Mus. *234966.*

I have tried over and over again to convince myself that this plant is a subspecies of *H. Lemmoni*, but there seems nothing to do but to treat it as distinct. It may very well be regarded as a derivative of *H. Greenei*, which has become adapted to a xerophytic existence. The character of the pappus at once separates it from *H. Cooperi.*

Hymenoxys helenioides (Rydberg)

Picradenia helenioides Rydberg, Bull. Torrey Club, **28**: 21. 1901.

Apparently biennial; similar in type of foliage and mode of growth to *H. Lemmoni* (not at all similar to *H. canescens biennis!*); rather taller, up to 5 dm.; foliage pale yellowish-green; leaf-segments much broader, of basal leaves up to 9 mm. broad, of stem-leaves to nearly 4; lowest leaves entire to bipartite, up to 18 cm. long; stem strongly striate, not reddened; involucre beset with white woolly hairs; outer bracts narrow and divided almost to base; disc-corollas only hairy at top; rays orange; hair of achenes, and pappus-scales, pale ferruginous; pappus-scales long-acuminate, practically as in *H. Lemmoni*, mostly much more than half length of disc-corolla. The receptacle is high-conical, rounded at apex; inner bracts very long fimbriate; outer bracts far exceeding inner, narrow, green, straight-sided.

I have seen only one sheet, from Sangre de Cristo Creek, Colorado, 7,200–8,100 ft., July 2, 1900, *Rydberg & Vreeland*, in hb. Univ. of Wyoming. This is from the original lot. The species is allied to *H. Lemmoni*, but as far as present evidence goes is quite distinct. It seems remarkable that such a striking plant should so long have escaped discovery. The plant is evidently a mesophyte.

Hymenoxys canescens biennis (Gray)

Actinella biennis Gray, Proc. Am. Acad. **13**: 373. 1878.
Picradenia biennis Greene, Pittonia, **3**: 272 (excl. descr.).

A tall xerophytic plant; base of stems not woolly, but with very numerous, much divided leaves, with linear segments. The foliage is not erect, as it is in *A. Lemmoni*, but divergent from the stem, with a strong tendency to curl, the whole appearance being very distinctive. The following particulars are based on a sheet (U. S. Nat. Mus. *27487*), representing the original lot, Dr. Palmer's *260*, collected in 1877 at Mokiak Pass, Arizona.*

Root large, 8 mm. diameter; a single stout (about 7 mm. diameter at base) strongly reddened main stem, profusely branched from the base upwards, the whole plant about 5.5 dm. high, with over 40 heads; leaves strongly punctate, practically glabrous; basal leaves very numerous, 6 to 8 cm. long, the divisions linear, not over 1.5 mm. wide; stem-leaves 3 to 5 cm. long, the divisions about 1.5 mm. broad: heads (excluding rays) about 15 mm. broad; rays deep ferruginous (probably originally yellow), large and conspicuous, 20 mm. long and about 6 broad; outer bracts 14, strongly punctate, narrow, pointed, with straight sides, divided

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* I am greatly indebted to Dr. J. M. Greenman for determining the true type of *A. biennis*. He writes (*litt.* Jan. 25, 1904) as follows:

"In looking up the original specimens on which *Actinella biennis*, Gray, Proc. Am. Acad., xiii, 373, was based * * * I find that which seems to me to be a most unfortunate circumstance, namely: there are under the name *Actinella biennis* apparently two species. The label for one of these is in the handwriting of Dr. Gray, and the locality given is 'Mokiak Pass, S. E. of St. George, Arizona,' and this label also bears the original number of Palmer, No. 260. The second plant bears a label in the handwriting of Dr. Watson, and the locality given is, 'Mokiak Pass, N. W. Arizona.' Although this second plant was passed upon by Dr. Gray in his work for the Synoptical Flora, I should assume the other must be the one to regard as the type of the species *A. biennis*, as it bears the original label in Dr. Gray's own handwriting, and the specimen has the large rays, and moreover is the one Dr. Gray had in mind when writing the description for publication.

"The differences between the two specimens under No. 260 of Palmer, as I see them, are as follows:

1. Stem suberect, much branched, 5 to 6 dm. high; heads large, including the rays 3.5 to 6 cm. in diameter; involucre biseriate; bracts more or less acuminate.
2. Stem erect, less branched than the preceding, about 3.5 dm. high; heads including the rays 3 cm. or less in diameter; involucre biseriate; bracts shorter than in the preceding, and of essentially the same length, the inner obtuse or subtruncate."

Of the above plants, No. 1 manifestly agrees with *U. S. N. M. 27487*.

nearly to base; inner bracts very broad, strongly glandular, with green subulate tips which extend beyond outer; disc-corollas densely pubescent; pappus-scales ferruginous, subulate-tipped, about half length of disc-corolla; hairs of achenes ferruginous.

In the herbarium of the Missouri Botanical Garden is another sheet bearing Palmer's number *260*. On it are two specimens; one only in bud and doubtful, the other in good flower and plainly *H. canescens biennis*. It is a smaller plant than that described above, the stem not branched until about 17 cm. from base, and there are only 14 heads. The outer bracts vary from broad to narrow on the same head. Still a third sheet of Palmer's *260* comes from the Redfield herbarium, now belonging to the Missouri Botanical Garden. This plant has a single stout reddened stem, branching about 4 dm. from base, with about 20 heads. The leaves are narrower than in the plant described as typical, and the stem is a little more scurfy. The heads agree with subsp. *biennis*; the outer bracts are 10, perhaps varying to more.

So far as I can see, all the above are one species; I presume the last described plant came from dryer ground than the type. At Mesilla Park, N. M., I have seen just the same sort of differences in the cruciferous genus *Sophia*, the specimens having single strict little-branched stems coming from higher, dryer ground.

Although *H. canescens biennis* was described from Arizona, it appears to be most abundant in Utah.

The following Utah material belongs here:

1. Pine Valley, 1874, *Dr. C. C. Parry*. Single stem about 4 dm. high, branching about one dm. from top, with three heads on long naked peduncles; foliage pale green, slightly scurfy, strongly punctate, the leaf-segments very narrow, not over one mm. wide, upper part of stem with only short inconspicuous leaves. Heads just like typical subsp. *biennis*, bracts similar but more hairy, inner bracts sometimes bifid-tipped; awns of pappus rather longer than in type, surpassing middle of disc-corolla. Another form of especially dry ground, apparently.

2. Silver Reef, 3,500 ft., May 4, 1894, *M. E. Jones*. Only in bud; very narrow linear leaf-segments; 12 outer bracts; stems several, four slender and coequal, all strongly reddish; root 7

mm. diameter. The manner of growth may result from the early destruction of the main axis by some animal.

3. Cañon above Richfield, 5,200 feet, June 5, 1875, *Lester F. Ward.* Only about 4 dm. high, with one to three new stems, but remains of the old stem of the year before. Pappus and achene-hairs ferruginous.

4. On grade south of Rockville, 4,500 feet, May 19, 1894, *M. E. Jones.* Single stems hardly 4 dm. high (one reddish, the other green), slightly lanulose at base, branching 1 dm. or less from top, with about six heads, averaging smaller than in the type, though some are as large; outer bracts 9 or 10, broad; inner very broad, strongly fimbriate, without produced tips. Pappus-scales and achene-hairs very pale, hardly ferruginous at all.

5. Near Rockville, 5,000 feet in gravel, May 19, 1894, *M. E. Jones.* Achenes and pappus more reddened than in the last.

Hymenoxys canescens nevadensis var. nov.

With the stature and appearance of *H. canescens biennis*, and the pappus of *H. canescens.* The type is from the Charleston Mts., Nevada, alt. 6–7,000 feet, 1898, *C. A. Purpus*, in herb. Calif. Acad. Sciences. It is about 75 cm. high, with a red stem, and looks exactly like subsp. *biennis;* outer bracts long, numerous and narrow; bristles of achenes bifid at tips; pappus-scales colorless, faintly stained with reddish-orange toward the base, their shape oval, more or less pointed, less than half length of disc-corolla. The lower part of the disc-corollas is densely covered with stout jointed hairs.

Hymenoxys canescens (Eaton)

Actinella Richardsoni var. *canescens* D. C. Eaton, Bot. King Exp. 175. 1871.

Picradenia canescens Greene, Pittonia, 3: 271. 1898.

H. canescens and *H. canescens biennis* might be considered distinct species, were it not that the var. *nevadensis* combines the characters of the two. Including *biennis* and *canescens* in the same specific category, it is natural to think of *biennis* — a plant better developed and apparently more common than the other — as the typical form of species, and the treatment by Gray in the Synoptical

Flora has already accustomed us to this way of regarding the matter. I have accordingly placed *biennis* at the head of the *canescens* combination, although the requirements of priority, as I understand them, oblige us to write *H. canescens* and *H. canescens biennis*. In Dr. Greene's treatment of *Picradenia*, *P. canescens* is placed far from *P. biennis*, but it appears that Dr. Greene did not know the real *P. biennis*.

The essential characters of the true *H. canescens* are as follows: Stature small, height usually from 8 to 18 cm.; large heads like *biennis*, 15 mm. broad excluding rays; rays about as in *biennis*, but hardly so large as in the type of that subspecies; plant decidedly hoary, but hardly more so than Jones' *biennis* from grade south of Rockville; bracts about as in subsp. *biennis*, inner not or hardly surpassing outer; pappus-scales short, hardly half length of disc-corolla, broad, pointed but not at all aristate; habitat at comparatively high altitudes in Nevada. The stems are one or several, not especially slender, reddish. The plant may be perennial, but if so, so is subsp. *biennis*.

I have seen *H. canescens* from only two localities:

1. E. Humboldt mts., Nevada, 9,000 ft., Aug. 1868, *Sereno Watson*. Pappus-scales and hair of achenes entirely ferruginous; leaf-segments a little broader than in the Mt. Gabb plant; basal part of disc-corollas glandular.

2. Rocky slopes, Mt. Gabb, Palmetto R., Nevada, 8,000–9,000 ft., May–Oct., 1898, *C. A. Purpus*. One stem is 21 cm. tall. Pappus-scales white, varying to ferruginous in same head; sometimes about the basal half ferruginous, the rest yellowish-white. These plants are more hoary than those collected by Watson.

✓ **Hymenoxys floribunda** (Gray)

Actinella Richardsonii var. *floribunda* Gray, Pl. Fendl. 101. 1849.

Picradenia floribunda Greene, Pittonia, **3**: 272. 1898.

Described originally from "around Santa Fé," New Mexico. Heller and Greene have considered it a valid species, and I cannot doubt the correctness of this opinion. It maintains its characters where I have seen it in New Mexico, covering, or rather dotting over, many acres of ground; and the tons of the Colorado plant which have been gathered for the extraction of rubber show it to be no less uniform near the northern limit of its range. This refers of course to the gross characters; there is much variation in small details. Dr. Greene thus characterizes *P. floribunda:* "Taller and more slender than *P. Richardsonii,* the wool at base of stem more silky; stems repeatedly branched; heads many times more numerous, of less than half the size, forming a broad flat-topped inflorescence; paleae of the pappus lanceolate, some slenderly acuminate, others not so."

The distribution of the species includes the southern half of Colorado, at comparatively high altitudes on the west side of the front range; northern New Mexico, as far east as Raton, and the region about San Francisco Mountain, Arizona. The characters of the forms of *H. floribunda,* and of the allied *H. Earlei,* may be compared as shown in the table on the opposite page.

H. Earlei, by its rather peculiar appearance and especially the cut of its foliage, appears to be a valid species. The other three are unquestionably races of one species (*H. floribunda*). The original description of **H. floribunda utilis** (PLATE 20) under the name *Picradenia floribunda utilis* (Bull. Colo. College Museum, No. 1, December 11, 1903) is as follows:

"Similar in appearance and mode of growth to *P. floribunda* (a topo-type collected by Heller at Santa Fé, N. M., compared) but easily distinguished by the pale yellowish, broad and subovate outer bracts, with strongly concave outer margins, and the back conspicuously keeled; these bracts are united about to the middle. (In *P. floribunda* these bracts are greener, long and pointed, with straight sides, and not united quite so far as the middle). The disc-corollas have a rusty-red ring in the throat, which appears to be absent in *floribunda.* Rays narrower, about 2 mm. in diameter. As far as the specimens seen go, the basal part of the stems is much more robust in *utilis* than *floribunda.*

"Compared with *P. macrantha* and *P. ligulaeflora,* the rubber plant differs conspicuously in its taller stature and smaller flowers. It is also readily distinguished from *P. Davidsoni* and the other described species of the genus. In *P. Davidsoni* (cotype examined) the outer bracts are narrower and shorter than the inner, and the inner are much more pointed than those of *utilis.* The disc-corollas of *Davidsoni* are considerably broader at the top than those of *utilis.* The length of the disc-corollas in *Davidsoni* is 3½ mm., in *utilis* and *floribunda* 4, in *ligulaeflora* 5. In *P. ligulaeflora* and

H. floribunda type.	*H. floribunda utilis.*	*H. floribunda arizonica*	*H. Earlei.*
Height of well-developed plant 30 cm.	Height of well-developed plant 26 cm.	Height of well-developed plant 25 cm.	Height of well-developed plant 32 cm.
Lower stem-leaves about 55 mm. long, their divisions very narrow, 1 mm. broad or less.	Foliage essentially as in *floribunda* type.	Foliage essentially as in *floribunda* type.	Lower stem-leaves about 125 mm. long; their segments much broader, up to 2.5 mm.
Stems numerous, not very woolly at base; the bases of the old leaves ferruginous.	Stems very numerous, very woolly at base; the bases of the old leaves pallid.	Stems several, not very woolly at base; the bases of the old leaves pallid.	Stems fewer, scarcely at all woolly at base; base of stems reddened, which is not the case in the other three.
Heads (excl. rays) about 7 mm. diam.	Heads (excl. rays) about 6 mm. diam.	Heads (excl. rays) about 8 mm. diam.	Heads (excl. rays) about 7 mm. diam., flatter than the others, except perhaps *arizonica*.
Bracts pale, outer bracts more resinous than in *utilis*, and not quite so much united.	Bracts pale yellowish; outer bracts united far up.	Bracts about as in *floribunda* type.	Bracts formed about as in *floribunda*, but outer bracts conspicuously tipped with dark green.
Pappus and achene-hairs deep ferruginous.	Pappus and achene-hairs shining silvery white.	Pappus ferruginous at base, the rest whitish; achene-hairs pale ferruginous.	Pappus and achene-hairs shining ferruginous, the pappus very dark. Achenes short.
Pappus-scales long-pointed (aristate) about ⅔ length of disc-corolla.	Pappus-scales fairly long-pointed, but not quite so long as in typical *floribunda*.	Pappus-scales broad, shorter-pointed.	Pappus-scales broad, short-pointed, as in *arizonica*.
Rays yellow.	Rays yellow.	Rays rather light orange.	Rays orange.
Type from vicinity of Santa Fé, N. M., 7000 ft.	Type from vicinity of Buena Vista, Colo., 8000 ft.	Type from near Flagstaff, Ariz., 7000 ft., *MacDougal.*	Type from Mancos, Colo.

macrantha the receptacle is hemispherical and somewhat fimbrillose, these species having in part the characters of *Gaillardia;* in *floribunda* and *utilis* the receptacle is conical and bare."

When I published this description, I was half inclined to treat *utilis* as a species, and did not in the least doubt that it should have at all events subspecific rank. Further studies, however, have shown that the characters of the bracts and the color of the pappus are not to be relied upon to the extent I had supposed; and moreover, the real type of *H. floribunda*, Fendler's plant, has the bracts nearly as in *utilis*. The characters of *utilis* are therefore largely evanescent, and until further studies can be made, especially in the field, it will be best to treat it as a variety; *i. e.*, as representing a tendency or type of uncertain taxonomic rank.

H. floribunda arizonica, here introduced as new, may also be treated as a variety. It has the appearance of *H. floribunda*, but it is characteristic of all the material from the region about San Francisco Mountain that the pappus-scales are abbreviated. It may be, possibly, that the abbreviation of the pappus tends to prevent the seeds from travelling so far as they otherwise would, a character which might be of service to plants growing on elevated ground surrounded by desert.

Here and there, wherever it occurs, *H. floribunda* seems to exhibit occasional plants of low stature, say 10 to 15 cm. high. These are probably the result of growth in very dry spots, or perhaps in some instances due to early destruction of the growing axis by animals. Such plants must not be confused with *H. Richardsoni macrantha* and the other *Richardsoni* types; they have essentially the characters of *H. floribunda*, — the same flowers, the same spreading foliage, etc. A rather extreme example is from Galisteo, N. M., collected by *Dr. J. M. Bigelow*, on the Whipple Survey in 1853–4. (U. S. Nat. Mus. *27458*.)

It is a singular thing that the *utilis* form in Colorado seems to grow always at quite high altitudes, while the *floribunda* proper in New Mexico grows lower down, notwithstanding the lower latitude.

The following material is referred to *H. floribunda* sens. lat.: COLORADO. — 1. Buena Vista, 1903, *F. R. Marsh*. Type of *H. floribunda utilis*.

2. Buena Vista, gravelly soil, 8,000 ft., July 27, 1892, *C. S. Sheldon*. Agrees with subsp. *utilis* as to bracts, etc., but achene-hairs ferruginous.

3. Marshall Pass, 10,000 ft., August 20, *C. F. Baker*. Genuine *H. floribunda utilis*, with white achene-hairs, etc. Dr. Greene had identified this as *H. Richardsoni*.

4. Gunnison, 7,680 ft., July 17, *C. F. Baker*. Just like the last, with silvery-white achene-hairs; typical subsp. *utilis*.

5. Huerfano, August 1867, *Dr. Parry*. Rather large heads; pappus-scales ferruginous, very low-awned; achene-hairs ferruginous. This is not subsp. *utilis*. Very similar is a doubtful plant,

more approaching *H. Richardsoni macrantha*, from South Park (*G. Engelmann*, August 24, 1881); this has the pappus-scales not so long-aristate. Better material is needed of these plants.

6. Wet Mountain Valley, July 25, 1872, *John H. Redfield*. Dark red achene-hairs and pappus-scales, which are quite long-awned. This cannot well go with subsp. *utilis*.

7. Wilson Creek, Fremont Co., *T. S. Brandegee*. Achene-hairs and pappus-scales ferruginous. Like the last but only half as tall.

8. Sangre de Cristo Creek, 7200–8100 ft., July 2, 1900, *Rydberg & Vreeland*. White achene-hairs, slightly ferruginous basally; pappus-scales white with ferruginous base.

9. Hesperus, 8500 ft., July 15, 1896, *Frank Tweedy*. Achene-hairs ferruginous; pappus-scales in same head from ferruginous to ferruginous at base only.

10. Durango, August, 1892, *Alice Eastwood*. Rather a poor specimen. Achene-hairs and pappus very pale ferruginous; the latter might be called sordid white.

11. Salida, August, 1888, *Alice Eastwood*. Achene-hairs and pappus ferruginous; stem not noticeably woolly at base.

12. Saguache Range, 9000 ft., August, 1880, *T. S. Brandegee*. Stem scarcely woolly at base; achene-hairs and pappus-scales pale ferruginous. This seems to be *H. floribunda* proper, from an unusually high altitude. It is a taller plant than the Gunnison and Marshall Pass *utilis*.

The typical *H. floribunda utilis*, it appears, grows in Chaffee, Gunnison, and northern Saguache Counties, at elevations of about 2300–3000 m. This is a region of little rainfall,* and it is probable that this circumstance permits an essentially xerophytic plant to reach such high altitudes, without being in any sense a true alpine. On the eastern slope of the front range of central Colorado, where the plant does not grow, the rainfall is at least twice as great. However, West Cliff (Wet Mountain Valley), the approximate locality of Redfield's plant (which however is not true *utilis*) had in 1902 nearly as much rain as Colorado Springs, *i. e.*, over 15 inches.

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* According to data published by F. H. Brandenburg of the Weather Bureau, the rainfall of Buena Vista in 1902 was only 2.81 inches. One suspects here some error; but Saguache had only 7.09 inches, and Salida 7.01.

As has been observed in other species, the color of the pappus and achene-hairs must not be regarded too seriously, as it sometimes varies greatly even in the same head. It seems probable that it darkens in plants which have been long in the herbarium, and perhaps it is affected in some instances by substances used as preservatives.

NEW MEXICO. — 1. Santa Fé and vicinity. (*Fendler 460 = Heller 423.*) Also on a creek five miles east of Santa Fé, June 30, 1846, *Wislizenus*. The Fendler plant is the type of *H. floribunda;* Heller's plant differs in the outer bracts; see description of subsp. *utilis*.

2. Glorieta, 1881, *G. R. Vasey*. True *H. floribunda.* In 1903 I found it abundantly between Glorieta and Pecos, and at Pecos. The altitude is about 2000 to somewhat over 2100 m. One Glorieta sheet from Vasey, and a sheet from near Santa Fé collected by Rusby, show smaller heads than usual, but are true *H. floribunda.*

3. Chama, *Baker 607*. Three sheets of this examined: rays pale canary yellow; white pappus-scales and achene-hairs in the manner of subsp. *utilis;* stem-leaves longer and broader than in typical *H. floribunda*. Outer bracts united nearly to middle, straight-sided, green; broader and shorter than in Heller's Santa Fé plant. Chama is only just south of the Colorado line.

4. Galisteo, *Dr. J. M. Bigelow.* Remarkably short (about 10 cm. tall), with very numerous fairly large flowers; pappus-scales and achenes light ferruginous; bracts as in true *H. floribunda.*

5. Grant's, *Jones 4352*. Outer bracts like subsp. *utilis;* pappus-scales rather short, these and achene-hairs very pale ferruginous. A sheet from mountains west of Grant's, Aug. 1, 1892 (*Wooton*), shows plants of the first year.

6. Santa Fé, *Herrick 789*. Pappus-scales sordid white, quite broad and not very long, the awns much shorter than in Fendler's type; bracts rather in the style of *utilis.*

7. Defiance, *C. C. Marsh 227*. Basal leaves entire; achene-hairs and pappus-scales ferruginous, the latter not long-awned.

8. Between Barranca and Embudo, Taos Co., 5900–6900 ft., May 27, 1887, *Heller 3602*. Just coming into flower; basal leaves divided; rays quite orange; pappus, etc., pale ferruginous.

9. Goat Mountain, Raton, Aug., 1900, *T. D. A. & W. P. Cockerell.* Basal leaves divided; bracts like *utilis*, outer united at least half-way up; pappus-scales white, achene-hairs slightly ferruginous. Raton is just south of the Colorado line, south of Trinidad, Colorado. The plant here gets well east of the front range. The large grasshopper *Leprus cyaneus* appears to have the same distribution, *i. e.*, only west of the front range in central Colorado, but passing east of it in northern New Mexico.

10. Mountains S. E. of Patterson, 6000 ft., *E. O. Wooton.* Plant low, rays chrome yellow; achene-hairs shining brownish-white; pappus-scales white, ferruginous at base. A bushy plant of rather peculiar aspect, with slender crowns; it is referred to var. *intermedia*, concerning which see below.

ARIZONA. — 1. Near Flagstaff, *MacDougal 219.* Achene-hairs pale ferruginous; pappus-scales broad and not long-awned, dullish white. This is subsp. *arizonica.* Also collected by *J. W. Toumey* at Flagstaff, Aug. 30, 1899, with achene-hairs white except at base.

2. San Francisco Mountain, Sept., 1884, *J. G. Lemmon.* Achene-hairs pale ferruginous; pappus-scales ferruginous, longish-pointed but short. Also subsp. *arizonica.*

3. Western foothill region of San Francisco Peak, 5700 ft., July 3, 1901, *J. B. Leiberg.* Outer bracts divided below middle; pappus-scales short. Also subsp. *arizonica.*

4. Williams, Aug. 28, 1884, *M. E. Jones.* Also subsp. *arizonica.*

5. Rim of Grand Cañon, Hance's Ranch, 7500 ft., July 12, 1892, *E. O. Wooton.* Heads larger than usual; outer bracts green and deeply cleft; pappus, etc., as in subsp. *arizonica*, which it is. Also collected at same place and date by *J. W. Toumey.*

6. About Walnut Cañon, 7000 ft., July 28, 1898, *MacDougal 359.* Slender pale plants; flowers quite orange; achene-hairs pale ferruginous; pappus-scales quite white, with ferruginous bases, fairly long-pointed; crowns slender. This is labelled *P. intermedia* Heller, but seems never to have been published. It should be collected in older material, when it would, I believe, be found to look like Wooton's plant from S. E. of Patterson, N. M., which exactly agrees in the character of the disc-florets.* For the

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*In the Gray Herbarium is some older material, confirming this opinion.

present it may stand as var. **intermedia**; I do not think it can possibly be regarded as a valid species. It has nothing to do with the *odorata* series, though the plants have a certain superficial resemblance to the annuals of southern New Mexico.

Hymenoxys Earlei (Ckll.)

Picradenia Earlei Cockerell, Bull. Colo. College Museum, December 11, 1903.

Apparently perennial, erect, as tall as *H. floribunda*, and with much the same manner of growth, but less spreading; leaves similar to those of *H. floribunda*, but segments inclined to be broader; stems reddened at base, without cottony tomentum; heads broader in proportion to their length than in *H. floribunda*, rays orange (clear yellow in *H. floribunda*); outer bracts yellowish, broad and obtuse, strongly convex, united not over one-third; pappus-scales (viewed by transmitted light in glycerine) ferruginous, pointed but not at all aristate; corolla cylindrical, not expanded above. The rays are only about 1 mm. broad. The inner bracts are much thickened dorsally. (PLATE 21, FIGURE 1.)

Mancos, Southern Colorado, in the piñon belt, July 8, 1898, *Baker, Earle & Tracy*. Type in herb. University of Wyoming. Other sheets from the same original lot are in the herbaria of the National Museum, the California Academy of Sciences, the Missouri Botanical Garden, and the New Mexico Agricultural College. Those in the last-mentioned herbarium are dwarfed plants, like those mentioned as frequently occuring in *H. floribunda*.

A rather unsatisfactory specimen, with scanty foliage, is from San Luis Park, Colorado, 1877, *J. D. Hooker & A. Gray*, in herb. Calif. Academy of Sciences. It has the pappus-scales longer-pointed than in the type, but the manner of growth, foliage, etc., are those of *H. Earlei*.

It is not altogether impossible that *H. Earlei* may be connected by intermediates with *H. floribunda*, but I expect that field-study will only emphasize its distinctions.

Hymenoxys Metcalfei sp. nov.

Perennial or at least biennial, when well developed 36 cm. high, but sometimes not over 16 cm.; stems one to two or three, these and the foliage a lively green, basal leaves inclined to spread, but the plant as a whole little spreading; base of stems little woolly: basal leaves up to about 7 cm. long, some entire, but some (the longer) always divided into about five broad-linear segments; stem-leaves similar in character: inflorescence rather flat-topped, heads (excluding rays) about 10 mm. diameter; rays 10 mm. long, and 5 mm. broad, of the most brilliant orange; bracts light green, outer bracts united nearly half way up, 8 in number, extending very little beyond inner; inner bracts of the *H. floribunda* type, strongly fringed: achenes pallid, their hairs very long, pale, mostly simple-tipped; pappus-scales long-acuminate, quite colorless except at extreme base, where they are ferruginous, over half length of disc-corolla: base of disc-corolla hairy: anthers rather narrow. (PLATE 21, FIGURE 3.)

Burro Mts., New Mexico, *O. B. Metcalfe 170.* The type was kindly sent to me by Prof. E. O. Wooton; it will be placed in the National Museum. Another sheet, of smaller plants, is in the herbarium of Professor Wooton, who collected the material on the northwest peak of Burro Mts., Grant Co., N. M., Aug. 18, 1902. An undersized plant in poor condition, collected by *F. H. Snow* in the Santa Fé mountains, August, looks like *H. Metcalfei*, but is perhaps only a peculiar state of *H. floribunda*, from unusually damp ground. It has the rays hardly developed, and is only 17 cm. tall, but it has leaves with comparatively broad segments, and rather the cut of *H. Metcalfei.*

H. Metcalfei is one of the most beautiful species of the genus, with very much the growth of some forms of *H. floribunda*, but bright orange rays reminding one of *H. helenioides.* It is easily known from *H. Rusbyi* by the divided basal leaves, character of the pappus, etc. It is as near to *H. Earlei* as to anything, but the latter has more olive-green foliage, smaller flowers with different bracts and much less conspicuous rays, and longer basal leaves. The manner of growth is about the same in the two.

Hymenoxys Vaseyi (Gray)

Actinella Vaseyi Gray, Proc. Am. Acad. **17**: 219. 1882.

Picradenia Vaseyi Greene, Pittonia, **3**: 272. 1898.

A bushy, glabrous plant about 30 cm. high or rather more, with heads about 10 mm. broad (excluding rays) on quite long peduncles; the outer bracts united about half-way up (more or less), light yellowish, firm, with a strong longitudinal ridge. The growth of the plant reminds one of the mountain forms of the *odorata* series; the foliage is quite a pale green, the leaves and their divisions narrowly linear. One specimen has the basal half of the stems dark red. The inner bracts are truncate and fimbriate, and have not long points. Hair of achenes ferruginous, varying to practically colorless; pappus-scales colorless, about or a little over half length of disc-corolla, decidedly pointed but not aristate. Base of disc-corolla densely hairy. Rays 5.75 mm. broad, pale orange.

Only known from the Organ mountains, in southern New Mexico. I have examined specimens collected by *Vasey* and several sheets collected by *E. O. Wooton* in the Organ Mts., at 5800 ft., July 1897. Professor Wooton also sends me a specimen collected by *Prof. J. D. Tinsley* in Fillmore cañon, Organ Mts., Aug. 27, 1897. Without being positive, I believe that *H. Vaseyi* must be the undetermined plant, not in flower, on which the coccid *Pulvinaria marmorata* Ckll. (Entom. 1898: 130) was discovered.

Hymenoxys Cooperi (Gray)

Actinella Cooperi Gray, Proc. Am. Acad. **7**: 359. 1868.
Picradenia Cooperi Greene, Pittonia, **3**: 272. 1898.

This species differs from *H. Rusbyi* by its larger, fewer heads and much more lax growth; from *H. Vaseyi* by its somewhat larger heads, taller growth, and generally less leafy stems. The form of *H. Cooperi* occurring in the Huachuca and Rincon Mts. of Arizona is so near *H. Vaseyi* that I thought at one time to reduce the latter to a subspecies, but renewed study convinces me that the evidence would not warrant this. Mr. Greenman writes me that he has compared Gray's types of *Actinella Cooperi* and *Actinella Vaseyi*, and believes them distinct.

I have not seen typical *H. Cooperi*, except some fragments from Gray's type (from Providence Mountain, Mohave District, California, 1860–61, *Dr. J. G. Cooper*) very kindly sent by Mr. Greenman.* These show the achenes densely covered with ferruginous hair; pappus-scales short as in the other forms, thick, very deep ferruginous, with a sort of purplish tint; rays narrower than the Huachuca Mts. plant, and about 6-nerved. Mr. Greenman, after comparing the Huachuca Mt. plant with Gray's type of *H.*

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* I have since seen the type sheet. The specimen is little more than a fragment, and affords no new evidence.

Cooperi, is somewhat in doubt regarding their specific identity, notwithstanding that Gray considered the former to be *A. Cooperi.* He adds, "the involucral bracts seem fewer and broader."

Mr. Greenman writes that the type of *A. Cooperi* is a very poor specimen; only the upper portion of a plant with one perfect head and an incomplete one. There is no Californian *A. Cooperi* in the herbaria of the Calif. Acad. Sci., National Museum or Missouri Botannical Garden.

Considering all the evidence available, I believe that the Arizona plant must be treated as a distinct subspecies, which is accordingly described.

Hymenoxys Cooperi Grayi subsp nov.

The type specimen (in U. S. Nat. Museum) is Lemmon's *2774*, Huachuca Mts., Arizona, June–Sept. 1882. These mountains are in Cochise Co., south of Benson, and just north of the Mexican border. The achenes are very broad, subquadrangular, 4-nerved on each face, and little pubescent, what hair there is being pale ferruginous. The pappus-scales are white, broad and very short; in one plant of the same lot (hb. Cal. Acad. Sci.) they are ferruginous. In well-developed specimens the basal leaves are very numerous.

The character of the achene is unique in this group, but it may be abnormal or due to greater maturity, as other specimens of undoubtedly the same species have quite ordinary achenes.

The following material is also referred to *H. Cooperi Grayi*:

1. Near Fort Huachuca, Arizona, September, 1894, *T. E. Wilcox.* Form slender and color light; no stout basal tuft; lower cauline leaves 8 or 9 cm. long, irregularly divided into 7 to 9 linear segments, these leaves are a curious whitish green, but quite glabrous; stems green, with only the faintest reddening at base; rays yellow; heads (excluding rays) about 12 mm. diameter; outer bracts thickened and carinate basally, apical part green; inner bracts broad, with long obtuse finger-like tips, sides of bracts copiously white-woolly. The outer bracts are seven in number. Receptacle conical; hair of achenes deep ferruginous; pappus-scales about half the length of disc-corolla, shining rather sordid white, deep ferruginous at extreme base, subacuminate but not in the least awned. This is unquestionably the same as subsp. *Grayi.*

2. Rincon Mts., Arizona, Sept. 1891, *G. C. Nealley*. Basal leaves narrowly linear and entire; caudex multicipital in one specimen; hair of achenes ferruginous; pappus-scales very short, white tinged with ferruginous.

It is hardly possible to rely on the character of the pappus to distinguish the forms of *H. Cooperi* from *H. Rusbyi*, but the aspect of the plants is extremely different.

A modified form of the above, which I call var. **argyrea**, occurs in the region of the Grand Cañon. It has some resemblance to *H. canescens biennis*, but unquestionably belongs with *H. Cooperi*. Its characters are as follows:

Root larger, 10 mm. broad: stem single, rather slender, about 6 dm. high, branching about the middle, with long, slender branches having few linear leaves, terminated by heads hardly 15 mm. broad excluding rays; rays narrow, about 13 mm. long; outer bracts eight, pale green, straight-sided, fairly broad; inner broad and fimbriate, with short green tips: disc-corollas as in *H. canescens biennis*, very pubescent and swollen basally: hair of achenes, and pappus, silvery-white, pappus-scales pointed but not awned. The stem is reddened, strongly grooved, glabrous except at extreme base; basal leaves as in *H. canescens biennis*. This is from about the Grand Cañon of the Colorado, 7,000 feet, June 28, 1898, *Dr. D. T. MacDougal*, in herb. U. S. Nat. Museum. Exactly the same thing is from the Grand Cañon north of Flagstaff, June 14, about 2,000 feet on rocks, *D. T. MacDougal 207*. I take it that this var. *argyrea* is more xerophytic than subsp. *Grayi;* perhaps some of the difference is not truly racial.

Hymenoxys Rusbyi (Gray)

Actinella Rusbyi Gray, Proc. Am. Acad. **19**: 33. 1883.
Picradenia Rusbyi Greene, Pittonia, **3**: 271. 1898.

Tall and bushy, with very numerous rather small heads, the rays inconspicuous, but the disc-florets prominent and bright orange; involucral bracts with prominent dorsal ridges; basal leaves long and linear, about 15 cm. long, simple and grass-like; pappus-scales very short, subtruncate to somewhat pointed, the apical margin serrulate. Rusby has written on a sheet of his collection, "I mistook it for *Senecio eremophilus*," a remark which at once suggests the appearance of the plant, especially the flowers.* The pappus-scales are ordinarily dark ferruginous, but in Wooton's plant from mountains north of Santa Rita, they vary from white to ferruginous in the same head. The disc-corollas have the upper part broad, but not at all suddenly expanded at the top as in the *odorata* series. The upper hairs of the achenes and flattened; some are bifid at the tips. There is no woolliness at the base of the plant.

I have examined Rusby's *216*, from grassy hills, Clairmont, N. M., and also Rusby's *246½* (three sheets) from grassy places, Mogollon Mts., N. M., August, 1881. More recent specimens are *Wooton's* from mountains north of Santa Rita, S. E. of Mogollon Mts., Socorro Co., N. M., 6,000 ft., August, 23, 1900, and Devil's Park, Mogollon Mts., August 9, 1900. Another plant collected by Professor Wooton is from Lower Plaza, Frisco, N. W. of Mogollon Mts., Socorro Co., N. M., alt. approx. 6,000 ft., July 25, 1900.

Some small slender plants with few heads, the basal leaves wanting, were collected by *Dr. MacDougal*, August 1, 1891, in dry soil, Rattlesnake Tanks, east of Flagstaff, Arizona. The heads, pappus, &c., are exactly those of *H. Rusbyi*, and I cannot do otherwise than refer them to that species. Whether they are merely starved specimens, or represent a race (as one might expect from the locality) I cannot now say.

Hymenoxys olivacea sp. nov.

Apparently perennial: well-developed plants nearly 30 cm. high, but some only 10 cm.: foliage a dark olive green, the leaves glabrous and strongly glandular-punctate, linear, but the stem-leaves up to 2.5 mm. broad, both the basal and stem-leaves entire, or some of the upper stem-leaves with linear lateral lobes; basal leaves 6 to 10 cm. long, similar in character to those of *H. Rusbyi*: heads (excluding rays) 8 to 10 mm. broad, not very numerous, on long peduncles; rays ordinary, broad, pale orange; outer bracts united to or beyond the middle, thickened dorsally, pale in color; inner bracts as usual in the group, strongly fimbriate; receptacle elevated, rounded, somewhat higher than broad: achenes densely covered with pale to deep ferruginous hair; pappus-scales pale or

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* Dr. Greene well defines it as "a large green and glabrous corymbose-panicled species."

dark ferruginous, about two thirds length of disc-corolla, very broad at base, with more or less of a lobe on each side, and with a rather long linear apical portion, so that they might be called short-aristate: disc-corollas quite glandular. (PLATE 22, FIGURE 2.)

I have before me five sheets of this plant; two represent *no. 633* of the Emory Survey, said to be (*i. e.*, the whole collection) chiefly from "the valley of the Rio Grande, below Doña Ana," New Mexico; one is Wright's *1260*, of his New Mexico collection of 1851–52; two were collected by Miss A. Isabel Mulford, *no. 807*, "Hanover Hills, 8, 9, 95," and *809*, "Santa Rita, 8, 9, 95," both places in New Mexico. The latter specimen is only in bud. One of the Wright specimens has entangled among its basal leaves a small leaf of *Quercus*, apparently *Q. Emoryi*, which indicates the sort of place the plant inhabits.

It takes the whole series to get the best idea of the true characteristics of this plant, but I take as the type Miss Mulford's *807*, in Dr. Greene's herbarium, for the reason that it is the only one in flower with a precise locality given.

H. olivacea has a decided resemblance to *H. subintegra*, but that is a pale, decidedly canescent plant, with broader, more lobed cauline leaves and larger heads. The peduncles also are stiff; in *H. olivacea* they are more or less flexuous.

Hymenoxys latissima sp. nov.

Plant doubtless tall, but only tops seen; stem slender, light yellowish, strongly grooved, more or less beset with loose white hairs, especially about the bases of the leaves: cauline leaves alternate, sessile, pale yellowish green, elongate-oval, entire, pointed at the apex, strongly punctate, not obviously nerved, glabrous except for scattered white hairs forming a sort of loose and scanty arachnoid pubescence on both surfaces; length of leaf about 30 mm., breadth little over 13, uppermost leaves smaller: heads hemispherical, the surface very convex, about 19 mm. broad excluding rays, on long and slender but apparently rigid peduncles; rays large and conspicuous, yellow (probably inclining to orange), over 20 mm. long, and fairly broad; base of head very woolly; outer bracts green, rather narrow, not united to middle; inner with long pointed tips and straight sides, not fimbriate; receptacle large, high-conical, rounded at apex: achenes narrow, yellowish-ferruginous, with white hairs not concealing the body-color: disc-corollas rather broadened to the apex: pappus-scales white, nearly three quarters length of disc-corolla, long-pointed, sometimes bifid-tipped. (PLATE 21, FIGURE 2.)

A remarkable species, represented only by some much broken material in the herbarium of Dr. E. L. Greene, marked Southern California, communicated by Wickson. The heads, and even the bracts, suggest *Macdougalia*, but the broad punctate leaves are quite different from that, or from any other *Hymenoxys.*

Hymenoxys texana (Coulter & Rose)

Actinella (*Hymenoxis*) *texana* Coulter and Rose, Bot. Gaz. **16**: 27. 1891. — Coulter, Botany of Western Texas, 231. 1892.

Picradenia texana Greene, Pittonia, **3**: 273. 1898.

The original description is as follows: "A small slender annual 5 to 15 cm. high, branching at base; leaves mostly radical, 3-nerved, oblong and tapering at base, entire or few-toothed; those of the stem narrower and toothed, becoming linear and entire above: heads small (4 to 6 mm. high): involucral bracts in two series; the outer ones about 8, rigid and keeled, united at base: rays minute, not projecting beyond the bracts; achenes pyramidal, 1 mm. long: pappus of 5 oval paleae with aristate acuminations very conspicuous in mature heads. Collected by F. W. Thurow, near Hockley, Texas, 1889 and 1890; also mounted on a sheet with *A. odorata* (No. 742) of Palmer's 1879–80 collection from S. W. Texas."

The type sheet collected by *Thurow* (U. S. N. M. *27467*) is before me. The plant probably appears in the early spring, along with other small annuals. Its general aspect is much like that of *Syntrichopappus Lemmoni* (Gray) Gray, from the Mojave Desert, at least as seen in the herbarium; from its better-developed rays, the *Syntrichopappus* must appear more different when alive. The stem-leaves are very small, and vary from linear to broad, obtuse, with short lateral lobes. These broad leaves are very characteristic, and are totally different from the divided leaves, with wire-like divisions, of *H. odorata.* The inner bracts are essentially as in the *odorata*-type. The pappus-scales, and the hair on the achenes, are white. The receptacle is excessively high-conical, so as to be very narrow and almost cylindrical, the pits large and deep. In *H. odorata* the receptacle is conical, but very much broader.

HYMENOXYS ODORATA DC.

DeCandolle described this in 1836 as *Hymenoxys odorata.* It was said to be part of *Cephalophora anthemoides*, Less., in Linnaea, **6**: 518. 1831. In 1898 Dr. Britton tranferred it to *Picradenia.* Prof. A. Nelson has very kindly copied for me the short latin description of DeCandolle. This tells us that the plant was collected by Berlandier, but the record of the precise locality was lost; it was however in "Mexico," which of course means the Mexico of 1836. The descriptive part reads as follows.

"*H. odorata*, invol. squamis lanceolatis acuminatis. Folia multo tenuius pinnatipartita quam prioris. Pedunculi foliis duplo triplove longiores. Ligulæ 5–6 flavae apice grosse tridentatae. Pappi squamellae lanceolatae acuminatae. Capitulum tritum valde odorum."

This has been understood to be the plant which Buckley named *Phileozera multiflora.* Dr. Greene, however, took up Buckley's name, declaring that the plant of DeCandolle could not be recognized. I cannot agree with Dr. Greene that the Texan plant is "much at variance" with that of DeCandolle; on the contrary, I think the description applies very well.* Unfortunately, however, it applies exactly as well to *P. chrysanthemoides*, and therefore I think it had better be dropped, unless the type specimen can be examined and the identity of the plant proved. Even in the latter case, it might be questioned whether a name is valid, when it is defined by a description which does not serve for its identification.

If we accept the view that *chrysanthemoides* and *multiflora* are merely extremes of one species, still *odorata* is not the name of that species, but *chrysanthemoides*, which dates from 1820.

HYMENOXYS CHRYSANTHEMOIDES (H. B. K.) DC. Prodr. **5**: 661. 1836.

Actinea chrysanthemoides H. B. K. Nov. Gen. et Sp. **4**: 298. *pl. 411.* 1820.

Actinella chrysanthemoides Gray, Proc. Am. Acad. **19**: 32. 1883.

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*As regards the odor, however, Dr. Greene writes: "I am positive that all through southern New Mexico the plant called '*odorata*' has but a feeble odor, and that not grateful. I walked over it, and gathered it often enough" (*litt.*, April, 1904).

Typically this is a rather tall plant, up to 50 cm. high, much branched and spreading at the top, with foliage very much like that of *Matricaria grandiflora*, and large (15 mm. broad excluding rays) hemispherical heads on tolerably long peduncles. The rays are ample, and orange. The outer bracts are long and narrow, united for a short distance only, the apical part green. The inner bracts are narrow, long-pointed, and surpass the outer; they show some tendency towards the characters so greatly emphasized in *Macdougalia*. The achenes are as usual in the genus, covered with hair; the pappus-scales are nearly two-thirds the length of the disc-corolla, with long tapering points and broad oval bases. In the plant from the San Luis Potosi region the pappus and hair of the achenes are ferruginous; in the plant from near Chalchicomula they are white. The disc-corollas are broadened at the top as usual in the group. The plant is no doubt an annual.

Specimens referred here are as follows:

MEXICO. — Esperanza, near Mt. Orizaba, 8,000 ft., Aug. 14, 1891, *H. E. Seaton;* about Chalchicomula, 8,500 ft., State of Pueblo, Aug. 13, 1901, *C. G. Pringle;* region of San Luis Potosi, 6,000–8,000 ft., 1878, *C. C. Parry & Edw. Palmer;* Salinas, Zacatecas, May 4, 1892, *M. E. Jones 286*. The wide difference in the time of year of these collections is surprising.

NEW MEXICO? — Three sheets of the Emory Survey, *no. 635*, are labelled *Actinella chrysanthemoides*. They represent very immature and poorly preserved plants, but from the character of the foliage, and the large heads, the identification seems correct.

Hymenoxys chrysanthemoides excurrens var. (vel. subsp.?) nov.

Well-developed plants fully 60 cm. tall, of laxer growth, with olive-green foliage; both outer and inner bracts broader, the inner much like those of *H. chrysanthemoides Osterhouti;* heads not quite so large, and not so convex. (PLATE 22, FIGURE 3.)

The type sheet is from Yuma, Arizona, 1881, *G. R. Vasey*, in U. S. Nat. Museum. Precisely the same thing is from Fort Yuma, San Diego Co., Calif., Feb. 1889, *S. B. & W. F. Parish*, in herb. Cal. Acad. Sci. Both were labelled *odorata*, and the plant does in fact offer a transition towards subsp. *multiflora* (*P. odorata* auctt.). A plant collected by Palmer in Arizona, in 1876 (locality not stated), has all the appearance of *excurrens*, but heads (excl.

rays) only about 9 mm. diameter! At this point I find myself in a difficult position. I am unable to define *H. chrysanthemoides*, subsp. *multiflora*, and the allied forms in such a way as to absolutely separate them. As in the *Richardsoni*-series, the extremes are so different that it seems ridiculous to think of them as allied, but there are innumerable intermediate forms, and structural differences of any consequence simply do not exist. As in *Matricaria* etc., these plants no doubt differ greatly according to the amount of moisture they get, specimens from very dry places being extremely small. At the same time, it is evident that genuine racial differences exist, and these, so far as they can be discerned, may very well be made the basis of subspecific names. To determine the minute characters I examined microscopically the achenes, pappus and corollas of plants from Oklahoma, Kansas, Texas, Chihuahua, New Mexico, and Arizona. The pappus-scales were practically alike in all, with quite long points; in color they were ferruginous of various shades, uniformly light in material from Texas and near Tucson, Arizona, more especially ferruginous at base in some from Las Cruces, N. M., and near Chihuahua. The achenes were essentially the same, as also the disc-corollas. The bracts vary as they always do in the genus, but the differences are unimportant. The high broad receptacle is sometimes (*e. g.*, Chihuahua material) narrower and more conical, but the differences are not striking.

Mr. M. L. Fernald (Am. Jour. Sci. **14**: 189), facing a very similar condition in *Betula*, writes: "But since it is obviously impracticable to regard all these forms as one species, it seems wiser to recognize the more marked centers of variation as species which are admitted to pass by exceptional tendencies to other forms ordinarily distinguished by marked characteristics." Of course it is true that species which are quite distinct in actual fact may seem to intergrade, because of the variation in the characters taken as specific. For example, *Helix nemoralis* is a snail having the lip of the shell black or nearly so, while the closely similar *Helix hortensis* has the lip white. There occur varieties of *H. nemoralis* in which the lip is pallid or even white, and varieties of *H. hortensis* in which it is black. These facts led some good authorities to treat *hortensis* as a variety of *nemoralis*, until it was discovered that there is a very good and perfectly constant anatomical character which separates the two species.

Similarly, two species of plants may appear to intergrade, without actually doing so; but to the best of my knowledge and belief the "species" of *Richardsoni*- and *chrysanthemoides*-groups of *Hymenoxys* do really intergrade on a quite extensive scale, and believing this, it seems best to use a trinomial nomenclature for them. This results in calling the common plant of Texas *Hymenoxys chrysanthemoides multiflora*, a name which cannot be regarded with much satisfaction. However, I think it will simplify matters if in all but formal statements we use only the initial letter of the intermediate name of a trinomial, thus *Hymenoxys c. multiflora*. This is almost like a binomial, and yet serves to distinguish races or subspecies from distinctly and sharply defined species.

