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Errata

VOLUME 50 (October, 1923)

Page 328, line 3 and line 6, for "*figure 8*" read "FIG. 9."

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Page 9, line 1, for "*tubucina*" read "*tubicina*."
Page 15, line 12, for "*Heffner*" read "*Heppner*."
Page 18, lines 21 and 22, for "*alvordiensis*" read "*alvordensis*."
Page 22, line 13, for "*Wallovoa*" read "*Wallowa*."
Page 37, center, for "*Aveua*" read "*Avena*."
Page 48, line 22, for "*hyphal*" read "*hyphae*."
Page 174, line 5 from bottom, for "*S. appendiculata*" read "*S. appendiculatum*."
Page 178, line 7 from bottom, for "*conferred*" read "*confirmed*."
Page 182, lines 8, 12, 21, for "*Sporobolis*" read "*Sporobolus*."
Page 182, line 8 from bottom, for "*P. dichotum*" read "*P. dichotomum*."
Page 183, line 3 from bottom, for "*novae-anglae*" read "*novae-angliae*."
Page 189, line 15, for "*Ulmus americanus*" read "*Ulmus americana*."
Page 191, line 4, for "*Pleuropteris sachalinense*" read "*Pleuropterus sachalinensis*."
Page 191, line 6, for "*Pleuropteris Zuccarini*" read "*Pleuropterus Zuccarinii*."
Page 194, line 8 from bottom, for "*Lechia*" read "*Lechea*."
Page 229, lines 4 and 6 from bottom, for "*S. bornense*" read "*S. bornensis*."
Page 261, line 3, and p. 272, line 26, for "*sculeatissimum*" read "*aculeatissimum*."
Page 371, line 7, for "*Liaburn*" read "*Liabum*."
Page 396, line 22, for "*Polygales*" read "*Polygalas*."
Page 396, line 25, for "*cespedezas*" read "*Lespedezas*."
Page 413, line 14 from bottom, for "*cervariaefolium*" read "*cervariaefolius*."

Vol. 51 No. 1

BULLETIN

OF THE

TORREY BOTANICAL CLUB

JANUARY, 1924

Studies of West Indian plants—XII

NATHANIEL LORD BRITTON

68. UNDESCRIBED SPECIES FROM CUBA

Cyperus naguensis Britton, sp. nov.

Culms short, about 8 dm. high, trigonous, smooth. Basal leaves rough-margined, strongly veined, 5–8 mm. wide, shorter than the culm, the apex attenuate, those of the involucre several, similar to the basal ones but shorter; umbel 8–10-rayed, the rays slender, the longer ones 6–10 cm. long; spikelets straw-colored, compressed, about 8-flowered, deciduous, 10–12 mm. long, very numerous in dense oval or subglobose, simple or compound spikes 2–3 cm. long; scales oblong-lanceolate, acute, striate, slightly spreading, 3 mm. long; achene linear, 1.5 m. long, about 3 times as long as thick, sharply pointed, narrowed at base.

Moist place between San Felipe and Nagua, Oriente (*Ekman 14720*). Similar to *C. stenolepis* Torr., but with shorter scales and achenes.

Reynosia camagueyensis Britton, sp. nov.

Twigs slender, leafy. Leaves oblong-obovate, coriaceous, entire, 12–17 mm. long, glabrous, very finely reticulate-veined, the midvein impressed above and prominent beneath, the base narrowed but obtuse, the apex obtuse, rounded or emarginate, tipped with a nearly straight awn about 0.7 mm. long, the petioles about 1 mm. long; fruit globose, rounded, 12–14 mm. in diameter, its peduncle about 5 mm. long.

Hills, Camaguey (*Padre Borrás*, 1918). Resembles *R. latifolia* Griseb., which has strongly reticulate leaves and ellipsoid pointed fruits.

[The BULLETIN for December (50: 373-414.) was issued Jan. 24, 1924.]

Peperomia Leoclemerocana Trelease, sp. nov.

A rather large assurgent glabrous herb; stem succulent and rather thick (5–8 mm.); leaves alternate, broadly elliptic-obovate, somewhat blunt-acuminate and often emarginulate, cuneate, rather large (2 × 5–4 × 6.5 cm.), drying rather coriaceous and dull, pinnately veined from about the middle, the principal ascending branches of the midrib 3 or 4 × 2; petiole scarcely 1 cm. long, winged; spikes terminal, paired or toward the end of a bracted stalk about 6 cm. long, 2 × 70–130 mm.; peduncle about 2 cm. long; bracts round-peltate, about .5 mm. in diameter and 10 to the pseudo-whorl; berries separated by somewhat evident ridges, ellipsoid, somewhat glandular, with stout curved beak; stigma anterior.

Cobre range, Sierra Maestra, Oriente (*Leon, Clement & Roca 10436*—the type at the New York Botanical Garden).

Clidemia Clementiana Britton, sp nov.

A shrub about 3 m. high, the very slender twigs, the petioles and the under leaf-surfaces puberulent. Leaves narrowly lanceolate, 1-nerved, chartaceous, entire, short-petioled, 2–6 cm. long, glabrous above, the apex acuminate, the base narrowed, the lateral venation faint, spreading; inflorescence 1–3-flowered; pedicels filiform, puberulent, 1–2 cm. long; calyx-lobes 4, linear, 2–3 mm. long; fruit 4-lobed, about 5 mm. in diameter.

Sierra Maestra, Oriente. TYPE from Loma del Gato, (*Leon, Clement and Roca 9830*).

Rondeletia Ekmanii Britton & Standley, sp. nov.

Branchlets brown, puberulent or scaberulous, finally glabrate; stipules deltoid-cuspidate, 2–3 mm. long, erect, persistent; petioles 2–3 mm. long, glabrous or obscurely puberulent; leaf blades broadly elliptic to elliptic-oval, 2–4 cm. long, 1.2–2.5 cm. wide, rounded or very obtuse at apex, rounded at base, coriaceous, dark green above, glabrous, lustrous, with prominulous-reticulate venation, paler beneath and brownish, glabrous, the costa salient, the lateral nerves few, distant, not conspicuous; inflorescence terminating the main branches and on short leafy lateral twigs, few-flowered, open, the flowers slender-pedicellate; rachis of the inflorescence scaberulous, the pedicels 4–5 mm. long; hypanthium globose, densely white-scaberulous; calyx-lobes linear-subulate, scarcely over 1 mm. long, subobtuse, brownish, scaberulous; corolla-tube 6 mm. long, dilated above, strigillose-scaberulous with white hairs, the 5 lobes broadly obovate, rounded at apex, tomentulose on the inner surface.

TYPE in the U. S. National Herbarium, No. 1,145,291, collected on banks of the Yara River, Oriente, August 14, 1922 (*E. L. Ekman 14852*).

Related to *R. calophylla* Standley,* but evidently distinct in the small and narrow calyx-lobes.

The type of *R. calophylla* was collected in the Sierra Maestra in July, 1922, by Brother Leon. Dr. Ekman also obtained it in August, 1922, at Arroyo Corojo, Nagua, Oriente (No. 14729).

69. AN UNDESCRIBED SPECIES FROM HISPANIOLA

Kallstroemia incana Rydberg, sp. nov.

Kallstroemia caribaea Urban, Symb. Ant. **8:** 319. 1920. Not *K. caribaea* Rydberg, 1910.

A diffusely branched herb, somewhat woody at the base; stems spreading, 2–3 dm. long, with coarser spreading and finer more appressed hairs, terete; stipules linear-oblong, 2–3 mm. long, tardily deciduous; leaves 1–1.5 cm. long; petioles 2–3 mm. long; leaflets mostly 3 pairs, obliquely ovate, 3–5 mm. long, hoary on both sides, acutish; peduncles 2–3 mm. long; sepals lance-linear, acute, 3 mm. long; petals elliptic-obovate, light yellow, 3 mm. long; fruit grayish-strigose, about 5 mm. broad, the beak 2 mm. long, conic at the base; carpels cross-ridged on the back and reticulate on the faces.

TYPE collected at Barahona, Santo Domingo, July 1920, *Fuertes 418* (herbarium of the New York Botanical Garden); also collected at Rincon, October 1911, *Fuertes 1352*.

The two numbers cited were determined by Urban as *K. caribaea* and included under that name in his Flora Domingensis, but it differs in the hoary pubescence, the small leaflets, the small petals, scarcely half as long as in *K. caribaea*, the short peduncles and short beak on the small fruit. It approaches more *K. curta* Rydberg, from Curaçao, with which it has the following characters in common: small leaflets, short peduncles, small petals and fruit, and short beak; but it is more canescent, more branched, with shorter internodes and smaller leaves, and the beak different, not at all swollen.

* Bull. Torrey Club **50:** 48. 1923.

70. UNDESCRIBED SPECIES FROM TRINIDAD

Anthurium aripoense N. E. Brown, sp. nov.

Glabrous in all parts. Petioles about 75 cm. long and (when dried) 4 mm. thick, sheathing for about 7 cm. at their base, apparently more or less flattened above with obtuse edges, rounded on the back; blades about 34 cm. long, 26 cm. broad across the basal lobes and 18½ cm. broad at the constriction, cordate, with the basal lobes slightly constricted into the front lobe at about 11 cm. above the insertion of the petiole; basal sinus about 4 cm. deep, broadly open, rounded; basal lobes semi-orbicular; front lobe ovate, abruptly acute, apiculate; both surfaces green; basal nerves 4 on each side of the midrib, the 3 outer united and denuded at the sinus for about 25 mm., much curved and all excurrent at the margin below the middle of the leaf; the inner one free, ascending and excurrent at the apex, running subparallel with the margin at about 12–15 mm. from it; primary lateral veins about 7 on each side of the midrib, with others similar but less prominent between them, widely spreading, subparallel, nearly straight. Peduncle about 57 cm. long, 4 mm. thick (dried), apparently terete. Spathe 11 cm. long, 12 mm. broad, strap-shaped or broadly linear, with a subulate point about 25 mm. long. Spadix 15 cm. long, 5 mm. thick at the base, much longer than the spathe, on a stipe 5 mm. long, apparently violaceous or dark purple. Flowers diamond-shaped, 4 mm. in their longer and 3 mm. in their shorter diameter.

Heights of Aripo, (*Broadway 9924*).

The venation of the leaf of this species is on the same plan as that of *A. Guildingii* Schott, but in outline the slight constriction above the basal lobes brings it nearer to *A. panduraeforme* Schott.

Piper maravalanum Trelease, sp. nov.

Stem nodose, glabrous; leaves ovate or elliptic-ovate, acuminate, equilaterally rounded at base, rather large (6–9 × 15–17 cm.), pinnately nerved from below the middle, the nerves about 5 × 2 and sparingly pubescent beneath; petiole rather short (scarcely 10 mm.), not winged; spikes opposite the leaves, as yet comparatively short and thick (2 × 15 mm.), mucronate; peduncle very short (scarce 5 mm.); bracts lunulate-subpeltate, rusty-ciliate; flowers sessile, perfect; stigmas 3, minute, sessile.

Maraval, December 30, 1914, (*Broadway 7829*, the TYPE in the New York Botanical Garden).

Scarcely to be placed anywhere except in close connection with *P. Schackii* and *P. ovatum*; but pubescent beneath on the veins.

Piper aripoense Trelease, sp. nov.

A shrub, 1 m. tall; flowering internodes moderately slender and short, zig-zag, hirsute; leaves elliptic or oblanceolate-elliptic, acuminate, more or less unequally cordulate, moderately large (5×14–9×20 cm.), pinnately nerved from below the upper fourth, the nerves about 9 × 2, paler and appressed-hirsute on the nerves beneath; petiole short (scant 5—exceptionally 10 mm.), sometimes covered by the longer side of the base, hairy, winged to the blade; spikes opposite the leaves, rather thick and short (4 × 25 mm.), blunt; peduncle short (5 mm.), hirsute; bracts concave-incurved, glabrous; flowers sessile, perfect; stigmas 3, sessile; berries subglobose, glabrous.

Heights of Aripo (*Britton and Freeman 2353*, the TYPE at the New York Botanical Garden).

Prestonia Brittoni N. E. Brown, sp. nov.

Stem twining, 3 mm. thick at the flowering parts, glabrous. Leaves opposite, stipulate; petioles in the specimen seen 15 mm. long, glabrous; blade about 16 cm. long and 7½ cm. broad, oblong-elliptic, shortly acute and apiculate at the apex, rounded at the base, glabrous on both sides, with 8–9 primary veins on each side of the midrib inarching and uniting 5 mm. from the margin; stipules formed of a number of small teeth 1 mm. long between the bases of the petioles. Cymes axillary pedunculate, 6–8 cm. in diameter, quite glabrous in all parts; peduncle 3–4 cm. long, nearly 2 mm. thick. Pedicels 15–25 mm. long. Sepals 10 mm. long and 4–5 mm. broad, oblong, obtuse, rather thick; at the base of each sepal, between it and the corolla is a broadly deltoid-ovate obtuse gland about 1 mm. long. Corolla only seen in bud and in that condition the tube is 12 mm. long and 3 mm. in diameter, cylindric, not dilated at any part, surmounted by a truncate-based acute cone 5 mm. long and 6½ mm. in diameter formed by the contorted lobes; mouth of the tube raised within into a distinct rim about 1 mm. high, without processes or other appendages; lobes as unfolded from the bud 5 mm. long and 6 mm. broad, suborbicular, entire. Stamens inserted 5 mm. below the top of the corolla-tube; filaments 1 mm. long; anthers 5 mm. long, not or scarcely exserted. Ovary surrounded by 5 large faintly crenulate or faintly toothed fleshy lobes.

Heights of Aripo (*Broadway 10009*).

Decastelma trinitense N. E. Brown, sp. nov.

Stem twining, up to 2 mm. thick at the flowering part, with internodes 2–3 cm. long, minutely puberulous, brown. Leaves spreading; petiole 4–6 mm. long, minutely puberulous; blade

2–6 cm. long, 15–30 mm. broad, ovate or oblong-lanceolate, acuminate, rounded at the base, glabrous on both sides to the eye, but with a microscopic scattered pubescence above, where the midrib is also minutely puberulous; primary veins 3–5 on each side of the midrib, distant, inarching and uniting into a submarginal vein 2–3 mm. from the margin, not prominent on either surface. Flowers in small sessile umbellate clusters at the nodes of leafless branches. Bracts very minute. Pedicels 2–2½ mm. long, and together with the flowering branches minutely puberulous. Calyx 5-lobed to the base; lobes about ⅔ mm. long, ovate, obtuse, thinly and very minutely puberulous. Corolla about 3 mm. in diameter; tube about 0.75 mm. long, glabrous; lobes spreading, about 1 mm. long, ovate, subacute, minutely and densely puberulous within; each sinus with a thickening or slight gibbosity, which seems nearly or quite to touch the staminal column so as to form 5 small pocket-like entrances to the tube at the base of the lobes. Staminal column subsessile, about 0.75 mm. long, somewhat conical, truncate at the apex. Corona of 5 lobes arising from the staminal column at the base of the anthers, minute, about ¼ mm. long, pressed close against the back of the anthers and shorter than the latter, ovate, obtuse; they seem to be connected at the base by a minute tooth under the anther-wings, but in the dried flowers this is difficult to determine.

Trinidad (*Dannouse 6419*, TYPE). Collected in 1898.

The genus *Decastelma* is very like *Metastelma* in appearance, but differs by having the staminal column subsessile instead of with a long stipe, and by the corona arising from the staminal column at the base of the anthers instead of at the mouth of the corolla-tube. But the description of the corona of *Decastelma* as given by Schlechter is entirely wrong, unless the flowers on different specimens vary very much. For in the type of the genus, *D. Broadwayi* Schltr. (*Broadway 474*), the flowers that I have examined have a corona consisting of 5 lobes only, which are shorter than the staminal column and pressed close to it; they are broader than long and somewhat truncate at the three-toothed top, the middle tooth being minute.

Probably some species from South America, now placed under the genus *Metastelma*, really belong to *Decastelma*.

71. A NEW GENUS OF MELASTOMACEAE FROM TRINIDAD

NECRAMIUM Britton, gen. nov.

An erect shrub with long branches. Leaves opposite, large, membranous, short-petioled, with a strong midrib and three pairs of veins, the first pair from near the base, the second pair from a short distance above, the third pair from below the middle, the transverse venation widely spreading. Inflorescence of sessile panicles borne on the branches much below the leaves, the panicle-branches filiform; flowers 2 or 3 together, sessile, subtended by subfoliaceous bractlets; calyx subcampanulate with 4 subulate teeth.

Necramium gigantophyllum Britton, sp. nov.

Stems slender, simple or few-branched, quadrangular, 2 m. high or higher, densely scurfy-puberulent above. Leaves oblong to oblong-oblanceolate, 2–4 dm. long, 12 cm. wide or less, entire, green on both sides, but paler beneath than above, glabrous above, scurfy-puberulent on the veins beneath, the apex acuminate, the base narrowed, the stout scurfy petioles 1–2 cm. long; panicles densely pubescent, several-flowered, about 4 cm. long; bractlets oblong-lanceolate, concave, acute, pubescent, 3 mm. long; calyx-tube 2 mm. long, its teeth 1 mm. long; petals and stamens unknown.

Forests at high altitudes, northern mountain range; TYPE from Heights of Aripo (*Trinidad Herbarium 9798*, collected by Broadway, January 10–26, 1922); Mount Tocuche (*Britton, Hazen & Mendelson 1334*), April 3–5, 1920.

72. THE GENUS DORSTENIA IN THE WEST INDIES

Leaves large, deeply lobed or undulate; receptacle quadrate.	1. *D. Contrajerva.*
Leaves small, dentate, crenate or entire; receptacle suborbicular, discoid or cyathiform.	
Leaves not peltate.	
Leaves orbicular, deeply cordate.	
Leaves crenate; receptacle cyathiform.	2. *D. crenulata.*
Leaves entire or obsoletely repand.	
Receptacle pubescent, discoid.	3. *D. tuberosa.*
Receptacle puberulent, about as long as broad	4. *D. Rocana.*
Leaves ovate to oblong or elliptic.	
Leaves ovate, deeply cordate.	5. *D. cordifolia.*
Leaves oblong to elliptic, cordate or subcordate, crenulate.	6. *D. tubicina.*
Leaves peltate.	
Leaves ovate-oblong, peltate very near the base	7. *D. petraea.*
Leaves ovate to orbicular, peltate at the middle or somewhat below.	
Leaves orbicular, pubescent on both sides.	8. *D. peltata.*
Leaves suborbicular to ovate, more or less longer than broad.	

Glabrous throughout; leaves rounded at both ends or the apex very obtuse. 9. *D. crassipes.*
Pubescent or puberulent; leaves acute or bluntly pointed.
Leaves suborbicular, very bluntly pointed. 10. *D. erythrandra.*
Leaves ovate.
Peduncles and petioles puberulent; leaves 6–8 cm. long. 11. *D. Roigii.*
Peduncles and petioles tomentulose or pubescent; leaves 3–5 cm. long.
Receptacle tomentulose, ciliate; peduncle about as long as the petioles. 12. *D. confusa.*
Receptacle puberulent; peduncle much shorter than the petioles. 13. *D. jamaicensis.*

1. DORSTENIA CONTRAYERVA L. Sp. Pl. 121. 1753

Porto Rico; St. Martin; Guadeloupe; Martinique; St. Vincent; Trinidad; Mexico to Colombia and Peru.

2. DORSTENIA CRENULATA C. Wright; Griseb. Mem. Ann. Acad. II. 8: 173. 1860

Banks of rivulets, Monte Verde, Cuba, (*Wright 1447*).

3. DORSTENIA TUBEROSA C. Wright; Griseb. Mem. Ann. Acad. II. 8: 173. 1860

Mountains of northern Oriente, Cuba.

4. **Dorstenia Rocana** Britton, sp. nov.

Rootstock short. Petioles very slender, tomentulose, 5 cm. long or less; leaf-blades orbicular, membranous, deeply cordate, rounded, entire, or some of them obscurely repand, puberulent on the veins beneath, otherwise glabrate, 10–23 mm. in diameter; peduncle filiform, puberulent, about as long as the petioles; receptacle cyathiform, about 5 mm. long and 4 mm. in diameter, puberulent, narrowed below, purple-margined above.

Shaded rocks on banks of Cupeyales, Banao Mountains, Santa Clara, Cuba (*Brother Leon & Father Roca, 8092*, August 5, 1918).

5. DORSTENIA CORDIFOLIA Sw. Prodr. 31. 1788

Central and western Jamaica. Recorded from Haiti.

6. DORSTENIA TUBCINA R. & P. Fl. Per. **1:** 65

Arima Savanna, Trinidad, collected by Purdie, according to Grisebach.

7. DORSTENIA PETRAEA Griseb. Cat. Pl. Cub. 58. 1866

Mountains of southern Oriente, Cuba.

8. DORSTENIA PELTATA Spreng. Neue Entd. **3:** 22. 1822

Santo Domingo, near Samana Bay.

9. DORSTENIA CRASSIPES C. Wright; Griseb. Cat. Pl. Cub. 58. 1866

Near La Catalina, Oriente, Cuba (*Wright 2224*).

10. DORSTENIA ERYTHRANDRA C. Wright; Griseb. Cat. Pl. Cub. 58. 1866

Rocks by the sea, Baracoa, Oriente, Cuba (*Wright 2225*).

11. **Dorstenia Roigii** Britton, sp. nov.

Rootstock stout, 8–10 cm. long, 5–6 mm. thick. Petioles rather stout, densely puberulent, 15 cm. long or less; leaf-blades ovate, peltate below the middle, chartaceous when dry, coarsely undulate-dentate all around, strongly veined, 6–8 cm. long, dark green and scabrous above, paler and densely puberulent beneath, the apex obtuse or acute, the base rounded; peduncle puberulent, 5–7 cm. long; receptacle orbicular, nearly flat, peltate, about 10 mm. in diameter.

On rocks at the foot of Mogote de la Jagua, Consolacion del Norte, Pinar del Rio, Cuba, June 17, 1923 (*Roig 2547*).

12. **Dorstenia confusa** Britton, sp. nov.

Rootstock slender, tuberiferous. Petioles slender, tomentulose, 4–6 cm. long; leaf-blades broadly ovate, membranous, 2.5–3 cm. long, peltate somewhat below the middle, finely pubescent beneath, especially on the veins, repand-crenate, the apex blunt, the base rounded; peduncle tomentulose, about 4 cm. long; receptacle orbicular, nearly discoid, 6 mm. in diameter, tomentulose, ciliate.

Monte Verde, Oriente, Cuba (*Wright 2226*, in Gray Herbarium).

13. DORSTENIA JAMAICENSIS Britton, Bull. Torrey Club **35:** 567. 1908

Limestone cliffs, Manchester, Jamaica.

73. UNDESCRIBED SPECIES FROM PORTO RICO

Maytenus ponceana Britton, sp. nov.

A tree about 12 m. high, with slender, somewhat tortuous, glabrous twigs. Leaves oblong, or oblong-obovate, coriaceous, 9 cm. long or less, indistinctly few-veined with the midrib rather prominent on both sides, shining above, dull beneath, the apex bluntly short-acuminate or obtuse, the base subcuneate, the rather slender petioles 6–8 mm. long; fruiting pedicels 3–5 mm. long, solitary or 2 together in the axils; fruit globose, whitish, 6–8 mm. in diameter.

Hillside, Rio Portugues, north of Ponce (*Britton 7818*). In fruit Feb. 12, 1923.

Eugenia Underwoodii Britton, sp. nov.

A shrub, 2.5–3 m. high, much branched, the very slender gray terete twigs puberulent when young, the inflorescence pubescent. Leaves elliptic or elliptic-lanceolate, chartaceous, 2–5 cm. long, slightly paler green beneath than above, somewhat shining, delicately veined and scarcely reticulated, rather coarsely punctate, flat, the apex acuminate, the base narrowed, the puberulent petioles 1.5–2.5 mm. long; flowers in small short-peduncled racemes near the ends of the twigs; pedicels 2–3 mm. long; bracts about 1 mm. long; calyx-tube campanulate, glabrate, about 1.5 mm. long, the lobes a little shorter, puberulent, ciliate, obtuse; petals nearly 2 mm. long; fruit unknown.

Collected at Yauco. (*L. M. Underwood & R. F. Griggs, 639*.)

Eugenia boqueronensis Britton, sp. nov.

A tree about 8 m. high, the slender short twigs gray, densely tomentose when young. Leaves ovate or elliptic-ovate, coriaceous, 2–3.5 cm. long, shining, nearly equally green on both sides, coarsely blackish-punctate, finely pinnately veined and scarcely reticulated, pubescent on the midvein beneath when young, glabrous or very nearly so when mature, the apex abruptly and bluntly acuminate, the base narrowed, the stout pubescent petioles 2–3 mm. long; racemes few-flowered, about 1 cm. long, borne in the uppermost axils, densely tomentose; pedicels about 3 mm. long; bracts oblong, shorter than the pedicels; calyx-lobes broad, rounded or obtuse, about 1.5 mm. long; petals rounded, not longer than the calyx-lobes; fruit unknown.

Base of limestone hill, Salinas de Boqueron, (*Britton, Cowell & Brown, 4627*).

Eugenia Stewardsonii Britton, sp. nov.

A tree, 5–10 m. high, glabrous throughout, the slender twigs gray. Leaves ovate, subchartaceous, very nearly sessile, 4–6 cm. long, bright green and shining on both sides, the venation rather prominent, coarsely reticulated, the apex obtuse or rounded, the base rounded or subcordate, the stout petioles about 1 mm. long; flowers sessile, in lateral clusters below the leaves; larger calyx-lobes obtuse, about 2 mm. long; fruit subglobose or depressed-globose, 5–7 mm. in diameter.

Mountain forests and summits. Central Cordillera of Porto Rico. Type from the summit of Monte Torrecillo (*Britton, Cowell & Stewardson Brown, 5603*). Included by Urban in *Eugenia cordata* (Sw.) DC.

Eugenia (?) **corozalensis** Britton, sp. nov.

A tree about 6 m. high, the rather slender subterete glabrous forking twigs slightly enlarged below the internodes. Leaves oval-orbicular, chartaceous, glabrous, sessile, 4–7 cm. long, green on both sides, densely punctate, the apex rounded, the base cordate, the venation slender, loosely reticulated; flowers and fruit unknown.

Limestone hill, Corozal (*Britton 7832*).

Eugenia (?) **xerophytica** Britton, sp. nov.

A shrub, or a small tree up to about 4 m. high, much branched, the slender terete twigs and the leaves glabrous. Leaves suborbicular or some of them a little broader than long, coriaceous, glabrous, shining above, yellow-green and reticulate-veined on both sides, 1.5–5 cm. long, the apex obtuse, rounded or short-tipped, the base subcordate or rounded, the stout petioles 2–4 mm. long; flowers and fruit unknown.

Limestone rocks, Cayo Muertos, Porto Rico, (*Britton, Cowell & Brown, 4982*, TYPE); limestone hill, El Tuque, west of Ponce (*Britton 7915*).

Calyptranthes portoricensis Britton, sp. nov.

A tree or shrub, the twigs and inflorescence densely brown-pubescent. Leaves elliptic or ovate-elliptic, coriaceous, glabrous above, pubescent beneath when young, 3–7 cm. long, very obscurely punctate, the apex rounded or acutish, the base obtuse, the midvein prominent beneath, the lateral venation obscure;

peduncles rather stout, 7 cm. long or shorter; panicles several-flowered, the flowers subglomerate, nearly sessile; calyx densely brown-pubescent, about 2 mm. long, obovoid, rounded; fruit finely pubescent, globose, about 5 mm. in diameter.

Vicinity of Maricao. Type from Monte Alegrillo (*Stevens 4718*).

Notes on Fabaceae—III

Per Axel Rydberg

1. HOMALOBUS (*cont.*)

F. Collini

Pod not with prominent coriaceous sutures.
  Pod straight or nearly so.
    Body of the pod 2–2.5 cm. long, not mottled, short-villous. 46. *H. collinus.*
    Body of the pod 2.5–3 cm. long, usually mottled, strigose. 47. *H. californicus.*
  Pod distinctly curved.
    Pod curved in less than a circle.
      Pod erect; leaflets linear. 48. *H. Tweedyi.*
      Pod pendulous.
        Body of the pod 1–1.5 cm. long; leaflets oblong. 49. *H. Laurentii.*
        Body of the pod 2–3 cm. long; leaflets obovate or obcordate.
          Stem and leaves decidedly pubescent.
            Stem and leaves long-villous, body of pod curved usually in less than a semicircle.
              Pod about 4 mm. wide. 50. *H. Gibbsii.*
              Pod about 6 mm. wide. 51. *H. Plummerae.*
            Stem and leaves short-hairy with incurved hairs.
              Body of the fruit 6–7 mm. wide, curved about one-third of a circle, sinuate on the lower suture. 52. *H. sinuatus.*
              Body of the fruit 4–5 mm. wide, curved in about a semicircle, not sinuate on the lower suture. 53. *H. Whitedii.*
          Stem glabrous; leaves glabrous above, sparingly short hairy beneath, often only on the margin and ribs. 54. *H. subglaber.*
    Pod spirally curved, the body forming one and a half to two circles; leaflets linear or oblong.
      Corolla more than 1 cm. long; pod 4–4.5 mm. broad, strongly reticulate. 55. *H. speirocarpus.*
      Corolla 5–6 mm. long; pod 3–3.5 mm. broad. 56. *H. alvordensis.*
Pod with thick coriaceous sutures; leaflets linear.
  Stipe of the pod nearly as long as the flat body. 57. *H. podocarpus.*
  Stipe of the pod about half as long as the more turgid body. 58. *H. bicristatus.*

46. HOMALOBUS COLLINUS (Dougl.) Rydb.

Phaca collina Hook., was described from specimens collected by Douglas in the Blue Mountains, Oregon. Hooker described the corolla as having a purple spot and G. Don gives it as purple. As far as I know the corolla in all the species of the group is ochroleucous or straw-colored without any purple. In herbarium specimens the corolla often shows a darker spot, but this is probably due to stain from the pistil. In any case this darker spot contains no purple or blue. Otherwise, Hooker's description is full and agrees with our plant so closely that there seems to be no doubt about the correctness of our interpretation. The range of the species includes Washington and Oregon, southern British Columbia, and western Idaho *Astragalus cyrtoides* A. Gray, is evidently a synonym of this. See under *A. Gibbsii.*

47. HOMALOBUS CALIFORNICUS (A. Gray) Heller. This is closely related to the preceding and is distinguished mainly by its longer and mottled pod*.

NORTHERN CALIFORNIA: Hornbrook, *T. Howell 1351;* between Iguna and Weed, *Heller 8082;* Pit River Ferry, *H. E. Brown 284;* Mount Shasta, *464;* Weed, *L. E. Smith 197;* Yreka, *Greene,* in 1876.

48. **Homalobus Tweedyi** (Canby) Rydb. comb. nov.

Astragalus Tweedyi Canby, Bot. Gaz. **15:** 150. 1890.

This is related on the one hand to *H. collinus* and on the other to *H. Gibbsii*, but it differs from both in the ascending stipe and nearly erect body of the fruit. In general habit and in the narrow leaflets it resembles *H. collinus*, but the pod is curved as in *H. Gibbsii.*

WASHINGTON: Yakima County, *Brandegee 731.*

OREGON: "Eastern Oregon," *T. Howell*, in 1880; Fifteen Mile Creek, *Lloyd*, in 1894.

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* Jones in his recent "Revision" placed this species in the *Homalobi*, together with *Astragalus stenophyllus, A. Antiselli, A. porrectus* and *A. inversus*, giving it No. 7, while the rest of the group he placed in his *Collini, A. collinus*, its closest relative being No. 93.

49. **Homalobus Laurentii** Rydb. sp. nov.

A perennial, with a cespitose caudex; stems 3–4 dm. high, striate, short-pubescent with incurved hairs; stipules triangular, 3–5 mm. long; leaves 3–7 cm. long; leaflets seven to seventeen, oblong, 8–13 mm. long, short-villous on both sides; racemes 1–2 dm. long; bracts lanceolate, 2–3 mm. long; calyx short-villous, the tube 8 mm. long, gibbous on the upper side, the two upper teeth triangular, the three lower lanceolate, 2 mm. long; corolla achroleucous; pod villous, stipitate, the stipe 5–7 mm. long, the body slightly curved, 10–15 mm. long, 4 mm. wide; seed obliquely reniform, 3 mm. long, 2 mm. wide.

TYPE collected east of Heffner, Oregon, *W. E. Lawrence 744* (herbarium of the New York Botanical Garden); also at the same locality, *745*.

50. **Homalobus Gibbsii** (Kellogg) Rydb. comb. nov.

Astragalus Gibbsii Kellogg, Proc. Calif. Acad. **2**: 161. 1862.

Astragalus Gibbsii was described from the headwaters of the Carson River. Since Kellogg's description is not complete and since his figure does not show any fruit it is a little doubtful if his plant was the same as the plant usually regarded as this species. This plant was collected by Anderson at Carson City and described by Gray* who included it under *A. cyrtoides*. It is, however, not the original *A. cyrtoides* A. Gray,† for this is described as having linear-oblong leaflets glabrous above, which fits only *H. collinus* and *H. californicus* among the species of this group. As, however, the fruit of *A. cyrtoides* was unknown, the identification has remained doubtful; but the type resembles *H. collinus* so closely that I do not hesitate to refer it to that species.

NEVADA: about Washoe Lake, *C. F. Baker 1072;* King's Cañon, *1035;* Carson City, *Anderson*, in 1863 and 1864; Eagle Valley, *Stretch 38;* Carson City, *M. E. Jones*, in 1883.

CALIFORNIA: Plumas County, *Heller & Kennedy 8868;* Modoc County, *Austin & Bruce 2212;* Sierra County, *Lemmon 977*.

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* Proc. Am. Acad. **6**: 525. 1865.
† Proc. Am. Acad. **6**: 201. 1864.

51. **Homalobus Plummerae** Rydberg, sp. nov.

Astragalus cyrtoides M. E. Jones, Zoe, **4**: 31. 1893. Not *A. cyrtoides* A. Gray, 1864.

A perennial, with a cespitose woody caudex; stems terete, striate, and villous with spreading hairs, 2–3 dm. high, stipules triangular, striate, distinct, 2–3 mm. long; leaves 4–7 cm. long; leaflets seven to thirteen, obcordate, 8–15 mm. long, 5–10 mm. wide, villous on both sides; peduncles 5–8 cm. long; raceme short and dense, in flowers 2–3 cm. long, in fruit 5–7 cm. long; bracts lanceolate, 2–3 cm. long, longer than the pedicels; calyx pilose-villous, the tube 8 mm. long, gibbous below on the upper side, the upper two teeth triangular, the lower three lanceolate, 1 mm. long; corolla ochroleucous, about 14 mm. long, similar to that of *H. Gibbsii*; pod short-villous, stipitate, the stipe about 8 mm. long, the body lunate, gradually tapering at each end, 2–2.5 cm. long, 7–8 mm. wide, reticulate; seeds reniform, 2.5 mm. long.

TYPE collected in Sierra County, California, in 1875, *J. G. Lemmon 622* (herbarium of Columbia University). The species is dedicated to Mrs. Lemmon, whose maiden name was Plummer. It is related to *H. Gibbsii*, differing in the broader fruit. *Lemmon 78*, without locality, also belongs here.

52. **Homalobus sinuatus** (Piper) Rydb. comb. nov.

Astragalus sinuatus Piper, Bull. Torrey Club **28**: 40. 1901.
Phaca sinuata Piper, Contr. U. S. Nat. Herb. **11**: 370. 1906.

This is related to the preceding and the next following species, differing from the former in the short pubescence, from the latter in the much broader pod, and from both in the sinuate lower suture of the pod.

53. **Homalobus Whitedii** (Piper) Rydb. comb. nov.

Astragalus speirocarpus falciformis A. Gray, Bot. Calif. **1**: 152. 1876. Not *A. falciformis* Desf. 1802.
Astragalus speirocarpus curvicarpus Sheldon, Minn. Bot. Stud. **1**: 125. 1894.
Astragalus Gibbsii falciformis M. E. Jones, Contr. West. Bot. **8**: 23. 1898.
Astragalus Gibbsii curvicarpus M. E. Jones, Contr. West. Bot. **10**: 62. 1902.

Astragalus Whitedii Piper, Bull. Torrey Club **29**: 224. 1902.
Homalobus curvicarpus Heller, Muhlenbergia **2**: 86. 1905.
Astragalus curvicarpus Macbr. Contr. Gray Herb. II. **65**: 38. 1922.

This is a fairly well known plant but has usually been considered a variety under different species. Heller raised it to specific rank, not knowing that it was the same as *A. Whitedii* Piper.

OREGON: Malheur County, *Leiberg 2187, 2332;* Stein's Mountain, *T. Howell,* in 1885; Rock Creek, *Leiberg 66.*

IDAHO: Nampa and Boise, *Mulford,* in 1892; Shoshone Falls, *Nelson & Macbride 1839;* Plymouth, *Macbride 75;* Big Butte, *Palmer 232.*

NEVADA: Pah-Ute Mountains, *S. Watson 282;* Reno, *Kennedy,* in 1901; *Curran,* in 1885.

CALIFORNIA: Goose Lake, *Mrs. Austin,* in 1885; Eagle Lake, *Mrs. Austin,* in 1879; *Brandegee,* in 1887; Grenada Station, Siskiyou County, *Heller 8066;* without locality, *Lemmon, 77;* Fall River, Shasta County, *Hall & Babcock 4252;* Sierra County, *Lemmon 621.*

54. **Homalobus subglaber** (A. Gray) Rydb. sp. nov.

Astragalus collinus subglaber A. Gray, in herb.

A perennial, with a cespitose caudex; stems 2–3 dm. high, striate, glabrous or nearly so; stipules deltoid, distinct, 2 mm. long; leaves 4–8 cm. long; leaflets 11–25, oblong, obovate or oblanceolate, 5–10 mm. long, 2–5 mm. wide, glabrous above, sparingly short-hairy beneath, often only on the margins and midrib, truncate or retuse at the apex, acute at the base; peduncles 5–10 cm. long; raceme 3–5 cm. long; bracts lanceolate, 2 mm. long; calyx villous, the tube 8 mm. long, gibbous on the upper side, the upper two teeth broadly triangular, the lower three lanceolate, 0.5 mm. long; corolla ochroleucous, 14 mm. long, similar to that of *H. collinus*; pod sparingly short-pubescent, stipitate, the stipe 8–10 mm. long, the body arcuate, 12–18 mm. long, 3 mm. wide.

TYPE collected on John Day River, Oregon, May 11, 1882, *Thomas I. Howell* (herbarium of the New York Botanical Garden).

This was distributed by Howell under the name *Astragalus collinus subglaber* A. Gray, but it is evidently more closely related to *H. Gibbsii*, lacking the long dense pubescence of the latter species. The little pubescence on the lower surface of the leaves and the calyx and pod is similar to that of *H. curvicarpus* but sparser. The pod, however, is more like that of *H. Gibbsii.* Besides the type the following specimens belong here:

OREGON: locality doubtful, *Lloyd*, in 1898; Moro, *N. Morrison*, in 1894; Eastern Oregon, *Cusick 1878.*

55. **Homalobus speirocarpus** (A. Gray) Rydb. comb. nov.

Astragalus speirocarpus A. Gray, Proc. Am. Acad. **6:** 225. 1866.

Gray formed a section from this and *H. podocarpus* on account of the thick sutures, which according to him separate from the valves of the pod, a character which is not manifest in the herbarium specimens seen. The flower of this as well as of *H. podocarpus* is the same as that of *H. collinus* and *H. Gibbsii*, and the pod of *H. speirocarpus* is practically the same as in the latter species except that it is longer, more reticulate and more curved often forming two almost complete circles.

WASHINGTON: Columbia River, opposite Alkali, *Howell*, in 1882; North Yakima, *Griffiths & Cotton 45;* Natchey Valley, *Piper 2758;* Wenash, *Lyall;* Yakima County, *Henderson 2351; Brandegee 32, 728;* Morgans Ferry, *Suksdorf 277.*

56. **Homalobus alvordiensis** (M. E. Jones) Rydb. comb. nov.

Astragalus alvordiensis M. E. Jones, Contr. West. Bot. **10:** 67. 1902.

Notwithstanding the fact that the author placed this species in another part of the genus *Astragalus**, the species is evidently closely related to the preceding, differing in the small flowers and fruit. The latter is similar, less spiral and more turgid. It is known only from the type locality.

57. **Homalobus podocarpus** (Hook.) Rydb. comb. nov.

Phaca podocarpa Hook. Fl. Bor. Am. **1:** 142. 1831. Not *Astragalus podocarpus* Meyer, 1831.

Astragalus sclerocarpus A. Gray, Proc. Am. Acad. **6:** 225. 1866.

Though the specific name *podocarpus* is not available in *Astragalus*, it is in *Homalobus*. The pod is quite different in

* Jones has corrected this error in his recent "Revision".

structure from all the preceding species of this group. It approaches that of *H. Plummerae* but is distinguished by the thick sutures. The habit of the plant is more like that of *H. collinus.*

WASHINGTON: Columbus, Klickitat County, *Suksdorf*, in 1909; same locality, *Suksdorf 852*, in 1886; Douglas County, *Sandberg & Leiberg 312;* Egbert Springs, *Sandberg & Leiberg*, in 1893; North Yakima, *Henderson 2352;* Yakima County, *Brandegee 727; Suksdorf 279, 280;* Pasco, *Piper 2955;* Walla Walla, *Colton 1043.*

OREGON: Alkali, *T. Howell*, in 1882.

58. **Homalobus bicristatus** (A. Gray) Rydb. comb. nov.

Astragalus bicristatus A. Gray, Proc. Am. Acad. **19:** 75. 1883.

This species is evidently related to the preceding, the flowers being practically those of this group of *Homalobus*, but on account of its more turgid, leathery fruit it is somewhat anomalous in the genus.

CALIFORNIA: San Bernardino Mountains, *Parish 3000, 1277, 1277a, 3743;* San Antonio Mountains, *H. M. Hall 1247;* San Gabriel Mountains, *Abrams & McGregor 646; Parry & Lemmon 92.*

G. PORRECTI

59. **Homalobus porrectus** (S. Wats.) Rydb. comb. nov.

Astragalus porrectus S. Wats. Bot. Kings Rep. 75. 1871.
Tragacantha porrecta Kuntze, Rev. Gen. Pl. 947. 1891.

This species is rather unique in the genus *Homalobus.* If the pod is taken into consideration, it might have been placed among the *Collini* as it is somewhat similar to that of *H. Tweedyi*, the stipe being ascending and the body erect; but the flower is not that of this group, for the calyx-tube is short-campanulate and the calyx-lobes elongate and of the same length, while the banner is narrow, retuse at the apex, and much longer than the other petals. It is therefore best to regard this species as constituting a section by itself.