Hymenoxys chrysanthemoides juxta

Picradenia sp. nov., Greene in herb.*

The type is a plant collected by O. B. Metcalfe (*no. 118*) at Mangas Springs, New Mexico, June 9, 1903, alt. 4770 ft. It is a large bushy annual 45 cm. high, with numerous flowers with light orange rays. The heads (excl. rays) are about 8 mm. diameter. The outer bracts are pale green; the inner bracts are very broad (as in *H. Davidsoni*) and extremely thin laterally. The pappus is colorless, about half the length of disc-corolla, with a short awn, perhaps one third of its total length. The disc-florets are smaller than in *H. Davidsoni*, but the difference is unimportant. This plant is not materially different from subsp. *Osterhouti*, except that it is typically larger, with broader bracts, and the basal part of the pappus-scales apparently broader. The two ought perhaps to be united, but they are separated geographically, and it is just possible that subsp. *Osterhouti* had an independent origin from subsp. *multiflora*.

The following plants, not all typical, but I think essentially the same, are referred to this:

MEXICO. — Valley near Chihuahua, April, 1885, *C. G. Pringle*. One of these Pringle plants is very large and robust, but another of the same lot is only half the size; these differences certainly do

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* The specific name applied by Greene is preoccupied in *Hymenoxys*.

not appear to be racial. Of the following, the first is tall, but the others are small bushy or low plants, intermediate between the present race and subsp. *multiflora:* "Manzanilla Cimarron, flower yellow, from a bunch forming a beautiful obtuse cone (usual style) 2 feet high and in diameter, Bolson de Mapimi (dry valley)," April 15, 1847, *Dr. J. Gregg;* "Manzanilla del Campo (a species) from wet place in plain S. E. from Presido de Yuajuquilla," April 19, 1847, *Dr. J. Gregg;* "Rio Grande Valley near Juarez, State of Coahuila," 3700 ft., May 5, 1901, *C. G. Pringle;* Sta. Eulalia plains, Chihuahua, 1885, *Wilkinson;* cultivated places on the plains, 6000 ft. alt., State of Chihuahua, April 29, 1891, *C. V. Hartman;* Bachimpa, south of Chihuahua, sandy soil, April 26, 1847, *Dr. A. Wislizenus;* "States of Coahuila and Nuevo Leon," 1880, *Dr. E. Palmer 741.*

The last plant, Palmer's *741*, is ridiculously unlike the Metcalfe plant, being a small densely leafy thing 9 to 12 cm. high. The others, however, are variously intermediate, and without a larger amount of material, or field study, it does not seem possible to define any more subspecies. None of the plants are just exactly the Texan subsp. *multiflora*, though some approach it.

TEXAS. — El Paso, April 17, 1884, *M. E. Jones;* "Texas," April 24, 1883, *C. G. Pringle;* El Paso, April, 1881, *G. R. Vasey;* "from Western Texas to El Paso," October, 1849, *Charles Wright;* El Paso, 1851–52, *C. Wright 1261;* thus all from the extreme western end of the State, not far from New Mexico.

NEW MEXICO. — Emory Survey, *no. 634;* College Farm, Mesilla Valley, May, 1894, *E. O. Wooton;* Rincon, prox. 4,000 ft., June 13, 1892, *E. O. Wooton;* Las Cruces, Mesilla Valley, May 17, 1893, *E. O. Wooton;* River bottom [of the Rio Grande], Mesilla Valley, April 7, 1900, *E. O. Wooton.* These plants, nearly all from the Mesilla Valley, are essentially the same as the El Paso plant. I was familiar with this form in life at Mesilla. It is not usually so large and bushy as the Mangas Springs plant, but it is certainly nearer to it than to the small typical subsp. *multiflora.*

ARIZONA. — Near Tucson, May, 1881, *J. G. Lemmon and wife,* sienega near Tucson, June 1881, *Lemmon*. This material is not as good as one could wish, but it seems inseparable from the New Mexico plant.

Hymenoxys chrysanthemoides Osterhouti (Cockerell)

Picradenia odorata Osterhouti Cockerell, Bull. Colorado College Museum, December 11, 1903.

The original description is as follows:

"Apparently annual, about 21 cm. high, broad and spreading, much in the manner of *odorata*, root about 5 mm. diameter; stems purplish at base, here neither wooly nor leafy, repeatedly branched, with cauline leaves divided into about five linear segments; heads numerous, with the leaves and mode of growth rather suggestive of *Matricaria*, disc convex, bright orange, about 7 mm. across, rays bright lemon-yellow, rather short; outer bracts divided nearly to base, with rather narrow but obtuse green tip; inner bracts longer than the outer, and rather more pointed, their shape recalling those of *P. Davidsoni*, except that they are by no means so large and broad; receptacle from hemispherical to broad-conical (not narrow conical and pointed as in *utilis*); disc-corollas 3½ mm. long, widened at the top, the lobes pubescent as in *odorata*; pappus-scales not at all ferruginous, rapidly narrowing to a long awn-like point, the whole being nearly half the length of the corolla." [PLATE 23, FIGURE 1.]

"Apishapa Crook, Otero Co., Colorado, June 9, 1900 (in full flower), collected by *Geo. E. Osterhout*. The plant of Kansas and Oklahoma is taken as true *P. odorata*. It has considerably smaller heads than the Colorado plant, with disc-corollas 3 mm. long. It also appears to flower earlier, and the color of the pappus-scales is very different.

"The discovery of *Osterhouti* nearly fills up the interval between *odorata* and *Davidsoni*. The only substantial differences between *Osterhouti* and *Davidsoni* are that the latter is certainly biennial, has the outer bracts the same color as the inner (in *Osterhouti* they are conspicuously tipped and narrowly margined with dark green), and the inner bracts nearly twice as broad as those of *Osterhouti*. It is possible that *Osterhouti* may yet prove biennial, in which case I should consider it a subspecies of *Davidsoni*."

No other material has been seen. There is I think no doubt whatever that the plant is an annual.

Hymenoxys chrysanthemoides Mearnsi subsp. (var.?) nov.

The type of this (U. S. Nat. Mus. *27473*) is from Dog Spring, New Mexico, May 26, 1892, collected by *Dr. E. A. Mearns* on the Mexican Boundary Survey. It is a many-stemmed densely leafy little plant, forming a tuft about 10 cm. high and twice as broad. The foliage is normal for the group, except for its abundance, but there is a good deal of short white almost scurfy hair about the stems and on the involucres. The heads (excl. rays) are about 8 mm. broad, quite convex, with well-developed broad rays; outer bracts broad, united nearly half-way up, green-tipped; inner bracts very broad; hair of achenes pale shining ferruginous; pappus-scales normal for the group, more or less ferruginous. This is a more densely tufted plant than subsp. *multiflora*, and has larger heads. The plant is leafy right up to the flowers, which are very numerous. The pappus-scales are much shorter than the disc-corollas. (PLATE 23, FIGURE 2.)

Quite provisionally, I refer also to subsp. *Mearnsi* a series of small plants having the heads no bigger than those of true *multiflora*, and the peduncles frequently elongated. They do not seem to be exactly *multiflora*, but rather between it and *Mearnsi*. The distribution of these plants seems to show that the *multiflora* type does invade the territory of the tall mountain form, and this may certainly be taken as an argument for the genuine specific distinctness of the two. On the other hand, it could be suggested that these small plants are but conditions of the tall one, similar to the small examples of *H. floribunda*. If the latter supposition is true, the plasticity of the organism is wonderful. The small plants just referred to are:

NEW MEXICO.— Mangas, April, 1897, *J. K. Metcalfe*; near Cliff P.O., in the Gila Valley, approx. 4500 ft., July 12, 1900, *E. O. Wooton*; below Silver City, 5700 ft., July 6, 1900, *E. O. Wooton*.

ARIZONA.— Agency, Mohave reserve, April 1, 1876, *E. Palmer*; San Simon Valley, July 27, 1894, *J. W. Toumey*.

Hymenoxys chrysanthemoides multiflora (Buckley)

Phileozera multiflora Buckley, Proc. Acad. Nat. Sci. Phila. **1861**: 459. 1862.

Picradenia multiflora Greene, Pittonia, **3**: 273. 1898.

This, the smallest member of its series, was thus described by Buckley:

"Plant 4–6 inches high, with numerous erect flowering branches, which are destitute of leaves near the flowers; leaves about half a line wide, elongated, and 3–6 parted, with opposite or alternate segments; whole plant sparingly pubescent; flowers 3–4 lines in diameter; the lower pappus of many white hairs is at the base of, and about equal in length to the achenia; palea nearly as long as the achenia which they crown. The flowers have a resemblance to those of *Riddellia*." The type is from prairies north of Fort Belknap, Texas, in May. Specimens are stated to be in the herbaria of the Philadelphia Academy, and of Elias Durand.

The specimens before me are separable into two groups or series; A, with larger heads and ranker, sometimes confervoid foliage, possibly plants of damper ground; and B, with numerous small heads on usually rigid stems, the plant less inclined to spread, these being apparently plants of dry ground. I am not sure that these are more than states of one thing, and they are not separated by any real interval. At the same time, their distribution is suggestive of true racial differentiation.

FORM A.

TEXAS.— Staked Plains, May 1899, *W. L. Bray*; Sandy plains, Taylor Co., April 1882, *J. Reverchon*; between the Frio and Nueces Rivers, on the road to Laredo, Jan. 27 and 28, 1880, *E. Palmer;* sandy western plains, headwaters of the Llano River, May, 1885, *J. Reverchon*; a fairly uniform lot, except Palmer's plant, which has short curled much-dissected leaves, and looks curiously like some species of *Batrachium*. It perhaps deserves a varietal name.

FORM B.

TEXAS.— Oldham Co., Aug. 13, 1891, *M. A. Carleton.*

NEW MEXICO.— On the upper Canadian, April, 1848, *A. Gordon;* water holes in plains, near McCarty's Ranch, July, 1880, *Henry H. Rusby.* The first is a small plant, the second about twice as large.

OKLAHOMA. — Cimarron River, July 13, 1869, *Mark White;* Woods Co., June 29, 1900, *A. H. Van Vleet*; Gloss Mts., July 13, 1899, *Mark White.*

KANSAS.— Coolidge, July 4, 1892, *A. S. Hitchcock*; Buffalo Wallows, Trego Co., July 19, *A. S. Hitchcock.*

Hymenoxys Davidsonii (Greene)

Picradenia Davidsonii Greene, Pittonia, **4** : 240. 1901.

This plant certainly appears to be a biennial, but otherwise it is very close to *Osterhouti* and *anthemoides ;* much closer to them, so far as general appearance goes, than they are to *multiflora* or *chrysanthemoides.* Dr. Davidson very kindly sent me some of the original material, from Clifton, Arizona, and also a specimen from Metcalf, Arizona. The latter is of smaller stature (about 12 cm. high), with light green foliage and rather smaller heads (disc flowers about 85 to a head).

The Clifton plant was found along the river bank in the muddy ground ; it has about 112 disc-florets to a head ; outer bracts 8 or 9. The outer bracts are greenish, pointed, not obviously nerved, with convex sides, and united not over one-third ; the inner are longer and larger, very broad, 3-nerved, pointed. The pappus-scales are colorless, broad basally, with a fairly long awn-like end ; they are not very much more than half the length of the disc-corolla, which is much widened at the top. The rays are well-developed, 5.75 mm. broad.

INSECTS AND FUNGI ON HYMENOXYS

I have not found any record of a parasitic fungus attacking *Hymenoxys*, though two species of *Puccinia* (*P. Actinellae* (Webber) Sydow, and *P. cornigera* Ell. & Ev.) are known from *Tetraneuris.*

The coccid *Palaeococcus Townsendi* (Ckll.) infests *H. floribunda* at Raton, N. M (see Psyche, 1901 : 175).

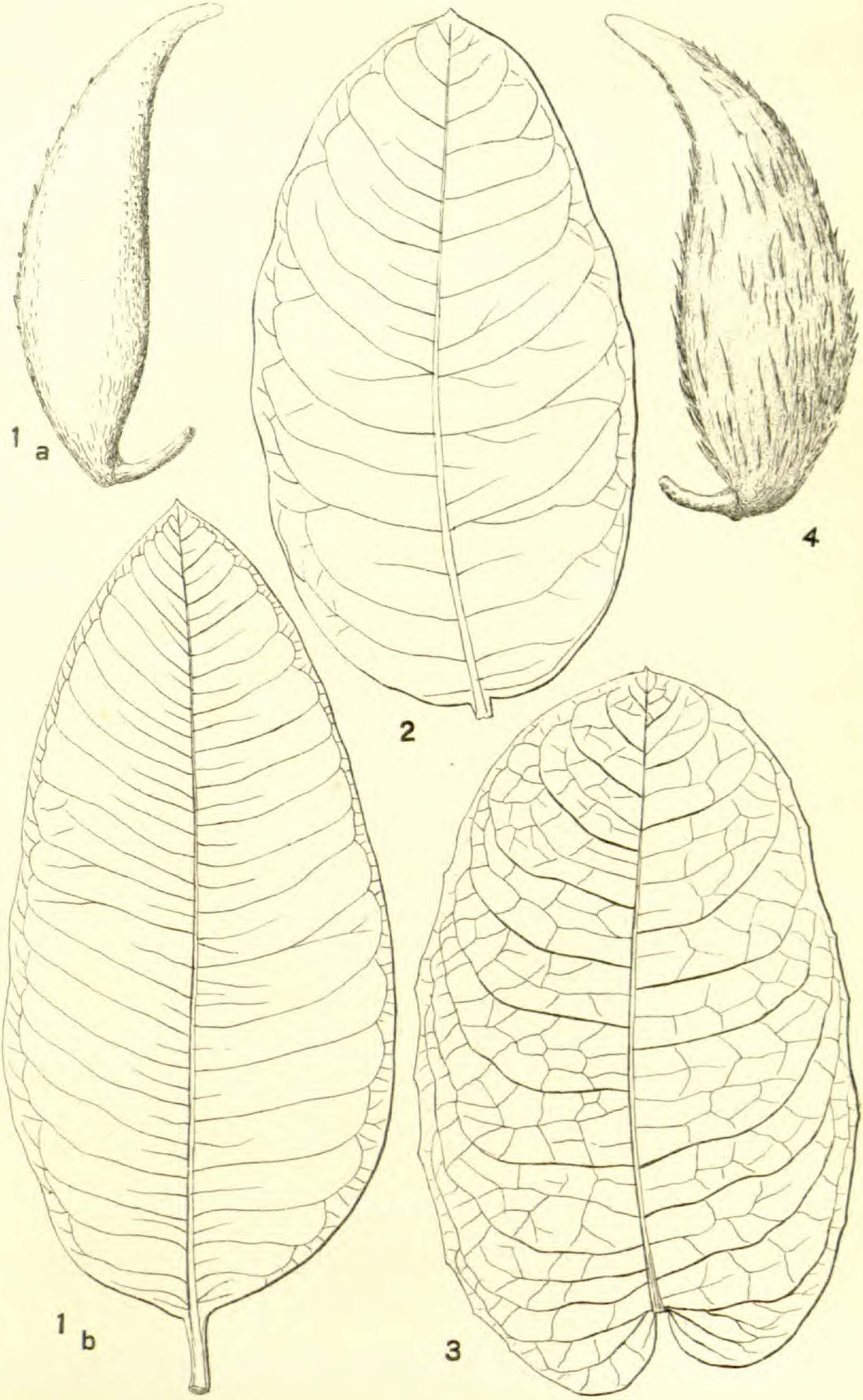
Two bees are recorded as visiting the flowers : *Halictus armaticeps* Cresson, visits *H. chrysanthemoides juxta* at Mesilla, N. M., and *Perdita chrysophila* Ckll., visits *H. floribunda* at Pecos, N. M. The latter observation is due to my wife.

UNIVERSITY OF COLORADO,
BOULDER, COLORADO.

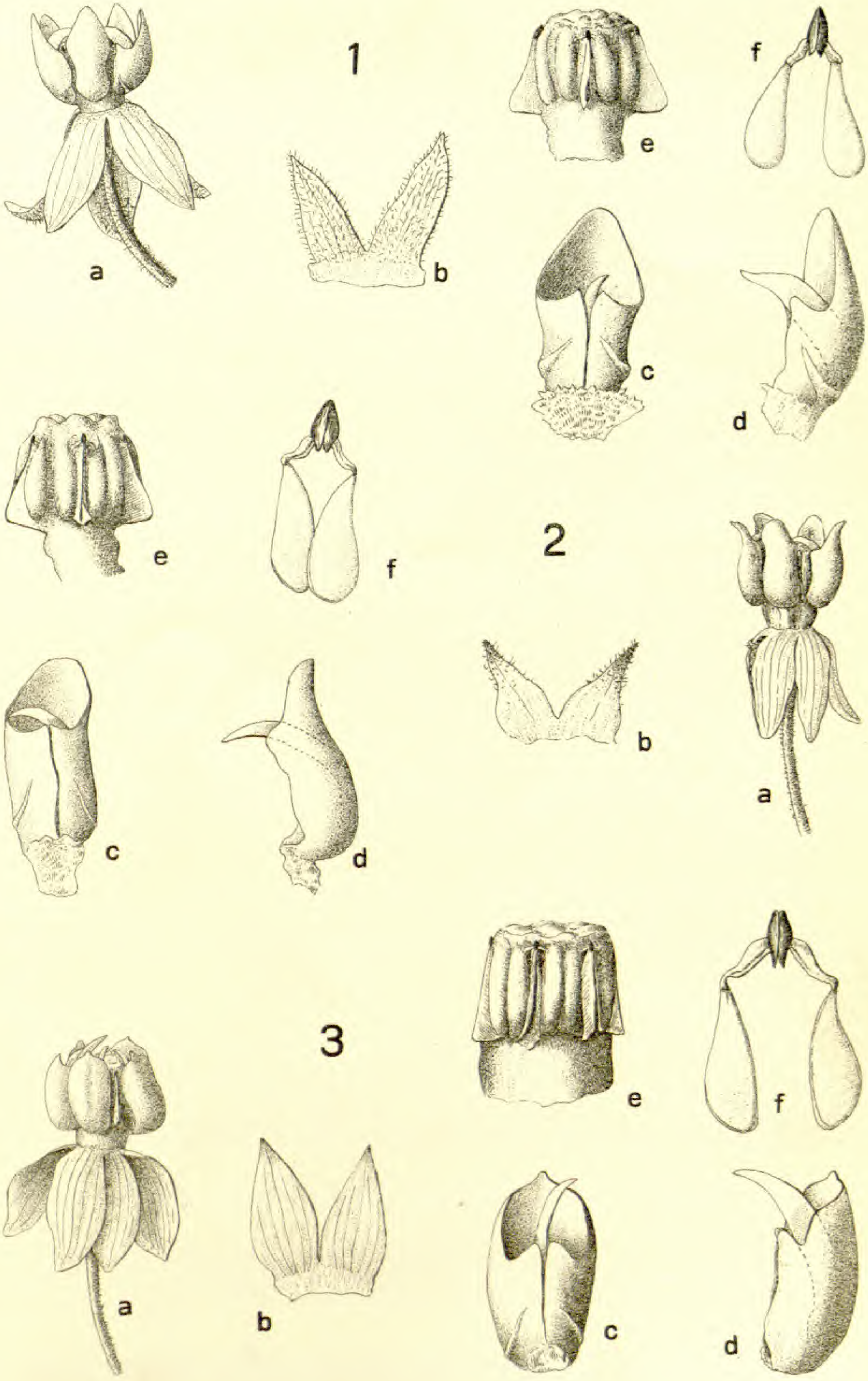
Explanation of plates 20-23

PLATE 20. *Hymenoxys floribunda utilis*
PLATE 21, FIGURE 1. *Hymenoxys Earlei.*
PLATE 21, FIGURE 2. *Hymenoxys latissima.*
PLATE 21, FIGURE 3. *Hymenoxys Metcalfei.*
PLATE 22, FIGURE 1. *Hymenoxys subintegra.*
PLATE 22, FIGURE 2. *Hymenoxys olivacea.*
PLATE 22, FIGURE 3. *Hymenoxys chrysanthemoides excurrens.*
PLATE 23, FIGURE 1. *Hymenoxys chrysanthemoides Osterhouti.*
PLATE 23, FIGURE 2. *Hymenoxys chrysanthemoides Mearnsi.*

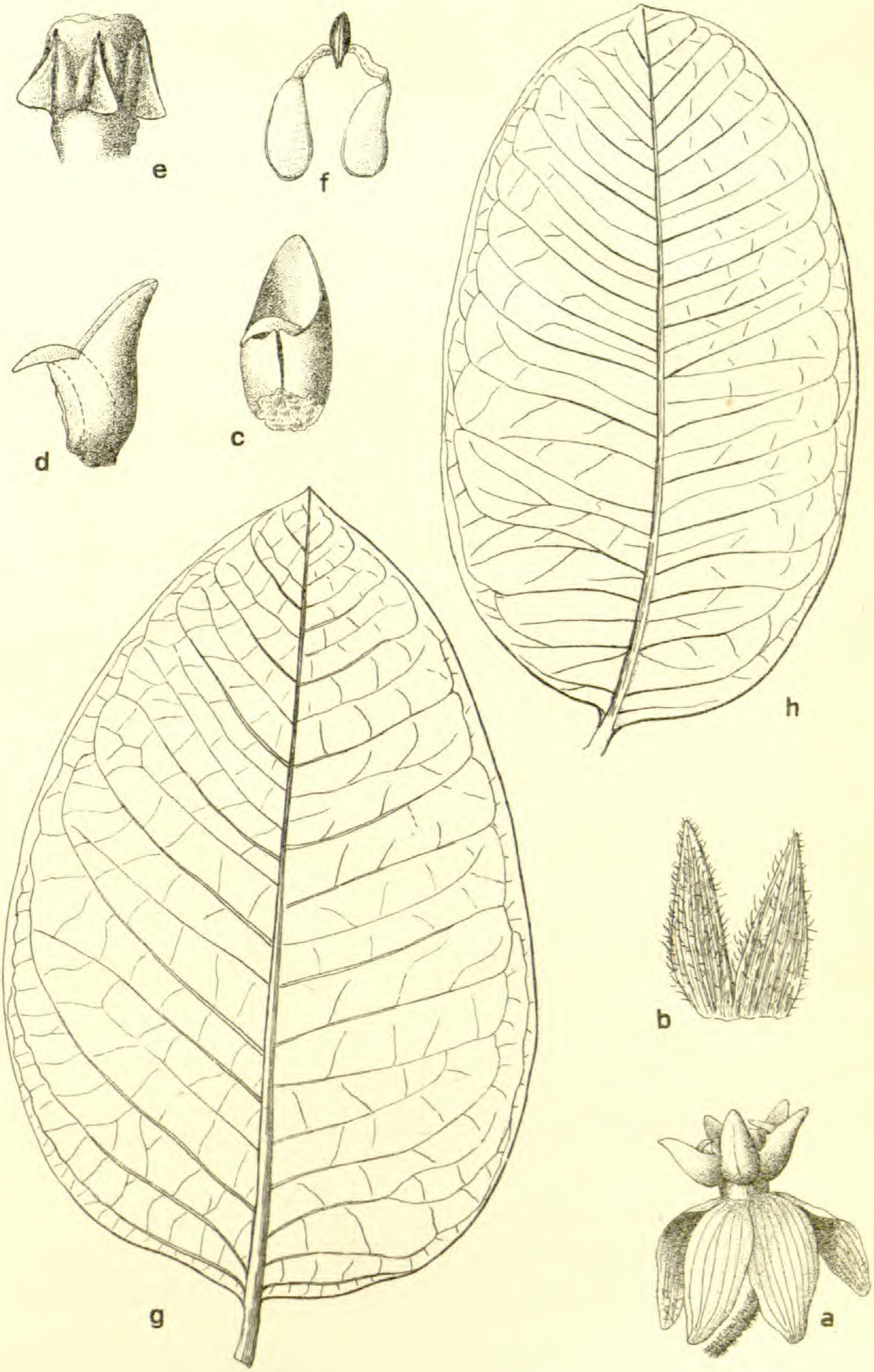
All of the figures are from photographs of the type specimens.



ASCLEPIAS

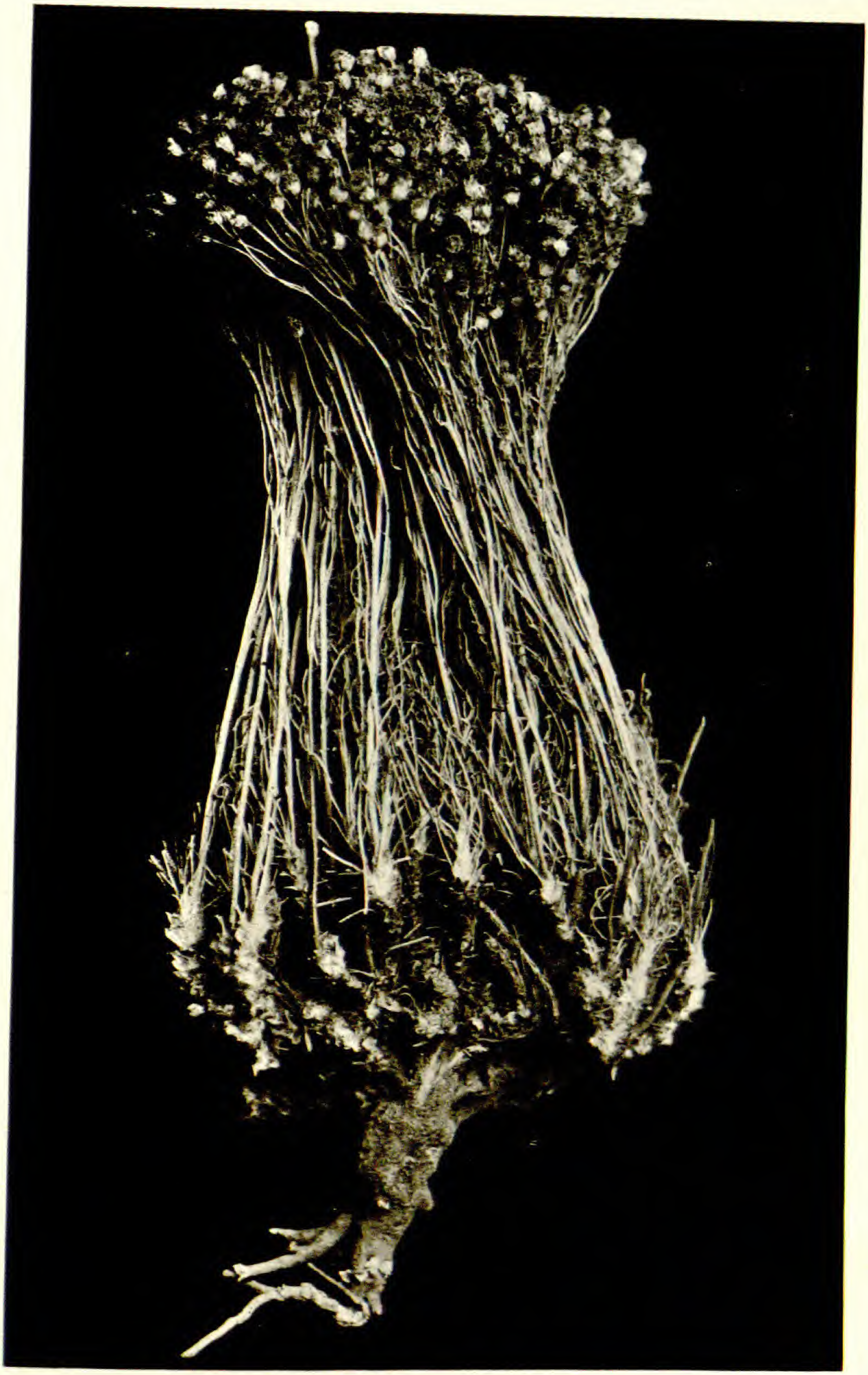


1. ASCLEPIAS SYRIACA L.
2. ASCLEPIAS INTERMEDIA Vail.
3. ASCLEPIAS AMPLEXICAULIS Smith.



ASCLEPIAS KANSANA Vail.

ASCLEPIAS BICKNELLII Vail.



HYMENOXYS FLORIBUNDA UTILIS

1. HYMENOXYS EARLEI

2. HYMENOXYS LATISSIMA

3. HYMENOXYS METCALFEI

1. HYMENOXYS SUBINTEGRA

2. HYMENOXYS OLIVACEA

3. HYMENOXYS CHRYSANTHEMOIDES EXCURRENS

1. HYMENOXYS CHRYSANTHEMOIDES OSTERHOUTI

2. HYMENOXYS CHRYSANTHEMOIDES MEARNSI

INDEX TO AMERICAN BOTANICAL LITERATURE

(1904)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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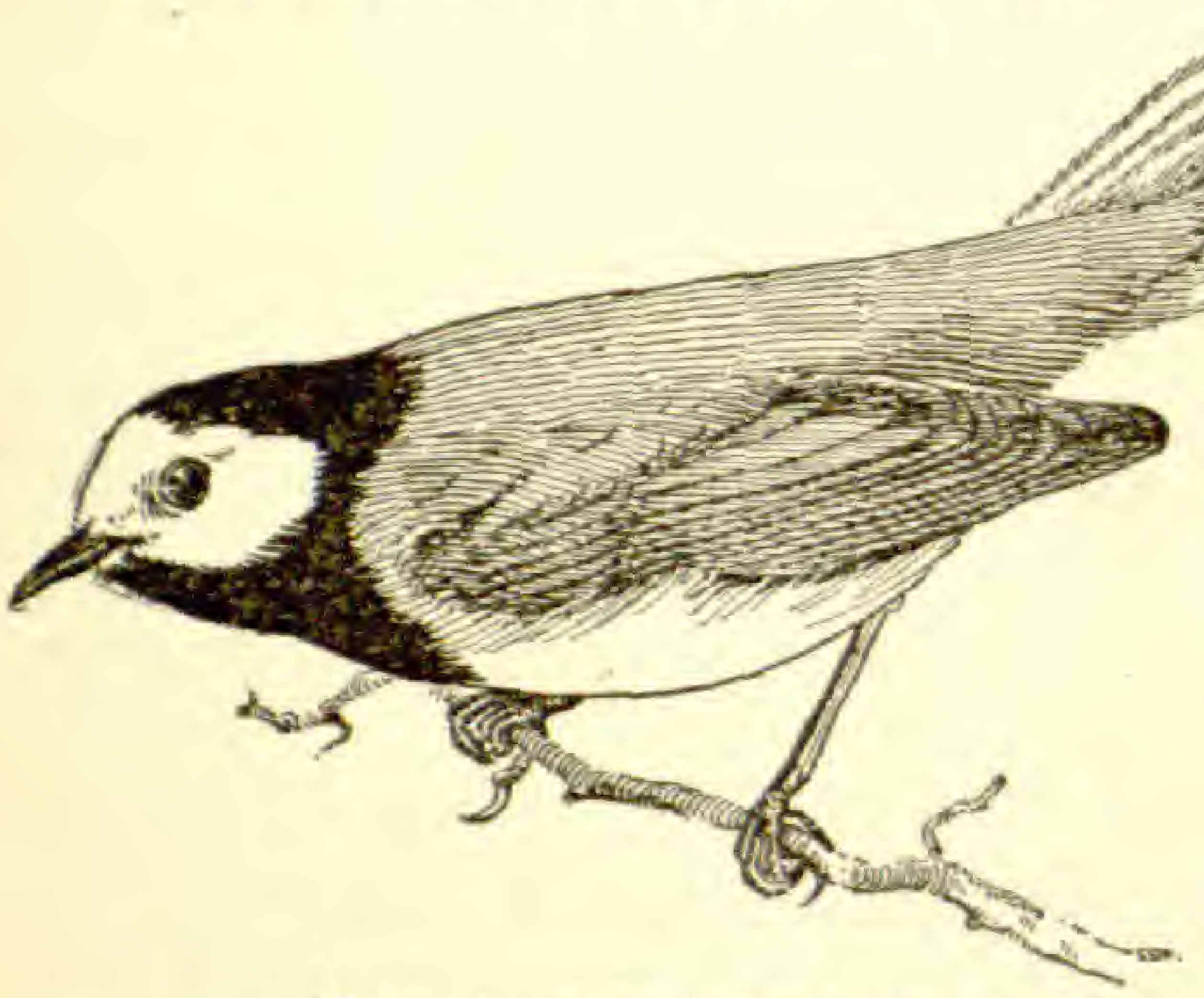

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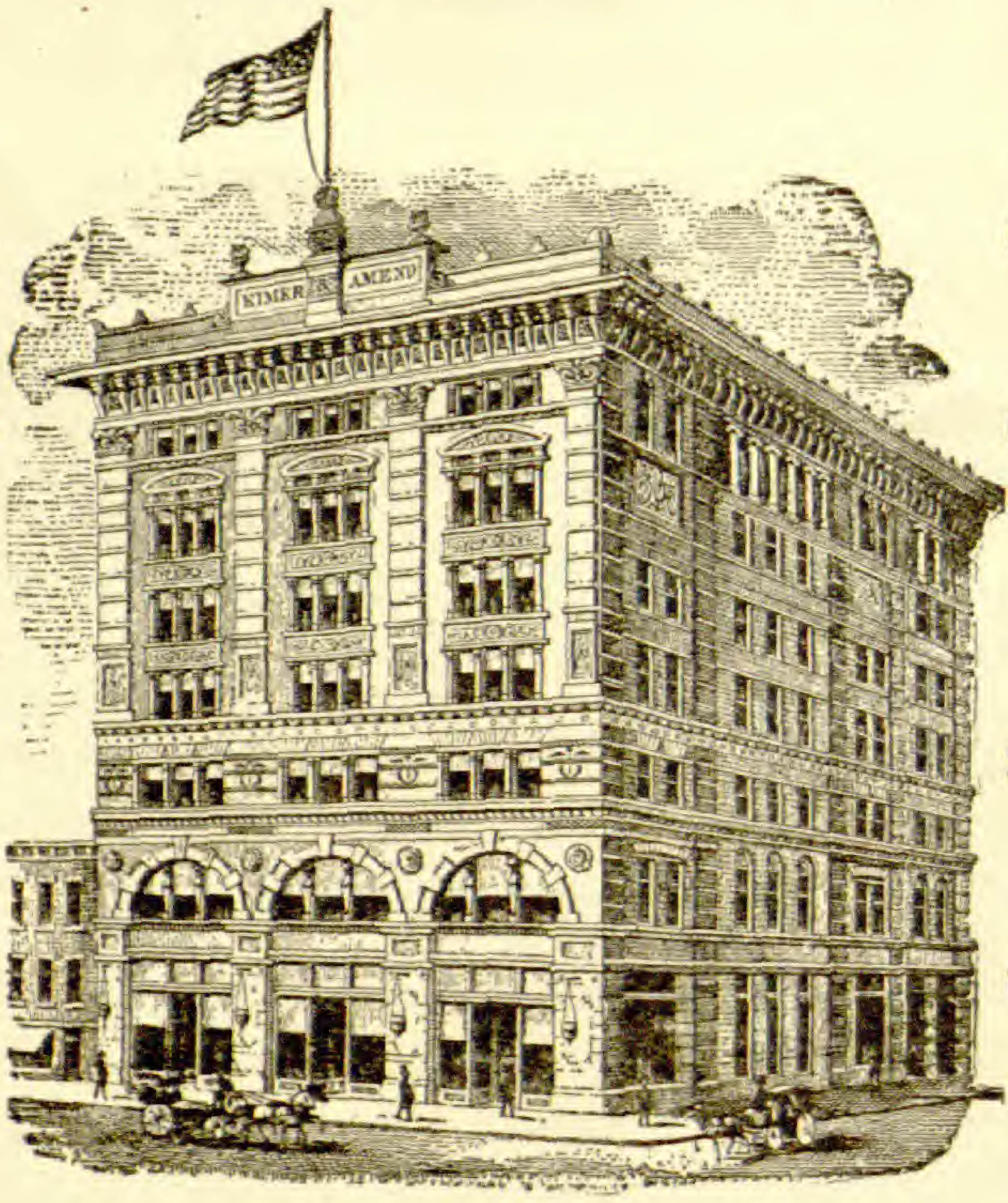
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OCTOBER, 1904

The chimney-shaped stomata of Holacantha Emoryi*

CHARLES E. BESSEY

(WITH PLATE 24)

Last December two fine twigs and a cluster of the ripe fruits of the "burro thorn" (*Holacantha Emoryi* Gray) were brought to the Botanical Department of the University of Nebraska by Mrs. Dorothy Bacon, who had collected them in the Salt River valley, near Phoenix, Arizona. They at once attracted attention because of their complete leaflessness, and the thorny nature of their branches. The shrub is said to grow about three meters high, and to form an impenetrable thicket from the ground up. It grows in the desert, where it was first found about fifty years ago by Major W. H. Emory of the United States Army in one of his expeditions. In the "Notes of a Military Reconnaisance from Fort Leavenworth in Missouri, to San Diego in California" (Washington, 1848), a poor drawing of a branch is given on the second plate of Appendix No. 2 (page 157). From an imperfect drawing, probably the original of the one given in the plate, Dr. George Engelmann surmised that it might be some species of *Koeberlinia*, a most excellent guess, as was afterwards shown. In

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*Seven years ago (1897) I read a paper on the peculiar stomata of the "burro thorn" (*Holacantha Emoryi* Gray) before the British Association for the Advancement of Science (at Toronto), accompanying it with a number of drawings. I did not print the paper at that time, hoping to add to it in certain details before doing so. I wished to get young twigs and the small leaves which appear only on the young plants (or the young shoots) in order to study the development of these peculiar stomata. As my repeatedly promised material has not yet appeared, it seems best to publish the paper in its original form with the figures which accompanied it.

[The preceding number of the BULLETIN, Vol. 31, No. 9, for September, 1904 (31 : 457-522, *pl. 16-23*) was issued 4 O 1904.]

1854 Dr. Gray described and named it,* referring it provisionally to the family *Rutaceae*, however suggesting its relationship with *Castala*, a genus of *Simarubaceae*. Good figures of the flowers (which are dioecious) are given by Torrey in *plate 8* of the "Report on the United States and Mexican Boundary Survey, made under the directions of the Secretary of the Interior, by William H. Emory" (Washington, 1858), and the genus is referred to the Quassia family, *Simarubaceae*, a disposition which has been confirmed by Bentham & Hooker, Baillon and Engler & Prantl. The best description of the genus is still that originally drawn up by Dr. Gray, only slight additions having since been found necessary. The description written some years ago by Dr. Gray for the "Synoptical Flora," and which has but recently been published (June 10, 1897), while concise, is very clear and entirely satifactory.

The plant is locally known as "burro thorn," "sacred thorn" "crucifixion thorn" and, according to a note in *Erythea* (March, 1897) by the Mexicans "*Crucifixo*," and "*Corono de Cristo*." It seems, also, that in some way the pseudo-scientific name "*Crucifera spinosa*" has currency among a certain class of people in Arizona, and it is used under the impression that it is a good botanical name.

Although described as a shrub, Professor J. W. Toumey, of the University of Arizona, assures me in a private letter under date of April 25, 1897, that "it reaches the size, and has the habit, of a tree on the plains four or five miles south of Maricopa." A photograph, in my possession, of a plant near Phoenix, shows it to be a much-branched, spreading shrub, with nothing of a tree-like habit. Seedling plants bear small leaves which are described by Dr. Gray as "lanceolate or linear, half an inch (12 mm.) long, thickish, entire or repand, or with a pair of small basal lobes." The mature plant is leafless, nothing more than the smallest scales remaining as vestiges. The branches have become modified into spreading thorns, which are themselves freely branched again.

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* Plantae novae Thurberianae: The characters of some new genera and species of plants in a collection made by George Thurber, Esq., of the late Mexican Boundary Commission, chiefly in New Mexico and Sonora. Memoirs American Academy of Arts and Sciences. II. 5: 297–328. 1854.

All parts of the surfaces of the branches and thorns are of a pea-green color, and minutely roughish to the touch. Upon making a transverse section the epidermis is found to be of unusual thickness, being no less than three, four, or five layers deep. The outer wall is of excessive thickness, and those below, while much thinner, are still very thick. The lateral walls, also, are greatly thickened, so that in a superficial view the cell-cavities are widely separated. Microchemical tests show that the outer epidermal cell-walls are strongly cuticularized, while those below are less so, or not all.

Below the epidermis lies a thick mass of palisade cells (*p*), averaging 110 μ in thickness, abundantly supplied with chlorophyl. These cells are closely packed in about three layers, the cells averaging from three to four times as long as their diameter. In this palisade mass there occur at frequent intervals large crystal-cells, each containing one large clustered crystal (*c*). The tissue beneath the palisade cells is thick walled (*h*), but the walls are not cuticularized, the stain reaction being that characteristic of cellulose.

The stomata are thickly scattered over the surface of the stems and thorns, a careful count showing that they number about seventy-three per square millimeter. Each stoma lies at the bottom of a narrow chimney-shaped cavity (*cy*) which passes entirely through the thickness of the epidermis and is prolonged both above and below it. This stomal channel is thus of greater length than the thickness of the epidermis. The measurements are as follows:

Average thickness of the epidermis.	72 μ.
Average depth of chimney-shaped channel.	123 μ.
Average height of chimney above the surface of the epidermis.	43 μ.
Average depression of the stoma proper below the inner boundary of the epidermis.	40 μ.

Cross-sections of the stomal cavity (chimney) show that at its outer end it is round or elliptical, and of somewhat smaller diameter than elsewhere. Below the top of the chimney the cavity is round, elliptical, ovate, or irregularly oblong in section, and has an average diameter of about 25 μ (*cy*). The walls of the chimney are composed of about eight vertical rows of cells (*bc*), whose boundaries may be faintly seen in the stomal papilla in preparations mounted for some time in glycerine. These vertical rows appear to be continuous down to the proper stomal apparatus at the bottom of the chimney. They become much more distinct as they pass inward.

The stomal apparatus at the lower end of the chimney consists of from forty to sixty or more cells which extend down into the mass of palisade tissue about 40 μ, prolonging the chimney about 8 μ. A cross section of this stomal apparatus shows it to be almost perfectly circular, or slightly elliptical, and to consist of from ten to twelve rows of thinner-walled cells than those which form the main portion of the chimney above. At the bottom of this structure is the proper stoma (*st*). It closely resembles the stomata of ordinary plants. The guard-cells are thick and large, and in cross-section are nearly circular. Each is provided with a projecting ridge on its upper surface, and these by approximating form a small "front cavity," the *Vorhof* of the German histologists. The "back cavity" or *Hinterhof* is entirely wanting. The vertical height of the stoma is 27 μ, and its diameter measured in cross-section of the guard-cells is 35 μ. Its diameter measured parallel to the opening very slightly exceeds its transverse diameter.

Beneath the stoma is the usual air-cavity (*sc*) which is lined with irregular and loosely bordered palisade cells. The intercellular spaces in the mass of palisade tissue are very small.

We have in this extraordinary structure a most ingenious device for protecting the plant against loss of water, while at the same time permitting free access of carbon dioxide. The highly translucent epidermis permits photosynthesis while its high degree of cuticularization prevents water-loss. It would be difficult to imagine a structure with a more perfect adaptation to existence under conditions extremely trying to most forms of vegetation.

Explanation of plate 24

A. Part of a cross-section of a twig: *ep*, epidermis; *p*, palisade tissue; *h*, hypodermal layer with thick, cellulose walls: *cr*, a crystal; *sp*, stomal papilla, in section; *cy*, chimney-like cavity extending from apex of papilla to the stoma at its bottom; *g*, guard-cells of stoma, in cross-section; *sc*, stomal cavity, the so-called air-cavity in the palisade tissue. × 240.

B. Another section similar to A, showing slight variations in the stomal apparatus: the lettering as in A. × 165.

C. Section of a papilla (*sp*), chimney-like cavity (*cy*) and guard-cells (*g*), showing the vertical rows of boundary cells (*bc*). × 240.

D. Section of the epidermis parallel and near to the surface, showing the outer layer of epidermal cells (*ep*), the cavities separated by thick walls; *bc*, the boundary cells of the stomal chimneys in cross-section. × 165.

E. Vertical section of the epidermis parallel to the surface but through or near to its inner layer, showing cross-sections of stomal chimneys (*cy*), and palisade tissue (*p*). At *st* is a stoma, with some of its boundary cells attached. × 165.

F. Transverse section of the epidermis, showing the inner epidermal layer (*iep*) and an isolated stoma (*st*). × 165.

The daily periodicity of cell-division and of elongation in the root of Allium

WILLIAM E. KELLICOTT

CONTENTS

1. Introduction

It is a well-known fact that rhythmic variation in the rate of growth is widespread, perhaps universal. It is similarly known that the nature of the rhythm varies considerably in different plants, so that there is no uniform hour at which the rate of growth is highest or lowest: each form seems to have its own peculiar rhythm. Perhaps this is one reason why there is at present so little uniformity of opinion among those who have studied the phenomena of growth in various plants, as to the factors involved in the production and maintenance of this rhythm. One possible factor has been overlooked almost entirely, namely, that of cell-division. As a matter of fact very little is known concerning the actual relations between cell-division and growth. Practically the only record of any observed correlation between cell-division and elongation is that of Ward,* who observed that, in *Bacillus ramosus*, "the period of cell-division entails more or less cessation of growth" (page 294), and that (pages 301–2) "periods

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*Ward, H. M. On the biology of *Bacillus ramosus* (Fraenkel), a schizomycete of the river Thames. Proc. Roy. Soc. **58**: 265–468. 1895.

of slowest growth . . . were the approximate moments of insertion of the septa, and consequently, moments when elongation would be going on with the least rapidity. . . ." Concerning the correlation of these processes in higher forms nothing at all is known.

Not only has there been no real attempt to correlate the processes of elongation and cell-division in a given organ, but there is a complete lack of knowledge concerning the course of cell-division alone in a growing part. And while much is known with regard to the daily rhythm of elongation or growth of organs, in nearly every instance the organ observed has been aërial and therefore subject to very profound and rapid environmental disturbances accompanying the alternating conditions of day and night. As far as can be discovered the only observations on the daily periodicity of growth of subterranean parts are those of Strehl* on the roots of *Lupinus*, and MacMillan † on the potato-tuber.

It seems, therefore, that here is an opportunity for profitable investigation: to determine whether there is a rhythmic daily variation in the rate of cell-division of a growing organ; to determine whether there is a definite daily rhythm in the growth or elongation of a subterranean part which is growing under much more uniform conditions than the aërial parts; and finally, if such rhythms are found to exist, to determine whether there is any correlation between the processes of cell-division and elongation. The observations described in this paper were designed to attack these questions, and it is believed that the results have been definite enough at least to warrant further serious investigation.

I wish to take this opportunity to express my very considerable indebtedness to Dr. C. C. Curtis, Columbia University, under whose direction these observations were carried out, for his ever ready aid and valuable counsel.

2. Summary

The principal facts brought out in this paper are the following:

1. In the root of *Allium* there are two maxima and two minima in the rate of cell-division during twenty-four hours.

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* Strehl, R. Untersuchungen über das Längenwachsthum der Wurzel und des hypokotylen Gliedes. Leipzig, 1874.

† MacMillan, C. On the growth-periodicity of the potato-tuber. Am. Nat. 25: 462–469. 1891.

2. The primary maximum occurs shortly before midnight (11 p. m.) and the primary minimum about 7 a. m. The secondary maximum occurs about 1 p. m. and the secondary minimum about 3 p. m.

3. There is no correspondence between the rate of cell-division and slight variations in temperature.

4. In the root of *Podophyllum*, maximal and minimal points occur at almost the same hours as in *Allium*.

5. Tap-water alone or with various substances in solution, seriously affects the course of cell-division. In some cases there may be recovery and partial return to the normal condition.

6. Under normal conditions of growth, the rate of elongation of the root of *Allium* exhibits a daily rhythm showing two maxima and two minima during twenty-four hours.

7. Elongation is most rapid (primary maximum) about 4 or 5 p. m., the secondary maximum occurring about 7 a. m. The primary minimum is about 11 p. m. and the secondary minimum about noon.

8. Periods of rapid cell-division coincide with low rate of elongation, and during rapid elongation the rate of cell-division is lowest.

3. Methods

(*a*) CELL-DIVISION

Sound average-sized bulbs of *Allium* were selected and allowed to germinate at ordinary room-temperature in moist sand or pine sawdust until the roots were from 50 to 100 mm. in length: this was usually after from four to six days. Then at definite intervals, usually of about two hours, throughout 24-hour periods, two root-tips from different parts of the bulb were taken for examination. The tips were fixed 20 minutes in acetic-alcohol (glacial acetic 1 part, 70 per cent. alcohol 2 parts), sectioned longitudinally 10 microns thick, and stained in Delafield's haematoxylin.

It is believed that the method used in determining the relative numbers of dividing cells in the different tips entirely obviated error due to differences in the size of the tips. From each, the three sections passing nearest the axis of the root were selected and the area to be examined determined in the following way. At a distance of 5 micrometer spaces (eye-piece micrometer ruled in millimeters, ocular 3, objective Zeiss A, tube-length 140 mm.) from the growing point of the tip (the root has attained a uniform diameter at this point) its diameter was measured carefully. An imaginary line was then drawn across the section at a distance from its extremity of twice its diameter. The area examined was that below this transverse line (FIGURE 1), and was found in every instance to contain practically all of the actively dividing cells of the undifferentiated tissue.

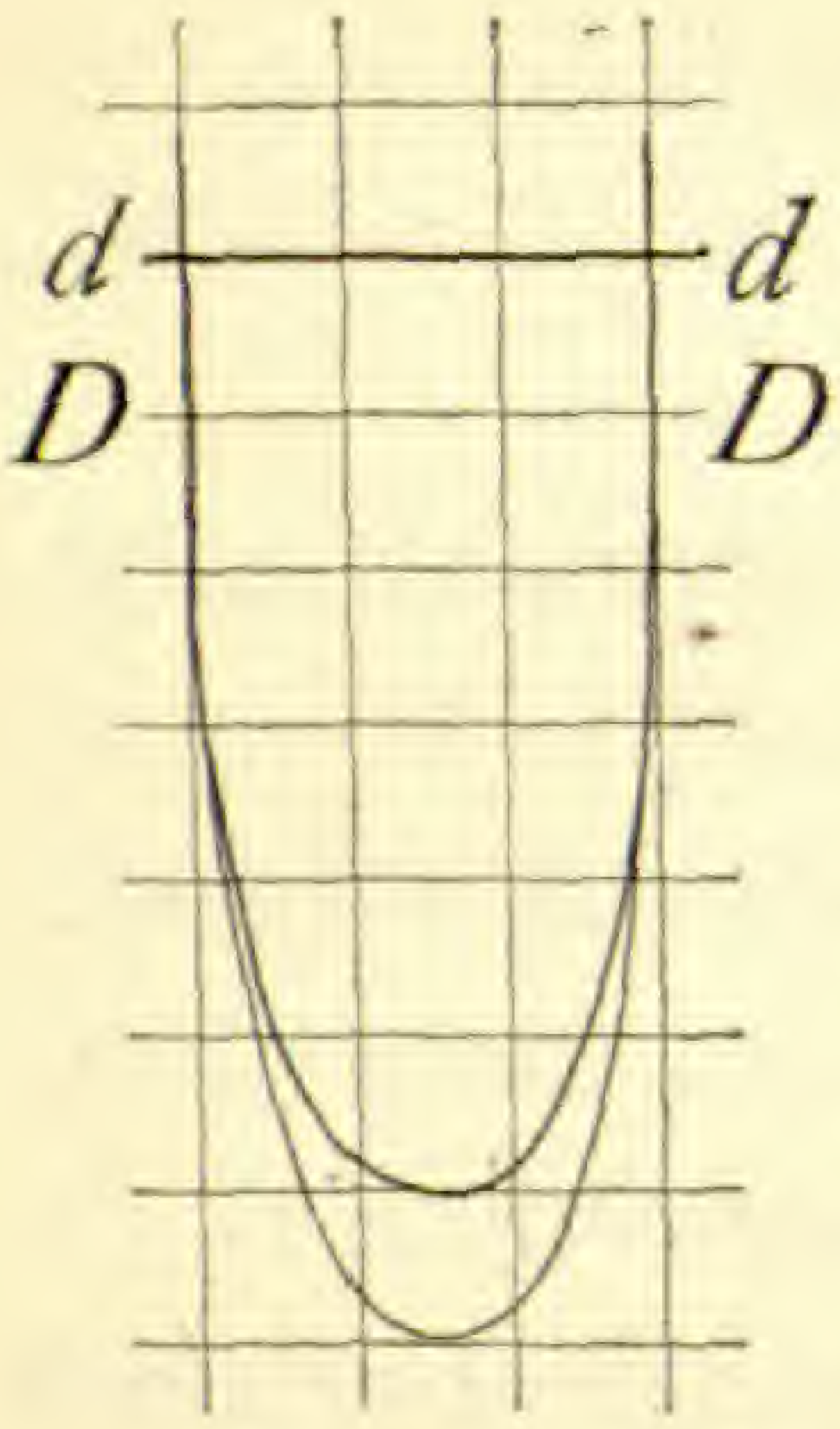

FIGURE 1. Diagram showing method of measurement. *DD*, diameter 5 spaces from apex. Area examined extended to line *dd*. Area of this tip = 15.

The number of dividing cells within the corresponding areas of the three selected sections was then carefully counted. The dividing cells were tabulated in three groups. The first group included those cells in the early stages of mitosis up to the time of the formation of the equatorial plate, *i. e.*, all stages of the prophase. The second group included those cells in metaphase and early anaphase up to the time when the divergence of the chromosomes is complete. The last group included the cells in late anaphase up to the time of the reconstruction of the nucleus and formation of the new cell-wall. These groups were then added and the average of the three sections taken as the number characteristic of the tip.

In order to avoid error due to the comparison of tips of different sizes the areas of the sections were reduced to a common area and the proportional numbers of dividing cells calculated. The average area of the sections was about fifteen micrometer squares; therefore the numbers of cells in sections having larger or smaller areas than this were calculated proportionally.

This method of comparison is justified by the fact that the size of a part or organ is determined by the number of cellular elements contained in it and not by variations in their size.* Several counts were made in given areas of large and small root-tips of *Allium*, and this was found to be true.

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* Amelung, E. Ueber mittlere Zellengrösse. Flora, 77: 176. 1893.—Strasburger, E. Histologische Beiträge. 5: 117–118. 1893.

The series of *Podophyllum* used as a check were treated in the same manner except that the smaller size of these tips necessitated their reduction to an average area of nine micrometer spaces.

(*b*) ELONGATION

In determining the periodicity of elongation the method of direct observation was used. Onions were grown in pine sawdust in pots with a narrow glass slip set in one side. Roots frequently grew almost vertically along this glass and would be exposed properly to moisture and air in the pot. These bulbs were of course grown entirely in the dark-room. When the roots were about 35–40 mm. long they were observed by candle-light through a horizontal microscope and the temperature recorded, at one- or two-hour intervals during a 24-hour period.

4. Daily periodicity of cell-division

A. UNDER NORMAL CONDITIONS

(*a*) *Typical observation.*—We shall consider first the rhythm of cell-division under normal circumstances of growth. To illustrate more fully the method employed and to furnish a basis for comparison, one of the records has been reproduced completely in TABLE I.

This table shows that by far the larger proportion of cells in the process of mitosis were in the prophase, as would be expected, since the preparation for and inauguration of mitosis occupy a much longer period than the later phases, which are passed through very rapidly. The table shows also how remarkably similar are the conditions of the root-tips examined at the same hour. This similarity is much closer than was expected on account of the numerous factors liable to cause individual variations. It will be seen that at 9 a. m., 11 a. m. and 1 p. m., for example, the numbers of dividing cells are almost identical in the two tips, while only in a few instances, such as at 5 p. m., 9 p. m. or 1 a. m., were there differences at all considerable.

The final averages of this table are represented in the form of a curve in FIGURE 2, *curve I*, which shows graphically the rate of cell-division during a 24-hour period. The curve is remarkably regular, with two maxima and two minima. Cell-division is most rapid (primary maximum) at 11 p. m., the secondary maximum

TABLE I

NUMBERS OF DIVIDING CELLS IN ROOTS OF SINGLE BULB OF ALLIUM

Time.	Temperature.	Area examined	Dividing cells.			Total dividing cells.	Total reduced to area=15.	Average for each tip.	Average of two tips.
			Early.	Middle.	Late.				
9 a. m.	16°	11.5	25	9	1	35	46	47	47
			23	8	4	35	46		
			30	5	3	38	50		
		13.5	33	3	3	39	43	47	
			36	2	4	42	47		
			37	3	5	45	50		
11 a. m.	17°	12.5	28	10	6	44	53	54	54
			33	8	6	47	56		
			27	9	8	44	53		
		12—	28	7	2	37	47	53	
			38	11	4	53	60		
			24	5	4	33	45		
1 p. m.	17.5°	13	46	4	4	54	62	61	62
			47	2	2	51	59		
			49	2	2	53	61		
		15.5	58	4	6	68	66	63	
			53	3	8	64	62		
			49	4	9	62	60		
3 p. m.	27°	12.5	26	2	3	31	37	39	35
			29	1	2	32	38		
			33	1	1	35	42		
		12	23	0	3	26	33	31	
			21	0	3	24	30		
			21	1	1	23	29		
5 p. m.	19°	13.5+	24	3	3	30	33	33	50
			26	2	2	30	33		
			25	2	2	29	32		
		11.5	37	4	6	47	61	67	
			46	1	3	50	65		
			45	6	6	57	74		
7 p. m.	17°	12	43	2	9	54	67	65	62
			39	4	8	51	64		
			38	3	10	51	64		
		13	42	2	4	48	55	59	
			47	4	4	55	63		
			45	1	6	52	60		
9 p. m.	15°	14	47	6	1	54	58	67	75
			53	8	4	65	70		
			65	2	0	67	72		
		13+	64	2	3	69	79	83	
			72	2	3	77	88		
			65	3	4	72	82		
11 p. m.	14.5°	11.5	65	3	4	72	94	93	89
			64	5	7	76	99		
			60	3	4	67	87		
		13	62	3	3	68	78	86	
			70	4	5	79	91		
			69	3	4	76	88		

TABLE I—*Continued*

NUMBERS OF DIVIDING CELLS IN ROOTS OF SINGLE BULB OF ALLIUM

Time.	Temperature.	Area examined.	Dividing cells.			Total dividing cells.	Total reduced to area=15.	Average for each tip.	Average of two tips.
			Early.	Middle.	Late.				
1 a. m.	14°	13—	37	1	1	39	45	48	57
			38	2	3	43	50		
			33	4	5	42	48		
		11+	45	5	2	52	69	66	
			40	2	3	45	60		
			44	5	2	51	68		
3 a. m.	14°	15	31	2	2	35	35	40	42
			35	3	2	40	40		
			35	8	1	44	44		
		17+	48	1	6	55	47	44	
			46	0	2	48	42		
			44	0	5	49	43		
7 a. m.	18°	16	23	1	2	26	24	24	24
			26	1	1	28	26		
			22	2	1	25	23		

occurring at 1 p. m. The primary minimum in the rate of cell-division occurs at 7 a. m. following the primary maximum, the secondary minimum at 3 p. m. following the secondary maximum.

Thus there are two regular waves of cell-division during each twenty-four hours, a more extensive wave extending from late in the afternoon until early in the morning, and occupying therefore practically all of the dark period; its crest occurs shortly before midnight. A less extensive but otherwise similar wave occupies the light period of the day extending from early morning until late in the afternoon. The crest of this wave occurs about noon. Both of these waves are remarkably regular with only the slightest secondary fluctuations.

The temperature of the air around the bulbs is recorded in the same diagram. It will be seen that there is no correspondence between these slight variations in temperature and the rate of cell-division.

(*b*) *Comparisons of other observations.* — FIGURE 2 includes curves derived similarly from two other series of root-tips. *Curve II* is introduced simply as another illustration of the normal type of curve such as *curve I*. Here the tips were cut less frequently so that all points of *curves I* and *II* do not correspond exactly.

The primary maximum occurs at 8 p. m., the secondary maximum at noon; the primary minimum at 5:30 a. m. and the secondary minimum at 5 : 30 p. m. It is unnecessary to give further examples of this character; in general it was found that under normal conditions of growth, cell-division was most active an hour or two before midnight and about noon, and was least active about 6 a. m. and 4 p. m.

Curve III in FIGURE 2 is introduced with its accompanying temperature curve to illustrate a very peculiar exception to this general rule. Cell-division here followed a perfectly normal course until just after the period of the primary maximum. Then instead of falling steadily to the primary minimum, it increased rapidly and reached a maximum far above that shown by any other series, at about the time when all other series showed the most pronounced minimum, *i. e.*, at 6 a. m. Then falling to its normal rate it proceeded after the typical fashion. That the rhythm of this plant was rendered abnormal in the prolongation of its most active period by some unknown conditions is evident. No other series showed any variation of this nature nor nearly of this extent. The curve is introduced here to show that when the usual rhythm of cell-division is interfered with, the normal rhythm

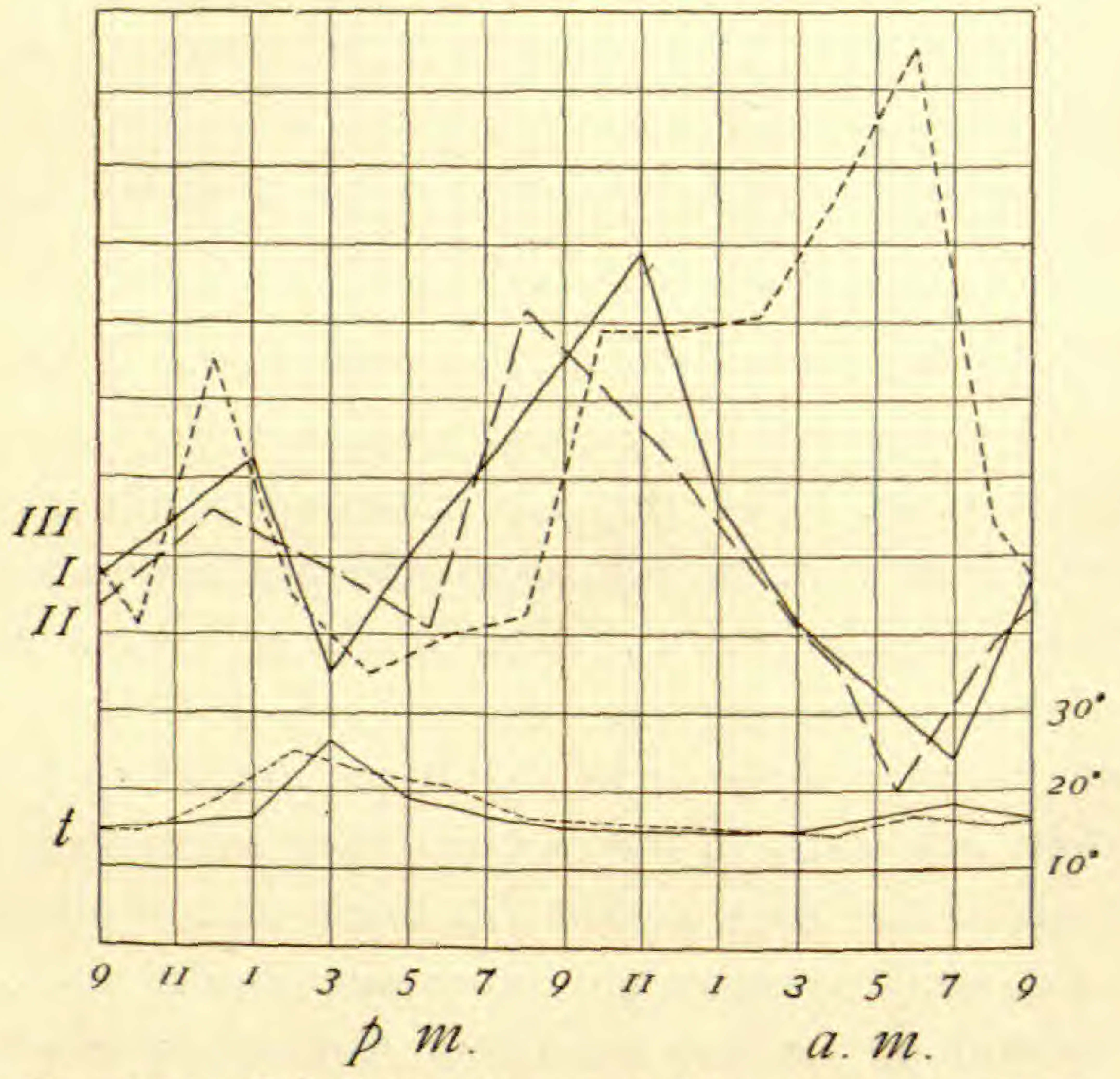

FIGURE 2. Cell-division in root of *Allium*. *t*, temperature.

tends to recur when the disturbing factor is removed or overcome. The fact that the specific cause of the disturbance is unknown in this instance does not lessen materially the value of the evidence.

(*c*) *Comparison of observations on Podophyllum.* — We may now review briefly the results obtained from a similar examination of the rhythm of cell-division in the root of *Podophyllum.* This form was selected to be compared with *Allium* because it too had very large cells, rapidly and easily grown roots, and because it was a representative of a totally different subclass. The method used was the same as with *Allium*, except that the plants were germinated in moist sphagnum, thoroughly rotted and washed.

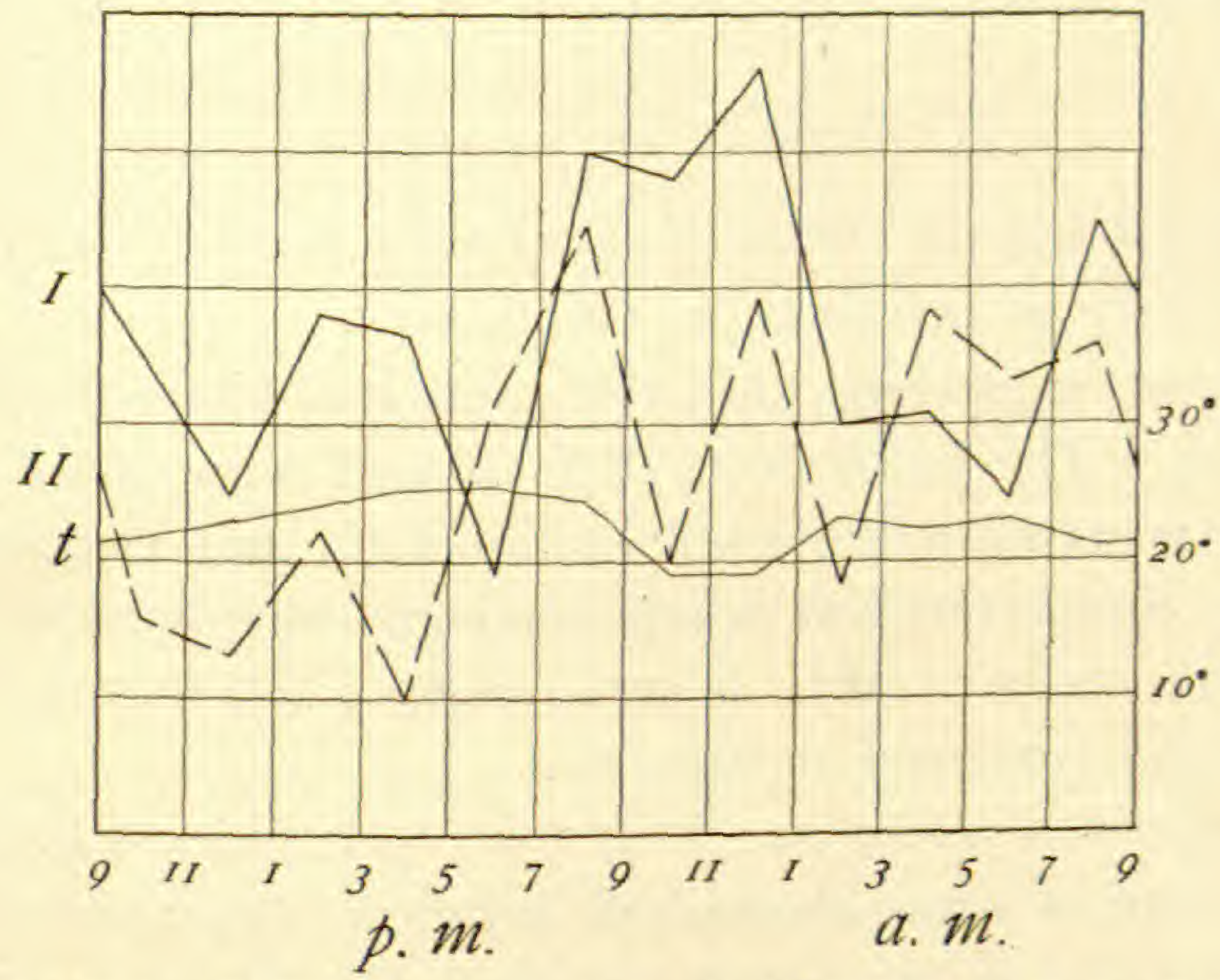

FIGURE 3. Cell-division in root of *Podophyllum.* *t*, temperature.

The results obtained from two series of root-tips cut every two hours, are shown in FIGURE 3, together with the record of the temperature of the surrounding air. These curves show more extensive minor variations than did those of *Allium*, but it is remarkable how closely similar are the curves obtained from the two plants. Even the minor variations of the main curve are always of the same nature, differing only in extent, with the single exception of the period from 4 to 6 p. m. when one curve began to ascend shortly before the other.

Underlying these minor fluctuations there are the general waves of cell-division, most clearly marked in *curve I.* These show primary maximum and minimum at midnight and 6 p. m.

respectively, and less definitely-indicated secondary maximum and and minimum about 2 p. m. and 6 a. m. respectively. In *curve II* the secondary waves are obscured by the more extensive minor variations.

In general the character of these curves derived from *Podophyllum* is quite like those from *Allium*, maximal and minimal points occurring at approximately the same hours. The most valuable evidence offered by the *Podophyllum*, however, is that such rhythms are actually present in the rate of cell-division, and that the rhythms are definite enough to be susceptible of comparison.

We may now turn to the third line of evidence upon this subject.

B. EFFECTS OF SOLUTIONS

In order to test the effects of various solutions upon the rapidity and periodicity of cell-division, onions were germinated as before in moist sand or sawdust until the roots had reached a length of 50–75 mm. The bulbs were then placed over glass tumblers where the roots were immersed in tap-water and exposed to the daylight. Some were left in tap-water and examined at intervals, others were removed after being in water a few hours, to certain solutions, and examined at intervals.

The solutions used were: (1) 4.2 per cent. glucose in tap-water, as an example of a non-electrolytic solution; (2) 2 per cent. magnesium chloride, as an isotonic electrolytic solution; (3) 2.5 per cent. peptone.

(*a*) *Water.* — We may consider first the rate of cell-division of the tips placed in tap-water and subject to the illumination of the laboratory about 2.5 m. from north and west windows. An onion with roots about 50 mm. long, grown in sand, was placed over tap-water, in such a manner that the roots were completely immersed, at 10 a. m. and beginning at 2:30 p. m. tips were removed and examined. The numbers of dividing cells at irregular intervals during the succeeding thirty-two hours are represented in *curve I*, FIGURE 4. At 2:30 p. m., when the roots had been in water for four and one-half hours, the curve is much higher than is normal for that hour. During the afternoon it falls normally and from 8 p. m. until midnight when the curve usually rises to its greatest height, this curve shows only a very slight rise which is rather an interruption in its rapid descent. After midnight there is continued descent until about noon when the curve ascends again to a maximum at 6 p. m. This maximum would have occurred normally at noon—just at the time when the ascent actually commenced. After the maximum at 6 p. m., which is the normal time for a minimal point, the curve falls again and was falling when observations ceased at 10:30 p. m.

The effect of removing the roots to water was at first a stimulation resulting in very rapid cell-division for a short time. This was followed by inhibition of cell-division and delay of its normal rhythms. The total number of dividing cells was very considerably reduced; the minimum which occurs normally about 6 a. m. was delayed until nearly noon, and the maximum which occurs normally at noon was delayed until 6 p. m. The inhibition of cell-division finally passed away partially and thirty-two hours after being placed in water (*i. e.*, at 6 p. m.) cell-division was again fairly rapid. Observations not included in the diagram were made at 10. a. m. on the two days following the last observation charted. These observations showed cell-division to be fairly active, the numbers of dividing cells being about 75–80 per cent. of the

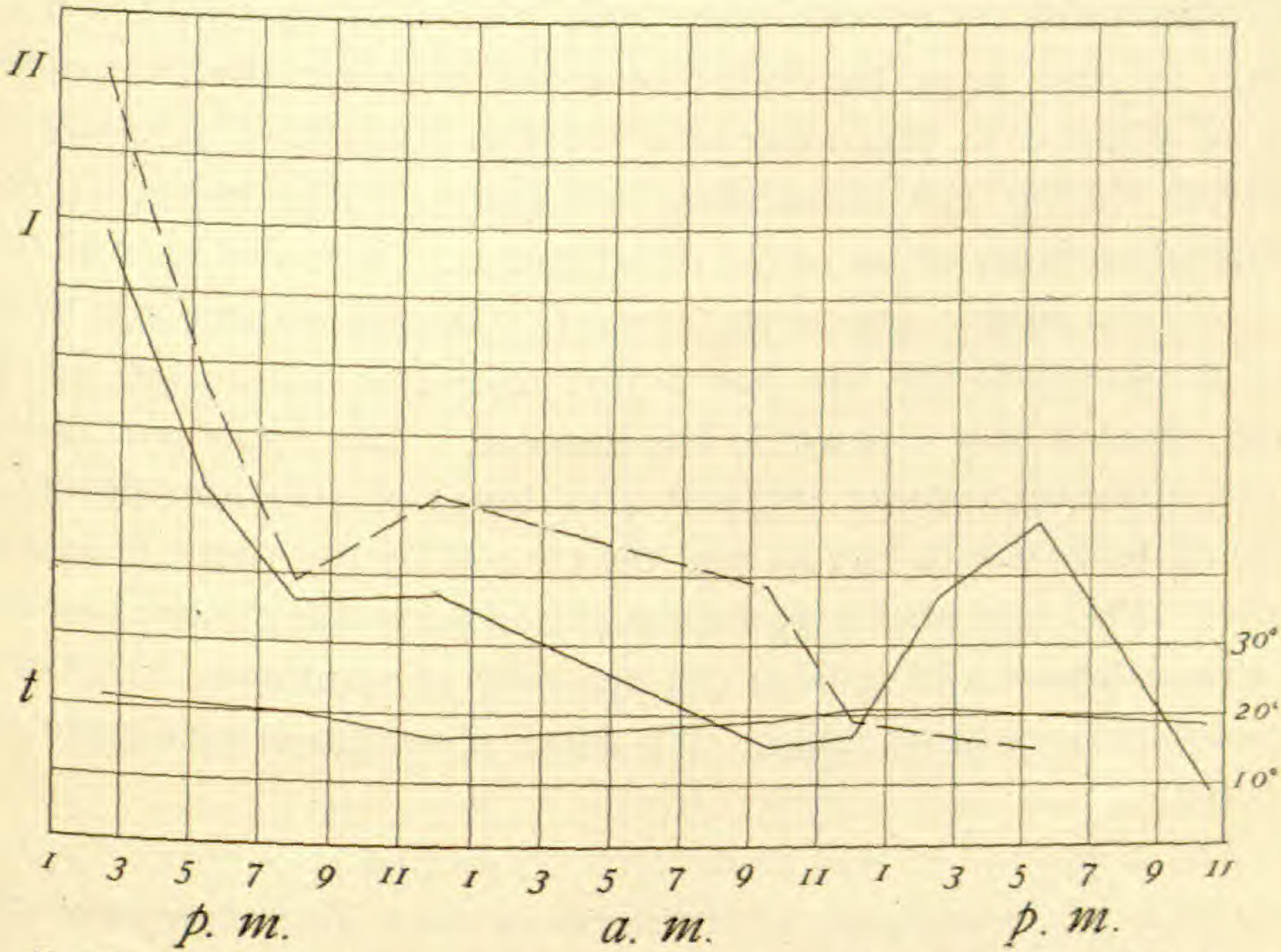

FIGURE 4. Elongation of root of *Allium* immersed in water (*I*), and in 4.2 per cent. glucose (*II*). *t*, temperature.

normal. This is important as showing that very soon (about thirty-two hours in this instance) after being placed in a new or unusual environment the process of mitosis, at first seriously deranged, tends to recover its normal course. In other words the roots very soon become adapted physiologically to their new conditions of growth.

No correlation could be observed between variations in illumination or temperature, and cell-division. In this series the temperature varied only slightly (FIGURE 4).

(*b*) *Glucose.* — As before, the roots of an onion grown in sand until they were 50–75 mm. long were placed in tap-water at 9:30 a. m. At 2:30 p. m. they were removed to a 4.2 per cent. solution of glucose in tap-water and the tips examined at irregular intervals during the succeeding 27 hours. The result of the examination is shown as *curve II*, FIGURE 4. The first part of the curve is remarkably similar to *curve I*. In one respect it is more typical, namely in the rise just before midnight, where the tips in water showed only a pause in the descent. The latter part of the curve, however, is more atypical and does not give any sign of a delayed tendency to rise as was the case with the roots placed in water. This is probably to be correlated with the greater amount of stimulation resulting from the presence of an unusual substance in solution in such quantity. No later observation was made on this bulb.

The temperature was as in *curve I*, so that it is similarly true here that the variations in temperature and illumination of the laboratory seem to have no effect upon the frequency of mitosis.

(*c*) *Magnesium chloride.* — It was found that root-tips removed from water to a solution of $MgCl_2$ isotonic with the 4.2 per cent. solution of glucose, *i. e.*, a 2 per cent. solution $MgCl_2$, were seriously affected. The cells became vacuolated and somewhat shrunken and their condition became so abnormal in a few hours that there was no cell-division whatever in progress. Consequently roots were left in the $MgCl_2$ solution for only a short time and then were replaced in water.

For example, the roots of an onion grown in sand were placed in tap-water at 9:30 a. m. At 1:30 p. m. the tap-water was replaced by a 2 per cent. solution of $MgCl_2$ in tap-water and left six hours; at 7:30 p. m. the roots were replaced in tap-water. Examination of the tips gave the results tabulated as *curve I,* FIGURE 5. At the time the roots were placed in the solution, cell-division was proceeding at about the usual rate for those tips similarly placed in water. After removal to the solution, however, cell-division decreased very rapidly. After replacing in water, cell-division recommenced and after a period of two hours we find the rate of mitosis gradually increasing until five hours after removal from the solution the rate was above the normal for roots placed in water, or about like those placed in glucose. Unfortunately the number of tips on this bulb was exhausted at this time and no further observation was possible.

(*d*) *Peptone.* — As a non-crystallizable, nutrient solution, a 25. per cent. solution of peptone in tap-water was used. As before, roots were removed from sand to water at 10 a. m. At 2:30 p. m. they were transferred to the peptone solution and examined at intervals during a period of thirty hours. The rate of mitosis in these tips is shown graphically in *curve II,* FIGURE 5. In general it is very similar to the curves of tips in water and glucose, especially during its later course. In its earlier portion it lacks the pause or rise just before midnight. Cell-division almost stopped after 16–20 hours in the solution.

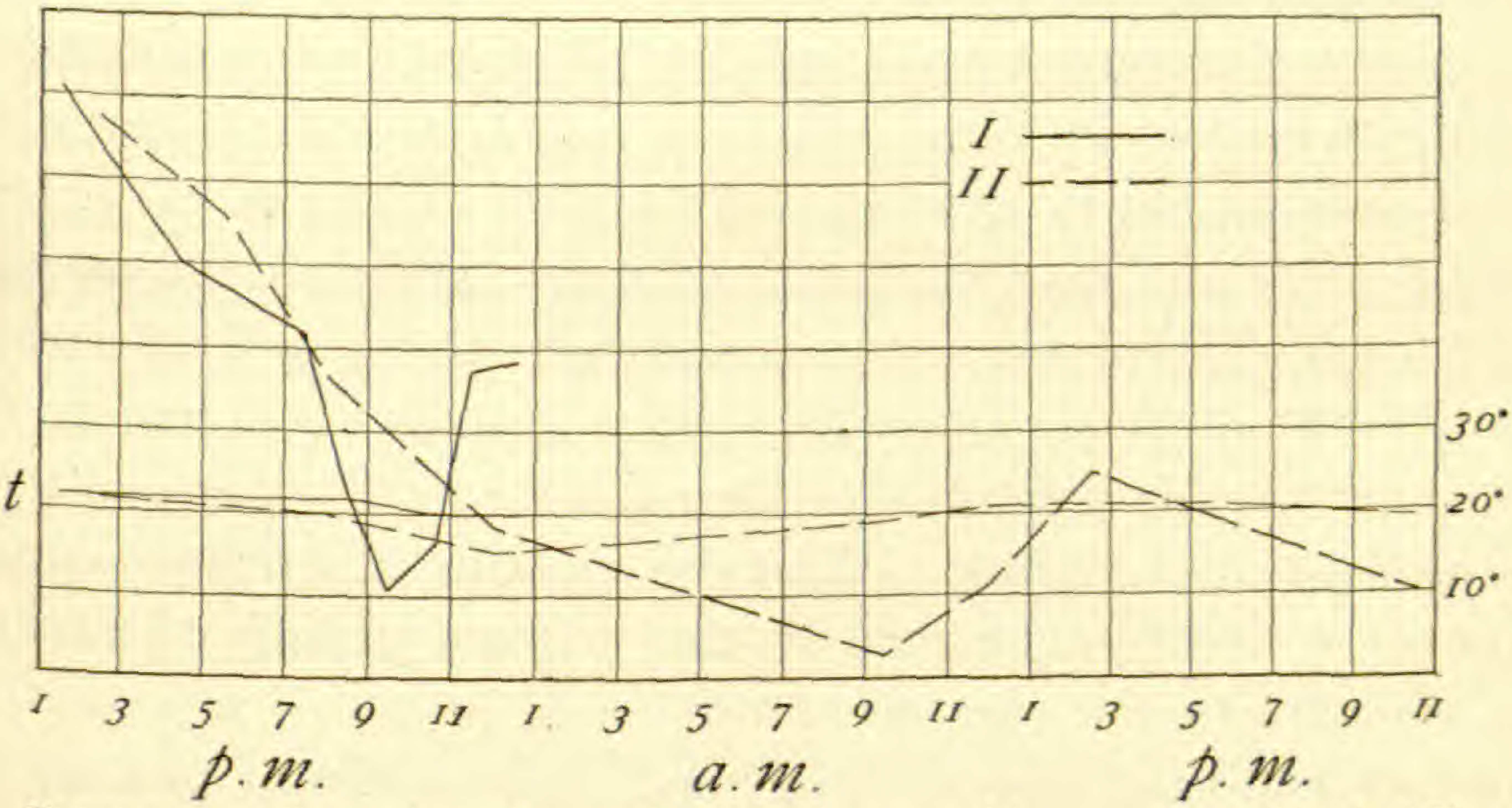

FIGURE 5. Elongation of root of *Allium* immersed in 2 per cent. $MgCl_2$ (*I*), and in 2.5 per cent. peptone (*II*). *t*, temperature.

As already stated the general result of placing growing roots in liquids or solutions is to decrease the rate of cell-division and to delay its normal rhythm. Upon comparing the effects of various types of solutions certain tentative inferences may be drawn. The effect of a non-electrolytic solution (glucose) is not different from that of tap-water alone; in this instance the plant did not tend to recover its normal rhythm, *i. e.*, to adapt itself, as did the plant placed in water alone, although the first effect was not quite as marked.

The effect of a brief immersion in an electrolytic solution (magnesium chloride), however, was the almost complete stoppage of cell-division; recovery commenced shortly after removal to water. The effect of a solution of peptone is to cause a reduction of the rate of cell-division greater than that produced by water alone; the rhythm is not affected dissimilarly.

From the small number of observations made it is obviously impossible to make a definite statement regarding the specific effect of any of these solutions upon cell-division. The purpose of placing the roots in these solutions was not at all to test their specific effects, but to determine the effects of liquids in general upon the rate and rhythm of cell-division; rather to see whether the normal rhythm was actually a definite thing and whether it would be maintained or modified under abnormal external conditions. From this point of view the evidence from the experiments was decisive and positive. That the rhythm is a definite occurrence is sufficiently indicated by the uniform periods of increase and decrease in the rate of mitosis in all series of tips whether under normal or abnormal conditions. The result of placing the tips in liquids is to prolong the rhythm and so to delay the maximal and minimal points, although these tend to recur at the normal hour even under abnormal conditions, and to decrease the rate of cell-division. This accords with the observations of Sachs,* Wacker,† and others that the roots of land plants are shorter when grown in water — undergoing a sort of retardation of growth.

It is noteworthy that in none of the series could there be seen any direct effect of change in temperature. The variations however were slight, and it almost goes without saying that wide varia-

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* Sachs, J. Arbeiten Bot. Inst. Würzburg, 1 : 385.

† Wacker, J. Die Beeinflussung des Wachsthums der Wurzeln durch das umgebende Medium. Jahrb. Wiss. Bot. 32 : 71–116. 1898.

tions in temperature would have a very marked effect upon the rate of mitosis. Nor could there be observed any effect upon mitosis of changes in the feeble illumination of the laboratory. Normally, of course, the root is in a constant condition of darkness and it is therefore worthy of note that the rhythm in the varying illumination of the room had no definite effect upon the rate of cell-division.

Finally then, summing up in regard to periodicity of cell-division, we may say that there is a definite and regular rhythm in the root of *Allium.* Under normal conditions of growth, cell-division is most active just before midnight and just after noon and is least active about 6 a. m. and 4 p. m. There may be variations from these times within limits of about two hours.

Very little is possible in the way of comparing these results with the work of others. Famintzin,* Strasburger † and others have noted that in most algae cell-division is most rapid at night. Lewis ‡ in a very brief communication noted that cell-division in the root of the onion growing in water and exposed to the light, was most rapid about noon and slowest about 4 p. m., while in roots growing in water but in a vessel painted with lamp-black cell-division was slowest at midnight and fastest about 4 p. m. Insufficient data are given concerning the conditions under which these results were obtained to enable us to judge of the value of these observations.

5. Daily periodicity of elongation

The observations upon the elongation of the root of *Allium* were all made upon the roots of bulbs of uniform size and with approximately equal numbers of roots, *i. e.* about six. The length of the roots varied between 35 and 50 mm. at the beginning of the observation. The roots had been grown entirely in the dark, the bulbs not having been exposed to the light after germination was begun, so that no rhythmic character of elongation could be due to the direct influence of alternating illumination. The tempera-

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* Famintzin, A. Die Wirkung des Lichtes auf Algen und einige andere ihnen nahe verwandte Organismen. Jahrb. Wiss. Bot. **6**: 40. 1867.

† Strasburger, E. Zellbildung und Zelltheilung. 3 Aufl. 171. 1880.

‡ Lewis, A. C. Contributions to the knowledge of the physiology of karyokinesis. Bot. Gaz. **32**: 424–426. 1901.

ture in the dark room varied within narrow limits only and the temperature within the pot containing the roots must have been nearly constant. Thus the factors of varying illumination and temperature were ruled out.

The facts that the roots were of different lengths and that they showed different total amounts of elongation during the periods of observation show that the roots were not all in the same phase of the grand period of growth. This has to be taken into account constantly in comparing the different curves of growth, for some will show a general upward course, others a downward or even course, depending upon the relative portion of the grand period of growth which is represented. Thus while in the daily curves of elongation the actual maximal and minimal points coincide, their relative heights might vary somewhat.

TABLE II

ELONGATION OF THE ROOT OF ALLIUM. TOTAL ELONGATION, 24 HRS. = 16.1 MM.

Time of observation.	Elongation in one hour, in micrometer spaces.	Temperature.	Time of observation.	Elongation in one hour, in micrometer spaces.	Temperature.
9 a. m.	10.00	21.0°	9 p. m.	8.00	20.5°
10 “	8.75	20.5°	10 “	8.00	“
11 “	8.50	“	11 “	6.00	“
12 m.	10.00	“	12 n.	7.00	“
1 p. m.	10.00	“	1 a. m.	8.00	“
2 “	9.00	“	2 “	8.00	20.0°
3 “	9.00	“	3 “	7.00	“
4 “	9.50	“	4 “	7.00	“
5 “	8.75	“	5 “	8.00	“
6 “	8.75	“	6 “	9.00	“
7 “	8.75	“	7 “	8.00	“
8 “	9.00	“	8 “	9.00	“

(*a*) *Typical observation.* — We may take as an example a record of the elongation of the root showing the hourly elongation in micrometer spaces (Leitz horizontal microscope) as given in TABLE II. This is expressed as a curve in FIGURE 6, *curve I*, where the observed elongation is multiplied by four to bring out better the form of the curve.

There are seen to be apparently three maxima and three minima in the rate of elongation. The most extensive maximum (primary maximum) has its apex at 4 p. m. The primary minimum has its apex at 10 p. m. Secondary maxima occur at 3 a. m.

and 7 a. m. and secondary minima at 5 a. m. and 1 p. m. These secondary maxima and minima are relatively much less marked than the primary waves and, occurring as they do so near together, it is likely that they are to be considered properly as minor fluctuations on a broader maximal wave reaching its height (secondary maximum) about 7 a. m.; the secondary minimum would then be found about noon. The other irregularities in the curve are quite slight.

The observations on some of the roots were made only bi-hourly, therefore for purposes of comparison later, we may write this curve as if observations had been made bi-hourly, as *curve I*, FIGURE 7. The result, of course, is to reduce the irregularities of the curve and slightly to alter the times of the apices of the principal waves, *e. g.* the primary maximum now appears at 5 p. m. instead of 4 p. m., the primary minimum at 11 p. m. instead of 10 p. m.

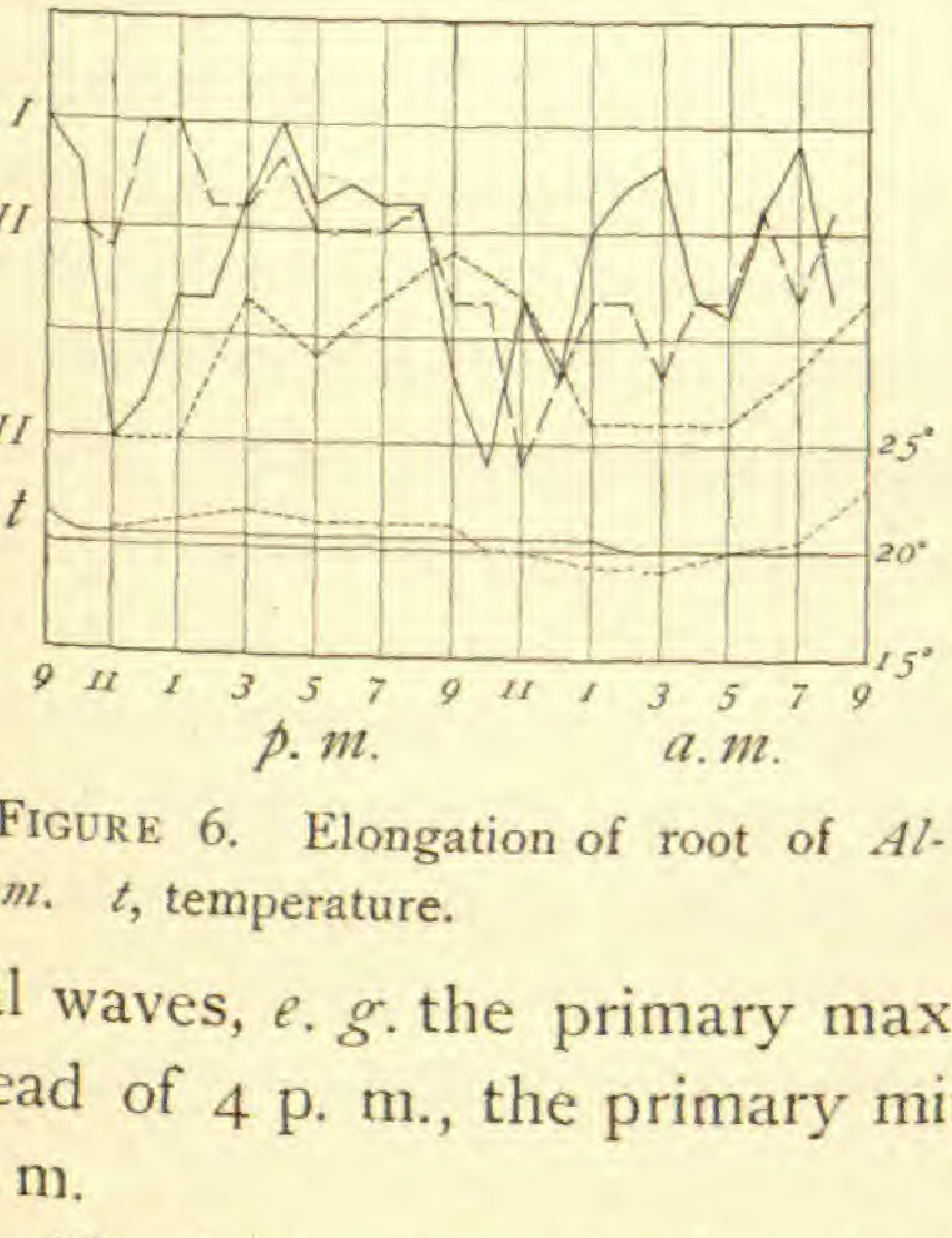

FIGURE 6. Elongation of root of *Allium*. *t*, temperature.

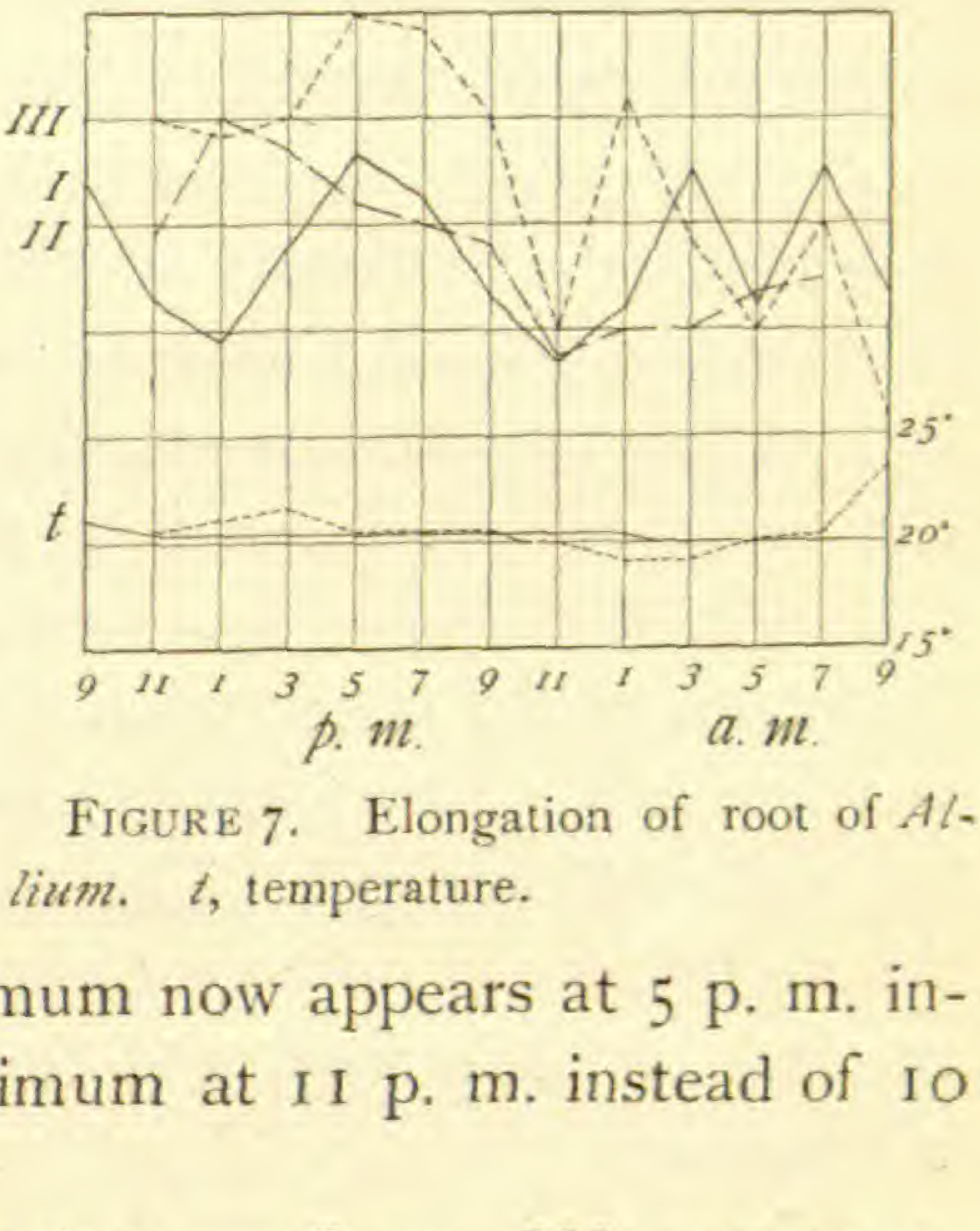

FIGURE 7. Elongation of root of *Allium*. *t*, temperature.

(*b*) *Comparison of other observations.* — *Curve III*, FIGURE 7, illustrates the rate of elongation of a root observed bi-hourly. The general appearance of this curve is somewhat modified from the fact that it was taken after the maximum of the grand period of growth had been passed and consequently the rate of elongation is lower at the end than at the beginning of the observation. The actual hours of maxima and minima are, however, almost exactly as in the curve just described. That is, there are primary maximal and minimal points at 5 p. m. and 11 p. m. respectively, and secondary maximal and minimal points at 7 a. m. and 1 p. m. The temperature varied more during this observation than during the preceding one, but still no correlation is observable between variations in temperature and rate of elongation.

Another record, *curve II*, FIGURES 6 and 7, was made at the same time as *curve I* and under identical conditions. The points of dissimilarity between the two are of degree rather than of kind. There is just the same pronounced minimum at 11 p. m. The primary maximum however occurs somewhat earlier, that is at 1 p. m. The secondary maximum occurs at the usual hour. The secondary minimum about noon is not very clearly marked but is indicated at 11 a. m. On the whole the secondary waves are all less definite than in the curves previously described.

Finally, another record made under conditions identical with those of *curve III*, FIGURE 7, must be considered. This record is illustrated as *curve III*, FIGURE 6. This is the only root observed during the ascent of the grand period of growth and most of its very evident peculiarities may be explained in connection with this fact. The rate of elongation reaches its primary maximum at 9 p. m. Another maximum is marked definitely at 3 p. m. and the rate was increasing again steadily when the observation ended at 9 a. m., as if to mark another maximum. A very extensive minimum occurs between 1 and 5 a. m., and at the beginning of the observation a minimal period extends from 9 a. m. to 1 p. m. The features of the curve are all remarkably regular and well marked. The total amount of elongation during the 24 hours was only 13.5 mm. There is no correlation between the rate of elongation and the comparatively slight variations in temperature.