NEVADA: Trinity Mountains, *S. Watson 284;* Reno, *Stokes*, in 1900.

The rest of the groups included by me in *Homalobus*, I rather think, should be removed from the genus. *Astragalus loncho-*

carpus A. Gray evidently does not belong there. *A. Hallii* A. Gray is just as good a species of *Phaca* as of *Homalobus*. The disposition of *A. flexuosus* and its allies is harder to settle. In general habit it resembles some of the species of *Homalobus* but the pod is terete, and it would be better to limit that genus to the flat-podded species.

KENTROPHYTA Nutt.

The genus *Kentrophyta* was established in 1838, in Torrey & Gray's Flora of North America. It was based on two species, *K. montana* and *K. viridis*, with an unnamed variety of the former. Gray merged the genus into *Astragalus* and united the species under the name *A. Kentrophyta* A. Gray. Thirty-three years later Watson described a species under the name *A. tegetarius* and a variety under the name *A. Kentrophyta elatus*, but failed to see the close relationship of the former to *A. Kentrophyta*, placing it in a far remote section of *Astragalus*. In 1899 A. Nelson added a fourth species, *A. aculeatus*, to the group. The remaining species have been described by the present author.

The species are very closely related and some botanists are inclined to regard them as a single variable species. If so this would have at least eight marked varieties.

1. KENTROPHYTA MONTANA Nutt. This species, the type of the genus, is characterized by the scarious stipules, united high up, long-acuminate or cuspidate. but scarcely spinulose, by the subulate leaves, scarcely narrowed at the base and by the very compressed pod. It is the most eastern and northern and the best known of the species, ranging from Saskatchewan and Alberta to Colorado and western Nebraska. Sheldon changed the name to *Astragalus viridis*, mistaking it for *Kentrophyta viridis*.

SASKATCHEWAN: Gull Lake, *J. Macoun;* Cypress Hills, *27;* Milk River, *10191*.

MONTANA: Yellowstone, *Hayden*.

SOUTH DAKOTA: White River, *Wallace;* Smithville, *T. A. Williams*.

WYOMING: Bitter Creek, *Britton;* "Rocky Mountains," *Nuttall;* Pine Bluffs, *A. Nelson 3621;* Badger, *2751;* Upper Platte, *Geyer 123*.

NEBRASKA: Scotts Bluffs, *Rydberg 79;* Belmont, *Webber;* Court House Rock, *Rydberg 79a.*

NEW MEXICO: Upper San Juan, *McComb's Expedition;* Inscription Rock, *Bigelow* (Whipple Expedition).

2. KENTROPHYTA VIRIDIS Nutt. This has been ignored by all later authors, except myself, though Nuttall pointed out that the green stipules were different in being distinct nearly to the base, more attenuate and sometimes spinulose-tipped. It seems to be a rare species, as I have seen only one collection besides the type.

WYOMING: Platte Plains, *Nuttall.*

COLORADO: Palisades, *Crandall,* in 1898.

3. KENTROPHYTA IMPENSA (Sheld.) Rydb. This was first described as *A. Kentrophyta elatus,* which name Sheldon changed to *A. viridis impensus.* It differs from *K. montana* in the elongated stems and in the long, almost distinct and decidedly spinulose stipules; from *K. viridis* in the stiff, spiny leaflets and in the lanceolate pod, 6–7 mm. long. Evidently M. E. Jones* mistook this species for *K. montana.*

COLORADO: Grand River Cañon, *Eastwood.*

UTAH: Maple Cañon, *Garrett 2647;* Fish Creek Cañon, *2512;* Lost Creek, *Jones 5833;* Southern Utah, *Parry 54;* Beaver Valley, *Palmer 122.*

NEW MEXICO: Shiprock Agency, *Standley 7850;* Fort Wingate, *Dr. Matthews,* in 1883.

ARIZONA: Navaho Reservation, *University of Arizona.*

NEVADA: Holmes Creek Valley, *Watson 291;* Bennett Springs, *Purpus 6275.*

4. KENTROPHYTA TEGETARIA (S. Wats.) Rydb. Watson placed *A. tegetarius* between *A. pauciflorus* (*Homalobus vexiliflexus*) and *A. miser,* but it is really a very close relative of *K. montana,* differing in the smaller flowers in more elongate racemes and in the shorter leaflets, distinctly tapering to the base as well as to the apex. This species seems to be confined to the East Humboldt or Ruby Mountains of Nevada.

NEVADA: East Humboldt Mountains, *S. Watson 286;* Death, *Heller 9223.*

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* Zoe 3: 298.

5. KENTROPHYTA ACULEATA (A. Nels.) Rydb. This was first collected by Nuttall and first described as *K. montana* β in Torrey & Gray's Flora. It was again described as *A. tegetarius implexus* Canby. M. E. Jones* makes the statement that it "does not seem to be worthy of varietal rank, as it is only a condensed form." Evidently Jones had misinterpreted *A. tegetarius* S. Wats., for *H. aculeatus* has much larger flowers, 5–7 mm. long, on very short peduncles, while in *A. tegetarius* they are only 3–5 mm. long and in racemes equalling or exceeding the leaves. Jones also in two places† states, first that *A. aculeatus* is "a form of *A. Kentrophyta*," and later that it is "*A. tegetarius*." Neither is true, though it is related to both.

OREGON: Wallovoa Mountains, *Cusick 2350, 1364*.

MONTANA: Cedar Mountain, *Rydberg & Bessey 4487*.

WYOMING: Dome Lake, *A. Nelson 2445;* Union Pass, *1077;* Nez Perces Creek, *6205;* Sheep Mountain, *Tweedy 256;* between Sheridan and Buffalo, *Tweedy 3189;* Big Horn Mountains, *Tweedy*, in 1898; Yellowstone Park, *R. S. Williams*, in 1888; *Rydberg & Bessey 4488; Kelsey*, in 1890; Headwaters of Cliff Creek and Upper Buffalo Fork, *C. C. Curtis;* Doyle Creek, *Goodding 372;* Big Horn Mountains, *Jack 8, 16;* West Yellowstone, *Payson 1913*.

COLORADO: Georgetown, *Jones 679*;* Chambers Lake, *Baker*, in 1896.

UTAH: Big Cottonwood Cañon, *Garrett 1543;* Fish Lake, *Jones 5810;* Alta, *Jones 1127‡; Leonard 181*.

IDAHO: Clyde, *Macbride & Payson 3127;* Mackay, *Nelson & Macbride 1474*.

6. KENTROPHYTA WOLFII Rydb. First described as *Homalobus Wolfii* Rydb. It is known only from the type collection, *Wolf 243*, from South Park, Colorado. It is related to *K. aculeata*, but differs in the small flowers, short leaflets and the grayish loose pubescence.

7. KENTROPHYTA MINIMA Rydb. Closely related to the preceding but differing in the short pubescence, the long stipules, and short pod.

* Proc. Calif. Acad. II. **5:** 650. 1895.

† Contr. West. Bot. **10:** 68. 1902; **12:** 11. 1908.

‡ These specimens were first named *A. Kentrophyta*, later corrected by Jones to *A. tegetarius*.

WYOMING: Yellowstone Park, *Tweedy 83; Rose 149.*

8. **Kentrophyta ungulata** (M. E. Jones) Rydb. sp. nov.

Astragalus Kentrophyta ungulata M. E. Jones, Proc. Calif. Acad. II. **5**: 650. 1895.

This is related to the two preceding but differs in the almost white strigose pubescence and in the more tinged pod.

NEVADA: Monitor Valley, *Watson 290;* Sprucemont, *Jones.*
UTAH: George Fork, Terron Creek, *Tidestrom 1366.*

9. **Kentrophyta rotunda** (M. E. Jones) Rydb. sp. nov.

Astragalus tegetarius rotundus M. E. Jones, Proc. Calif. Acad. II. **5**: 650. 1895.

Astragalus Kentrophyta rotundus M. E. Jones, Contr. West. Bot. **10**: 63. 1902.

The synonyms show that this was first regarded as a variety of *K. tegetaria* and later as one of *K. montana.* It is closely related to the former but still more closely to *K. ungulata.* It is a greener plant, the leaves being glabrate above.

UTAH: Panguitch Lake, *Jones 6002;* Loa, *56496;* American Fork Cañon, *Leonard 167.*

Mr. Jones has described another variety, *Astragalus Kentrophyta coloradensis*, from Lee's Ferry, Arizona. This I have not seen, but from the description it seems that it might belong to *K. impensa.*

NEW YORK BOTANICAL GARDEN

The mid-styled form of Piaropus paniculatus

Alice M. Johnson

(WITH TWO TEXT FIGURES)

Certain species of the Pickerel Weed Family (*Pontederia cordata* and *rotundifolia*) are completely trimorphic, while other species are, as far as is known, incompletely trimorphic. Thus, for *Piaropus azureus* (Sw.) Raf., only the short-styled and long-styled forms are known, for *P. crassipes* (Mart.) Britton only the long-styled and mid-styled forms have been reported, and for *P. paniculatus* (Spreng.) Small only the mid-styled form has been observed to date (see Fig. 1).

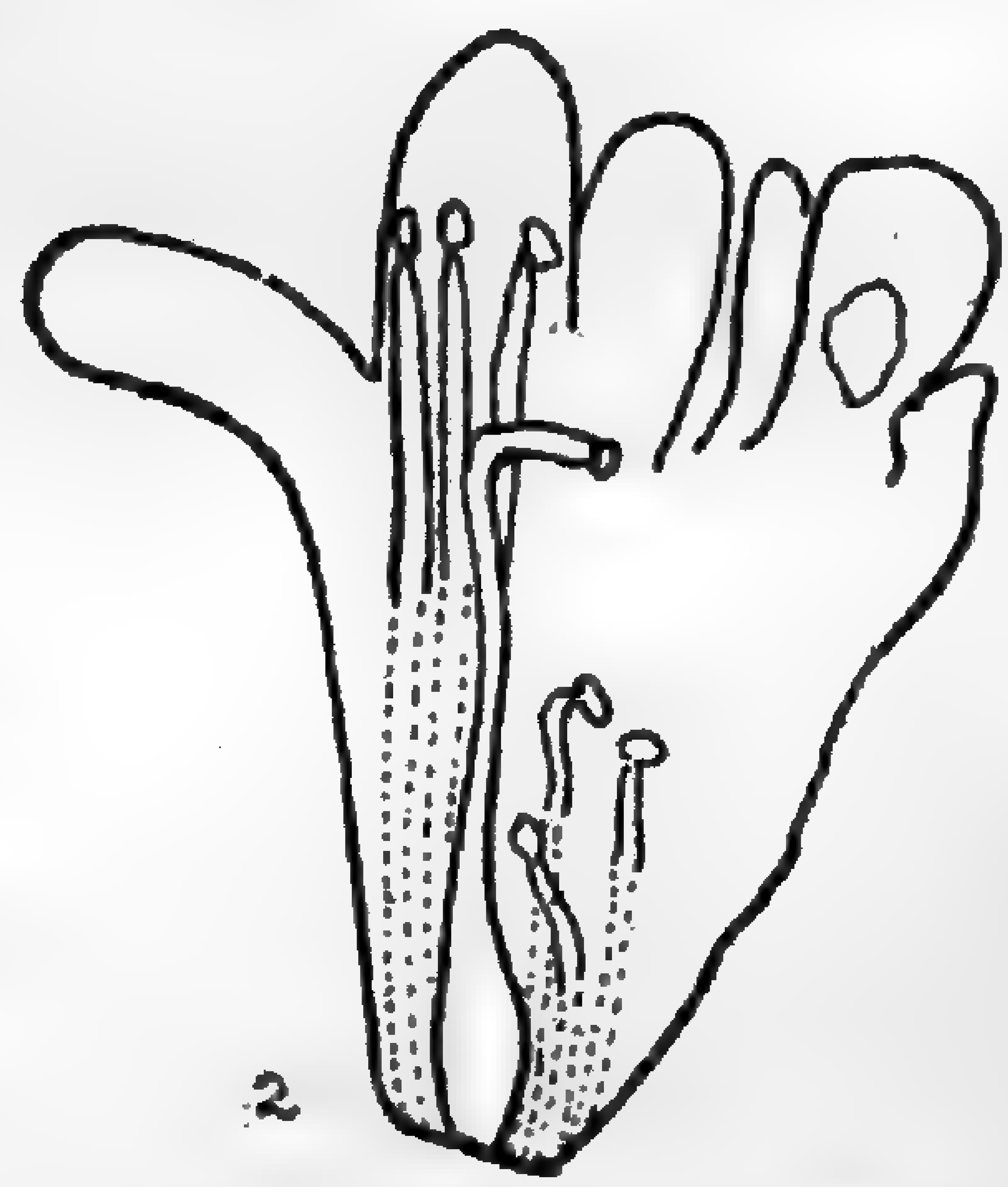

Fig. 1. Drawing of corolla of flower of *P. paniculatus* opened out to show relative lengths and positions of the pistil and the two sets of stamens (× 3).

At least for *P. paniculatus* seed production is not uncommon. In the spring of 1920 Professor Tracy E. Hazen gathered seed from the single form of this species growing in the Royal Botanical Garden in Trinidad. Plants from this seed grown at the New York Botanical Garden also produced seed. The natural production of seed in this one form raises the question whether there are here any limitations to fertility and seed production such as have been considered characteristic of trimorphic species (see especially Darwin, 1865 and 1877, for *Lythrum Salicaria*). It is obvious that in the production of seed by plants of only the mid-styled form, as in *P. paniculatus*, there is no opportunity for legitimate pollinations, such as exist when two or three different forms are growing together. There is, however, opportunity for discriminative fertilizations involving the two sets of stamens either in selfing or in crossing and also for variation among plants either in self-compatibility or in cross-compatibility. It was to determine these points that the investigation here reported was undertaken.

MATERIAL

From seed of *P. paniculatus* brought from Trinidad by Professor Hazen in the spring of 1920, several plants were grown in the New York Botanical Garden. From the seed of one of these a progeny of 17 plants was grown and from the seed of one of these another generation of 20 plants was grown. All these plants were definitely to be classed as mid-styled.

FIG. 2. Stalk of *Piaropus paniculatus* with seventeen fine capsules all frcm illigitimate self-pollination.

RESULTS OF SELF-POLLINATIONS

The 37 plants of the two generations were all tested for seed production to controlled self-pollinations, using pollen from both sets of stamens. A total of 186 pollinations were made with pollen of long stamens, the number ranging from 1 to 18 flowers per plant. Of these 157 were successful, yielding from 8 to 70 seeds per capsule and with an average of 31.

A total of 118 self-pollinations were made with the pollen from short stamens. Of these there were 24 failures and 94 successes that yielded pods, containing from 6 to 63 seeds per pod with the average at 36.

One stalk of a highly self-compatible plant produced 13 long-selfed pods and 4 short-selfed pods (see FIG. 2). The counts of seeds in the former were as follows: 32, 39, 41, 44, 47, 51, 54, 56, 57, 58, 59, with an average of 50, while the counts for 3 of the short-selfed pods (seed lost from one of the four) were 35, 43, 61, with an average of 49.

For another highly self-compatible plant there were 14 fine pods out of 15 long-self-pollinations and 4 fine pods to 4 short-selfings.

There were a few plants that gave a high proportion of failures and a low number of seed per pod. These failures may have been due to low grades of self-compatibility or to experimental errors in that pollen may not have been applied when the pistils were most receptive or the pollen in the best condition. But every plant produced some pods with viable seeds to both short- and long-pollen.

RESULTS OF CROSS-POLLINATIONS

A total of 33 plants were involved in the cross-pollinations that were made. Of 100 crosses with pollen of long stamens, 62 produced pods with seeds per pod ranging from 2 to 58 and an average of 24. The 73 crosses involving short-pollen gave 50 pods with seed per pod ranging from 4 to 59 and with an average of 30. Among the crosses there were five reciprocals which yielded pods and seeds in each of the four pollinations possible between them.

In all but 5 of the crosses that failed only one flower was used so that no definite evidence exists of the presence of cross-incompatibility in these plants. The results indicate a very general cross-compatibility.

MEASUREMENTS OF POLLEN

H. Müller (1873) reports decided differences in the size of pollen from the different lengths of stamens in the three forms of *Lythrum Salicaria* (see also Darwin, 1877). Darwin (1877) reports such differences based on average measurements for pollen in a species of *Pontederia*. Such differences are reported for *Pontederia cordata* by Halsted (1889) and by Hazen (1918). In these cases the pollen of long stamens is found to be larger than pollen of short stamens while the pollen of mid-stamens is intermediate in size.

In making the measurements here reported pollen grains from several anthers and from several flowers of each plant were mounted in water and numerous measurements made to determine the ranges in size. The pollen of long stamens measured 38–88 μ in length and from 32–70 μ in short diameter. Only one grain was found 88 μ long, only one 76 μ, and only one 74 μ. For the greatest number of grains the long diameters were from 38 μ to 70 μ, inclusive. The pollen from short stamens measured 34–62 μ in long diameter and 26–54 μ in short diameter.

The amount of overlapping in size of pollen of the two sets of stamens for individual plants was from 0 to 20 μ. For only two plants was there no overlapping. For 21 plants the overlapping was more than 6 μ and for some of these it was as much as 12 μ. This means that for a large number of plants many of the pollen grains in the two sets of stamens were identical in size.

CONCLUSIONS

As far as now known *Piaropus paniculatus* exists as an incompletely trimorphic species or as a homomorphic species with two sets of stamens differentiated as in the mid-styled form of a trimorphic species.

Each of the 37 plants tested with its own pollen either from long or from short stamens produced pods with viable seeds, thus reproducing in some cases abundantly to what constitutes illegitimate fertilization.

There was no evidence of real and inherent differences in the degrees of self-compatibility or of cross-incompatibility. The differences observed may well have involved errors in manipulation.

The mid-styled form of *P. paniculatus* appears to reproduce true to form through seed progenies.

NEW YORK BOTANICAL GARDEN.

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BULLETIN

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Internal sori of Puccinia Sorghi

Mabel A. Rice

(with four text figures)

During a series of cytological studies made upon *Puccinia Sorghi* on corn I found several cases of internal sori both of uredo and of teleutospores. Such phenomena have already been reported from a variety of sources, and for the whole series of rust spores: spermatia, aecidiospores, uredospores, and teleutospores. The cases which I have found reported are listed below.

Occurrence of Internal Rust Sori

Date	Author	Parasite	Spore Stage	Host	Location
1885	Smith, W. G. (19)	*Puccinia graminis* Pers.	III	*Aveua* sp.	Between gluten and starch layers of seed.
1886	Smith, W. G. (20)	*Puccinia graminis* Pers.	I	*Berberis vulgaris*	In cotyledons of seeds within barberry fruit.
1896	Eriksson, J. (9) & Henning, E.	*Puccinia glumarum* (Schmidt) E. & H.	II III	Cereal Grains	In pericarp
1898	Bolley, H. S. & Pritchard, F. J. (4)	*Puccinia graminis-tritici* E. & H.	II III	*Triticum* sp.	Beneath bran laye and about embryo of seed.
1899	Klebahn H. (12)	*Puccinia cari-bistortae*	I	*Carum Carvi*	In parenchyma of stem within fibrovascular bundles.

[The Bulletin for January (51: 1–36) was issued Feb. 8, 1924.]

1907	Marryat, D. (12a)	*Puccinia glumarum*	II	*Triticum monococcum vulgare*	In leaf
1908	Clinton, G. P. (5)	*Gymnosporangium macropus* Lk.	o I	*Pirus Malus* *Pirus Malus*	Within the fruit tissue. In the seed cavities.
1909	Stämfli, Ruth (21)	*Uromyces Pisi*	o	*Euphorbia cyparissias*	At insertion of abortive seeds.
1911	Pritchard, F. J. (15)	*Puccinia graminis-tritici* E. & H.	III	*Triticum* sp.	In seed near hilum.
1911	Pritchard, F. J. (16)	*Puccinia graminis-tritici* E. & H.	III	*Triticum* sp.	In pericarp of wheatseed.
1912	Reynolds, E. S. (17)	*Puccinia Xanthii*	III	*Xanthium canadense*	In mesophyll of leaf.
1913	Beauverie, M. J. (2)	*Puccinia glumarum*	III	Several Gramineae	On glumes and pericarps.
1913	Wolf, F. A. (23)	*Puccinia angustata*	II	*Lycopus virginicus*	In parenchyma of petioles and stems.
1913	Atkinson, G. F., Edgerton, C. W. Reddick, D. (23)	*Nigredo Caladii* (Schw.) (*Uromyces Caladii* Farlow)	I	*Peltandra virginica*	?
1913	Reddick, D. (23)	*Puccinia graminis* Pers.	I	*Berberis vulgaris*	In fruit.
1913	Reddick, D. (23)	*Dicaeoma poculiforme* (Jacq.) Kuntze = (*Puccinia graminis* Pers.)	II	*Secale* sp.	In stem.
1914	Fromme, F. D. (10)	*Puccinia Claytoniata* Peck	o	*Claytonia virginica*	Deep in parenchyma of stem.
1916	Adams, J. F. (1)	*Nigredo caryophyllina* (Schrank) Arthur (*Uromyces caryophyllinus* (Schroeter)	II	*Dianthus Caryophyllus*	In leaves.

1917	Colley, R. H (7)	*Cronartium ribicola*	III	*Ribes* sp.	In pith and pericycle of petioles.
1917	Colley, R. H. (8)	*Cronartium ribicola*	II	*Ribes hirtellum* Michx.	In cortex of stems.
1917	Colley, R. H. (8)	*Cronartium ribicola*	I	*Pinus Strobus*	In resin ducts of stem.
1920	Taylor, Minnie (22)	*Puccinia albiperidia* Arthur		*Ribes glandulosum*	In fruit and seeds.
1920	Hungerford, C. W. (11)	*Puccinia graminis-tritici*	II III	*Triticum* sp.	In pericarp of hilar end of seed.
1923	Dodge, B. O. (8a)	*Pucciniastrum americanum* (Farl.)	II	*Rubus strigosus*	In cortex of stem.

Such a list of cases of internal sori indicates that they are by no means rare. They are of interest in connection with the whole problem of the interrelations of host and parasite, as well as in connection with the problem of the causes underlying the production of the different spore forms of the rusts. In a number of cases mentioned above the occurrences were reported by the authors as having a possible bearing upon the overwintering of the rust (Smith, **19**, **20**; Eriksson & Henning, **9**; Bolely, **4**; Pritchard, **4**, **15**, **16**; Beauverie, **2**; Hungerford, **11**). Others report merely brief notices of an abnormality (Klebahn, **12**; Marryat, **12a**; Clinton, **5**; Stämfli, **21**; Reynolds, **17**; Atkinson, **23**; Edgerton, **23**; Reddick **23**; Fromme, **10**; Taylor, **22**; Dodge, **8a**). Wolf (**23**), Adams (**1**), and Colley (**7**, **8**) have given more attention to the cases. They agree in considering internal spore-formation as a non-adaptive, abnormal development of the parasite. Wolf (**23**) lays to chance the more deep-seated position of some sori, which causes them to push inward and open toward the center as the line of less resistance. He believes the causes must be the same as those which bring about production of spores in general. Adams (**1**) considers the development of the internal uredosori favored by an abundant mycelium and by the texture of the *Dianthus* leaf, which "allows wide ramifications of the rust mycelium." Colley (**7**) thinks internal sori are to be expected, in spite of unfavorable position, whenever the point at which the sorus begins to form is located beneath a layer of tissue which offers a greater resistance than the developing sorus can overcome. In the many cases where internal sori are obviously formed under conditions which afford ample space it may still be that the line of least resistance is inward. The point of interest in both these cases is why the fungus should form spores under either of these conditions. Miss Marryat (**12a**) reports a very interesting case in the formation of abortive sori in immune Einkorn wheat. They lay beneath the epidermis and deep down in the leaf tissue. The spores however were small, ill-shaped,

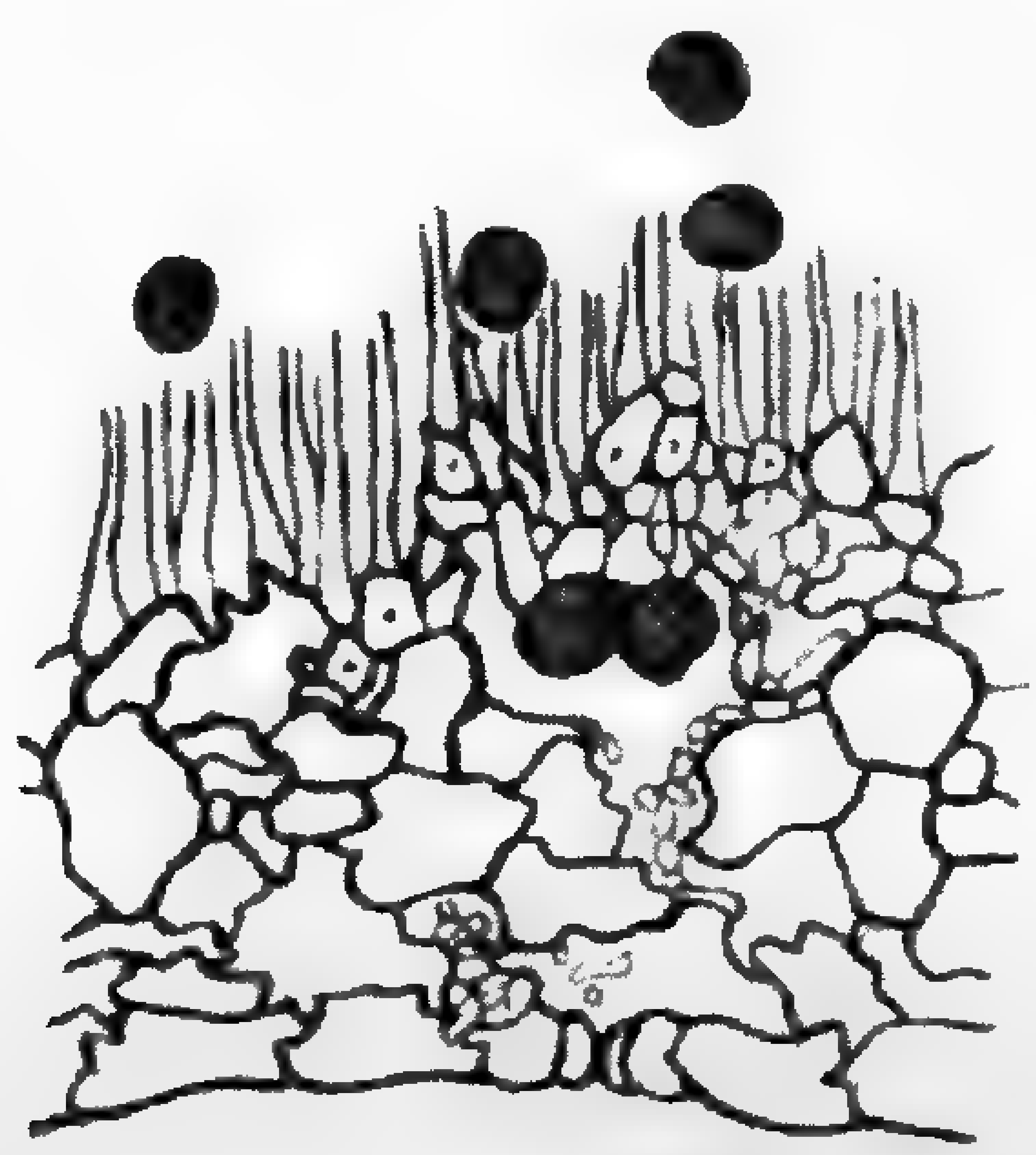

FIG. 1. Uredospores in a pocket at the base of an external sorus on a corn leaf. Stalks of the uredospores are represented diagrammatically and incomplete as they were shrunken in the preparation. Drawing made with camera lucida, × 160.

and scarcely recognizable as such. This would seem to be a case in which the general impoverished condition of the fungus had led to widespread abortive attempts at spore formation in the mycelium.

I found internal sori of *Puccinia Sorghi* on corn grown in the plant house of Columbia University during 1921 and 1922. The material was fixed in Fleming's medium solution, cut 7.5 μ thick, and stained with triple stain. Two instances of uredosori were observed: one in a leaf, the other in a leaf sheath. Several instances of teleutosori were found: in the leaf, in the leaf sheath, in the stem, and in the soft tissue of an abnormally branched ear.

The first instance was one of uredospores found in April 1921, in sections made through an erumpent sorus upon a mature leaf. The mesophyll is heavily infected with crowded intercellular hyphae from which the sorus arises, and at its base there is a space in the midst of the hyphal mass enclosing a few uredospores (FIG. 1). This pocket extends through a series of about one hundred sections, 7.5 μ thick, and from one to three spores lie in the pocket in each section. In the few cases where the point of origin of the spores is indicated, the attachment of the uredospores is on the side of the sorus above.

The second instance of internal uredospores was found in 1922 in a leaf sheath which, as the result of inoculation from spores placed between stem and sheath, showed a heavy infection. A succession of erumpent sori occurs between the veins on the inner surface of the sheath. These sori themselves are internal in so far as the chance for dissemination of spores is concerned but, in addition, intercellular strands of hyphae connect with young sori developing on the outer surface of the sheath, and in the midst of these intercellular hyphae there is an internal sorus appearing as a mass of close-packed angular uredospores. The mesophyll cells near the internal sorus show small haustoria and the cells are many of them hypertrophied, a condition not usually apparent in infected corn leaves. The pocket seems to have been formed by the breaking down of a host cell. This pocket formation suggests the hyphal arrangement described by Richards (**18**) for *Uromyces Caladii*, and by Nemec (**14**) for *Uromyces Betae* although there is in these cases no internal spore formation. Richards describes hyphae which, starting in large intercellular cavities, push out and surround neighboring cells, cutting them off from their fellows. Such isolated cells, he says, are usually completely broken down and absorbed. Nemec describes intercellular hyphae of *Uromyces Betae* which fill not only the original intercellular spaces but also spaces made by dissolving the middle lamella until many host cells appear completely enclosed by a hyphal felt. It is also of interest to compare the internal cysts of the corn rust with the close-packed masses of intercellular hyphae which Clinton (**6**) figures for *Cronartium ribicola* in needles of *Pinus Strobus*. These sclerotia, as he names them, are a tangle of hyphal threads, which swell the intercellular space to abnormal proportions. Such host cells as are enclosed in them are finally disintegrated. There is no hollow center in these masses, as in the case of the internal sori in the corn. The production of spermatia and aecidia comes later in the pine stem, and Clinton believes that these sclerotia function as "storehouses to insure the penetration of the fungus through the vascular system of the leaf into the stem."

I first found internal teleutospores in a mature leaf on the under side of which a confluent line of teleutosori had broken the epidermis for a distance of approximately 2 cm. This strip of leaf was cut into pieces 3 mm. long and prepared for sectioning.

FIG. 2. Internal teleutosorus in a storage cell of the midrib tissue of a corn leaf underlying an external sorus. Drawing made with camera lucida, × 400.

The sections disclosed a succession of internal teleutosori, which apparently ran parallel with the external line of spores. In this midrib region of the mature leaf the bundles lie in the chlorenchyma close to the lower epidermis, while above them large thin-walled storage cells extend to the upper epidermis, giving the characteristic thickened central region of the corn leaf. The external sorus extends between two primary veins over two secondary veins. The close-set hyphal mass from which the teleutospores arise is of very limited depth above the bundles. Scarcely more than the epidermis seems to be destroyed. There is little distortion of the cells below. The intercellular spaces are packed with hyphae, from which many small haustoria enter the cells. In the large-celled tissue also, although the intercellular spaces are filled with hyphae, there has been little crowding apart of the cells. Therefore the group of internal sori stands out sharply in the parenchyma region between the two primary bundles already mentioned as the limits of the external sorus. Each sorus is intracellular and the host cell is not only isolated by intercellular hyphae but is lined with a hyphal felt, thus giving to each sorus the appearance of a more or less complete hollow cyst. All stages of development of these cysts are present. Many cells show simply the small haustoria which penetrate from the intercellular hyphae while the host nucleus when present shows a delicate chromatin net-work and a densely stained nucleolus. Other cells contain long hyphae running parallel to the wall. These seem to enter by a break in the wall close to an intercellular space. In certain cells there is a pseudoparenchymatous wall consisting of a close woven felt of hyphae lining the inside of the cell wall, adnate to it, and clearly distinct from the hyphae which fill the intercellular spaces around the cell. Such so-called cysts may occur singly, or as aggregates of several cells whose boundaries persist. In some cases the central space of such a cyst is filled by teleutospores of irregular shape due to crowding. Again normal teleutospores, complete even to their specially thick end-walls, are borne in a tuft projecting into the cell lumen from one corner of the cell (FIG. 2). The conditions agree with those described, in the following words, by Reynolds (**17**) for the infected *Xanthium* leaf, except that he does not mention the intracellular position of the cysts.

> Within the mixture of parenchyma cells and mycelium which replaces the normal tissue there are cyst-like bodies which are composed of masses of mycelium. These are hollow spheres and from the inner surface arise telial spores exactly similar to those borne in the normal way upon the exterior of the leaf.

There is in the corn no trace of host cell contents in the cysts, although in some nearby cells encroached upon by intercellular hyphae a granular disintegrated mass remains.

A second instance of internal teleutospores was found in a leaf sheath which was heavily encrusted on both surfaces with teleutosori (FIG. 3). In this case, in the interior of the leaf between two bundles an enlarged mesophyll cell is lined by a close felt of hyphae from which branches extend toward the center

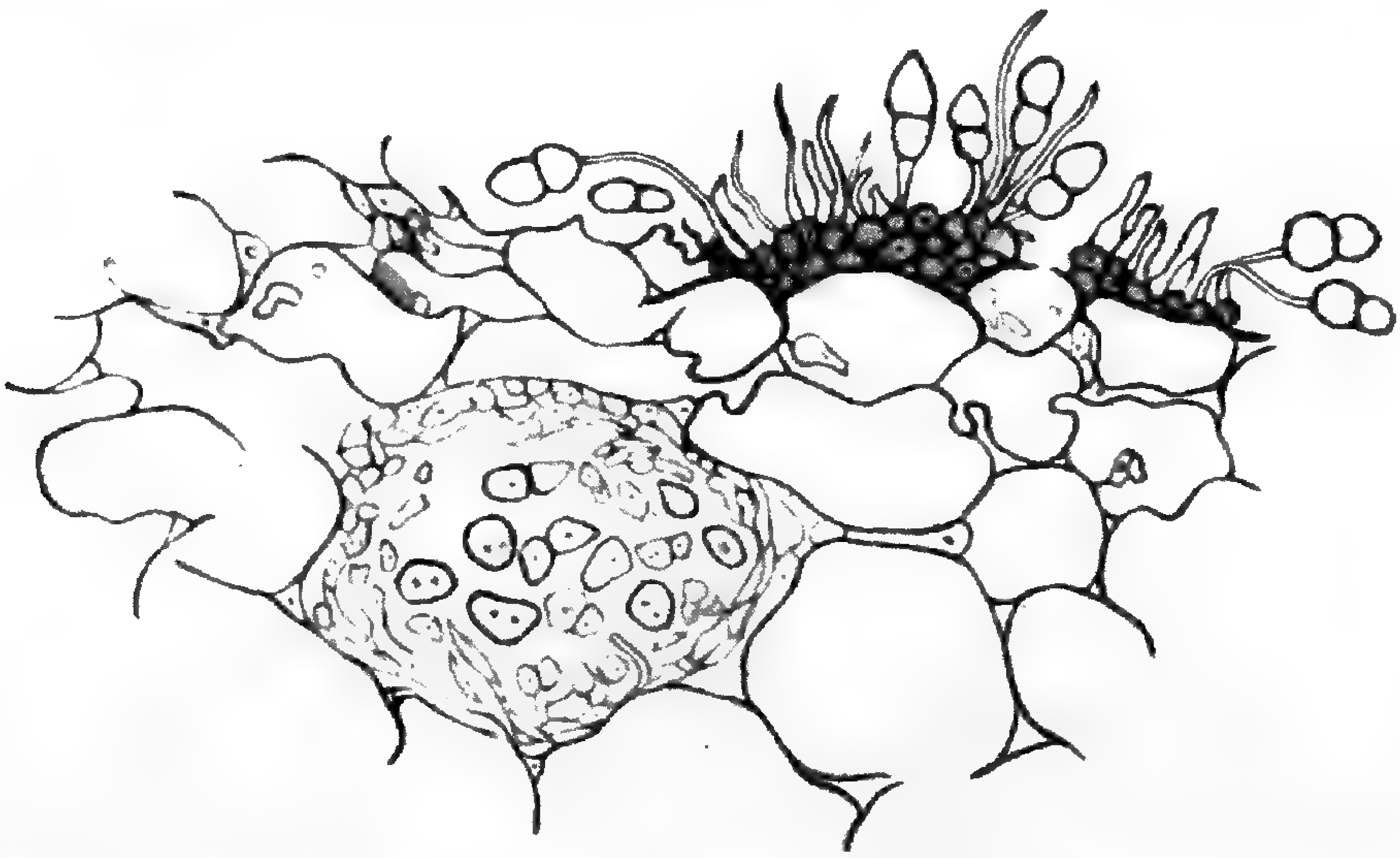

FIG. 3. Internal teleutosorus in mesophyll of a leaf sheath which was heavily encrusted on both surfaces with teleutosori. Drawing made with camera lucida, × 160.

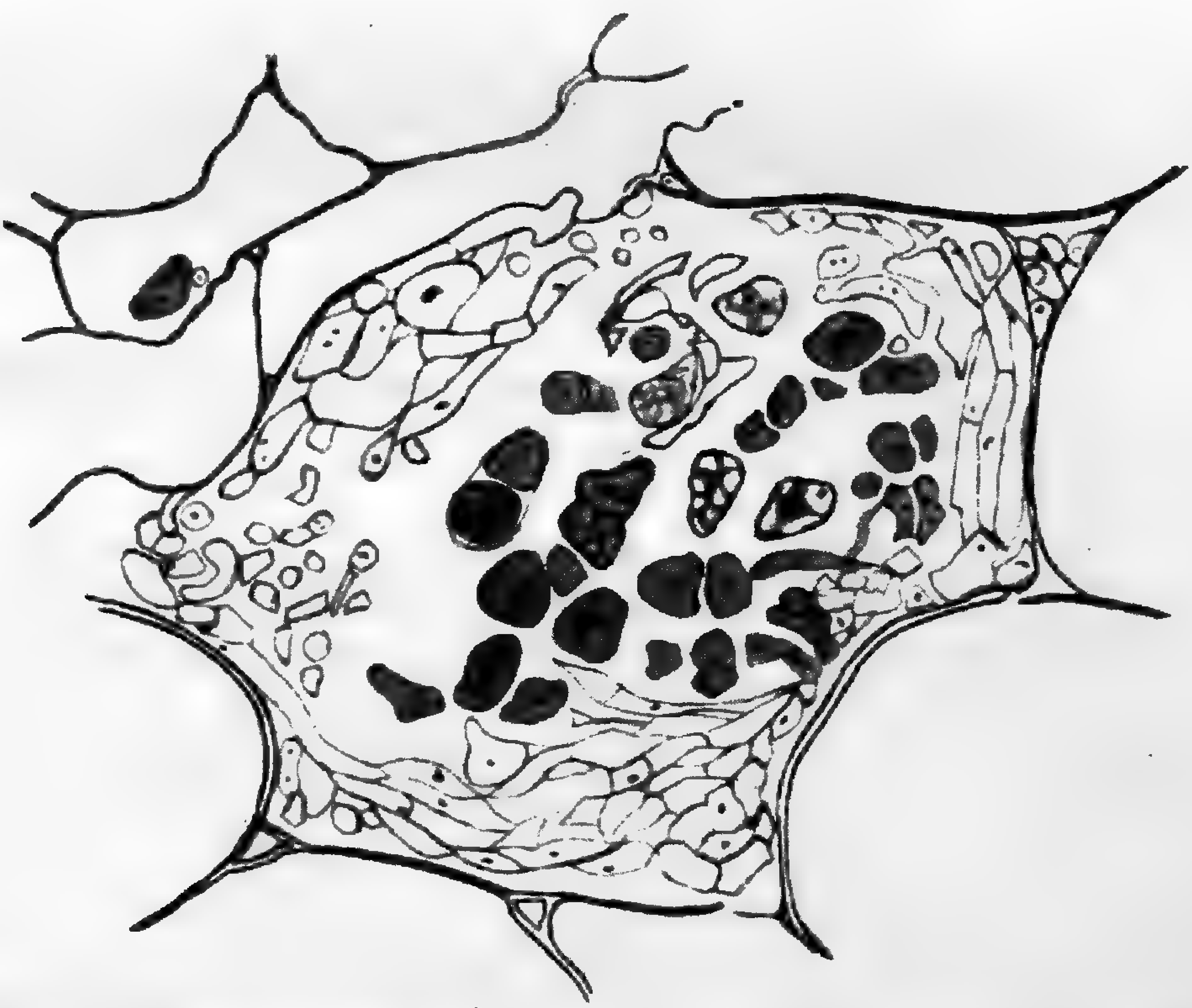

FIG. 4. Internal sorus of FIG. 3, showing intracellular encystment. Drawing made with camera lucida, × 400.

bearing spores of all sizes and shapes (FIGS. 3, 4). The surrounding cells are distorted by the hypertrophy of the enclosed cell and by the abundant intercellular mycelium but many of them still show nuclei. Often the large nuclei are indented by haustoria.

A third case was in a stem—one of the upper internodes—which developed infection from a surface inoculation between sheath and stem. The sections showed a heavy infection in the cortex underlying a mature teleutosorus bordered by two young sori just breaking the epidermis. At the depth of the second vascular-bundle-circle an internal sorus lies in the parenchyma between two bundles. The cells are in some cases fairly complete and show triangular, intercellular spaces but they are encroached upon and broken by hyphae from the intercellular spaces. The largest pocket had been formed by the breaking down of several cells as shown by incomplete remaining partitions. The central space is crowded with angular abnormal spores so incompletely developed by reason of pressure that their identification as teleutospores is doubtful.

Internal teleutosori were found also, as noted, in the tissue of an abnormal branching ear which had been artificially infected. Cuts from the succulent tissue showed to the naked eye brown spots in the white tissue. The sections showed a thin-walled parenchyma tissue with a mesh of slender hyphae in all the intercellular spaces, and the characteristic two-lobed haustoria extending into the cells to the vicinity of the nuclei. Under the external teleutosorus, just within the circle of bundles, pockets occur formed of enlarged broken cells and meshes of hyphae. The hyphae generally enter from the corners of the cells and form tufts of branches bearing irregular, unevenly developed teleutospores.