The principal peculiarities of this record are due to the appearance of the primary maximum and minimum about five hours later than normally and to the absence of the secondary waves in the early morning. A possible explanation of these peculiarities may be the following. From the comparative levels of the beginning and end of the curve and from the small amount of elongation of the root, we are evidently concerned here with a root which has not yet reached the maximum of its grand period of growth. Such a young root is growing with a greater vigor, has a greater momentum so to speak, and as a consequence is not affected by stimuli (external or internal) which would affect roots growing with less potential, such for instance as are on the descent from the maximum of the grand period. Ordinary stimuli would produce either a delayed reaction or none at all. Therefore the daily maximal and minimal periods are delayed and the stimuli usually producing the secondary waves are inoperative.

Summarizing then in regard to elongation we may say that there is a daily rhythm of elongation of the root of *Allium* which occurs in the absence of variation in illumination and independently of slight variations in temperature: this rhythm must be the result of internal factors. The daily rhythm is such that elongation is most rapid about 4 or 5 p.m. and slowest about 11 p. m. Besides these primary waves there are secondary points, the secondary maximum occurring about 7 a. m. and the secondary minimum about noon.

It will be well to compare, at this point, these results on *Allium* with those derived from the study of other subterranean organs. As mentioned in the introduction to this paper,* the only records are those of Strehl and MacMillan. Strehl found that there was a single maximal and minimal wave in the rate of elongation every twenty-four hours, the rate being highest about midnight and lowest about noon. His curves, which represent observations extending over several days, show admirably the varying appearance of the daily curve depending on the phase of the grand period which it represents. Strehl's observations were made upon the roots of *Lupinus*, and the conditions under which they were growing were far from normal; *i. e.*, the roots were growing in water and were contained in glass placed only 1.5 m. from a west window where they would be subject to moderately strong illumination.

In MacMillan's observations upon the growth-periodicity of the potato-tuber, the plants were under normal conditions of growth and the results are entitled to more weight. Unfortunately, as he himself states, his observations were of a fragmentary nature and were to be considered rather as a preliminary report. MacMillan concluded that the rate of increase in diameter of the potato-tuber occurred rhythmically, with one, two, or perhaps more maxima in twenty-four hours. He believes that the tuber

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* See page 530.

has an independent rhythm of its own in addition to a rhythm induced by that of the stem and other aërial parts, and offers some tentative explanations of both of these. The fact that here interests us particularly is that there is frequently a double maximum in the rate of growth during the twenty-four hour period. Thus far there is agreement with the root of *Allium;* how much farther this agreement extends can not be stated, for MacMillan does not mention any hours at which these maxima occur.

We may also compare briefly at this point, the rhythm of elongation of the aërial parts. Observations upon *Allium* have been made by Stebler * on the elongation of the leaf. Stebler found that the maximum of growth coincides with the period of greatest light intensity (12–4 p. m.), growth being slower during the night, the minimum occurring between 12 and 4 a. m. His curves show this single wave very definitely. Many others working on other plants have found similarly a single daily wave of growth, although the actual periods of maximum and minimum do not always correspond by any means. Thus, for example, Sachs † found the elongation in *Dahlia* to be most rapid in the early morning (6–9 a. m.) and the slowest in the evening, (3–6 p. m).; Prantl ‡ in *Cucurbita* found the maximum elongation to occur about 3 p. m. (12–6 p. m.) and the minimum from 3 to 6 a. m.; and, to complete the possibilities, MacDougal § found that in the leaf of *Hyacinthus* the maximum of elongation occurs between midnight and 4 a. m. and the minimum about noon. The only uniformity here is the single maximum and minimum each day.

Godlewski ‖ at first observed only a single wave of elongation in the epicotyl of *Phaseolus*, but later he found that there were definitely two maximal and two minimal periods during twenty-four hours. The minima occurred morning and evening

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* Stebler, F. G. Untersuchungen über das Blattwachsthum. Jahrb. Wiss. Bot. **11**: 47–123. 1878.

† Sachs, J. Arbeiten Bot. Inst. Würzburg. **1**: —.

‡ Prantl, K. Arbeiten Bot. Inst. Würzburg, **2**: —.

§ MacDougal, D. T. Text-book of plant physiology, 295. New York. 1901.

‖ Godlewski, E. Studien über das Wachsthum der Pflanzen. Abh. Krakauer Akad. Wiss. Math-Naturw. Classe, **23**: 1–157. (Abstract by Rothert, Bot. Centralblatt, **55**: 34–40. 1893.)

and the maxima day and night; the relative intensities of the maxima and minima were inconstant even in the same plant. This is apparently the only recorded instance of a double daily wave of growth in an aërial part, of such a nature as is found in the root.

6. Relation between cell-division and elongation

The actual relation in time between cell-division and elongation can be seen most easily by reference to FIGURE 8, where there are composite curves of all my records of normal cell-division and elongation reduced to similar proportions. It is at once evident that the rhythms agree in time but always occur in opposite directions, *i. e.* when elongation is at a maximum cell-division is at a minimum and vice versa. The primary maximum of cell-division corresponds perfectly with the primary minimum of elongation at 11 p. m. The primary maximum of elongation corresponds with the secondary minimum of cell-division about 5 p. m., while the primary minimum of cell-division occurs at the time of the secondary maximum of elongation at 5 a. m. In general, throughout, the curves have opposite directions. The only real exception occurs between 3 and 7 a. m. when, as already noted, the decreasing rate of elongation can hardly be considered a constant

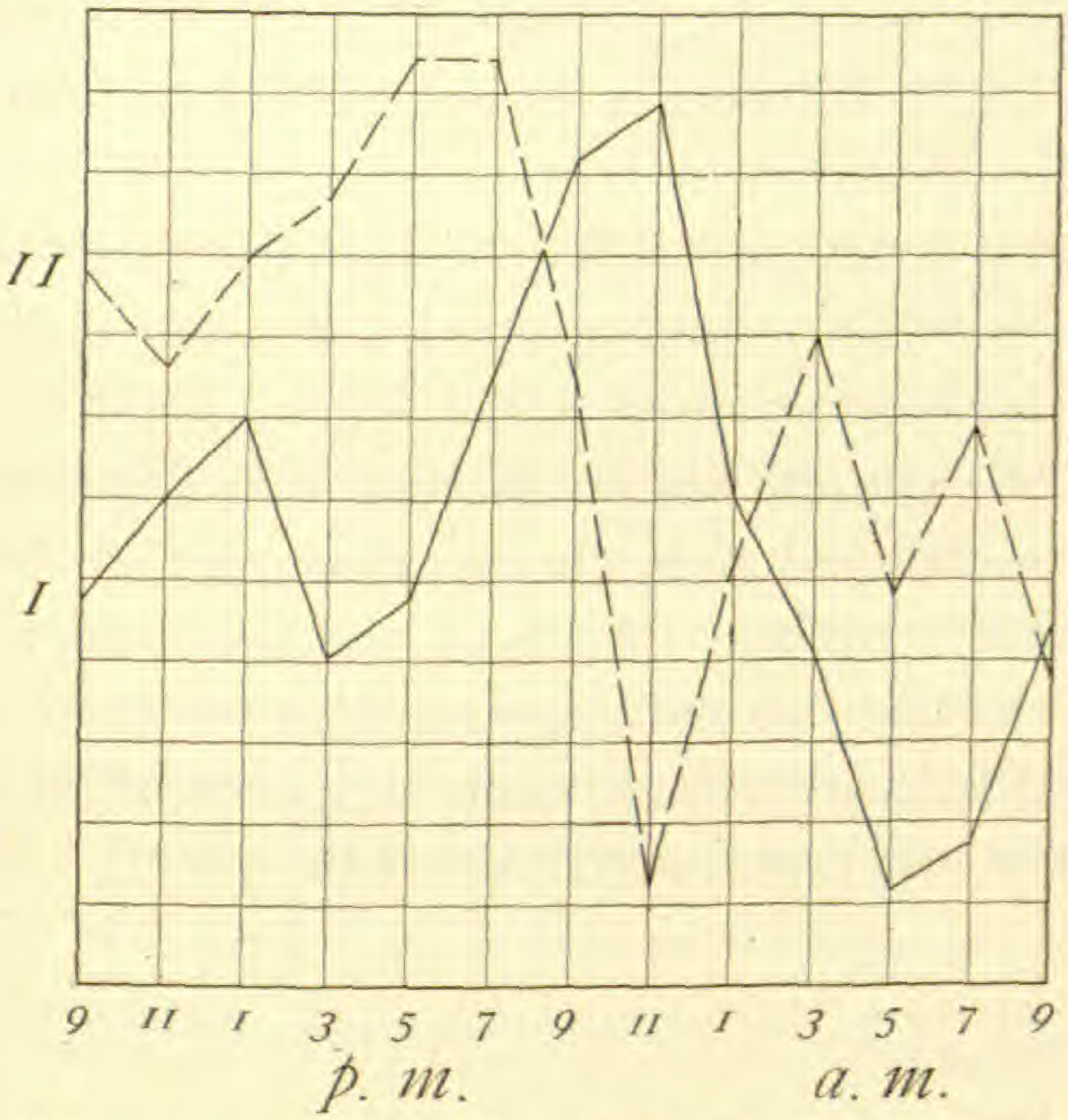

FIGURE 8. Composite curves of cell-division (*I*) and elongation (*II*).

feature; it is quite likely that the rate of elongation increases uniformly from 11 p. m. until 7 a. m.

These time relations, however, do not lead to the understanding of any causal relation more definite than that expressed by Ward,* that the energy of the cell is not sufficient to enable it to continue its growth and at the same time form new cellular elements; therefore when the cell is dividing and the new cell-wall forming, etc., the energy of the cell is diverted from its other growth-processes and elongation is arrested. Rhythmic activity resulting from the uniform action of stimuli or forces is quite universal and it may be that here in the root where external conditions are practically uniform, we are dealing with a rhythm which is not related directly to the external environment, but which results from the activity of the root itself, *i. e.*, is internal in its origin. There can be no doubt that the rhythm in the stem is to a greater or less extent an induced one, and it is difficult to believe that the pronounced rhythm of the stem is without influence upon the root; yet in the roots of these bulbs without growing aerial organs, definite rhythms are established. We should know whether this rhythm of the root is maintained unchanged after the development of the leaves with their marked daily rhythm. With our present limited information we are hardly justified in making assumptions as to what are the causal relations between cell-division and elongation, both to each other and to the other vital activities of the plant.

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* Ward, H. M., *loc. cit.*

COLUMBIA UNIVERSITY,
June 1, 1904.

Relationship of Macrophoma and Diplodia

JULIA T. EMERSON

(WITH PLATE 25)

In December, 1902, Mr. Earle brought back to the New York Botanical Garden from Jamaica, West Indies, various collections of cocoanut affected with diseases. One set was handed over to the writer to see how it would develop when grown in cultures. It was *no. 510*, collected at Bowden, Jamaica, November 18, 1902, on flower-bud spathes of *Cocos nucifera*, labelled "dying of wasting disease." The spathes were covered with black spots just visible to the unaided eye, which proved to be pycnidia of *Macrophoma* and *Diplodia*, so closely associated that from one point both the hyaline unicellular *Macrophoma* spores and the brown two-celled *Diplodia* spores could be secured.

In March, 1903, cultures were started from the spathes by scraping off some of the black pycnidia where *Macrophoma* spores had previously been found, examining with a microscope and transferring a few spores to ordinary neutral agar. In the same manner cultures were taken from spathes where *Diplodia* spores had been seen. In this way two sets of cultures from each kind of spore were obtained, with reasonable assurances that they started one from pure *Macrophoma* spores and the other from pure *Diplodia*.

At first only agar and potato were used as media, then bread and milk, bread and water and pith and blade of cocoanut leaf were added. All the cultures were kept in a dark room where the temperature was uniformly at about 24°C. In five days or less after sowing spores or mycelium on agar, vigorous, spreading colonies of silky hyphae were evident. When they were still young, however, it was found best to transfer them to one of the other media; for this fungus will not develop well on agar alone, active growth ceasing in a week or ten days and a few dark chlamydospores being the only result; whereas on potato and the other materials the growth is vigorous and rapid from the beginning. In spite of such good growth pycnidia develop slowly and sparingly on potato but very freely on cocoanut pith. It was not possible to obtain young healthy cocoanut plants which could be inoculated with pure *Macrophoma* in order to prove whether it was parasitic or simply saprophytic. When fresh leaves from a greenhouse were used for inoculation, moulds and other fungi which were already established quite prevented the *Macrophoma* from growing at all.

In the development of the fungus, first a white film of mycelium spreads quickly over most of the medium; in about a week parts become dark green and gradually black, and in ten days to two weeks from the sowing the pycnidia are formed. On cocoanut pith, bread or potato cultures these were often quite above the substratum, even as early as eight or nine days from the sowing, when they looked like tiny green bubbles covered with hyphae. Even in this immature condition the *Macrophoma* spores were abundant; being pale green, granular and often containing what appeared to be oil-drops, and seeming to have more abundant contents than those from maturer pycnidia. In a damp atmosphere the *Macrophoma* spores are apt to come out of the mouth of the pycnidia and form a white mass. No spores which resembled conidiospores were noticed, but there were several other forms which seemed to be sclerotial or resting in their function. Soon after the green color came in a culture, on examining the mycelium it would be seen that a few cells or as many as eight in a hypha had become round or oblong, thick-walled, brown, sometimes quite rough, 25–29$\mu \times$ 8–18 μ. They germinate very readily, putting out several tubes from one spore (FIGURE 4). Sometimes two of these will cling together and the two might easily be mistaken for a *Diplodia* spore. Around the outside of the pycnidium there is apt to be a mass of empty two-celled bodies, one cell being slightly smaller than the other, as in a *Puccinia* teleutospore. Possibly they are merely short, swollen hyphae similar to the cells which make the outside wall of the pycnidium.

From the time the cultures were first obtained pure it was evident that the growths of *Macrophoma* and *Diplodia* were very much alike, as had been suspected from their close association and the similarity of their pycnidia. So it was with no little pleasure that pycnidia were noticed on two seperate cultures, one pure *Macrophoma* and the other pure *Diplodia.* Cultures on cocoanut pith started January 11th showed on January 23d pycnidia with an abundance of *Macrophoma* spores in each of the cultures, and on February 12th there was obtained from the same pycnidium both unicellular hyaline *Macrophoma* spores and bicellular brown *Diplodia* spores. This is the average time that it takes a pure culture on the most favorable medium to develop, namely 10–12 days for pycnidia with *Macrophoma* spores and 12–18 days more before *Diplodia* spores are also abundant. There may be a slightly earlier development of the two-celled spores in the pycnidia of cultures from *Diplodia* spores than those from *Macrophoma*, but in general there is no difference in appearance of mycelium, size, or shape of spores or pycnidia. There certainly seems to be no doubt that the unicellular white *Macrophoma* spores in the pycnidia are simply the immature forerunners of the mature *Diplodia* spores.

In microtome sections of the leaf with the fungus growing on it from a culture five weeks old, the cells near the pycnidium seem much disorganized by the intercellular hyphal threads, being contracted into irregular darkly-stained masses and the cell-walls being difficult to trace. This affected area extends along the lower part of the leaf to some distance on either side of the pycnidium, but does not go through to the upper side.

Material for microtome sections was put into weak Flemming's solution to kill and fix. It was then washed in water, dehydrated, and imbedded in paraffin. Some sections were mounted in Canada balsam without any staining, but the *Macrophoma* spores proved to be almost invisible and some of the *Diplodia* spores too dark. As the pycnidia are very black an attempt was made to decolorize the sections by putting them into hydrogen peroxide and alcohol for about five hours. After washing they were stained in saffranin, gentian violet and orange gentian and mounted in balsam. This combination stains the *Macrophoma* spores orange and the rest of the pycnidium brown, but care must be taken not to overstain. The most satisfactory staining method was saffranin ten minutes, Delafield's hematoxylin five minutes, washing out excess of stain with acidified alcohol, and mounting in balsam. In this way the *Macrophoma* spores are stained light purple and the rest of the fungus brown, while the leaf-tissues become brown or red.

The *Macrophoma* form of this species was described originally by Cooke in Grevillea (**5**: 101), under the name *Sphaeropsis palmarum*, as follows:

"Erumpens. Peritheciis subglobosis, applanatis, demum superne detectis, atris; sporis ellipticis, hyalinis, intus granulosis. On petioles and midribs of *Cocos nucifera*. Demerara. Spores .02 × .012 mm. Perithecia rather large, splitting the cuticle."

On the next page of the same paper Cooke thus describes the *Diplodia* form under the name *Diplodia epicocos*:

"Sparsa vel subgregaria. Peritheciis demum superficialibus vel semi-immersis, globosis, atris; sporis ellipticis, uniseptatis, constrictis, brunneis. On dead young leaves of *Cocos nucifera*. Spores .022 × .01–.012 mm. Externally resembling a small *Sphaeria* of the section *Denudatae*."

In the following description I have included both stages:

Pycnidia buried to erumpent, sometimes becoming superficial, black, carbonaceous, opaque, cells indistinct, 150–250 μ in diameter, subgregarious, globose or conical at the mouth; *Macrophoma* spores elliptical or ovoid, obtuse, hyaline, granular, 20–25 × 10 μ. *Diplodia* spores elliptical, one septate, brown, obtuse, sometimes slightly constricted, 20–25 × 10 μ; spores borne on simple hyaline sporophores 12–15 by 2–3 μ, hyaline and brown spores in the same way, without any order; mycelium of contorted, irregular, septate threads, brown near the pycnidia and when old.

Explanation of plate 25

Fig. 1. Three pycnidia breaking through the epidermis of cocoanut spathe. Seen from above. × 44.

Fig. 2. The single pycnidium from Fig. 1. × 44.

Fig. 3. *Macrophoma* and *Diplodia* spores. × 280.

Fig. 4. Chlamydospores sprouting. × 192.

Fig. 5. Longitudinal section through pycnidium in leaf. × 192.

Fig. 6. *Macrophoma* and *Diplodia* spores from a hanging drop culture. 48 hours old. × 280.

Fig. 7. Similar to Fig. 5, more highly magnified and somewhat diagrammatic. × 280.

Fig. 8. Longitudinal section of pycnidium growing above medium. × 280.

Figs. 3, 6 and 7 are drawn with a camera lucida.

Studies on the Rocky Mountain flora — XII.

PER AXEL RYDBERG

Draba coloradensis sp. nov.

Annual, leafy below, often branched, 5–10 cm. high; leaves obovate, entire, 1–2 cm. long, 0.5–1 cm. wide, subsessile, coarsely hirsute, hairs often branched but not truly stellate; peduncles 5 cm. or in fruit often 10 cm. long; raceme short and corymbiform at first, more elongated in fruit; sepals oval or oblong, obtuse, 1.5–1.75 mm. long; petals white, 3–3.5 mm. long, spatulate, emarginate; fruiting pedicels 4–5 cm. long, divergent; pods linear-oblong, 10–12 mm. long and nearly 2 mm. wide, hirsute; style none.

This species belongs to the *D. caroliniana* group. From that species it differs in the hirsute pods, stouter habit and larger leaves; from *D. micrantha* in the large petals, the larger leaves and the more elongated raceme in fruit; and from *D. cuneifolia* in the entire leaves and the larger pods. It grows on river flats, dry hills and plains at an altitude of about 1500 m.

COLORADO: Fort Collins, river flats, lower Armstrong, 1897, collector not given (type); plains near Denver, 1870, *E. L. Greene*; Mancos, 1891, *Alice Eastwood.*

Draba streptocarpa Grayana var. nov.

Low and densely cespitose, almost pulvinate; flowering stems 1–3 cm. high, almost scapose; stem-leaves few and reduced; even the basal leaves much smaller than in the type.

It grows at an altitude of 3600–4000 m.

COLORADO: Gray's Peak, Aug. 1895, *P. A. Rydberg* (type); same locality, 1892, *C. S. Crandall 31*; mountain west of Como, 1895, *Crandall & Cowan 41.*

Smelowskia lineariloba sp. nov.

Densely cespitose; caudex densely covered by the bases of the dead leaves; leaves 2–5 cm. long, pinnately divided to the midrib into linear acute divisions, finely stellate and the petioles ciliate; stems about 1 cm. high, few-leaved; inflorescence at first short and corymbiform, in fruit elongated; sepals oblong, pubescent, about 3 mm. long; petals clawed, 5–6 mm. long, white or pink; blades broadly spatulate; fruit 11–12 mm. long and about 1 mm. wide, tapering at both ends.

This species is nearest related to *S. americana*, but differs in the narrow segments of the leaves and the long narrow pod. It grows on high peaks of Colorado at an altitude of 3,600–4,200 m.

Colorado: Douglass Mountain, 1878, *M. E. Jones 447* (type in herb. Columbia University); Hindsdale Co., 1878, *F. M. Pease;* near Ironton, 1899, *C. C. Curtis.*

Sophia purpurascens sp. nov.

Stem very slender, diffusely branched above, glabrous and purplish; lower leaves not known, having all fallen off; upper leaves simply pinnate with linear-oblong divisions, slightly stellate; racemes slender; sepals broadly oblong, over 1 mm. long, light yellow, almost equaling the similar petals; pedicels ascending in fruit, 4–5 mm. long, 0.75 mm. thick; fruit very slender, 5–8 mm. long, linear, 3–6-seeded, nearly cylindrical and tapering somewhat at both ends, slightly torulose; seeds in one row.

This is perhaps nearest related to *S. incisa* and *S. leptophylla*, but differs in the slender purple stem, the diverging branches above, the slender inflorescence, and slender short pod. It grows in the mountains at an altitude of about 3,300 m.

Colorado: Red Mountain, south of Ouray, 1901, *Underwood & Selby 275.*

Sophia ramosa sp. nov.

Stems 3–6 dm. high, finely but sparingly stellate, branched, especially above; branches ascending or diverging, forming with the stem an angle of 45° or more; leaves once or twice pinnate, sparingly stellate; divisions linear or linear-oblong; racemes oblong; petals oblanceolate, pale yellow, slightly longer than the sepals; pedicels in fruit 7–8 mm. long, ascending; pod somewhat clavate, 8–10 mm. long, erect or strongly ascending, about 1 mm. thick; seeds in two more or less distinct rows; styles almost none.

This species is perhaps nearest related to *S. intermedia*, but differs in the spreading branching, the smaller and paler petals, and the shorter pedicels and style. It grows in waste ground at an altitude of about 2,750 m.

Colorado: Pitkin, 1901, *Underwood & Selby 413.*

Arabis oblanceolata sp. nov.

Perennial, somewhat branched at the base, 3 dm. or more high; basal leaves petioled, sparingly stellate-pubescent, 3–10 cm. long; blades oblanceolate, acute, entire; stem-leaves sessile, lanceolate, sagittate-auricled at the base; sepals oblong, acute, 3–4 mm. long, white-hairy near the apex; petals dark reddish-purple, 7–8 mm. long, spatulate with a long claw; pedicels in fruit ascending, about 12 mm. long; pods ascending, about 5 cm. long and 2 mm. wide, glabrous; seeds in 2 rows; style none.

This is perhaps nearest related to *A. Crandallii* Robinson, but is a larger plant, less stellate, with much larger basal leaves and pods, and the flowers are much darker. It grows at an altitude of about 3,000 m.

COLORADO: Valley Spur, 1901, *Underwood & Selby 454*.

Arabis Selbyi sp. nov.

Perennial, with a basal rosette of leaves; basal leaves oblanceolate, 5–10 cm. long, short-petioled, acute, sinuate-denticulate, green but stellate on both sides, not ciliate; stems 4–5 dm. high, branched; stem-leaves linear-lanceolate, sagittate at the base; racemes long and lax; sepals linear, green, obtuse, about 3 mm. long, sparingly stellate; petals red-purple, narrowly oblanceolate, long-clawed; fruiting pedicels 3–4 mm. long, divergent; pods divergent, about 3 cm. long and 2 mm. wide, obtuse at both ends; style obsolete; seeds in 2 rows.

This species is perhaps nearest related to *A. lignifera* and *A. brachycarpa*. From the first it differs in the large, denticulate basal leaves, the stouter branched stem and the narrow dark petals. The latter has hispid ciliate as well as stellate leaves. *A. Selbyi* grows in cañons and neighboring meadows at an altitude of 2,300–2,800 m.

COLORADO: West of Ouray, 1901, *Underwood & Selby 207*.

Erysimum oblanceolatum sp. nov.

Biennial; stem 4–6 dm. high, strigose, rather simple; leaves narrowly oblanceolate, 5–12 cm. long, entire or sinuate dentate; the lower petioled, sparingly strigose; racemes elongated; sepals linear, about 6 mm. long, about equaling the claw of the light yellow petals; blades of the latter broadly spatulate or almost orbicular; the whole length of the petals about 15 mm., fruiting pedicels about 8 mm. long, ascending or spreading; pod tetragonal, ascending, about 8 cm. long, almost straight, not twisted, about 1.5 mm. thick; style about 1 mm. long.

This is intermediate between *E. elatum* and *E. Wheeleri.* The former has longer petals, the claws of which are much longer than the sepals and the leaves are usually more dentate. From *E. Wheeleri* it differs in the light yellow petals. It grows on foothills and plains at an altitude of 1,500–3,000 m.

COLORADO: Georgetown, 1895, *P. A. Rydberg* (type); La Plata P. O., 1898, *Baker, Earle & Tracy 906;* mesas near Pueblo, 1900, *Rydberg & Vreeland 6193;* Williams Cañon, 1894, *E. A. Bessey.*

WYOMING: Buffalo, 1900, *F. Tweedy 3595.*

Erysimum radicatum sp. nov.

Perennial with a tap-root, branched at the base; stems 1.5 dm. or less high, slightly strigose; leaves linear-oblanceolate, sinuately toothed, 4–7 cm. long, strigose; raceme short and dense; sepals fully 1 cm. long, linear, acutish, equaling the claws of the petals; the latter light yellow, about 15 mm. long; blades broadly spatulate, almost orbicular; fruiting pedicels about 8 mm. long, ascending; pods ascending, tetragonal, about 4 cm. long.

This is somewhat related to **Erysimum nivale** (*Cheiranthus nivalis* Greene) but differs in the basal rosettes of sinuate-dentate leaves. It grows at an altitude of about 3,800 m.

COLORADO: Bottomless Pit (Pike's Peak), 1901, *Clements 441* (type); also in 1900 at the same place.

Opulaster bracteatus sp. nov.

A shrub a meter or two high; bark of the stems brownish-gray, more or less flaky; that of the young twigs yellowish-green, glabrous or nearly so; stipules linear-lanceolate, about 5 mm. long, pubescent; petioles 1–3 cm. long; leaf-blades 3–7 cm. long, ovate or cordate in outline, 3–5-lobed and doubly crenate, acute, glabrous or nearly so on both sides, somewhat paler beneath; corymb rather many-flowered; bracts obovate or spatulate, often foliaceous and more or less persistent, pubescent; hypanthium sparingly stellate; sepals oblong-ovate, obtuse or acutish, about 3 mm. long, densely stellate on both sides; petals white, rounded-ovate, 4–5 mm. long; carpels 2, densely stellate, united at least half their length; styles ascending.

This resembles mostly *O. intermedius* in habit and leaves, but has the fruit of *O. monogynus.* It differs however from both in the conspicuous persistent bracts. It grows along streams in the foothills of northern Colorado.

COLORADO: New Windsor, 1898, *G. E. Osterhout 23* (type); also Buckhorn Creek, 1897, and Cheyenne Cañon, 1895; foothills west of Fort Collins, 1893, *C. F. Baker.*

Opulaster glabratus sp. nov.

A shrub about 1 m. high; bark of the stems gray and flaky, that of the old branches dark brown and of the young shoots yellowish or reddish; petioles 1–2 cm. long; leaf-blades rounded-ovate, orbicular or sometimes slightly reniform, 2–3 cm. long, glabrous, slightly paler beneath, 3–5-lobed, obtuse; corymb rather small, glabrous; bracts small, lanceolate, deciduous; hypanthium almost glabrous; sepals oval or rounded-ovate, obtuse, sparingly stellate beneath, densely so above, about 3 mm. long; petals rounded-ovate, about 4 mm. long, pink or white; carpels 2, united to above the middle, densely stellate.

This resembles in habit a small-leaved *O. intermedius*, but is closer related to *O. monogynus*, differing in the larger, less dissected leaves and the less stellate and larger calyx and hypanthium. The type grew at an altitude of between 3,000–3,800 m.

COLORADO: West Spanish Peaks, 1900, *Rydberg & Vreeland 6027* (type); Turkey Creek, *6026;* Rist Canon, 1898 and 1899 (collectors not given).

Holodiscus microphyllus sp. nov.

A low shrub; bark of the stems dark brown; that of the branches light, yellowish or brownish, soft-strigose; leaves spatulate-cuneate, 1–1.5 or rarely 2 cm. long, evenly serrate, with strong nerves beneath, finely strigose or glabrate above, densely soft-pubescent beneath, at first almost white, in age more glabrate; inflorescence small, 3–5 cm. long, its branches short and few-flowered; sepals about 1 mm. long, ovate, as well as the peduncle and pedicels soft-villous; petals broadly obovate, a little exceeding the sepals; hairs of the carpels copious, about equaling the stamens.

This has gone under the name of *H. dumosus*, but the original *Spiraea dumosa* Nutt. is a larger plant with large inflorescence and larger incised or doubly toothed leaves, and apparently the same as *S. discolor* Pursh.

UTAH: Alta, Wahsatch Mountains, 1879, *M. E. Jones 1142* (type in herb. Columbia University); Uintahs, 1869, *S. Watson*

305 in part; Stansbury Island, 1850, *Stansbury;* Southern Utah, 1877, *E. Palmer 136.*

COLORADO: Chicken Creek, 1898, *Baker, Earle & Tracy 863.*

Potentilla Bakeri sp. nov.

Perennial; stem rather stout, about 4 dm. high, rather loosely hirsute, branched; basal leaves usually digitately 7-foliolate; petioles 6–8 cm. long, loosely hirsute; leaflets oblanceolate, 3–5 cm. long, strongly veined, coarsely silky on both sides and slightly grayish tomentose beneath, cleft to about three-fourth to the midrib into oblong acute lobes; stem-leaves similar but smaller and short-petioled, usually only 5-foliolate or the upper 3-foliolate; inflorescence open, usually flat-topped and corymbiform; hypanthium and calyx silky-hirsute and slightly tomentulose; bractlets linear-lanceolate, about 3 mm. long and half as long as the ovate or ovate-lanceolate acuminate sepals; petals obcordate, a little exceeding the sepals; stamens about 20; achenes smooth and shining; style filiform.

In my monograph I included the only specimen then at hand in *P. viridescens*, but it has deeper dissected leaves and more spreading pubescence than that species. Specimens of the present species are found in collections under the name of *P. Blachkeana*, *P. candida* and *P. flabelliformis.* It can, however, not well be confounded with any of these, except perhaps *P. candida*, which it resembles in general habit and leaf-form. *P. candida* is, however, a small plant with leaves intensely white on both sides. *P. Bakeri* grows at an altitude of 2,100–2,700 m.

COLORADO: Grizzly Creek, 1896, *C. F. Baker* (type); Doyle's, 1901, *647;* banks of Grizzly, 16 miles from Walden, 1894, *Crandall 1224.*

Rosa Underwoodii sp. nov.

Shrub, 1–2 m. high; bark of the old stems gray; that of preceding year's branches purplish and of the new twigs purplish or green; prickles infrastipular and scattered, strongly curved, 7–10 mm. long, with an oblanceolate base, 5–10 mm. long; stipules narrow, the lanceolate free portion about 5 mm. long, glandular-dentate; leaves 5–10 cm. long; petiole and rachis puberulent and with sessile glands; leaflets 2–4 cm. long, obovate or oval, usually obtuse, doubly serrate, glabrous on both sides or finely puberulent and slightly paler beneath; flowers usually solitary;

sepals lanceolate, acuminate, about 2 cm. long, erect and persistent in fruit, tomentulose above, glandular and bristly beneath, often with linear lobes; petals obcordate, about 2.5 cm. long and fully as wide; hip in fruit more or less pear-shaped, about 3 cm. long and 2 cm. in diameter, sparingly bristly.

This species has the general habit of *R. Nutkana* and *R. MacDougalii*, but differs from both in the curved prickles. It has bristly fruit as the latter, but the fruit is more tapering at the base and the bristles fewer. It grows in the mountains at an altitude of 2,300–2,700 m.

COLORADO: Hills about Box Cañon, west of Ouray, 1901, *Underwood & Selby 122* (type) and *113*; La Plata Cañon, 1898, *Baker, Earle & Tracy 860*.

Rosa oreophila sp. nov.

A shrub 2–3 m. high; bark reddish, glossy; prickles mostly infrastipular or lacking, weak, 5 mm. long or less, curved with elliptic bases; stipules broad, finely pubescent and glandular-denticulate on the margin; free portion ovate, 5–15 mm. long; leaves 7–10 cm. long, 5–7-foliolate; rachis and petiole finely pubescent and with sessile glands; leaflets 2–3.5 mm. long, ovate or oval, acute or obtuse, glabrous and dark green above, sparingly and finely pubescent and paler beneath, coarsely serrate; flowers mostly solitary; sepals narrowly lanceolate, acuminate, finely pubescent on both sides and glandular-denticulate on the margins, erect and persistent in fruit; petals obcordate, 2–2.5 cm. long; hip glabrous, when ripe fully 2 cm. long, often acute at the base.

This is perhaps nearest related to the preceding, but differs in the smooth and more rounded fruit and more slender prickles. It grows at an altitude of 2,300–2,500 m.

COLORADO: Four-miles Hill, Routt Co., 1896, *Baker* (type); Dix P. O., 1898, *Baker, Earle & Tracy 474*; Box Cañon, Ouray, 1901, *Underwood & Selby 121a* and *b*.

Astragalus oreophilus sp. nov.

Erect perennial, 3–6 dm. high; stem sparingly strigose, branched with almost erect branches; leaves about 15 cm. long, with 7–23 leaflets; stipules triangular to lanceolate, strigose, acuminate, free from the petioles but more or less united with each other across the back of the stem; petioles 2–4 cm. long; leaflets oblong or elliptic, about 3 cm. long, strigose on both sides, glabrate above; peduncles 0.5–1.5 dm. long; inflorescence racemose, 5–10 cm. long; bracts lanceolate, acuminate, 3–5 mm. long; pedicels very short; calyx-tube nearly cylindric, about 5 mm. long, gibbous above, white-pubescent with short hairs; lower calyx-teeth subulate, about 1.5 mm. long; the upper lanceolate, shorter and slightly broader; pod oblong, about 1.5 cm. long and 5 mm. thick, often sparingly hairy when young, in age glabrous, almost terete, leathery, completely 2-celled.

This species has been confounded with *A. Mortonii* and sometimes with *A. canadensis.* The former is found only in the Columbia Valley region and is characterized by the intermixed black hairs on the calyx, and by the more hairy pod which is distinctly sulcate on the lower suture. *A. oreophilus* is really closer related to *A. canadensis*, but differs principally in the short bracts and calyx-teeth. In *A. canadensis* the bracts are linear-lanceolate, long-attenuate, the lower almost as long as the calyx, and the calyx-teeth longer, fully half as long as the tube. *A. oreophilus* grows in the foot hills at an altitude of 1,500–2,200 m.

COLORADO: Pagosa Springs, 1899, *C. F. Baker 419* (type); near Boulder, 1902, *F. Tweedy 5154;* Stone Prairie, Larimer Co., 1897, *G. E. Osterhout;* Wahatoya Creek, 1900, *Rydberg & Vreeland 5990;* Durango, 1898, *Baker, Earle & Tracy 478.*

Astragalus Shearii sp. nov

Perennials with horizontal rootstock; stems slender, strigose and striate, about 2 dm. high; stipules triangular, strigose, free from the petioles, but slightly united across the back of the stem; leaves 3–5 cm. long with 13–19 leaflets; these 5–8 mm. long, oblong, obtuse or retuse at the apex, glabrate above, grayish strigose beneath; peduncles 4–5 cm. long; raceme short, 5–10-flowered; calyx-tube campanulate, about 4 mm. long, strigose, partly with black hairs; teeth triangular; corolla reddish-purple, nearly 1 cm. long; pod oblong, 12–14 mm. long, glabrous, reticulate, sessile, almost terete in cross-section; the lower suture intruded and forming a narrow partial partition.

In general habit somewhat resembling *A. Hallii* and *A. flexuosus*, but the structure of the pod places it nearest to *A. elegans.*

COLORADO: Twin Lakes, 1896, *C. L. Shear 3317.*

Homalobus Wolfii sp. nov.

Low depressed cespitose perennial; stems intricately branched, less than 1 dm. long, covered by the scarious, strongly-veined, hirsute-strigose triangular stipules; leaves pinnate with 5 approximate leaflets; these 3–4 mm. long, lanceolate, strongly conduplicate, grayish hirsute, spine-tipped; racemes 1–2-flowered, very short-peduncled in the axils of the leaves; calyx-tube scarcely 2 mm. long, grayish strigose; teeth subulate, about 1 mm. long; corolla ochroleucous, about 4 mm. long.

A species related to and confounded with *H. tegetarius* (*Astragalus tegetarius* S. Wats.), but the latter is a larger plant, has long-peduncled raceme exceeding the leaves, and longer calyx teeth, which about equal the tube in length.

COLORADO: South Park, 1873, *John Wolf 243* (type in herb. Columbia University).

Homalobus Clementis sp. nov.

Perennial, slightly branched, erect or ascending; stem glabrate or slightly strigose, about 2 dm. high; stipules broadly triangular, strigose, abruptly acuminate, more or less united across the back; leaves 5–7 cm. long, with 11–21 leaflets; these oblong or lanceolate, acute, 7–12 mm. long, glabrous above and sparingly strigose beneath; inflorescence 7–10 cm. long, 8–12-flowered; bracts lanceolate, small; flowers very short-pediceled; calyx-tube campanulate, about 3 mm. long, strigose with black hairs, teeth lanceolate-subulate, about half as long; corolla bluish-purple, about 8 mm. long; pod oblong, latterally compressed, sessile, about 1 cm. long, 3–4 mm. wide, black-hairy with very short hairs; both sutures prominent, the upper almost straight.

This species is perhaps closest related to **Homalobus wingatensis** (*A. wingatensis*); but that species is grayish canescent and has a glabrous pod. *H. Clementis* grows at an altitude of 2,500–3,000 m.

COLORADO: Sangre de Cristo, 1896, *F. Clements 354* (type); Marshall Pass, 1901, *C. F. Baker 489*.

Homalobus decurrens sp. nov.

Perennial with a rootstock, somewhat cespitose; stems erect, 3–4 dm. high, slightly strigose and angled, stipules lanceolate, free, about 5 mm. long, strigose; leaves 1–1.5 dm. long with 11–15 leaflets; these 2–4 cm. long, linear-oblong to oblanceolate, sparingly strigose or glabrate above; the terminal one usually larger, more or less decurrent on the rachis and without a definite node; racemes slender, 1–1.5 dm. long, lax, 5–10-flowered; bracts subulate; calyx-tube campanulate, about 2.5 mm. long, more or less black-hairy; teeth nearly 2 mm. long and subulate; pod fully 2 cm. long and 3 mm. wide, sessile, linear, straight, glabrous.

This species is nearest related to *H. campestris* and *H. hylophilus;* but differs from both in the peculiarities of the terminal leaflets. It has broader and less hairy leaflets than the former and narrower and longer than the latter. It grows on hillsides.

COLORADO: Estes Park, 1895, *G. E. Osterhout* (type); also in 1900; Gray-Back Mining Camps, 1900, *Rydberg & Vreeland 5960.*

Ceanothus subsericeus sp. nov.

A small shrub, apparently not spiny; bark of the stems gray or brown; of the twigs light gray and finely pubescent; leaves short-petioled; petioles 3–6 mm. long; blades elliptic or elliptic-lanceolate, acute at both ends, 2–3 cm. long, more or less glandular-denticulate, 3-ribbed, sparingly strigose above, grayish-silky beneath; umbels axillary and terminal; peduncles 3–10 mm. long; pedicels 5–10 mm.; calyx about 3 mm. in diameter; sepals semi-orbicular; petals white, broadly spatulate, clawed, 1–5 mm. long; fruit dark brown, about 4 mm. in diameter, slightly 3-lobed above.

This species is intermediate between *C. ovalis pubescens* and *C. Fendleri.* In habit it resembles most the latter, but differs in the denticulate leaves and in not being spiny. From the former in the smaller size, the silky, instead of villous, pubescence and the principally axillary umbels. *C. subsericeus* grows in the foothills at an altitude of about 1,800 m.

COLORADO: Larimer Co., 1895, *J. H. Cowen* (type); "Colorado," 1874, *G. C. Woolson.*

Sphaeralcea Crandallii sp. nov.

Perennial, about 6 dm. high; stem simple, sparingly stellate; petioles 3–4 dm. long; leaf-blades cordate in outline, 5-lobed, about 5 cm. in diameter; lobes lanceolate, coarsely toothed; inflorescence mostly terminal; pedicels and calyx sparingly and finely stellate; bractlets subulate, nearly equaling the lanceolate long-attenuate sepals; petals white or nearly so, about 2.5 cm. long, cuneate and slightly emarginate; fruit not known.

This resembles a small *S. rivularis,* but differs in the long bractlets and the lanceolate sepals. It grows at an altitude of about 2,000 m.

COLORADO: Steamboat Springs, 1894, *Crandall 97.*

Sphaeralcea grandiflora sp. nov.

A meter or two high; stem glabrous below, stellate above; petioles of the lower leaves 1–2 dm. long; blades cordate or reniform in outline, maple-like, 9–15 cm. wide, deeply 5–7-lobed; lobes lanceolate or triangular, coarsely toothed with triangular teeth; flowers in small axillary clusters, but at the end of the stem the subtending leaves become diminished and the inflorescence resembles a congested panicle; pedicels and calyx densely hirsute-pubescent with long stellate hairs, the branches of which are 1–2 mm. long; bractlets lanceolate, about half as long as the triangular-ovate, acute or somewhat acuminate sepals; petals pinkish, 3 cm. or more long; fruit spherical, and deeply retuse at the apex; carpels membranous, smooth on the sides and bristly on the back, rounded at the apex; seeds reniform, brown, muricate.

A close ally of *S. rivularis*, but differs in the larger flowers, the broader bractlets, the long hairs of the calyx, the usually blunter leaves and more rounded carpels. It grows at an altitude of 2,200–2,800 m.

COLORADO: Mesa Verde, 1901, *F. K. Vreeland 882* (type); west of Ouray, 1901, *Underwood & Selby 1904* (in fruit).

Touterea laciniata sp. nov.

Biennial or short-lived perennial; stems 3–4 dm. high, white, puberulent, strict, in age branched; leaves narrowly lanceolate in outline, 5–10 cm. long, deeply pinnatifid to near the midrib; sinuses rounded or nearly semi-rhombic; lobes oblong to lanceolate, obtuse: flowers usually bracted by 1–2 laciniate bracts; sepals about 1 cm. long, lanceolate with a subulate tip, soon reflexed; petals golden yellow 15–20 mm. long, short-clawed; blades oblanceolate, acute; staminodia similar and imitating another set of petals; filaments nearly filiform, ¾ as long as the petals.

This species is closely related to *T. speciosa*, but differs in the deeply dissected leaves and more slender stem. In general habit it resembles somewhat *T. multiflora*, for which it has been mistaken; but that species has broader, obtuse petals, more dilated filaments, and more diverging branches. *T. laciniata* grows on dry hillsides at an altitude of 1,500–2,200 m.

COLORADO: Pagosa Springs, 1899, *Baker 470* (type); Durango, 1898, *Baker, Earle & Tracy 496;* Cañon City, 1900, *Osterhout;* Antonito, 1898, *Earle.*

Touterea sinuata sp. nov.

A decumbent biennial, 3–4 dm. high; stems stout, white, pubescent, much branched; lower leaves 10–15 cm. long, lanceolate or oblanceolate, tapering at the base, sinuately lobed or dentate; lobes or teeth broadly triangular, but often obtusish; upper leaves broadly lanceolate, or even ovate, sessile and cuneate or rounded at the base; flowers numerous, usually with 1–2 linear bracts; sepals lanceolate, tapering into a subulate tip, soon reflexed, about 8 mm. long; petals golden yellow, 15–20 mm. long; oblanceolate, acute; staminodia similar; filament slightly dilated; capsule 2.5–3 cm. long, 7–8 mm. thick; seeds winged, about 3 mm.

This species is also a close relative of *T. speciosa*, differing in the decumbent, branched habit and the broad leaves. The type grew in a cañon at an altitude of about 1,800 m.

COLORADO: Boulder, 1895, *Rydberg*.

Acrolasia gracilis sp. nov.

Annual, 3–5 dm. high, at first simple, but later branching; leaves 5–10 cm. long, deeply pinnatifid to near the midrib; rachis and lobes 2–3 mm. wide; the latter oblong or lanceolate, obtuse; floral leaves lanceolate, sessile, pinnatifid or toothed, rarely entire; sepals lanceolate, 4–5 mm. long; petals obovate, 6–7 mm. long, strongly striate; capsule sessile, linear-cylindric, 2.5–3 cm. long and about 2 mm. thick; seeds more or less prismatic, muricate.

This is Nuttall's *Trachyphytum gracile*, a specimen of which is in the Columbia University herbarium. The species was never published, however. The name appears only as a synonym under *Mentzelia albicaulis* in Torrey and Gray's Flora, 1: 534. I think, however, that it is well distinct from *A. albicaulis* or *Bartonia albicaulis* Hook. The latter is characterized by the smaller petals, only 3–4 mm. long; the middle and upper leaves are often entire or with an entire lower and upper portion and only with a few lobes in the middle. In Hooker's type specimen the leaf-lobes are very few and Urban and Gilg confused it with *A. integrifolia*, claiming that *Mentzelia dispersa* Wats. (which is the same as *A. integrifolia*) is the typical form of *Mentzelia albicaulis*. *A. integrifolia* (Wats.) Rydb. and *A. compacta* (A. Nels.) Rydb. are, however, easily distinguished from the other species by the short linear-oblong, obtuse sepals, only ⅓ as long as the petals, and by the seeds, which are apparently smooth, the fine murication being seen only under a strong lens. *A. gracilis* grows in sandy soil, on hillsides and in river bottoms at an altitude of 1,500–2,500 m.

COLORADO: Foothills, Larimer County, 1895, *J. H. Cowen* (type); Ridge below Tobe Miller's, *Cowen;* Salida, 1898, *Baker, Earle & Tracy 14* (in part); mesas near Pueblo, 1900, *Rydberg & Vreeland 5865.*

WYOMING: Fort Steele, 1901, *Tweedy 4573* and *4574*.

IDAHO: Common, 1892, *Isabel Mulford.*

"OREGON": Nuttall's specimens of *Trachyphytum gracile.*

Acrolasia latifolia sp. nov.

Stout annual, 3–5 dm. high, branched; leaves sessile, ovate or ovate-lanceolate, coarsely toothed or entire, 5–10 cm. long, 2–3 cm. wide; sepals lanceolate, 2.5–3 mm. long; petals obovate-spatulate, about 5 mm. long; capsule linear, cylindric, 2.5–3 cm. long, about 2.5 mm. thick, sessile; seeds prismatic, muriculate.

This has been mistaken for *A. integrifolia* on account of its broad, merely toothed leaves, but the sepals and seeds place it in the *A. albicaulis* group and nearest the preceding and *A. ctenophora.* It grows on hills at an altitude of 1,200–2,400 m.

COLORADO: Mountains between Sunshine and Ward, 1902, *Tweedy 5149* (type); Boulder, 1901, *Osterhout 2471;* Larimer County, 1895, *Cowen.*

Epilobium ovatifolium sp. nov.

Plant 2–6 dm. high, propagating by turions; stem glabrous except the decurrent lines which are more or less crisp-hairy, especially above; leaves sessile or nearly so, ovate or ovate-lanceolate and acute, or the lowest oval and obtuse, 3–4 cm. long, entire or denticulate, glabrous; petals purple or rarely rose, 5–7 mm. long; pods 5–6 cm. long, 1.5–2 mm. in diameter, sessile, more or less crisp and glandular hairy; seed a little over 1 mm. long, abruptly contracted above, but without neck; coma white, about 6 mm. long.

The type specimens are labeled *E. Hornemannii* Reichenb. which it resembles somewhat in general habit; but that species propagates in an altogether different way and the leaves are more or less petioled. The present species is more closely related to *E. brevistylum* and *E. glandulosum.* It differs from the former mainly in the seeds, which lack the hyaline neck characteristic of that species. From *E. glandulosum* it is separated by the smaller size of the plant and of the flower, and by the light green leaves, which lack the coarse toothing of that species. It may also be confused with *E. adenocaulon*, but that species has smaller and lighter flowers, propagates by leafy rosettes and has usually distinct although short petioles. *E. ovatifolium* grows in wet places, especially in springs, in the mountains of Colorado and Utah at an altitude of 2,300–3,800 m.

COLORADO: Near Empire, 1892, *Patterson 205* (type); Red Mountain, 1901, *Underwood & Selby 297;* Bob Creek, 1898, *Baker, Earle & Tracy 855;* Ironton Park, 1901, *Underwood & Selby 303b;* Columbine, 1901, *Tweedy 4429*; headwaters of Sangre de Cristo Creek, 1900, *Rydberg & Vreeland 5847*.

UTAH: "Southern Utah," 1877, *Palmer 155*.

Epilobium rubescens sp. nov.

Stem 3–4 dm. high, strict and simple, often more or less reddish, glabrous below, crisp-hairy above and more or less on the decurrent lines; leaves 3–4 cm. long, perfectly sessile, lanceolate, rounded at the base, denticulate, very acute, slightly crisp-hairy beneath when young; petals white, about 4 mm. long; pods 4–5 cm. long and 1.5 mm. thick, more or less crisp-pubescent; seeds without neck, brownish, smooth, about 1 mm. long; coma white, 5–6 mm. long.

This species is perhaps most closely related to *E. adenocaulon*, but differs in the perfectly sessile leaves and simpler habit. It grows in wet places up to an altitude of 2,700 m.

COLORADO: Pagosa Springs, 1899, *Baker* (type); Middle Park, 1892, *Beardslee*.

Epilobium stramineum sp. nov.

Stem 5–6 dm. high, simple, light and more or less straw-colored, glabrous below, more or less pubescent and somewhat glandular in the inflorescence; leaves sessile, light green, lanceolate, tapering at both ends, denticulate, 4–5 cm. long, 1–1.5 cm. wide, very acute; petals white, 4–5 mm. long; pod 4–5 cm. long and 1 mm. wide, more or less crisp and glandular; seeds light-brown, without a neck; coma white.

This has been taken for *E. Drummondii*, but the type of that species has narrow, almost linear leaves, and is seldom over 3 dm.

high. *E. stramineum* grows at an altitude of 2,400–3,200 m. in the mountains of Colorado, while the range of *E. Drummondii* extends further north.

COLORADO: Idaho Springs, 1905, *Rydberg* (type); Pagosa Peak, 1899, *Baker 487;* Sangre de Cristo Creek, 1900, *Rydberg & Bessey 5848;* Chicken Creek, 1898, *Baker, Earle & Tracy 341.*

Epilobium Palmeri sp. nov.

Perennials propagating by turions or occasionally with more leafy rosettes; stem 4–6 dm. high, branched, glandular pilose, nearly terete, usually reddish or brownish; leaves sessile or nearly so, ovate or ovate-lanceolate, rounded or obtuse at the base, acute, denticulate, 3–4 cm. long, more or less pubescent; petals pink or light purple, about 5 mm. long; pod 4–6 cm. long, 1.5 mm. thick; seeds brown, more or less papillose, without a beak; coma white or in age somewhat tawny, 6–8 mm. long.

The type was named *E. tetragonum* L., which species is not found in the United States. It resembles much *E. brevistylum* and *E. ovatifolium* in habit, but is characterized by the pubescent stem and leaves.

UTAH: "South Utah," *E. Palmer 156* (type in herb. Columbia University).

IDAHO: Moscow, 1900, *L. R. Abrams 848.*

MONTANA: Camp Glazier, 1901, *Umbach 327.*

COLORADO: Tobe Miller's Ranch, 1897, *A. Fry.*

Gayophytum intermedium sp. nov.

Profusely branched glabrous annual; stem white and shining, with more or less peeling bark, 3–7 dm. high, erect; leaves linear or nearly so, light green; sepals about 1.5 mm. long, soon spreading or reflexed, yellowish; petals 1.5–2.5 mm. long, rose with yellow base; capsule 8–12 mm. long, nearly twice as long as the reflexed pedicel, somewhat clavate and torulose, somewhat strigose when young; seeds 1.75 mm. long, glabrous.

This species is intermediate between *E. diffusum* and *E. ramosissimum* in some respects. The flowers approach the latter more in size but the former in coloration. The pod is comparatively longer than in either. In both it is scarcely longer than the pedicels. *E. intermedium* grows in sandy soils in Colorado at an altitude of 1,500–3,000 m.

COLORADO: Ouray, 1901, *Underwood & Selby 193* (type); mountains between Sunshine and Ward, 1902, *Tweedy 5092*; near Boulder, *5091;* Chamber's Lake, 1899, and 1896, *Baker;* Veta Pass, 1900, *Rydberg & Vreeland 5860;* Ward, 1901, *Osterhout 2460;* Caribou, 1891, *Penard 122;* Empire, 1892, *Patterson 208.*

WYOMING: West De Lacy's Creek, 1899, *Aven & Elias Nelson;* Headwaters of Clear Creek and Crazy Woman River, 1900, *Tweedy 3640;* Dayton, 1899, *Tweedy 2609;* Biscuit Geyser Basin, 1897, *Rydberg & Bessey 4578.*

Anogra cinerea sp. nov.

Branched perennial, stem 3–4 dm. high, whitish, cinereous, strigose when young; leaves lanceolate to ovate-lanceolate, mostly subsessile, 3–5 cm. long, sinuate-dentate or denticulate, cinereous; calyx glabrous or sparingly long-hairy, acuminate; tips free and rather long; petals 15–18 mm. long; pods divergent at right angles to the stem, 3–3.5 cm. long, almost straight.

This species is nearest related to **Anogra latifolia** (*Oenothera pallida latifolia* Rydb.), but differs in the almost glabrous not cinereous calyx and the narrower leaves.

COLORADO: Between Bent's Fort and Pueblo, 1885, *Fremont 234* (type in herb. Columbia University); Denver, 1895, *Pammel 202.*

SOUTH DAKOTA: Banks of Cheyenne River, 1891, *T. A. Williams.*

WYOMING: St. Antony, 1901, *Merrill & Wilcox 876* (this with more hairy calyx).

Anogra Vreelandii sp. nov.

Perennial; stem erect, strict, 3–5 dm. high, white and shining; leaves narrowly lanceolate, about 5 cm. long, short-petioled or the upper sessile, glabrous, except occasionally strigose-ciliate on the margins, sinuate-dentate; calyx sparingly hairy, acute; the tips free but very short; petals about 2 cm. long, obcordate, white turning pink; pod cylindric, divergent at right angles or reflexed, usually somewhat curved upwards.

The species is a close relative of *A. pallida*, but differs in the silky hairy calyx, the very short calyx-tips and the darker green foliage. It grows at an altitude of about 1800 m.

COLORADO: McElmo Cañon, 1901, *Vreeland 861.*

Pachylophus hirsutus sp. nov.

Cespitose, almost acaulescent perennial; leaves oblanceolate in outline, 1–2 dm. long, more or less petioled, runcinate-pinnately lobed or divided, hirsute-villous, especially on the margins and the veins; teeth or lobes acute; hypanthium 8–12 cm. long, slender, widening upward, conspicuously hirsute, at the throat 1–1.5 cm. wide; sepals lanceolate, 3–4 cm. long, soon reflexed; petals obcordate, 3–4 cm. long; pod 4–5 cm. long, lance-ovoid, about 1 cm. in diameter, sessile; ridges low and rounded, slightly if at all tubercled.

In general habit, this species resembles most *P. macroglottis* and *P. marginatus*. From the former it differs in the hairy hypanthium and calyx, the more hairy leaves and the longer and less tubercled fruit. From the latter it is distinguished by the sessile pod and always subacaulescent habit. *P. hirsutus* grows at an altitude of 2,200–3,000 m.

COLORADO: Georgetown, 1895, *Rydberg* (type); mountains between Sunshine and Ward, 1902, *Tweedy 5094;* South Park, 1872, *Wolf 132;* Ruxton, 1896, *Clements 213;* Pike's Peak, 1896, *Shear 3713;* Mancos, 1898, *Baker, Earle & Tracy 141;* Georgetown, 1885, *Patterson;* vicinity of Como, 1895, *Cowen;* also 1896, *Shear 4576;* Empire, 1893, *Bethel;* Como, 1895, *Crandall 8;* Pennock, 1896, *Crandall 10.*

UTAH: Salt Lake City, 1880, *M. E. Jones 1746;* Diamond Valley, 1902, *Gooding 840.*

Pachylophus caulescens sp. nov.

More or less caulescent perennial; stem 1–2 dm. high, angled, leaves with the long petioles about 2 dm. long; blades lanceolate or ovate-lanceolate, about 3 cm. wide, pubescent on the margins and veins, sinuately dentate with a few lobes on the petiole; hypanthium about 9 cm. long, glabrous, at the throat nearly 1.5 cm. wide; petals about 2.5 cm. long, obovate; pod sessile, about 3 cm. long, lance-ovoid with rounded low ridges.

In habit the species resembles *P. eximius*, but that species has a hirsute hypanthium and calyx and the ridges of the fruit with almost foliaceous crests.

COLORADO: Palisades, 1894, *Crandall 12* (type in herb. Columbia University).

Gaura coloradensis sp. nov.

Herbaceous, biennial or perennial with fusiform root; stem 5–7 dm. high, strict, but somewhat branched, finely strigose, more or less red; leaf-blades narrowly oblanceolate, 5–10 cm. long, gradually tapering below into a short petiole, or the upper sessile, callous-denticulate, finely strigose; inflorescence slender and rather lax, 1.5–2 dm. long; hypanthium about 2 cm. long, finely strigose; sepals about 1 cm., linear-lanceolate, reflexed; petals about 8 mm. long, spatulate, pink, short-clawed; filaments about equaling the petals; anthers brown, about 4 mm. long; fruit 8–10 mm. long, fusiform, 4-angled, tapering below into a short and rather slender stipe-like base.

In habitat and pubescence this species resembles most *G. Pitcheri*, but the leaves are oblanceolate instead of lanceolate and the fruit is that of *G. sinuata*. *G. coloradensis* grows in meadows at an altitude of about 1,500 m.

COLORADO: Fort Collins, 1895, *Cowen* (type); east of College, 1897, *Crandall 1308;* east of Poudre, 1895, *Cowen 1632.*

Suida interior sp. nov.

Cornus Baileyi Coult. & Evans, Bot. Gaz. **15**: 37, in part. 1890.

A shrub 2–5 m. high; bark of the old stems grayish, of the young shoots brownish; young shoots, petioles and inflorescence densely pubescent with short villous hairs; leaves elliptic or oval, acute at both ends, 5–9 cm. long, finely short-strigose on both sides and more or less villous on the veins and in their angles beneath; hypanthium strigose; sepals minute, about 0.5 mm. long or less; petals linear-lanceolate, about 4 mm. long; fruit white, about 5 mm. in diameter; stone elliptic, slightly oblique, longer than broad, nearly smooth.

This species was included in the original description of *Cornus Baileyi*, but is quite different from the type thereof from the lake-shores of Michigan. This has conspicuous sepals and has a more flattened stone, channeled on the edge and with square shoulders. In reality, *S. interior* is much more closely related to **S. stolonifera** (*Cornus stolonifera* Michx.), especially the western variety described below, but differs in the villous pubescent instead of sparingly strigose twigs and inflorescence. In *S. stolonifera* and its variety the stone is usually broader than long and very oblique. *S. interior* grows on river banks west of Mississippi River.

NEBRASKA: Dismal River, 1893, *Rydberg 1414* (type); St. James, 1893, *Clements 2626;* Pine Ridge, 1889, *Webber;* Cedar Island, 1854, *Hayden.*

SOUTH DAKOTA: Piedmont and Little Elk Creek, 1892, *Rydberg 735;* Cobbs Creek, 1894, *T. A. Williams.*

COLORADO: Merker, 1902, *Osterhout 2602;* Walsenburg, 1896, *Shear 4774;* Cañon City, 1896, *Clements 101.*

WYOMING: Dayton, 1899, *Tweedy 2631* and *2632.*

Suida stolonifera riparia var. nov.

Leaves usually oval or elliptic, acute, thinner, lighter green and less pale beneath than in the eastern type; bark on young twigs brownish; sepals and fruit smaller.

In the field this variety looks very unlike the eastern *S. stolonifera.* It grows as a high bush on river banks and is as far as I know not stoloniferous. In the eastern plant the leaves are comparatively thick, darker green above and very pale beneath, and the young shoots bright red. The plant of the interior may represent a distinct species, but on account of the lack of good diagnostic characters it is perhaps better to regard it at present as a variety of the eastern plant. The variety is the only form found in the region of the Rockies and the Great Plains. It is common from Manitoba, the Mackenzie River, to Alaska and south to Nebraska, Colorado and Arizona; as the type may be designated:

COLORADO: Crystal Creek, 1901, *Baker 257.*

Aletes obovata sp. nov.

Cespitose, glabrous, acaulescent perennial with deep tap-root; leaves 1–2 dm. long, pinnate with 4–5 pairs of leaflets; these broadly obovate, 1–2 cm. long, more or less cleft and toothed with short ovate teeth, strongly veined beneath; scapes 1–3 dm. high, round-angled and striate; bracts none; branches of the umbel 2–2.5 cm. long in fruit; bractlets lanceolate, 3–4 mm. long, reflexed in age; pedicels very short or obsolete; flowers yellow; calyx-teeth prominent, in fruit .5–.75 mm. long; fruit 5–6 mm. long and 1.5 mm. in diameter; ribs rather thick; oil-tubes 1 in the intervals, 2 on the commissure, rather large; seed-face only slightly concave.

This species has been confused with the closely related *A. acaulis,* which is easily distinguished by its rhombic, deeply cut leaflets with lanceolate, acuminate lobes and smaller fruit about 4 mm. long.

COLORADO: Near Morrison, 1889, *Greene* (type, in mature fruit, in herb. Columbia University); Golden, 1892, *Crandall* (in flower); Lower Boulder Cañon, 1901, *Osterhout 2433* (in young fruit).

Phellopterus camporum sp. nov.

Perennial with a deep-seated thick tap-root; leaves twice to thrice pinnatifid, petioled, pale-green; petioles 4–7 cm. long; ultimate divisions oblong, obtusish, 3–6 mm. long; peduncles 5–20 cm. long, usually exceeding the leaves; involucres of white hyaline bracts; branches of umbel about 2 cm. long in fruit; bractlets orbicular, 5–7 mm. long, with greenish center and broad white hyaline border, 7–13 nerved; pedicels short, in fruit only 3–5 mm. long; flowers white; fruit with the very broad wings 10–13 mm. long and 9–11 mm. wide; oil-tubes 3–4 in the intervals, 6–7 on the commissure; seed flattened with broadly concave face.

The specimens has been determined as *P. purpurascens Eastwoodiae*, but it is evidently well distinct from that as shown by a duplicate of the type in the herbarium of the N. Y. Botanical Garden; the bractlets are larger and many-nerved, the flowers white and the fruit is longer than in the variety mentioned. It grows on dry mesas at an altitude of 1,500–16,00 m.

COLORADO: Pueblo, 1900, *Rydberg & Vreeland 5825* (type, in flower) and *5824* (in fruit).

Pseudocymopterus montanus mutifidus var. nov.

Low, about 2 dm. high; lower leaflets broadly rhombic in outline, thrice pinnate; the upper twice pinnate; ultimate divisions linear; fruit smaller and more rounded.

On high mountains, at an altitude of 2,700–3,600 m.

NEW MEXICO: Range between Sapello and Pecos rivers, 1900, *Cockerell.*

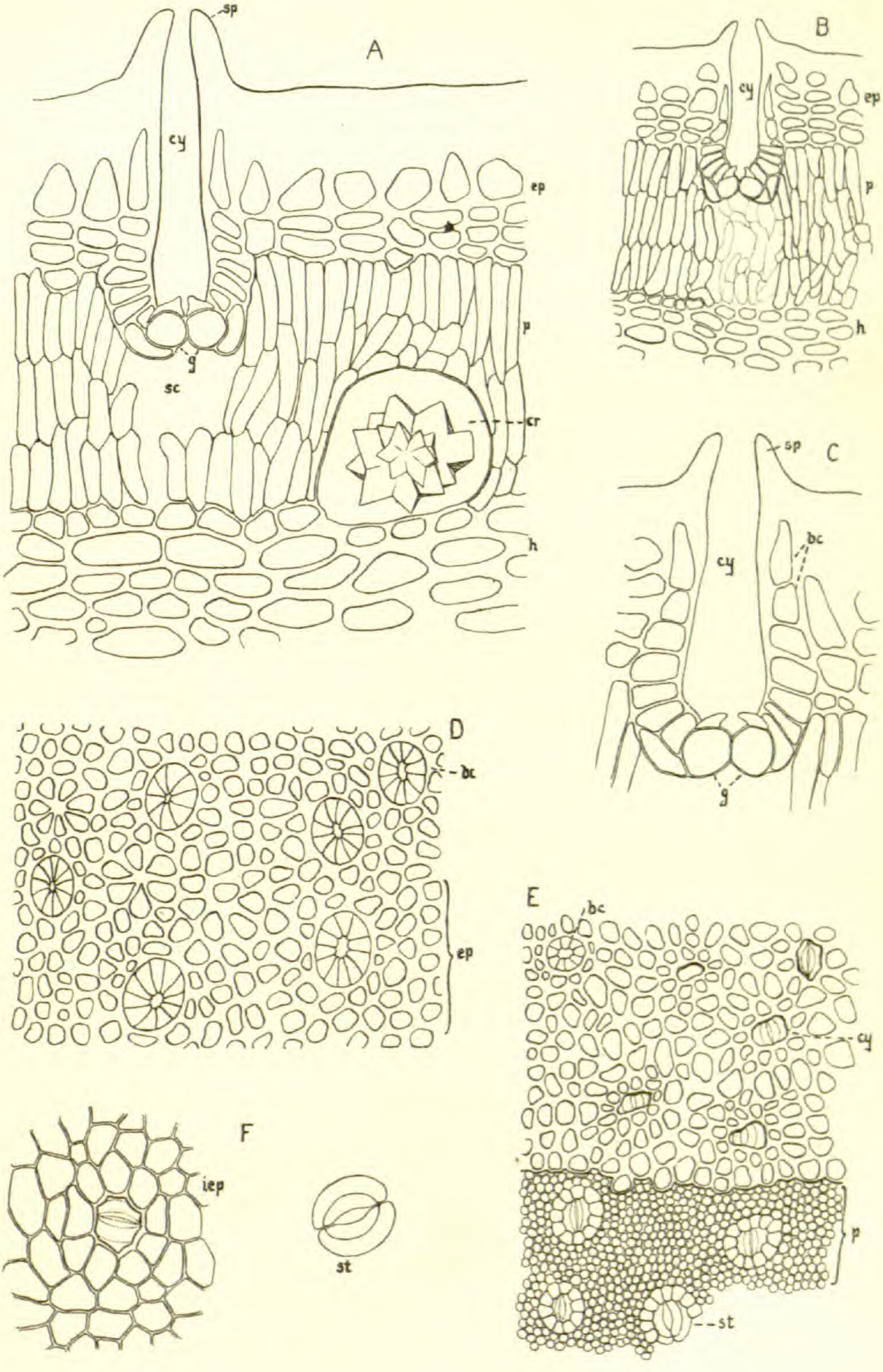
COLORADO: Ironton, 1899, *C. C. Curtis;* Cumberland Basin, 1898, *Baker, Earle & Tracy 619;* West Indian Creek, 1900, *Rydberg & Vreeland 5798;* Ironton Park, *Underwood & Selby 358.*

Pseudocymopterus aletifolius sp. nov.

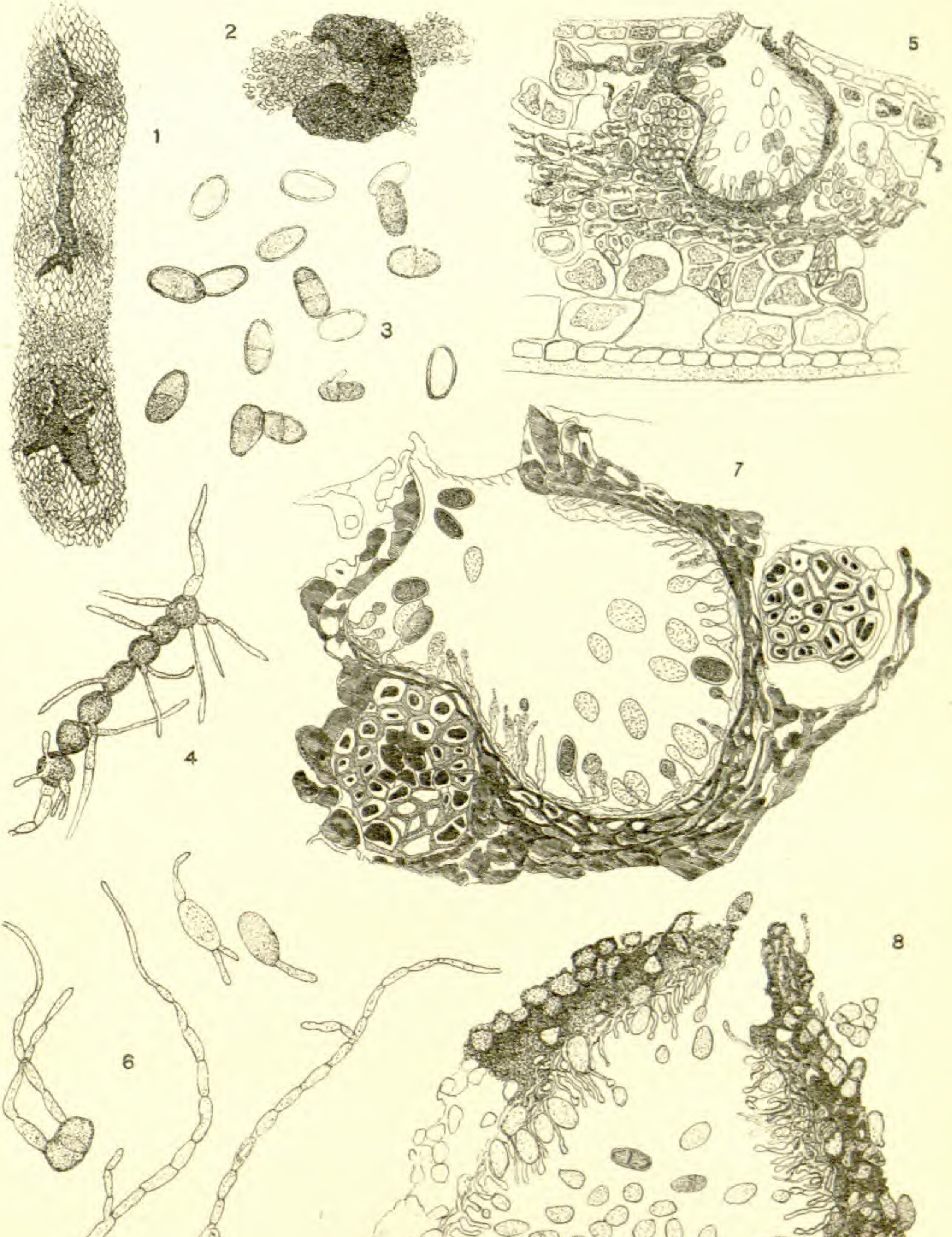
Densely cespitose acaulescent glabrous perennial with a very thick root and short caudex, covered by the broad striate bases of dead leaves; leaves once or twice pinnate, dark green, glabrous, stiff and shining, 1–2 dm. long; petioles about equaling the blades, striate; leaf-segments obovate to rhombic-cuneate, deeply cleft; lobes usually 3-toothed with lanceolate acuminate teeth; scapes 1–1.5 dm. long; involucres lacking; branches of the umbel very unequal, in fruit 1–5 cm. long; bractlets linear-subulate, 4–5 mm. long; pedicels also very unequal, in fruit 1–8 mm. long; sepals conspicuous, in fruit 1–2 mm. long; flowers yellow; fruit 5–6 mm. long, 2.5–3 mm. wide; lateral wings evident but rather narrow; dorsal ribs acute or slightly winged; seed flattened and with somewhat concave face; oil-tubes usually solitary in the intervals.

This species is evidently most closely related to *P. anisatus*, but easily distinguished by the very unequal branches of the umbel, the longer, usually less winged fruit and especially by the leaves, which (although much firmer) resemble closely those of *Aletes acaulis.* The plant evidently connects the two genera *Aletes* and *Pseudocymopterus.* The fruit of the present species is also intermediate between *A. acaulis* and *P. anisatus*, and were it not for the flatness of the seed and the lateral wings of the fruit, it might have been referred to *Aletes.* It grows in the mountains of which Pike's Peak is the center, at an altitude of 2,000–2,600 m.

COLORADO: Minnehaha, 1901, *Clements 94* (type); same locality, 1895, *E. A. Bessey;* North Cheyenne Cañon, 1895, *E. A. Bessey*, and 1892, *C. S. Sheldon;* South Cheyenne Cañon, 1900, *Rydberg & Vreeland 5815;* Cheyenne Mountain, 1892, *Alice Eastwood;* Manitou, 1900, *Clements;* Ruxton, 1896, *Clements 211;* Halfway House, 1896, *Shear 3709* (Rydberg & Vreeland's specimens are in flower, the others in fruit).



STOMATA OF HOLACANTHA



MACROPHLOMA AND DIPLODIA

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(1904)

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Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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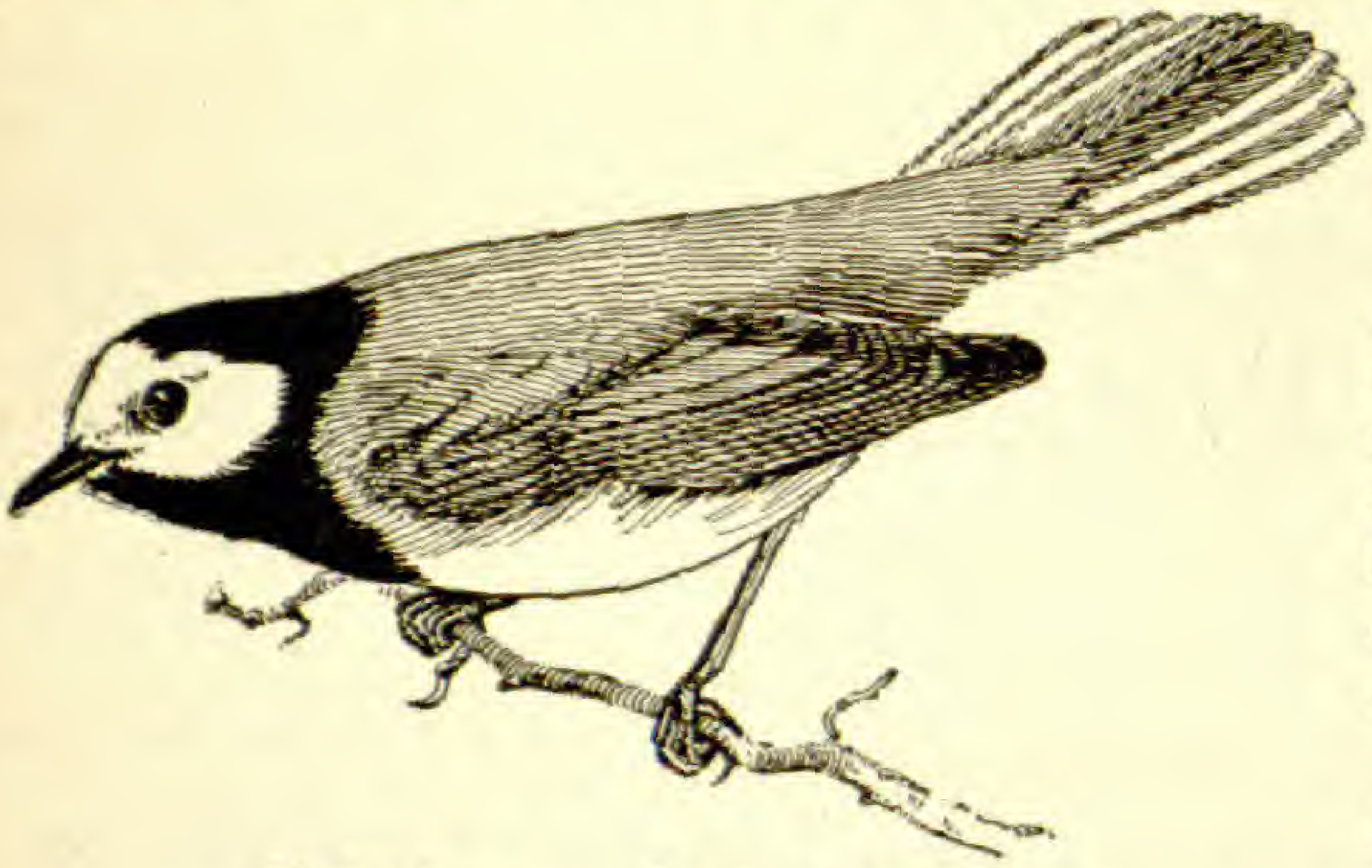

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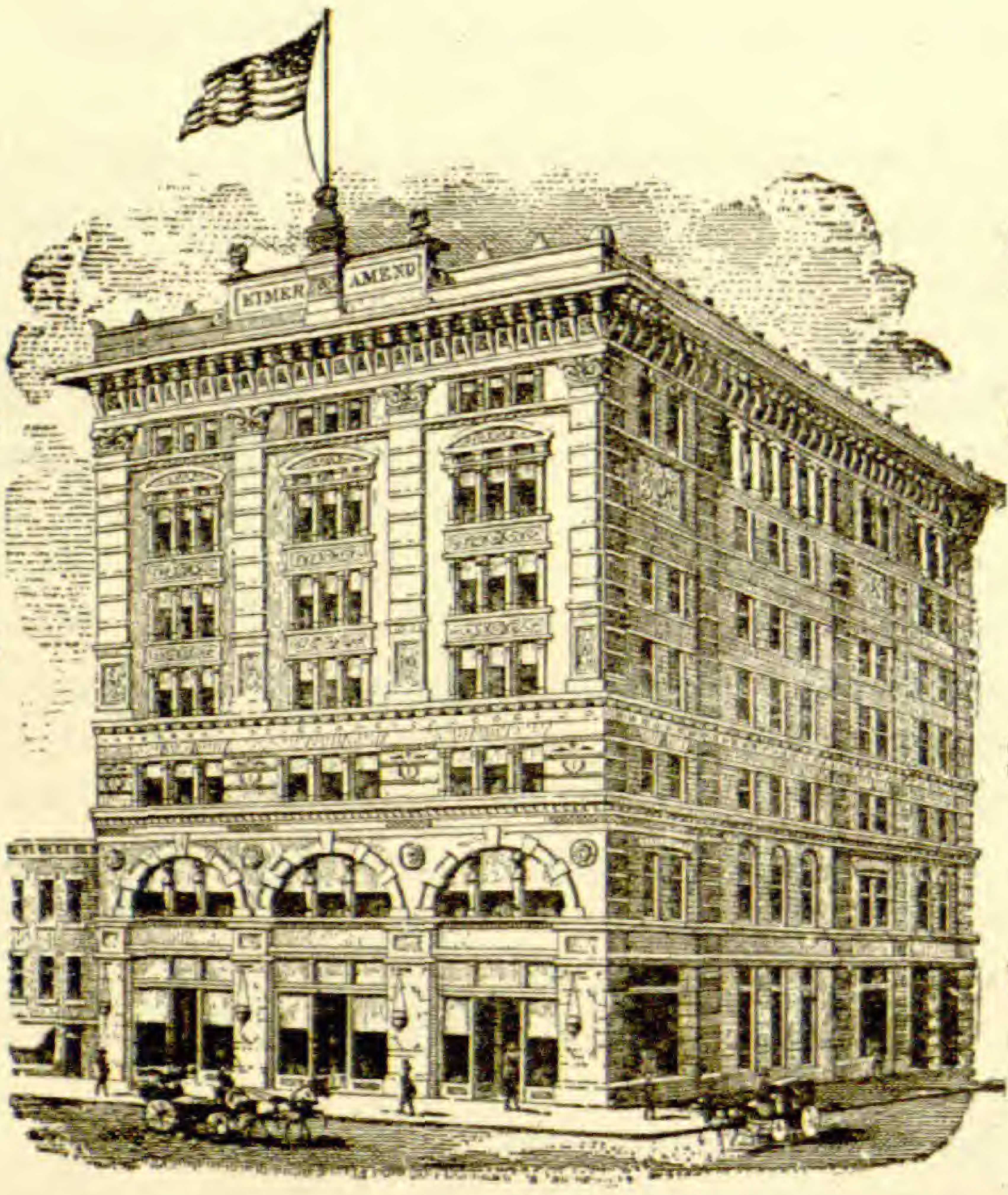
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NOVEMBER, 1904

Desmids from Newfoundland

JOSEPH A. CUSHMAN

(WITH PLATE 26)

The material here reported upon was collected at Rose au Rue, Newfoundland, September 10 and 11, 1903, by Dr. Glover M. Allen. It consisted of but two bottles of material, one containing sphagnum from a pond on an alpine hilltop, the other containing portions of leaves of water-plants with a little of the sediment washed from them. From the lateness of the season and the small amount of material the twenty species represented a fair number for such circumstances. Certain species were especially abundant, *Tetmemorus*, *Cylindrocystis*, *Mesotaenium* and *Cosmarium* being the genera most frequently met with. These are, I believe, the first desmids that have ever been reported from any part of the island. The following were found :

DESMIDIUM BAILEYI (Ralfs) De By.

Diameter of filament, 25 μ.

But one filament of this species was found, but that was of the typical American form figured by Nordstedt (K. Sv. Vet.-Akad. Handl. **22**^{8} : *pl. 2. f. 4.* 1888). Wolle seems, as Nordstedt says, to have been wrong when he says that this species has a twisted filament and that "the lateral margins are straight, not bicrenate." In all the specimens I have seen, the crenae of the margin have always been apparent and I have not yet seen a twisted filament. The figure referred to above seems to be typical of the American form of this species.

[The preceding number of the BULLETIN, Vol. 31, No. 10, for October, 1904 (31 : 523-580, *pl. 24, 25*) was issued 1 N 1904.]

MESOTAENIUM ENDLICHERIANUM Naeg.

Long. 35 μ; lat. 12 μ.

Very common in the second bottle of material mentioned above.

CYLINDROCYSTIS AMERICANA W. & G. S. West. (PLATE 26, FIG. 1.)

Long. 40 μ; lat. 18 μ.

Although this is slightly smaller than the typical form, it has the same proportions and the same characteristic shape. Frequent in the first collection.

CYLINDROCYSTIS sp. ?

Long. 37.4 μ; lat. 24.8 μ; lat. apic. 15 μ.

Very finely but sparsely punctate, slightly constricted in the middle. But one specimen of this character noted.

PENIUM DIGITUS (Ehrenb.) Bréb.

Long. 160–180 μ; lat. 63–71 μ.

Varying somewhat in size and form, fairly common.

PENIUM CLOSTERIOIDES Ralfs.

Long. 98 μ; lat. 29 μ.

Few of this species noticed.

TETMEMORUS BREBISSONII TURGIDUS Ralfs. (PLATE 26, FIG. 2.)

Long. 174–198 μ; lat. 40–44 μ.

Very common among the moss in the first collection.

TETMEMORUS LAEVIS (Kütz.) Ralfs. (PLATE 26, FIG. 3.)

Long. 133 μ; lat. 25 μ.

Not as common as the other two species of this genus.

TETMEMORUS MINUTUS De By. (PLATE 26, FIG. 4.)

Long. 62–65 μ; lat. 15–16 μ.

The commonest species in the collection.

EUASTRUM AMPULLACEUM Ralfs. (PLATE 26, FIG. 5.)

Long. 87 μ; lat. 47 μ; lat. lob. pol. 22 μ.

Somewhat smaller than the form usually found; frequent.

Euastrum Allenii sp. nov. (PLATE 26, FIG. 6.)

Long. 105 μ; lat. 49 μ; lat. lob. pol. 33 μ; lat. isthm. 18 μ.

E. submagnum, circiter duplo longius quam latum, modice constrictum, sinu lineare: semicellulae septemlobae, lobis lateralibus retusis, lobis polaribus truncatis : supra isthmum tumore instructae : membrana sparse scrobiculato-punctata.

This species is very distinct. The peculiar rectangular form and its multilobate character will at once distinguish it. It is named for Dr. Glover M. Allen, who collected it.

EUASTRUM BINALE Ralfs.

Long. 18 μ; lat. 15 μ.

Not at all frequent : in second collection.

EUASTRUM ELEGANS (Bréb.) Kütz., var.

Long. 25 μ; lat. 15 μ; lat. isthm. 4 μ.

In the second collection, rare.

XANTHIDIUM ARMATUM Bréb. (PLATE 26, FIG. 7.)

Long. s. spin. 148 μ; lat. s. spin. 93 μ; lat. c. spin. 115 μ; lat. isthm. 45 μ.

Central series of four granules : several specimens found in the first collection. Considerable variation was seen in the two semicells of the same specimen. The form figured was the most common.

Micrasterias conferta Novae-terrae var. nov. (PLATE 26, FIG. 8.)

Long. 102 μ; lat 93 μ; lat. isthm. 12 μ; lat. lob. pol. c. sp. 37 μ.

This in some of its characters is like the var. *hamata* of Wolle, but the polar lobe is less widely separated from the lateral ones, the polar lobe not so wide at the apex and distinctly spinose. The edges of the lateral lobes adjacent to the polar lobe have a median angle, but not greatly developed. The constrictions are more open and the ultimate portions not so elongated as in the var. *hamata*.

COSMARIUM IMPRESSULUM MINOR Turner. (PLATE 26, FIG. 9.)

Long. 16 μ; lat. 12 μ; isthm. 3.5 μ.

This form is common in the two collections. It seems to be exactly like the forma *minor* of Turner in shape and measurements.

COSMARIUM PSEUDOPYRAMIDATUM Lund.

Long. 50–56 μ; lat. 31–33 μ; lat. isthm. 9–10 μ.

Very common in the collections, varying slightly in size.

STAURASTRUM DUBIUM West.

Long. 28 μ. lat. 22 μ; lat. isthm. 10 μ.

Very common.

STAURASTRUM NANUM Wolle. (PLATE 26, FIG. 10.)

Long. 25 μ; lat. c. acul. 31 μ; lat. s. acul. 22 μ; lat. isthm. 8 μ.

Common in the first collection.

STAURASTRUM CRENULATUM (Naeg.) Delp.

Lat. c. proc. 37 μ.

A single empty cell found.

BOSTON SOCIETY OF NATURAL HISTORY.

Explanation of plate 26

FIG. 1. *Cylindrocystis americana* W. & G. S. West. × 600.
FIG. 2. *Tetmemorus Brebissonii turgidus* Ralfs. × 600.
FIG. 3. *T. laevis* (Kütz.) Ralfs. × 600.
FIG. 4. *T. minutus* De By. × 600.
FIG. 5. *Euastrum ampullaceum* Ralfs. × 600.
FIG. 6. *E. Allenii* sp. nov. × 600.
FIG. 7. *Xanthidium armatum* Bréb. × 600.
FIG. 8. *Micrasterias conferta Novae-terrae* var. nov. × 600.
FIG. 9. *Cosmarium impressulum minor* Turner. × 1200.
FIG. 10. *Staurastrum nanum* Wolle. × 1200.

An anomalous structure on the leaf of a bean seedling

W. T. HORNE

A number of red Valentine beans were placed in the soil of some pots in the physiological laboratory of the New York Botanical Garden on September 12, 1903, and the preparations were covered with bell-jars. The seedlings which soon arose were somewhat drawn, being grown under a high temperature and in a relatively highly humid atmosphere.

When the bell-jars were removed a structure which was apparently a root was noticed on one of the plants just below the cotyledons. On the same plant an apparently similar organ but somewhat smaller was noticed on the back of one of the leaves, appressed to the midvein. The bell-jar was replaced to prevent injury to the unusual structures by drying. FIGURE 1 shows the plant one week from planting the seed, the root-like structures at *a* and *b*. Both were without chlorophyl and had the appearance of strong root-tips, the upper being more slender toward the tip.

FIGURE 1. Bean seedling, showing anomalous structures at *a* and *b*. Half nat. size.

After being kept for another week neither had apparently made farther growth and the lower was turning brown at the tip. It was removed, fixed in Flemming's fluid and imbedded in paraffine. Longitudinal sections showed that it had a root-cap and the arrangement of tissues characteristic of a true root. It had bent strongly away from the light and downward.

The other structure was left for a week longer, when, as it showed no sign of changing further and the plant under the bell-jar was becoming unhealthy, the whole leaf was cut off and examined. The midvein was cut in pieces, fixed in Flemming's fluid and imbedded in paraffine. The free part of the root-like organ was about 5 mm.

long, and it could be traced back along the midrib as a white ridge to about 1 cm. from the base of the leaf. It was bent slightly away from the light and by the position of the leaf was directed downward. No root-cap could be seen. Trans-sections were made at various points and stained with saffranin- Delafield's haematoxylin. At about 7 mm. from the base of the leaf the structure of the midrib is normal, only a very slight ridge showing at its lower side. At 2 mm. farther the ridge is distinct with the narrow celled parenchyma about the bundle somewhat increased below the ridge but the fibrovascular elements not disturbed (FIGURE 2). At 8 mm. farther the ridge has increased in size and a group of slightly narrower cells occupies nearly half of the space from the bundle to the epidermis. At 5 mm. farther the ridge is larger and the group of more slender cells is narrower and extends out towards its axis; the parenchyma is shrunken at one side. At 9 mm. farther the organ has reached its full size and commenced to separate from the midvein. An axial strand of slender cells is distinctly differentiated here and entirely separated from the vascular bundle of the mid-

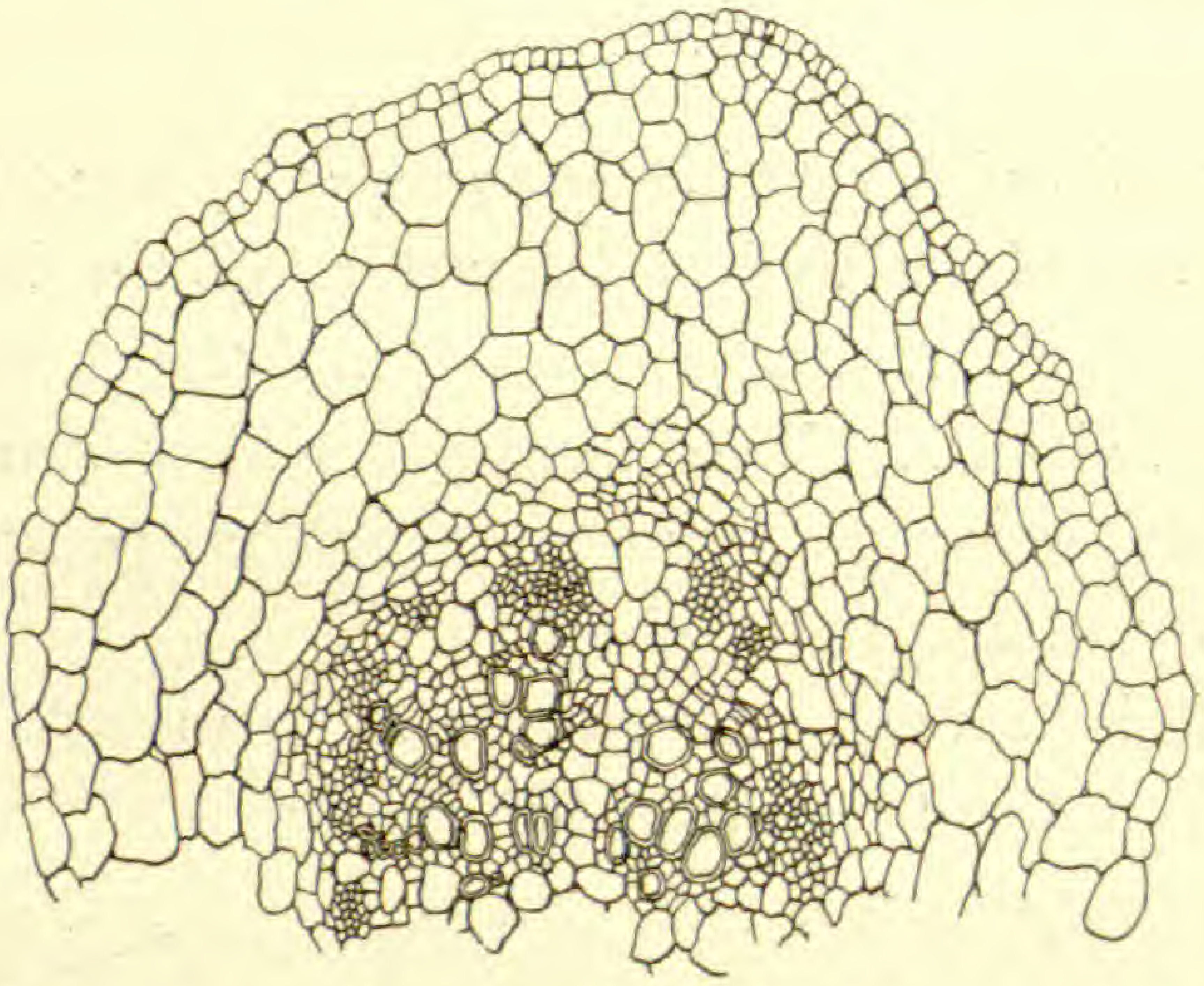

FIGURE 2. Transverse section of midrib, about 9 mm. from base, of the leaf bearing the anomolous appendage.

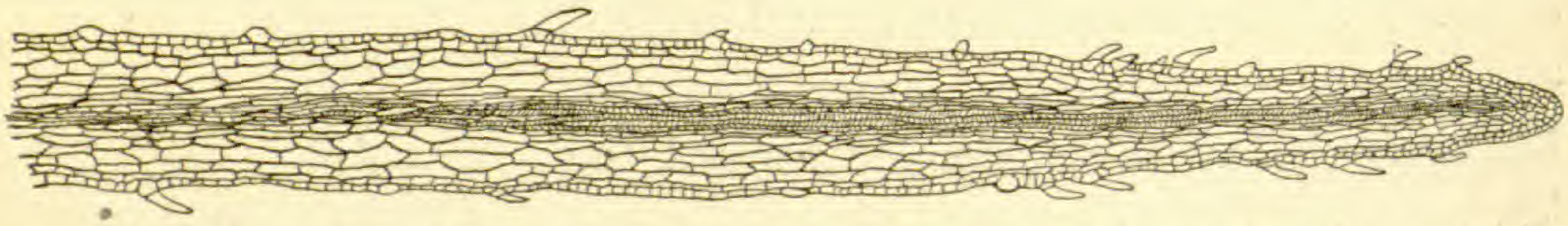

FIGURE 3. Longitudinal section of terminal portion of structure shown at *b* in *figure 1*. × 45.

rib. At 4 mm. farther the organ is very nearly free from the midrib and shows the same internal structure as where it has become separated.

The outer end was sectioned longitudinally. The epidermis is contiuous to the tip and set with short hairs The body of the structure is parenchyma, the inner cells being larger and longer. There is a distinct axial strand composed of much narrower cells varying considerably in length and some having oblique and some square ends. The central strand is much broader in the first two millimeters from the end and has developed in it numerous lignified vessels with simply reticulated or spirally thickened walls. At about 2 millimeters from the end

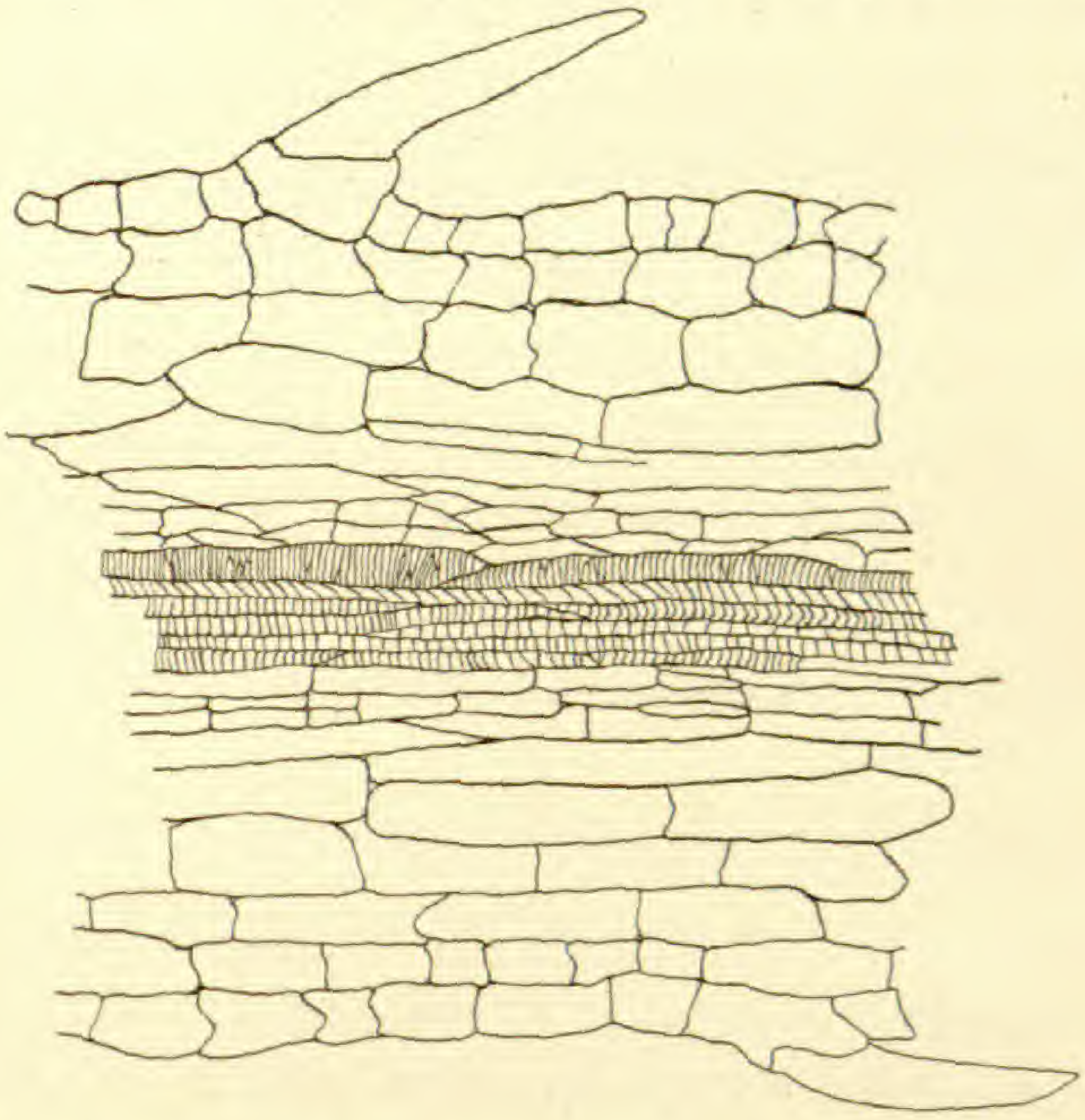

FIGURE 4. Part of a section such as that shown in *figure 3*, enlarged. × 200.