In the teleutospore cysts, particularly in those of the first case described, one is impressed by the many parallel hyphal strands both within and without the host cell walls which thus form a pseudo-parenchymatous capsule for the spores. Such encystment within the cells has not been described by others. There is evidence, I believe, of the same tendencies which lead to the formation of a mass of hyphae at the base of a normal sorus rather than of adaptation such as is seen by Bolley in the case of subepidermal rusts. The phenomenon of subepidermal sori Bolley ascribes to a fusion of host cells and fungal hyphae which imprisons the spores before they have become strong enough to rupture and throw off the epidermis. He makes the following suggestion that the subepidermal sori exemplify a further specialization in the interrelation of host and parasite.

It is in completion of the sorus under the uninjured epidermis that the fungus displays a high degree of parasitism in that, when mature, the mat of fungal tissue which surrounds the spores becomes essentially a part of the host.

In the corn, on the contrary, single host cells come to enclose the abnormally placed sori.

In the several cases of internal spores described for the corn rust there are certain points of agreement which need to be considered in any discussion of the significance of the phenomena. First, the cases all developed in the latter part of the winter or in the spring: a period in which the greenhouse begins to afford better growing conditions for corn. It is a matter of repeated observation with greenhouse cultures that from fall through the early winter it is difficult to grow corn and hard to maintain rust cultures on it.

Again it has happened so far that the internal sori all occurred in mature, although still more or less succulent tissue, on plants where many leaves were yellowing, but it is doubtful whether in the case of the corn, ageing of the tissue has anything to do with the production of internal sori. Other authors reporting internal sori have given no evidence upon this point. I am inclined to think that in general in corn as in many hosts of rusts the conditions of teleutospore formation support Morgenthaler's (**13**) conclusion from experiments with *Uromyces Veratri* upon *Veratrum album* that the nutritive supply of the host is an all important factor, and that greater age in the host is one of the conditions which by disturbing the nutritional functions checks uredo, and stimulates teleuto formation. But in the matter of the production of internal sori in the corn the occurrence of internal as contrasted with external teleutosori seems merely an example of excessive reproductive activity. In the first case which I described in the corn the long confluent external sorus on the leaf repeats itself in a succession of cysts just within in the soft parenchyma. The second instance shows internal sori in a leaf already heavily encrusted on both surfaces by sori. In the rather unusual infection induced in the succulent parenchyma of stem and ear the host conditions have seemed to stimulate the parasite to both vegetative and reproductive excesses, as evidenced by the abundant mycelium emeshing the internal sori. Although Hungerford (**11**) does not make the point, it seems to me his description of internal teleutosori in the wheat seed involves also good evidence of excessive reproductive activity. He believes these sori in the wheat seed have "no special significance but the infection spreads to these tissues (from the rachis or rachilla) just as it does from an infection point in any of the vegetative parts of the plant."

A third point of agreement is that the internal sori in the corn all occurred when the parasite was mature as shown by the abundant intercellular mycelium and the heavy external spore formation. So far as I can judge this was true in the cases described by others.

Fourth, in the cases described in the corn the sori occur, with one exception, in thin-walled parenchyma tissue: along the midrib of the leaf, in mesophyll between the bundles, in the deeper stem parenchyma, in soft tissue of the ear. The freedom of development which such tissue allows to the fungus is striking. In more resistant tissue this very freedom of development resolves, it seems to me, into development along the line of least resistance. This is the explanation which Colley (**8**) offers for reversed polarity in some aecidial sori of *Cronartium ribicola* where he states the aecidial chains grow toward the center of the tree, usually into a resin-duct. Dodge (**8a**) describes deep-seated uredosori of *Pucciniastrum americanum* in the stem of *Rubus strigosus*. Some lie deep in the cortex with the peridium on the inner side, just outside the cork cambium and Dodge suggests that such inversion may "facilitate spore discharge the following spring as the cortical parenchyma peels off." Other sori which lie only two or three cells deep beneath the epidermis are erect. In both these cases there is apparently development along the line of least resistance. It seems well illustrated also by Clinton's (**5**) case of aecidia of *Gymnospcrangium* in the seed cavities of the apple fruit and by Miss Stämfli's (**21**) figure of spermagonia of *Uromyces Pisi* at the insertion of abortive seeds in *Euphcrbia* capsules. Thus the same cause may underlie the development of internal sori in widely differing environments. The tendency of the mycelium to get to an open surface for fruiting may in one case cause inversion of sori and in another, as in the nests which I have figured, cause a concentric radially oriented structure where the open surface is the center of the cell.

The notable point of agreement in these occurrences of internal sori in the corn is that the sori all lie under external sori. In such connection, it seems to me we must view the internal sori as merely the expression of an excess of reproductive activity arising under favorable conditions of nutrition and maturity of the fungus. The first example described where the internal uredo pocket is really enclosed in the stroma just beneath an external sorus is good evidence of such an expression even under unfavorable circumstances. Here the hyphae forming the fruit cluster have developed uredospores not merely on the upper side but in their crowded meshes below. The second instance of internal uredospores described above is also striking as an expression of excess reproductive activity in cramped conditions. Here both sides of the leaf sheath had external sori. The older were on the inner surface where inoculation occurred. The internal sorus is in a central mesophyll cell and from the enclosing hyphal strands connect with two young sori on the outer surface as though the mycelium in its progressive development through the leaf had fruited, from a tendency toward reproduction, indiscriminately within, as well as on the outer surface. The cases described by Reynolds (**17**) of internal teleutospore sori in the heavily infected *Xanthium* leaf, and by Colley (**7**) in the petioles of dead *Ribes* leaves seem similar instances of reproductive excess under crowded conditions. Colley's (**8**) description of internal uredospores in the stems of *Ribes hirtellum* indicate almost conditions of proliferation. Although at first sight such cramped conditions seem to give the most striking evidence of excess reproductive activity, the many instances of internal sori developed in soft tissues and along lines of least resistance should, I think, be similarly interpreted. I see excess reproductive activity, for example, in the abundant growth of mycelium and formation of teleutosori found in the young succulent ear of corn, and again in the parenchyma of a corn stem. The internal sori of *Uromyces* in the carnation leaf (Adams, **1**) and *Cronartium ribicola* in the pine stem (Colley, **8**) although under such different conditions are also linked by reference to the activities of reproductive maturity.

It is by no means sufficiently clear just what is involved in our conception of reproductive maturity but these cases of spore formation in abnormal and non-adaptive positions certainly emphasize its importance in determining both structural and functional modifications.

It is a pleasure to acknowledge the assistance of Dr. Robert A. Harper of Columbia University in work upon this problem.

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New species of Uredineae—XV*

Joseph Charles Arthur

The following new species and new combinations are the result of studies carried on since the publication of the fourteenth article in this series, somewhat more than a year ago. They include some unusually interesting forms of the Uredinales.

Coleosporium Spigeliae sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, in groups 2–6 mm. across, on slightly discolored areas, the sori 0.3–0.5 mm. apart or somewhat confluent, roundish, 0.3–0.8 mm. in diameter, soon naked, yellowish or nearly colorless, pulverulent, ruptured epidermis inconspicuous; urediniospores irregularly globoid or ellipsoid, 13–18 by 15–23 µ; wall colorless, thin, about 0.5 µ, closely and evenly verrucose.

III. Telia unknown.

On *Spigelia Humboldtiana* Cham. & Schlecht. (*Loganiaceae*), Sierra de Apaneca, in the region of Finca Colima, Department of Ahuachapan, Salvador, January 17–19, 1922, *20170;* near Ahuachapan, Salvador, altitude 800–1000 meters, January 9–27, 1922, *20278* (type); near Quiriguá, Department of Izabal, Guatemala, altitude 75–225 meters, May 15–31, 1922, *23933;* all collected by Paul C. Standley.

The sori of this species are subepidermal, and have the gross appearance of other uredinia in the genus Coleosporium. The absence of a peridium and the catenulate, verrucose spores also agree with characters of Coleosporium. But all these characters could also belong to a species of Melampsoropsis. Moreover, the spores are small, the largest scarcely equaling the smallest of any other known species of Coleosporium. These considerations throw some doubt on the present assignment of the species.

Another source of some uncertainty is the presence on the same leaves, and often among and close to the uredinial sori, of telia-like spores, much resembling a rust. These spores are in

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* Contributions from the Botanical Department of Purdue University Agricultural Experiment Station.

small, subepidermal groups, forming a single restricted layer. They are small, about 15 by 25 µ, smooth, with walls evenly thin, about 1 µ. The writer can not place this fungus, but because of a blackish color, spreading into the surrounding tissues, the small size of the spores, and because, if it be assumed that they belong with the uredinia, it does not agree with any known genus of rusts, it is believed not to belong to the Uredinales.

Coleosporium aridum H. S. Jackson, sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, scattered or gregarious, small, roundish, 0.2–0.3 mm. across, orange-yellow fading to pale-yellow, early naked, ruptured epidermis noticeable; urediniospores globoid or ellipsoid, 16–20 by 20–28 µ; wall colorless, 1–1.5 µ thick, closely, finely and uniformly verrucose.

III. Telia unknown.

On *Coleosanthus californicus* (T. & G.) Kuntze (*Brickellia californica* A. Gray) (*Carduaceae*), Andreas Cañon in the Mojave desert, Riverside County, California, March 12, 1922, *P. A. Munz 4720*. The specimen was communicated by Professor W. C. Blasdale. The material in hand is meager, but indicates a strong and characteristic development of the rust.

Milesia Scolopendrii (Fuckel) comb. nov.

Ascospora Scolopendrii Fuckel, Jahrb. Nass. Ver. Nat. **27–28:** 19. 1873.
Uredo Scolopendrii Schroet. Krypt. Fl. Schles. **3:** 374. 1887.
Uredinopsis Scolopendrii Rostr. Bot. Tidsskr. **21:** 42. 1897.
Melampsorella Blechni Syd. Ann. Myc. **1:** 537. 1903.
Milesina Blechni Syd. Mycoth. Germ. *877*. 1910.
Milesina Scolopendrii Jaap, Fungi Sec. Exsicc. *571*. 1912.
Milesia Blechni Arth. Bot. Gaz. **73:** 61. 1922.

Two forms of a common European rust on certain ferns are here united as the result of a careful study of a large number of collections. The morphological characters of the two are the same. The opinion of the writer regarding their identity is also held by Klebahn (Krypt.-fl. Brand Pilze **3:** 853), and possibly by others.

The highly absurd claim that the genus *Milesia* is "obsolete" cf. Jour. Bot. **59:** 109. 1921), because, as W. B. Grove says) (Brit. Rust Fungi, p. 377), "it was founded on an imperfect state which might belong to any one of several genera," may be dismissed as untrue, for he himself points out further along on the same page, that "the markings on the spores [urediniospores] of this and the allied species are more often of the nature of mere roughnesses than like the neat and regular higher types (*Puccinia*, etc.)." He described and figures three British species of the genus, and has since added two more, without a word describing teliospores, which in fact are scarcely known and wholly negligible taxonomically, the urediniospores being sufficient to separate the species, and the genus as well.

Milesia australis nom. nov.

Uredo Blechni Diet. & Neg. Bot. Jahrb. **22:** 358. 1896. Not *Milesia Blechni* Arth. 1922.

The urediniospores are much smaller and thinner-walled than in *Milesia Scolopendrii* of Europe. The original collection of *Uredo Blechni* Diet. & Neg. was made near Concepcion, Peru, in May, 1896, on *Blechnum hastatum.* The same fungus on *Lygodium polymorphum* from Trinidad, Thaxter *45*, was erroneously listed by the writer (Bot. Gaz. **73:** 61. 1922) under the name *Milesia Blechni*, a synonym of *M. Scolopendrii*, and a name belonging to a European species, not yet found on the Western Hemisphere.

Chrysopsora Cestri (Diet. & Henn.) comb. nov.

Puccinia Cestri Diet. & Henn.; P. Henn. Hedwigia **41:** 295. 1902.

This characteristic species has been known for more than a couple of decades, the type collection being from Brazil, but without being recognized as belonging to the genus *Chrysopsora.* The spores are much smaller than in *C. Gynoxidis* Lagerh., the only species heretofore assigned to the genus, but the germination shows the same peculiar Coleosporiaceous character. The species has now been found in Central America, having been collected in Dept. Bocas del Tora, Panama, on *C. aurantiacum* Lindl., September 1920, by M. A. Carleton, no. *35*, and in same region, June 1921, by John R. Johnston, no. *2555*. It was also collected on *Cestrum* sp. at Estrella, Costa Rica, in 1920, by John R. Johnston, no. *1201*.

Chrysopsora Mikaniae sp. nov.

O. Pycnia chiefly epiphyllous, few in groups on discolored spots 2–4 mm. across, prominent, dark brown, immersed, globoid, 112–125 µ in diameter; ostiolar filaments short or wanting.

III. Telia hypophyllous, in annular groups 1.5–4 mm. across, roundish or oblong, 0.3–1 mm. long, soon naked, at first waxy and reddish or golden yellow, becoming somewhat pulverulent and dirty white, ruptured epidermis usually conspicuous; teliospores cylindric, 13–16 by 54–63 µ, rounded at both ends, not constricted at septum; wall colorless, uniformly thin, 1 µ, smooth; pedicel colorless, fragile, about as thick and long as the spore.

On *Mikania buddleiaefolia* DC., Theresopolis, Estado do Rio, Brazil, September 28, 1921, *E. W. D. & Mary M. Holway 1159* (type); *Mikania* sp., San Felipe, South Yungas, Bolivia, May 21, 1920, *E. W. D. & Mary M. Holway 637* (*Carduaceae*). The teliospores of this species have considerable resemblance to those of *Puccinia Spegazzinii* De-Toni, also occurring on *Mikania*, but differ greatly in their mode of germination. The presence of conspicuous pycnia and very dissimilar telia make the two species readily separable under a hand lens.

Diorchidium brasiliensis sp. nov.

O. Pycnia epiphyllous and petiolicolous, punctiform, brownish, not conspicuous, subcuticular, flattened-conoidal, 32–40 µ high by 90–110 µ broad; ostiolar filaments short or wanting.

III. Telia hypophyllous and petiolicolous, scattered, often confluent, roundish, 0.3–0.5 mm. across, subepidermal, soon naked, chestnut-brown, pulverulent, ruptured epidermis noticeable; teliospores broadly ellipsoid or obovoid, the septa vertical, the cells binate, each one being obovoid or ellipsoid, 13–16 by 20–25 µ, rounded above, narrowed or rounded below; wall pale chestnut-brown, uniformly thin, 1–1.5 µ, coarsely verrucose above, smooth or somewhat verrucose below, the pore apical or nearly so; pedicel colorless, simple, short, fragile, almost wholly disappearing from the spore.

On *Cassia* sp. (*Caesalpiniaceae*), Rio de Janeiro, Brazil, August 9, 1921, *E. W. D. & Mary M. Holway 1009*. The genus *Diorchidium* was established by Kalchbrenner in 1882 (Grevillea **11**: 26), for a South African rust on *Millettia caffra* Meissn., a leguminous host. The genus was characterized as having teliospores with didymous cells separated by a vertical septum.

Many species having teliospores with more or less vertical septa have since been placed under the genus, but more recently all of these, including the original species, have usually been referred to the genus *Puccinia*. With the discovery of the subcuticular pycnia, and the consequent certainty that only pycnia and telia occur in the life cycle, all doubt of the validity of the genus is removed. In addition to the type species and the present one the following appear to me to be genuine members of the genus: *D. Piptadeniae* Dietel. on *Piptadenia latifolia*, *D. Puiggarii* Speg., on *Cassia* sp., and *D. australe* Speg., on *Mimosa Roca*, all three from South America.

Puccinia Lygodii (Hariot) **comb. nov.**

Uredo Lygodii Hariot, Jour. de Bot. **14:** 117. 1900.

O and I. Pycnia and aecia unknown.

II. Uredineae hypophyllous, scattered or somewhat gregarious, round, 0.3–0.5 mm. in diameter, at first bullate, becoming naked, pulvinate, moderately pulverulent, cinnamon-brown, prominent, ruptured epidermis inconspicuous; urediniospores ellipsoid or obovoid, 18–23 by 26–29 μ; wall pale cinnamon-brown, thin, 1.5 μ, moderately and evenly echinulate, the pores indistinct, probably 2 or 3, equatorial.

III. Telia hypophyllous, scattered, round or oblong, 0.5–1 mm. long, soon naked, pulvinate, cinnamon-brown, ruptured epidermis inconspicuous; teliospores globoid, broadly ellipsoid or obovoid, 19–23 by 24–29 μ, rounded above, rounded or somewhat narrowed below, not constricted at septum, pale cinnamon-brown, 1.5 μ thick, thicker above, 3–7 μ, smooth, the septum variously oblique; pedicel colorless, about length of spore.

On *Lygodium polymorphum* (Cav.) H. B. K. (*Schizaeaceae*), near Bahia, Brazil, May 28, 1915, *J. N. Rose & P. G. Russell 21514*. A collection of the host, made at the same place and date, bearing the number *19664a*, now in the National Herbarium, also shows an abundance of the rust. For a fragment from this sheet I am indebted to W. R. Maxon. This is the material erroneously referred to by the writer as *Desmella*, in Bot. Gaz. **73:** 62. January 1922. The superficial appearance of the rust is not unlike that of a Desmella, but by making sections it is easily seen that the sori are subepidermal, and wholly accord with those of the genus *Dicaeoma*, to which it may be referred as **D. Lygodii** (Hariot) comb. nov. This is the first fern rust to be referred to the genus *Dicaeoma*, and is undoubtedly heteroecious. The pale color of the teliospore-walls and the generally oblique septum remind one of species in *Desmella*. It can scarcely be doubted that we have in this species the most primitive form yet known in the great genus *Dicaeoma*.

Puccinia ecuadorensis sp. nov.

II. Uredinia hypophyllous, scattered or somewhat grouped, roundish, applanate, 0.2–0.4 mm. across, early naked, pulverulent, cinnamon-brown, ruptured epidermis evident; urediniospores globoid, 23–30 μ in diameter; wall cinnamon- or golden-brown, moderately thick, 1.5–3 μ, sparsely and prominently verrucose-echinulate, the pores evident, usually 6, scattered.

III. Telia hypophyllous, similar to the uredinia; teliospores oblong or clavate-oblong, 19–23 by 42–48 μ, rounded or obtuse above, narrowed below, somewhat constricted at septum; wall pale cinnamon-brown, thin, 1–1.5 μ, thicker above, 3–5 μ, smooth; pedicel nearly or quite colorless, slender, as long as spore or less.

On *Wedelia* sp. (*Carduaceae*), vicinity of Guayaquil, Ecuador, August 11, 1918, II, iii, *J. N. & Geo. Rose 22113*. The general aspect of this rust is similar to that of *Puccinia Helianthi* Schw., but the urediniospores and teliospores appear abundantly distinct. The available material is scanty, and only a few old telia were found, all upon one leaf. All of the teliospores had germinated, and were more or less collapsed. The urediniospores are remarkable in having a number of scattered pores; most of the rusts known on the tribe Heliantheae have but two equatorial pores.

Puccinia minuscula sp. nov.

O. Pycnia epiphyllous, subepidermal, globoid, 110–128 μ in diameter; ostiolar filaments long and prominent.

I. Aecia hypophyllous, in groups 2 to 3 mm. across, without much discoloration, cylindric or cupulate, 0.3–0.5 mm. in diameter; peridial cells in face view oblong-polyhedric, 16–23 by 35–48 μ, prominently verrucose, in section linear, 7–9 by 32–45 μ, scarcely overlapping, the outer wall very thin, about 1 μ, smooth, the inner wall slightly thicker, 1.5–2 μ, verrucose; aeciospores ellipsoid, 19–26 by 30–35 μ; wall colorless, thin, about 1 μ, coarsely verrucose, reticulate, or reticulately rugose.

II. Uredinia hypophyllous, thickly scattered, round, 0.3–0.5 mm. in diameter, soon naked, applanate, cinnamon-brown, pulverulent, ruptured epidermis inconspicuous; urediniospores broadly ellipsoid or globoid, 23–26 by 26–29 μ; wall light cinnamon brown, 1–1.5 μ thick, finely and closely echinulate, the pores indistinct, about 6, scattered.

III. Telia hypophyllous, similar to the uredinia, somewhat pulvinate, chestnut-brown, ruptured epidermis inconspicuous; teliospores oblong or cylindroid, 18–21 by 48–67 μ, rounded or blunt at both ends, slightly or not constricted at septum, germinating at maturity; wall dark cinnamon-brown, uniformly thin, about 1 μ, or slightly thicker at apex with a small hyaline papilla over germ-pore, smooth; pedicel delicate, colorless, 10–16 μ in diameter, collapsing, once to twice length of spore.

On *Helianthus hypargyreus* Blake ined. (*Carduaceae*), vicinity of Huigra, Ecuador, on the Hacienda de Licay, September 6, 1918, i, II, III, *J. N. & Geo. Rose 22569.* This species, like *P. ecuadorensis*, has urediniospores with scattered pores, which taken with the long delicate teliospores with their obtuse ends, germinating at maturity, make it a distinctive form. The markings of the aeciospores are also unusual, often appearing distinctly reticulate. Only old aecia have been seen, which have not yielded all the characters with certainty.

Uromyces Standleyanus sp. nov.

II. Uredinia hypophyllous, scattered or closely gregarious, round, 0.3–0.5 mm. in diameter, soon naked, pulverulent, cinnamon-brown, ruptured epidermis inconspicuous; urediniospores broadly ellipsoid or obovate, 23–26 by 29–32 μ; wall pale golden-brown with a colorless outer layer becoming evident in lactic acid, moderately thick, 3 μ, strongly and sparsely echinulate, the points 3–5 μ apart, the pores indistinct, apparently 3, approximately equatorial.

III. Telia hypophyllous, scattered, round, about 0.5 mm. in diameter, soon naked, pulvinate, cinnamon-brown, slightly darker than the uredinia, ruptured epidermis inconspicuous; teliospores obovate or cuneiform, 15–19 by 38–42 μ, rounded above, narrowed below, germinating at maturity; wall pale cinnamon-brown, thin, 1 μ, greatly thickened above, 12–16 μ, smooth; pedicel colorless, fragile, length of spore or less.

On *Gaudichaudia Schiedeana* Juss. (*Malpighiaceae*), near Tonacatepeque, Department of San Salvador, Salvador, Dec. 30, 31, 1921, *Paul C. Standley 19461.* This species possesses the sparsely and strongly echinulate urediniospores so general in the rusts of the *Malpighiaceae*, and also the hygroscopic layer beneath the cuticle, causing the cuticle to swell like a bladder. Of the nine or more other species of rusts known on *Malpighiaceae* all but *Puccinia barbatula* Arth. & Johnston, from Cuba, have sculptured teliospores, but that species and the present one are in every other way unlike.

I am especially pleased to have this opportunity to call attention to the excellent work of Mr. Paul C. Standley of the National Herbarium, as a taxonomist and collector. Although largely engaged with phanerogamic plants, he has made notable additions to the knowledge of the cryptogams. In his recent botanical excursion to Salvador, a region heretofore almost unknown to uredinologists, he obtained about 125 collections of rusts, among them being some new species. The name given to the present species is in recognition of Mr. Standley's contribution to uredinology.

Uromyces Betheli sp. nov.

O. Pycnia not seen.

I. Aecia hypophyllous, in orbicular groups 2–5 mm. across, short, cupulate, 0.3–0.4 mm. in diameter; peridium colorless, fragile, the margin recurved, ragged; peridial cells rhomboidal, 16–19 by 20–32 µ, somewhat overlapping, the outer wall 5–7 µ thick, transversely striate, smooth, the inner wall thinner, 1.5–2.5 µ, strongly verrucose; aeciospores globoid, ellipsoid or oblong, 13–16 by 16–22 µ; wall colorless, thin, 1 µ, finely verrucose.

III. Telia mostly hypophyllous or caulicolous, intermixed with the aecia or separate, roundish or oblong, 0.5–0.8 mm. across, often confluent into groups 2–5 mm. across, soon naked, somewhat pulverulent, dark chestnut-brown, ruptured epidermis evident; teliospores globoid, 25–30 µ in diameter; wall chocolate-brown, 3–4 µ thick, sometimes slightly thicker above, coarsely and closely verrucose; pedicel colorless, fragile, half length of spore or less.

On *Silene verecunda* S. Wats. (*Caryophyllaceae*), Whitmore, California, June 26, 1923, *E. Bethel.* This is the first Caryophyllaceous rust known in which the telia immediately follow the aecia with no production of uredinia. *Uromyces Lychnidis* Tracy & Earle was originally described without uredinia. But they do occur, and this name is now made a synonym of *U. Suksdorfii* Diet. & Holw. Beside the two species already named there are three other species in North America, viz., *U. caryophyllinus*, *U. verruculosus* and *U. Silenes*. Under the genus Nigredo these names become **N. Suksdorfii** (Diet. & Holw.)

comb. nov., *N. caryophyllina* (Schrank) Arth., **N. verruculosa** (Schroet.) comb. nov., and *N. Silenes* (Schlecht.) Arth. In the same manner the new species here described becomes **Pucciniola Betheli** comb. nov. The last is not correlated with any of the others, for besides the lack of uredinia, the teliospores are more globose, less thickened above, and much more strongly sculptured.

I take especial pleasure in naming this new and interesting species in honor of Mr. Ellsworth Bethel, of Denver, Colorado, who has given many years to the extensive collection and close observation of the Uredinales, particularly throughout the mountainous region of western North America.

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LAFAYETTE, INDIANA

Fossil fruits from the Eastern Andes of Colombia

Edward W. Berry

(with twenty-five text figures)

The interesting fruits described on the following pages are part of a series of paleobotanical specimens that I owe to the friendship and courtesy of Brother Aristé of Bogotá, whose interest in all branches of Natural History is well worthy of emulation in other lands. These specimens come from the localities Zipacón or Cipacón and the Paramo of Guasca, in the Province of Cundinamarca, and at no great distance from Bogotá.

They are from the post Cretaceous coal bearing series of shales and sandstones, and I regret that their precise age is undeterminable. The Saccoglottis is Tertiary and probably late Eocene or Oligocene, the other two species appear to be somewhat younger than the former and may be Miocene or Pliocene.

The Eastern Andes around Bogotá are said by Veatch* to be synclinal mountains, hence there has been an enormous amount of erosion in late geological times, as the uplift was admittedly very recent.† The present fossils, which are tropical forms, support the view of the recency of elevation, but are less significant than they would be if precisely dated.

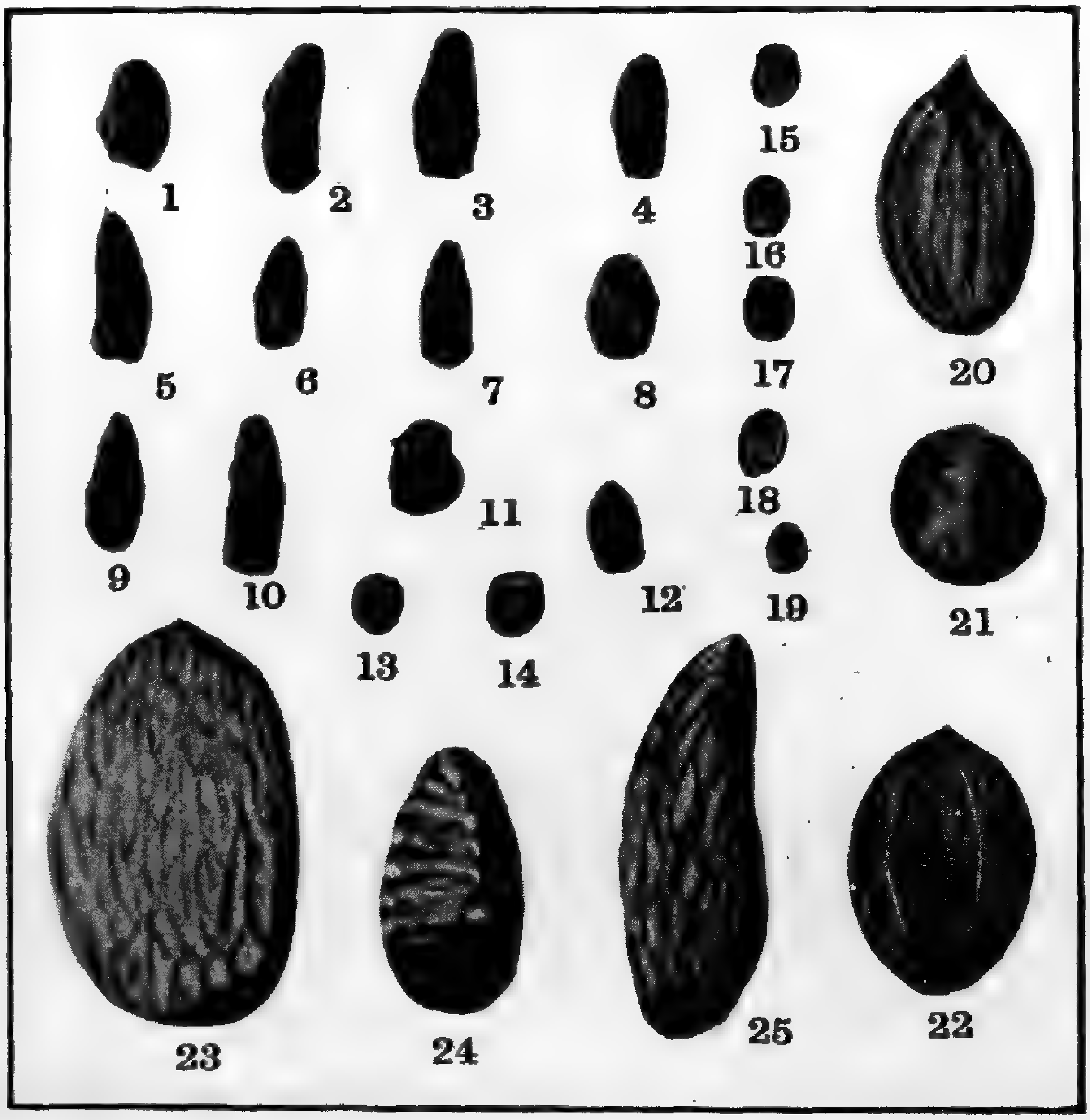
The locality at Zipacón at the mines is 8185 feet in altitude and it therefore falls in the subtropical altitudinal zone which, according to Chapman,‡ lies between 6000 and 9500 feet. I suppose that *Saccoglottis* might live at 8185 feet in that latitude but its optimum conditions would be at a lower level and I imagine the rainfall would have to be greater than it is at the present time. I do not know the altitude of the locality of Guasca from which the other two specimens were obtained. It is spoken of as Paramo, but may not be true Paramo, since the western upland of the Sabana of Bogotá has the Paramo of San

* Quito to Bogotá. 1917.

† In this connection see Gutiérrez, M., Geologia de Bogotá y sus alrededores, Am. Ing. 20: 313–331. 1913.

‡ Am. Mus. Nat. Hist. Bull. 36. 1917.

Fortunata and the Paramo of Pasquilla, the one slightly under and the other slightly over 10,000 feet. The true Paramo in the Eastern Andes near Bogotá lies, according to Chapman, above 12,000 feet. At any rate Guasca appears to be in the temperate altitudinal zone (9500–12,000 feet) and therefore unsuited at its present elevation for Simaruba and Cordia.



FIGS. 1–19. CORDIA VERA Berry, sp. nov. 20–22. SACCOGLOTTIS CIPACONENSIS Berry, sp. nov. 23–25. SIMARUBA VERSICOLOROIDES Berry, sp. nov.

These species therefore indicate a certain undeterminable amount of uplift since they were living in the region. The question of actual amount is so complicated by direction of winds, consequent humidity, and position of exposure, that much more knowledge will have to accumulate before precise data are available, but it is not without either interest or significance that all of the evidence of this sort from the Andes in Bolivia, Peru, and Colombia, meager as it is, all points in the same direction, and places the uplift of this great mountain chain in late Tertiary times. Indeed the distributional evidence of the avifauna of Colombia, set forth in such a masterly way by Chapman (op. cit.), leaves little to be added in the future in the way of proof beyond confirmation, from a study of the past floras of the region—today a practically unknown field.

Order **GERANIALES**

Family SIMARUBACEAE

Genus SIMARUBA Aublet

Simaruba versicoloroides sp. nov.

FIGS. 23-25

Species based upon the crustaceous stones of a thin fleshed unsymmetrical drupe. These are compressed so that their lateral diameter (maximum thickness) is about half their width and about one-third their length The surface is conspicuously marked by anastomosing low ridges separated by shallow unsymmetrical longitudinally elongated depressions. These stones are not bilaterally symmetrical in any profile. They are broadly rounded proximad with a conspicuous scar one-third of the distance from the widest side. Distad they terminate as a blunt point, the profile when viewed from the side is therefore approximately elliptical, widest in the middle and slightly more narrowed distad than proximad. When viewed from the edge the profile is very slightly sigmoid, more broadly rounded proximad than distad. Viewed from below the profile is elliptical, more broadly rounded toward the inside than the outside, the scar occupying the position of the inner foci of the ellipse toward its inner edge.

Length 3.2 cm. Maximum width 2.0 cm. Thickness 1.1 cm.

The identity of this well marked and characteristic drupaceous stone has proved somewhat of a puzzle but it appears to be referable to the genus Simaruba and doubtless with adequate recent material for comparison could be closely matched among existing species. Among these in so far as comparisons have been possible, it most closely resembles *Simaruba versicolor* St. Hil., a Brazilian species, and this resemblance is recognized in the specific name proposed for it.

The genus *Simaruba* of the family Simarubaceae has about 6 existing species, confined to the warmer parts of the Western

Hemisphere in the region extending from southern peninsular Florida to Brazil. The characteristic leaflets of the pinnate leaves have occasionally been found fossil and three species, based upon leaves, have been described by the writer. These are *Simaruba eocenica** from the Eocene of Tennessee, *Simaruba miocenica*† from the Miocene of Venezuela and *Simaruba haitensis*‡ from the Miocene of Haiti. The present is the first recorded occurrence of fossil fruits of this interesting genus.

The specimens figured are from Guasca, Province of Cundinamarca.

Family HUMIRIACEAE

Genus SACCOGLOTTIS Martius

Saccoglottis cipaconensis sp. nov.

FIGS. 20–22

Fruits relatively small, drupaceous, with thin mostly corroded flesh (sarcotesta). The stone or pericarp varies in form from a nearly rounded prolate spheroid with but slight evidence of a beak to elongate specimens with a pronounced central pointed beak. The proximal end of the stone is rounded, with a chalazal scar centrally located. The distal end, as mentioned above, is more or less acutely pointed. The surface is minutely mammillated, and if these mammae represent the resin cysts which are so prominent in the modern *Saccoglottis amazonica* which is the only living species of which I have had fruits for comparison, these cysts are much smaller in the present fossil than in the existing species, or in the Pliocene *Saccoglottis tertiaria* Berry of Bolivia.

The stone has imbedded in it from five to seven large seeds arranged symmetrically around the central axis, more rounded distad and more pointed proximad, narrowing inward with flat sides and triangular in cross section. These seeds are narrowly much elongate-elliptical in surface outline and are mostly 1.5–1.75 cm. in length and 2–3 mm. in width. The seeds are somewhat unequally developed in all of the specimens, but not markedly so. Of the four specimens collected one is five-seeded, two are six-seeded, and one is seven-seeded. The total dimen-

* U. S. Geol. Survey Prof. Paper 91: 252. *pl. 54, f. 7.* 1916.

† U. S. Natl. Mus. Proc. 59: 573. *pl. 109, f. 2,* 1921.

‡ Idem. 62: 6. *pl. 1, f. 8.* 1922.

sions of the stone are 1.75–2.25 cm. in length and 1.2–1.5 cm. in greatest diameter, which is in the equatorial region. The present species is of unknown age and comes from Cipacón, or Zipacón in the Province of Cundinamarca, which locality is commemorated in the specific name.

Since this paper was submitted for publication I have received a considerable collection of silicified fruits from the upper Eocene (Lobitos formation) of Peru. Among these are the abundant remains of a Saccoglottis, scarcely, if at all, distinguishable from the present species, which leads me to think that the latter may be as old as late Eocene or early Oligocene.

I know of no plant family except the Humiriaceae which has the features shown by these fruits, that is, thin flesh, woody stone with radially symmetrically arranged seeds. The family is a small one, consisting of but three or four genera and about a score of existing species. The nearest living relative of the fossil in the upper basin of the Amazon I am unable to state, being hampered in this respect by the lack of comparative material. This scarcity is well illustrated by the number of years that elapsed before the botanists at Kew could determine the fruits of *Saccoglottis amazonica*, which are so abundant in the Antillean sea drift.

The modern Humiriaceae are usually segregated into the three genera *Humiria*, *Vantanea* and *Saccoglottis*, and all of the species are dwellers in the wet forests of Brazil, the Guianas, Venezuela and eastern Peru, except the single west African species *Saccoglottis* or *Humiria gabonensis* Urban, which is sometimes considered the type of a fourth genus—*Aubrya*. The genus *Saccoglottis* has about ten existing species in the region mentioned above, and *Saccoglottis amazonica*, whose curious fruits are such a feature of the sea drift in the Antilles, and has even reached southwestern England, is an inhabitant of the estuarine forests of the great rivers of Brazil, the Guianas, and Venezuela, and a few individuals have been found growing in southern Trinidad. The tree has never been recorded from Colombia, Central America, or the Pacific coast, but I collected characteristic fruits in the sea drift of Panama Bay, and I subsequently came across a record from the Pacific coast of Costa Rica. The presence of a fossil species in central Colombia, of a second fossil species in Bolivia and the finding of *Saccoglottis amazonica* on the Pacific coast of Central America suggests an American origin for the family, and that the single west African coastal species reached that region either by means of the equatorial counter current, or before the continental outlines had assumed their present form.

Order **POLEMONIALES**

Family BORAGINACEAE

Genus CORDIA Linné

Cordia vera sp. nov.

FIGS. 1–19

Fruit a more or less elongated drupe with a thin flesh, which is not over 1 mm. thick as lignified; the interior filled with a relatively large woody stone. Stones varying considerably in size and proportions, ranging from prolate spheroids in the smaller specimens to cylindrically tapering forms somewhat truncated proximad and somewhat narrowed and rounded distad. They are slightly compressed by pressure during fossilization and are frequently somewhat curved but whether the last is a natural or assumed feature cannot be determined. The surface of the stone is faintly and shallowly longitudinally sulcate; the walls are thick and there are from one to four long seed-cavities somewhat reniform in cross section when not distorted by pressure. Sometimes but one is abortive, more frequently two or three are abortive. Dimensions ranging from 6 × 4 mm. in the small less elongated forms, which are far less common than the more elongated forms, to 14 × 5 mm. in the latter. Average of a great many specimens slightly under the maximum dimensions.

There are a number of unrelated drupaceous genera with fruits superficially like the fossils, particularly in the families Rubiaceae and Boraginaceae. Many somewhat similar stones are only single-celled. Others like the rather similar stones of the genus Chomelia (Rubiaceae) are two-celled.

The genus *Guettarda* of the Rubiaceae has stones with from four to nine cells, but these are less elongated than the fossils. There is naturally very little available material of recent species for comparison. Among this the fossils agree remarkably with the one- to four-celled stones of the genus *Cordia*. I am unable to point out the most closely related existing species of *Cordia*, since the majority of the species are not represented by fruiting material in the larger herbaria, but there can be no doubt but that the fossils represent a late Tertiary species of this genus.

The fossils are exceedingly abundant and I have some hundreds of specimens from the lignite deposit at Guasca, in the Province of Cundinamarca. The only previously known fossil species of *Cordia* are based upon leaves and thus lack the certainty of identification of the present species. They include an Upper Cretaceous species from southeastern North America,* a Tertiary species from Tasmania,† two Eocene species from southeastern North America,‡ a lower Miocene species from Chile,§ and a second from Bohemia,|| and an early Pleistocene species from Java.¶

The genus comprises about 250 existing species of shrubs or trees of the tropical and warmer extra tropical regions of both hemispheres. The majority are American and the genus is largely developed in northern South America, ranging through the Antilles to the Bahamas and Florida Keys and through Central America and Mexico to the valley of the Rio Grande.

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* Berry, E. W. U. S. Geol. Surv. Prof. Paper 112: 137. *pl. 30, f. 7, 8.* 1919.

† Ettingshausen, C. v. Tertiarfl. Australia 34. *pl. 5, f. 3–5.* 1883.

‡ Berry, E. W. U. S. Geol. Surv. Prof. Paper 91: 345. *pl. 106, f. 11, 12; pl. 107, f. 1.* 1916.

§ Engelhardt, H. Abh. Senck. Naturf. Gesell. 16: 659. *pl. 6, f. 3.* 1891.

|| Ettingshausen, C. v. Foss. Fl. von Berlin 2: 221. *pl. 37, f. 21.* 1868.

¶ Schuster, J. Abh. k. Bayer. Akad. 25: 28. *pl. 25, f. 1, 2.* 1911.

INDEX TO AMERICAN BOTANICAL LITERATURE

1923

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Reviews, and papers that 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 omissions, their kindness will be appreciated.

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BULLETIN

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TORREY BOTANICAL CLUB

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New Polygalas from Colombia

S. F. Blake

Polygala diversa sp. nov.

Frutescent, sometimes flowering the first year, densely pubescent; leaves oval to elliptic, 1.5–4 cm. long, 7–14 mm. wide; racemes short, 12–15 mm. thick, short-peduncled; bracts deciduous; pedicels 1.5–2 mm. long; sepals ciliolate with glandular and eglandular hairs; wings suborbicular-obovate, 6.5–7 mm. long, 4.5–5.8 mm. wide, inequilateral, densely spreading-pubescent and ciliate; capsule quadrate-oval, 5 mm. long, ciliolate; seed 4 mm. long, silky-pilose.