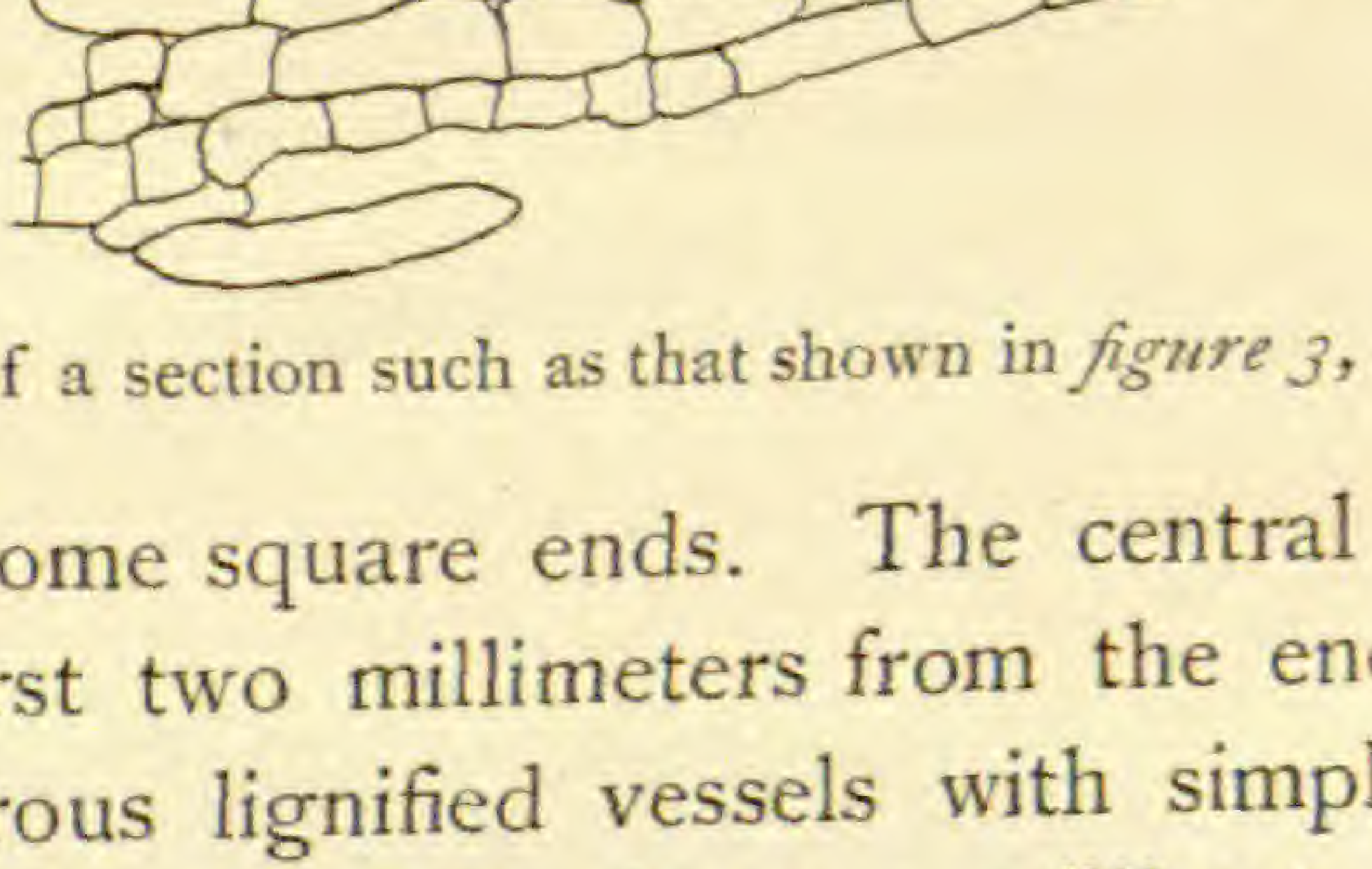

FIGURE 5. Tip of a section such as that shown in *figure 3*, enlarged. × 200.

the lignified elements disappear and the central strand becomes much narrower. FIGURE 3 shows somewhat diagrammatically the relation of the different parts. FIGURE 4 shows a section at about the center of the group of vessels, and FIGURE 5 shows the structure of the tip.

The first structure was a true root formed in a somewhat unusual position. The second is probably best regarded as an anomalous appendicular structure. The stimulus of high temperature and humidity probably favored the growth of these unusual structures.

The nomenclature of Calonyction bona-nox

HOMER D. HOUSE

The species described in Dr. Small's recent *Flora of the southeastern United States*, as *Calonyction bona-nox*,[*] is known under the common name of moonflower. A study of available herbarium material shows that two very distinct species are represented, and in an effort to determine their proper status a formidable array of synonymy is encountered. The condition of affairs was pointed out by Kuntze[†] in 1891, and briefly the facts are as follows: In the first edition of *Species Plantarum*, Linnaeus describes *Convolvulus aculeatus*[‡] and *Ipomoea alba*.[§] Later, Linnaeus combines them under the name of *Ipomoea bona-nox*,[‖] and includes there nearly all of the citations given under the two previously named species. *Ipomoea alba* is again taken out under the name of *Convolvulus grandiflorus*,[¶] and given the same pre-Linnaean citation as *Ipomoea alba* with an additional citation. These changes may be shown by the following tabulation.

Pre-Linnaean citations.	*Convolvulus aculeatus* L 1753.	*Ipomoea alba* L. 1753.	*Ipomoea bona-nox* L. 1762.	*Convolvulus grandiflorus* L. f. 1781.
Hort. Cliff. 496.	×		×	
Pluk. Alm. *t. 276. f. 3.*	×		×	
Sloan. Jam. 55; Hist. 1: *t. 96. f.* 1.	×		×	
Raj. Suppl. 371.	×			
Bauh. Pin. 296.	×	×	×	×
Rheed. Mal. 11: *t. 50.*			×	
Herm. Mus.				×

The genus *Calonyction* Choisy[**] is based upon the characters of large salverform corolla, exserted stamens and thickened

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[*] Small, J. K. Flora of the Southeastern United States, 961. 1903.

[†] Kuntze, O. Rev. Gen. 442. 1891.

[‡] Sp. Pl. 155. 1753.

[§] Sp. Pl. 161. 1753.

[‖] Sp. Pl. Ed. 2, 228. 1762.

[¶] Linn. f. Supplement, 136. 1781.

[**] Choisy. Mem. Soc. Phys. Genev. 6: 440. 1833. –Conv. Or. 59. 1834.—In DC Prodr. 9: 345. 1845.

pedicels. The type is *Calonyction speciosum* Choisy,* which includes at least the Linnaean species *Convolvulus aculeatus* and *C. muricatus.* The revised nomenclatorial status, therefore, of the two species under consideration may be presented as follows:

✓ **Calonyction aculeatum** (L.) comb. nov.

Convolvulus aculeatus L. Sp. Pl. 155. 1753.

Ipomoea bona-nox L. Sp. Pl. Ed. 2, 228. 1762. In part.—Jacq. Hort. Schoenb. **1**: 16. 1797.

Convolvulus latiflorus Desr. Encyc. **3**: 537. 1790.

Calonyction speciosum Choisy, Mem. Soc. Phys. Genev. **6**: 441. 1833.—In DC. Prodr. **9**: 345. 1845. In part, excl. vars. β and γ, at least.

Calonyction bona-nox Boj. Hort. Maurit. 228. 1837.—Small, Fl. S. E. U. S. 961. 1903.

Ipomoea aculeata Kuntze, Rev. Gen. 442. 1891.—Blume, Bijdr. 715. 1825 (according to Choisy but not according to Kuntze).—G. Don, Gen. Syst. **4**: 270. 1838.

Convolvulus foliis cordatis, caule aculeato L. Hort. Cliff. 496.

Convolvulus americanus, subrotundis foliis, viticulis spinosis Pluk. Alm. 115.

Convolvulus maximus, caule spinulis, etc. Sloane, Jam. 55; Hist. 1: 151.

Smilax aspera Indiae occidentalis Bauh. Pin. 296.

Characterized by a smooth or muricate, high-twining stem with milk-like sap: leaf-blades glabrous, ovate or suborbicular, 5–15 cm. long, entire or variously 3–5-lobed, acuminate, cordate, of a thin, somewhat membranaceous texture: peduncles axillary, one- to several-flowered; pedicels becoming much thickened in fruit: sepals appressed to the corolla, about 1.5 cm. long, all, or at least the outer, with infraterminal tail-like appendages: corolla white, nocturnal, strictly salverform, tube 8–12 cm. long, limb 6–10 cm. broad: capsules ovoid, 2 cm. high; seeds dark brown or nearly black, shining, but very minutely pubescent, sometimes strongly so.

TYPE LOCALITY: Tropical America.

DISTRIBUTION: Florida; western Mexico to Central and South America; West Indies and the tropical regions of the Old World.

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* Choisy, *l. c.*

ILLUSTRATIONS: Pluk. Alm. *pl. 276. f. 3;* Sloane, Hist. **1**: *pl. 96. f. 1;* Jacq. Hort. Schoenb. **1**: *pl. 36;* Cav. Ic. **3**: *pl. 300;* Gaertn. Sem. **2**: *pl. 134. f. 3;* Vell. Fl. Flum. **2**: *pl. 54;* Bot. Repos. **6**: *pl. 403;* Bot. Mag. *pl. 752;* Bot. Reg. *pl. 889,* and *pl. 917.*

Among the many sheets examined the following may be cited:

FLORIDA. Newport, Key Largo, *Pollard, Collins & Morris 170,* 1898. Everglades, west of Miami, *Small & Nash,* 1901. Snapper Creek, south of Cocoanut Grove, *Small & Nash,* 1901. Miami, *Small & Carter 675,* 1903; *A. P. Garber,* June, 1877; *Britton 419,* 1904. Myers, Lee Co., *A. S. Hitchcock 225* and *226,* 1900. Steamboat Key, *Tracy 6789,* 1900. Eustis, Lake Co., *Nash 1333,* 1894. Jupiter Inlet, *A. H. Curtiss 5543,* 1895.

MEXICO. Lower California, *C. A. Purpus 530,* 1901. Maleje, Lower Calif., *Palmer 33,* 1887. Tres Marias Isl., *Nelson 4269,* 1897. Mazatlan, *W. G. Wright 1212,* 1888. Chapala, Jalisco, *Palmer 727,* 1886. Orizaba, *F. Muller 3017,* 1855. Oaxaca, *Holway 3735,* 1899; *Chas. L. Smith 904,* 1894. Yucatan, *Gaumer 330.*

WEST INDIES. Matanzas, Cuba, *Britton & Shafer 264* and *517,* 1903. Pinar del Rio, Cuba, *Palmer & Riley 657,* 1900; *Shafer 529,* 1903. Cienequinta, Santa Clara, Cuba, *Combs 716,* 1896. Santiago, Cuba, *Hamilton 6* and *9,* 1902. Porto Rico, *Mr. & Mrs. A. A. Heller 375,* 1899.

The form with 3–5-lobed and subhastate leaf-blades is described as var. *heterophylla* by Kuntze,* but cannot be regarded as a subspecies.

Calonyction album (L.) comb. nov.

Ipomoea alba L. Sp. Pl. 161. 1753.

Ipomoea bona-nox L. Sp. Pl. Ed. 2, 228. 1762. In part.

Convolvulus grandiflorus L. f. Suppl. 136. 1781.

Ipomoea longiflora R. Br. Prodr. **1**: 484. 1810.

Calonyction grandiflorum Choisy, Mem. Soc. Phys. Genev. **6**: 442. 1833.—Conv. Or. 60. 1834.—In DC. Prodr. **9**: 346. 1845.

Calonyction speciosum var. γ *pubesceus* Choisy, in DC. Prodr. **9**: 345. 1845.

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* Kuntze. Rev. Gen. 442. 1891.

Munda Valli Rheede, Mal. **11** : 103.

Similar to *C. aculeatum*. The stem not muricate, but covered with a thin, whitish, often rough or pubescent bark : peduncles and pedicels very stout : leaf-blades ovate, deeply cordate, entire, acuminate, of a thick and somewhat coriaceous texture, prominently reticulate-veined and slightly pubescent beneath : sepals ovate, thick and coriaceous, rounded or blunt at the apex, apparently never appendaged : corolla larger than in the preceding species, 12–18 cm. long, the limb 8–15 cm. broad.

TYPE LOCALITY : Malabar.

DISTRIBUTION : Florida Keys ; Bahamas and St. Vincent. Also St. Domingo and St. Thomas (*fide* Choisy). Common in the tropics of India and the East Indies. Perhaps introduced into America.

ILLUSTRATIONS : Rheede, Mal. **11** : *pl. 50 ;* Jacq. Hort. Vind. **3** : *pl. 69.*

The following specimens have been examined from North America and compared with old world specimens :

FLORIDA. Elliotts Key, *Small & Nash*, Nov. 6 and 7, 1901 ; *N. L. Britton 378*, 1904.

BAHAMAS. South Cat Cay, *Millspaugh 2416*, 1904. Rum Cay, *Coker 445*, 1903. Salt Cay, New Providence, *John I. & Alice R. Northrop 244*, 1890.

ST. VINCENT. *H. H. & G. W. Smith*, March, 1890.

A perplexing array of synonymy can be attached to each of the above species, but no attempt will be made to assign these numerous names at the present time, lest mistakes in so doing might be misleading as regards the identity of the two species above described.

NATIONAL MUSEUM, WASHINGTON, D. C.

The Polyporaceae of North America — IX. Inonotus, Sesia and monotypic genera

William A. Murrill

Continuing the work begun in article VIII of this series upon colored sessile forms, an attempt is here made to treat in their proper relations plants with brown context and spores, constituting the genus *Inonotus*, and plants with brown context, hyaline spores and daedaleoid or lamelloid tubes, constituting the genus *Sesia*. A few genera are also added that contain only a single species each.

Inonotus Karst. Medd. Soc. Faun. et Fl. Fenn. **5**: 39. 1879

Inoderma Karst. Medd. Soc. Faun. et Fl. Fenn. **5**: 39. 1879.
Inodermus Quél. Ench. 173. 1886.

This genus was based upon four species, *I. cuticularis* (Bull.), *I. hispidus* (Bull.), *I. unicolor* (Schw.) and *I. hypococcinus* (Berk.). The two last can hardly be considered congeners of the first. The type species is *I. cuticularis*, not found in America. Karsten in later publications included also *I. fibrillosus*, *I. vulpinus*, *I. triqueter*, *I. radiatus* and *I. nidulans* in the genus, although some of them have hyaline spores. These he divided into two groups, one in which the pileus is spongy-fleshy and anoderm and the other containing species with a dry, thin, fibrous cuticle. To the first group, such species as *I. cuticularis* and *I. hispidus* belonged, while *I. radiatus* and *I. fibrillosus* were in the second group.

This second group at first constituted the genus *Inoderma* of Karsten, but the name is untenable, because preoccupied by *Inoderma* of S. F. Gray for a genus of lichens. Quélet's genus *Inodermus* was not only preoccupied so far as the name was concerned, but was founded upon *I. hispidus* (Bull.), one of the original typical species of *Inonotus* Karst. The species here included in the genus *Inonotus* are brown, sessile, usually anoderm, with fibrous context and brown-tinted spores. There is considerable variation in spore coloration, the spores of some species being very deeply colored, while others are so pale as to appear almost hyaline, especially when not fully matured.

The largest species is *I. hirsutus*, sometimes over 30 cm. in diameter, while the smallest, *I. pusillus*, is rarely over two or three millimeters across. As regards the distribution of our species, two, *I. hirsutus* and *I. radiatus*, occur in Europe and in temperate North America; three others, *I. perplexus*, *I. dryophilus* and *I. amplectens*, appear to be confined to temperate regions of North America; while the remaining six are known only from certain localities in tropical America.

Synopsis of the North American species

1. Spores deep brown in color. 2.
Spores faintly tinted with brown. 5.

2. Surface of pileus hirsute, tubes luteous, margin obtuse; plants of large size and two centimeters or more in thickness. 1. *I. hirsutus.*
Surface of pileus conspicuously tomentose, margin acute; plants of medium size and one centimeter or less in thickness. 2. *I. perplexus.*
Surface of pileus glabrous or finely tomentose. 3.

3. Pileus 8 cm. or more in width, rigid, ferruginous throughout, margin rather obtuse. 3. *I. dryophilus.*
Pileus 5 cm. or less in width. 4.

4. Surface of pileus very rimose, tubes 2 cm. long. 4. *I. texanus.*
Surface of pileus rugulose and zonate, but not rimose, tubes 1 cm. long. 5. *I. jamaicensis.*

5. Pores scarcely visible to the unaided eye. 6.
Pores conspicuous. 7.

6. Pileus thick, azonate, margin obtuse, hymenium dull. 6. *I. corrosus.*
Pileus thin, zonate, margin very sharp, hymenium glistening. 7. *I. Wilsonii.*

7. Plants minute, only a few millimeters across, erumpent from lenticels of dead twigs. 8. *I. pusillus.*
Plants of medium size. 8.

8. Surface soft, anoderm, sporophores growing on living shrubs, often encircling the smaller branches. 9.
Surface hard, becoming encrusted, sporophores found on decaying wood. 9. *I. radiatus.*

9. Hymenium very concave, umbrinous, margin sharp and depressed. 10 *I. amplectens.*
Hymenium plane or nearly so, becoming almost black, margin rather blunt and not depressed. 11. *I. fruticum.*

1. **Inonotus hirsutus** (Scop.)

Boletus hirsutus Scop. Fl. Carn. ed. 2. **2**: 468. 1772.
Boletus spongiosus Lightf. Fl. Scot. 1033. 1777.
Boletus hispidus Bull. Herb. Fr. *pl. 210.* 1784. *pl. 493.* 1791.

Boletus flavus Poll. Fl. Ver. **3**: 607. 1824.

Polyporus hispidus Fr. Syst. Myc. **1**: 362. 1821.

Polyporus endocrocinus Berk. Lond. Jour. Bot. **6**: 320. 1847.

Inonotus hispidus Karst. Medd. Soc. Faun. et Fl. Fenn. **5**: 39. 1879.

Inodermus hispidus Quél. Ench. 172. 1886.

As one would naturally suppose, such a large and attractive plant as this did not long remain unnoticed by the early mycologists. Micheli refers to it as the "hairy and obscure agaric with golden hymenium." Batarra figures it and calls it *Agaricus favaginosus uvidus*. Scopoli describes it as a *Boletus* with reddish hispid surface and white or reddish hymenium occurring on the trunks and branches of trees; and he assigns to it the specific name *hirsutus*. Bulliard not only described it well under his name *Boletus hispidus*, the name by which it is best known, but he also made two excellent plate figures of it showing its stages and varieties. Under one name or another it has received attention from nearly all writers who have treated this group.

To the stranger in Europe there are few more attractive species among the fungi. It grows in considerable abundance on the sycamore, ash, oak, beech, walnut, etc., often infesting a large part of the trunk and emerging in brilliantly colored sporophores from wounds made in pruning or other openings into the heartwood. These sporophores sometimes measure a foot and a half in diameter and are clothed above with a dense coat of long reddish hairs which become black with age. The hymenium is at first white but soon becomes yellow, yielding a yellow dye when treated with water.

In Sweden, this species is rare and occurs only on ash. It is also rare in the northern United States, but is somewhat more common farther south; although it is by no means so abundant here as in Europe. Its principal host in America is the oak. A year or two ago I collected seven large sporophores on a decayed spot in a living oak trunk at Fort Lee, New Jersey. This was in September and the fruit-bodies were already much decayed. Plants collected by Lea on hickory in Ohio in the latter part of August, 1844, were so advanced as to seem new to Berkeley, who named them *Polyporus endocrocinus*, remarking that the species was allied to *P. Schweinitzii*, but was distinguished by its saffron-colored substance and strigose-squamose pileus. The two specimens collected are still at Kew and are practically identical in form and appearance with my own collections made in September. The species has also been found by Commons in Delaware, Ellis in New Jersey, Memminger in North Carolina and Dr. Martin in Florida. European exsiccati are too numerous to mention here.

2. **Inonotus perplexus** (Peck)

Polyporus perplexus Peck, Rept. N. Y. State Mus. Nat. Hist. **49**: 19. 1896.

This species was described from plants collected by Peck on beech trunks in Oneida County, New York. It is hairy-tomentose to setose-hispid, resembling *I. cuticularis* and *I. hispidus*. Its spores are ferruginous and broadly elliptical, being smaller than those of *I. hispidus*. The same plant was distributed by Shear in his New York Fungi, *no. 110*, under the name of *Polyporus radiatus*. His specimens were found at Alcove, New York, on a dead beech trunk. Plants were recently determined for me by Prof. Peck, although he thinks the types were destroyed while the herbarium was housed in the state capitol.

The present species is well named *P. perplexus*, since it has troubled more than one mycologist and collector during the last quarter of a century, some calling it *P. cuticularis* because of its hairy surface and others passing it for *P. radiatus* on account of its general appearance and evident close relationship with that species. During the past summer I had the opportunity of studying a large number of the fresh and growing sporophores on the trunk of a living sycamore maple in Bedford City, Virginia; and found the velvety, bright ferruginous surface and the sharp, sterile margin very characteristic. It seems to range much farther south than *I. radiatus* and is also more commonly collected, although neither can be said to be abundant.

Specimens are at hand from Pennsylvania, *Stevenson*; Delaware, *Commons*; Maine, *Hodson*; Georgia, *Underwood*; Virginia, *Murrill 1005*; Alabama, *Earle*; Louisiana, *Langlois*; Mississippi, *Tracy*. The hosts given are oak, spruce (?), and maple. It occurs on trunks and logs of either dead or decaying trees.

3. **Inonotus dryophilus** (Berk.)

Polyporus dryophilus Berk. Lond. Jour. Bot. **6**: 321. 1847.

The types of this species were sent from Ohio by Lea, who collected them on living trunks of red oak. The fruit-body is large and rigid, anoderm, ferruginous throughout, whitened externally by a fine canescence, with thin, angular, brown pores. The species resembles *Polyporus dryadeus*, but is smaller and more rigid and has larger and differently colored pores. In some respects it is allied to *Hapalopilus gilvus*, but the spores are deep ferruginous instead of hyaline and the pileus is much thicker, with a more obtuse margin. Excellent specimens are to be seen in the Ellis collection, which were found by Morgan in Ohio in 1885. He reports this species as occurring at the base of living oak trees and on oak logs.

4. **Inonotus texanus** sp. nov.

Pileus ungulate, attached by the vertex, 3 × 5 × 4 cm.; surface fulvous to fuliginous, concentrically and radially rimose, especially in age, the separated areas imbricated; margin very obtuse, concolorous: context corky, concentrically banded, fulvous to umbrinous, very thin, only one-tenth the length of the tubes in thickness; tubes 3 cm. long, 2–3 to a mm., tawny chestnut, polygonal, edges thin, entire; spores ovoid, smooth, very dark brown, 1–2-guttulate, 8 × 10 μ.

The above description is based upon a single rather old sporophore collected by Underwood on a mesquite (?) tree near Austin, Texas, November 24, 1891. Although young stages are not represented, still the characters as shown are very distinct.

5. **Inonotus jamaicensis** sp. nov.

Pileus dimidiate to triquetrous, convex, sessile, attached by a broad base, simple or imbricate, 2 × 3 × 1–1.5 cm.; surface encrusted, minutely rugose, cinereous behind, marked toward the margin with dark-brown or black zones; margin regular, often obtuse: context fibrous, fulvous, only a few millimeters thick; tubes 1 cm. long, 4 to a mm., larger by confluence, fulvous, polygonal to irregular, edges thin, entire; spores ovoid, smooth, deep ferruginous, 1–2-guttulate, very copious, 5 × 7 μ.

The type plants of this species were collected by Underwood on the Mabess river, Jamaica, at an altitude of 3,000 ft., April 23, 1903. None of the young stages was found. Judging from the fruit-bodies, the host must have been the small dead or dying branches of some broad-leaved tree.

6. **Inonotus corrosus** sp. nov.

Pileus conchate, clasping, simple or imbricate, 3 × 5 × 1–4 cm.; surface ferruginous to fulvous, furrowed and much corroded in age; margin entire, obtuse, tomentose, honey-yellow: context thick, spongy, fibrous, ferruginous, perforated by insects soon after maturity; tubes very short, only 1 mm. long each season, 8 to a mm., fulvous, subcylindrical, edges entire, obtuse to acute; spores lenticular, smooth, pale ferruginous, 4 μ in diameter, 1 μ thick, hyphae deep ferruginous.

The type plants of this species were collected by Earle, *no. 203*, near Hope Gardens, Jamaica, October 27, 1902. They grew upon a dead vine clinging to a tree. Two or three years growth were represented in the much weathered and wormeaten central parts of the sporophores, while the latest growths stood out in marked contrast. The flattened appearance of the spores may be due to desiccation, but this character is fairly constant. A single sporophore of this species was also collected in the island of New Providence by Britton, *no. 246*, Aug. 24, 1904, growing on a small dead twig.

What appear to be specimens of this same plant are placed at Kew under *Polyporus chrysites* Berk., a species described from the region of the Rio Negro river in Brazil as thin and leathery, while the various plants bearing that name at Kew are mostly thick and soft or even hard and perennial. Specimens collected in Cuba by Wright should probably belong to *I. corrosus* instead of to *P. chrysites.*

7. **Inonotus Wilsonii** sp. nov.

Pileus dimidiate, applanate, sessile, 2–3 × 4–6 × 0.5 cm.; surface anoderm, velvety-tomentose, fulvous, marked with a few shallow concentric furrows; margin thin, entire, concolorous, sulcate, deflexed in drying: context soft, punky, homogeneous, ferruginous-fulvous, 1–3 mm. thick, separated from the tubes by a very thin black layer; hymenium ferruginous, glistening, tubes 1–2 mm. long, 6–9 to a mm., isabelline within, mouths polygonal, regular, edges thin, entire; spores lenticular, smooth, pale ferruginous, 3–4 μ in diameter, 1–1.5 μ thick.

This species was collected by Percy Wilson, *no. 438*, on decaying logs in Honduras, Feb. 16, 1903. It resembles some plants called *P. chrysites* at Kew, but is quite distinct from that species. The shape of the spores as given above may be due to extreme desiccation.

8. **Inonotus pusillus** sp. nov.

Pileus sessile, convex, flabelliform, tapering to a narrow base, erumpent from lenticels, 2 × 2 × 0.5–1 mm.; surface ferruginous to fulvous, silky-striate, subzonate, shining, margin pallid, acute, often depressed: context thin, fibrous, ferruginous; tubes umbrinous, comparatively large, 2–4 to a mm., polygonal, becoming irregular, much exceeding in length the thickness of the context; mouths at first whitish-pulverulent, dissepiments thin, entire: spores small, ovoid, $3.5 \times 5\ \mu$, pale ferruginous, copious, hyphae concolorous.

This species is based upon plants collected by Dr. Edward Palmer, *no. 1520*, at Manzanillo, Mexico, in 1892. The tiny brown sporophores were found in large numbers emerging from the lenticels of small dead branches of *Jacquinia*. It was apparently recognized as a new species by Ellis and Galloway and distributed by them jointly under the genus-name *Trametes*, and later listed by Patouillard (Tax. Hymen. 101. 1900) as a species of *Xanthochrous*. The tentative name first proposed for the species is here made use of, but according to present usage I am, unfortunately, not permitted to cite the authors, since no description accompanied the name.

This is one of the very smallest plants met with in the *Polyporaceae*. Two other tiny plants are of interest in this connection, *Porodiscus pendulus*, which is also erumpent from lenticels, but has hyaline spores; and *Coltriciella dependens*, which is more like the present species in general appearance and structure, but is stipitate instead of sessile, having the stipe attached to the vertex of the pileus like the handle of a tiny bell.

9. INONOTUS RADIATUS (Sowerby) Karst.

Boletus radiatus Sowerby, Eng. Fung. *pl. 196.* 1799.
Polyporus radiatus Fr. Syst. Myc. **1**: 369. 1821.
Polyporus glomeratus Peck, Rept. N. Y. State Mus. Nat. Hist. **24**: 78. 1873.
Inoderma radiatum Karst. Medd. Soc. Faun. et Fl. Fenn. **5**: 39. 1879.

Inonotus radiatus Karst. Rev. Myc. 3: 19. 1881.

This species was first described from specimens collected on a decaying stump in Sussex, England. In the description, Sowerby refers to its habit of emerging from the substratum in a small woolly mass and then growing in a radiating manner with this mass as a center. He describes the pileus as zoned, with yellow margin, and the texture as woody. Berkeley mentions hazel stems as its favorite host in England. In Sweden it is abundant on hazel and birch, while in Germany and Austria it is found mostly on alder, which last is its most common host in America.

The form found on a prostrate sugar maple trunk and described as *P. glomeratus* by Peck, in 1873, hardly differs sufficiently from the typical form to constitute a distinct species. With the two forms before me, I can find no specific distinguishing character either with the unaided eye or with the microscope. This similarity was long since noticed and published by Cooke. The relations of *Polyporus scrobiculatus*, and various forms included in *Inonotus radiatus* by Karsten, to the typical form of this species do not come within the scope of the present paper.

Specimens are at hand from England, *Plowright;* Berlin, *Magnus*, *Hennings;* Tyrol, *Bresadola;* Sweden, *Murrill;* Canada, *Macoun;* Connecticut, *Underwood;* New York, *Peck*, *Earle*.

10. **Inonotus amplectens** sp. nov.

Pileus hemispherical, clasping, concave beneath, 1–3 cm. in diameter, 1–2 cm. thick; surface soft, velvety, dark yellowish orange, margin at first obtuse, entire, straw-colored, becoming thin, undulate or toothed, deflexed and concolorous: context soft, spongy-fibrous, ferruginous; hymenium at first honey-yellow, becoming umbrinous, tubes 2–4 mm. long, 2–4 to a mm., larger by confluence, umbrinous within, mouths at first closed by a yellowish membrane, subcircular, regular, entire, becoming large, irregular, coarsely toothed and concentrically split into irpiciform plates; spores ellipsoidal, smooth, hyaline, 1–2-guttulate, 4 × 6 μ.

Type specimens of this plant were collected by R. M. Harper, *1990a*, on the Ocmulgee river near Lumber City, Georgia, Sept. 11, 1903. The fruit-bodies were found encircling living twigs of *Asimina parviflora* (?). The upper surface of the plant resembles *Inonotus fruticum* (B. & C.), but the hymenium is very distinct.

11. **Inonotus fruticum** (B. & C.)

Polyporus fruticum B. & C. Jour. Linn. Soc. Bot. **10**: 310. 1868.

This species was named from its habit of growing upon shrubs. In shape it varies from thin and dimidiate to nearly spherical, according to its position on the branch and the size of the branch. If on a small twig it frequently encircles it. The pileus is very soft and spongy and the pores become almost black. Orange and oleander are mentioned as hosts. Several well-preserved specimens are among Wright's Cuban collections at Kew.

SPECIES INQUIRENDAE

Polyporus aureonitens Pat. & Peck, Rept. N. Y. State Mus. Nat. Hist. **42**: 25. 1889.

This species is based on material collected in New York by Peck and described by Patouillard. It occurs on birch, alder and maple. There are several specimens of it in the herbarium here collected in Massachusetts, Connecticut and New York. In his original publication, Peck says it is related to *P. radiatus*, but is distinguished by its paler color, often lineate-zoned pileus and paler spores. In a recent letter to me, Dr. Peck distinguishes *P. glomeratus* from *P. aureonitens* as follows: "*P. glomeratus* differs from *P. aureonitens* in its darker colors, more uneven surface of the pileus, entire absence of concentric lines or narrow zones on the surface of the pileus, which is more irregular and wavy on the margin, and never shining. Its spores in mass are of a brighter, richer, yellow color. The two are readily distinguished at sight by any one who has seen them growing."

By referring to Sowerby's description of the young stages of *P. radiatus*, it will be seen that the zonate pileus and yellow margin are present in that species. Also excellent European specimens from Bresadola and others, called by them *young P. radiatus*, seem to differ in no particular from New York specimens of *P. aureonitens*. It can hardly be imagined that two such eminent mycologists as Peck and Patouillard could have confused American and European species in this way, but they may not have had at hand good material of the young stages for comparison. In view of the above facts, I have thought it best to defer the settlement of the question at least until I can study our American form in the field.

SESIA Adans. Fam. **2**: 10. 1763

Serda Adans. Fam. **2**: 11. 1763.
Gloeophyllum Karst. Hattsv. **2**: 79. 1882.
Lenzitina Karst. Finlands Basidsv. 337. 1889.

The genus *Sesia* was founded upon Vaillant's figures of *S. hirsuta* (Schaeff.) drawn from specimens collected on the timbers of a boat at St. Cloud, Paris. The genus *Serda* is based upon a resupinate form of the same species collected at the same time and place and figured in the same work. In establishing the genus *Gloeophyllum*, Karsten overlooked Adanson's genera already founded and later even overlooks or purposely changes his own generic name to *Lenzitina*. All four names above mentioned are strictly synonymous, being founded on the same type species. Karsten listed three other European species, *L. abietina* (Bull.), *L. cinnamomea* (Fr.) and *L. septentrionalis* Karst., as congeners of the type.

The species of this genus have white spores, brown substance and normally daedaleoid or lamelloid tubes. Abnormal poroid forms quite frequently occur. All the species are found on decaying wood, and, as is often the case, some grow only on the wood of conifers, while others are confined to deciduous wood. *S. hirsuta* is abundant in the northern hemisphere on coniferous wood of all kinds, *S. Berkeleyi* is rare on coniferous wood in tropical America; *S. pallidofulva* is abundant in North America on wood of deciduous trees, while its place is taken in tropical America by *S. striata*. The species are all of medium size, easily distinguished by striking characters.

Synopsis of the North American species

1. Context ferruginous to chestnut. 2.
Context avellaneous to umber. 3.

2. Surface hirsute. 1. *S. hirsuta*.
Surface finely tomentose or glabrous. 2. *S. Berkeleyi*.

3. Furrows broad, a millimeter or more in width, pileus very thin, multizonate. 3. *S. striata*.
Furrows narrow, only a half of a millimeter in width, pileus rather thick, usually devoid of zones. 4. *S. pallidofulva*.

1. SESIA HIRSUTA (Schaeff.) Murrill

Agaricus hirsutus Schaeff. Fung. Hist. *pl. 76.* 1762.
Agaricus saepiarius Wulf. in Jacq. Collect. **1**: 347. 1786.
Agaricus boletiformis Sowerby, Eng. Fung. *pl. 418.* 1814.
Daedalea saepiaria Fr. Obs. Myc. **1**: 105. 1815.
Lenzites saepiaria Fr. Epicr. 407. 1838.
Lenzites rhabarbarina B. & C. Ann. Mag. Nat. Hist. II. **12**: 428. 1858.—Grevillea, **1**: 35. 1872.
Sesia hirsuta Murrill, Jour. Myc. **9**: 88. 1903.

This species is very abundant in the north temperate zone on logs, stumps and various other decaying wood of pine, fir, spruce, hemlock, juniper and other coniferous trees. It varies considerably in its wide range. In the higher regions of Colorado and adjoining states, for example, it is large and coarse and almost shaggy; while in the southeastern states, on the other hand, it is thinner and less densely hirsute than the typical European form, with more delicate, easily lacerated gills and a somewhat differently colored surface. The latter form was described from South Carolina by Berkeley and Curtis as *Lenzites rhabarbarina*, but I cannot distinguish it specifically from many of the typical specimens of *S. hirsuta*. It has been quite frequently collected in the South by Earle, Langlois, Britton, Schrenk and others. Another form, called *var. porosa* by Peck, is very distinct and would constitute a good species if it could be proven to be constant. In one instance Peck found a number of specimens on a single pine trunk that were all alike poroid. Further observation might establish a definite form found sometimes alone and sometimes growing with the species under consideration.

From the large list of specimens examined in connection with this study the following are listed to show the range of the species: Canada, *Macoun, Dearness*; New York, *Peck, Jelliffe, Underwood*; Maine, *Miss White*; New Jersey, *Ellis*; Connecticut, *Miss White*; Ohio, *Morgan*; Colorado, *Underwood & Selby*; Montana, *Rydberg & E. Bessey, Anderson*; Tennessee, *Murrill 689*; Virginia, *Murrill 121, 152*; Alabama, *Earle, Schrenk*; Florida, *Britton*; Louisiana, *Langlois*; Sweden, *Murrill*; Switzerland, *Murrill*; Tyrol, *Bresadola, Murrill.*

2. **Sesia Berkeleyi** (Sacc.)

Daedalea rhabarbarina Berk. & Cooke, Grevillea, **6**: 130. 1877; not *D. rhabarbarina* Mont.

Daedalea Berkeleyi Sacc. Syll. Fung. **6**: 381. 1888.

This species was described from specimens collected on pine stumps near Gainesville, Florida. The fruit-body is larger than in any other American species and the surface is only slightly tomentose, becoming glabrous with age. The margin is much lighter than the surface, being tawny-orange in color and contrasting vividly with the dark umber of the older growth. It is also more porous than most species of *Sesia*, the tubes rarely becoming more than sinuous, though it is sometimes lamellate in parts of the tropics where the fruit-body grows quickly. The only specimens at hand are those collected by C. G. Lloyd in Florida and by Smith in Nicaragua and Mexico.

3. **Sesia striata** (Sw.)

Agaricus striatus Sw. Prodr. 148. 1788.—Fl. Ind. Occ. **3**: 1920. 1806.

Daedalea striata Fr. Syst. Myc. **1**: 334. 1821.

Lenzites striata Fr. Epicr. 406. 1838.

Lenzites protracta Fr. Nov. Symb. 45. 1851.

This species was the first of two plants listed by Swartz in his *Prodromus* under the genus *Agaricus*, the second being *Schizophyllum alneum*, also common in Jamaica. The brief description, "*A. acaulis, convexus ferrugineus pubescens, margine integro, lamellis alternis interruptis cinereis*," is, as usual, much amplified in his later work.

Specimens from Mexico, still to be seen in the Fries herbarium at Upsala, were described by Fries as *L. protracta*, a name which has been generally assigned in Europe to a very different plant. Fries also called some of the Mexican collect~~ions~~ of this species *L. umbrina*.

Sesia striata is quite abundant on decaying wood in various parts of tropical America, as the following partial list of specimens will show: Colombia, *Baker;* Nicaragua, *Smith;* Honduras, *Wilson 200, 276;* Mexico, *Smith;* Cuba, *Underwood & Earle 503, 740, 750, 1526, 1562, Shafer;* Jamaica, *Underwood 740*; *Earle 82,* *96, 118, 145, 161, 180;* Porto Rico, *Earle 53;* New Providence, *Mrs. Britton;* Florida, *C. G. Lloyd.*

4. **Sesia pallidofulva** (Berk.)

Daedalea pallidofulva Berk. Hook. Lond. Jour. **6**: 322. 1847.
Lenzites vialis Peck, Rept. N. Y. State Mus. Nat. Hist. **26**: 67. 1874.

This species was described from material collected by Lea in Ohio in 1842. The type plants were taken from a dead log in a log fence in March. According to Berkeley, it stands exactly intermediate between *Daedalea* and *Lenzites.* Specimens sent to Fries by Berkeley are still to be seen in the herbarium at Upsala and they correspond in all points with the plant known as *Lenzites vialis* Peck, described from specimens found on railroad ties in New York by Peck in 1874.

The present species is a very common one in the United States, occurring abundantly on railroad ties and other dead timber of oak, willow, ash and other deciduous trees and more rarely on coniferous wood; though the broad general distinction between this species and *S. hirsuta* in regard to host usually holds good, the former being common on coniferous wood and the latter on deciduous wood. In appearance, there is considerable difference in the two species, *S. pallidofulva* being less brightly colored, and less distinctly zoned, with the furrows closer, shorter and more porous. The margin also is white when fresh and turns dark when bruised. There is a close resemblance between this species and *L. trabea* (Pers.) Fr., which occurs on deciduous wood in Europe.

The following specimens are at hand: Canada, *Dearness;* New Jersey, *Ellis;* New York, *Barnhart, Murrill, Peck;* Ohio, *Morgan, C. G. Lloyd;* Indiana, *Underwood;* Louisiana, *Langlois;* Kentucky, *Miss Price;* Tennessee, *Murrill 494, 495, 542, 579;* Iowa, *Macbride, Holway;* Pennsylvania, *Rau, Banker.*

SPECIES INQUIRENDAE

Lenzites mexicana Mont. Ann. Sci. Nat. II. Bot. **20**: 360. 1843. Collected on dead wood in the province of Oaxaca, Mexico, by Andrieux. Apparently a stipitate and otherwise abnormal form of *S. striata*, but Montagne is decidedly opposed to this opinion and specimens are not at hand to settle the question. Compare his remarks on this point:

"Si l'on ne considère que l'hyménium de ce *Lenzites*, il est évident qu'on le distinguera mal du *L. striata;* mais si l'on observe la disposition du duvet dressé et comme conglutiné qui forme les zones concentriques, la profondeur des sillons qui séparent ces zones, et l'aspect rugueux et peluché qui en résulte, caractères que je ne rencontre dans aucun des nombreux individus du *L. striata*, on se convaincra promptement que, quoique voisines, ces deux espèces ne sauraient être confondues."

Daedalea Burserae Pat. Jour. de Bot. **3**: 341. 1889. Described from plants found on rotten wood of *Bursera gummifera* in Martinique by Duss. It is said by the author to be easily distinguished from all its congeners by the yellow powder which covers its pores in the young stages. I have not seen the type plants.

Daedalea jamaicensis P. Henn. Hedw. **37**: 281. 1898. Collected on dead wood at Port Antonio, Jamaica, and thus described:

"Pileo suberoso-spongioso, dimidiato, sessile, interdum imbricato, zonato sulcatoque rugoso, rufo-brunneo vel atro-violaceo nigricante, zonis obscurioribus, margine pallidiori, acuto; intus cinnamomeo; hymenio poroso-labyrinthiformi vel sinuoso-lamelloso, subochraceo vel subcinerescente."

This species is very near to *Sesia Berkeleyi*. Further study of the type plants, however, is necessary in order to decide whether or not the two species are synonymous.

ISCHNODERMA KARST. Medd. Soc. Faun. et Fl. Fenn. 5: 38. 1879

This genus was founded upon *Isch. resinosum* (Schrad.) and four other European species, the one here mentioned being the nomenclatorial type. Karsten describes the genus as follows:

"Receptaculum pileatum, sessile, primitus subcarnoso-succosum dein induratum, crusta tenuiore tectum. Hymenium heterogeneum. Pileus azonus. Pori integri, demum subsecedentes."

Ischnoderma fuliginosum (Scop.)

Boletus fuliginosus Scop. Fl. Carn. ed. 2. **2**: 470. 1772.
Boletus rubiginosus Schrad. Spic. Fl. Ger. 168. 1794.

Boletus resinosus Schrad. Spic. Fl. Ger. 171. 1794.
Trametes benzoina Fr. Epicr. 489. 1838.—Icon. *pl. 483. f. 2.*

This large and striking species was originally described from Carniola by Scopoli. It is quite abundant in temperate regions of Europe and North America on fallen trunks of basswood, beech, maple, fir, spruce, etc. On account of its habit of growing beneath logs, the fruit-bodies often persist in a good state of preservation until the following spring. Logs are frequently found entirely covered on the under side with these extensive hymenophores. Whether the form found on coniferous wood is the same as that occurring on hard wood is an old question. There seems to be usually some difference in size and color, but after examining a large assortment of specimens, it seems impossible to distinguish the forms specifically either in this country or in Europe. More specimens from coniferous trees in this country would doubtless throw light on the question.

The following specimens have been examined in the Garden herbarium: Ell. N. A. Fung. *406*; Shear, N. Y. Fung. *112*; Kellerman, Ohio Fung. *105*; Canada, *Dearness, Macoun*; New York, *Earle, Atkinson, Miss Overacker, Murrill*; Delaware, *Commons*; Pennsylvania, *Sumstine*; West Virginia, *Nuttall*; Virginia, *Ricker*; Ohio, *James, Lloyd, Kelsey, Kellerman*; Michigan, *Merrow*; Wisconsin, *Baker*; Alabama, *Earle*; Florida, *Calkins*; Tyrol, *Bresadola & Murrill.*

Laetiporus gen. nov.

Hymenophore annual, epixylous, fleshy, anoderm, caespitose-multiplex; context cheesy to fragile, light-colored, tubes thin-walled, fragile, bright yellow, mouths irregularly polygonal; spores smooth, hyaline.

This genus is based on *Agaricus speciosus* Batarr. Fung. Hist. 68. *pl. 34. f. B.* 1755, commonly known as *Polyporus sulphureus* Fr. It may be at once distinguished from species of *Grifola* by its yellow color and arboreal habit. The generic name chosen refers to the brilliantly colored hymenium.

Laetiporus speciosus (Batarr.)

Agaricus speciosus Batarr. Fung. Hist. 68. *pl. 34. f. B.* 1755.
Boletus sulphureus Bull. Herb. France, *pl. 429.* 1788.
Boletus citrinus Planer, Ind. Plant. Erf. 26. 1788.

Polyporus sulphureus Fr. Syst. **1**: 357. 1821.
Polypilus sulphureus Karst. Rev. Myc. **3**: 17. 1881.
Polypilus speciosus Murrill, Jour. Myc. **9**: 93. 1903.

This species is widely and abundantly distributed both in Europe and America and is exceedingly well known on account of its size, conspicuous habitat, and bright attractive coloring. The mycelium spreads widely through the trunks of deciduous, and even evergreen, trees, causing serious damage, while the sporophores appear annually in caespitose-multiplex masses at knot-holes on the affected parts. The various names under which the plant has been known all refer to the bright color of these sporophores, which are usually reddish-yellow above and sulfur-yellow below, fading to almost white with age. A few of the numerous collections in which this plant figures are noted here: Sweden, *Murrill;* Maine, *Miss White;* Connecticut, *Miss White;* Delaware, *Commons;* New York, *Peck & Earle;* Pennsylvania, *Everhart & Haines;* New Jersey, *Ellis, Murrill;* Alabama, *Earle;* Louisiana, *Langlois;* Mexico, *Smith.*

Trichaptum gen. nov.

Hymenophore annual, epixylous, sessile, dimidiate; context brown, firm and leathery below, very loosely fibrous and darker above; tubes short, thin-walled, mouths polygonal, becoming labyrinthiform; spores smooth, hyaline.

The type of this genus is *Polyporus trichomallus* Berk. & Mont. (Ann. Sci. Nat. III. **11**: 238. 1849), described from Guiana. It resembles the old-world genus *Funalia* erected by Patouillard in 1900 with *P. mons-veneris* Jungh., *P. leoninus* Kl. and *P. funalis* Fr. as typical species and *P. trichomallus* Berk. & Mont. in a subsection; but it may be easily distinguished from *Funalia* by its darker context and daedaleoid hymenium. While splitting often occurs, rendering the hymenium irpiciform, the splitting is not so radical as in *Funalia.* The name chosen refers to the loosely woven context.

Trichaptum trichomallum (Berk. & Mont.)

Polyporus trichomallus Berk. & Mont. Ann. Sci. Nat. III. **11**: 238. 1849.
Funalia trichomalla Pat. Tax. Hymen. 95. 1900.

The type plants of this species were collected in the eastern part of Guiana by Poiteau and fully described by Montagne. It has since been frequently collected in many parts of South America and ranges northward to Central America and the West Indies. Plants seen in some herbaria labelled *P. heteromallus* are only large zonate forms of this species. A decidedly sinuous hymenium is present in specimens recently collected in Cuba and Jamaica. Collections are at hand from Bolivia, *Williams;* Colombia, *Baker;* Nicaragua, *Smith;* San Domingo, *Massee;* Jamaica, *Underwood 2833;* Cuba, *Underwood & Earle 1131.*

Pogonomyces gen. nov.

Hymenophore annual, epixylous, dimidiate-sessile to flabelliform, thickly covered with rigid hairs; context dark-brown, punky, tubes short, thick-walled, mouths small, circular; spores smooth, hyaline.

This genus is founded upon *Boletus hydnoides* Sw. (Prodr. 149. 1788), described from Jamaica. It may at once be distinguished from *Trichaptum* by its small, cylindrical, very thick-walled tubes. The name selected refers to its thick covering of bristly hairs.

Pogonomyces hydnoides (Sw.)

Boletus hydnoides Sw. Prodr. 149. 1788. — Fl. Ind. Occid. **3**: 1924. 1806.

Boletus hydnatinus Bosc, Gesell. Natur. Freunde Mag. **5**: 84. *pl. 4. f. 3.* 1811.

Polyporus pellitus Mey. Fl. Esseq. 304. 1818.

Boletus crinitus Spreng. Vet. Acad. Handl. 51. 1820.

Boletus fibrosus Hook. in Kunth, Syn. Pl. **1**: 10. 1822.

Polyporus Feathermanni Rav. Grevillea, **6**: 130. 1877.

This very abundant tropical species was first described in 1788 from Jamaica. In enlarging his original brief description for the Flora of the West Indies, Swartz also enlarged his description of the type locality to read: "On trees in the mountains of Jamaica." In 1811, Bosc describes and roughly figures the same plant, remarking that "one might use it as the type of a new genus." Meyer later described it from South America under the name of *Polyporus pellitus,* and Sprengel from Porto Rico, as *Boletus crinitus.* Its most recent name was assigned by Ravenel to specimens collected by Featherman at Gainesville, Florida.

The great abundance and striking appearance of this species account for the attention which it has received, but should tend rather to lessen than to increase the list of synonyms. Every expedition to the southern states or the West Indies discovers quantities of it. The following list of specimens will indicate its range: Florida, *Martin*, *Calkins*, *Small & Carter 1319*, *1331*, *1332*, *1351*; *Britton 127*, *128*, *343*, *366*, *448*, *477*; Louisiana, *Langlois 1280*; Cuba, *Underwood & Earle 374*, *1524*, *1532*, *1538*; Porto Rico, *Earle 30*, *52*, *Underwood*, *Wilson 114*; Haiti, *Nash 24*; Jamaica, *Earle 200*, *425b*, *189*, *619*; Yucatan, *Millspaugh*; Colombia, *Baker*; Nicaragua, *Smith*, *Shimek*; Mexico, *Smith*.

SPECIES INQUIRENDAE

Trametes ocellata B. &. C. Jour. Linn. Soc. Bot. **10**: 319. 1868. Investigation had indicated that this species also was synonymous with *P. hydnoides*, but the recent discovery of a large-pored specimen by Small and Nash on Totten's Key, Florida, reopens the question and further comparison and probably more material will be necessary in order to settle it satisfactorily. The evanescent membrane mentioned by the authors in connection with this species appears to be present also in *P. hydnoides* and cannot serve as a distinguishing character.

NEW YORK BOTANICAL GARDEN.

On Pisonia obtusata and its allies

N. L. BRITTON

Pisonia obtusata was described by Jacquin in Hort. Schoenbr. **3**: 36 (1798), and figured at *pl. 314* of that work; a detailed description is given of the plant which came from the island of New Providence, Bahamas, "in insula providentiae." Eight years later, in 1806, Swartz in Fl. Ind. Occ. **3**: 1960, described another *Pisonia obtusata*, which came from the island of Saint Bartholomew, one of the Windward Islands, south of St. Thomas. Grisebach in Fl. Br. W. I., 71, credits the species to Swartz and not to Jacquin, making no mention of the type locality in the Bahamas, and this blunder is continued by Heimerl in Engler's Bot. Jahrb. **21**: 625, in his monograph of West Indian *Nyctaginaceae*, although he cites Jacquin's original description and figure, placing it, however, after his citation of Swartz. This all goes to show that attention to type localities is desirable.

In looking over the collections of Bahamian plants made by Professor Coker, during the exploration conducted by the Geographical Society of Baltimore in the summer of 1903, and those made by me in the summer of 1904, I have had occasion to identify the *Pisonia obtusata* of Jacquin, which is well illustrated by several specimens.

Contingent upon his error in the proper identification of the species, Heimerl has described (*loc. cit.*) the Bahama plant as *Pisonia calophylla*, which thus becomes a synonym of *P. obtusata* Jacq.

A further part of the history of the misidentification of this species is to be found in the reference of the plant of southern Florida to *Pisonia obtusata* Sw., by Chapman, South. Fl. 374; by Sargent, Silva, **6**: 111. *pl. 297*, and by Small, Fl. SE. U. S. 411; this has nothing to do with either the *Pisonia obtusata* of Jacquin or with that of Swartz; Heimerl has included it in his *Pisonia discolor longifolia* (*loc. cit.* 627), making, I believe, a further error in supposing it to be only a form of *P. discolor* Spreng., the type locality of which is Jamaica.

The *Pisonia obtusata* of Swartz has been referred, together with *P. coccinea* Sw., which came from Haiti, to *P. inermis* Jacq., originally from Cartagena on the mainland of South America, but without the present opportunity to examine type-specimens I am unable to verify this reference; Heimerl places *P. coccinea* Sw., in the related genus *Neea*. *Pisonia Pacurero* H.B.K. is referred by Grisebach and by the Index Kewensis to *P. inermis*, and plants from the Windward Islands, Porto Rico and Jamaica, as well as numerous South American specimens, certainly appear to be conspecific with the one figured on *plate 24* of the Botany of the Herald; if Herr Heimerl had stopped to compare the plate of Jacquin illustrating *P. obtusata* with this illustration, I think he could not have failed to have noticed that they represent two entirely different species, although he cites them both under *P. obtusata* Sw.

I have a further criticism to make of current generic references of these trees to the genus *Pisonia* L., the type species of which is *P. aculeata* L., a woody vine with recurved prickles and clavate gland-bearing fruit; the trees under consideration being wholly unarmed and with red drupe-like fruits, the smooth fleshy or juicy exocarp completely enclosing the hard ribbed anthocarp; that they can be congeneric with *P. aculeata* it is quite impossible to believe after seeing them growing in proximity with it in the Bahamian coastal thickets, and from an examination of the literature bearing on *Pisonia* I conclude that the generic name *Torrubia* Vell. Fl. Flum. 139 (1825), is the first one available for them, having as its type *T. opposita* Vell. *loc. cit.*, from maritime woods at Santa Cruz, Brazil. The Floridian and West Indian species known to me are as follows:

1. **Torrubia obtusata** (Jacq.)

Pisonia obtusata Jacq. Hort. Schoenbr. **3**: 36. *pl. 314*. 1825.
Pisonia calophylla Heimerl, Bot. Jahrb. **21**: 625. 1896.

Leaves oval or elliptic, thick, rounded at the apex, 6–9 cm. long, about twice as long as wide, often revolute-margined, the upper ones subcordate, the lower sometimes rounded or a little narrowed at the base; petioles stout, 3–5 mm. long; fruit bright red, shining, juicy, the anthocarp 5–8 mm. long.

Low coppices and scrub lands, mostly near the sea, island of

New Providence, Bahamas, *Cooper 18* and *23 ; Curtiss 126 ; Coker 5* and *252 ; Brace 163, 183* and *189 ; Britton & Brace 176* and *484*.

2. **Torrubia rufescens** (Griseb.).

Pisonia calophylla rufescens Heimerl, Bot. Jahrb. **21**: 626. 1896.

Pisonia rufescens Griseb.; Heimerl, *loc. cit.*, as synonym.

Leaves thick, flat, obovate, finely and densely tomentulose beneath, rounded or truncate at the apex, cuneately narrowed at the base, the stout petioles 1–1.5 cm. long.

Cuba, *Wright 464*.

3. **Torrubia Cokeri** Britton, sp. nov.

Glabrous, the twigs gray. Leaves firm, obovate, 8 cm. long or less, 3–4 cm. wide, rounded at the apex, narrowed or somewhat cuneate at the base; petioles stout, about 1 cm. long; flowers sessile, the perianth and corymb-branches minutely tomentulose; staminate perianth about 3 mm. long, bluntly 5-toothed, about one-half as long as the stamens.

Tarpum Bay, Eleuthera, Bahamas, *Coker 401* (type); Cuba, *Linden 1988*.

This is included by Heimerl in his *P. calophylla*, in so far as Linden's specimens are concerned, but it is certainly distinct; Wright's Cuban numbers *2041* and *2042*, cited by Heimerl under *P. calophylla*, I have not seen.

4. **Torrubia suborbiculata** (Hemsl.)

Pisonia suborbiculata Hemsl.; Duss, Ann. Inst. Colon. Marseilles, **3**: 62. 1897.

A low glabrous shrub, 2.5 m. high or less, with round or broadly obovate glaucous leaves less than 4 cm. long, their petioles extremely short; fruit pulpy, cylindric, red and glaucous when ripe.

Known only from Martinique; *Duss 1467* and *4391*.

5. **Torrubia discolor** (Spreng.)

Pisonia discolor Spreng. Syst. **2**: 168. 1825.

Leaves oblong-elliptic, thin, 8 cm. long or less, 2–4 cm. wide, obtuse at the apex, narrowed at the base, slender-petioled; anthocarp about 6 mm. long, about one-half as thick as long; fruit oblong, red, the pulp rather thin.

The type is from Jamaica; the species is also known from Haiti (according to Heimerl), and from Cuba, *Wright 2040 ; Combs 446 ; Britton & Wilson 72*.

6. **Torrubia longifolia** (Heimerl).

Pisonia discolor longifolia Heimerl., Bot. Jahrb. **21**: 627. 1896.

Pisonia obtusata Chapm. South. Fl. 374. 1860. Not Jacq.

Leaves thin, the blades obovate to spatulate, 5 cm. long or less, or on young shoots longer, 2 to 4 times as long as wide, rounded or often emarginate at the apex, the very slender petioles 8–13 mm. long; fruiting corymbs dense or loose; fruit very juicy, shining, bright red to magenta red, obovoid-cylindric to globose-obovoid, often depressed at the top, the anthocarp 5–6 mm. long.

Type from the Bahamas, where it is very abundant in coastal coppices.

BAHAMAS: New Providence, *Brace 129* and *387*; *Coker 15* and *41*; *Britton & Brace 164, 166, 178* and *292*; Andros, *Northrop 517*; St. George's Cay, *Coker 316*; Watling Island, *Coker 472*.

FLORIDA: Key West, *Blodgett*, "large tree flowering in the summer;" same island, *Blodgett*, "shrub 10–15 feet;" Indian River, *Curtiss 2338*; Palm Beach, *Curtiss 5379*; Miami, *Garber*, *Britton 404*; Annette Key, *Simpson 342*, shoots showing the obovate nearly veinless leaves; Bull Key, *Small & Carter 657* and *660*.

CUBA: seashore near Matanzas, *Rugel 411*.

7. **Torrubia Bracei** Britton, sp. nov.

A slender tree, 5 m. high or less, the bark gray. Leaves thin, green on both sides; petioles very slender, 6–8 mm. long; blades narrowly obovate, 5 cm. long or less, rounded at the apex, cuneate-narrowed at the base; fruiting pedicels about 0.5 mm. long; fruit very juicy, oblong-obovoid, twice as long as thick, claret-red, truncate at the top; anthocarp 7–8 mm. long, 2 mm. thick.

Coastal coppice, Ft. Montague, New Providence, Bahamas, *Britton & Brace 168*, August 23, 1904.

This grows in company with the next preceding species and with *P. obtusata*, and is certainly different from either of them.

8. **Torrubia inermis** (Jacq.).

Pisonia inermis Jacq. Select. Am. 275. 1763.

Pisonia obtusata Sw. Fl. Ind. Occ. **3**: 1960. 1806. Not Jacq.

This type is from Cartagena, South America. The species, as I understand it, is widely distributed in northern South America and in the West Indies south of the Bahamas. It is said by Heimerl to grow in Florida, but our collections from that State do not contain it.

9. **Torrubia floridana** (Britton).

Pisonia floridana Britton ; Small, Fl. SE. U. S. 411. 1903.

Known only from Rock Key, Florida, and readily distinguished from the other species by its dense pubescence.

Key to the above-mentioned species

- Petioles stout.
  - Petioles 3–15 mm. long ; blades 6–9 cm. long.
    - Petioles 3–5 mm. long ; leaves subcordate. 1. *T. obtusata.*
    - Petioles 1–1.5 cm. long ; leaves cuneate or narrowed at the base.
      - Leaves densely brown-tomentulose beneath. 2. *T. rufescens.*
      - Leaves glabrous on both sides. 3. *T. Cokeri.*
  - Petioles only 1 or 2 mm. long ; blades 4 cm. long or less. 4. *T. suborbiculata.*
- Petioles slender.
  - Leaves glabrous.
    - Leaves rounded at the apex or emarginate.
      - Leaves oval or oblong. 5. *T. discolor.*
      - Leaves obovate or oblanceolate.
        - Fruit globose-obovoid, little longer than thick ; anthocarp 5–6 mm. long. 6. *T. longifolia.*
        - Fruit oblong-obovoid, twice as long as thick ; anthocarp 7–8 mm. long. 7. *T. Bracei.*
    - Leaves pointed, sometimes only bluntly acute. 8. *T. inermis.*
  - Leaves densely pubescent, small. 9. *T. floridana.*

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(1904)

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Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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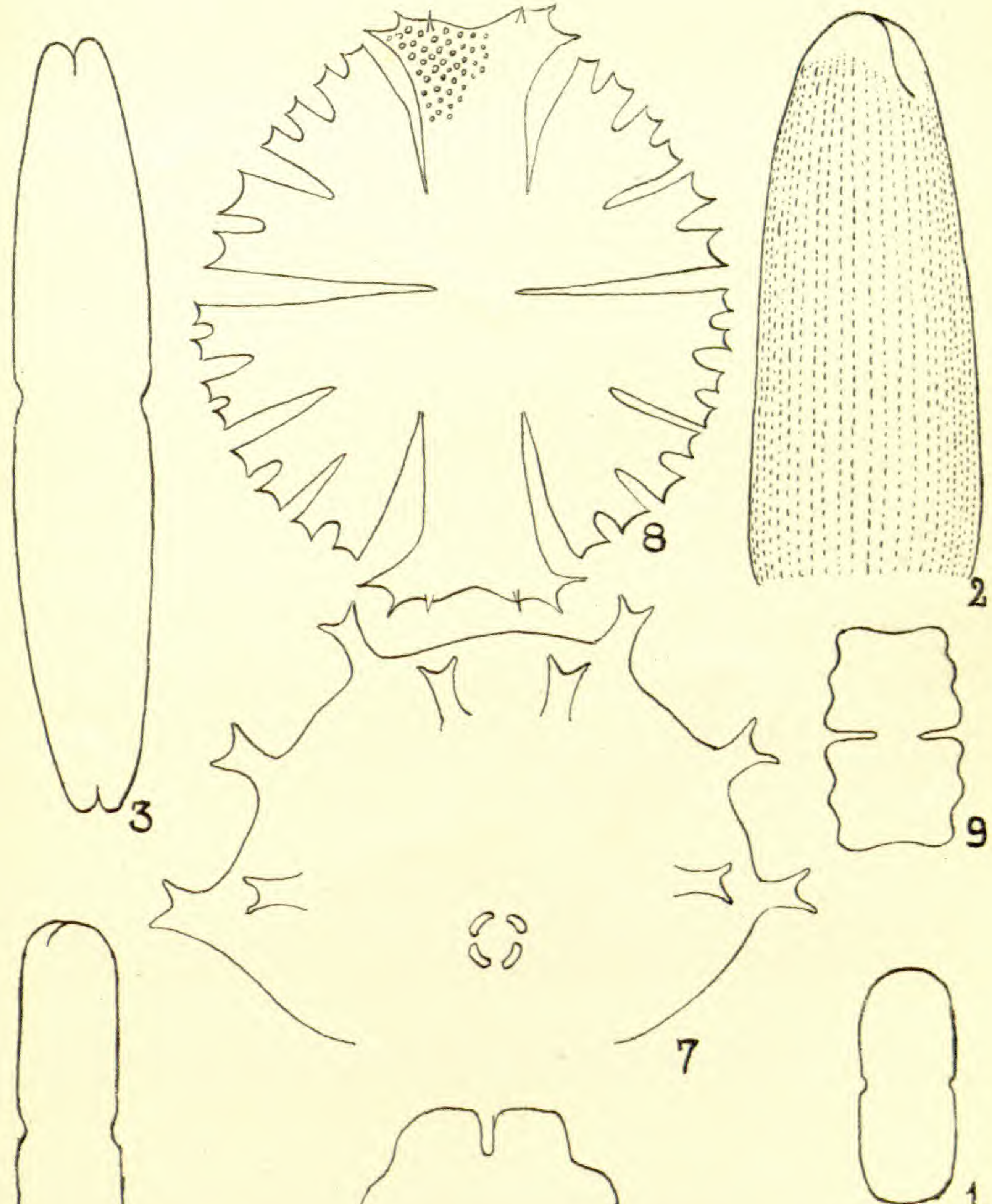

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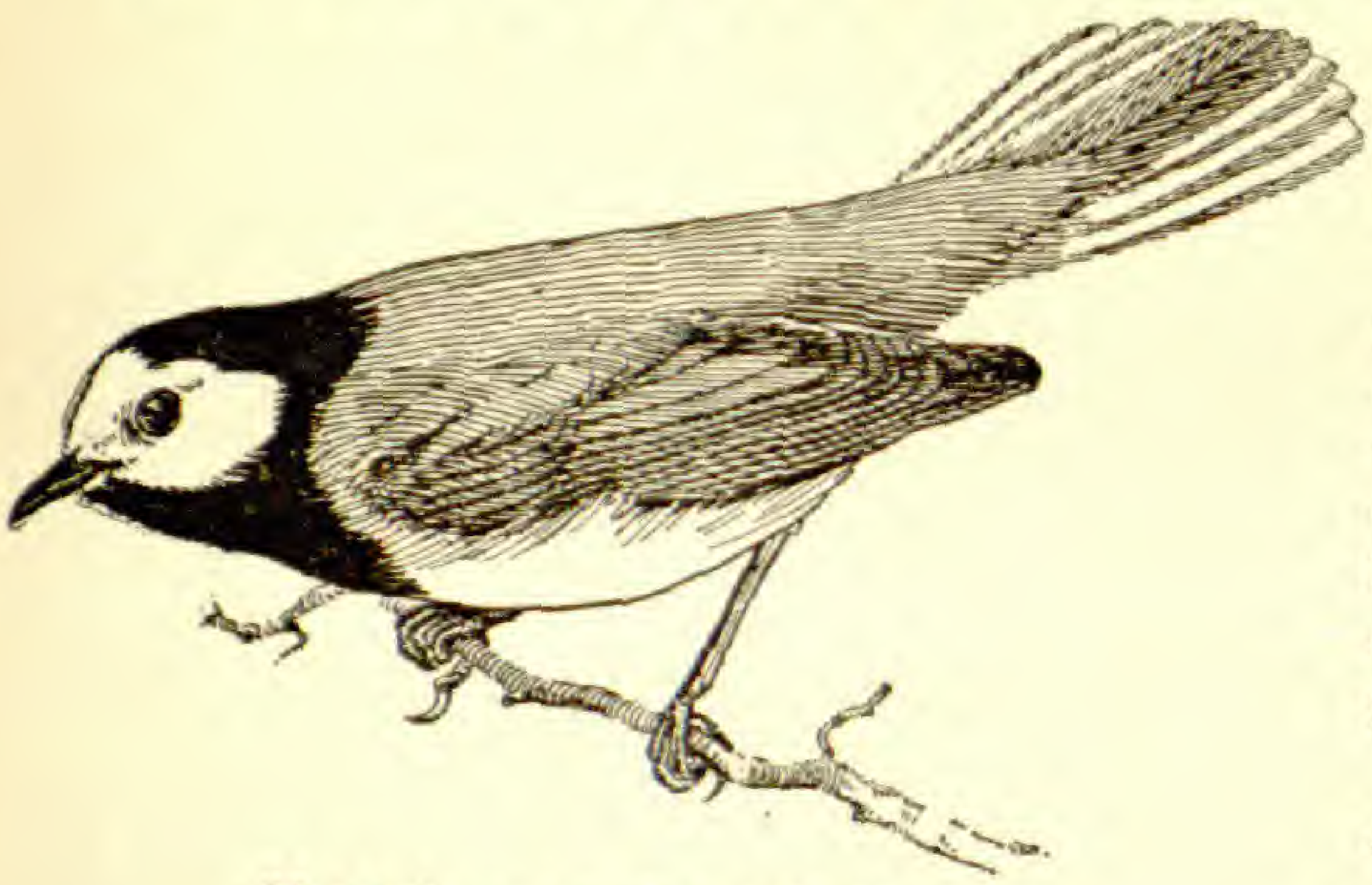

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BULLETIN

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Notes on the blackening of Baptisia tinctoria

Julia T. Emerson

Any one who is accustomed to the aspect of our dry open fields or sandy hills in the summer can not have failed to notice the Wild Indigo (Yellow Indigo Broom, *Baptisia tinctoria* (L.) R. Br.). The bright yellow flowers and small three-parted leaves make a very conspicuous plant. In early July, on Cape Cod, before the flowers are open the plants are green, but a few weeks later a black twig or branch will be noticed, and by August often whole plants will be black, even the flowers. If a green leaf is pinched or injured so that the epidermis is broken, there will presently be a black spot at the injury, and it is generally the branches which have been stepped on or have suffered from an insect burrowing into the stem near the ground, which are the first to show this very characteristic blackening. It is not always due to an injury; an apparently healthy plant will be so black that one can easily believe that a good substitute for indigo could be found in it, and indeed during the Civil War this was tried; while in drying it is well known how dark a specimen it makes.

The following facts were noted at the Marine Biological Laboratory at Woods Hole, Massachusetts, during some studies made at Dr. True's suggestion and with his kind assistance, upon the cause of the blackening of the leaves of *Baptisia tinctoria*. It was thought probably to be due to an oxidizing enzyme, and various experiments were tried to prove whether or not this was the case.

It may be well to say a word about the enzymes. Effront *

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* Effront, J. Les enzymes et leurs applications, 63, 64. 1899.

[The preceding number of the Bulletin, Vol. 31, No. 11, for November, 1904 (31: 581–620, *pl. 26*), was issued 26 N 1904.]

has classified them into three large groups according to the effects which they produce:

A. Soluble hydrating ferments or enzymes.

B. Soluble oxidizing enzymes.

C. Enzymes causing molecular decomposition.

It is with the middle group that this paper is concerned. The oxidizing enzymes are found in both animals and plants, are widely distributed in all the parts of plants and in every kind of plant from bacteria to the phanerogams. Laccase, the first of the oxidases to be discovered (in 1883 by Yoshida, a Japanese chemist), makes lacquer; malase acts on fruits and causes apples and pears to turn brown when exposed to air; and others are connected with the ripening of olives or are found in wine. Without giving them actual names, like the foregoing, there are two kinds of oxidases generally recognized by the differences of their reactions, one "oxidase," which oxidizes guaiaconic acid (the characteristic reactive in the guaiac resin) to guaiac blue without the aid of peroxide of hydrogen, and the other "peroxidase," which oxidizes it only when this substance is present.*

There is a third, catalase, which according to Loew † is of general occurrence in the vegetable kingdom.

In this paper only very general experiments are described, but the methods of preparation of the material and ways of applying the tests are the ones usually adopted for this kind of work.

Preparation of material. — Fresh stems were gathered and the leaves stripped off; flowers also were used when present, but not the pod or thicker stems, as these could not easily be sufficiently broken up. The leaves were ground up in a mortar with quite fine sand, which had been previously treated with dilute hydrochloric acid and washed until no acid reaction could be detected with litmus paper, then dried in the sun. When ground, the leaves were covered with distilled water and left to macerate for a period of a half to one hour; the extract was next filtered, the leaves being squeezed in a cloth as dry as possible and thrown away. The filtrate was treated with three times its bulk of strong

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* Loew, O. Curing and fermentation of cigar leaf tobacco, 27. (U. S. Dept. Agriculture Rep. No. 59.) 1899.

† Loew, O. Catalase, 30. (U. S. Dept. Agriculture Rep. No. 68.) 1901.

alcohol and left for an hour or two, to precipitate chlorophyl, proteins and other matters; this precipitate, dissolved in distilled water, was filtered again, and this solution used for the experiments.

Kinds of extracts made. — It was found that as soon as the pounded leaves were exposed to the air they turned from green to black in less than half an hour, whereas those not so much exposed kept green. So two kinds of extracts were made, one in which the pounded leaves were at once covered with water, when only those near the top became black, another in which the pounded leaves were left for twenty-four hours to get as black as possible in the air, and then extracted as usual. The first method gave a dark brown solution which kept growing darker so that it was difficult to see the color-reactions; the second gave a clear amber-colored extract, free from the products of oxidation, easily showing the slightest reaction to color tests, but otherwise acting like the first. In order to get purer enzyme solutions, a portion of the original solution was treated with three times its bulk of alcohol and filtered, dissolving the precipitate in water, and this process was repeated, thus securing second and third extractions much lighter and clearer and rather more sensitive than the first.

In general 95 per cent. alcohol was used for the first treatment, and 80 per cent. for the second and third. Although some absolute alcohol was also used for the first extraction and gave much heavier precipitates, it was too expensive to use in the necessary quantities. There was little difference in the amount of precipitate between 95 per cent. and 80 per cent. alcohol.

Tests for enzymes. — When the extracts were ready they were tested by taking about ten cubic centimeters in a tube and adding a few drops of solution of gum guaiac (2 grams of guaiac in 100 cubic centimeters of absolute alcohol); then the solution turned an opalescent blue, becoming slightly darker when shaken, and a clear blue on adding 95 per cent. alcohol, which dissolves the excess of guaiac. This showed that an oxidase was undoubtedly present. Upon the addition of one drop of hydrogen peroxide, the solution turned a very deep blue, and this color would last several hours without fading. This second reaction suggested the presence of a peroxidase. These two tests were used in all the experiments, the colors given above being considered the normal reaction and any variations, as the rapidity in the change, or shades of blue, were taken to mark disturbance in the action of the enzyme. It was found that the guaiac solution did not keep its power more than three or four days. The best reactions were produced the day it was made up. Green * considers that it is not safe to rely upon the guaiac test as a method of recognition for an oxidase, as several ordinary chemicals and mineral compounds also yield a blue color with it, and says the surer way is to isolate the enzyme and prove its presence by its action. On the other hand Loew † considers that "such objections are groundless when fresh organized tissues are under investigation. Other oxidizing influences are easily recognized by control tests, which the careful worker will not omit to make. . . . Such blue reactions are not restricted to certain limits of temperature as the reactions of oxidizing enzymes are."

Temperature experiments. — These were made by putting five or ten cubic centimeters of the enzyme solution into tubes and exposing them for five, ten, fifteen and thirty minutes as nearly as possible to the same temperature, by means of water baths. Exposures begun at 55° C. and up to 75° C. showed no difference from the normal. At 75° C. for shorter exposures the guaiac or oxidase reaction was slower in appearing and not such a good blue, and the hydrogen peroxide or peroxidase coloring became greener and clear, instead of deep blue. For longer exposures the reactions were still slower.

At 79° C. to 81° C. for thirty minutes the guaiac reaction was very slight; the peroxide light blue, and the color faded.

At 85° C. for five or ten minutes there was almost no reaction to gum guaiac, and the peroxide reaction was green and clear and slow; while at 86° to 87° C. for twenty and thirty minutes there was no reaction to either. Therefore the thermal destruction point is 86° C. for long exposures and 87° C. for shorter times, that of the oxidase being probably a few degrees lower than that for the peroxidase; the third extractions were a trifle more sensitive than the original one.

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* Green, J. R. The soluble ferments and fermentation. 1899.

† Loew, O. Physiological studies of Connecticut leaf tobacco, 31. (U. S. Dept. Agriculture Rep. No. 65.) 1900.

These conclusions are drawn from over fifty experiments made under the same conditions with the various solutions, each solution being tried at least twice, generally more often, at each degree of temperature between the extremes indicated.

A little different temperature test was made by holding branches with the leaves on in water at 70°, 80°, 90° and 100° C. for five, ten and fifteen minutes, then mashing the leaves and precipitating with alcohol and testing as usual. In this way the enzyme was not destroyed until the branch had been at 90° C. for fifteen minutes, and even then there was a little reaction with hydrogen peroxide. At the boiling point of water the oxidase was destroyed by a five-minute exposure, the peroxidase by a ten-minute exposure. Even this high temperature for less than five minutes does not quite destroy the enzyme, and this fact was noticed with a solution which gave reactions when brought once to the boiling point, and ceased only when boiled several minutes. The leaves on the branches when exposed to the lower degrees for short periods turned dark or black on drying, while the boiled ones remained green.

These temperature results correspond fairly well with those given for the maple leaf by Woods.* He found that in the plant tissues both the oxidase and the peroxidase will stand somewhat higher temperature than in aqueous or alcoholic solutions. The oxidase of a hard maple leaf is usually destroyed by heating five minutes at 70° C. in an aqueous solution; the peroxidase requires five minutes at 80° C. In the leaf, however, it took fifteen minutes at 85° C. to destroy them, while both were destroyed in a 50 per cent. alcoholic solution in three minutes at 70°–72° C. The enzymes of other leaves behaved in a similar manner. The tobacco oxidase is destroyed between 65° and 66° C. and the peroxidase between 87° and 88° C. On this subject Loew † says: "The temperatures thus far observed which render enzymes inactive are not constant under all conditions; the acidity of the plant juice, the degree of dilution, the duration of the heating, and the presence of certain salts have a modifying influence on the height of

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* Woods, A. F. The destruction of chlorophyll by oxidizing enzymes. Centralbl. Bakteriol. Parasit. Abt. 2. 5: 745–754. 1899.

† Loew, O. Physiological studies of Connecticut leaf tobacco, 21. 1900.

the temperature at which the change to the inactive modification takes place." He then gives destruction temperatures for several oxidases in various plants, which vary from 60° to 95° C.

Citric acid tests.— Ten cubic centimeters of the enzyme solution were put in tubes, then by means of a burette 1 cc., .5 cc., and .2 cc. of citric acid of different strengths were added, the tubes set aside for an hour and then tested with the solution of gum guaiac and hydrogen peroxide. Citric acid (normal) was used to begin with, then one fourth normal, one eighth normal and one sixteenth normal, each one tried in three tubes with the three different amounts of acid. The normal solution gave no result at all, except a heavy brown precipitate.

The quarter normal, when only two tenths cubic centimeters were added, gave a weak guaiac reaction and a gray-blue peroxide coloration.

With one half a cubic centimeter of the one eighth normal solution there was a fair reaction with both, but not normal in color, the good colors being reached only with .2 cc. of the one sixteenth normal solution. In all but the last there was a precipitate ; in the stronger solutions this was brown, in the weaker blue, and in most the color faded. No definite conclusions could be drawn from these results.

Sodium hydroxide tests. — These were made in the same way as those with citric acid : a one quarter normal solution was the strongest used (ten grams in one litre of water), the weaker ones being one quarter, one eight and one sixteenth of that. Results follow :

One quarter normal — no reaction with either guaiac or hydrogen peroxide, a clear yellow liquid.

$\frac{1}{16}$ normal.	$\frac{1}{32}$ normal.	$\frac{1}{64}$ normal.
(10 cc. $\frac{1}{4}$ normal and 30 cc. H_2O.)	(5 cc. $\frac{1}{4}$ normal and 35 cc. H_2O.)	($2\frac{1}{2}$ cc. $\frac{1}{4}$ normal and $37\frac{1}{2}$ cc. H_2O.)
.5 cc. in a few cases gave a slight reaction to guaiac, none to H_2O_2. .2 cc. and less gave generally a guaiac reaction, occasionally one with H_2O_2.	Most of these experiments gave a guaiac reaction, but none with H_2O_2 until only .2 cc. was used.	All gave guaiac reaction, though greenish instead of blue, and with .5 and .2 cc. there was a reaction to H_2O_2, though green instead of blue.

The sodium hydroxide solution gave a yellow color to the enzyme solutions which was noticeable even in the weaker ones, making the color reactions greenish instead of blue. There was no precipitate in any and the color faded in most of them. In these results it is seen that it is the oxidase which is more resistant, while in the thermal tests it was the peroxidase. Loew * states that in the majority of cases the oxidase will prove the more energetic of the two but it succumbs much more quickly to noxious influences, as alcohol or heat.

A few experiments were tried with both citric acid and sodium hydroxide, using for each .5 cc. of $\frac{1}{8}$ normal solution (where a slight though decided reaction to both guaiac and hydrogen peroxide was observed), and then heating the tubes. It was found that the thermal destruction point was thus reduced from 86° to 79° C.

MISCELLANEOUS EXPERIMENTS

1. The experiments given above seemed to prove that there were two oxidases and it was thought probable that catalase was also present, but although two attempts were made to prove this neither was successful. Hydrogen peroxide was poured on freshly chopped leaves and though bubbles came off, when collected they proved to be only air, not oxygen. However, when hydrogen peroxide was dropped on freshly made hand-sections of the stem many air-bubbles came off, especially from the wood and xylem, which action may have been due in part to catalase, as this property of developing oxygen by decomposition of hydrogen peroxide is one which Loew † proved to belong to catalase.

2. Tubes with enzyme solution were exposed to sunlight and strong light for several hours, together with controls wrapped in black paper, so that all were at the same temperature, but all gave perfectly normal reactions.

3. A solution of hydroquinone was made up (one gram in 100 cubic centimeters of distilled water), and equal amounts of this and the enzyme solutions, and one tube of distilled water and hydroquinone were put aside in the dark, for twenty four hours. As no result was apparent for this period they were left for a

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* Loew, O. Curing and fermentation of cigar leaf tobacco, 30. 1899.

† Loew, O. Physiological studies of Connecticut leaf tobacco, 23. 1900 — Loew, O. Catalase. 1901.

week; then the solutions had all become a rich, red, clear sherry color, that with distilled water also having a reddish tinge.

4. One drop of twenty per cent. ferric chloride turned a solution of freshly chopped leaves in water a deep black, showing the presence of tannin, but none could be detected in the alcoholic extracts.

5. The various extracts seemed to be quite neutral, that is, they produced no change in either blue or pink litmus paper, even when kept some days so that there was a decided musty or cider smell. A few drops of chloroform do not affect the action of the enzymes and keep the solutions from growing musty.

In the field those branches which had turned black were in general injured in some way, by being stepped on, blown over or sometimes some insect eggs were found in the hollow stems of older branches. These are some suggestions as to the possible cause for the starting of the action of the enzymes.

In the plants which are described in Woods' interesting paper he enzymes show much greater activity in or near the cells which are injured in a leaf than in the normal green cells. He suggests that the insects which cause punctures may "inject substances possibly related to saliva into the wounds which they produce, and it may be the irration caused by these substances which is responsible for the increase of oxidase and peroxidase." He also states that these enzymes rapidly destroy chlorophyl and that "under certain conditions not yet well understood" they "either become active or else are produced in abnormally large quantities, causing variegations and various diseases." *

"The oxidizing enzymes are evidently contained in the plasmatic living part of the cell, and not in the cell sap which fills the vacuoles. On the other hand, the matters easily oxidized by them and representing products of metabolism or by-products of certain synthetical operations are mostly contained in the cell sap. These matters, often of a chromogenic character, are, of course, produced in the plasmatic parts, but secreted rapidly into the cell sap. When the cells die the soluble substances locally separated in the cytoplasm and the cell sap intimately mix, since the coagulating protoplasm, becoming easily permeable, can no

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* Woods, *l. c.* 754.

longer retain any soluble matters—as, for example, oxidase. Thus after death the direct action of the oxidase on the oxidizable matter of the cell sap sets in with a production of colored bodies, as is the case in the tobacco leaves. This action can also be noticed very well in the juice pressed out from the fresh leaves, since this juice, containing cell sap as well as soluble matters previously contained in the protoplasm, turns brown rapidly on coming into contact with air. The darkening of the juices of potatoes, beets, and other plants depends upon the same principle." *

It might be concluded from these two extracts that though present in the whole plant of *Baptisia tinctoria*, the enzymes have become particularly active in the blackened parts, and that these black parts have become susceptible to the enzyme from having lost their vitality from some cause. The black leaves do not seem dead, and always contain plenty of chlorophyl. Of course the blackness is the product of oxidation, but my observations would suggest a possibility that there is a pigment as well, which gives the extreme dark color, so much darker than the same product in potatoes and beets and tobacco, and so different from the white and green of variegated leaves.

SUMMARY

The blackening of the leaves of *Baptisia tinctoria* is due to oxidizing enzymes.

There are at least two enzymes, an oxidase which gives an opalescent blue with gum guaiac solution and is destroyed by heat at about 83°–84° C., and a peroxidase which gives a deep blue with hydrogen peroxide and which has a thermal destruction point of 86°–87° C.

Both enzymes can be destroyed with dilute solutions of citric acid and sodium hydroxide.

I wish to express my gratitude to Dr. D. T. MacDougal and Dr. W. J. Gies of the New York Botanical Garden, for their kind assistance and advice in revising this paper.

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* Loew, O. Physiological studies of Connecticut leaf tobacco, 40, 41. 1900.

Studies on the Rocky Mountain flora—XIII

Per Axel Rydberg

Dodecatheon multiflorum sp. nov.

Plant glabrous, perennial with a very short caudex and cluster of fibrous roots; leaves about 2 dm. long, sinuate-denticulate, obtusish, narrowly oblanceolate, tapering below into a short petiole; scape stout 3–4 dm. high; bracts linear-lanceolate, 1–2 cm. long; flowers 10–20; the longer pedicels often over 1 dm. long; calyx-tube 5–6 mm. long, more or less turbinate at the base; lobes lanceolate, about 5 mm. long; corolla bluish violet, paler in the throat but without any markings; lobes oblong, obtuse; filament-tube obsolete; anthers narrowly linear-lanceolate, acute, 7–8 mm. long; connective narrow, lance-subulate, with a longitudinal groove, but not rugose; capsule about 12 mm. long, cylindric-ovoid, septicidal.

In habit this species resembles *D. radicatum* and *D. pauciflorum*, but differs in the stamens, which are almost without a filament-tube. In river valleys at an altitude of 2400–2700 m.

COLORADO: Sangre de Cristo Creek, 1900, *Rydberg & Vreeland 5781.*

WYOMING: Elk Mountains, 1899, *Little & Stanton.*

Dodecatheon radicatum sinuatum var. nov.

Leaves more elongated than in the type, oblong, rarely elliptic, sinuate, thin.

COLORADO: Foothills, Larimer County, 1890, *Crandall* (type); Buena Vista, 1892, *C. S. Sheldon;* Fort Collins, 1896, *Baker.*

Gentianella Clementis sp. nov.

Annual, usually more or less branched, 2–4 dm. high; stem sharply angled; internodes usually longer than the leaves; these 3–6 cm. long, the basal ones spatulate, the cauline ones lanceolate, acuminate, truncate or even subcordate at the base, sessile; peduncles 1–4 from the axils of the leaves, more or less elongated 1–6 cm. long; sepals linear, acute, usually very unequal in length, the longer often ⅔ as long as the blue or greenish-yellow corolla; corolla 15–18 mm. long; lobes ovate-lanceolate, acute.

This belongs to the *Amarella* group of *Gentiana* and is perhaps most nearly related to *G. plebeja*, which, however, has shorter ovate or ovate-lanceolate, acute or obtuse stem-leaves, lower stem and shorter and more nearly equal calyx-lobes. *G. Clementis* grows in the mountains from South Dakota and Montana to Colorado and Arizona. As the type I regard the following:

COLORADO: Minnehaha, 1901, *Clements 253*.

Frasera speciosa stenosepala var. nov.

Usually with very numerous flowers; sepals narrowly linear, some of them usually equaling or exceeding the petals; petals large, about 15 mm. long or more; floral leaves very long and narrow.

In the mountains and foothills of Colorado and Wyoming. As the type may be regarded:

COLORADO: Foothills, Larimer County, 1895, *Cowen*.

Frasera speciosa angustifolia var. nov.

Low, 3–4 dm. high; basal leaves very short; stem-leaves narrowly linear-lanceolate; floral leaves, except the lower, shorter than the branches of the inflorescence; petals rather small, about 12 mm. long.

On dry hillsides from Montana to Colorado. As the type may be regarded:

MONTANA: Lima, 1895, *Shear 3369*.

Gilia scariosa sp. nov.

Perennial with a tap-root; stems one to several, simple, strict, 3–6 dm. high, glandular-puberulent throughout; leaves numerous, alternate, pinnatifid with linear-filiform spinulose-tipped divisions, more or less white-villous when young, glandular-puberulent; inflorescence a narrow, strict, interrupted thyrsus; branches very short, few-flowered; calyx-tube about 6 mm. long, puberulent, scarious except the green angles; teeth short, broadly rounded-ovate, abruptly contracted into a subulate acumination; corolla pink, 3–4 cm. long; tube narrow, very gradually broadening upwards; lobes ovate-lanceolate, acute, about 8 mm. long; stamens very unequally inserted; capsule obovoid, about 1 cm. long.

This is closely related to *G. aggregata*, but differs in the scarious calyx with short, abruptly cuspidate-acuminate lobes. The lobes of the corolla are also acute rather than acuminate. The species is common in Colorado, in open valleys. It was first collected by James in Long's expedition; but James' specimen in the Torrey herbarium is a mere scrap. I have therefore selected as the type a better specimen, viz.:

COLORADO: Veta Pass, 1896, *C. L. Shear 3590*.

Gilia spergulifolia sp. nov.

Gilia congesta crebrifolia Wats, King's Exp. **5**: 268, in part. 1871. Not *G. crebrifolia* Nutt.

Low perennial, more or less woody at the base, more or less cespitose; flowering branches 5–10 cm. high, more or less pubescent with white, crisp hairs or puberulent; leaves linear-filiform, entire or the upper rarely with 1–2 similar lobes, tipped with a pungent point; flowers in capitate clusters, which are usually on naked peduncles; bracts similar to the leaves but smaller; calyx villous with short subulate pungent teeth; corolla 4–5 mm. long, white; lobes oblong, obtuse, a little over 1 mm. long.

This has been mistaken for *G. crebrifolia* Nutt., but that species has much shorter fleshy leaves and very short copiously leafy flowering stems. It is nearer related to *G. iberidifolia*, from which it differs in the entire leaves and solitary heads ending the branches.

WYOMING: Headwaters of Tongue River, 1898, *Tweedy 576* (type).

COLORADO: Arboles, 1899, *Baker 534*.

UTAH: Bear River Valley, 1869, *Watson 917*.

Gilia roseata sp. nov.

Perennial with a woody base, cespitose; flowering branches about 1 dm. high, purple-tinged, more or less villous or crisp-hairy; leaves pinnatifid with linear-filiform pungent-pointed lobes, about 2 cm. long; flowers capitate at the ends of the leafy branches; bracts similar, shorter, rose-tinged and more villous; calyx also very pubescent and rose-tinged; lobes subulate and spinulose-pointed; corolla about 8 mm. long; its lobes 4–5 mm. long, elliptic, obtuse.

This species is nearly related to *G. iberidifolia*, but differs in the larger flowers (in *G. iberidifolia* the corolla-lobes are rarely over 2 mm. long), the rose-colored bracts, purplish stem and more solitary heads.

COLORADO: Grand Junction, 1892, *Alice Eastwood*.

Gilia polyantha sp. nov.

Perennial with a short woody base; stems several, 3–4 dm. high, striate and simple up to the inflorescence, glandular-puberulent; leaves 3–4 cm. long, pinnatifid, glabrous or with a few white hairs; lobes linear-filiform, pungent-pointed; flowers numerous in a narrow thyrsus; calyx campanulate, about 5 mm. long, more or less scarious at the sinuses; lobes broadly ovate-triangular, abrubtly cuspidate-pungent; corolla white, about 1 cm. long, funnelform-salvershaped; lobes about 5 mm. long, lance-oblong, obtusish; filaments about equaling the corolla-lobes, somewhat incurved.

This has been mistaken for *G. multiflora* Nutt., but is more closely related to *G. Macombii* Torr., differing mainly in the shorter corolla and shorter pubescence.

COLORADO: Pagosa Springs, 1899, *Baker 538*.

Gilia Tweedyi sp. nov.

Annual, branched, 2–4 dm. high; stem and branches glandular-puberulent, especially the upper part; leaves 2–3 cm. long, pinnatifid, with lanceolate cuspidate lobes; flowers paniculate; pedicels 1–8 mm. long; calyx about 3 mm. long, scarious between the green ribs; lobes lanceolate; corolla funnelform, about 4 mm. long, bluish; capsule ovoid, about 4 mm. long.

This species is related to *G. inconspicua* and *G. minutiflora*. From the former it differs in the smaller corolla, of which not only the corolla-tube but also the throat is included in the calyx; from the latter it differs in the pinnatifid leaves. *G. Tweedyi* grows in river bottoms and on sandy soil, at an altitude of 1000–2200 m.

WYOMING: Encampment, Carbon County, 1901, *Tweedy 4422* (type); between Sheridan and Buffalo, 1900, *Tweedy 3481;* Fort Steele, 1901, *Tweedy 4421;* also, 1898, *Aven Nelson 4802*.

Gilia Crandallii sp. nov.

Perennial with a woody tap-root; stem 3–5 dm. high, sparingly puberulent, glandular above, rather stout, much branched; basal leaves 3–10 cm. long, spatulate or oblanceolate, serrate or pinnately lobed, with lanceolate teeth or lobes; lower stem-leaves often similar; the upper narrower and usually entire; calyx glandular, about 5 mm. long; teeth lanceolate, scarious-margined; corolla salvershaped, about 15 mm. long, rose color; tube about 1 mm.

wide below, about 2 mm. at the throat; lobes oblong-spatulate, acutish; capsule about 5 mm. long, acute.

This has been mistaken for *G. Haydeni*, but that species is a much more slender plant with shorter calyx, scarcely scarious-margined lobes, minute subulate stem-leaves and shorter (3.5 mm. long) obtuse capsule. It is more closely related to *G. subnuda*, but differs in the branched stems and the finer and sparser pubescence. It grows in dry soil, especially on "sage-plains," at an altitude of 1900–2100 m.

COLORADO: Durango, 1898, *Crandall 2053* (type) and *2040;* also 1896, *Tweedy 448;* Mancos, 1898, *Baker, Earle & Tracy 404;* also 1901, *Vreeland 885.*

Polemonium robustum sp. nov.

Perennial with a woody caudex; stem 4–10 dm. high, more or less short-villous and above glandular; leaves 6–10 cm. long, glandular-pubescent; leaflets 11–17, lanceolate or lance-oblong, acute, 1.5–2.5 cm. long; the upper confluent and decurrent on the rachis; inflorescence much branched and corymbiform, but the main axis usually overtopping the branches; calyx glandular-villous, 7–8 mm. long; lobes lanceolate; corolla rose or purplish, 12–15 mm. high; lobes rounded and obtuse.

This species is a close relative to *P. foliosissimum*, but differs in the large flowers and the more conical or obovoid inflorescence. It grows in the mountains of Colorado, especially along streams, at an altitude of 2400–3000 m.

COLORADO: Bob Creek, La Plata Mountains, 1898, *Baker, Earle & Tracy 274* (type); Keblar Pass, 1901, *Baker 796;* Clear Creek Cañon, 1885, *Patterson 104;* Sangre de Cristo Creek, 1900, *Rydberg & Vreeland 5718;* Veta Pass, 1900, *Rydberg & Vreeland 5717.*

Polemonium Grayanum sp. nov.

Perennial with a cespitose rootstock; stems about 1 dm. high, glandular-villous; leaves 3–5 cm. long, glandular-villous; leaflets at least of the basal leaves more or less verticillate, obovate or spatulate, 2–6 mm. long, obtuse; calyx about 18 mm. long, villous with white hairs; lobes linear-lanceolate; corolla about 2 cm. long, campanulate-funnelform with a wide tube; lobes rounded.

This species is nearest related to *P. viscosum* Nutt., but is characterized by the long white hairs on the calyx. It grows on the higher peaks of Colorado among rocks, at an altitude of 2700–4000 m.

COLORADO: Gray's Peak, 1895, *Rydberg* (type); also 1886, *Letterman 323*; Graymount, *Letterman 322*; Central City, 1869, *Leville.*

Phacelia sericea ciliosa var. nov.

Usually taller than the typical *P. sericea*, often 5 dm. high, not silvery, green; pubescence very sparse and short, except some long silky hairs on the pedicels and lower portion of the stem.

This variety has been mistaken for *P. Lyallii* and *P. idahoensis.* It has been confused with the first on account of the similar pubescence, but *P. Lyallii* is a much smaller plant and with less deeply dissected leaves. It resembles *P. idahoensis* very closely in general habit, but in that species the stamens are only slightly exserted and the corolla smaller. The variety has the same range as the species, but grows usually at a lower altitude. As the type may be taken:

COLORADO: North of Merker, 1902, *Osterhout 2619.*

Lappula Besseyi sp. nov.

Biennial; stem 5–10 dm. high, hirsute, branched above; lower leaves petioled, 6–15 cm. long; blades spatulate or oblanceolate, obtuse, hispidulous and hirsute on the veins; upper leaves sessile, lanceolate; inflorescence branched; bracts small; pedicels in fruit 4–5 mm. long, more or less reflexed; corolla dark blue, scarcely over 1.5 mm. wide; fruit about 3 mm. wide; marginal spines distinct and in one row; back flat, spineless, but minutely hispidulous.

In general habit this species resembles most *L. floribunda,* but is distinguished by the very small flowers and fruit. It grows in cañons at an altitude of about 2400 m.

COLORADO: Cheyenne Cañon, 1895, *E. A. Bessey* (type); also in 1896.

Lappula angustata sp. nov.

Biennial or short-lived perennial; stem strict, hirsute, 6–8 dm. high; lower leaves petioled, 9–15 cm. long, strigose or hirsute on the petioles; blades narrow, linear-oblanceolate, mostly acute; stem-leaves linear-lanceolate, sessile; inflorescence with strongly ascending branches; pedicels reflexed in fruit, about 5 mm. long; corolla blue, about 4 mm. wide; fruit 4–5 mm. wide; marginal prickles united ⅓–½ their length into a distinct wing, the alternate ones usually much smaller; back slightly keeled, without prickles, minutely hispidulous or glabrous.