Frutescent, up to 90 cm. high, much branched, but flowering also as a simple-stemmed annual only 18 cm. high; stem 5 mm. thick or less, terete, densely incurved-pubescent or ascending-pubescent, often with spreading hairs intermixed; leaves alternate; petioles 1–2 mm. long, pubescent like the stem; blades oval to elliptic or ovate-elliptic, 1.5–4 cm. long, 7–14 mm. wide, acute or acuminate to rounded, sometimes mucronulate, at base rounded to cuneate, papery, above evenly spreading- or ascending-puberulous, glabrescent except toward margin, beneath about equally green, spreading-pubescent, more densely so along the veins, these 3–5 pairs, prominulous beneath, the secondaries obscure; peduncles terminal and supra-axillary, 5 mm. long or less; racemes 12–25 mm. long, 12–15 mm. thick, obtuse or acute, slightly comose, pubescent like the stem, the axis becoming 4 cm. long or less; bracts subulate, 1.5 mm. long, hispid-pilose, deciduous; pedicels puberulous, 1.5–2 mm. long; flowers "pink or violet-pink"; upper sepal oblong-ovate, 3.5–3.8 mm. long, obtuse, densely ciliolate with eglandular hairs for its basal third, above bearing about 8 pairs of stipitate glands and a few eglandular hairs, on back spreading-puberulous; lower sepals united nearly to apex, obtuse, 2.8 mm. long, spreading-puberulous on back, bearing about 10 pairs of stipitate glands from base to apex, the eglandular hairs few; wings suborbicular-obovate, 6.5–7 mm. long, 4.5–5.8 mm. wide, strongly inequilateral, emarginate, at base unequal, cuneate on one side,

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obliquely rounded 1 mm. above base on other side, rather densely and evenly spreading-pubescent outside and ciliate, about 5-veined, the veins forked above and anastomosing toward the margin; upper petals 4.8 mm. long, pilose within to middle, the limb oblong-obovate, rounded, glabrous, about 7-nerved; keel 5 mm. long, ciliate at extreme base, not ciliate on the upper margin of the saccate portion, spreading-pubescent on the outer anterior face of the saccate portion; capsule quadrate-oval, 5 mm. long, 4.2–4.8 mm. wide, ciliolate, narrowly margined, emarginate, at base subcordate; seed 4 mm. long (including aril), oblong-oval, terete, densely appressed-silky-pilose; aril 1.3 mm. high, 1.8 mm. long, casque-shaped, white, subcorneous, sparsely pilose, 3-lobed from near the middle, the lobes equal, the dorsal the broadest.

COLOMBIA: On sandstone cliff at Honda, Dept. Tolima, 250–350 m., 3–4 Jan. 1918, *F. W. Pennell 3602* (TYPE in herbarium of the N. Y. Botanical Garden; duplicate in U. S. National Herbarium). Open clayey loam, Melgar, Dept. Cundinamarca, 500–600 m., Dec. 1917, *Pennell 2902*. Open woodland, west of San Lorenzo, Dept. Tolima, 500–700 m., Dec. 1917, *Pennell 3549*. Open rocky slope, Honda, Dept. Tolima, 300–400 m., Jan. 1918, *Pennell 3582*.

Polygala diversa belongs in the subgenus *Hebeclada*, and may be distinguished readily by its densely pubescent wings. At maturity it is distinctly frutescent, but it also flowers as a seedling, as shown by *Pennell 3549*, which in all other characters is identical with the type of the species.

P. Smithii sp. nov.

Suffrutescent, densely incurved-puberulous; leaves ovate, 5.5–8 cm. long; racemes 1.2–5 cm. long, 1–1.4 cm. thick; bracts deciduous; pedicels 1–2 mm. long; sepals densely ciliate with eglandular hairs; wings obliquely oval-obovate, 5–6 mm. long, 3.8–4.5 mm. wide, inequilateral, ciliolate; capsule quadrate-oval, 4–4.8 mm. long, shorter than the wings; seed 4.2 mm. long, subsericeous-pilose.

Suffrutescent, erect, about 1 meter high, simple or sparsely branched, the base not seen; stem subterete, 2–3 mm. thick, greenish, densely incurved-puberulous, a few longer straighter hairs sometimes present; leaves alternate; petioles pubescent like the stem, 2–4 mm. long; blades ovate, 5.5–8 cm. long, 2–4.2 cm. wide, acuminate (sometimes abruptly so), at base cuneate or rounded-cuneate, membranaceous, above deep green, evenly spreading-puberulous on surface (the hairs along the veins shorter and incurved), beneath sparsely spreading-puberulous on surface, along the veins incurved-puberulous and sparsely spreading-pubescent, the veins 7–8 pairs, prominulous beneath, the secondaries obscure; peduncles terminal and supra-axillary, 4 mm. long or less; racemes loose or rather dense, 1.2–5 cm. long, obtuse to acute, slightly comose, 1–1.4 cm. thick, the axis becoming 10 cm. long or less, pubescent like the stem; bracts lance-subulate, 1.8 mm. long, attenuate, hispid-pilose, deciduous; pedicels glabrous, curved, 1–2 mm. long; flowers greenish; upper sepal oblong-ovate, 3 mm. long, obtuse, densely ciliate with eglandular hairs; lower sepals similar, 2.2 mm. long, united for four-fifths their length, obtuse; wings obliquely oval-obovate, 5–6 mm. long, 3.8–4.5 mm. wide, strongly emarginate, inequilateral, cuneate at base on one side, contracted 1.2 mm. above base on other, ciliolate except on narrowed basal portion, 4-nerved, the nerves branched and anastomosing toward margin; upper petals 3.5 mm. long, pilose within except on the expanded portion of limb, this oblong-ovate, rounded, erose, many-nerved; keel 4.2 mm. long, pilose-ciliate on the posterior upper margin of the saccate portion; capsule quadrate-oval, 4–4.8 mm. long, 4–4.7 mm. wide, distinctly shorter than the wings, margined, emarginate at apex, subcordate at base, not stipitate, glabrous; seed oval, terete, 4.2 mm. long (including aril), 1.8 mm. wide, rounded at apex, densely subsericeous-pilose with subappressed hairs; aril 1.8 mm. high and wide, sparsely pilose, rounded-quadrate, compressed, with much excavated sides, yellowish-white, not corneous, with three subequal rather short rounded lobes.

COLOMBIA: In dry forest near Agura Dulce, vicinity of Santa Marta, 8 June 1898–1899, *Herbert H. Smith 1309* (TYPE in herbarium of the N. Y. Botanical Garden; duplicate of this number in U. S. National Herbarium, no. 533,456, labeled October 1898–1901). Lower hills on the trail from Río Frío to San Andrés de la Sierra, State of Magdalena, 400 m., July 1906, *Pittier 1714*.

This species is a member of the section *Apopetala* of the subgenus *Hebeclada*, and is nearest *P. Vauthieri* Chod., which is described as having lanceolate or lance-oblong leaves and larger wings (up to 8 mm. long), these as wide as long. The type collection was distributed as *P. violacea* Vahl, but the original *P. violacea* Aubl., a still doubtful species, is described as having a crested keel.

Polygala Fendleri heterothrix var. nov.

Leaves sometimes nearly all in (2–4) whorls; hairs of seed straight; otherwise as in *P. Fendleri*.

COLOMBIA: Dry grassy bank, Guayabotal, southeast of Quetame, Dept. Cundinamarca, 1300–1400 m., 5 Sept. 1917, *F. W. Pennell 1746* (TYPE in U. S. National Herbarium, no. 1,041,907; duplicate in herbarium of N. Y. Botanical Garden).

The group of the subgenus *Orthopolygala* known as the Series *Glochidiatae* is characterized principally by the uncinate hairs clothing the seed. In the variety above described, however, the hairs of the seed are straight, although the most careful comparison has failed to disclose any other constant difference from *P. Fendleri* Chod. in habit or structure. The occurrence of a very few hook-tipped hairs on some of the seeds, moreover, shows conclusively that the plant in question is merely an anomalous form of *P. Fendleri* and not a mimetic species of the group *Tenues*, to which I was at first inclined to refer it.

Polygala Fendleri Chod. was based on *Fendler 238*, from Colonia Tovar, Venezuela. The following specimens agree with the type collection in every respect except in having the crest on each side composed of a lamella and a single linear lobe, while there are a lamella and two linear lobes in *P. Fendleri*. The seeds in the specimens of the type collection examined, kindly lent from the Gray Herbarium and the herbarium of the New York Botanical Garden, are obtusish at each end, not attenuate as described, and rather densely pubescent with somewhat spreading hairs which are as distinctly uncinate as they are in any of this group.

COLOMBIA: Open rocky ridges and grass lands above Jivacasaca, vicinity of Santa Marta, 915–1065 m., 27 Sept. 1898–1899, *Herbert H. Smith 1306* (U. S., N. Y. Bot. Gard.; distr. as *P. paniculata*). In open loam, El Convenio, west of San Lorenzo, Dept. Tolima, 1000–1200 m., Dec. 1917, *F. W. Pennell 3494* (N. Y. Bot. Gard.).

Polygala Pennellii sp. nov.

Glabrous annual; lower leaves whorled, the others alternate, linear; racemes subcapitate or short-cylindric, acute; flowers white, pedicellate; bracts caducous; wings oval or obovate-oval, 1.8–2 mm. long, 1.2 mm. wide, rounded, short-clawed; crest of 2 pairs of 2-lobed or bifid segments; capsule oval, 1.7 mm. long, very short-stipitate, equaling the wings or one-fourth shorter; seed densely uncinate-pilose; aril obsolete.

Slender single-stemmed annual, freely branched, 12–33 cm. high; stem subterete, glabrous; lower leaves in about 5 whorls of about 4, or sometimes opposite or ternate on the branches, the others alternate, linear, 4–9 mm. long, 0.3–0.6 mm. wide, cuspidate-acuminate, subsessile, revolute-margined, glabrous; peduncles terminal and axillary, 3–19 mm. long; racemes subcapitate or short-cylindric, rather dense, acute, not comose, 3–12 mm. long, 2.5–4.5 mm. thick, the axis becoming 14 cm. long or less; bracts ovate, acuminate, glabrous, 1-nerved, caducous, 0.7 mm. long; pedicels 0.5–0.8 mm. long; flowers white; upper sepal ovate-oval, 1 mm. long, obtuse, 1-nerved; lower sepals similar, oval, 0.8 mm. long; wings oval or obovate-oval, 1.8–2 mm. long, 1.2 mm. wide, rounded, at base rather abruptly short-clawed (claw 0.4 mm. long), 3-nerved, the lateral nerves extending to middle; upper petals 1.5 mm. long, the free portion oblong-ovate, obtuse, about 3-veined; keel 1.8 mm. long, the crest on each side of a 2-lobed lamella and a single lobe 2-fid to middle; capsule oval, 1.7 mm. long, 1.2 mm. wide, equaling the wings in fruit or about one-fourth shorter, emarginulate, at base cuneate-rounded and usually unequal, very short-stipitate; seed oval, 0.7 mm. long, obtuse at each end, densely uncinate-pilose, the hairs about two-thirds as long as the diameter of the seed; aril obsolete.

COLOMBIA: On open foothill in the Cordillera Oriental, east of Neiva, Dept. Huila, 1000–1700 m., 1–8 August 1917, *H. H. Rusby & F. W. Pennell 534* (TYPE in herbarium of the N. Y. Botanical Garden; photograph in U. S. National Herbarium). Fusagasugá, 3 Jan. 1853, *I. F. Holton* (N. Y. Bot. Gard.). Open clayey loam, Melgar, Dept. Cundinamarca, 500–600 m., Dec. 1917, *Pennell 2890* (N. Y. Bot. Gard.).

This species is a close relative of *P. Fendleri* Chod. It seems distinct, however, in its smaller distinctly short-clawed wings and its oval capsule which is usually nearly or quite as long as the wings, while in the other species, *P. Fendleri*, the distinctly obovate capsule is much shorter than the wings.

Polygala subsecunda sp. nov.

Incurved-puberulous annual; leaves alternate, linear; racemes cylindric, acutish; flowers rosy, pedicellate; bracts caducous; wings elliptic to obovate-elliptic, 2.3–3 mm. long, 1.1 mm. wide, rounded; capsule elliptic, 3.5 mm. long, about one-fourth longer than the wings; seed obconic, silky-comose, 2.7 mm. long; aril 0.4 mm. long.

Slender one-stemmed erect annual, simple or sparsely branched, 27–50 cm. high; stem subterete, sparsely and finely incurved-puberulous; leaves (except sometimes for a basal whorl of 4) alternate, linear or linear-acicular, 7–19 mm. long, 0.3–1 mm.

wide, cuspidate-acuminate, subsessile, obscurely papillose, slightly revolute-margined, 1-nerved, chiefly erect or ascending; peduncles terminal, rarely axillary, 3–10 mm. long; racemes slender-cylindric, acutish, loose, slightly comose at apex, secund or subsecund especially in fruit, 5–9 cm. long, 3–7 mm. thick, the axis becoming 19 cm. long or less; bracts obovate or oblong-obovate, 1.8 mm. long, abruptly attenuate above by the excurrent costa (this 0.4 mm. long), erose above, glabrous, caducous; pedicels glabrous, 0.8–1 mm. long; flowers "light rosy"; upper sepal ovate-oval, rounded, 1.2 mm. long, 1-nerved, glabrous, slightly glandular-thickened along the costa; lower sepals similar but narrower, oblong, 1.2 mm. long; wings elliptic, oval-elliptic, or slightly obovate-elliptic, 2.3–3 mm. long, 1.1 mm. wide, rounded, cuneate at base, glabrous, 3-nerved, the nerves simple, the lateral ones usually reaching nearly to apex; upper petals 2.5–3 mm. long, equaling wings, the free portion ovate, 4-veined, narrowed to an obtuse or truncate-rounded apex; keel 2.8–3.2 mm. long, slightly exceeding the wings and upper petals, the crest on each side of an ovate sometimes lobed lamella and two 2- to 4-parted lobes; upper stigmatic lobe slightly stipitate; capsules elliptic, 3.5 mm. long, 1.2 mm. wide, emarginulate, rounded at base, not gland-bearing, chiefly spreading in fruit, about one-fourth longer than the wings; seed obconic, silky-comose, 2.7 mm. long (including coma), short-rostrate at base; aril 0.4 mm. long, 2-lobed, appressed.

COLOMBIA: Open grass lands, near Escoleva de los Indios, vicinity of Santa Marta, 240 m., August 1898–1899, *Herbert H. Smith 575* (TYPE in U. S. National Herbarium, no. 533,071; duplicate in herbarium of the N. Y. Botanical Garden).

A member of the Series *Trichospermae*, as nearly related to *P. variabilis* H. B. K. as to any other described species, but readily distinguished by its long, slender racemes and its eglandular capsule distinctly longer than the wings. The type collection was distributed as *P. paniculata* L., a species of a different series. The original label of the sheet in the New York Botanical Garden herbarium states that the species is fairly common in open grass lands between 150 and 750 meters elevation, flowering from July to October.

Polygala apodanthera sp. nov.

Incurved-puberulous annual; leaves alternate, linear; racemes cylindric, acuminate; flowers pale pink, pedicellate; bracts caducous; wings elliptic, obtuse, 3–3.2 mm. long, 1.2 mm. wide; crest plurifid; capsule elliptic, 3.3–3.8 mm. long, not stipitate, distinctly exceeding the wings; seed short-rostrate, 2 mm. long, spreading-pilosulous; aril 2-lobed, 0.5–0.7 mm. long.

Slender erect annual, 23–38 cm. high, with few erect branches; stem below the inflorescence finely puberulous with incurved glanduliform hairs; leaves alternate except for one or two basal pairs, numerous, rather crowded, erect, linear, 1–2 cm. long, 0.5–1 mm. wide, acute, cuspidulate, very shortly petioled, 1-nerved; peduncles 3 to 8 mm. long, terminating stem and branches; racemes cylindric, dense above, loose below, acuminate to an obtusish somewhat comose apex, occasionally secund, 2–9.5 cm. long, 5–7 mm. thick, the axis becoming 15.5 cm. long or less, rather densely puberulous with longer hairs than those of the stem; pedicels glabrous, 0.6–1 mm. long, spreading or recurved at maturity; bracts oval, abruptly cuspidate-acuminate, erose above, caducous, 1.8 mm. long; flowers pale pink, the upper petals and keel apparently more purplish; upper sepal oval-ovate, obtuse, 1-nerved, 1.2 mm. long; lower sepals elliptic-oblong, obtuse, 1-nerved, 1.2 mm. long; wings elliptic, 3–3.2 mm. long, 1.2 mm. wide, equaling the keel, obtuse, cuneate but not clawed at base, 3-nerved, the nerves simple; keel 3.1 mm. long, the crest on each side of a 3-fid or 3-parted lamella and a 2-parted lobe; upper petals shorter than keel, the free portion obliquely ovate, obtuse, 3- or 4-nerved; anthers sessile or subsessile; capsule elliptic, 3.3–3.8 mm. long, 1.5 mm. wide, emarginulate, not stipitate, about one-fourth longer than the wings; seed subcylindric, short-rostrate, 2 mm. long, rather densely spreading-pilosulous; aril attached to the beak, 2-lobed, 0.5–0.7 mm. long, the lobes oblong, obtuse or sometimes acutish.

COLOMBIA: Rocky bank in prairie, Mariquita, Dept. Tolima, 250–300 m., 7 Jan. 1918, *F. W. Pennell 3638* (TYPE in U. S. National Herbarium, no. 1,044,846; duplicate in herbarium of the New York Botanical Garden).

A species of the *Tenues* group, nearest the Venezuelan *Polygala Funkii* Chod., in which, according to description, the stem and raceme axis are glabrous, the wings and sepals acute, the crest on each side composed of a lamella and a slender lobe (both entire), and the free portion of the filaments nearly as long as the anthers.

Studies in the genus Lupinus—X. The Micranthi concluded

Charles Piper Smith

(with text figures 92–94)

My treatment of this group was introduced in the seventh paper of this series (Bull. Torr. Club **49**: 204. 1922). The list of published names and combinations there given shows that at least nineteen proposed species, plus some seven "ined." proposals, have called for consideration in the preparation of this review. Careful study of all these propositions, with the exception of one Mexican form, has now been completed, the result being that just seven real species seem to stand the test given them. Six of these are indicated and contrasted in the following key.

Key to the species of the Micranthi

Densely velvety pubescent with short, spreading hairs; flowers 10 mm. long; pods 8–10 mm. wide; seeds 5–6 mm. long. — 2. *L. niveus.*

Loosely villous and (or) minutely appressed or spreading pubescent, but not velvety.

 Pedicels 3–8 mm. long; flowers 8–16 mm. long, banner suborbicular or wider than long; verticils four to several. — 1. *L. nanus.*

 Pedicels 1–3 mm. long; flowers 5–12 mm. long; verticils one to five.

  Stems quite fistulous, flattening in the press; flowers 8–10 mm. long, banner suborbicular or broader than long. — 3. *L. chihuahuensis.*

  Stems more solid, not flattening in the press.

   Keel non-ciliate.

    Banner suborbicular or obcordate; flowers about 8 mm. long; pods 6–9 mm. wide; seeds 4–5 mm. long by 3–3.5 mm. wide. — 5. *L. pachylobus.*

    Banner obovate, rhombic, or elliptic, longer than wide; flowers 5–7 mm. long; seeds 2–3 mm. long by about 2 mm. wide. — 6. *L. bicolor.*

   Keel ciliate on the free edges above, between middle and apex.

    Keel slender, with long, narrow acumen, nearly straight to much arcuate; banner orbicular-obcordate, obovate, rhombic, or oblong-spatulate, more often longer than wide; flowers 5–12 mm. long. 6. *L. bicolor.*

Keel short and broad, the blunt acumen little or not at all upturned; banner cuneate or spatulate; flowers 5–8 mm. long. 7. *L. micranthus.*

1. LUPINUS NANUS Dougl., Benth. Trans. Hort. Soc. II, **1**: 409. 1835.

This species was treated in the eighth paper of this series (Bull. Torr. Club **50**: 159. 1923).

2. LUPINUS NIVEUS Wats., Proc. Am. Acad. **11**: 126. 1876.

Treated in the seventh paper (Bull. Torr. Club **49**: 205. 1922).

3. LUPINUS CHIHUAHUENSIS Wats., Proc. Am. Acad. **21**: 423. 1886. [Fig. 92.]

Annual, erect, 25–45 cm. tall, simple or branched, fistulous, inconspicuously short-appressed hairy, with fewer, spreading, stiff hairs; leaves several, not crowded at the base, somewhat hairy on both sides, especially on the margins; petioles 6–8 mm. long, villous; stipules conspicuous, linear, with long filiform free portion; leaflets five to seven, oblanceolate, obtuse or broadly acute, 15–40 mm. long, 4–12 mm. wide; peduncles 5–15 cm. long, villous, equaling or surpassing the leaves; racemes 5–10 cm. long; flowers 8–10 mm. long, subverticillate; bracts linear, deciduous, about equalling the calyx; pedicels 2–3 mm. long, spreading-pubescent; calyx appressed- or subappressed-pubescent, minutely bracteolate, upper lip two-toothed or bifid, about 4 mm. long, lower lip entire and acute, 6–7 mm. long; petals broad, mostly blue, banner 8–10 mm. long by 8–11 mm. wide, glabrous, wings elliptic or oblong, 8–10 mm. long by 5–7 mm. wide, keel covered by the wings, ciliate on the upper edges along the acute upturned acumen, 8–10 mm. long: pods 20–25 mm. long by 4–5 mm. wide, ovules five to seven; seeds about 2.5 mm. long by 2 mm. wide, pale yellowish and finely mottled; roots stout, 10–15 cm. long, much shorter than the stems.

The above diagnosis is practically that of Watson, as supplemented for me by Mr. I. M. Johnston, from the type specimen at the Gray Herbarium. With this type sheet are dissections of a flower, from which, through the kindness of Dr. Robinson, I was permitted to get drawings for the accompanying figure. For purposes of record only, and the convenience of others, I am citing here the two Gray Herbarium specimens. Although I have not seen these, Mr. Johnston's critical notes have made it possible for me to recognize the species and name the Arizonan collection here recorded.

CHIHUAHUA: Cumbre, on the summit of the mountains above Batopilas, 8850 feet, 1885, *E. Palmer 318* (G); summits of the Sierra Madre, Oct., 1887, *C. G. Pringle 1483* (G).

ARIZONA: Cochise County: Chiricahua Mountains, May, 1894, *W. W. Price* (DS, CPS).

This appears to be a species with fair characters, although closely allied to *L. nanus*, which it resembles not a little. The fistulous character of the stems and branches seems to be one of its strongest peculiarities.

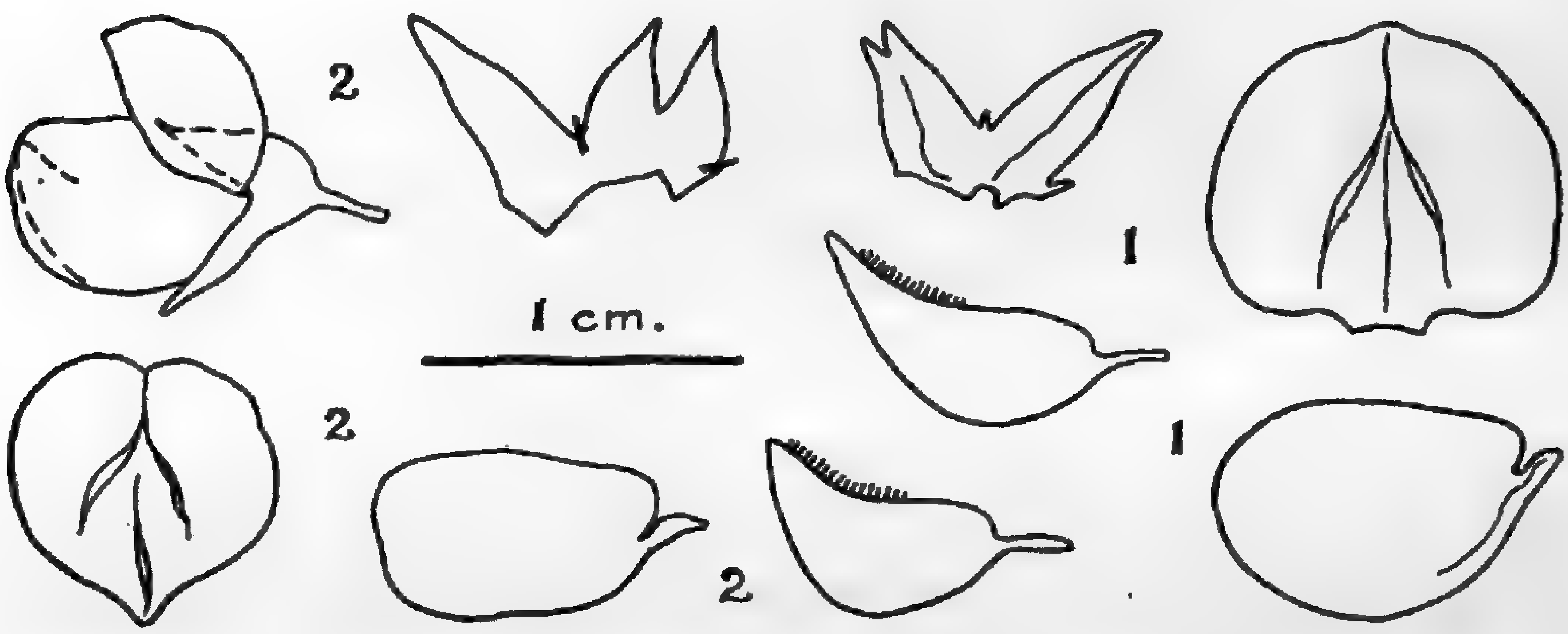

Fig. 92. LUPINUS CHIHUAHUENSIS Wats. 1. *E. Palmer 918*, Chihuahua (G). 2. *W. W. Price*, Arizona (CPS).

4. LUPINUS ASCHENBORNII S. Schauer, Linnaea **20**: 739. 1847.

In my seventh paper I listed this species as a member of the *Micranthi*. This was done because I have, for some four years, been interpreting a certain Chihuahuan plant as Schauer's species. His description is unusual in its comprehensiveness, and applies quite well to the specimens concerned; but no hint is given as to the ciliation of the keel. Recently, however, I have been favored with flowers for dissection from specimens from Southern Mexico and Costa Rica, all labelled *L. Aschenbornii*. Since three possible species seem to be included in this small assortment of material, I now feel it necessary to withhold my treatment of both Schauer's species and the Chihuahuan plant until after I have had opportunity to study Aschenborn's own collection, especially since the actual type locality of same is unknown.

5. LUPINUS PACHYLOBUS Greene, Pittonia 1: 65. 1887. [Fig. 93.]

Lupinus micranthus pachylobus (Greene) Jepson, Fl. West. Mid. Cal. ed. 1: 318. 1901.

Annual, stoutish, 10–30 cm. tall, usually branched at the base, villous with spreading hairs 1–2 mm. long; leaves several, not crowded; petioles slender, 6–8 cm. long; stipules subulate, 7–10 mm. long; leaflets six to eight, linear-oblanceolate to elliptic-oblanceolate, 15–25 mm. long by 2–4 mm. wide, hairy on both sides; peduncles 6–8 cm. long; racemes loose, of two to four

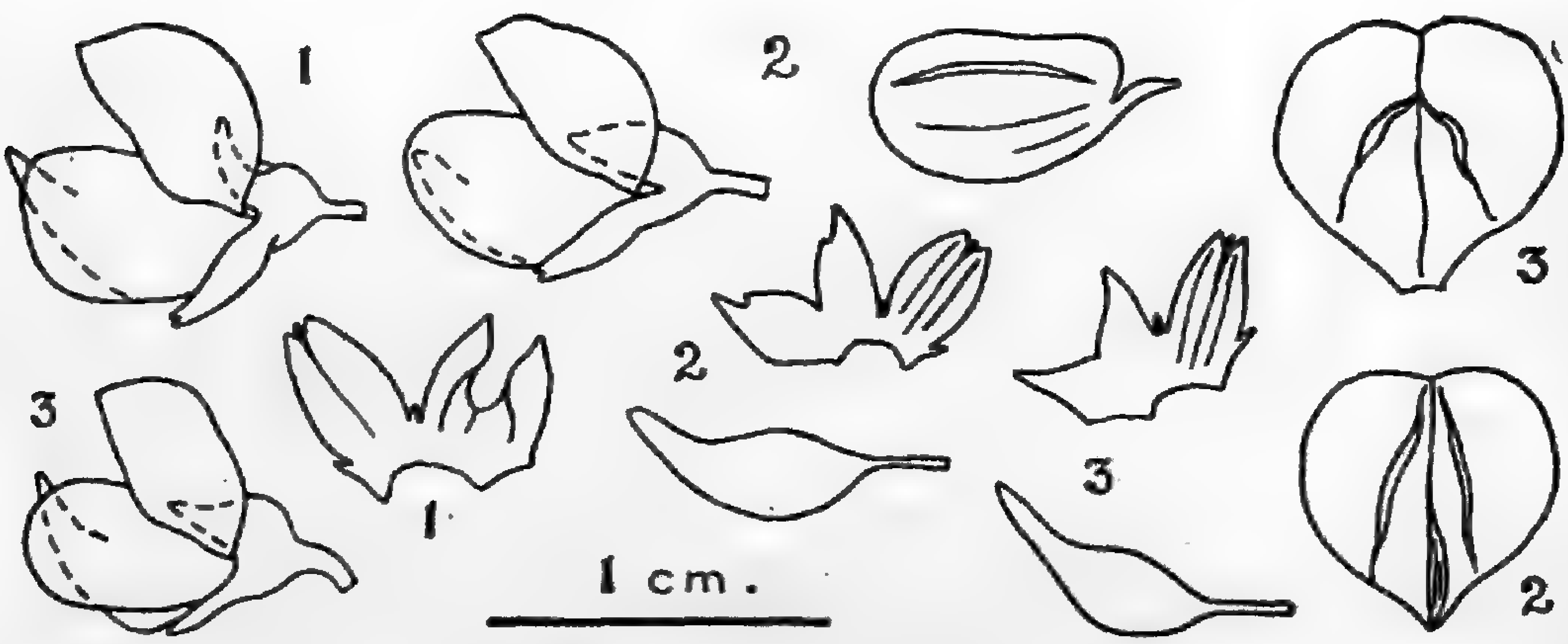

Fig. 93. LUPINUS PACHYLOBUS Greene. 1. *E. B. Copeland*, Baker distribution 3043, Butte County (US). 2. *A. A. Heller 10,682*, Butte County (CPS). 3. *C. P. Smith 3232*, Santa Clara County (CPS).

whorls; flowers few, 6–8 mm. long, sometimes almost scattered; bracts shorter than the calyx, early deciduous; pedicels short, 1–2 mm. long; calyx much shorter than the petals, its upper lip bifid, 2–4 mm. long, lower lip usually three-toothed, broad, 3–5 mm. long; petals blue, except the white center of the banner, which is suborbicular, 6–8 mm. wide, usually as wide as long, wings 6–8 mm. long and about 4 mm. wide; keel non-ciliate, somewhat arcuate, with slender acumen; pods especially large, 25–30 mm. long, 6–9 mm. wide, usually thick and succulent when green, ovules four to six; seeds 4–5 mm. long, 3–3.5 mm. wide, brown, more or less marked with darker brown lateral and marginal lines; roots slender, much shorter than the stems; cotyledons of the seedlings about 15 by 10 mm., with petioles about 5 mm. long (*Heller 11,150*).

While I feel justified in maintaining this as a distinct species, I must admit that certain forms of *L. bicolor*, in flower, approach close to it, and have been, and probably still will be, confused with same. Those, however, have the keel ciliate, and the pods and seeds as in typical *L. bicolor*. The species is evidently very local in the southern part of its range, as I have made three trips into the type region without finding a trace of it, and I also failed to find it where found by Bradshaw. It is scarce and very restricted at its Los Gatos station.

CALIFORNIA. Butte County: Chico, April, 1903, *E. B. Copeland*, Baker distribution 3043 (B, BP, CA, UC, US); Oroville, March, 1913, *A. A. Heller 10,682* (DS, UCX, US, CPS); same, Dec., 1913, *A. A. Heller 11,150* (CA, DS, UCX). Calaveras County: Mokelumne Hill, *F. E. Blaisdell* (CA, CPS). Contra Costa County: Mount Diablo, May, 1862, *W. H. Brewer 1074* (UC); same, March, 1892, *G. W. Dunn* (CA); same, May, 1915, *A. Eastwood 4498* (CA). Eldorado County: near Pilot Hill, May, 1909, *K. Brandegee* (B, UC), and April, 1915, *K. Brandegee* (UC). Glenn County: near Orland, May, 1915, *A. A. Heller 11887* (UCX). Mariposa County: Cathey Valley, April, 1915, *A. Eastwood 4350* (CA). Napa County: Mount St. Helena, May, 1918, *A. Eastwood 6844* (CA). San Diego County: Sweetwater, April, 1908, *Christino Simpson* (UC). San Mateo County: Woodside, hills north, April, 1922, *R. V. Bradshaw 2599* (CPS). Santa Clara County: Los Gatos, March, 1907, *R. L. Pendleton 534* (UC); same, March, 1912, *A. A. Heller 10,379* (CA, DS, US); same, March, 1921, *C. P. Smith 3232* (CPS). San Antonia Creek hills, March, 1898, W. R. Dudley (DS). Shasta County: Redding, May, 1896, *M. S. Baker* (UC). Sonoma County: Altura, April, 1900, *A. Eastwood* (UC, US); Taylor Mountain, April, 1898, *M. S. Baker 631* (UC).

6. LUPINUS BICOLOR Lindl. Bot. Reg. **13:** *pl. 1109*. 1827.

This species was treated in the last paper of this series, (Bull. Torr. Club **50:** 373. 1923.).

7. LUPINUS MICRANTHUS Dougl. Lindl. Bot. Reg. **15:** *pl. 1251*. 1829. [Fig. 94.]

Lupinus polycarpus Greene, Pittonia **1:** 171. 1886.

Annual, rather stout and succulent or slender and dry, 10–40 cm. tall, simple or branched at the base, erect or the branches ascending, short-appressed or subappressed pubescent, and more or less villous, rarely densely villous with hairs 2 mm.

long; leaves several to many, thick and fleshy or rather thin, appressed pubescent below, glabrous or sparsely hairy above; petioles 5–8 cm. long; stipules subulate, often purplish-brown; leaflets five to seven, linear-oblanceolate to oblanceolate, 15–40 mm. long, by 2–6 mm. wide; peduncles 3–6 cm. long; racemes 1–8 cm. long, verticils two to seven, but usually three to five; flowers few to many, 5–8 mm. long; bracts subulate, purplish-brown, early deciduous; pedicels stout, 1–2 mm. long; calyx relatively large, minutely bracteolate, upper lip bifid, about 3 mm. long, lower lip broad, minutely three-toothed, 3–4 mm. long, three-nerved; petals blue and white, banner 6–8 mm. long, cuneate-obovate to spatulate, the purple-dotted white center often turning violet, the sides only slightly reflexed, wings 5–6 mm. long by about 3 mm. broad, keel short and broad, nearly straight along the upper edges, ciliate above the middle,

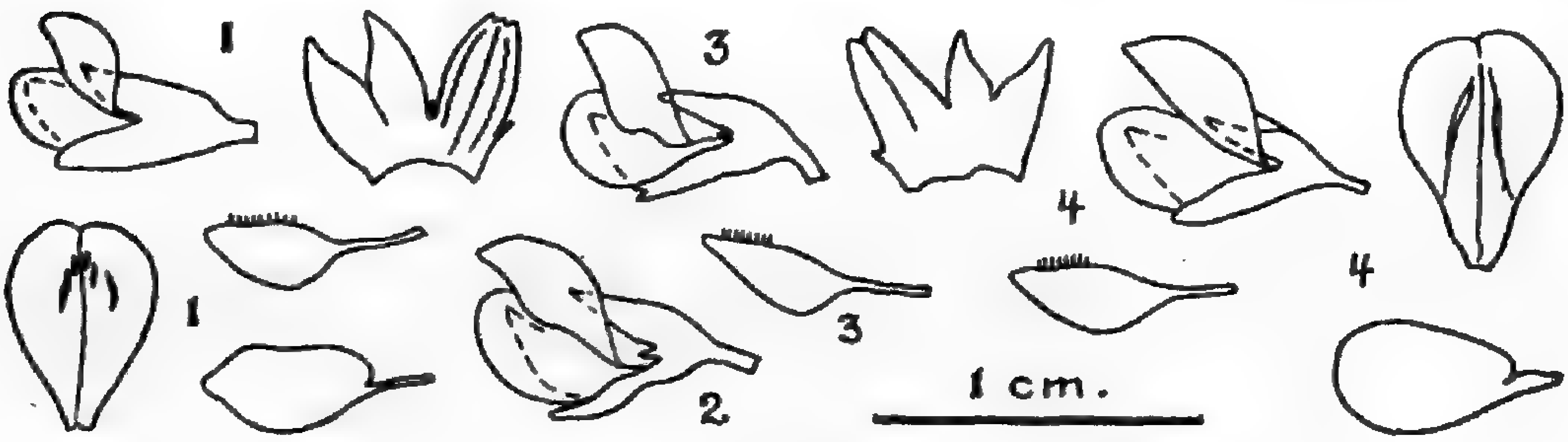

Fig. 94. LUPINUS MICRANTHUS Dougl. 1. *A. A. Heller 10,100*, Oregon, (CPS). 2. *C. P. Smith 3262*, Santa Cruz County (CPS). 3. *B. Dold 101*, San Francisco (CPS). 4. *J. W. Congdon*, Toulumne County (US 466,502).

the blunt acumen not well defined: pods 25–30 mm. long by 5–6 mm. broad, appressed-hairy, ovules six to seven; seeds oblong, rather thick, about 3 × 2 mm., gray or brown, usually much mottled and often with marginal or lateral lines.

Since the original description of *L. micranthus* has been so recently republished by Heller (Muhlenbergia 7: 2. 1911), I will not reproduce it here. Neither the original description nor plate leaves any doubt in my mind as to the species to which this name must be applied. Just one descriptive phrase given by Lindley, namely: "keel falcate, acute," has made me hesitate at times; but the lower edge of the keel is much curved, as seen in many undissected flowers, while dissection shows the upper edge to be nearly straight. I have examined over one hundred collections of the species and hundreds of plants in the field, and fail to find first-class excuse for retaining *L. polycarpus* even as a variety. It is certainly a mere ecologic form of more moist soils, showing only vegetative characters uncertain and non-dependable. Greene surely had an odd hallucination when he saw his *L. polycarpus* as "more related to the coarse, fleshy, large-flowered *L. affinis*" [*L. succulentus*] than to "the very different *L. micranthus*." Though quite variable in its vegetative parts, the flowers are remarkably constant in type, so that varietal classification must be based upon leaflets and pubescence, characters found by me to be largely unsatisfactory for such purposes, though at times offering real temptation.

Quite a few specimens examined are not cited below, especially some from Santa Clara County.

BRITISH COLUMBIA. Vancouver Island: Victoria, May, 1901, *A. J. Pineo* (BP, UC); same, May, 1908, *J. Macoun 78,884, -5, -6*, and *-7* (UCX).

WASHINGTON. King County: Seattle, June, 1891, *C. V. Piper 255* (UC). Klickitat County: Bingen, April & June, 1911, *W. N. Suksdorf 7203* (B, UC, CPS); same, June, 1911, *Suksdorf 7240* (B, UC, CPS); same, May, 1914, *Suksdorf 7743* (CPS).

OREGON. Douglas County: Winchester, May, 1922, *M. W. Gorman 5624* (CPS). Hood River County: Hood River, June, 1896, *L. F. Henderson* (DS); same, May, 1910, *A. A. Heller 10,100* (B, DS, CPS). Josephine County: Grants Pass, May, 1910, *A. A. Heller 10,024* (CPS); same, May, 1912, *H. S. Prescott* (CPS). Lane County: Eugene, April, 1920, *R. V. Bradshaw 1405* (CPS); same, May, 1922, *F. L. Wynd 971* (CPS); same, July, 1922, *C. P. Smith 3561* (CPS). Marion County: Champoeg, May, 1919, *M. W. Gorman* (DS); Chemawa, April, 1915, *J. C. Nelson 71* (DS); Gervais, May, 1922, *M. W. Gorman 5725* (CPS); Salem, April, 1921, *J. C. Nelson 3468* and *3529* (CPS); same, July, 1922, *C. P. Smith 3579* (CPS). Umatilla County: Pendleton, May, 1896, *T. Howell* (DS).

CALIFORNIA. Alameda County: Berkeley, May, 1893, *E. L. Greene* (UC); same, May, 1891, and May, 1893, *Michener & Bioletti* (UC); Oakland, April, 1921, *C. P. Smith 3338* (CPS). Butte County: Chico, April, 1903, *E. B. Copeland*, Baker's distribution 3043 (BP); Oroville, 8 miles N., March, 1914, *A. A. Heller 11,198* (CA, DS, UC, UCX). Calaveras County: Mokelumne Hill, *F. E. Blaisdell* (CA, CPS). Colusa County: Williams, April, 1917, *R. S. Ferris 545* (DS). Contra Costa County: Antioch, April, 1922, *C. P. Smith 3485* and *3486* (CPS); Byron

Springs, May, 1914, *A. Eastwood 3825* (CA); Moraga Valley, April, 1888, *V. K. Chesnut* (UC); Walnut Creek, *K. Brandegee* (UC). Eldorado County: Pilot Hill, April, 1915, *K. Brandegee* (UC). Glenn County: Willows, April, 1921, *A. Eastwood 10,220* (CPS). Humboldt County: Alton, May, 1912, *J. P. Tracy & E. B. Babcock* (UC); Bucksport, June, 1911, *J. P. Tracy 3251* (UC); Grizzly Creek, Van Duzan River, July, 1916, *L. R. Abrams 6035* (DS); Scotia, May, 1901, *H. P. Chandler 1094* (UC). Kern County: Tehachapi, *K. Brandegee* (UC). Marin County: Olema, May, 1913, *H. A. Walker 2971a* (UC); Point Reyes, May, 1906, *A. Eastwood* (CA); Sausalito to Larkspur, April, 1918, *L. R. Abrams 6883* (DS). Mendocino County: Ukiah Valley, Russian River, April, 1918, *L. R. Abrams 6978* (DS). Modoc County: no locality, Aug., 1893, *M. S. Baker* (BP, UC). Monterey County: Santa Lucia Mountains, May, 1920, *R. S. Ferris 1854* (CPS). Napa County: Calistoga, April, 1903, *C. F. Baker 1982* (B); same, *C. F. Baker 1988* (CA, UC); Napa City, 1893, *W. L. Jepson* (UC). Plumas County: Crescent Mills, July, 1921, *C. P. Smith 3419* (CPS); Greenville, June, 1920, *Mary S. Clemens* (CA); same, July, 1921, *C. P. Smith 3410* (CPS). San Bernardino County: Crafton, April, 1876, *J. G. Lemmon 122* (UC). San Diego County: Cuyamaca Lake, June, 1903, *L. R. Abrams 3840* (DS, US). San Francisco County: Twin Peaks, April, 1921, *Bertha Dold 101* (CPS). San Mateo County: Crystal Springs Lake, April, 1903, *C. F. Baker 1931* (BP, CA, UC); San Bruno hills, Bay Shore road, April, 1918, *L. R. Abrams 7054* (DS); San Mateo, April, 1921, *C. P. Smith 3297* and *3298* (CPS); Stanford Park, March, 1921, *C. P. Smith 3228* (CPS). Santa Clara County: Betabel, April, 1921, *C. P. Smith 3265* (CPS); Halls Valley, May, 1907, *C. P. Smith 1297* (CPS); Los Gatos, April, 1904, *A. A. Heller 7294* (B, DS, UC, UCX), same, April, 1911, *A. A. Heller 10,246* (B, BP, DS, UCX, CPS); Monto Bello Ridge, April, 1921, *C. P. Smith 3332* (CPS); Morgan Hill, April, 1921, *C. P. Smith 3253* (CPS); Sargent, April, 1921, *C. P. Smith 3272* (CPS); Stanford University, April, 1895, *W. R. Dudley* (DS); Wright, April, 1921, *C. P. Smith 3309* and *3310* (CPS). Santa Cruz County: Chittenden, April, 1921, *C. P. Smith 3261* and *3262* (CPS); Scott Creek, May, 1920, *R. S. Ferris 2012* (DS, CPS). Sonoma County: Bodega, May, 1900, *H. P. Chandler 671* (UC); Healdsburg, April, 1918, *L. R. Abrams 6915* (DS); Petaluma, April, 1908, *C. P. Smith 1379* and *1385* (DS, CPS); Santa Rosa, Sept., 1898, *M. S. Baker 707* (UC); same, April, 1902, *Heller & Brown 5226* (B, DS); same, April, 1918, *L. R. Abrams 6899* (DS). Sutter County: Marysville, March, 1905, *A. A. Heller 7560* (B, DS, UC, CPS). Tehama County: Corning, April, 1901, *H. C. Stiles* (UC). Yolo County: Davis, April, 1915, *P. B. Kennedy 27, 28*, and *33* (UCX).