In habit this species also resembles *L. floribunda*, but is distinguished by the narrow leaves and the united marginal prickles of the fruit. These characters would place it near *L. scaberrima*, which, however, has a different pubescence.

SOUTH DAKOTA: Oreville, 1902, *Rydberg 891* (type).

COLORADO: La Veta, 1896, *Shear 3640.*

Oreocarya argentea sp. nov.

Cespitose perennial; stems 3–4 dm. high, hispid; basal leaves spatulate or oblanceolate, obtuse, 5–6 cm. long, densely white- or yellowish-pubescent, partly with stiff bristle-like hairs, partly with fine hairs, but all strictly appressed; stem-leaves oblanceolate, with the bristles more spreading; inflorescence narrow and virgate; calyx in fruit 8–10 mm. long, hispid; its lobes linear-lanceolate; corolla white, less than 5 mm. long; its tube included and limb 5–6 mm. wide; nutlets about 3.5 mm. long, papillose and with more or less distinct cross-ridges.

This species is perhaps nearest related to *O. sericea*, which, however, is a much smaller plant and has mammillate-papillose nutlets without cross-ridges. It grows on dry hills in Colorado.

COLORADO: Rifle, Garfield County, 1900, *Osterhout 2122.*

✓ **Oreocarya eulophus** sp. nov.

More or less cespitose perennial; stem about 2 dm. high, hispid with yellowish hairs; basal leaves numerous, spatulate, 4–5 cm. long, finely cinereous and appressed hispid; stem-leaves oblanceolate, with the hispid hairs more spreading and often yellowish; inflorescence a narrow and almost spikelike thyrsus; calyx in fruit about 7 mm. long, yellowish hispid; its lobes lanceolate; corolla white, 10–12 mm. long; tube exserted from the calyx; limb about 5 mm. wide; nutlets 4–5 mm. long, with irregular honeycomb-like crests.

This species is a near relative of *O. fulvocanescens* and *O. cristata*, but easily distinguished in fruit by its nutlets. It grows on gravelly hills at an altitude of 1800–2300 m.

COLORADO: Dolores, 1892, *Crandall* (type); McCoy's, 1903, *Osterhout 2750.*

UTAH: Price, 1900, *Stokes.*

Mertensia picta sp. nov.

Perennial, perfectly glabrous, except the hispidulous-ciliate margins of the leaves and calyx-lobes; stem 3–5 dm. high, pale and somewhat bluish below, more or less angled; lower leaves petioled; blades oval or elliptic-ovate, 5–9 cm. long, obtuse or acutish, rounded or somewhat truncate at the base, finely pustulate but not hairy on the surfaces, thin; upper leaves lanceolate or ovate-lanceolate and subsessile; inflorescence leafy and with short branches; pedicels and calyx more or less pustulate; calyx-lobes linear-oblong, obtuse, in fruit nearly 2 mm. long, the back with a thickened pale spot; corolla blue; its tube 6–7 mm. long and 2–3 mm. wide; throat and limb together 5–6 mm. long, the latter about 5 mm. wide; filaments dilated, about 2 mm. long and wider than the anthers; nutlets ovate in outline, strongly and irregularly reticulate-crested on the back.

This is closely related to *M. ciliata* but distinguished by the pale-spotted and thickened calyx-lobes.

COLORADO: Estes Park, Larimer County, 1903, *Osterhout 2823* (type); Mount Baldy, 1901, *Clements 288*.

Mertensia polyphylla platensis var. nov.

Like the species, but the calyx-lobes linear, fully 3 mm. long; basal leaves large; blades about 1 dm. long, cordate at the base and cuspidate at the apex.

Along streams at an altitude of 3000 m.

COLORADO: Bob Creek, La Plata Mountains, 1898, *Baker, Earle & Tracy 180* (in part).

Mertensia alba sp. nov.

Perennial; stem pale, 6–8 dm. high, more or less branched; lower leaves petioled, upper sessile; blades lanceolate or elliptic-lanceolate, acute or acuminate at both ends, glabrous beneath, hispidulous-strigose above and on the margins; pedicels and calyx strigose; lobes linear-lanceolate, acute, about half as long as the tube of the white corolla; corolla-tube about 8 mm. long, and 4 mm. wide; throat and limb together of about the same length; the latter 8–10 mm. wide; nutlets irregularly crested-tuberculated, and finely pubescent.

This is a species of the *M. paniculata* group and nearest related to *M. pratensis*, but it lacks the dense white pubescence of the calyx characterizing that species and the corolla in all specimens seen is white.

COLORADO: La Plata River, 1898, *Baker, Earle & Tracy 825*.

Mertensia viridula sp. nov.

Perennial with a cespitose rootstock; stems slender, 2–3 dm. high, glabrous; leaves glabrous beneath, hispid-strigose above; the lower petioled, the upper sessile; blades of the basal ones spatulate, obtuse; those of the stem-leaves acute, elliptic, or the upper lanceolate; pedicels strigose; calyx glabrous, except the base and the margins of the lobes; these broadly lanceolate, about 2.5 mm. long; corolla blue; tube about 4 mm. long; throat and limb of about the same length; filaments broader than the anthers; nutlets muricate and somewhat irregularly ridged.

This species resembles *M. viridis* A. Nels. closely in habit, but the dilated conspicuous filaments associate it with *M. linearifolia* and *M. ovata*, from which it is distinguished by the broader calyx-lobes. It grows in the mountains at an altitude of 2700–3800 m.

COLORADO: North Cheyenne Cañon, 1894, *E. A. Bessey* (type); West Spanish Peak, 1900, *Rydberg & Vreeland 5683*.

Mertensia Parryi sp. nov.

Perennial with a cespitose rootstock; stems about 2 dm. high, glabrous; leaves glabrous beneath, hispidulous-strigose above, only the basal ones petioled and spatulate; stem-leaves sessile, lanceolate or oblanceolate, about 5 cm. long; inflorescence small and short; pedicels strigose; calyx glabrous except the very base and the ciliate margins of the lobes; these narrowly linear-lanceolate, about 3 mm. long; tube of the blue corolla about 5 mm. long and about equaling the length of the throat and limb together; limb about 8 mm. wide; filaments evident but short, broader than the anthers.

This species is nearest related to *M. ovata* Rydb., but differs in the narrower leaves and the comparatively longer corolla-limb. In *M. ovata* the tube is longer than the throat and limb together. *M. Parryi* grows in the higher mountains.

COLORADO: Alpine ridges lying east of Middle Park, *Parry 286* (type); Estes Park, 1903, *Osterhout 2848;* Cameron Pass, 1896, *Baker;* Alpine Tunnel, 1897, *Shear 3853*.

Mertensia perplexa sp. nov.

Perennial with branched rootstock; stem about 3 dm. high, glabrous; basal leaves spatulate, 4–10 cm. long, petioled; stem-leaves sessile; the lower oblanceolate; the upper ovate, glabrous beneath, minutely hispidulous-strigose above; pedicels minutely hispid-strigose; the hairs with pustulate bases; calyx glabrous except the ciliate margins of the lobes; these oblong-lanceolate, acute or obtuse; corolla blue, about 12 mm. long; tube equaling the throat and limb; the latter 7–8 mm. wide; tube densely villous at the base within; anthers subsessile, inserted a little below the throat.

This species is evidently nearest related to *M. alpina*, notwithstanding the much larger size and erect habit. The corolla is almost twice as long as in that species.

COLORADO: Mountains south of Ward, Boulder County, 1901, *Osterhout 2439*.

✓ **Mertensia canescens** sp. nov.

Low and cespitose perennial with woody caudex; stems about 1 dm. high, strigose; leaves linear or linear-oblanceolate, grayish strigose on both sides; pedicels and calyx strigose; calyx-lobes linear-lanceolate, acute, about 2 mm. long, on the margin ciliate with longer hairs; corolla blue, about 8 mm. long; tube 1.5 mm. wide and about as long as the throat and the limb, the latter about 3 mm. wide; anthers subsessile at the margin of the corolla-tube.

Closely related to *M. alpina*, it is easily distinguished by the canescent and narrow leaves. It grows on the mountains at an altitude of 3360–3600 m.

COLORADO: Berthaud Pass, 1903, *Tweedy 5664* (type); mountains northwest of Como, 1895, *Cowen 1808*.

✓ **Stachys teucriformis** sp. nov.

Perennial, 4–6 dm. high; stem round-angled, glandular-villous; lower leaves short-petioled, the upper sessile; blades oblong or oblong-ovate to ovate, cordate or truncate at the base, 5–10 cm. long, crenate, pubescent on both sides; calyx glandular, villous, its lobes linear-lanceolate, long-aristate, about equaling the tube; corolla 12–15 mm. long, light rose, with reddish-purple veins and blotches; upper lip narrow and nearly straight; lower lip large, 3-lobed; lateral lobes triangular; middle lobe rounded-reniform.

The species is closely related to *S. scopulorum*, but differs from it in the larger corolla, the longer calyx-lobes and the usually broader leaves. The type sheet contains two specimens: one of *S. teucriformis* and one of *Teucrium occidentale*, and the two are so alike in foliage that it is hard to distinguish them except by the flowers and bracts.

COLORADO: New Windsor, 1894, *Osterhout* (type); McCoy, 1898, *Shear & Bessey 5302*; Colorado Springs, 1896, *Shear 5189*.

Monardella dentata sp. nov.

Cespitose perennial, somewhat ligneous at the base; stems slender, light brown, about 3 dm. high; leaves short-petioled; blades ovate, 1.5–2 cm. long, serrate-dentate, finely pubescent and strongly punctate, obtuse, strongly veined beneath; heads terminal, solitary, about 1.5 cm. in diameter; bracts lanceolate, obtuse, nearly 1 cm. long, finely canescent, strongly veined, rather thick, of fully as firm structure as the upper leaves; calyx about 8 mm. long, grayish pubescent; lobes lanceolate; corolla about 12 mm. long; its lobes linear, 4 mm. long.

This has been mistaken for *M. odoratissima*, but is easily distinguished by the distinctly toothed leaves and the narrow firm bracts.

COLORADO: Gray's Peak, 1872, *Torrey*.

Solanum interius sp. nov.

Annual, more or less branched; stem 3–6 dm. high, usually with narrow denticulate margins or wings, finely pubescent with short white appressed crisp hairs; leaves with short winged petioles, sparingly pubescent above, usually densely grayish-strigose beneath; blades deltoid or rhombic, 3–7 cm. long, acuminate, usually sinuately lobed or dentate with acute or acuminate lobes or teeth; peduncles 2–4 cm. long, strigose; inflorescence corymbiform, rarely umbelliform; pedicels in fruit about 1 cm. long, recurved but scarcely reflexed; calyx-lobes ovate, 2 mm. long, abruptly acute, in fruit appressed or spreading; corolla yellowish-white; lobes ovate, acute, 3–4 mm. long; filaments very short, less than 0.5 mm. long, glabrous; anthers oblong, about 2 mm. long, yellow, obtuse, opening by terminal pores; berry greenish black, nearly 1 cm. in diameter.

This has gone under the name of *S. nigrum* throughout the interior region where it is a native plant; but the true *S. nigrum* of Europe has almost glabrous leaves with rounded lobes if lobed at all, very obtuse sepals, subumbellate inflorescence and usually reflexed pedicels in fruit. *S. interius* is in reality more closely related to *S. Douglasii*, which, however, differs in the much larger and bluish corolla. It is with some doubt I propose this species as new, as several North American species were described by

Dunal in De Candolle's Prodromus; but our plant does not agree with the description of any of these, except perhaps that of *S. pterocaulon;* a specimen of the latter cited by Dunal is in the herbarium of Columbia University, and this shows that it is more closely related to *S. nodiflorum* than to *S. nigrum.*

S. interius grows in river valleys and on sandy soil among bushes at an altitude of 600–1800 m.

Nebraska: On Middle Loup River, near Mullen, 1893, *Rydberg 1385* (type).

Kansas: Reno County, 1897, *Hitchcock 362-a.*

Colorado: Near Boulder, 1902, *Tweedy 5236;* Timnath, 1899, *Osterhout;* along Platte River, Denver, 1878, *M. E. Jones 605;* Cañon City, 1896, *Shear 3777;* Bent's Fort, 1846, *Lt. Abert.*

Arizona: Chiricehun Mountains, 1894, *Toumey.*

New Mexico: Mesilla, Dona Ana County, 1898, *Wooton 50.*

Pentstemon strictiformis sp. nov.

Perennial with a woody caudex; stems 3–5 dm. high, glabrous and strict, simple; basal leaves petioled, 5–10 cm. long; blades oblanceolate, obtuse, glabrous and slightly glaucous; stem-leaves sessile, lanceolate, acuminate, 4–8 cm. long; inflorescence more or less secund; calyx-lobes lanceolate, acuminate, 8–10 mm. long, more or less scarious and dentate on the margin; corolla violet-purple, funnelform, somewhat gibbous, about 2.5 cm. long and limb nearly 2 cm. wide; anthers long-villous with white hairs; sterile stamen villous with yellow hairs.

This is closely related to *P. strictus,* but differs mainly in the long-acuminate sepals. It grows up to an altitude of 2800 m.

Colorado: Mancos, 1898, *Baker, Earle & Tracy 76* (type); Gray-Back Mining Camp, 1900, *Rydberg & Vreeland 5630;* Arboles, 1899, *Baker 602.*

Pentstemon oreophilus sp. nov.

Perennial branched at the base, perfectly glabrous throughout, 2–4 dm. high; basal leaves oblanceolate, obtuse, short-petioled; stem-leaves lanceolate and sessile, 5–10 cm. long, acute or acuminate; inflorescence dense and usually more or less one-sided, calyx 8–10 mm. long; lobes lanceolate, long-acuminate with toothed scarious auriculate sides; corolla funnelform, more or less gibbous, bluish purple, 12–15 mm. wide at the mouth; lower lip more or less bearded within; anthers hispidulous on the margin and more or less short-hairy on the back and sides; sterile stamen with yellow beard at the end.

This is closely related to *P. glaber* and *P. alpinus*, differing from the former in the lower habit and the shape of the calyx-lobes, which in *P. glaber* are orbicular or short ovate and with very scarious erose margins. *P. alpinus* Torr. (= *P. riparius* A Nels.), is more or less puberulent throughout. *P. oreophilus* grows at an altitude of 1800–3600 m.

COLORADO: Eldora to Baltimore, 1903, *Tweedy 5711* (type) and *5710*; Halfway House, 1896, *Shear 4781*; Manitou, 1896, *Clements 171*; Larimer County, 1893, *Crandall*; Quartz Ridge, Pike's Peak, *Clements 113*; South Cheyenne Cañon, 1895, *E. A. Bessey*; mountains near Empire, 1892, *Patterson 256*.

Pentstemon cyathophorus sp. nov.

Perennial and more or less cespitose at the base, glabrous throughout or the basal leaves minutely puberulent; stem very strict, 3–4 dm. high; basal leaves spatulate, petioled, 3–6 cm. long; lower stem-leaves also spatulate; the others ovate or orbicular, often abrubtly acuminate or mucronate; bracts round, ovate or orbicular, abruptly short-acuminate, the upper usually scarious-margined and erose, reniform and the pairs together resembling a cup; calyx 6–8 mm. long; lobes lanceolate, scarious-margined and more or less erose-dentate; corolla pink-purple, a little over 12–15 mm. long, more or less open-funnelform from a narrow tube, little oblique and scarcely gibbous; anthers glabrous; sterile stamen spatulate at the apex and with a yellow beard.

This is closely related to the northern *P. acuminatus* and has been mistaken for it, but differs in the scarious-margined and toothed calyx-lobes and upper bracts. It grows in mountain meadows at an altitude of 2500–3000 m.

COLORADO: Pearl, 1901, *Tweedy 4307* (type); Grizzly Creek, 1896, *Baker*; also 1894, *Crandall 1438*; North Park, 1896, *Osterhout 59*; also 1891, *Crandall 1439*.

Castilleja brunnescens sp. nov.

Perennial with a short cespitose caudex; stems 3–5 dm. high, more or less pubescent and purplish; leaves narrowly linear-lanceolate, more or less distinctly 3-nerved, 4–5 cm. long, finely pubescent; bracts ovate to oblong-lanceolate, obtuse or rounded at the apex, entire or with a short tooth on each side, tinged with pale brown; calyx about 2 cm. long, densely and finely pubescent, cleft about equally deep in front and on the back; each division with 2 lanceolate lobes, about 3 mm. long; corolla about 3 cm. long; upper lip about 1 cm. long; lower about 3 mm.

This species may be most closely related to *C. confusa* Greene, but is easily distinguished by the light brownish color of the obtuse bracts. On account of this light color the type-specimens were labeled *C. pallida*, which it resembles somewhat but has an altogether different corolla. It grows in the mountains at an altitude of 2700–3300 m.

COLORADO: Cameron Pass, 1896, *Baker* (type); Gray's Peak, 1871, *Porter;* Red Mountain, south of Ouray, 1901, *Underwood & Selby 293;* Pike's Peak, 1894, *E. A. Bessey.*

Castilleja obtusiloba sp. nov.

Perennial with a very short caudex; stem very sparingly hairy, 3–4 dm. high; lower leaves oblong-lanceolate, 3-nerved, minutely pubescent, 3–4 cm. long, entire; the upper broader, 3-cleft; lateral lobes lanceolate; the middle one oblong, obtuse; bracts similar, but broader, purple; middle lobe elliptic, rounded at the apex; calyx about 2.5 cm. long, almost equaling the corolla, equally deeply cleft in front and on the back; lobes short, oblong and rounded at the apex; corolla yellowish and purple-tinged; upper lip nearly 1 cm. long; lower nearly 3 mm.

This species is perhaps a near relative of *C. rhexifolia* and *C. confusa*, but easily distinguished by the peculiar bracts and short and very obtuse calyx-lobes. It grows at an altitude of about 2700 m.

COLORADO: Leroux Park, Delta County, 1892, *Cowen.*

Castilleja puberula sp. nov.

Perennial with a short cespitose caudex; stems less than 1 dm. high, finely puberulent; leaves 2–3 cm. long, pinnately divided into linear lobes or entire and linear, finely puberulent; bracts similar, but shorter and broader, tinged with yellowish, often more villous; calyx more or less villous, 1–1.5 cm. long, deeper cleft in front than on the back; lobes lanceolate, acute; corolla yellowish, 18–20 mm. long; upper lip 6–8 mm. long; lower lip 3–4 mm., very gibbous.

This species has been taken for *C. brachyantha* Rydb. (*C. brevi-*

flora A. Gray); but that species is a much taller plant and the galea is about three times as long as the lower lip. It grows at an altitude of 2500–3600 m.

COLORADO: 1872, *Parry* (type, in herb. Columbia University): Empire, 1903, *Tweedy 5742;* Berthoud Pass, 1903, *Tweedy 5741.*

Valeriana trachycarpa sp. nov.

Perennial with a thick fleshy root; stem glabrous or nearly so, 5–7 dm. high; basal leaves oblanceolate or spatulate, 7–18 cm. long, finely puberulent, especially on the margins and veins; entire or with a few linear lobes, thick; stem-leaves 1–2 pairs, pinnatifid with linear lobes; inflorescence large and branched; corolla of the staminate plant 2.5–3 mm. wide; that of the essentially pistillate plant about 1.5 mm. wide; fruit broadly ovate, not hairy, but strongly rugose.

This is closely related to *V. edulis* and *V. purpurascens*, but the former has pubescent ovary and fruit and narrower bracts, and the latter has narrower fruit, narrower leaves, more slender inflorescence and smaller staminate flowers, only 2 mm. wide; *V. trachycarpa* grows at an altitude of 2500–3000 m.

COLORADO: Red Mountain, 1901, *Underwood & Selby 352* (type); Alpine Tunnel, *441;* Marshall Pass, 1901, *Baker 481;* Rabbit Ears Pass, 1896, *Baker.*

NEW MEXICO: White Mountains, 1897, *Wooton 320.*

Valeriana ovata sp. nov.

Perennial with a rootstock; stem about 3 dm. high, glabrous; basal leaves entire, petioled, glabrous; petioles 2–6 cm. long; blades ovate, usually truncate or slightly cordate at the base, acute, entire or sinuate; stem-leaves 2–3 pairs; lateral lobes oblong to linear-lanceolate; the terminal one lanceolate or of the lower leaves elliptic; inflorescence small and corymbiform; corolla funnelform-salvershaped, about 8 mm. long; limb of the fertile flowers about 4 mm. wide; of the staminate ones about 6 mm. wide; fruit ovate, glabrous.

This species belongs to the *V. septentrionalis* group, but is characterized by its basal leaves. It grows on wooded hillsides at an altitude of 2400–2900 m.

COLORADO: Cameron's Cove, 1901, *Clements 241* (type).

NEW MEXICO: Cañon four miles east of Santa Fé, 1897, *Heller 3613;* Elizabeth Town, 1897, *Berg.*

Coleosanthus albicaulis sp. nov.

Brickellia Wrightii and *B. californica* A. Gray, Syn. Fl. 1²: 106; both in part. 1884.

Shrubby at the base, 0.5–1 m. high; bark of the older wood brownish, striate and fissured, that of the younger branches straw-colored or grayish, hirsute-puberulent, more or less flaky; leaves short-petioled; blades broadly cordate, 2–5 cm. long, strongly veined, thick, scabrous-puberulent, crenate-dentate; inflorescence consisting of small axillary clusters scarcely exceeding the leaves, of 2–6 heads on short peduncles; heads 10–20-flowered; involucres turbinate; lower bracts short-ovate, the inner linear, all acutish or obtuse, greenish straw-color; corolla cream-color; pappus white.

This has been confused mostly with *C. Wrightii*, but the type of that species has more ovate leaf-blades, longer petioles, longer flower clusters, which exceed the leaves, and purple-tinged involucre, the bracts of which are very obtuse or rather rounded at the apex. It is rather nearer **Coleosanthus reniformis** (*Brickellia reniformis* A. Gray); from which it differs mainly in the longer, cordate, not reniform leaf-blades and larger and sharper teeth. It grows on the foothills and in cañons at an altitude of 1500–2500 m.

COLORADO: Manitou, 1900, *Clements* (type); Larimer County, 1891, *Cowen;* Lower Boulder Cañon, 1901, *Osterhout 2411;* Spring Cañon, 1897, *Crandall 2785;* Manitou, 1896, *Shear 4589;* Golden, 1895, *Shear 3261;* Mount Harvard, 1896, *Clements 63;* Golden, 1895, *Rydberg;* Boulder, 1885, *Letterman.*

UTAH: Salt Lake City, 1880, *M. E. Jones 1921;* Wahsatch Mountains, 1869, *Watson 495;* Provo, 1887, *Tracy & Evans 709.*

Grindelia serrulata sp. nov.

Biennial or perhaps short-lived perennial; stem glabrous, about 6 dm. high; leaves sessile, oblanceolate or oblong, acutish, very viscid, 3–5 cm. long, finely and densely serrate; inflorescence corymbiform; involucre very viscid, about 15 mm. broad; bracts subulate, very squarrose and reflexed; ligules 7–8 mm. long, 1–1.5 mm. wide; pappus-awns apparently smooth; barbules seen only under a compound microscope.

This is nearly related to *G. perennis* and *G. squarrosa.* From the former it differs in the closely and sharply toothed leaves, and from the latter in the oblanceolate instead of ovate or oval leaves. grows on plains at an altitude of about 1500 m.

COLORADO: Fort Collins, 1891, *Cowen* (type); Denver, 1869, *B. H. Smith.*

Grindelia aphanactis sp. nov.

Apparently perennial; stem 3–4 dm. high, glabrous and striate; leaves very viscid, oblanceolate, acute, 4–7 cm. long, sharply dentate and sessile, or the lower more or less pinnatifid and petioled; inflorescence corymbiform; heads about 15 mm. broad; bracts very viscid, subulate; all very squarrose and the lower reflexed; rays none; awns of the pappus apparently smooth.

This species has been confused with *G. nuda* Wood, but that species has broad leaves and large heads and resembles in general habit more the radiate *G. squarrosa. G. aphanactis* grows in gravelly soil.

COLORADO: Durango, 1898, *Baker, Earle & Tracy 526* (type).

NEW MEXICO: Lincoln, *Earle.*

Gutierrezia linearis sp. nov.

Shrubby and branched; leaves linear, about 3 cm. long, 1–2 mm. wide, puberulent and viscid, punctate; heads 5–6 mm. high; involucres campanulate, slightly turbinate at the base; bracts scarious-margined; the outer ovate or obovate, the inner elliptic, obtuse; inflorescence corymbiform; ray- and disk-flowers each 3–4.

This species resembles *G. longifolia* in habit but has the head of *G. diversifolia.* It grows at an altitude of 1800–2300 m.

NEW MEXICO: Gray, Lincoln County, 1900, *Earle 474* (type).

COLORADO: Gunnison, 1901, *Baker 821;* Red Rock Cañon, 1896, *E. A. Bessey.*

Gutierrezia scoparia sp. nov.

Woody only at the base; flowering herbaceous branches numerous, about 3 dm. high, puberulent, mostly simple up to the inflorescence; leaves linear, 3–5 cm. long, 1–2 mm. wide, puberulent; inflorescence corymbiform; involucre oblong-turbinate, over 5 mm. high; outer bracts lanceolate, inner oblong; disk- and ray-flowers each about 4.

This is closely related to *G. diversifolia,* but has a longer, more turbinate involucre and narrower bracts. It grows at an altitude of 1500–2100 m.

COLORADO: Manitou, 1901, *Clements 16* (type); Boulder, 1902, *Tweedy 4888.*

Chrysopsis caudata sp. nov.

Perennial, with a thick tap-root and a very short, erect and much-branched caudex; stems many, erect, purplish, hirsute with long white hairs; lower leaves oblanceolate, tapering into a short petiole, silky-strigose on both sides, 3–5 cm. long; middle leaves similar but sessile, uppermost elliptic or oblong; heads congested in small clusters at the end of the branches and subtended by the uppermost leaves; bracts linear-lanceolate, hirsute, the innermost with a subulate usually brownish and spreading tip; disk about 15 mm. wide; rays bright yellow, about 12 mm. long and 3 mm. wide.

This species is closely related to *C. villosa*, but differs in the sessile heads subtended by oblong leaves and in the subulate tips of the involucral bracts. It grows on hills at an altitude of 1500–2950 m.

COLORADO: Ruxton Dell, 1901, *Clements 143* (type); near Boulder, 1902, *Tweedy 4897*.

Chrysopsis amplifolia sp. nov.

Perennial, with a tap-root, rather simple; stem 3–5 dm. high, often branched, pubescent and sparingly hirsute; lower leaves spatulate, strigose, obtuse or slightly mucronate, middle and upper leaves broadly oblong or elliptic; the upper cordate or truncate at the base, 3–4 cm. long, 12–15 mm. wide; inflorescence corymbiform; heads usually subtended by oblong leaves; bracts hirsute-strigose, linear-lanceolate, acute; disk 15 mm. or more wide; rays golden yellow, about 12 mm. long and 2.5 mm. wide; achenes densely strigose-canescent.

This is also closely related to *C. villosa*, but distinguished by the ample upper stem-leaves with subcordate or truncate bases and the large sessile heads. It grows on plains and foothills at an altitude of about 1500 m.

COLORADO: Longmont, 1902, *Tweedy 4898* (type); Ward, 1901, *Osterhout 2444*.

Chrysopsis horrida sp. nov.

Perennial with a tap-root, more or less cespitose; stems about 2–3 dm. high, hirsutulous and hispid, more or less branched, especially above; leaves obovate, broadly oblanceolate or oblong, subsessile, except the lower, densely hirsute with short hairs and slightly glandular-puberulent; heads corymbose, peduncled, about 8 mm. high; disk 1 cm. or less wide; rays about 8 mm. long and 1–1.5 mm. wide; achenes 2 mm. long, canescent; pappus about 5 mm. long, yellowish.

This has been taken for *C. hispida*, but the original *Diplopappus hispidus* Hook. is less hairy with longer hairs and more viscid ; the leaves are narrowly oblanceolate and petioled and the heads larger, the disk being 12–15 mm. wide. *C. horrida* grows on dry hills and plains at an altitude of 1200–1600 m.

COLORADO : New Windsor, 1900, *Osterhout 2326* (type), and 1901, *2362 ;* Platte, *Frémont.*

NEBRASKA : Pumpkin Seed Valley and Lawrence Fork, 1891, *Rydberg 141.*

Chrysopsis alpicola sp. nov.

Cespitose perennial ; stems about 1 dm. high, silky-villous, numerous ; leaves oblanceolate, about 3 cm. long ; nearly all petioled, white-silky strigose or the pubescence more spreading on the petioles ; heads solitary, subsessile, about 1 cm. high ; bracts linear-lanceolate, hirsute, acute ; disk about 12 mm. in diameter ; rays about 8 mm. long and 2 mm. wide ; achenes white silky-hirsute.

This is perhaps most closely related to *C. Bakeri*, but is much lower, more silky, with sessile heads and more hirsute involucre. It grows on the higher mountains, at an altitude of about 3500 m.

COLORADO : Clark's Peak, 1896, *Baker.*

Solidago rubra sp. nov.

Stout, about 3 dm. high ; stem pubescent or at the base merely puberulent, reddish; basal and lower cauline leaves broadly oblanceolate, 6–12 cm. long, firm, bluish-green, glabrous, pinnately veined, serrulate and minutely scabrous on the margins, acute, petioled ; upper stem-leaves sessile and lanceolate ; inflorescence paniculate but very narrow and elongated ; heads about 8 mm. high. and as broad ; bracts narrowly linear-lanceolate, acute, ciliolate on the margin ; rays rather pale yellow, about 4 mm. long and 0.7 mm. wide ; achenes strigose.

This species is related to *S. scopulorum*, but is distinguished by the stouter habit, the broad leaves, the compound and dense inflorescence.

COLORADO : North Park, 1899, *Osterhout 5.*

Solidago laevicaulis sp. nov.

Rather tall, 4–7 dm. high ; stem glabrous up to the inflorescence, light-colored and shining ; basal leaves narrowly oblanceolate, indistinctly if at all triple-nerved, rather thin, obtuse, 5–10 cm. long, entire or crenate above, glabrous except the scabrous margin; lower stem-leaves similar; upper stem-leaves narrowly lanceolate, sessile; inflorescence paniculate, but rather narrow, with numerous heads; branches nearly erect; heads about 8 mm. high; bracts narrowly linear-lanceolate, acute, ciliolate on the margin; disk about 8 mm. wide; rays numerous, about 4 mm. long and nearly 1 mm. wide; achenes sparingly strigose.

This is nearest related to the preceding, but taller and more slender, with narrower leaves and glabrous stem. It approaches the *S. serotina* group but has neither triple-nerved leaves nor secund branches. It grows in the mountains of Colorado and southern Wyoming at an altitude of 2500–3300 m.

COLORADO: North Park, 1899, *Osterhout 4* (type); Berthoud Pass, 1903, *Tweedy 5857*.

WYOMING: Copperton, 1901, *Tweedy 4009*.

Solidago radulina sp. nov.

Perennial; stem 3–4 dm. high, grayish-puberulent; basal and lower cauline leaves spatulate, obtuse, crenate at the apex, finely puberulent; upper stem-leaves elliptic or spatulate, acute; inflorescence narrow and elongated, paniculate; heads about 4 mm. high; bracts oblong, obtuse, or the inner linear, ciliolate on the margin; rays about 2.5 mm. long, 1 mm. wide; achenes hirsutulous.

This species is intermediate between *S. nana* and *S. pulcherrima*, but differs from the former in the taller habit and the elongated inflorescence and from the latter in the broader and shorter stem-leaves. In leaf-form it resembles somewhat *S. radula*, but is a smaller plant, with smaller leaves and narrow inflorescence, the branches of which are short and only somewhat secund. The type grew at an altitude of 1800 m.

UTAH: Cottonwood Cañon, 1869, *Watson 558* (type in herb. Columbia University).

COLORADO: Meadow Park, 1895, *Shear 5049*.

Solidago serra sp. nov.

Perennial with a rootstock; stem simple up to the inflorescence, about 6 dm. high, more or less pubescent especially above; leaves lanceolate, about 8 cm. long, acuminate, sharply toothed, rather thin, glabrous on both sides; inflorescence paniculate; branches arching and secund; heads numerous, 3–4 mm. high; bracts linear or linear-lanceolate, acute; rays 1–1.5 mm. long, less than 0.5 mm. wide; achenes hirsutulous.

This is closest related to *S. canadensis*, but differs in the glabrous leaves and the less pubescent stem. It may also be confused with *S. serotina* and *S. elongata*, but the former has much larger heads, fully 5 mm. high, and in the latter the inflorescence is narrower, rhombic in outline and with ascending scarcely arched branches.

COLORADO: Yampa, 1898, *Shear & Bessey 5274* (type).

WYOMING: Copperton, 1901, *Tweedy 4007*.

Solidago polyphylla sp. nov.

Tall, sometimes a meter high; stem strict, simple and puberulent up to the more hirsutulous inflorescence; leaves narrowly lanceolate, sessile, acute at the base, acuminate at the apex, distinctly triple-nerved, serrate above the middle with small distant teeth, thick and firm, green, scabrous above, more softly short-pubescent beneath; inflorescence panicled; branches more or less arching and secund; heads about 5 mm. high; bracts linear, acute; rays 1.5–2 mm. long, 0.5 mm. wide; achenes hispidulous.

This species is closely related to *S. procera* and has been mistaken for it. It differs from that species in the larger heads (in *S. procera* only 3–4 mm. high), the more compact inflorescence, the more toothed upper leaves and the shorter pubescence on the stem and lower leaf-surfaces.

COLORADO: Cañon City, 1896, *Clements 295* (type); Gunnison, 1901, *Baker 899;* Engelmann Cañon, 1901, *Clements 400*.

NEW MEXICO: Roswell, 1900, *Earle 346*.

Solidago viscidula sp. nov.

Low, about 2 dm. high; stem finely pubescent, reddish; basal leaves and lower stem-leaves narrowly linear-oblanceolate, finely puberulent and somewhat viscid, denticulate, obtuse or acutish, indistinctly triple-veined; upper stem-leaves sessile; inflorescence paniculate but flat-topped, branches scarcely secund; heads numerous, small, about 5 mm. high; bracts linear, obtusish, viscid; rays pale, about 2 mm. long and 0.5 mm. wide.

This is closely related to *S. missouriensis*, but is distinguished by the viscid inflorescence and the indistinctly triple-nerved leaves.

COLORADO: Grand Lake, 1888, *Holway*.

Oligoneuron canescens sp. nov.

Solidago rigida humilis Porter Syn. Fl. Colo. 63, 1874. Not *S. humilis* Mill.

Stout perennial; densely yellowish-canescent throughout; stem simple up to the inflorescence, 5–7 dm. high; basal leaves long-petioled; blades oval, 7–12 cm. long, thick, canescent on both sides, in age scabrous, distantly crenulate with small callous teeth; upper stem-leaves oval, sessile, entire or sinuate, crenulate, very densely canescent; inflorescence corymbiform but much congested; heads about 1 cm. high; bracts oblong, striate, canescent; rays 3–4 mm. long, less than 1 cm. wide, light yellow; achenes slightly hairy above, otherwise glabrous.

This differs from *O. rigidum* Small (*Solidago rigida* L.) in the shorter leaves, the smaller and denser inflorescence, the dense yellowish-canescent pubescence, and the achenes which are apparently always slightly hairy above. It grows on prairies and in valleys at an altitude of 900–1800 m.

WYOMING: Buffalo, 1900, *Tweedy 3117* (type); Dayton, 1899, *Tweedy 2017*; Devil's Tower, 1899, *L. W. Carter*.

NEBRASKA: Plummer Ford, Dismal River, 1892, *Rydberg 1666*.

SOUTH DAKOTA: Custer, 1892, *Rydberg 769*.

NORTH DAKOTA: Tower, 1891, *Wright*.

Chrysothamnus patens sp. nov.

Shrubby, half a meter or so high; stems white-tomentulose when young, soon glabrous and yellowish green; leaves 6–8 cm. long, about 1 mm. broad, soon glabrous, spreading or even reflexed; bracts lanceolate, acute, carinate, glabrous, in 5 vertical rows of about 3 each; corolla-lobes about 1 mm. long, lanceolate, acute, in age more or less spreading; achenes strigose.

This is closely related to *C. graveolens*, but differs in the narrow, spreading leaves. It grows on dry hills at an altitude of 1300–2100 m.

COLORADO: 1873, *Wolf 452* (type); Grand Junction, 1901, *Underwood & Selby 498b*; 1900, *Stokes*; Manitou, 1900, *Clements*; Alamosa, 1896, *Shear 3753*; Zola, 1901, *Baker 668*.

Chrysothamnus Newberryi sp. nov.

Shrubby below; stem white-tomentose, rather slender; leaves erect, linear-filiform, 1-nerved, slightly tomentulose when young;

the upper smaller; involucres turbinate; bracts in about 5 vertical rows, usually 3 in each row, narrowly lanceolate, attenuate into a long slender subulate spreading tip, carinate, slightly tomentulose and webby; achenes narrow, tapering downwards, strigose-pubescent; corolla narrowly tubular-funnelform; lobes erect, lanceolate.

This species is closely related to *C. Parryi* and *C. Howardi,* but the former differs in the broad, 3-nerved leaves and broader bracts, and the latter by its spreading arcuate leaves, broader bracts, depressed habit and elongated upper leaves, which usually equal or exceed the heads. *C. Newberryi* grows on dry hills.

NEW MEXICO: Cañon Largo, 1859, *Newberry* (Macomb's Expedition; type in herb. Columbia University).

COLORADO: Mesa Verde, 1892, *Eastwood.*

Sideranthus annuus nom. nov.

Aplopappus rubiginosus A. Gray, Syn. Fl. $\mathbf{1}^2$: 130. 1884. Not Torr. & Gray, Fl. **2**: 240. 1842.

A little comparison between the descriptions of *A. rubiginosus* in Torrey and Gray's Flora and in Gray's Synoptical Flora will show that they are drawn from different plants. The first line in Torrey and Gray's description, viz. "suffruticose? branching from the base, viscidly pubescent and cinereous" and further down "scales of the involucre . . . in about 2 series, nearly equal, loose, at length spreading" do not at all fit the plant of the upper Platte, for that plant is strictly annual, simple at the base and branched above, viscid but can hardly be called cinereous; the bracts are in 4 or 5 series, well imbricated and the outer much shorter. The type of *Aplopappus rubiginosus* was collected by Drummond, and a specimen is in the Gray herbarium. This is very unlike the plant of the upper Platte region, which is described in Gray's Synoptical Flora, but agrees fully with the description of Torrey and Gray. It is more closely related to *A. phyllocephalus* DC., but perhaps distinct.

Aster griseolus sp. nov.

Perennial with a horizontal rootstock; stem 1–1.5 dm. high, hirsute with ascending hairs, rather simple; leaves linear, 3–5 cm. long, sparingly hairy on both sides, sessile, acute, entire; heads about 1 cm. high, 1–4 in a small corymb; bracts oblanceolate or linear, the outer obtuse, the inner acute, green or the inner white on the sides below, pubescent on the back, but not bristle-pointed; rays purple, about 8 mm. long and 1 mm. wide; achenes pubescent.

This is nearest related to *A. griseus* Greene, but differs in the small size, the narrow short sessile leaves, and the pubescence which is not reflexed on the lower part of the stem. *A. griseolus* grows on the higher mountains of Colorado.

COLORADO: Mt. Harvard, 1896, *Clements 37* (type); Twin Lakes, 1896, *Shear 3499*.

✓ **Aster Underwoodii** sp. nov.

Perennial with a horizontal rootstock; stems simple up to the inflorescence, 2–3 dm. high, often purplish, more or less hirsute-strigose; lower leaves spatulate or oblanceolate, tapering into a winged petiole, glabrous except the ciliolate margin or slightly pubescent when young; the other stem-leaves sessile and the uppermost linear-lanceolate; inflorescence racemiform or corymbiform with 4–8 heads; these fully 1 cm. high; bracts oblanceolate, the outer obtuse, the inner acutish, all with a rather thick green tip, pubescent on the back; rays purple or bluish, about 1 cm. long and 1–1.5 mm. wide; achenes hirsute.

This is related to *A. adscendens* and *A. Nelsonii*. From the former it differs in the hairy bracts and from the latter in the broad leaves. It suggests also *A. griseus*, but has shorter and almost glabrous leaves. It grows at an altitute of 2500–3000 m.

COLORADO: Ironton Park, 1901, *Underwood* and *Selby 318* (type); Eldora to Baltimore, 1903, *Tweedy 5831*.

✓ **Aster Osterhoutii** sp. nov.

Tall, branched and leafy, about 1 mm. high; stem striate, glabrous below, hairy in decurrent lines above; leaves linear or linear-lanceolate, 5–12 cm. long, 8 mm. wide or less, scabrous-ciliolate on the margin, otherwise glabrous, entire-margined, sessile and half clasping; those of the branches much smaller; inflorescence open-paniculate; heads nearly 1 cm. high; bracts in 4–5 series, the inner linear, acute, the outer oblanceolate, apiculate, green and with white margins below; rays white or rarely pinkish, nearly 1 cm. long and fully 1 mm. wide.

This species is related to *A. salicifolius*, but differs in the narrow, thin, entire leaves. Mr. Fernald, to whom some of the specimens had been sent, named it *A. salicifolius caerulescens* Gray, but that has very narrow, linear outer bracts and usually purplish or bluish rays. *A. Osterhoutii* grows along ditches at an altitude of about 1500 m.

COLORADO: New Windsor, 1899, *Osterhout 2506* (type); also 1898, *9*, and 1900, *2328*.

✓ **Aster corymbiformis** sp nov.

About 3 dm. high; stem strict, branched above, pubescent on decurrent lines; leaves linear, 5–8 mm. long, scabrous on the margins, otherwise usually perfectly glabrous, half-clasping; inflorescence leafy, corymbiform; heads about 8 mm. high; bracts linear-lanceolate, very acute, glabrous, rather firm, with an oblanceolate green tip, in about 3 series of nearly equal length; rays white or purplish, about 7 mm. long and 1 mm. wide.

This is perhaps nearest related to *A. paniculatus*, but in habit reminding somewhat of *A. adscendens*. From the former it differs in the strict habit, the corymbiform inflorescence and the entire leaves. From *A. adscendens* it differs in the more numerous heads and the bracts, the outer of which at least are oblanceolate and obtuse in *A. adscendens*.

COLORADO: West Cliff, 1896, *Shear 3460* (type); also *3813* and *3819*; Parlin, Gunnison Co., 1901, *B. H. Smith 114* and *116* (?).

✓ **Aster Tweedyi** sp. nov.

Perennial with a horizontal rootstock; stem simple, usually purplish, pubescent only on decurrent lines, about 4 dm. high; leaves oblanceolate, acute, glabrous except the ciliate margin, rather firm, often 1 dm. long; the lower with a winged petiole; the upper sessile and half clasping; inflorescence paniculate, leafy; heads about 1 cm. high; bracts in about 3 series, linear or oblanceolate, not very unequal in length, the outer mostly green and obtuse, the inner with green tips and midrib, whitish on the sides below; rays rose or purple, 8–10 mm. long and 1.5 mm. wide.

This species is related to *A. adscendens* but differs in the stouter habit, broader and firmer leaves and larger heads. It grows in valleys at an altitude of 1500–2600 m.

WYOMING: Copperton, 1901, *Tweedy 4096* (type); Big Horn Mountains, 1899, *Tweedy 2523*; Laramie, 1897, *Elias Nelson 152*.

COLORADO: Laramie River, Larimer County, 1897, *Osterhout 2518*.

A new Asplenium from Mexico*

WILLIAM R. MAXON

For nearly twenty years the specimen described below has lain among the undetermined material of *Asplenium* in the United States National Herbarium. Recent studies in this genus have failed to discover any species to which it may be referred, and the writer has come to the conclusion that it represents a species hitherto unnoticed. It may be known as:

Asplenium modestum sp. nov.

Fronds 5, about 8 cm. high, borne from a stoutish suberect rhizome: stipes 0.5–2.3 cm. long, naked, greenish, sulcate: laminae 4.5–6 cm. long by 1.5 cm. broad, somewhat coriaceous, oblong-lanceolate, with six to eight pairs of subopposite to alternate, distant to close-set, short-stalked pinnae; pinnae ovate-deltoid to irregularly rectangular, broadly excised below, the lowermost pinnately parted into three cuneate lobes (the superior, and in some cases the inferior, quite free), which in turn are deeply and sharply cleft, the margins thus coarsely and unequally fimbriate; succeeding pinnae less deeply parted, commonly only the superior lobe free; venation obscure, subflabellate-pinnate: sori rather short, two or three to each lobe; indusia suberose, partially concealed by the mature sporangia.

Asplenium modestum, natural size.

Founded upon a single sheet, *no. 27674*, in the United States National Herbarium, collected in southwestern Chihuahua, Mexico, August to November, 1885, by Dr. Edward Palmer (*no. 162*). The type sheet bears two plants, one fully mature which may stand as the type, and a second plant which though very young is without doubt the same.

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Asplenium modestum is apparently an aberrant member of the *lanceolatum* group of Hooker and Baker's Synopsis Filicum, its nearest Mexican allies being, perhaps, *A. micropteron* Baker and *A. Glenniei* Baker, the latter hardly distinct from the Asiatic *A. exiguum* Bedd. From these, however, it differs conspicuously in many particulars, but notably in its wholly green stipes and in its broad divided pinnae, the lowermost scarcely at all reduced. The flabellate aspect of the pinnae is pronounced and should serve at once to distinguish the species.

The writer is indebted to Mr. H. D. House for the accompanying drawing, which represents at natural size one of the five fronds of the type-specimen before mentioned.

UNITED STATES NATIONAL MUSEUM.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1904)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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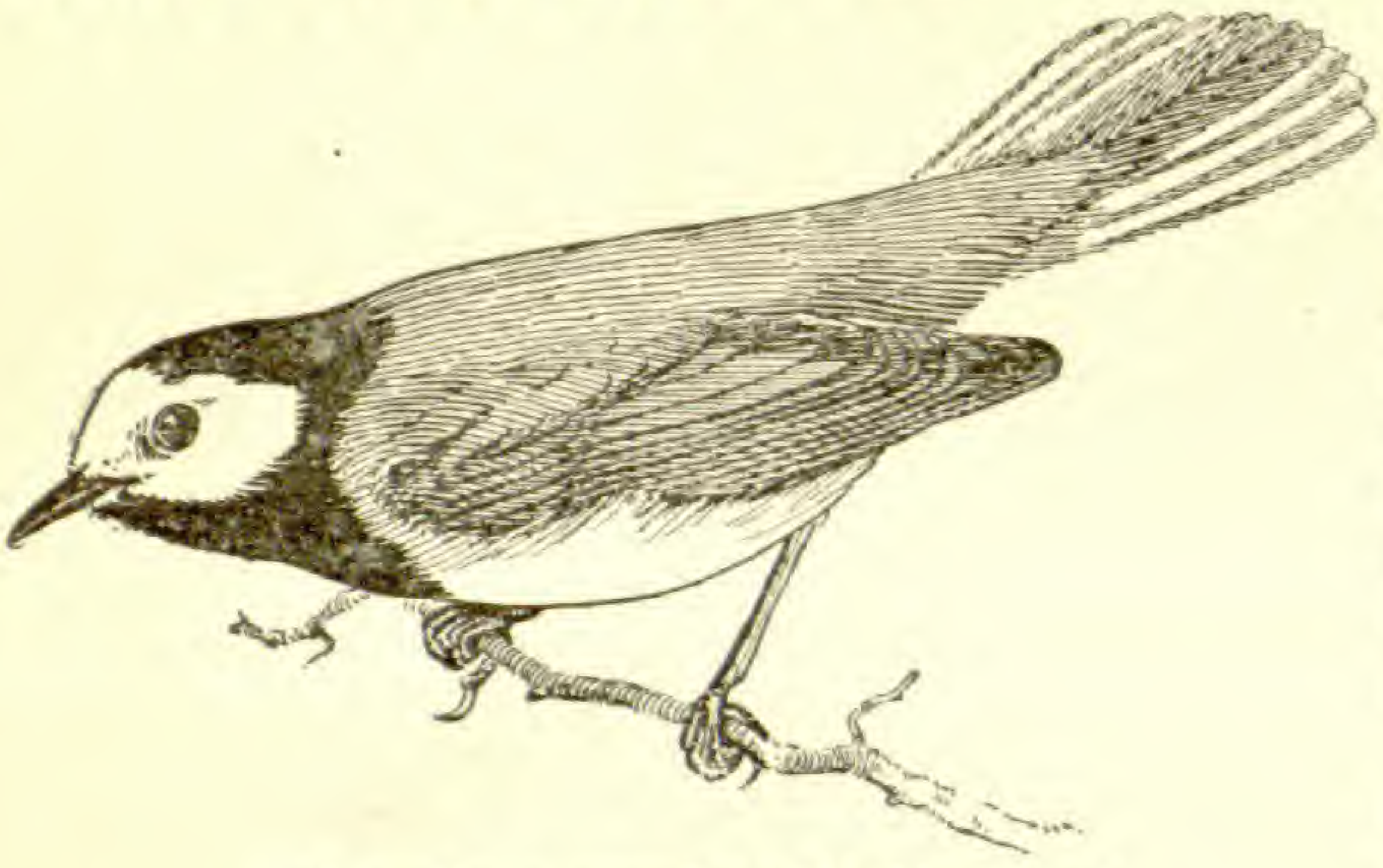

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