Usually abundant where found, especially in the Bay Region. As recorded by both Dr. Greene (Pittonia **1**: 171. 1886) and myself (Muhlenbergia **6**: 141. 1911), this species is the least conspicuous of all when in flower; yet in fruit it is more conspicuous than *L. bicolor*.

Just one variety do I care to characterize here.

7b. **Lupinus micranthus Congdoni,** var. nov.

Erectus 5–8 cm. altus, caulibus gracilibus pubescentibus pilis brevis ascendentibus; foliis paucibus, petiolis 1–3 cm. longis, foliolis sex ad octo spathulatis 4–6 mm. longis 1–1.5 mm. latis utrimque pubescentibus; racemis 1–2 cm. longis, floribus paucibus alternis 6–7 mm. longis, pedicellis circa 1 mm. longis, petalis iis plantae typicae persimilibus; legumina seminaque non vidi.

Erect, 5–8 cm. tall, the slender stems pubescent with short ascending hairs; leaves few, the petioles 1–3 cm. long, the leaflets 4–6 mm. long by 1–1.5 mm. wide, six to eight, spatulate, pubescent on both sides; raceme 1–2 cm. long, flowers 6–7 mm. long, few and scattered, pedicels about 1 mm. long, petals not different from those of the typical plant.

CALIFORNIA. Tuolumne County: Big Oak Flat, Smith Ranch, Yosemite road, April, 1902, *J. W. Congdon* (TYPE, G; type-duplicates US 466,501 and 466,502).

Labelled, "*L. gracilis* Agardh," and annotated, "n. sp." I at first freely accepted it as a new species; but after making dissections and drawings of the floral parts, came to the decision followed here. It is certainly an odd extreme, evidently representing the result of a keen struggle for existence. My drawings are included in Fig. 94.

The abbreviations used herein, in citing specimens, are explained in the list below.

B, Brooklyn Botanic Garden;
BP, C. F. Baker Herbarium, Pomona College, Claremont, Calif.;

CA, California Academy of Science, San Francisco;
CPS, herbarium of the writer;
DS, Dudley Herbarium, Stanford University;
G, Gray Herbarium, Harvard University;
NY, New York Botanical Garden;
UC, Department of Botany, University of California;
UCX, Division of Agronomy, University of California Experiment Station;
US, United States National Herbarium.

* * * * * *

This paper completes my review of the annual and biennial lupines of North America, exclusive of Southern Mexico and southward. The next paper, therefore, will probably be concerned with some one of the several perennial groups that have already received considerable of my attention. It seems appropriate, then, to append here notes concerning certain forms, as follows:

Lupinus microcarpus scopulorum, comb. nov.

Lupinus densiflorus scopulorum C. P. Smith, Bull. Torr. Club **45:** 201. 1918,—as to Vancouver Island plants.

When this variety was published I made certain reservations, expressed in the following words:

While this form and var. *austrocollinum* may not be properly included in *L. densiflorus*, they certainly are less closely related to typical *L. microcarpus*.

In July, 1922, I had the pleasure of visiting Victoria, Vancouver Island, and studying this plant in its natural home and type locality. It was abundant, in full bloom, fruit, and seed, and I followed it along the seacoast cliffs, throughout the area occupied, looking for variations. Much to my surprise, I found the flowers to be constantly and conspicuously suberect or ascending in both the axial racemes and in all those of the branches. The petals are decidedly yellow in the fresh flowers, the fruits typical of the group, ovate, 10–12 mm. long, secund, the seeds dull, dark brown, unmarked, 5 × 4 mm. The plants are widely branched at the base, often also above.

Thus I was able to settle, in my own mind, all doubts as to the proper classification of the Victoria elements of my original treatment, the phrase, "floribus ad anthesin et postea pandentibus," applying to the Whidby Island and Fossil Island* elements only, and not to the Vancouver Island plants which I supposed were merely in bud. The form of the Puget Sound islands will be studied in the field, as soon as possible, and then disposition made of it according to my findings.

LUPINUS HAVARDII Wats., Proc. Am. Acad. **17**: 369. 1882.

The idea of a perennial lupine of the *Sericei* along the upper Rio Grande in Texas has frequently started some mental speculations, and often have I entertained the desire to visit that region and investigate the matter. The specimens in the *L. Havardii* cover at the National Herbarium offered no help to a conclusion and I did not think to investigate the case when looking up the annuals at the Gray Herbarium. Recently access has been had to scraps of this, filed at the University of California, labelled as coming from the type at Harvard, and annotated, "*L. Havardii—leonensis* ?, annual." The questioned identification thus indicated is fully justified by the material concerned, a leaf, a flower, and dissected floral parts. Thus *L. subcarnosus* Hook. seems to claim a fifth synonym.† *L. bimaculatus* Hook. was described as a perennial, as well as *L. Havardii;* but why Watson should compare the latter with *L. sericeus* and *L. Sitgreavesii* I am not prepared to explain at this time. I see nothing in Watson's description to oppose the conclusion that *L. Havardii* is the same as *L. texensis* and *L. leonensis*, which are phases of *L. subcarnosus*, having narrower petals and leaflets.

LUPINUS UNCIALIS Wats., Bot. King's Rep. 54. 1871.

It would doubtless seem odd if I closed a series of papers upon the annual lupines of North America without referring to this species, the sole representative of Watson's subgenus *Lupinellus*. Watson's illustrations (Plate VII) are excellent and his description good enough; and I have examined the type specimens at the Gray Herbarium.

The character of "flowers axillary, solitary" is, indeed, a remarkable variation for the genus *Lupinus;* but I have already reported that in *L. concinnus* the very common axillary branches

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* WASHINGTON.—San Juan County: Fossil Island, June 25 and Aug. 1, 1917, S. M. & E. B. Zeller 1229 (B).

† See Bull. Torr. Club **48**: 230. 1921.

are sometimes reduced to mere racemes, as noted by Watson, himself, in his *L. Orcuttii*, and often also to one or two flowers only (Bull. Torr. Club **48**: 222. 1921). I therefore now confess, that, to me at least, *L. uncialis* is nothing more or less than an extreme reduction of *L. brevicaulis* Wats., described by him at the same time and illustrated in the same plate. His figures do not disprove this conclusion, and same should be compared with my figure 46, showing variations in *L. brevicaulis* (Bull. Torr. Club **46**: 397. 1919).

SAN JOSE, CALIFORNIA.

Expression of the sexual state in Sagittaria latifolia*

John H. Schaffner

In 1921, the writer† published a paper on the nature of sexual expression in those plants which have a definite reversal of sex in the inflorescence, one part of the axis bearing staminate and the other carpellate flowers. *Sagittaria latifolia* Willd. was mentioned as being a plant of this type with carpellate flowers below and staminate flowers above.

During the past summer the opportunity was presented for an extensive study of this plant in the field, observations being made in Ohio, Missouri, Kansas, and Colorado. As will be seen from the facts presented below the development of flowers in *Sagittaria* agrees completely with the idea that sex is dependent on a functional state of the protoplasm and that when there is alternative sexual expression or sex reversal in the inflorescence axis there must be a neutral zone of tissue, of greater or less extent, between the two parts.

The inflorescence of *Sagittaria* is commonly a scapose, simple raceme with the flowers in whorls of threes. Quite frequently one or more members of the lowest whorl are developed as branches giving rise to a paniculate inflorescence, which probably represents a more primitive evolutionary stage. In the manuals, *Sagittaria latifolia* is described as normally monecious or occasionally diecious. Buchenau in "Das Pflanzenreich" also describes it as "Monoeca, rarius dioeca." Probably this statement means only that entire inflorescences are known to be purely staminate or purely carpellate. Since the plant is perennial, stoloniferous and tuberiferous it would be difficult to determine whether entire individuals were staminate or carpellate unless the plants were subjected to experimental control. The stamen vestiges of the carpellate flowers are usually small and few in the lower flowers, while near the top of the carpellate inflorescence they are more numerous and more perfectly developed. Usually

* Papers from the Department of Botany. The Ohio State University. No. 145.

† Schaffner, John H. Reversal of the sexual state in certain types of monecious inflorescences. Ohio Jour. Sci. **21**: 185–200. 1921.

also the carpel vestiges are more perfectly developed in the lowest staminate flowers. Commonly the transition is abrupt from carpellate whorl to staminate whorl.

Since, as intimated above, in passing from the female to the male state the inflorescence bud must pass through a neutral condition, it becomes evident that this may occasionally take place in a node rather than in the internodal tissue. It is then possible for one side of the axis to pass into the one sexual condition and the other side into the opposite sexual condition. Such cases were found to be quite common, the transition whorl containing one carpellate flower and two staminate flowers or two staminate and one carpellate. It is also evident that a flower incept may be exactly on the neutral tissue and then continue for a while in the neutral state, in which case the original, bisporangiate flower, from which type *Sagittaria* evolved, should again be produced. A search for this condition showed the reasoning to be correct: such bisporangiate flowers of all degrees of staminateness and carpellateness being not at all difficult to find. In fact they are quite frequently developed. One flower was found with a nearly equal number of good stamens and normal carpels. But usually there are only a few normal carpels at the tip of the flower, which soon become green, or a few normal stamens at the base together with the vestiges. There are also flowers which have nearly perfect carpels but which are plainly staminate in general nature and some which are plainly carpellate but with a few imperfect stamens. From these conditions one can find all gradations to the ordinary type of staminate and carpellate flowers with the usual types of vestiges for each.

When the basal whorl develops one or more branches, they often change immediately, or after the production of one or two carpellate flowers, to the staminate condition while the main axis may continue to be carpellate for some distance up. Bisporangiate flowers are apt to be produced in the lower part of such branches; for there is apparently a slight disturbance of the normal progression of functional states as the branch develops. One such branch was found which had its terminal bud slightly injured through some unknown cause and which showed a complete reversal of the normal sexual development. The lowest whorl of this branch was staminate and the next node ended the growth with a single large carpellate flower. There was in this case, therefore, a complete reversal of sex, as stated, in the opposite direction from what usually takes place, a change from the male to the female condition in the progressive development of the inflorescence axis. Apparently it required but a slight change in the physiological activity to throw the branch from the female state to the male state and then back to the female state again. The other two basal branches of this compound inflorescence were carpellate below and staminate above in normal order. This case brings out an important point and shows that with a proper knowledge of the functional states of the protoplast, it should be possible to bring out reversals of sex of an opposite nature from that which the heredity of the plant allows under the normal environment of the species.

The reversal of the sexual state from female to male typically takes place at or near the middle of the inflorescence axis. It may take place at any point, however, through all gradations from inflorescences with an equal number of carpellate and staminate flowers to those in which there is a single carpellate flower at the base or a single staminate flower at the tip. The next step results in monosporangiate inflorescences. If the male condition is determined before the development of the first flower incept the entire inflorescence is staminate, there being no reversal to the female state under normal conditions. If the female condition is determined at the beginning as is normally the case and this state is continued to the end, the entire inflorescence must, of course, be carpellate. Since in the field the patches of plants are usually crowded with interlacing rhizomes, it was not possible to determine whether any individual was completely staminate or carpellate. Theoretically such a condition must occasionally be produced in any given season.

The following data which are taken from a single gathering of inflorescences in a patch of *Sagittaria*, growing in a ditch along the roadside east of Manhattan, Kansas, will show what one can frequently find in the field. The list does not show the proportion of monosporangiate inflorescences to bisporangiate inflorescences, since they were gathered especially with reference to their apparently extreme staminateness or carpellateness and the ordinary monecious ones were passed by.

1. A compound inflorescence with two basal branches, with a large number of staminate flowers having the usual vestigial carpels. In the basal whorl with the two branches there was a carpellate flower or rather a bisporangiate flower with a large number of normal carpels, with three pollen-bearing stamens and a considerable number of large stamen vestiges. The head of carpels was of normal size. In the second node of the main axis there was one staminate flower together with one staminate intermediate flower with a few perfect carpels, and a carpellate intermediate flower with twenty pollen-bearing stamens, a number of stamen vestiges, and a large number of normal carpels. The rest of the inflorescence was staminate.

2. A simple inflorescence with all the flowers carpellate.

3. A compound inflorescence with all the flowers staminate.

4. A compound inflorescence, the first whorl with one staminate branch, one staminate flower, and one carpellate flower with normal stamen vestiges. The rest of the inflorescence was staminate.

5. A simple inflorescence completely staminate.

6. A compound monecious inflorescence, the lower half carpellate, the upper half staminate.

7. A compound inflorescence with one branch in the lowest node. The first whorl of the main axis contained one normal carpellate flower; the rest of the inflorescence was staminate.

8. A compound staminate inflorescence with three basal branches.

9. A completely carpellate, compound inflorescence but the upper flowers with unusually large staminodes, none, however, bearing pollen.

10. A completely carpellate, simple inflorescence with all the flowers typical.

11. A completely carpellate, compound inflorescence.

12. A compound inflorescence with two carpellate flowers in the lowest whorl together with a staminate branch; the rest of the main axis was staminate.

13. A simple, completely staminate inflorescence.

14. A compound, completely staminate inflorescence.

15. A normal monecious inflorescence.

16. A completely staminate, compound inflorescence.

17. A completely staminate, compound inflorescence.

18. A compound inflorescence; the first node with one staminate branch, one carpellate flower with large stamen vestiges, and one partly carpellate flower. This flower had a large number of normal, green carpels, six pollen-bearing stamens, and a number of stamen vestiges. The remaining part of the inflorescence was staminate.

DISCUSSION AND CONCLUSIONS

It is evident that the different expressions or types of inflorescences do not depend on differences of hereditary constitution. The genotype is the same, and the diversity of sexual expressions between different inflorescences and different branches or flowers of the same inflorescence represent alternative functional activity. Recently Stout* has come to similar conclusions in his paper on alternation of sexes in Cleome. He says that—"The theory of sex chromosomes decidedly fails in general application to plants, and even in animals, where its application seems most marked, sex is often intergrading and reversible, showing that there is alternative expression rather than alternative inheritance."

One of the most unwarranted developments of recent genetic analysis is the setting up of an inadequate or rather improper symbolism to designate monecious and hermaphroditic states. One might, with nearly as much reason, use a genetic symbol for ontogenetic fluctuations, as to have a simple symbol H for the heredities that lead to the many different types of normal and abnormal monecious conditions. There is a large number of types of moneciousness, and so far as sexual condition is concerned a plant with bisporangiate flowers is not fundamentally different from the monecious types. Individuals of both types express both maleness and femaleness in their bodies. There are hereditary factors or groups of factors which are responsible for the different types of hermaphroditic and bisporangiate expressions developed under their normal environments, as well as for those which are unisexual or monosporangiate. The hereditary background is fundamental. But the expression of any type of sexual condition in the individual is not to be inter-

* STOUT, A. B. Alternation of sexes and intermittent production of fruit in the spider flower (Cleome spinosa). Am. Jour. Bot. **10**: 57–66. 1923.

preted as being due to the presence or absence of a specific sex chromosome gene or set of genes. The sexual expression changes with the proper change of environment as has been abundantly shown by the writer and others through direct experiment. Therefore sexuality as maleness or femaleness is not primarily a matter of heredity. There can be no doubt that apparently the functional activity which leads to maleness or femaleness under the given environment or at the proper stage in the ontogeny may depend on the properties of a single chromosome in some groups, and in others on a number of chromosomes. But even with such chromosomes present it would still be possible to change the sexual state, since the influence of such hereditary factors must be the same in bringing about a given sexual state of the cell, whether neutral, male, or female, as any other influence which affects the metabolic processes. As stated above, the writer has shown by observation and direct experiment in a considerable number of plants that the sexual expression of an individual or part of an individual as male, female, or hermaphrodite, of various type and degree, is not at all due to a compelling sex factorial arrangement in the organism and that the same individual may at one time be pure male, at another time pure female, and at another hermaphroditic. The given sexual character can only be understood and explained by the circumstances of its expression even though we believe that the expression of a given sexual condition must come through an ultimate hereditary constitution which permits or leads up to that condition under the given environment.

It is, therefore, entirely superficial and contrary to both observation and experimental evidence to treat sexual expressions and sexual characters as being dependent on three simple Mendelian factors and their combinations, namely, F, M, H, FM, FH, MH, or whatever such symbols are employed. The inadequacy of such a procedure becomes evident when one can cause all the characters, which are supposed to be due to such different factorial combinations, to be developed in a single individual.

If one takes a comprehensive view of the plant kingdom certain fundamental facts become prominent. Sexuality in the lowest organisms is purely physiological. In the higher plants the segregation of chromosomes has nothing to do with the sexual expression, the sex of the gametophyte coming through the process unchanged. Unisexual forms are plainly related by intergradations to the more primitive hermaphrodites. Sex is from the lowest to the highest expressed in three simple states, female or positive, male or negative, and neutral, but with numerous gradations of intensity and fixity between either extreme and the neutral condition. Sex is definitely reversible, in many cases at least, through environmental influence. Mendelian phenomena and unit factors are concerned with minute morphological and physiological characters of multitudinous diversity, ranging from the unicellular forms to the higher plants and the higher animals. The phenomena of sexuality are entirely different. The evolution of primary sexual dimorphism is attained, being practically complete, before the multicellular condition is reached. Secondary sexual characters of the lower forms are in no way different from those of the higher. The only difference is that in the higher the cell has a larger number of factors which may become dimorphic or trimorphic. It is only in a few plants and in the higher animals that there is a seeming similarity to Mendelian segregations, because of the sex ratios obtaining and because of a certain type of association of specific chromosomes which it has become the vogue recently to call "sex chromosomes." Such allosomes with peculiar differential complements of factors, which are not to be regarded as of any different nature from other factors in other chromosomes, may and no doubt do in certain groups of organisms give the cell a functional activity that leads to a specific sexual state under the ordinary environment of the species and the ordinary hereditary complex. But the control is brought about in the same way as through any other environmental influences, like length of illumination period, external nutritive supply, etc., which are known to control or modify the sexual state in the individual. It is far better to call these special chromosomes "allosomes" in contradistinction to the "autosomes" as was done by Montgomery,* who proposed the terms, rather than "sex chromosomes." The matter will thus be considerably cleared for a rational and understandable discussion of the prob-

* MONTGOMERY, JR., THOS. H. The Terminology of aberrant chromosomes and their behavior in certain hemiptera. Science N. S. 23: 36–38. 1906.

lems of sex. The term allosome implies no special hypothesis as to the nature of these bodies. From a general or fundamental point of view, every chromosome of a sexual organism is a "sex chromosome"; for apparently in gametes the primary sexual property of attraction is possessed to a high degree by the chromatin. The attractive property disappears or is neutralized when the two sex nuclei have united. Now at synapsis, in the reduction division, this primary attractive property develops again but the attraction is between the specific pairs of chromosomes in the diploid nucleus, whether the cell be an oöcyte or spermatocyte, a megasporocyte or microsporocyte, or a more primitive homosporous sporocyte, zygospore, or primitive oöspore. Attractive properties appear between the specific pairs of chromosomes and continue until the extreme folding or looping stage of synapsis when the two members of the diploid chromosome seem to be neutralized and are then soon separated by the reduction spindle. There is no need of assuming that this attractive property of the synaptic chromosomes is anything different from the sexual attraction shown at a previous stage between the entire male and female nuclei which are usually in the resting stage during fusion. The dimorphism of allosome pairs, together with their apparent differences in complements of hereditary factors, may have a decided influence over the attractive states which arise in them, both while they are in synapsis and while they form a part of the chromatin masses of conjugating male and female nuclei. And this specificity may lead to differential attraction between the gametes.

The evolution of sex from the primitive, physiological, isogamous condition has come about by the shifting of the origin of the male and female states into an earlier and earlier stage of the sexual cell ontogeny. In case of the primary or gamete sexual characters, the lowest type shows gametes with no apparent morphological difference. The sexual state evidently does not arise until the development of the gamete is complete. By a succession of forms in many independent lines the extreme dimorphism of egg and sperm is soon attained. This progression can be explained by assuming that the origin of the sexual state arises at an earlier and earlier stage of the ontogeny of the gamete as stated above. When it arises with sufficient intensity at the very beginning of the development of the gametes, the greatest dimorphism results. The heterogametes of the higher organisms, whether plant or animal, are not different in general aspects from those near the base of the evolutionary series.

The evolution of the secondary sexual states and characters is along exactly similar lines. In the simple sexual plants and in gametophytes with an alternation of generations, there is a progression from the condition where dimorphism arises only at the end of the ontogeny in cells and tissues immediately contiguous to the gamete-producing cells, and the progression leads backward from this condition through sex determination at earlier and earlier stages of the ontogeny until the entire individual is involved, the determination of sex taking place, or being already determined, in the spore from which the gametophyte arises.

Finally, there is an exactly similar progression in the evolution of sexual states in the sporophyte. In the lowest heterosporous sporophytes the secondary sexual states arise side by side at the end of the ontogeny, namely, when the sporangia are produced, just as they do in the primitive hermaphrodites. Then the different types fall into an orderly progression of earlier and earlier sex determination; first the male and female states arising in the same sorus, second in separate sori of the same leaf, and third in entirely different sporophylls, giving rise to bisporangiate flowers. This condition remains in most groups even to the very highest. From the condition of bisporangiate flowers there are various types and degrees of moneciousness, with the sex determined at the base of or beyond the floral axis, up to the complete diecious condition. The determination of sex is again thrown back into earlier and earlier stages of the ontogeny until it coincides with the development of the female gamete or the time of its fertilization.

In view of these evident conditions and the nature of sexual expression in monecious plants together with the fact that the sex of diecious sporophytes can be reversed in both directions, the writer* in an earlier paper said that the characters of an

* SCHAFFNER, JOHN H. Progression of sexual evolution in the plant kingdom. Ohio Jour. Sci. **22**: 101–113. 1922.

organism appear to be conditioned on the interaction of four fundamental causes:

1. The presence of hereditary factors in the protoplast, apparently properties of the chromosomes. This is, of course, the fundamental influence or cause.

2. The influence of environment, both external and internal, giving rise to fluctuations, often resulting in very great morphological and physiological differences.

3. The progression of senility or rejuvenation which often has a decided effect on the hereditary expression.

4. The presence or absence of sexual states in the living substance through which primary and secondary sexual characters or dimorphisms are produced without a change in genotype.

In so far as the evidence goes, the observed conditions of the monecious state in *Sagittaria* are in entire agreement with these conclusions.

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INDEX TO AMERICAN BOTANICAL LITERATURE

1923

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 the broadest sense.

Reviews, and papers that 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 omissions, their kindness will be appreciated.

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Cuscuta lucidicarpa and *C. rubella,* spp. nov.

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Study of *Amarantus retroflexus* and other plants.

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BULLETIN
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The Tissue Fluids of *Cuscuta**

J. Arthur Harris

I. INTRODUCTION

The relationship of the phanerogamic parasite to its host presents a group of problems of great biological interest and economic importance. Physiologically, one of the most interesting of these groups of problems is that of the relative magnitude of various physico-chemical constants in the parasite and host form, since it is upon these forces that the absorption of water and essential solutes may be reasonably assumed to depend.

Earlier studies on the mistletoes have indicated that in general the osmotic concentration of the tissue fluids of the parasites is higher than that of the host plant. This has been shown for *Viscum* by plasmolytic studies by Senn (8).† It has been found to be the case in Jamaican Montane Rain Forest (4) and in desert Loranthaceae (1). The osmotic concentration of a secondary loranthaceous parasite has been found to be higher than that of the primary parasite (2), (4). Furthermore there is evidence that the specific electrical conductivity, K, of the tissue fluids of desert mistletoes is higher than that of the host plant (5). Finally, it is interesting to note that in these parasites, as in terrestrial vegetation, the osmotic concentration is far higher in the desert forms than in those of the rain forest.

* The determinations reported here were made in part in connection with field operations for the Office of Alkali and Drought Resistant Plant Investigations and the Office of Biophysical Investigations of the Bureau of Plant Industry, U. S. Department of Agriculture.

† Numbers refer to literature cited.

[The Bulletin for March (51: 83–126) was issued April 22, 1924.]

While some of these Loranthaceae are leafless species, all are chlorophyll-bearing. The investigation of a form less capable of photosynthesis seems desirable.

III. PRESENTATION OF DATA

As far as I am aware determinations on *Cuscuta* have not been published heretofore. The purpose of the present note is to call attention to a few readings made on plants growing under a rather wide range of environmental conditions.*

A single set of determinations† of osmotic concentration in atmospheres, P, as computed from the freezing point depression, Δ, made in August, 1914, on *Cuscuta* sp. growing on *Impatiens biflora* Walt. in saturated soil at Cold Spring Harbor, Long Island, gave for the stem and leaves of the host and for the stems of the parasite:

Sample Number	Freezing point depression, Δ	Osmotic concentration in atmospheres, P
Stems of *Impatiens*, C14431 A	0.41	4.88
Leaves of *Impatiens*, C14431 B	0.46	5.55
Stems of *Cuscuta*, C14431 C	0.45	5.36

The host and parasite do not seem to differ significantly in osmotic concentration.

A single determination was made on *Cuscuta* sp. growing on *Chrysoma laricifolia* (A. Gray) Greene at the mouth of Pima Canyon, Santa Catalina Mountains, Arizona, April 3, 1914. The host tissue was accidentally lost. The parasite gave:

Sample Number	Freezing point depression, Δ	Osmotic concentration in atmospheres, P
C14131 *B*	0.74	8.90

The osmotic concentration of the desert *Cuscuta* is higher than that growing in the hydrophytic habitat.

* This fragment is published because of the fact that the writer has been unable, notwithstanding persistent effort during the past several years, to secure sufficient materials for further determinations.

† All determinations of physico-chemical constants of the expressed tissue fluids have been determined by a technique employed during the past several years in a number of investigations. Methods and results have been recently reviewed elsewhere (3).

In 1920 while working in cooperation with R. A. Gortner, W. F. Hoffman and A. T. Valentine in Tooele Valley, Utah, the writer found *Cuscuta salina* Engelm. on the extremely halophytic *Allenrolfea occidentalis* (S. Wats.) Kuntze. The determinations in the accompanying table were made on tissues of the parasite collected from many host plants and on the samples of tissue of the individual host plants upon which the parasites were growing. The results appear in the accompanying table.

Number and Species	Freezing point depression Δ	Osmotic pressure in atmospheres P	Specific electrical conductivity K	Ratio of conductivity to depression K/Δ	Chloride content per liter Cl
C 20723					
Cuscuta	2.25	27.0	.0205	.0091	5.3
Allenrolfea	3.70	44.4	.0700	.0186	21.8
Difference	—1.45	—17.4	—.0495	—.0095	—16.5
C 20727					
Cuscuta	2.16	26.0	.0183	.0085	3.8
Allenrolfea	3.56	42.6	.0690	.0194	19.1
Difference	—1.40	—16.6	—.0507	—.0109	—15.3
C 20729					
Cuscuta	2.07	24.8	.0203	.0098	4.5
Allenrolfea	3.21	38.5	.0652	.0203	17.2
Difference	—1.14	—13.7	—.0449	—.0105	—12.7

In each of the three pairs of determinations the osmotic concentration as measured in terms of freezing point depression, △, and atmospheres osmotic concentration, P, is lower in the parasite than in the host. The same is true of the specific electrical conductivity, K, and of the ratio of specific electrical conductivity to freezing point depression, K/△. Thus the concentration of total solutes and of solutes capable of carrying the electric current is lower in the parasite than in the host plant.

The determinations on chloride content made by Mr. Lawrence by a method described elsewhere (7) are particularly interesting. The results are given in terms of grams of Cl per liter of tissue fluid. The tissue fluids of *Cuscuta* contain only about one-fourth of the chlorides found in the host plant.

The explanation of these results, which are conspicuously different from those elsewhere announced for the Loranthaceae, and from others which are still unpublished for root parasites, is not clear. It must be the object of further investigation. Possibly the hydration of colloids plays a part in the phenomenon. Possibly the *Cuscuta* is highly ephemeral in its development and grows only at a time when water lost from the host to the parasite can be readily replaced by the host plant from the soil.

In this connection it is interesting to note that the *Allenrolfea* upon which these plants of *Cuscuta* were found grew in a locality where a number of other plant species occurred, and not under the most saline conditions of the areas along the southern shore of the Great Salt Lake (3), (6).

SUMMARY

Determinations on *Cuscuta* indicate that the desert forms have a far higher osmotic concentration of their leaf tissue fluids than those of moist regions. This result is in accordance with the findings so far published for the osmotic concentration of the mistletoes.

When parasitic on an extreme halophyte, *Allenrolfea occidentalis*, the dodder, *Cuscuta salina*, shows high values of osmotic concentration, specific electrical conductivity and chloride content, but these are in every instance lower than those demonstrated in the tissue fluids of the host plant. This result is contrary to that generally found for the Loranthaceae.

Dynamic phases of these interrelationships are open to investigation.

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Chinese Marine Algae

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(WITH PLATES 1 AND 2)

In November, 1919, the late Mr. F. S. Collins published in Rhodora (**21**: 203–207) a short paper on "Chinese Marine Algae," based chiefly on a small collection made by Mrs. Spencer Lewis in 1915 at Pei-tai-ho, in the Gulf of Pe-chi-li. In this Lewis collection Mr. Collins named 27 species and referred three others to genus only. Of the 27 species, 17 are said to be reported for the first time as occurring in China. From the previous rather meager literature on the Chinese marine algae, Mr. Collins accepted 18 species as satisfactorily determined, making the very modest grand total of 45 species of marine algae known from the Chinese coasts. However, specific determinations in the important genus *Sargassum* were not included, as the author considered determinations in that genus more difficult and uncertain than in the other genera. And under the heading "Species recorded from China but unverified and improbable," Mr. Collins listed 11 species reported by von Martens in 1866, nine species (excluding one duplicated by v. Martens) reported by Debeaux in 1875, and one species reported by Mrs. Gepp in 1904.

In compiling and combining the previous lists of Chinese algae Mr. Collins overlooked the longest list of all, the one published by Mr. A. D. Cotton in 1915.* This list included 39 species and is based chiefly on specimens collected at Wei-hai-wei, with addition of a few from Hong Kong, Macao, and Formosa, the last-named being Chinese geographically, even though Japanese politically. Cotton's list includes 11 species of *Sargassum*, a genus omitted by Collins on account of its difficult nature, but in naming the species of *Sargassum* Cotton had the assistance of Yendo, who had given much attention to this genus in Japan, and it seems probable that at least 10 of these species are as deserving of recognition as are any of the other species that have been attributed to Chinese waters. But *Ecklonia cava* Kjellm., found in the markets of

* Some Chinese Marine Algae. Kew Bull. Misc. Inf. **1915**: 107–113. 1915.

Peking, may well have been imported from Japan, as was recognized by Cotton, and should probably be excluded.

A shorter list of Chinese seaweeds, published only a few months before Collins' paper, was contributed by Major Th. Reinbold to Loesener's Prodromus Tsingtauensis.* Excluding one doubtful determination, referred to below under *Polysiphonia japonica*, this list includes 9 species, of which 4 appear to be additions to lists published before that date. Including these 4 species, 10 of the 11 species of *Sargassum* reported by Cotton, and the other species of Cotton's enumeration that are not recognized in Collins' approved list, and allowing for one duplication in the lists of Reinbold and Collins, we seem justified in stating that the number of Chinese algae known on the publication of Collins' paper may conservatively be placed at 80.

The small collections reported upon below were made by Mr. N. H. Cowdry, partly in the summer of 1919 in the vicinity of Pei-tai-ho, the locality from which came also the specimens studied by Mr. Collins, and partly in the summer of 1920 at Chefoo. The specimens from Pei-tai-ho were forwarded for determination by Dr. Wm. R. Maxon, Associate Curator, Division of Plants of the U. S. National Museum, as was the case also with the specimens collected at the same place four years earlier by Mrs. Spencer Lewis. Later, Dr. Maxon sent a fluid-preserved specimen of *Grateloupia* that had been collected at Pei-tai-ho by Lieut. A. deC. Sowerby. Later, also, after the present writer had studied the Pei-tai-ho material submitted by Dr. Maxon, Mr. Cowdry himself brought his collection of Chinese algae to The New York Botanical Garden, most of the specimens with determinations provided by Professor K. Okamura of Tokyo, a list of whose determinations had been published by Mr. Cowdry at about the same time (Journal of the North China Branch of the Royal Asiatic Society **53**: 180, 181. 1922). The present enumeration is then but an expansion and in a small way a revision of Cowdry's previously published list. The number of species collected by Cowdry and now listed is 39, in addition to two named varieties and three species that are referred to genus only. Of the 39 named species, 12 do not appear in lists previous to Cowdry's and these 12 added to the 80 mentioned above bring the conser-

* Beih. Bot. Centralb. **37^2**: 76. 15 Ap 1919.

vatively compiled list of known Chinese algae to 92 species, which is somewhat more than twice the known total as figured by Collins in 1919.

But even as now increased, the list is a brief one for a coast line as long and as varied as is China's and the number is sure to be greatly increased by future investigations. It seems probable, however, as already noted by Cotton, that owing to the great amount of fresh water brought down by the rivers Hoang-Ho and Yang-ste-Kiang and to other causes, the marine flora of China may prove to be not particularly rich.

Besides the two species and one variety that are here described as new, the collections made by Mr. Cowdry appear to add to lists published previously to his own the following species: *Ulva rigida*, *Enteromorpha Linza*, *Myriactis pulvinata*, *Chorda Filum*, *Sargassum microceratium*, *Dictyota divaricata*, *Neurocarpus divaricatus*, *Endocladia complanata*, *Gymnogongrus flabelliformis*, and *Gloiopeltis coliformis*.

The list is remarkable for the inclusion of a considerable number of species that appear to be identical with species that are more or less common on the Atlantic coast of the United States, such as *Ulva Lactuca*, *Enteromorpha compressa*, *E. Linza*, *E. prolifera*, *Bryopsis plumosa*, *Scytosiphon Lomentaria*, *Myriactis pulvinata*, *Leathesia difformis*, *Chorda Filum*, *Gracilaria confervoides*, *G. lacinulata*, *Champia parvula*, *Rhodomela subfusca*, *Dasya pedicellata*, *Ceramium rubrum*, and *Corallina officinalis*. This fact harmonizes well with correspondences in the land floras of eastern North America and eastern Asia already pointed out by Asa Gray and others. The annotated list follows, P referring to Pei-tai-ho and C to Chefoo:

CHLOROPHYCEAE

ULVA LACTUCA L. P, *292*. Thallus 37–45 μ thick, the cells subquadrate in section.

ULVA RIGIDA Ag. C, *525*. Thallus 60–80 μ thick, the cells twice as high as broad, showing conspicuous trigones in a surface view. The membrane is occasionally perforate and it is apparently the *Ulva pertusa* of Cowdry's list.

ENTEROMORPHA COMPRESSA (L.) Grev. P, *294*.

ENTEROMORPHA LINZA (L.) J. Ag. *forma*. P, *291*; C, *553*; apparently the first record for China.

ENTEROMORPHA PROLIFERA (O. F. Müll.) J. Ag. C, *526, 527.*

CLADOPHORA sp. C, *528.*

BRYOPSIS PLUMOSA (Huds.) Ag. P, *293;* C, *531.*

CODIUM FRAGILE (Sur.) Hariot. P, *285;* C, *529.* *Codium mucronatum* of Cowdry's list. Setchell and Gardner (Univ. California Publ. **8**: 171. 1920) have recently reduced the more widely recognized *Codium mucronatum* J. Ag. to the position of a synonym of *C. fragile*, the type of which was Japanese. *Codium mucronatum* was originally described with three named forms (no specified or implied type) from Tasmania, Alaska, California, New Zealand, and Chatham Island.

PHAEOPHYCEAE

COLPOMENIA SINUOSA (Roth) Derb. & Sol. P, without number.

SCYTOSIPHON LOMENTARIA (Lyngb.) J. Ag. P, *286;* C, *550.*

MYRIACTIS PULVINATA Kütz. In cryptostomata of *Sargassum microceratium*, C, *523.*

LEATHESIA DIFFORMIS (L.) Aresch. C, *550 p.p.*, a minute form, making cushions 1 mm. broad or less, but fertile; C, *551*, making cushions 5–8 mm. broad.

CHORDARIA FIRMA Gepp. P, *288a;* C, *538*, in rock pools.

Chordaria Chordaria (Harv.) comb. nov. *Cladosiphon Chordaria* Harv. Phyc. Austral. *pl. 60.* 1858. *Chordaria Cladosiphon* Kütz. Tab. Phyc. **9**: 2. *pl. 2. f. 11.* 1859. C, *536*, attached to *Chorda Filum.*

The plants are 8–12 cm. tall and are more slender and smaller in every way than in the type (from Port Phillip, Australia) figured by Harvey, who says that specimens from Georgetown, Tasmania, are "very much larger and more robust than our figure." Kützing's figure is based upon a plant from Port Fairy, Victoria, and is somewhat similar to Harvey's. Okamura has referred the present number to *Chordaria Cladosiphon* Kütz. (in herb. Cowdry) and it is apparently this that bears that name in Cowdry's Pei-tai-ho list, although the label in the Cowdry herbarium indicates that the plant really came from Chefoo. Collins also has listed the same species from Pei-tai-ho.

CHORDA FILUM (L.) Stackh. P, *284;* C, *963.* The appearance of this name in the Cowdry list seems to be the first record for China.

CYSTOPHYLLUM THUNBERGII (Mert.) J. Ag. P, *282*; C, *521*, *522*. Yendo (Jour. Coll. Sci. Tokyo **21**[12]: 118. 1909) adopts Otto Kuntze's reference of this species to *Sargassum* on the ground that the receptacles are "axillary." It seems, however, to the present writer that the receptacles are as much terminal as axillary and that the plant is rather more at home in *Cystophyllum*.

SARGASSUM CONFUSUM Ag. (?) P, *283* and another without number (May 23, 1919); C, *520 pp.*, "drifted on shore in large quantities with *Zostera*." We have not seen Agardh's original from Japan. Our more or less doubtful determination is based chiefly on Yendo's figures and descriptions (Jour. Coll. Sci. Tokyo **21**[12]: 106–112. *pl. 14. f. 1–12.* 1909), and may be influenced by Okamura's doubtful reference of no. 520 to this species. However, no. *520* in herb. Cowdry is possibly a mixture.

A specimen from Pei-tai-ho, without number, is about 25 cm. long and shows a pronounced dimorphism or polymorphism in its leaves. Most of the leaves on certain young branches are oblanceolate or obovate, 20–35 mm. long and 6–17 mm. wide and dentate, while all of the leaves now remaining on longer older branches are narrowly linear or subfiliform, 5–45 mm. long, and subentire. The Pei-tai-ho specimen under no. *283* manifestly represents the terminal parts of a plant of the same species, with vesicles, receptacles, subfiliform leaves, and nothing at all to suggest that parts of it might bear leaves of a very different character.

SARGASSUM MICROCERATIUM (Mert.) J. Ag. C, *523*, *524*. In *523*, the plants are 20–35 cm. long, the basal leaves are linear, twisted, 1–2 cm. long, 1–1.5 mm. wide, entire or nearly so; the upper leaves filiform, 2–4 mm. long, 0.2–0.3 mm. wide; the receptacles are fusiform, 2–4 mm. long; the vesicles are 1.5 mm. wide, ellipsoid or obovoid, apiculate or muticous, on pedicels that are often very short but are sometimes longer than the vesicles, sometimes showing much variation on a single plant. The part bearing the basal leaves is short, only 2 or 3 cm. long; the rest of the plant is loosely paniculate, with numerous slender branches, small vesicles, and rather inconspicuous leaves and receptacles. In another specimen, *524*, from the same locality, the leaves and receptacles are less numerous.

The no. *523* is the *Sargassum fuliginosum* (?) of the Cowdry list. Yendo makes *S. microceratium* a synonym of *S. piluliferum* (Turn.) Ag., but Turner's original plates of the two look very different and our Chefoo plant is nearer the *S. microceratium*. *Sargassum piluliferum* has large compound dichotomous leaves; the Chefoo specimens have very small simple leaves.

DICTYOTA DIVARICATA Lamour. C, *548*, in rock pools.

DICTYOTA INDICA Sond. With the preceding and under the same number. The two species or forms apparently intergrade, as also in the West Indies. *D. indica* has been reported from Pei-tai-ho by Collins and *D. divaricata* appears in the Cowdry list, based on determinations by Okamura.

Neurocarpus divaricatus (Okam.) comb. nov. *Haliseris divaricata* Okam. Ic. Jap. Alg. **1**: 57. *pl. 13, 14*. 1907. C, *549*, in rock pools. Apparently seen and named by Okamura.

RHODOPHYCEAE

GELIDIUM CORNEUM (Huds.) Lamour. In rock pools, P, *296;* C, *540, 541, 544*, and *554*. Nos. *540* and *544* are slender bitripinnate forms of this notoriously variable species, resembling Turner's varieties *pulchellum* and *claviferum;* these formed the basis of the *Gelidium Amansii* of the Cowdry list. Nos. *296* and *544* are taller, less densely and rather less regularly branched plants, somewhat resembling Lamouroux's figure of his *Fucus Amansii* (from Mauritius and Madagascar) and resembling also some of the Australian plants distributed by J. Agardh as his *Gelidium australe;* no. *554* appears to be the "*Gelidium Amansii* Lmx., f. *radicans* Okam. mscr." of the Cowdry list. No. *541* is more regularly bipinnate with more clavate, more obtuse branchlets; this is apparently the *Pterocladia capillacea* of the Cowdry list, but the specimens are sterile or tetrasporic and we find no reason for believing them to belong to *Pterocladia* rather than to *Gelidium*. A Pei-tai-ho form similar to no. *544* from Chefoo is the *Gelidium australe* of the Collins list.

ENDOCLADIA COMPLANATA Harv. C, *969 p.p.*, forming a matted covering on rocks. The thallus is only slightly complanate, but it agrees with the plant distributed under this name by Okamura in Alg. Jap. Exs. 56. In herb. Cowdry the species is mounted with fragments of *Symphyccladia gracilis*, to which it may bear some superficial resemblance in size, color, and general habit.

GYMNOGONGRUS FLABELLIFORMIS Harv. C, *546* and *547*, in shaded rock pools. A narrow form, the thallus segments only about 0.6–0.8 mm. broad (when soaked out) except under the dichotomies where they may reach a width of 1.2 mm. Suringar, who, like us, had not seen Harvey's type, makes the laciniae 3 mm. broad, and Cowdry plant would seem to accord better with Suringar's *G. japonicus* (Alg. Jap. 36. *pl. 24 A*), which appears to differ from *G. flabelliformis* only in its narrower segments and generally smaller size. However, the Chefoo plant is no narrower than the Japanese plant distributed by Okamura as *G. flabelliformis* in the Algae Japonicae Exsiccatae no. 10. Possibly *G. japonicus* should be considered a synonym of *G. flabelliformis*.

GRACILARIA CONFERVOIDES (L.) Grev. P, *287* and *288b;* C, *538 p.p.* Under 287 are elongate sparingly branched tetrasporic plants 20–32 cm. long; under 538 are a few smaller more branched plants, tetrasporic and cystocarpic.

GRACILARIA LACINULATA (Vahl) M. A. Howe. P, *290*. Two or three small fragments.

CHAMPIA PARVULA (Ag.) Harv. C, *556*. Very similar to European and American forms in habit, but the superficial cells of the thallus cortex are somewhat smaller and less clearly defined and the cystocarps are often slightly larger and more globose. Mrs. Gepp has reported the species from Wei-hai-wei.

Lomentaria sinensis sp. nov. Plants small, 2–3 cm. high, flaccid, somewhat gelatinous, intertangled, dichotomous below, the main axes irregularly bipinnate, with an occasional branch in another plane, mostly 0.3–0.6 mm. in diameter, the branches and branchlets lightly constricted at base, other constrictions rare, the ultimate branchlets ovoid-fusiform to digitiform; thallus wall thin, mostly 30–65 μ thick; cells of the superficial layer mostly 12–24 μ in maximum diameter in surface view, often broader than high in cross sections of the older parts; tetrasporangia in sori at the bottom of orbicular, oval, or elliptic pits 75–300µ wide or long, and also scattered. (PLATE 1, FIGURE 1.)

In rock pools, Chefoo, July 29, 1920, N. H. Cowdry *556, p.p.* in herb. Cowdry.

Lomentaria sinensis is allied to the type of the genus, the European *L. articulata* (Huds.) Lyngb., and to the Japanese *L. catenata* Harv., but manifestly differs from both in the smaller size of the plants, in the more bifarious branching, in the lack of a catenate or moniliform appearance owing to the rarity of constrictions except at the bases of lateral branches, and in the large superficial cells, which have 2–5 times the diameter of corresponding cells of *L. articulata* and twice the diameter of those of *L. catenata*. In general consistency, the plant is more gelatinous and less cartilaginous than *L. catenata*. The pits which form ostioles for the tetrasporic sori are more highly specialized and more obvious than in *L. articulata*, but less so than in *L. catenata*.

LAURENCIA OBTUSA (Huds.) Lamour. P, *289;* C, *539*. Referred to genus only by Okamura (in Cowdry's list) but Collins has identified similar plants from Pei-tai-ho with this widely distributed species. Tetrasporic plants under no. 539 have sporangiophores that are more corrugated and more constricted at the base than in West Indian plants that are currently referred to this species.

CHONDRIA sp. P, *299*, with incipient tetrasporangia. Near *C. tenuissima* (Good. & Woodw.) Ag.

POLYSIPHONIA JAPONICA Harv. P, *300* and a specimen without number (Sept. 4, 1919); C, *967* (on *Zostera*) and *968* (on *Chorda*); and perhaps also C, *555*, on rocks at low tide. Resembles in habit some of the West Indian plants currently referred to *P. ferulacea* Suhr, but the segments are often relatively longer, the sporangial branchlets are often more podlike or stichidioid, the main axis is corticated at the base, and there are often traces of cortication on the principal branches in the form of narrow inconspicuous cells alternating with the primary siphons. This species is omitted in J. Agardh's "Species" and in De-Toni's "Sylloge." A plant from Wei-hai-wei has been referred to this species by Mrs. Gepp (1904), who publishes a copy of Harvey's description.

The plant from Pei-tai-ho referred by Collins to *P. ferulacea* belongs here; perhaps also the poor specimen from the Kiautschou region referred doubtfully to this species by Reinbold. In Cowdry's list the species is referred to genus only. No. *555*, on rocks, may be a form of the present species, but the plant is usually corticated almost to the apices and it has more divaricate branches; it is possibly *P. Stimpsoni* Harv.

SYMPHYOCLADIA GRACILIS (Mart.) Falkenb. P, *295;* C, *545* and *969 p.p.*

RHODOMELA SUBFUSCA (Woodw.) Ag. C, *543*, thrown up on a sandy shore. A single tetrasporic plant differing somewhat in habit from European and American plants, the difference due, perhaps, chiefly to the more curved and contorted tetrasporic branchlets. Also several loose denuded basal fragments in a bundle of "duplicates" supposed to have come from Pei-tai-ho. The species has been recorded from Chefoo by Cotton and from Wei-hai-wei by Gepp.

DASYA PEDICELLATA Ag. *Dasya elegans* (Mart.) Ag. P, *297;* C, *965*. Rather small tetrasporic plants, 9–13 cm. long. Collins was the first to ascribe this species to China, basing the record on plants from Pei-tai-ho. Okamura, in the Cowdry list, refers the specimens doubtfully to *Dasya punicea* Menegh.

CERAMIUM JAPONICUM Okam. P, May, 1919, without number; C, *557*, tetrasporic plant in rock pool, determined by Okamura.

CERAMIUM BOYDENII Gepp. P, May, 1919, without number, cystocarpic; C, *966, p.p.*, thrown up on a sandy shore, tetrasporic. Type from Wei-hai-wei. The cystocarps, which seem to be hitherto undescribed, are mostly terminal on short lateral proliferations; they are subtended and more or less enclosed by a sort of calyx of 2–8 (usually 4–6) mostly incurved bracts.

CERAMIUM RUBRUM (Huds.) Ag. P, *298* and *301;* C, *542*. Reported from Tsingtau by Reinbold.

GLOIOPELTIS COLIFORMIS Harv. C, *530*, in small clumps on rocks, often uncovered at low tide. Plants about 2 cm. high, irregularly furcate.

GRATELOUPIA FILICINA (Wulf.) Ag. C, *535* (tetr.) and *537 p.p.*

(cyst.), in shaded rock pools at low-tide mark. Like Japanese specimens currently referred to *G. filicina* (*e. g.*, Okam. Alg. Jap. Exsicc. *32*), Cowdry's plants are somewhat softer and more gelatinous and rather more inclined to be hollow than Mediterranean plants that are held to be typical of the species.

GRATELOUPIA FILICINA **porracea** (Mert.)

Grateloupia porracea (Mert.) Kütz. Phyc. Gen. 397. 1843; Tab. Phyc. **17**: *pl. 25. f. a–c.* 1867.

Grateloupia tubulosa Okam. MS. in herb. Cowdry. C, *537, p.p.*, in rock pools. This evidently intergrades with the preceding and also with the following.

GRATELOUPIA FILICINA **Lomentaria** var. nov.

Thallus terete or subterete, coriaceous or subcoriaceous, tubulose, occasionally constricted, especially in the lomentarioid ultimate branchlets, rather copiously and very irregularly branched in all directions, the cystocarpic plants sometimes vaguely bipinnate, the ultimate branchlets ovoid, ellipsoid, fusiform, or much elongated, obtuse or subacute, the tetrasporic less branched and subspinescent, the tetrasporangial branchlets commonly rostrate, mostly 0.75–1.5 mm. long. (PLATE 1, FIGURES 2–4; PLATE 2.)

East Cliff, vicinity of Pei-tai-ho, *Cowdry 302* (type, cystocarpic) Sept. 25, 1919; also at Pei-tai-ho, *A. de C. Sowerby 94* (cyst.), Aug., 1921; and at Chefoo, *Cowdry 537, p.p.* (tetr.) *538, p.p.* (cyst.) Aug. 2, 1920 and *966 p.p.* (tetr.)

The above variety differs so much in habit from the ordinary solid flattened pinnate representatives of the extremely variable *Grateloupia filicina* that its true affinities eluded the writer on the first examination. The hollow thallus, the frequently ovoid or ellipsoid branchlets very strongly constricted at the base and with occasional constrictions elsewhere suggested relationship with *Lomentaria* of the Rhodymeniaceae, from which family, however, the deeply immersed cystocarps and the more obviously filamentous cortex seemed to exclude it. The first impulse to describe the rigid Pei-tai-ho plant as a new species or even as the type of a new genus was counteracted by the discovery of its relationship to the terete or subterete hollow-thallused West Indian plant originally described as *Grateloupia porracea* (Mert.) Kütz. and now currently considered to be a form of *Grateloupia filicina*, and furthermore by seeing later Cowdry's collections made at Chefoo, which appeared to show all gradations between the rigid mostly short-branched plant here described as *G. filicina Lomentaria* and a laxer more gelatinous longer-branched plant close to the typical *G. porracea* (*Grateloupia tubulosa* Okam. MS. in herb. Cowdry). The last-mentioned forms, on the other hand, intergrade at Chefoo with flattened pinnate forms which may be compared without violence with typical *G. filicina*.

GRATELOUPIA sp. C, *532* in herb. Cowdry. A single sterile fragment 8 cm. long, 5–10 mm. wide, subpinnate, with lanceolate lobes, which are scarcely or not at all constricted at base. Perhaps related to the Japanese *Grateloupia acuminata* Holmes. In herb. Cowdry the specimen was named *Nemastoma*.

Nemastoma Cowdryi sp. nov. Thallus lubricous, moderately gelatinous, subcorneous on drying, deep purplish vinaceous, Indian lake, or dahlia carmine, repeatedly (mostly 7–12 times) and rather regularly dichotomous, rarely trichotomous, 4–10 cm. high, the more finely divided somewhat suggestive of *Ceramium rubrum* in habit, occasionally proliferous, mostly terete or subterete, but more or less complanate in older parts and below the dichotomies, tubulose below, the wider parts 1–3 mm. broad, the widely spreading, often subdivaricate terminal branches 150–300 μ in diameter (not including the mucous sheath, which is 75–150 μ thick), the apices subacute; medullary filaments 12–24 μ in diameter; cortex consisting of 3–5 times closely di-(tri-)chotomous strictly fastigiate filaments 80–120 μ long, the penicillate clusters rather easily separable, their proximal cells ovoid, about 12–15 μ in diameter, sometimes broader than high, the succeeding cells ellipsoid or short-cylindric, 7–9 μ broad, the clusters usually terminating in rather rigid tapering unbranched filaments 2–4 cells long, their cells mostly about 3 μ broad and 2 or 3 times as long, the distal cells 12–25 μ long, commonly trichomic and often capitate; tetrasporangia scattered, sessile on cortical branchlets of the penultimate order, ellipsoid or obovoid, 30–42 μ × 16–24 μ (incl. wall), the spores decussately paired; other parts unknown. (PLATE 1, FIGURE 5.)

In shaded rock pools, Chefoo, July 14, July 29, and Aug. 2, 1920, *N. H. Cowdry 534* (type) and *533* (July 10, 1920).

Nemastoma Cowdryi is related to *N. dichotomum* J. Ag., but differs in its more delicate, more terete, more Ceramioid thallus, and very decidedly in the longer-celled, more rigid and tapering short-piliferous filaments of the cortex.

CORALLINA OFFICINALIS L. C, *552* in herb. Cowdry.

On rocks at low tide. Reported from Pei-tai-ho by Collins.

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Explanation of plate 1

FIG. 1. *Lomentaria sinensis.* Photograph of the type specimen (dried). Natural size.

FIG. 2. *Grateloupia filicina Lomentaria.* Photograph of the dried type specimens (*Cowdry 302*). Natural size.

FIG. 3. *Grateloupia filicina Lomentaria.* Photograph of a formalin-preserved specimen (*Sowerby 94*, from the U. S. National Museum). Natural size.

FIG. 4. *Grateloupia filicina Lomentaria.* Photograph of a transverse section of the thallus near the base. From dried material (*Cowdry 302*), soaked out. Enlarged 84 diameters.

FIG. 5. *Nemastoma Cowdryi.* Photograph of the type specimen (dried). Natural size.

Explanation of plate 2

Grateloupia filicina Lomentaria

All figures are photomicrographs of microtome sections of soaked-out fragments of the dried type material (*Cowdry 302*).

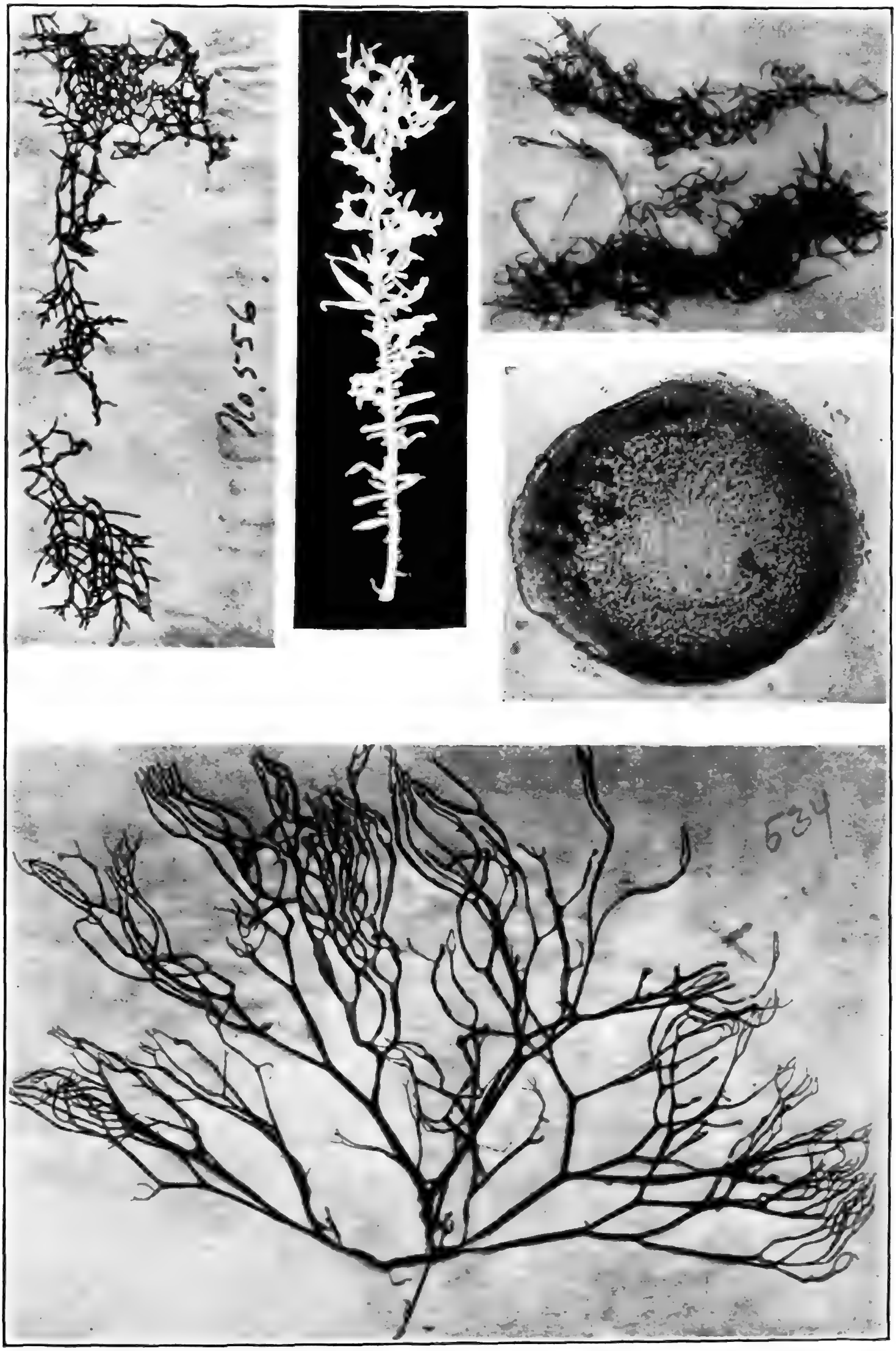
FIG. 1. A transverse section through a primary or secondary axis (to the left) and median longitudinal section through the base of an ultimate branchlet, showing the tubulose character and the septum at the base of the branch. Enlarged 100 diameters.

FIGS. 2 and 3. Transverse sections showing immersed cystocarps projecting into the lumen and sometimes coalescent there. Enlarged 74 diameters.

FIG. 4. Transverse section of thallus, showing cell structure, etc. Enlarged 450 diameters.

FIG. 5. Longitudinal section of thallus. Enlarged 450 diameters.

3

1  2 4 5

1. LOMENTARIA SINENSIS
2-4. GRATELOUPIA FILICINA LOMENTARIA
5. NEMASTOMA COWDRYI

1
2
3
4
5

Grateloupia filicina Lomentaria

The section Tuberarium of the genus Solanum in Mexico and Central America

P. A. Rydberg

This section belongs to the subgenus *Pachystemon* of Dunal, *i. e.*, the anthers are short, thick, subcylindric or oblong, not attenuate at the apex. It is in general characterized by odd-pinnately dissected leaves, by terminal and lateral corymbiform or racemiform cymes, plicate corollas, pedicels with an articulation, and, as the name indicates, supposedly with tuber-bearing stolons. Some botanists may have been inclined to separate it as a genus distinct from *Solanum*, and Carl Börner* united the section with *Lycopersicum* into a new genus *Solanopsis*. None of the characters by which the section is separated from the rest of the genus holds, however. *Solanum bulbocastanum* Dun., *S. muricatum* Ait., *S. apalophyllum* Dunal, *S. simplicifolium* Bitter, and *S. morelliforme* Bitter, which evidently belong to this section, have simple leaves and several species in the sections Morella and Dulcamara have pinnatifid leaves. The pedicels are usually articulate some distance above the base, but in some species the articulation is practically basal. In the rest of the genus it is basal but often obsolete. The shrubby species of Tuberarium bear, as far as known, no tubers and in several of the herbaceous ones no tubers have as yet been found. There are therefore no constant characters to separate the section generally from the rest of the sections included in the subgenus Pachystemon. Bitter† has shown that there exists still less reasons for uniting the section with *Lycopersicum*.

Since Dunal's monumental work on Solanum in De Candolle's Prodromus,‡ very little systematic work on this group has been made until in the last decade. Dunal divided the section into two groups "Potatoe," with interruptedly pinnatifid leaves, and "Pterophyllum," with regularly pinnatifid leaves. As the presence or absence of smaller intermittent lobes vary in the same

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* Abh. Nat. Ver. Bremen **21**: 282. 1912.

† Rerpert. **11**: 255–260. 1912.

‡ D. C. Prod. **13**[1]: 27–43. 1852.

species, this division was very artificial. Bitter, who in 1812–15 published such valuable contributions to the knowledge of Solanum and especially of this very section, substituted instead the mode of articulation of the pedicels as the main bases of classification of this section, and established two subsections: BASARTHRUM, with basal articulation, and HYPERBASARTHRUM, with the articulation higher up. He also pointed out that the latter could be subdivided by the shape of the fruit, subconic or subglobose, and the deeper or shallower division of the corolla. Following these suggestions and elaborating on the same, I have been able to present the following key of the Mexican and Central American species as far as they are known to me.

Bitter, following more or less the German fashion of classifying the different forms of a genus in many categories, used the ranks: superspecies, or collective species, species, subspecies, variety, and forma. In most cases I have regarded his subspecies as distinct species, admitting, however, that each is most closely related to the species of which he made it a subspecies. In most cases I have not regarded it worth while to pay special attention to his varieties or formas. In one case, however, I think, a certain variety deserves specific rank, better than some of his subspecies and even better than one of his species.

Key

Pedicels articulate some distance above the base (*Hyperbasarthrum*).	
Stem herbaceous.	
Fruit globose or ellipsoid, rounded at the apex; plants with tubers.	
Leaves pinnatifid.	
Corolla 5-agonal, its lobes as broad as or broader than long....................	1. TUBEROSA.
Corolla distinctly star-shaped, its lobes longer than broad....................	2. PINNATISECTA.
Leaves simple; corolla star-shaped..........	3. BULBOCASTANA.
Fruit elongated-ovoid or sub-conical, acute at the apex; plant probably not tuber-bearing..	4. OXYCARPA.
Stem woody, climbing; plant not tuber-bearing...	5. JUGLANDIFOLIA.
Pedicels articulate at or near the base; plant not tuber-bearing as far as known. (BASARTHRUM).	
Stem herbaceous..........................	6. SUAVEOLENTIA.
Stem woody, climbing and rooting at the nodes..	7. APPENDICULATA.

1. TUBEROSA

Leaf-segments of an ovate type, acute or obtuse or abruptly short-acuminate.
Leaf-segments distinctly stalked, cordate or rounded at the base.
Corolla more than 15 mm. high; leaflets rather thick, densely pubescent on both sides; calyx-lobes long-acuminate.................... 1. *S. tuberosum.*
Corolla less than 15 mm. high; leaflets rather thin; calyx-lobes acute.
Leaves equally pubescent on both sides; calyx-lobes distinctly longer than broad.
Inflorescence many-flowered, usually exceeding the leaves; corolla white to sky-blue, about 20 mm. broad; leaf-segments 7–11, intermittent segments quite numerous.............................. 2. *S. longipedicellatum.*
Inflorescence few-flowered, usually not exceeding the subtending leaf; leaf-segments 3–7; intermittent segments rare or none.
Corolla blue-violet; leaflets mostly 5–7... 3. *S. Papita.*
Corolla white, leaflets 1–3, or if 5 the lower pair small.................... 4. *S. Wightianum.*
Leaves almost glabrous above; calyx-lobes as broad as long; corolla white, 12–16 mm. broad.............................. 5. *S. stoloniferum.*
Leaf-segments sub-sessile or the lower ones very short-stalked.
Plant grayish, stem and leaves densely hirsute with long white hairs.................... 6. *S. polytrichon.*
Plant green; stem and leaves rather sparingly hirsute with short hairs.
Corolla distinctly 5-angled, the sinuses without lobes.............................. 7. *S. Fendleri.*
Corolla somewhat 10-angled, the interpetalar membranes produced into short lobes.............................. 8. *S. demissum.*
Leaf-segments of a lanceolate type, usually long-acuminate.
Leaf-segments 7–11, decidedly pubescent, broadly lanceolate, mostly acute at the base.
Corolla 2 cm. broad or more; leaves coarsely hirsute, with intermittent segments........ 9. *S. verrucosum.*
Corolla 1 cm. broad; leaves finely pubescent, without intermittent segments............ 10. *S. Ervendbergii.*
Leaf-segments 11–15, narrowly lanceolate, glab-

rous or nearly so, very oblique at the base, acute on the upper margin, semi-cordate on the lower. . . . . 11. *S. agrimonifolium.*

1. SOLANUM TUBEROSUM L. Sp. 185. 1753

The cultivated potato is apparently not wild in North America. In the United States it is found occasionally on garbage dumps and waste places, but rarely persists more than a single season. From reports, it seems to be more common in Mexico and Central America. In the United States National Herbarium there are but two Mexican specimens and in the collections of the New York Botanical Garden only one from Costa Rica. These are:

VERA CRUZ: (Orizaba) *Rose & Hay 5709.*
NUEVO LEON: *Palmer 938,* in part.*
COSTA RICA: *Kuntze 2296.*

2. SOLANUM LONGIPEDICELLATUM Bitter, Repert. **11**: 457. 1912

This species is closely related to *S. tuberosum,* differing in the smaller flowers, thinner leaves and acute instead of acuminate calyx-lobes. I see no reason for regarding the var. *pseudoprophyllum* Bitter, *l. c.* 458, as anything but an individual variation. Bitter himself was inclined to regard the specimen representing the type number *Pringle 8602* in the Munich herbarium as belonging to the variety, or at least approaching it. The following specimens belong here:

MEXICO (Federal District): *Pringle 8602, 8571.*
MEXICO (State): *Pringle 9142.*
GUANAJUATO: *Dugès 417 A.*

3. **Solanum Papita** Rydberg sp. nov.

A perennial, with subterranean stolons and tubers; stems herbaceous, 1–2 dm. high, terete, slender, puberulent with short acute hairs; leaves odd-pinnatifid, 4–10 cm. long; rachis slightly winged, sparingly pubescent, principal leaf-segments

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* This number in the National Herbarium consists of two plants; one belongs to *S. tuberosum,* the other to *S. Fendleri.* To the latter belongs also *Palmer 937.* Maybe the specimens have been mixed.

5–7, more or less stalked, ovate, rounded or obtuse at the base, obtuse, acute, or sometimes short acuminate at the apex, 1–3 cm. long, short hirsute with few-celled hairs on both sides, dark-green above, paler beneath, the lower pairs much smaller than the rest; intermittent small segments rarely present, 1–3 mm. long; pseudo-stipular leaves lunate, 2–4 mm. long; peduncle 1–3 cm. long, puberulent; inflorescence 3–7-flowered; pedicels 1–3 cm. long, articulate above the middle, the lower portion puberulent, the upper glabrous; calyx sparingly hirsutulous, the tube 2.5 mm. long, the lobes lanceolate, acute, 2.5 mm. long; corolla dark bluish-violet, about 12 mm. broad, the lobes broadly triangular, 3 mm. long, broader than long, puberulent without; anthers oblong, cordate at each end, 3 mm. long; fruit globose, the mature berry unknown.

Type collected at Otinopa, Durango, 1906, *Palmer 392* (U. S. Nat. Herb. no. *571417*).

This is also related to the potato, but is still smaller, the corolla only about 12 mm. broad. The leaf-segments are few, 5 or 7, the intermittent smaller ones usually found in the potato and its relatives are practically lacking in this species. No specimens except the type have been seen.

4. **Solanum Wightianum** Rydberg sp. nov.

A perennial, with subterranean stolons and tubers; stem herbaceous, about 3 dm. high, striate, pilose with flat, somewhat kinked hairs; leaves on the seedlings or young shoots simple, the petioles 1–1.5 cm. long, the blade ovate, 2–3 cm. long; leaves of the better developed plant pinnately 3–5-foliolate, 1–1.5 dm. long; rachis wing-margined; leaf-segments distinctly petioluled, long-pilose on both sides, the blade ovate or oval, acute or acutish, that of the terminal segment 4–6 cm. long, that of the upper pair 2–4 cm. long and that of the lower pair if present, 5–15 mm. long; peduncle 4–5 cm. long; raceme about 5-flowered; pedicels 2–3 cm. long, articulate above the middle; calyx white-pilose, 5 mm. long, the lobes lance-deltoid, acute, slightly longer than the tube; corolla pentagonal, 14–15 mm. wide, white, puberulent without; anthers oblong, 4 mm. long, cordate at the base.

Type grown from tubers, collected by F. S. Lozano near Acambaro, Guanajuato, in 1904 (Gray Herbarium).

This species is named in the honor of W. T. Wight of Washington, who has done a good deal of work on the tuber-bearing Solanums, and has indicated on the type sheet that he regarded it as belonging to an undescribed species.

5. SOLANUM STOLONIFERUM Schlecht. & Bouché, Verh. Beförd. Gartenb. Preussen **9**: 317. *pl. 2.* 1833

Bitter seems not to have seen any native specimen except those collected by Schiede and Deppe. There is, however, no uncertainty as to its identity as the original publication contains a good illustration. Furthermore, there is a cultivated specimen in the Columbia University herbarium from the Botanic Garden at Brasel. A specimen collected on ballast, near Communipaw Ferry, New Jersey, by Addison Brown might belong to it. The only Mexican specimens I have seen are the following:

QUERÉTARO: Near Cadueyta, *Rose, Painter & Rose 9841.*

6. **Solanum polytrichon** Rydberg sp. nov.

A perennial, with subterranean stolons and tubers; stem herbaceous, 1–3 dm. high, densely hairy with long white crisp many-celled hairs; leaves 6–15 cm. long, odd-pinnatifid; rachis narrowly winged, densely hirsute; principal leaf-segments 5–9, sessile, ovate, or the terminal one broadly oval, 1–4 cm. long, obtuse or acute at the apex, rounded at the base, densely white-hairy on both sides, the lowest one or two pairs much reduced; intermittent smaller segments usually present, 1–4 mm. long, rounded; pseudo-stipular leaves lunate, 3–5 mm. long; peduncles 1–4 cm. long, hirsute; inflorescence branched, 5–8-flowered; pedicels 1–2 cm. long, articulate above the middle; calyx sparingly hirsute, the tube and the lobes each about 2.5 mm. long, the latter lanceolate, acute; corolla white, about 1.5 cm. broad, puberulent, the lobes broadly triangular; anthers 4 mm. long, cordate at each end; young fruit globose.

Type collected in the vicinity of San Luis Potosi, 1878, *Parry & Palmer 632* (U. S. Nat. Herb. *42677*).

This species is most closely related to *S. Fendleri*, but differs in the dense pubescence with long white hairs.

7. SOLANUM FENDLERI A. Gray, Am. Journ. Sci. II. **22**: 285. 1856

S. tuberosum boreale A. Gray, Syn. Fl. **2**[1]: 227. 1878.

S. boreale Bitter, Repert. **11**: 459. 1912.

The original specimens of *S. Fendleri* had deep violet corollas but the color varies considerably and white-flowered specimens are as common as those with purple or bluish shades. Bitter thought that the white-flowered specimens represented a distinct species and adopted for this Dr. Gray's varietal name, *boreale*. Though the white-flowered specimens often are less hairy and the leaves of a paler color, these characters are by no means constant, and all kinds of grades exist. Apparently the first specimens collected of the white-flowered form were those by Bigelow at Puerto de Paysano, *Mexican Boundary Survey 1008*, in part. These were referred by Dr. Torrey* to *S. Jamesii*, probably because they had white flowers. The blue- or purple-flowered specimens from the Copper Mines were named by him *S. Fendleri*.

The following specimens belong here. Those numbers with white flowers are so indicated.

NEW MEXICO: *Mex. Bound. Surv. 1009; 1008*, in part (white); *Greene* (in 1880); *Rusby 313* (white); *Wooton* (in 1894, 1895 and 1899); Metcalfe *838*.

ARIZONA: *Wilcox* (in 1892); *Gooding 746, 264*, (white); *Griffiths & Thornber 102* (white); *Blumer 1432* (white); *1566, 1579; Mearns 1534*.

SONORA: *Mearns 1599, 1635, 1752*.

CHIHUAHUA: *Pringle 667* (white); *E. W. Nelson 6166; Townsend & Barber 173; Gregg 420*.

COAHUILA: *Palmer 305*.

NUEVO LEON: *Palmer 937, 938*, in part (white).

DURANGO: *Palmer 484* (white).

8. SOLANUM DEMISSUM Lindl. Jour. Hort. Soc. **3**: 69, 70. 1848

S. utile Klotzsch. All. Gart. Zeit. **17**: 315. 1849.

S. demissum Klotzschii Bitter, Repert. **11**: 454. 1912.—**12**: 454. 1913.

S. demissum resembles *S. Fendleri* in habit, and Mr. W. F. Wight of Washington has regarded the latter as a synonym of the former. From Lindley's figure on page 69 and Bitter's description of *S. utile*, the corolla is different. In *S. Fendleri* the corolla is pentagonal, but in *S. demissum* the intrapetalar membranes are developed into lobes, making the corolla almost 10-angled, a character which the species has in common with *S. verrucosum*. The characters by which Bitter tries to distinguish *S. utile* from *S. demissum* seem to me trifling, and perhaps due to cultivation. Bitter evidently knew *S. utile* only in the cultivated form. A cultivated specimen of *S. utile* is in the herbarium of Columbia University. This agrees with Lindley's figure of *S. demissum*.

* Bot. Mex. Bound. Surv. 151. 1859.

MEXICO (Federal District): *Bourgeau 346.*
MEXICO (State): *Kuntze 23611, 23774.*
VERA CRUZ: *Rose & Hay 5701, 6024, 6240.*
HIDALGO: *Rose & Hough 4487.*
SAN LUIS POTOSI: *Palmer 83½, Schaffner 407–693.*
ZACATECAS: *Pringle 3499.*

9. SOLANUM VERRUCOSUM Schlecht. Ind. Sem. Hort. Hal. **1839**: 10. 1839.—Hort. Hal. **13**,: *pl. 2.* 1841

S. squamulosum Mart. & Gal. Bull. Acad. Brus. **12**: 140. 1845.
S. verrucosum iopetalum Bitter, Repert. **11**: 455. 1912.

In the United States National Herbarium there is a specimen which bears the following label:

"1132. Solanum stoloniferum Schlecht. et Bouche. (*Solanum squamulosum* Martens et Galeotti). Mexico. C. Ehrenberg."

This specimen had come from the Botanical Museum at Berlin. The specimen does not agree with the description of *S. stoloniferum*, but well with that of *S. verrucosum*. Schlechtendahl,* who had before him Ehrenberg's specimens of both species, stated that the flowers of *S. stoloniferum* had white flowers and *S. verrucosum* bluish-purple. In the specimen mentioned in the National Herbarium the flowers are purple and the leaves bearing the strong hairs of the latter species. Furthermore, *S. squamulosum* is supposed to be a synonym of *S. verrucosum*, not of *S. stoloniferum*. Evidently there must have been some error committed in labelling the specimen. Perhaps it represents part of the original collection of *S. verrucosum* made at Mineral del Monte.

The species was originally published in the Index Seminum of 1839, though the description is very meager. In that publication no reference was made to Ehrenberg's specimen and the species must therefore be regarded as based on the cultivated specimens, which according to Schlechtendahl would be illustrated together with another species with acute fruit. These illustrations were published two years later, when the author stated that the seeds were collected by Ehrenberg at Mineral del Monte. Bitter regarded one of Ehrenberg's herbarium specimens as the type, and drew his description from that. Schlechtendahl's illustration in

* Linnaea **19**: 274. 1847.

Hortus Halensis, drawn from the cultivated material, resembles so closely our duplicate of the type of Bitter's var. *iopetalum*, that I regard the latter as typical *S. verrucosum*. The Ehrenberg specimen, however, does not differ, as far as I can judge, very much from them.

SAN LUIS POTOSI: *Parry & Palmer 633* (in part, as represented in U. S. Nat. Herb.*).

HIDALGO: *Rose & Rose 11490; Pringle 8954; Rose & Hay 5579; Ehrenberg 1132.*

MEXICO (State): *Rose & Hay 6259.*

VERA CRUZ: *F. Mueller 3041, 1673.*

OAXACA: *Galeotti 1190, 1225 P.*

COSTA RICA: Volcan Irazu, *Popence 1015.*

10. **Solanum Ervendbergii** Rydberg sp. nov.

A perennial with subterranean rootstocks and tubers; stem low, less than 2 dm. high, striate, puberulent; leaves 6–10 cm. long, the rachis scarcely margined, puberulent; leaf-segments mostly 7, distinctly petioluled, the blades lanceolate, somewhat oblique at the base, 2–3 cm. long, acute or somewhat acuminate, puberulent on both sides; intermittent segments not present; peduncle 6–7 cm. long, slender, puberulent; racemes 4–7-flowered; calyx strigose, 3–3.5 mm. long, the lobes lanceolate, longer than the tube, acute; corolla white, pentagonal, about 1 cm. wide, the lobes broader than long.

Type collected at Wartenberg, near Tantoyuca, Vera Cruz, in 1858, *Ervendberg 175* (Gray Herbarium).

The type was first determined as *S. Jamesii* Torr.?, then changed to *S. appendiculatum* Dunal? Somebody has later determined it as *S. stoloniferum*, which name again has been changed by Wight to *Solanum Jamesii* Torrey. It has nothing to do with *S. appendiculatum* which is a climbing vine with subbasal articulation on the pedicels. In habit it resembles *S. Jamesii* but the leaflets are stalked and the corolla pentagonal and not star-shaped. *S. stoloniferum* has ovate leaf-segments and larger flowers. It is probably most closely related to *S. verrucosum*, but the plant is more slender, with much smaller corolla, and the leaves are puberulent not hirsute and without intermittent segments.

* On this specimen in the U. S. Nat. Herb., the number has been changed from 753 to 633, which change might have been unwarranted. Number 633 in the Columbia University herbarium belongs to *S. cardiophyllum*.

11. **Solanum agrimonifolium** Rydberg sp. nov.

A perennial, probably stoloniferous and with tubers; stem at least 5 dm. high, angled, or even slightly winged, glabrous; leaves odd-pinnatifid, 1–2 dm. long; rachis narrowly margined, glabrous; principal leaf-segments 9–15, narrowly lanceolate, 3–8 cm. long, 1–2 cm. wide, long-acuminate, glabrous or with a few scattered hairs, the lateral ones sessile, very oblique at the base, cuneate on the upper margin, semicordate on the lower; intermittent smaller segments numerous, often two pairs in each interval, elliptic, 2–8 mm. long; pseudo-stipular leaves obliquely ovate, 5–10 mm. long; cymes 8–10-flowered; peduncle 7–10 cm. long, glabrous; pedicels 2–4 cm. long, articulate above the middle; calyx glabrous, turbinate, the tube 3 mm. long, the lobes lanceolate, 4–5 mm. long, acuminate, corolla 15–18 mm. broad; lobes broadly triangular, short-acuminate, puberulent without; anthers oblong, 4 mm. long, cordate at each end; fruit unknown.

Type collected at Cerro del Boqueron, Chiapas, September, 1913, *C. A. Purpus 6977* (U. S. Nat. Herb. *567248*).

NEW YORK BOTANICAL GARDEN

[To be continued in May Bulletin.]

INDEX TO AMERICAN BOTANICAL LITERATURE
1923

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 the broadest sense.

Reviews, and papers that 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 omissions, their kindness will be appreciated.

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Vol. 51 No. 5

BULLETIN

OF THE

TORREY BOTANICAL CLUB

MAY, 1924

The Section Tuberarium of the Genus Solanum in Mexico and Central America: Concluding Paper

PER AXEL RYDBERG

2. PINNATISECTA

Fruit globose; plant not glandular.
- Leaf-segments distinctly stalked; calyx-lobes broadly deltoid, as broad as long (except in *S. brachistotrichum*).
  - Leaf-segments of an ovate or cordate type, rounded, obtuse, or merely acute at the apex. . 12. *S. cardiophyllum.*
  - Leaf-segments of a lanceolate type, acuminate.
    - Calyx 5 mm. long; corolla fully 1 cm. long; leaflets 9–11 . . . . 13. *S. sambucinum.*
    - Calyx 2.5–4 mm. long; corolla 8–9 mm. long; leaflets 7–9.
      - Calyx-lobes broadly triangular, shorter than the tube.
        - Leaves glabrous above, glabrous or slightly pruinose beneath. . . . . 14. *S. lanciforme.*
        - Leaves pubescent on both sides, segments short petioluled. . . . . 15. *S. Ehrenbergii.*
      - Calyx-lobes lanceolate, fully as long as the tube; leaves puberulent on both sides . . . . 16. *S. brachistotrichum.*
- Leaflets sub-sessile, decurrent on the rachis.
  - Calyx-lobes lanceolate, as long as or longer than the tube; plant 3–5 dm. high.
    - Leaf-segments lanceolate, usually 7 or more.
      - Corolla more or less crisp-hirsute without; leaves hirsute on both sides; pedicels articulate above the middle. . . . . 17. *S. nayaritense.*
      - Corolla glabrous or puberulent.
        - Inflorescence more or less hairy; leaf-segments mostly 5–9; pedicels articulate near the middle.

[The BULLETIN for April (51: 127–165) was issued May 17, 1924.]

Leaves glabrate or with a few scattered hairs; calyx glabrous; corolla 8–10 mm. long........................ 18. *S. Jamesii.*
Leaves decidedly pubescent, especially above; calyx sparingly hirsute; corolla about 12 mm. long............ 19. *S. michoacanum.*
Inflorescence and calyx glabrous or nearly so; leaf-segments 9–15; pedicels articulate above the middle............ 20. *S. pinnatisectum.*
Leaf-segments lance-linear, usually 5........ 21. *S. stenophyllidium.*
Calyx-lobes triangular, shorter than the tube; plant 1–2 dm. high....................... 22. *S. nicaraguense.*
Fruit ellipsoid; upper part of the stem, the peduncle, and its branches more or less glandular with stipitate hairs.............................. 23. *S. polyadenium.*

12. SOLANUM CARDIOPHYLLUM Lindl. Jour. Hort. Soc. **3:** 70, 71. 1847.

S. cardiophyllum oligozygum Bitter, Repert. **11:** 439. 1912.
S. cardiophyllum pliozygum Bitter, *l. c.*

With the more numerous specimens before me, I think that the varieties proposed by Bitter are of little value. Bitter cited altogether only three specimens. The type of the first variety was a cultivated specimen raised from seeds of Uhde's collection, probably from the very type collection of *S. cardiophyllum. Schmitz 670* was also cited, with the remark that it verges towards the var. *pliozygum.* The only specimen cited under the second variety is *Pringle 6421.* The specimen of this number in the Columbia University herbarium has only 2 or 3 pairs of leaf-segments, and does in no way differ essentially from the other specimens.

ZACATECAS: *Palmer 593, 376; Rose 2784.*

AGUASCALIENTES: *Rose & Hay 6225.*

HIDALGO: *Pringle 13138.*

SAN LUIS POTOSI: *Parry & Palmer 633* (in part, Columbia Univ.).

MEXICO (Federal District): *Rose & Hay 5975; Pringle 6421.*

PUEBLA: *Purpus 3365, 3364.*

There is one collection from Querétaro, *Rose & Rose 11183* (represented in the U. S. Nat. Herb. and herbarium N. Y. Bot. Gard.), which has larger, fully 1 cm. long, purple-tinged corollas and the leaves decidedly pubescent beneath. This may represent a distinct species closely related to *S. cardiophyllum,* though more material is needed.

13. **Solanum sambucinum** Rydberg sp. nov.

A perennial, with subterranean stolons and tubers; stem herbaceous, perhaps 5 dm. high, angled, with scattered several-celled hairs; leaves odd-pinnatifid, about 1.5 dm. long; rachis wing-margined, glabrous or nearly so; principal segments 9–11, short-stalked, lanceolate, 2–5 cm. long, acute at the base, acuminate at the apex, glabrous above, paler and somewhat pruinose beneath; intermittent segments wanting; pseudo-stipular leaves lanceolate, oblique, 3–5 mm. long; inflorescence branched, 5–8 cm. long, glabrous; pedicels 1 cm. long or more, articulate at the middle; calyx glabrous, 5 mm. long, the lobes ovate, nearly as long as the tube; corolla white, fully 1 cm. long, the lobes lanceolate, about as long as the tube, puberulent on the margins; anthers 6 mm. long, cordate at the base, retuse at the apex; fruit unknown.

Type collected on stony hillsides near San Juan del Rio, Querétaro, August 18, 1905, *Rose, Painter & Rose 9586* (U. S. Nat. Herb. *no. 453076*).

14. **Solanum lanciforme** Rydberg nom. nov.

S. cardiophyllum subsp. *lanceolatum* Bitter, Repert. **11**: 440. 1912.

S. lanceolatum Berth.; Bitter, *loc. cit.*, as synonym. Not *S. lanceolatum* Cav. 1794.

I think that this very well deserves specific rank. The name originally proposed is preoccupied, however. It would not be advisable to adopt one of Bitter's varietal names *endoiodandrum* and *amphixanthandrum*, as these varieties and these names were based on the variable color of the anthers, a character of no value whatever. Both were described from individuals of *Pringle 8599*.

HIDALGO: *Rose & Painter 6627*.

PUEBLA: *Pringle 8599*.

15. **Solanum Ehrenbergii** (Bitter) Rydberg sp. nov.

Solanum cardiophyllum subsp. *Ehrenbergii* Bitter, Repert. **11**: 443. 1912.

This is closely related to the preceding but the leaves are densely short-pubescent, the inflorescence more branched and the pedicels longer. The type was collected in Mexico by Ehrenberg, but without any definite locality and without number.

The only specimen seen, which agrees with the original description, is the following.

SAN LUIS POTOSI: *C. C. Parry 10.*

16. **Solanum brachistotrichum** (Bitter) Rydberg sp. nov.

S. Jamesii brachistotrichum Bitter, Repert. **11**: 444. 1912.

Bitter made this merely a variety of *S. Jamesii*, evidently overlooking the fact that the leaf-segments are distinctly stalked, and the lateral ones decidedly oblique at the base. The general habit, leaf-form, and corolla, are practically the same as in *S. lanciforme*, but the calyx-lobes are lanceolate and fully as long as the tube, and the leaves are decidedly puberulent.

CHIHUAHUA: *Pringle 668; Wilkinson* (in 1885).

17. **Solanum nayaritense** (Bitter) Rydberg sp. nov.

S. Jamesii subsp. *nayaritense* Bitter, Repert. **12**: 8. 1913.

This is related to *S. Jamesii*, but distinguished from all related forms by the corolla which is crisp-hairy without, and the leaves hirsute on both sides. It is represented by the type collected by Diguet, in Sierra Nayarit and by the following specimen, which agrees fully with the original description.

TEPIC: *Rose 2134.*

18. SOLANUM JAMESII Torr. Ann. Lyc. N. Y. **2**: 227. 1827.

S. Jamesii heterotrichum Bitter, Repert. **11**: 444. 1912.
S. Jamesii subsp. *septentrionale* Bitter, Repert. **12**: 10. 1913.
S. Jamesii subsp. *septentrionale ripicolum* Bitter, Repert. **12**: 151. 1913.

The first variety, proposed by Bitter, represents one of the common forms of the typical *S. Jamesii* from Colorado. The subspecies *septentrionale* was proposed to cover all the varieties of *S. Jamesii* from the United States and Northern Mexico. It included the typical form, the two varieties mentioned above and the variety *brachistotrichum*, which last one evidently is distinct. The variety *ripicolum* I have not seen, but from the description I judge that it represents a form of *S. Jamesii*. *S. Jamesii* is mostly confined to the United States, *i. e.* Colorado, New Mexico, southeastern Utah, and Arizona, but is also found in Chihuahua and perhaps in Sonora.

19. **Solanum michoacanum** (Bitter) Rydberg sp. nov.

S. Jamesii subsp. *nayaritense michoacanum* Bitter, Repert. **12:** 9. 1913.

In my opinion, this is more closely related to *S. Jamesii* than to *S. nayaritense,* differing from the former in being decidedly more pubescent, in the sparingly hirsute calyx, and in the larger corolla about 12 mm. long. The question may be asked: Why not accept Bitter's views and include all these species in *S. Jamesii?* They are all closely related to it. If so, we must include also *S. pinnatisectum* Dunal and *S. stenophyllidium* Bitter, which are also closely related to it and not based on better characters. *S. michoacanum* is known only from the type collected at Pungauto, near Morelia, Michoacan, *Arsène 2896.*

20. S. PINNATISECTUM Dunal, in D.C. Prodr. **13**[1]**:** 40. 1852.

This species is characterized by its narrower and more numerous leaflets, glabrous inflorescence and the articulation of the pedicels, which is higher up. Bitter* proposed two varieties, *pentazygum,* the typical form, and *heptazygum,* of very little value.

MICHOACAN: *Arsène 2895.*

QUERÉTARO: *Agniel 10380, 10467, 10580.*

21. SOLANUM STENOPHYLLIDIUM Bitter, Repert. **12:** 51. 1913.

This species is closely related to the preceding, but differs in the still narrower, and few, usually 5, leaf-segments. *Palmer 611* from Jalisco is the type.

22. **Solanum nicaraguense** Rydberg sp. nov.

A perennial, with stolons and probably tubers; stem 1–2 dm. high, sparingly hirsute or glabrate; leaves 7–12 cm. long, odd-pinnatifid; segments 3–7, subsessile, elliptic or lance-elliptic, glabrous or sparingly hirsute above, more pubescent beneath, the terminal one 3–5 cm. long, the lateral ones gradually smaller; intermittent segments rare and very small; pseudo-stipular leaves minute or wanting; inflorescence 2-forked; peduncle 2–5 cm. long; pedicels 1–1.5 cm. long, sparingly hirsute, the articulation far below the middle; calyx puberulent, 3–4 mm. long, the lobes triangular or ovate, acute, shorter than the tube;

* Repert. **12:** 49–50. 1913.

corolla about 8 mm. long, the lobes deltoid-lanceolate, longer than the tube, puberulent especially along the margins; fruit unknown.

Type collected in Nicaragua, 1868, *C. Flint 8* (U. S. Nat. Herb. *no. 42676*).

23. SOLANUM POLYADENIUM Greenm. Proc. Am. Acad. **39:** 89. 1903.

This is a very distinct species, differing from the other species with star-shaped corolla in the glandular pubescence, the broader corolla lobes, and the oblong fruit.

HIDALGO: *Pringle 13136, 8692; Rose & Painter 7080.*

MICHOACAN: *Arsène 5232.*

3. BULBOCASTANA

Leaves pubescent, acute or obtuse; corolla 17–20 mm. broad.................................. 24. *S. bulbocastanum.*

Leaves glabrous, acuminate; corolla about 10 mm. broad.................................. 25. *S. morelliforme.*

24. SOLANUM BULBOCASTANUM Dunal, in Poir; Lam. Encycl. Suppl. **3:** 749. 1813.

Bitter* proposed two varieties: *dolicophyllum* and *latifrons.* The former cannot be separated from the type, the latter I have not seen.

VERACRUZ: *F. Mueller* (in 1855).

PUEBLA: *Arsène 10132.*

MEXICO (Federal District): *Pringle 9340; 9136; Rose & Hay 5513; Salazar.*

MORELOS: *Pringle 6397.*

25. SOLANUM MORELLIFORME Bitter & Muench, Repert. **12:** 154. *pl. 2.* 1913.

In both of the two instances this plant has been collected, it was found growing in hollow trees.

Chiapas: Muench (in 1912).

Puebla: Purpus 7399.

4. OXYCARPA

Principal leaf-segments 9–11; calyx-lobes lanceolate.

Calyx-lobes 3–4 mm. long, acuminate; corolla not glandular; leaf-segments elliptic-lanceolate, abruptly contracted at the base.............. 26. *S. monoteranthum.*

* Repert. **11:** 447. 1912.

Calyx-lobes 2 mm. long, acute; corolla glandular without near the base; leaf-segments lanceolate, tapering at the base........................ 27. *S. oxycarpum.*
Principal leaf-segments 7–9; calyx-lobes ovate, 1.5 mm. long, short-acuminate; leaf-segments abruptly contracted at the base.................. 28. *S. longiconicum.*

26. SOLANUM MANOTERANTHUM Bitter, Repert. **11:** 383. 1912.

I have seen no specimens, but the description and its stated relationship to *S. columbianum*, makes it easy to place it systematically. It must be related to *S. oxycarpum*. The type was collected at Vulcan Barba Volu, Panama, *Rcesl.*

27. SOLANUM OXYCARPUM Scheede, in Schlecht. Hort. Hal. **1:** 5. *pl. 3.* 1841.

No specimens have been seen, but there is a good illustration in "Hortus Halensis."

28. SOLANUM LONGICONICUM Bitter, Repert. **10:** 534. 1911.

Bitter cited two collections from Costa Rica; to these may be added:

COSTA RICA: San Cristobal, *C. Wercklé.*

5. JUGLANDIFOLIA

29. SOLANUM JUGLANDIFOLIUM OERSTEDII Bitter, Repert. **11:** 461. 1912.

As I have not seen the specimens on which Bitter based this variety, I am not prepared to state if it is distinct from the *S. juglandifclium* of Columbia, or not.

6. SUAVEOLENTIA

Principal leaf-segments 5–7; foliage and inflorescence somewhat glandular.......................... 30. *S. Grossularia.*
Principal leaf-segments 9–11; foliage and inflorescence not glandular.
Leaves 1–2 dm. long; principal segments short-stalked, the intermittent ones small, sessile; inflorescence usually simple................. 31. *S. suaveolens.*
Leaves 2–3 dm. long; principal segments with stalks 5–30 mm. long, the intermittent ones often 1–2 cm. long, stalked; inflorescence 2-forked................................. 32. *S. canense.*

30. SOLANUM GROSSULARIA Bitter, Repert. **10:** 537. 1911.

This species was described from cultivated specimens raised from seed from Costa Rica or Nicaragua. No wild specimens have been seen by me.

31. SOLANUM SUAVEOLENS Kunth & Bouché, Ind. Sem. Hort. Berol. **1848:** 14. 1848.

This resembles *S. verrucosum* in habit, but the flowers are smaller, white and more deeply lobed and the articulation of the pedicels strictly basal. No tuber has been found. Bitter* proposed three varieties, *glabrescens*, *plucphyllidium*, and *chalarophyes*, apparently on trifling characters. The following specimens belong to the species:

MEXICO: Zacuápan, *Purpus 6329.*

COSTA RICA: *Cock & Doyle 329: Tonduz 11495, Kuntze 2053.*

NICARAGUA: Volcan Mombacks, *Baker 34.*

32. **Solanum canense** Rydberg sp. nov.

A perennial, probably without tubers; stem herbaceous, 1–2 mm. long, spreading, pruinose, angled; leaves 1–3 dm. long, odd-pinnatifid; rachis barely wing-margined; principal leaf-segments 9–11, lanceolate, acuminate, minutely granular-puberulent on both sides, sometimes with a few scattered hairs on the veins, the terminal one 5–10 cm. long, the lateral ones stalked, the petiolules 1–3 cm. long, the blades 3–8 cm. long, oblique at the base; intermittent segments 5–20 mm. long, stalked; peduncles infra-axillary, sub-opposite the leaves, 1–1.5 dm. long (below the forking), 2-forked, the branches 5–10 cm. long; pedicels 1–1.5 cm. long, articulate at the base; calyx puberulent, the tube 1.5 mm. long, the lobes ovate, less than 1 mm. long; corolla white, star-shaped; fruit globose, about 1.5 cm. in diameter.

Type collected between April 17 and June 8, 1908 in the vicinity of Cana, Panama at an altitude of 2500 feet, *R. S. Williams 844* (herb. N. Y. Bot. Gard.).

7. APPENDICULATA

Style shorter than the stamens.
  Leaves and branches sparingly hairy; leaf-segments 3, rarely 5, thin.......................... 33. *S. appendiculata.*
  Leaves and branches densely hairy; leaf-segments 7, rarely 5, firmer.......................... 34. *S. subvelutinum.*
Style much longer than the stamens; leaf-segments mostly 5, moderately pubescent.................. 35. *S. inscendens.*

* Repert. **11:** 352–354. 1912.

30. SOLANUM APPENDICULATUM Humb. & Bonpl.; Dunal Solan. Syst. 5. 1816.

There are at least three species in Mexico, which have been taken for *S. appendiculatum*. Of the three known to me, there is only one which agrees with the original description and that in De Candolle's Prodomus. The other two do not agree in the following particulars: "foliis . . . 1–2 jugis, segmentis oblongis acuminatis, utrinque acutis, supra adpresse pilosiusculis, subtus in venis pubescentibus; . . . Stylus staminibus subaequalis;" for the second has 7 leaflets, densely pubescent, and in the third the style is twice as long as the stamens. The first one which I regard as the true *S. appendiculatum*, is well represented by *Pringle 4922* from Oaxaca. The type came from Hidalgo.

34. **Solanum subvelutinum** Rydberg sp. nov.

A perennial woody vine; stem brown, in age glabrate, rooting at the nodes; branches densely short-pilose, subvelutinous when young; leaves 5–10 cm. long, odd-pinnatifid; petioles 1–2 cm. long, as well as the rachis subvelutinous; leaf-segments 5–7, elliptic or oblanceolate, acute at both ends, or short-acuminate at the apex, pilose on both sides, densely so beneath, short-stalked, the terminal one 2–4 cm. long, the lateral ones successively smaller; inflorescence at the ends of the leafy branches, 2-forked and again branched; common peduncle 1–2 cm. long, as well as its branches subvelutinous; pedicels glabrous, about 1 cm. long, articulate at the base, gradually thickened upwards; calyx sparingly pilose, the tube 1 mm. long, the lobes triangular-ovate, 1.5 mm. long, corolla white, 4 mm. high and 6–7 mm. broad, star-shaped, the lobes ovate; anthers oblong, 3 mm. long, cordate at each end; style shorter than the stamens; stigma capitate; fruit unknown.

Type collected at San Ramón, Durango, in April or May, 1906, *Edward Palmer 183* (U. S. Nat. Herb. *no. 571203*).

35. **Solanum inscendens** Rydberg sp. nov.

A perennial woody vine; stem brown in age, glabrate, rooting at the nodes; branches rather densely and finely pilose when young; leaves 5–8 cm. long; petioles 1–3 cm. long, finely pilose; rachis not winged; leaflets 3–7, sparingly hispidulous above puberulent and on the veins somewhat pilose beneath; terminal leaf-segments rhombic-ovate, or rhombic-lanceolate, 2–4 cm. long, cuneate at the base, acuminate at the apex; upper lateral segments ovate or lanceolate, 1.5–3 cm. long, short-stalked, the lower pair if present much smaller; inflorescence at the ends of the leafy branches, 6–10-flowered, 2-forked and again branched; common peduncle 1–2 cm. long, finely pilose; pedicels glabrous, about 1 cm. long, articulate at the base; calyx sparingly pilose, the tube scarcely 1 mm. long, the lobes broadly ovate, 1.5 mm. long; corolla about 5 mm. high and broad, star-shaped, the lobes broadly ovate; anthers broadly oblong; 2–2.5 mm. long, cordate at each end; style 6 mm. long, more than twice as long as the stamens, in age curved; stigma capitate; fruit globose, 15 mm. in diameter when fully developed.

Type collected on Ixtaccihuatl, January, 1906, at an altitude of 8000 ft., *C. A. Purpus 1733* (herb. N. Y. Bot. Gard.).

Apparently the same species in fruit was collected near Cataract, Orizaba, Vera Cruz, in 1883, *A. Gray*.

There are a few species reported from Mexico or Central America, of which I have seen no specimens and which I cannot place in my key.

SOLANUM MURICATUM PARVIFOLIUM H. B. K. Nov. Gen. & Sp. **3**: 21. 1818.

The type of *S. muricatum* came from Peru, and no specimen of the subsection Basarthrum with simple leaves has been seen from Mexico. The name *parvifolium* cannot be used as specific name, however, as it has already been used as such. It is a possibility that this variety is the same as *S. morelliforme* Bitter.

SOLANUM SCHENCKII Bitter, Repert. **11**: 448. 1912.

SOLANUM SCHIZOSTIGMA Bitter, Repert. **11**: 449. 1912.

Both these species are related to *S. tuberosum*. The types are both in the Berlin herbarium. No specimens answering the descriptions have been seen by me.

NEW YORK BOTANICAL GARDEN.

Contributions to the Flora of Long Island, N. Y. Second Paper

William C. Ferguson

Introductory

The writer became interested in Botany in 1917. At the end of the season of 1918 he had collected 753 herbarium sheets comprising 370 species. At the end of 1923, 8800 herbarium sheets comprising 1345 species of Long Island plants, all found and collected by himself, with the exception of 15 to 20 sheets. 1080 native species and 264 introduced.

At the close of the season of 1921 the writer published a list of the plants he had found that seemed of most interest entitled: Some Interesting Plants from Long Island, by William C. Ferguson. Torreya **22:** 43–49. May–June, 1922.

The present paper (the 2d) gives a list of the more interesting plants the writer has found on Long Island since the first publication, but includes also some of earlier date, goes more into details as to locality, in some cases describes plants more elaborately and offers some opinions, but with the diffidence that comes through a realization of but few years' field experience.

The writer gratefully and with pleasure acknowledges the kind assistance of other workers who have kindly reviewed his plants.

Mrs. Agnes Chase—All grasses.

Dr. N. L. Britton—All sedges except Carex.

Mr. K. K. Mackenzie—Carex.

Professor M. L. Fernald, Dr. Witmer Stone, Dr. P. A. Rydberg, Dr. J. K. Small, Mr. Bayard Long, Mr. Eugene P. Bicknell, Mr. Paul C. Standley, Mr. F. V. Coville. Dr. Ezra Brainerd, Dr. H. M. Denslow, Dr. Edward S. Burgess, Dr. F. W. Pennell, Mr. Percy Wilson, Mr. Norman Taylor, and others have kindly reviewed plants when there was doubt about identity. Such progress as the writer has made is largely due to kind assistance from the above experienced botanists.

The views of many authorities both from the literature and from letters to the author are freely quoted. The names of the plants are based mainly upon Britton & Brown's "Illustrated Flora" with the exception of the grasses which are in accordance with Hitchcock & Chase and in a number of cases the interpretation of Professor M. L. Fernald is given prominence.

EQUISETACEAE. Horsetail Family

Equisetum fluviatile L. — Open swamp. Woodside.
" " Sag Harbor.

TAXACEAE. Yew Family

Taxus canadensis Marsh. — Woods, 3 to 4 miles northwest of Deer Park.

Plant 12 to 15 ft. × 12 ft. associated with *Lycopodium complanatum* var. *flabelliforme.* The writer can find no other record of a wild plant on Long Island. Mr. Henry Hicks knows of but three, all introduced, on estates.

Mr. R. W. DeForest—Cold Spring Harbor, Plant 19 years old
Mr. Paul Dana—Glen Cove, Plant 50 years old 20 ft. × 20 ft.
Parsons' Estate—Flushing, Plant 50 years old 20 ft. × 20 ft.

This wild plant is older than that at Cold Spring Harbor, and is either a native survival from colder times or may be due to birds carrying the seeds from the Long Island cultivated plants or from wild plants further north.

NOTE—Britton & Brown's Illustrated Flora describes the leaves as "dark green on both sides;" Gray's Manual as "green on both sides;" F. Schuyler Mathews' Field Book of American Trees and Shrubs describes the leaves "of warm bright-yellow green beneath, very dark green above." This last description is the only good one.

ZANNICHELLIACEAE. Pondweed Family

Potamogeton confervoides Reicht — Pine barrens, Sandy Pond, Manorville.
Name conferred by Norman Taylor.

ALISMACEAE. Water Plantain Family

Sagittaria teres S. Wats. — Growing in water, Kent Pond, Manorville.
Pond northeast of Kent Pond, Manorville.

Deep Pond and Long Pond, Wading River.
All four stations in the pine barrens.

The beak of mature achenes is horizontal or somewhat inclined, not vertical as described and figured in Gray's Manual, Britton & Brown's "Illustrated Flora" and J. G. Smith's "North American Species of Sagittaria and Lophotocarpus." The writer's determinations were kindly corroborated by Mr. Bayard Long who describes them as typical but observes that the beak is more or less oblique. Professor M. L. Fernald has also examined them and pronounces them typical; as the same as twenty-four collections from Massachusetts, all with horizontal beaks.

Sagittaria Engelmanniana J. G. Smith

Pine barrens, shores of ponds and swamps.
Ronkonkoma.
Central Islip.
Wading River.
Manorville, 4 stations.

Leaves varying from phyllodia to linear, to sagittate with narrowly linear to ovate parts. Extremely variable. The writer's identification has been kindly verified by Dr. Witmer Stone, Mr. Bayard Long, and Mr. E. P. Bicknell.

This species has been so puzzling to the writer that it seems worth while to review his experience. Britton & Brown's "Illustrated Flora," Gray's Manual, J. G. Smith's "North American Species of Sagittaria and Lophotocarpus 1894" all separate *Sagittaria Engelmanniana* J. G. Smith from *Sagittaria longirostra* (Micheli), J. G. Smith principally by leaf form, describing and figuring the former with sagittate leaves with linear parts, and the latter with sagittate leaves with ovate parts, although Smith in his monograph in general introductory remarks calls attention to the unreliability of leaf form as a means of separating species unless co-related with other more important characters. So late a publication as "Flora of the District of Columbia", Contributions from the National Herbarium at Washington, 1919, separates the above two species (?) by leaf form. As to localities, in a general way all of the above authorities place *S. Engelmanniana* north of New Jersey and *S. longirostra*, New Jersey and south, with but few exceptions.

In Torreya, February, 1909, Mr. K. K. Mackenzie as a result of field observation states that as described in the manuals *S. Engelmanniana* and *S. longirostra* are but different forms of the same species, the leaf form having no diagnostic value.

In Flora of Nantucket, Bulletin of the Torrey Botanical Club, Mr. E. P. Bicknell describes the Nantucket plant as *Sagittaria Engelmanniana* J. G. Smith with lamina of blades varying from linear to ovate, from 1 mm. to 4 cm. wide.

In Plants of Southern New Jersey, Dr. Witmer Stone describes as the common arrowhead of the Pine Barrens *Sagittaria longirostra* (Micheli) J. G. Smith with a very variable leaf form narrowly linear to broadly hastate and states that the narrow leaved form of the Pine Barren plants was long confused with *S. Engelmanniana*, a more northern species.

At a time when the writer was much perplexed over this subject he found in a Pine Barren swamp at Ronkonkoma two colonies of *Sagittaria* one-quarter of a mile apart, one colony growing in the open with linear sagittate leaves and one colony in shady thickets with ovate sagittate leaves. They were undoubtedly the same species, but which; *Engelmanniana* or *longirostra?* Specimens of both forms were sent to Dr. Witmer Stone who identified them as the same as the New Jersey Pine Barren plant described as *S. longirostra* (Micheli) J. G. Smith in Plants of Southern New Jersey. Dr. Stone wrote that the researches of Mr. Bayard Long had caused them to now name this plant *S. Engelmanniana* J. G. Smith.

Specimens from the same colonies were also sent to Mr. Eugene P. Bicknell, who identified them as the same as his Nantucket plants, *S. Engelmanniana*. Mr. Bicknell wrote as follows: "I should call these plants *S. Engelmanniana* believing at the same time that this name will be a synonym of *S. longirostra* with variations named as forms if one wants to do hair-splitting. The winging of the fruit varies with the width of the leaves. In a swamp now filled in at Lynbrook was a plant 7.5

dm. tall with leaf blades 3 dm. long. Such plants further south would undoubtedly pass as *S. longirostra*."

The writer has not yet found this type of arrowhead outside of the Pine Barrens and it is suggestive to realize that the robust plant referred to above by Mr. Bicknell undoubtedly grew in much richer soil.

Is there a *Sagittaria* with long oblique beak that is specifically distinct from that described above as *Sagittaria Engelmanniana* J. G. Smith or is the more robust plant due to the more favorable conditions that one would expect outside of the Pine Barrens? It is to be hoped that Mr. Bayard Long will soon publish the result of his study of this subject.

Sagittaria latifolia Willd.

Although widely distributed throughout Long Island the writer has not found this Arrowhead in the Pine Barrens. Writing of this experience to Mr. Bayard Long, Mr. Long replied that neither he nor his associates had ever found it in the Pine Barrens of New Jersey.

GRAMINEAE. Grass Family

Danthonia compressa Austin. Hempstead Reservoir, edge of oak woods.
Roslyn, edge of rich woods.
Montauk, edge of rich woods.

Eragrostis capillaris (L) Nees Northwest of Plattsdale, edge of woods.
Smithtown, edge of woods.
Roslyn, edge of woods.

Festuca nutans Willd. Hempstead Reservoir, thicket, one small colony.

Festuca gigantea (L) Mill. Lloyd's Neck, north of Huntington roadside. Native of Europe. Letter from National Herbarium, Washington, states, "The only records from America Ottawa, Canada and Dobbs Ferry, N. Y. 1881."

Hordeum jubatum L. Montauk near village. One clump.
Yaphank, Camp Upton. One clump.

Panicularia septentrionalis (Hitch) (Bicknell)	Montauk Point. Swampy woods.
Panicularia acutiflora (Torr.) Kuntze	Swamps, Montauk. Hempstead Reservoir. Queens. Three Mile Harbor.
Panicularia laxa Scrib.	Freeport. Swampy woods.
	Rockville Centre. Swampy woods.
Sporobolis uniflorus Muhl.	Pine Barrens widely distributed wherever it is wet. The writer has not seen it outside the Pine Barrens.
Sporobolis compressus (Torr.) Kunth. (*S. Torreyana* (Schulte.) Nash)	Both the Illustrated Flora and Gray's Manual state that this species is found in the Long Island Pine Barren Bogs. Taylor's Flora of the Vicinity of New York states, "No records or specimens from Long Island available. The writer has looked for but never seen this plant."
Sporobolis asper (Michx.) Kunth.	Cold Spring Harbor, Sandy roadside and sea beach.
	Merrick. Dry sandy bank.
Panicum spretum Schult.	Riverhead. Swamp. Single station Montauk. Borders swamps and ponds. Several stations.
Panicum microcarpon Muhl.	Flushing. Swamp northeast of Bowne Pond. Pubescent throughout. The only specimen like this known to the National Herbarium is from Arkansas.
Panicum Ashei Pearson?	Hempstead Reservoir. Dry oak woods. Intermediate between *P. Ashei* and *P. dichotum* or *barbulatum*. Much narrower blades than typical *P. Ashei*.
Panicum Ashei Pearson?	Rockville Centre. Dry oak woods. Intermediate between *P. Ashei* and a more pubescent plant. Leaves pubescent beneath.

The two last strongly suggest *hybrids*.

CYPERACEAE. Sedge Family

Cyperus erythrorhizus Muhl. Coram. Swampy meadow Edwards Pond. Mr. E. S. Miller found this plant and locality many years ago.

Cyperus ferax L. C. Richard Flushing. Bog.
East Hampton. Salt marsh.
Long Beach. Salt marsh.
Millneck. Edge of pond. Edge of woods.

NOTE—*Cyperus speciosus* Vahl. *Cyperus Engelmannii* St. as described and figured in The Illustrated Flora. The writer has not yet found these plants.

ELEOCHARIS

Eleocharis capitata (L.) R. Br. (*E. tenuis* (Willd.) Schultes) Montauk. Edge of swampy woods. Much taller and correspondingly stouter than the type with upper scales of spike acute as in *Eleocharis acuminata* (Muhl.) Nees, but lacking the flat culms of the latter.

Eleocharis Robbinsii Oakes Manorville. Pond northeast of Kent Pond. Long Pond. Pine barrens.
Wading River. Pine barrens.

ERIOPHORUM

Eriophorum tenellum Nutt. Meadowbrook.
Montauk. Open swamps.
Central Islip. Open Pine Barrens Swamps.
Ronkonkoma. Open Pine Barrens Swamps.
Manorville. Open Pine Barrens Swamps.

SCIRPUS

Scirpus novae-anglae Britton North of Queens. Water hole. Motor Parkway.
One colony.

Scirpus heterochaetus Chase	Montauk. Small pond. One colony.
Scirpus polyphyllus Vahl.	Setauket. Swamps. Wading River. Swamps.
Scirpus Torreyi Olney	Manorville. Pine barrens. Bog near Kent Pond.
Scirpus Olneyi Gray	Riverhead. Salt marsh. Douglaston. " " Mr. E. N. E. Klein knew of last-named locality.
Scirpus subterminalis Torr.	Yaphank. Ronkonkoma. Flanders. Last two localities, pine barrens.
Scirpus lineatus Michx.	Montauk. Road near village. Colony of a half-dozen plants. Swamps both sides of road. Located by Mr. Roland Speed of Sea Cliff.

HEMICARPHA

Hemicarpha micrantha (Vahl) Pax.	Lake Ronkonkoma. Sandy shore

RYNCHOSPORA

Rynchospora pallida M. A. Curtis	Central Islip. Pine Barren swamp. July 24, 1920–21. Small colony. Drier ground and maturing earlier than *R. alba* in same swamp. Probably never found before north of Pine Barrens of Southern New Jersey. It is interesting to record here that in a Pine Barren Swamp at Ronkonkoma, four miles distant from the Central Islip Swamp the writer discovered *Lycopodium carolinianum*, a plant never before reported north of the New Jersey Pine Barrens.

Rynchospora fusca (L.) Ait.	Manorville. Wet sandy shores of Kent Pond and pond northeast of Kent Pond. Ronkonkoma swamp. All in Pine Barrens.
Rynchospora macrostachya Torr.	Smithtown. Wet shore of Miller's Pond. Middle Island, wet shore Artists' Lake. Long Pond, wet shore. Wading River swamp. Manorville. Sandy pond. Two last localities in pine barrens.
Rynchospora inundata (Oakes) Fernald	Manorville. Grows in some depth of water Kent Pond and pond northeast of Kent Pond. Pine barrens. Mr. E. S. Miller guided writer to first locality.

These plants have been determined by Professor M. L. Fernald. For a review of this group see Rhodora, Aug. 1918, "Allies of Rynchospora macrostachya." M. L. Fernald.

Rynchospora corniculata (Lam.) Gray

The above plants were also determined by Dr. N. L. Britton as *R. corniculata* and so reported in my first paper, Torreya **22**: 43–49. Dr. Britton includes all forms of the large beaked *Rynchospora* under one species. See Britton & Brown's Illustrated Flora.

Scleria reticularis Michx.	Long Pond, Wading River. Pine barrens wet sand shore.
Scleria Torreyana Walp.	Central Islip. Grassy, sandy swamp.

The name of *Torreyana* Walp. is in accordance with the opinion of Dr. N. L. Britton who, with the writer, has studied these Long Island plants at the New York Botanical Garden and compared them with the type *Scleria setacea* from Porto Rico. The Porto Rico plants have the achene very deeply reticulated and with sharp edges. The lobes of the hypogynium are rounded. Some characteristics of the above two Long Island plants are given herewith:

	S. Torreyana Walp	*S. reticularis* Michx.
Height of plant	4½ to 5½ dm.	2½ to 3 dm.
General aspect	Slender or more drooping	Stouter, erect
Lower leaf sheaths	Glabrous	Pubescent
Roots when fresh	Fibrous, pinkish-red	Fibrous, pinkish-red
Hypogynium lobes	Acute or acuminate	Blunt, or emarginate
Achene	Pubescent. Irregularly roughened. Broader than long. 1¾ to 2 mm. broad. 1½ mm. high. Smooth and rather flat on top. Immature achenes perfectly smooth and glabrous	Glabrous. Regularly reticulated. Reticulations shallow with rounded edges. Achenes as broad as long—1½ mm. broad, 1½ mm. high. Reticulation right up to the prominently apiculate top.

Dr. N. L. Britton is of the opinion, in which the author concurs, that this group should be revised and has urged the writer to undertake it. The latter feels it should be done by one with far more experience.

Certainly the above two Long Island plants are separate species.

CAREX

Carex cristatella Britton	Woodside. Swampy woods. Abundant. Only locality found.
" *trisperma* Dewey	Coast cedar swamp between Good Ground and Flanders.
" *virescens* Muhl.	Rich woods. Wading River. Douglaston. Northwest of Huntington.
" *festucacea* Schk.	Rich woods. Richmond Hill. Northwest of Huntington.
" *anceps* Wahl.	Rich woods. Plattsdale. Roslyn. Bayside.
" *prasina* Wahl.	Bayside. Open bog.
" *umbellata* Schk.	Lakeview. Open dry sand, but few plants associated with *C. tonsa*.
" *hystricina* Muhl.	Woodside. Swamp. In shade in tall grass.
" *typhina* Michx.	Swampy woods. Queens, Hollis, Bayside, Flushing.
" *squarrosa* L.	Swampy woods. Douglaston.

" *hirsutella* Mackenzie	Rich woods. Wyandanch.
" *brachyglossa* Mackenzie	Montauk. Sandy bank shore of Great Pond.
" *laxiculmis* Schwein	Rich woods. Wyandanch. Bayside. Plattsdale.
" *umbellata* × *tonsa*	Hempstead Reservoir. Dry open sand.
" *varia* × *tonsa*	Hempstead Reservoir. Dry open sand.
" *Swanii* × *gracillima*	Plattsdale. Rich woods.

ARACEAE. Arum Family

Orontium aquaticum L.	Pond in Queens woods. Coast cedar swamp southeast of Flanders.
	Bog, Roosevelt.

XYRIDACEAE. Yellow-eyed Grass Family

Xyris Congdoni Small.	Pine barrens Manorville, two stations Sandy Pond.
	Pond northeast of Kent Pond. Growing in water.

JUNCACEAE. Rush Family

Juncus militaris Bigel.	In water. Most pine barren ponds of Manorville. Wading River. Middle Island.
" *Torreyi* Coville	Calverton. Swamp. Small colony ½ dozen plants.
" *articulatus* L.	Pine barren swamp south of Flanders.
	Wet salt shore pond, Seaford.
" *Greenii* Oakes & Tuckm.	Wading River. Dry woods.

Plants extremely slender, prostrate, inflorescence attenuate. Superficially bearing no likeness to typical *J. Greenii*. This plant was sent to Professor K. M. Wiegand who suggested it was a shade form of *J. Greenii* and advised sending it to F. V. Coville who examined it and had never seen anything so attenuate, advising careful field study to find intermediates between this and form of open plains. He stated it might be a shade form of *J. Greenii*, a hybrid of *J. Greenii* or a new species. Mr. E. P. Bicknell has determined it as a shade form of *J. Greenii* similar to plants he found at Nantucket. (See Bull. Torrey Botanical Club, Jan. 1909). Mr. Bicknell writes "as nearly as I can remember there were intermediate forms between the hard open soil and the loose soil of shady pine woods."

LILIACEAE. Lily Family

Lilium canadense L.	Montauk. Open swamps. Rare.
" *philadelphicum* L.	Montauk. Open rolling downs. Locally frequent.

CONVALLARIACEAE. Lily-of-the-Valley Family

Uvularia nitida (Britton) Mackenzie	Manorville. Pine barrens. Thicket near swamp, Jones Pond. Single colony of 3 plants found by Mr. E. S. Miller when with the writer. Determination confirmed by K. K. Mackenzie.

TRILLIACEAE. Wake Robin Family

Trillium erectum L.	Millneck. Wet woods. Abundant.
" *cernuum* L.	Cold Spring Harbor. Wet woods. Single plant, Bayside. The Alley. Rich hilly woods. Small colony.

ORCHIDACEAE. Orchid Family

Blephariglottis psycodes (L.) Rydbg.	Montauk. Reed Pond. Rich woods. Single plant.
Isotria affinis (Austin) Rydbg.	Woods. Half Hollow Hills. Wyandanch. Two plants; one single and one double-flowered, ½ mile apart. Thorough search at each station revealed no others. Have never seen *Isotria verticillata* in these woods. Name verified by Dr. H. M. Denslow. Both in fruit. Found middle of October.

Malaxis unifolia Michx. — Montauk Point. Open swampy meadow. Two plants.
Rich woods north of Wyandanch. One plant.
Rich woods northeast of Wyandanch. One plant.

BETULACEAE. Birch Family

Betula lutea Michx. f. — Cold Spring Harbor. Several trees both sides of ponds.

Betula papyrifera Marsh — Wading River. Coram. Shown these trees by Mr. E. S. Miller.
Millneck. Rich woods. Single tree.

ULMACEAE. Elm Family

Ulmus americanus L. — Growing as dominant tree in extensive woods at Trains Meadows south of North Beach and north of Woodside. Associated with *Quercus bicolor* and *Acer rubrum*, both abundant and *Fraxinus pennsylvanica* occasional.
Very wet woods. Unquestionably native. The writer has also observed it in woods at Kissena Flushing and scattered through Long Island, in such cases difficult to decide whether native or introduced.

ARISTOLOCHIACEAE. Birthwort Family

Asarum reflexum Bicknell — Rich woods northeast of Woodside.
Southeast of North Beach. Single station to which the writer was taken by Mr. Edward N. E. Klein of College Point who had collected it years ago.

POLYGONACEAE. Buckwheat Family

Persicaria pennsylvanica var. *laevigata* Det. by M. L. Fernald Det. by Bayard Long.	Small colony. Pine barren bog. Sandy pond. Manorville.
Persicaria Careyi (Olney) Greene	Wet shore, Edwards Pond, Coram. Wet shore, Long Pond, Wading River. Swamp southeast of Deep Pond, Wading River. All in pine barrens.
" *coccinea* (Muhl.) Greene	Aquatic form, pond Cypress Hills. Aquatic form, Bowne Pond, Flushing. Terrestrial form in swamps and wet pond borders, Woodside, Queens, Plattsdale, Bowne Pond, Flushing. Edwards Pond, Coram—the last in pine barrens.

This name is from a revision of the group in Flora of the Rocky Mountains and Adjacent Plains by Dr. P. A. Rydberg who kindly determined the Long Island plants.

The aquatic form was reported in my former paper Torreya **22**: 43–49 as *P. amphibia* (L.) S. F. Gray. The terrestrial form as *P. muhlenbergii* (S. Wats.) Small; both following description in Britton and Brown's "Illustrated Flora."

Rumex persicarioides L. This plant was so reported in my former paper Torreya **22**: 43–49 following treatment in Britton and Brown's "Illustrated Flora." Salt wet shores at Great pond and Oyster pond. Montauk. Shore of bay at Point of Woods.

The plants were sent to Professor M. L. Fernald who named them *Rumex maritimus* var. *fueginus* (Phil.) Dusen. See Rhodora, April 1915. *Rumex persicarioides* and its allies. H. St. John.

Rumex britannica L.	Swamps, Flushing, Kissena and swamp northeast of Bowne Pond.

	Oyster Pond, Montauk.
	Smithtown.
	Pine barrens Central Islip.
Pleuropteris sachalinense Schmidt	Old Field. Sound Avenue, Native of Asia.
Pleuropteris Zuccarini Small	Extensively established at Laurel Hill and Woodside in waste ground. Native of Japan.

AMARANTHACEAE. Amaranth Family

Amaranthus pumilus Raf.	Sea beach, Point of Woods.

CHENOPODIACEAE. Goosefoot Family

Chenopodium hybridum L.	Smithtown, Woods.
Bassia hirsuta (Linn.)	Salt beaches, Long Beach. Point of Woods.
	Salt marsh, Massapequa.

This plant impresses one as being native.

Dondia maritima (L) Druce.	Marshy salt beach, Cold Spring Harbor, 10/2/23.
	Gravelly beach, Lloyd's Neck, 10/2/23.
	Gravelly beach, Oyster Bay, 10/20/23.
	Gravelly beach, Kings Park, 10/13/23.
" *linearis* (Ell) Heller	Sea beach, Kings Park, 10/13/23
	Beach, Eaton's Neck, 10/13/23
	Beach, Oyster Bay, 10/20/23
	Beach, Northport, 10/13/23
	Salt marsh, Millneck, 10/3/23
	Salt marsh, Merrick, 10/17/23
	Salt marsh, Massapequa, 10/16/23.

The naming of both species was verified by Mr. Paul C. Standley.

The two species aside from the radical difference in size of seed can be distinguished when mature at a glance. *D. maritima* mostly with red stem and dark green leaves as long on the branches as on the main stem, and *D. linearis* with stem mostly yellowish; but most striking are the very short leaves of the branches. The writer has observed two types of *D. linearis*, that on sea beaches being slenderer in all its parts with smaller leaves and bright green; that of muddy, salt marshes, heavier, stouter, fleshier and pinkish. The seeds of both types are identical.

Most herbarium specimens of both species are immature and in this state often difficult to determine.

D. maritima matures later than *D. linearis*. The plant from Cold Spring Harbor, October 2, had ripe seed but that seems exceptional as even as late as October 20 the seed in a large majority of the plants had not matured. *D. maritima* grows in wetter situations than *D. linearis* and is almost completely submerged at high tide.

D. linearis matures probably late in September; all of the plants the writer collected in October had ripe seed. It grows in drier situations, farther back on the beaches nearly, if not quite out of reach of high tide. Or on the salt marsh—where it is just wet or damp.

These remarks are based on comparatively few observations during one season and further experience may change or modify them.

PORTULACACEAE. Purslane Family

Claytonia virginica L.	Millneck. Swampy woods. One small colony, 4/29/20.
	Northwest of Plattsdale. Rich woods. Two small colonies, 4/22/21.
	Wet woods, south of North Beach and north of Woodside, extensive colonies, 5/10/23.

RANUNCULACEAE. Crowfoot Family

Anemone virginiana L.	Montauk. Rich woods.
Batrachium trichophyllum (Chaix) F. Schultz	Valley Stream. Running water.
Caltha flabellifolia Pursh.	Central Islip. Pine barren stream. Determined by P. A. Rydberg.

CRUCIFERAE. Mustard Family

Cardamine parviflora L. — Wading River. Pine barrens. Wet sandy shore of Deep Pond. One small colony.

Dentaria laciniata Muhl. — South of North Beach. Rich woods. One colony.

SARRACENIACEAE. Pitcher Plant Family

Sarracenia purpurea L. — Coast cedar swamp between Flanders and Good Ground. Sphagnum barren with small bushes, Calverton.

SAXIFRAGACEAE. Saxifrage Family.

Heuchera americana L. — Richmond Hill. Rich hilly woods. One small colony.

FABACEAE. Pea Family

Lespedeza capitata Michx. × *Lespedeza angustifolia* (Pursh.) Ell.
" *Bicknellii* House)

Hempstead Plains, between Garden City and Mineola. These hybrids show every possible variation between the parents with which they are closely associated in growth. Mr. E. P. Bicknell has kindly verified the naming and wrote that he had collected them years ago.

Lathyrus palustris L. var. *pilosus* (Cham) Led — Easthampton. Salt marsh.

Reported in my first paper as *L. palustris* L. Torreya **22**: 43–49.

See Rhodora, March 1911. Variations of *Lathyrus palustris*. M. L. Fernald.

OXALIDACEAE. Wood Sorrel Family

Ionoxalis violacea (L.) Small — Richmond Hill. Rich hilly woods. One colony.

ILICACEAE. Holly Family

Nemopanthes mucronata (L.) Merrick. Coast cedar swamp. Trelease.

ACERACEAE. Maple Family

Acer platanoides L.	Northwest of Plattsdale. Rich woods. Two trees far apart and far from roads; one 9 inches in diameter and one somewhat smaller. Native of Europe.
" *Saccharum* Marsh	Northwest of Plattsdale. Rich swampy woods quite in center of woods away from roads. Colony of maybe 50 trees including many saplings. Largest tree 11 inches in diameter—next largest 9 inches. The interesting question and one difficult to determine is whether they are native or introduced.

HYPERICACEAE. St. Johnswort Family

Hypericum virgatum Lam. var. *ovalifolium* Britton	Manorville. Pine barrens. Meadow bordering small pond. Small colony. In flower 7/22/23. Flowers withered 8/7/22. Writer can find no previous record for Long Island. Determination verified by N. L. Britton.

CISTACEAE. Rock Rose Family

Lechia Leggettii Britt. & Hall	South Hempstead. Oak woods. Merrick. Dry grassy hollow.
" *tenuifolia* Michx.	Wading River. Pine woods at Long Pond. North of Pinelawn, edge of woods. Northwest of Central Islip. Dry woods. All three localities in pine barrens.

ONAGRACEAE. Evening Primrose Family

Ludwigia sphaerocarpa Ell. Boggy shores and in stream at Kent Pond and northeast of Kent Pond, Manorville. Pine barrens.

KNEIFFIA

These plants are named from "A Brief Conspectus of The Species of Kneiffia with the Characterization of a New Allied Genus." By Francis W. Pennell. Bull. Torrey Bot. Club. Oct. 17, 1919.

Kneiffia tetragona (Roth) Pennell. Woodside. Wet meadow and thicket. The only colony the writer has so far seen.

This is the *K. fruticosa* (L) Raimarin of The Illustrated Flora.

Kneiffia fruticosa (L.) Raimarin. Very variable, common and widely distributed.

This plant is *K. linearis* (Michx.) Spach and *K. longipedicellata* Small. of The Illustrated Flora.

HALORAGIDACEAE. Water Milfoil Family

Myriophyllum tenellum Bigel. Montauk. Small pond. One station.

ARALIACEAE. Ginseng Family

Aralia hispida Vent. Point of Woods. Swamp near bay.
East of Amagansett on Montauk road between pine barrens and sand dunes.
Cypress Hills. Rich swampy woods.

" *spinosa* L. Valley Stream. Swampy woods. Probably introduced.

AMMIACEAE. Carrot Family

Cicuta bulbifera L. Calverton. Wet border stream.

OLEACEAE. Olive Family

Fraxinus pennsylvanica Marsh. South of North Beach. Swampy woods.
Greenport. Swampy woods.

GENTIANACEAE. Gentian Family

Dasystephana saponaria (L.) Small — Meadowbrook. Open swamp and thicket.
Meadowbrook stream ½ mile south of Meadowbrook swamp.
Hempstead. Damp meadow and thickets northeast of village near water tower.
Massapequa. Damp meadows near salt meadows.

Gentiana clausa Raf. — Millneck. Thicket between rich woods and swamp. Small colony.

Both plants have been verified by Mr. E. P. Bicknell and by Professor M. L. Fernald. The Millneck plant was reported in my former paper, Torreya **22**: 43–49 as *Dasystephana Andrewsii*, following The Illustrated Flora.

For a review of this group by M. L. Fernald see Rhodora, August 1917.

Gentiana crinita Froel — Northwest of Deer Park, not Brentwood as reported, Torreya **22**: 43–49.
Woods north of Kew Gardens. In Richmond Hill woods, a continuation of Kew Garden woods, 50 years ago, I found a single plant.

ASCLEPIADACEAE. Milkweed Family

Asclepias quadrifolia Jacq. — Rich woods. Richmond Hill, 6/15/20.

LABIATAE. Mint Family

Stachys palustris L. — Montauk Point. Damp edge of pond. Small colony.

SCROPHULARIACEAE. Figwort Family

Agalinis holmiana (Greene) Pennell. — Ronkonkoma.
Setauket.
Manorville.

	All in dry pine barrens. Not common but widely distributed through the pine barrens and dry oak woods adjoining.
Mimulus moschatus Dougl.	Woods. Millneck. Swampy border stream. ½ dozen plants. There is some doubt whether this is a native of Long Island or introduced. Determination verified by F. W. Pennell.

LENTIBULARIACEAE. Bladderwort Family

Utricularia pumila Walt.	Pine barren bogs. Ronkonkoma, Yaphank, Central Islip, Long Pond, Wading River Bog (not pine barrens), Speonk.
" *fibrosa* Walt.	Ronkonkoma.
	Jones Pond, Manorville.
	Central Islip.
	All in pine barrens.
" *intermedia* Hayne	Manorville between Jones & Sandy Ponds.
	Jones Pond, in water.
	Pine barrens.
" *radiata* Small	Wading River, Long Pond.
	Coram, Edwards Pond.
	Both in pine barrens.
	Rockville Centre, waterworks pond.
" *Gibba L.*	Deep Pond, Wading River. Pine Barrens. Small colony in shallow water.

Dr. J. H. Barnhart has kindly verified the determinations of *Utricularia*.

Vesicularia purpurea (Walt) Raf.	Kent Pond, Manorville.
	Long Pond, Wading River.
	Ronkonkoma swamp.
	Pond, Wyandanch.
	All in pine barrens.
	Miller's Pond, Smithtown.
	Pond at Babylon.

Setiscapella subulata (L.) Barnhart — Reported Torreya **22**: 43–49. Determination verified by Dr. J. H. Barnhart.
Ronkonkoma, 6/6/21.
Long Pond, Wading River, 6/19/21, 7/21/23.
Central Islip, 9/14/21.
All pine barrens, sandy shores and swamps.

Setiscapella subulata (L) Barnhart forma *cleistogama* (Gray) N. comb.
Setiscapella cleistogama (A. Gray) Barnhart of The Illustrated Flora.

Late in September 1923, the writer found a large colony of these plants growing on the sandy shore of Long Pond, Wading River where earlier in the season in former years typical *Setiscapella subulata* grew. The plants varied from 1 to 3 cm. high with small bluish heads and on the larger ones an occasional small yellow flower. The writer did not realize that this was the *Setiscapella cleistogama* of The Illustrated Flora, but considered it a depauperate form of *S. subulata* due to the late date combined with an abnormally dry season and unfortunately with this view did not keep the specimens.

For the views of other observers the reader is referred to Fernald Expedition to Nova Scotia; Rhodora 1921 pp. 100-108-142-143-169-291; Bull. Torrey Bot. Club, June 1915. Bicknell, Flora of Nantucket. Flora of Southern New Jersey, Witmer Stone.

RUBIACEAE. Madder Family

Galium verum L. — Kings Park. Waste field. Adventive from Europe.
" *cruciatum* — Easthampton. Roadside. Adventive from Europe.

CAPRIFOLIACEAE. Honeysuckle Family

Lonicera sempervirens L. — South Hempstead. Woods.
" *japonica* Thunb. var. *flexuosa* — Bayside Woods. Native of Japan.

var. *Morrowi* Gray	Kissena Flushing. Border of swamp. Native of Japan.
" *Standishii*	Roslyn. Hilly woods. Native of China. Only escape known to Mr. Alfred Rehder of the Arnold Arboretum who kindly named the last three species.

LOBELIACEAE. Lobelia Family

Lobelia Dortmanna L.	Riverhead. Great Pond. In profusion in 6 inches to a foot of water on white sand bottom.

CICHORIACEAE. Chicory Family

Nabalus altissimus (L.) Hook.	Roslyn. Border hilly woods. One colony.

Hieracium venosum L.
" *marianum* Willd.

The typical *H. venosum* of the manuals, a slender, almost glabrous plant with few stem leaves is wide-spread on Long Island in shady woodlands. In more open dry and sterile pine barrens what the writer believes is the same species is more pubescent and rougher and on the open rolling wind-swept downs at Montauk, the plant varies from almost typical *venosum* through almost every possible gradation to almost typical *marianum* of the manuals, leafy and with long pilose hairs on stem and leaves, floccose pubescence and abundant glands on stem and inflorescence. In the Hither Woods, Montauk, a mile from the open downs and separated by the depression of Fort Pond, the writer has found typical woodland *H. venosum*.

Mr. E. P. Bicknell has kindly examined these Montauk plants and describes them as intermediate in varying degree between *H. venosum* and *H. marianum*, one plant being quite typical *marianum*, and as being similar to the plants of Nantucket found on open ground. On Nantucket, Mr. Bicknell found no typical *venosum*. For a complete description of the Nantucket plants, see Bulletin Torrey Bot. Club **42**: 552–3.

Dr. F. W. Pennell examined most of the Montauk plants and named them *venosum*. He doubted that *marianum* occurred in our area.

Mr. K. K. Mackenzie has written the writer that he doubts there is such a species as *marianum* and that all he has seen so named were referable to *venosum* or *scabrum*. One of the Montauk plants closest to *venosum* was sent to Mr. Mackenzie who called it unquestionably *venosum*.

"Flora of the Vicinity of Washington" does not record *Hieracium marianum*, only *H. venosum*.

In "Plants of Southern New Jersey" Dr. Witmer Stone writes of *Hieracium marianum:* "These plants are very unsatisfactorily identified. While extreme examples fit the description of *H. marianum* others seem to be *H. venosum* with one or two stem leaves. The veining does not seem an important matter as many plants from the pine barrens have uniformly green leaves and they also show a great variation in pubescence."

"From the material on hand I cannot see any clear cut line of separation between the two and possibly we do not have *marianum* at all."

The writer has reached the conclusion from his own field experience and from the variations recorded by others as condensed in this article, that all of these plants are forms of one species quite sensitive to environment and all should be named *venosum* or *marianum* according to which name has priority.

In the writer's experience typical *venosum* is a plant of woods protected from wind and sun. In the more open pine barren woods it is a rougher, more pubescent plant.

On the flat or rolling downs at Montauk it occurs on windswept hills and open plains and the more or less protected hollows, often shielded by thickets and varies as described above from nearly typical *venosum* to *marianum* of the manuals.

The writer has seen *Solidago rugosa* and *S. altissima* in shady woods, slender and almost glabrous. The same species in the open are very pubescent and rough in varying degree.

COMPOSITAE. Thistle Family

Eupatorium Torreyanum Short	Hempstead Plains, Garden City. Many colonies.
	Montauk. Open downs. One colony.

Eupatorium rotundifolium L.	Hempstead Plains, Garden City. Small colony. Long Pond, Wading River. Two small colonies opposite shores of pond.
Eupatorium sessilifolium L.	North of Kew Gardens. Rich hilly woods. Single colony.
Solidago arguta Ait.	Woods north of Wyandanch. Colony of three plants. The only plants the writer has seen. Mr. E. P. Bicknell wrote that he had found the basal leaves in hilly woods at Roslyn west side of Hempstead Harbor.

A Study on the Effect of Evaporation and Light on the Distribution of Lichens

Charles C. Plitt and Louis J. Pessin

An investigation has recently been completed of the effect of climatic conditions on the distribution of *Polypodium polypodioides* in Mississippi by the junior writer. It was found that the evaporating power of the air plays the main rôle in determining the distribution of this epiphytic fern. The intensity of the light, the humidity of the air, the temperature in the immediate vicinity of the tree and the temperature of the bark to which the fern was attached exerted only an indirect influence on the occurrence of this polypody.*

The aim of the present paper is to give the results obtained from a study of the effect of certain climatic conditions on the distribution of the lichens on a tree on Mt. Desert Island, Maine, Lat. 44°26′ N. The writers sought to determine what correlation exists between the evaporating power of the air, the intensity of the light, and the distribution of the lichens along the height of the tree and around its circumference.

A tree (*Quercus rubra*) a little over thirteen meters in height and about one-half meter in diameter at two meters from the ground was selected for the investigation. The tree was located in a rather dense woods in the immediate vicinity of the Harpswell Laboratory. A small part of this oak projected above the tops of the neighboring trees. From the base to the top of tree, zones, about a meter apart, were measured off vertically along the tree. In each individual zone a careful study of the lichen flora was made. Three of the zones were selected for the study of the climatic conditions. These were located at 1 to 2 meters, 5.5 to 6.5 meters, and 9 to 10 meters above ground. In each of three selected zones a white, spherical, porous-cup atmometer was set up on the northeast, northwest, and south sides. Evaporation was recorded once a day, generally at nine o'clock in the morning. At these stations the light intensity was also measured. Light readings were usually made at nine and eleven

* This paper will appear in ECOLOGY within the year.

in the morning, and two and four in the afternoon by means of a "Wynne Photographic Exposure Meter." The observations began July 10th, 1923, and ended August 23d of the same year. Thus, records were obtained during forty-three consecutive days.

The different species of lichens are indicated in "Table I" together with the evaporation and the light measurements obtained for the different stations in each zone. It will be noted that the stations in the table are arranged according to the evaporation rates for each station.

It is realized that the ectinometer is not especially suitable for measuring the light intensity, since the rays that act on the photographic paper are not the ones that affect the main activities of the plant. It may be sufficiently accurate for our purpose since it gives the comparative light intensity of two regions for the kind of light it records. The readings obtained by means of this instrument were compared with those obtained in direct sunlight. It was found that it took four seconds (the average of four tests) to change the color of the photographic paper, when the ectinometer was exposed four times at noon to direct sunlight. Four seconds were then regarded as the standard or maximum light intensity. All the other readings obtained were computed as percentage of the intensity of the light in the open.

TABLE I

RELATION OF EVAPORATION AND LIGHT TO THE DISTRIBUTION OF LICHENS ON THE TRUNK OF QUERCUS RUBRA

Station	Exposure	Lichen	Evaporation	Light
1 to 2 m. from ground I	Northwest	*Conotrema urceolata* *Pertusaria multipuncta*	427.62 c.c. in 43 days	6.2%
1 to 2 m. from ground II	South	*Buellia parasema* *Lecanora albella* *Lecidea vernalis* *Leptogium tremelloides* *Lobaria pulmonaria* *Parmelia* sp. *Pertusaria amara*	432.13 c.c. in 43 days	13.5%

1 to 2 m. from ground III	Northeast	*Buellia parasema* *Conotrema urceolata* *Lecanora subfusca* *Parmelia* sp. *Pertusaria amara*	435.12 c.c. in 43 days	10.6%
5.5 to 6.5 m. from ground IV	South	*Arthonia radiata* *Buellia parasema* *Parmelia caperata* *Parmelia* sp. *Parmelia physodes* *Pertusaria multipuncta* *Usnea florida* *Usnea hirta*	477.31 c.c. in 43 days	29.7%
5.5 to 6.5 m. from ground V	Northeast	*Arthonia radiata* *Buellia parasema* *Lecanora albella* *Parmelia sulcata* *Ramalina canaliculata*	489.56 c.c. in 43 days	19.8%
5.5 to 6.5 m. from ground VI	Northwest	*Arthonia radiata* *Conotrema urceolata* *Lecanora albella* *Lecanora varia* *Parmelia conspurcata* *Parmelia* sp. *Ramalina canaliculata*	495.33 c.c. in 43 days	19.8%
9 to 10 m. from ground VII	South	*Buellia parasema* *Lecanora subfusca* *Parmelia conspurcata* *Parmelia sulcata* *Pertusaria multipuncta* *Ramalina canaliculata* *Usnea florida* *Usnea hirta*	717.63 c.c. in 43 days	50.1%
9 to 10 m. from ground VIII	Northeast	*Buellia parasema* *Lecanora subfusca* *Parmelia conspurcata* *Parmelia sulcata* *Pertusaria multipuncta* *Ramalina canaliculata* *Usnea florida* *Usnea hirta*	734.7 c.c. in 43 days	41.3%

9 to 10 m. from ground IX	Northwest	*Buellia parasema* *Lecanora subfusca* *Parmelia conspurcata* *Parmelia tiliacea* *Parmelia sulcata* *Pertusaria multipuncta* *Ramalina canaliculata* *Usnea florida* *Usnea hirta* *Xanthoria parietina*	764.64 c.c. in 43 days	55%

A study of the table seems to suggest that it is the evaporating power of the air that most affects the distribution of the lichens on the tree. It is true that there is some correlation between the intensity of the light and the distribution of the lichens, but this correlation is not as definite as that existing between the plant distribution found and the evaporating power of the air. It seems quite evident even from the limited data, thus far gathered that evaporation plays the chief rôle in limiting the distribution of the lichens. Accepting this as a fact one can arrange the lichens found on this tree into four groups: Group I would include those lichens which inhabit only regions of relatively low evaporation. Thus, *Lecidea vernalis*, *Leptogium tremelloides*, *Lobaria pulmonaria* and *Pertusaria amara* would fall in this group. Into Group II would fall such lichens which inhabit regions of moderate evaporation. This group would include *Conotrema urceolata*, *Arthonia radiata*, *Lecanora albella*, *Parmelia caperata*, *Parmelia physodes*, and *Lecanora varia*. Into Group III would fall those lichens which are able to withstand dry conditions, and are found only in regions of high evaporation. Lichens included in this group are *Pertusaria multipuncta*, *Lecanora subfusca*, *Parmelia conspurcata*, *Parmelia tiliacea*, *Ramalina canaliculata*, *Usnea florida*, *Usnea hirta* and *Xanthoria parietina*. Group IV includes those lichens which seem to show no preference and are found in regions of high evaporation as well as in regions of low evaporation such as *Buellia parasema*.

LIST OF LICHENS FOUND ON QUERCUS RUBRA AND THEIR DISTRIBUTION

Arthonia radiata (Pers.) Th. Fr.

The lowest level at which this lichen was found was about four meters above ground in the northeast zone. No trace of it was found above eight meters from the ground.

Buellia parasema (Ach.) Th. Fr.

The occurrence of this lichen began at one meter above ground, and from there on, it was distributed abundantly all over the tree. More than one hundred patches of this lichen were counted from the lower portion of the tree to the top.

Candelaria concolor (Dicks.) Wainio.

Only two patches of this species were found on the tree. Both were on the south side of the tree, and both just where a branch extended out from the trunk.

Conotrema urceolata (Ach.) Tuck.

This is perhaps the best represented species on the tree. In ascending the tree it was first found at one meter above ground on the north side of the tree. At first only small patches of it were present, but the higher one climbed the larger and more abundant became the patches of this lichen. From about seven meters above ground, the lichen became less and less abundant, so that at about eight meters from the ground there was no trace of it left. Apparently this lichen is an ombrophilous form, for it is found exclusively on the shady side of the tree in the northeast to northwest zones.

Lecanora albella (Pers.) Ach.

At about two meters from the ground only a small patch of this lichen was found. At about four meters from the ground it began to appear abundantly competing, as it were, with *Conotrema*. Higher up the patches became more abundant. At about eight meters from the ground it reached its maximum distribution. Two meters above that this lichen did not appear.

Lecanora subfusca (L.) Ach.

Over thirty patches of this lichen were counted beginning above the lower third of the tree. This lichen occurred on all sides, and was especially abundant on the upper third of the tree.

Lecanora varia (Ehrh.) Ach.

Only two patches of this species were found. Both were on the upper third of the trunk.

Lecidea vernalis (L.) Ach.

One small patch of this lichen was found on the south side of the tree at about two meters from the ground.

Leptogium tremelloides (L.) Gray.

Near the base of the tree this lichen was very abundant. At one meter above ground practically no trace of it was left.

Lobaria pulmonaria (L.) Hoffm.

The distribution of this species is similar to that of *Leptogium* but it was not quite as abundant.

Parmelia sp.

This species was practically all over the tree. Although so abundant, it was impossible to decide upon the species, for everywhere it seemed to be in a juvenile condition.

Parmelia caperata (L.) Ach.

One large specimen of this lichen was found on the upper third of the trunk on the south side.

Parmelia conspurcata (Schaer.) Wainio.

A few patches of this lichen were found on the upper third of the trunk. No preference to any particular side was evident.

Parmelia physodes (L.) Ach.

Only one patch of this form was found at about seven meters from the ground, on the south side of the tree.

Parmelia rudecta Ach.

One patch only of this species was found, at about eight meters from the ground, on the northeast side of the trunk.

Parmelia saxatilis (L.) Ach.

This form had a similar distribution to *Parmelia rudecta.*

Parmelia sulcata Tayl.

More than fifteen patches of this lichen were found on the upper quarter of the tree.

Parmelia tiliacea (Hoffm.) Ach.

One specimen of it only was found, near the very top of the tree.

Pertusaria amara (Ach.) Nyl.

A few specimens of this lichen were found on the north side of the tree between one and two meters from the ground.

Pertusaria multipuncta (Turn.) Nyl.

This lichen was most abundant on the upper half of the tree. No preference for any particular side of the tree was apparent.

Physcia stellaris (L.) Nyl.

Several specimens of this lichen were found on the tree. There seemed to be no definite distribution.

Pyrenula nitida (Schrad.) Ach.

One specimen of this lichen was found at about six meters from the ground on the northwest side of the tree.

Ramalina canaliculata Fr.

This lichen was found only in the upper half of the tree. At first a very few depauperate specimens were found, but at the upper third of the tree the lichen was very abundant. Possibly the patches on the lower part of the tree were washed down by the rains from above.

Ramalina farinacea (L.) Ach.

A small patch of this was found on the upper third of the tree on the south side.

Usnea florida (L.) Hoffm.

The distribution of this lichen was very similar to that of *Ramalina canaliculata*.

Usnea hirta (L.) Hoffm.

This lichen was found in abundance in the same regions on the tree inhabited by *U. florida*.

Xanthoria parietina (L.) Fr.

One patch of this form was found near the very top of the tree on the northwest side.

SUMMARY

1. The evaporating power of the air was found to be different at the different sides and heights of the tree.

2. The evaporating power of the air seems to be the condition which most affects the distribution of the lichens.

3. Certain lichens may be restricted to certain heights or sides of the trunk. Their restriction depends on the evaporation rates at those regions.

4. Some lichens seem to have no restrictive distribution, and occur all along the height of the tree, on any side.

5. Some lichens seem to show preference for the north side; others for the south side.

6. Marked illustration of restriction is shown by *Leptogium tremelloides*, *Pertusaria amara*, and *Lobaria pulmonaria*. These occur only in regions of low evaporation.

7. *Usnea* and *Ramalina* occur only in regions where light is intense. The high evaporation in those regions does not seem to affect their distribution.

In conclusion it may be stated that although these results should be regarded as preliminary ones, it is safe to say that this method of investigation opens up an interesting phase in the study of epiphytes, for in two different regions (in Mississippi and in Maine) and in two diverse types of plants (a fern and lichen) the investigation brings out similar results.

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INDEX TO AMERICAN BOTANICAL LITERATURE

1923

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 the broadest sense.

Reviews, and papers that 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 omissions, their kindness will be appreciated.

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New Species of Mosses from the Malay Peninsula

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For some years I have been accumulating in my herbarium undescribed species from the East Indies, a number of them from Mitten's herbarium in The New York Botanical Garden. A large proportion of these were collected by Mr. H. N. Ridley and sent to Mitten for naming, but unfortunately remained undetermined at Mitten's death.

I have also received a considerable number of specimens of the same collector, some from Mr. Ridley himself, some from the Kew Herbarium, and others from the Singapore Botanical Gardens. The present paper deals with such of these as come from the Malay Peninsula.

The order and nomenclature followed are for the most part those of Brotherus in Engler & Prantl, Pflanzenfamilien.

Dicranaceae

Braunfelsia longipes Dixon sp. nov. (Plate 3, Fig. 1)

Species insignis, habitu *B. scariosae*, sed caulibus propter folia densissime conferta *turgidis*, *robustioribus*, usque ad 6 cm. altis, infra spadiceis, *apice stramineis*.

A *B. scariosa* quoque differt foliis *omnino enerviis;* a *B. enervi* foliis *longius*, *angustius acuminatis*, cellulis alaribus *magis rectangularibus*, (1.5–2 × 1); ab omnibus speciebus *seta longiore*, 2.5 cm. vel paullo ultra. Bracteae perichaetii pilo longissimo tenuissimo thecam aequante vel superante terminatae. Theca *B. scariosae*.

HAB. Gunong Tahan, Pahang, alt. 7000 ft., 1922; Mohammed Haniff and Mohammed Nur (7905).

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Distinct from all the species in the long seta, and from all but *B. luzonensis* Broth. and *B. enervis* (Doz. & Molk.) in the nerveless leaves. The former differs in the small size, piliform leaves and short seta; *B. enervis* varies considerably in the form of the leaf-point; the leaf figured by Fleischer in the Musci der Flora von Buitenzorg, **1**: 95 being much more finely acuminate than as shown in the Musci Frond. Ined. Arch. Ind., Tab. III; the present plant has them still more finely and longly acuminate, while the seta is more than twice as long as usual in that species, though it may at times approach it in length.

Dicranoloma perintegrum Dixon sp. nov.

D. Billardieri (Schwaegr.) affine; differt foliis siccis inferne *plicatis*, superne *integerrimis*. Fructus ignotus.

HAB. Mt. Ophir, Malacca, Dec. 1898; Ridley (780).

In the absence of perichaetia and fruit it must not be too hastily assumed that this is a very close ally of *D. Billardieri*, but in the vegetative characters it could only be separated by those underlined above. The leaves are falcate-secund, the stems 6 cm. or more high. *D. braunfelsioides* Herzog from Ceram is near it, but has leaves and back of nerve somewhat toothed above, a narrow hyaline border to the leaf-base, absent here, and the leaves not falcate.

All the other Indo-Malay species differ in the leaves being toothed, apart from other characters.

Dicranoloma brevicapsulare Dixon sp. nov. (PLATE 3, FIG 2)

Stirps procerus, habitu *D. Braunii* vel formarum validarum *D. Blumii;* caules 10 cm. alti vel supra; folia valde patentia, sicca flexuosa, *haud falcata*, apicalia solum leniter falcato-secunda.

Folia *D. assimilis* fere, sed cellulis superioribus angustioribus, atque *limbo hyalino perangusto*, saepe obsoleto. Setae *singulares nec aggregatae* 2.5 cm. longae, eis *D. assimilis crassiores;* theca *multo brevior latiorque, deoperculata vix 3 mm. longa, turgide subcylindrica vel ab ore ad infra sensim angustata, leniter curvata*, subhorizontalis, basi *estrumosa;* peristomium magnum, intense rubrum.

HAB. Gunong Tahan, Pahang, 5500–7000 ft. alt., 1922; Mohammed Haniff & M. Nur (7915a).

All the allied species of the genus in this region are at once known by having the setae either aggregate or much shorter, or the capsule narrowly cylindric and distinctly strumose. In *D. sumatranum* Broth. the capsule is suberect, not arcuate, and more cylindrical, with a somewhat distinct neck. In the present plant there is no trace of struma, and very little of collum.

Thysanomitrium abbreviatum Dixon sp. nov. (PLATE 3, FIG. 3)

Habitu *T. exasperati*, sed caulibus siccis *turgide julaceis*, et propter folia multo breviora *subteretibus*. Folia eis *T. exasperati* similia sed breviora, apice latiora, obtusa, valde concava, nervo *omnino alieno*, basi 1/5–1/4 folii latitudinem aequante, *tenerrimo, plerumque unistratoso, cellulis 3–4-seriatis medianis tantum bistratosis, omnibus homogeneis*. Caulis unicus fructiferus vel masculus juvenis *T. exasperato* similis.

HAB. Summit of Gunong Tahan, Pahang, alt. circa 7000 ft.; Ridley (1012).

This and the following species are very remarkable; with nearly all the characters of *T. exasperatum* and *T. umbellatum* respectively, they present a nerve structure which is totally different, so much so as to suggest even a generic distinction. In those species, as is well known, the broad nerve, though thin, consists of at least three elements throughout the breadth, viz., a central layer of guide-cells, and both a ventral and dorsal layer of stereid ones, with occasionally outside these a slightly differentiated superficial layer of external cells. In the two species under consideration the nerve, while broad, consists for the greater part of its width of a single layer of small cells, scarcely distinguishable in section from those of the lamina (though quite distinct, owing to their form, from these when viewed from the front or back); the middle part of the nerve alone showing a double layer, but still of the same form of cells, and only extending for the width of three or four rows.

The leaves are shorter, more closely imbricated and appressed when dry, so that the stems are more terete and julaceous than occurs, unless very rarely, in *T. exasperatum*.

Thysanomitrium Ridleyi Dixon sp. nov. (PLATE 3, FIG. 4)

Praecedenti (*T. abbreviatum*) peraffine; differt tantum foliis *pilo longiusculo hyalino sublaevi* abrupte terminatis.

HAB. Gunong Tahan, Pahang, July, 1911; Ridley (1019b).

The stems of this plant are a little taller than in the specimen of *T. abbreviatum*, but there is no reason to suppose that this is a specific character. The sole difference lies in the constant presence of a distinct hyaline hair-point; otherwise the leaf form and structure, nerve, &c., are identical.

It stands therefore in the same relation precisely to that species that *T. umbellatum* (*T. Blumii* Nees) does to *T. exasperatum*, from which it only differs in the presence of a hair-point and in one or two very minor and perhaps doubtful characters. (The fringing of the calyptra, which is perhaps the chief distinguishing character given by Fleischer, is certainly of no real value, for I have more than once found in *T. umbellatum* capsules with calyptra both fringed and unfringed on the same tuft).

The two plants being described, therefore, give decided support to the opinion that I have elsewhere expressed that *T. exasperatum* may be only a muticous leaved form of *T. umbellatum*. There is, however, this difference, that while in *T. umbellatum* the leaves are acuminate at the apex, and taper gradually into the hair-point, in *T. Ridleyi* they are obtuse and cucullate, just as in *T. abbreviatum*, then passing abruptly into the hyaline point.

FISSIDENTACEAE

Fissidens subdiscolor Dixon sp. nov. (PLATE 3, FIG. 5)

§ Aloma. *F. discolori* Wils. ceylonensi affinis; differt caulibus *altioribus*, circa 1.5 cm. altis, foliis latioribus, *magis obtusis*, costa saepius ad apicem attingente; cellulis *minoribus*, 10–14 μ latis (*F. discoloris* 15–18 μ), et lamina dorsali *sat abrupte desinente, haud anguste decurrente*. Fructus subsimilis.

HAB. Gemas, Negri Sembilan, 1920, on root in a boggy hollow; Burkill (6388).

This may ultimately have to be united with the South Indian and Ceylonese species; but it differs in the larger size, the leaves nearly always rounded and obtuse at apex with percurrent nerve (In *F. discolor* the apex though often quite obtuse is frequently somewhat pointed, and the nerve generally ceases just below the apex); the cells also are decidedly smaller, and the dorsal lamina is not narrowed at the base as in that species.

Fissidens amblyotis Dixon sp. nov. (PLATE 3, FIG. 6)

§ Amblyothallia. Stirps subrobustus; caules 2 cm. vel ultra alti, rufi, crassiusculi, *stricti;* folia laxiuscula, *madida patentia pulchre plumosa*, sicca rigide decurvo-falcata, 1–1.5 mm. longa, lingulato-lanceolata, *breviter acuminata*, *subacuta*, integra vel apice subintegra; costa fuscescens, inferne valida, superne sensim angustata, saepe sinuosula, *infra apicem desinens*. Lamina vaginans vix dimidiam partem folii aequans, apice in *media lamina rotundate vel obtuse terminata;* lamina dorsalis ad basin sat abrupte desinens. Cellulae 9–13 μ latae, *incrassatae*, irregulariter ovoideae, laeves, pellucidae.

Fructus terminalis; seta perbrevis, circa 2 mm., theca parva, erecta.

HAB. On wet rock by stream, circa 700 ft. alt., Gunong Lambak, Johore, 1922; Holttum (9456).

The nearest species to this would appear to be *F. irroratus* Card. from Formosa, but from the description the cells in that species are smaller and of a different nature; while the obtuse termination of the vaginant lamina here, forming a sort of rounded auricle (whence the specific name) is a very distinct and unusual feature. It appears best placed in the Amblyothallia.

CALYMPERACEAE

Syrrhopodon Ridleyi Broth. in sched. (PLATE 3, FIG. 7)

§ Leucophanella. Inter *S. bornensem* et *S. rufescentem* ludens. Ab illo foliis siccis *apice plus minusve flexuosis*, *nec arcte imbricatis*, *angustius acuminatis;* ab hoc foliis siccis madidisque *haud reflexis*, cellulis chlorophyllosis *multo paucioribus*, pellucidioribus, *leniter tantum papillosis*, limbo latiore; ab utroque colore fuscescente vel sordide viridi, infra nec pallido nec rufescente.

HAB. On Platycerium, Bukit Timah, Singapore, 1908; Ridley (731). On large Platycerium, 2400 ft. alt., Government Hill, Pulau Penang, 1915; Burkill (763). Both fruiting.

Near to *S. bornense*, which also occurs on the peninsula, but quite distinct in the narrowly acuminate leaves and their arrangement. In *S. bornense* they are in the dry state erect and closely appressed, the leaf-point quite straight and unaltered by drying; so that the stems are more or less terete; in the present plant the upper part of the leaf or the apex only is distinctly flexuose and not appressed, giving a totally different appearance under the lens. In *S. rufescens*, which is perhaps nearer, the leaves are rather abruptly bent back from the erect base, both moist and dry; the chlorophyllose cells there too reach much farther down the leaf, and are highly scabrous and opaque.

The type specimen is of a bright snuff colour above, and not much paler below; the Penang plant however is of a dull green; neither plant showing the very pale neat stems in the interior of the tufts characteristic of the two allied species, nor is the red colour often produced by the radicles in these at all pronounced here.

Syrrhopodon ligulifolius Dixon sp. nov.

Eu-syrrhopodon. § Tristichi. *S. Griffithii* Mitt. subsimilis, sed longe differt colore *rufo-fusco*, foliis *perstrictis*, e basi appressa rigide divaricatis, *siccis vix mutatis;* e basi perhyalina margine *fortiter anguste reflexo* cito in laminam *strictam, exacte ligulatam perangustam*, circa 80 μ latam, acutiusculam nec acuminatam contractis. Limbus marginalis *apicem attingens, ubique, nisi summo apice denticulato, integerrimus;* laminae cellulae fortiter papillosae, costa dorso *laevissima*.

Seta 1 cm. longa, tenuis; theca parva, deoperculata vix 1 mm. longa, elliptica, nitida, fusca.

HAB. Penara Bukit, Pulau Penang, 1896; Ridley (576).

Differs from *S. Griffithii* and others of that affinity in the extremely narrow, ligulate leaves, highly rigid, not at all crisped when dry, as well as in other characters. From *S. tristichus* and its allies it differs entirely in the small size, red colour, entire margin, &c.

Syrrhopodon elimbatus Dixon sp. nov. (PLATE 3, FIG. 8)

§ Eu-syrrhopodon. *S. spiculoso* Hook. & Grev. peraffine; differt autem foliis *longioribus*, 5–6 mm. longis vel paullo ultra, peranguste ligulatis, siccitate superne hamatis, colore (propter vetustatem?) fusco, lamina *omnino elimbata*, margine basilari *fortius spiculoso*.

HAB. Mt. Ophir, Malacca; Ridley (sine numero); herb. Mitten, ex herb. New York Botanical Garden.

Very near to *S. spiculosus*, but differs in the longer leaves, apparently in the colour, in the more strongly toothed border of the shoulder, and especially in the quite borderless lamina. In

S. spiculosus the hyaline border varies very greatly, and may be almost or quite obsolete here and there in a leaf; but it is always to some extent at least present. The basal part of the leaf here is perhaps narrower than in that species.

Syrrhopodon perakensis Dixon sp. nov. (PLATE 3, FIG. 9)

§ Calymperophyllum Fleisch. *S. Treubii* Fleisch. affinis, longe autem differt foliis omnibus multo *brevius, latius acuminatis*, margine basilari *integro*, cellulis *majoribus, multo pellucidioribus*, cancellina *multo breviore quam parte folii vaginante.*

HAB. Lumut Dindings, Perak, 1896; Ridley (449).

This plant belongs to a small Section of Syrrhopodon separated recently by Fleischer as § Calymperophyllum; the resemblance to certain species of Calymperes, notably of the § Calymperidium, renders the determination very perplexing. In these species, however, the thickening of the margin is usually intramarginal, so that the actual margin forms a sort of wing to the thickened border, while in the present species the margin itself is thickened; the cells however being of just the same character as those of the rest of the lamina, not being elongated nor incrassate. The lamina cells are larger (8–10 μ) and much more pellucid and distinct than in *S. Treubii*, and the leaves, especially the upper, "abnormal" ones much more shortly and broadly pointed. The sheath is narrow, very short, as in *S. Treubii*, about 1/5–1/4 the length of the leaf, and quite entire at margin, or only obtusely and sinuosely notched; the cancellina is only about half the length of the sheath, and the cells pass abruptly into the lamina cells. This is at variance with the character of the Section as defined by Fleischer, but the relationship of the species with *S. Treubii* is otherwise so close that I do not think it can be separated on that account. The cancellina cells decrease in width gradually from the nerve to the broad, narrow-celled border of the leaf-base.

Syrrhopodon pungens Dixon sp. nov. (PLATE 4, FIG. 17)

Thyridium. *S. undulato* (Doz. & Molk.) et affinibus comparabilis, sed gracilior, *multo rigidior, brunnescens;* rami 1–2 cm. alti, strictiusculi. Folia madida erecto-patentia vel patentia, sicca erecta subtorta apicibus horride patentibus; eis *S. undulati* similia sed apice in *cuspidem pungentem longam subtubulosam strictam acutam* producto.

Seta circa 1 cm. alta; calyptra angusta, basi subinflata, supra longe aciculata; theca erecta, 1.5 mm. longa (deoperculata), anguste elliptica, operculo longiore aciculari.

HAB. Petaling, Selangor, 1898; Ridley (772).

Nearest to *S. undulatus* and *S. Junquilianus*, but with a very marked difference in the leaf apex; the lingulate, undulate lamina quickly contracted into a straight, acute, narrow, subtubular, cuspidate acumen of varying length, frequently tipped, in the upper leaves, with gemmae. The hyaline border reaches usually to about the base of this acumen.

It is possible that it may prove to be a varietal form of *S. undulatus*.

Note on **Calymperes setifolium** Hampe.

Calymperes angustatum Broth. n. sp. in sched. Hab. Tapah, Perak, 1908; Ridley (149). This is certainly *C. setifclium* Hampe.

This species, and *C. aeruginosum* Hampe belong to a small Section of Machrimanta (consisting of two or three species only) having the leaves markedly constricted above the leaf-base and below the lamina, so as to form a sort of waist; this being especially noticeable in the upper, "abnormal" leaves, where the lamina cells are often reduced to an exceedingly narrow strip on either side of the nerve. Brotherus in his Key,—following Bescherelle—puts *C. aeruginosum* in a group with the margin at shoulder toothed. Bescherelle, it is true, describes the leaves as toothed in the upper part, and with the marginal cells at shoulder "dentiformes;" the latter character, however, is contrasted with "acute serratae" in *C. setifolium*, and does not imply, apparently, a high degree of dentation. But Hampe's specimens do not appear to bear out even this, and I am not able to explain the statement.

The figures of the leaf in Lacoste, Sp. Nov. vel Ined. Musc. Arch. Indici, Tab. V, show the leaf-base quite entire, and all the leaves I have examined of Hampe's type bear this out. In the present species (*C. setifolium*) the marginal and submarginal (perhaps representing the teniole) cells of the leaf-base remain elongated not only to the shoulder, but in a very narrow, 1–2 seriate border almost to the apex. The apical part of the leaf margin also is usually distinctly toothed, while in *C. aeruginosum* the leaf apex is quite entire or only very faintly toothed at the extreme tip.

Calymperes stenophyllum Dixon sp. nov.

Hyophilina. § Climacina. Humile; dense caespitosa. *C. hyophilaceo* et *C. Delessertii* affine; differt foliis superioribus *multo angustioribus*, e marginibus convolutis *subtubulosis*, nervo dorso infra *laevi*, supra sublaevi vel minute tantum scaberulo, cellulis superioribus laevibus.

Folii pars vaginans anguste obovata vel elliptica, tertiam partem folii longitudinem vel ultra aequans. Teniola nulla. Cancellinae cellulae *rectangulares*.

Ditissime fructiferum. Seta perbrevis, folia suprema haud superans. Calyptrae anguli supra fortiter serrulato-papillosi.

HAB. Lumut Dindings, Perak, 1899; Ridley (777).

Very near to the two species with which I have compared it, and to others closely allied, but with the leaves (except perhaps the very lowest) much narrower, tubular above, and the nerve nearly and often quite smooth at back. *C. hyophilaceum* and *C. Brotheri* Besch. have the cancelline cells quadrate. C. *eutrichostomum* C. M. I have not seen, but Fleischer states that it is only a narrow-leaved form of *C. Dozyanum*. *C. Delessertii* Besch. has distinctly wider leaves, and the back of nerve strongly papillose.

Calymperes constrictum Dixon sp. nov. (PLATE 3, FIG. 10)

Eu-calymperes. § Machrimanta. *C. setifolio* Hampe affine, folia latiora, medio *minus constricta*, apice latiore, integro vel raro indistincte distanter denticulato; teniola ad apicem fere, *limbum perangustum instruente*, circumdata; et parte basilari vaginante multo angustiore, sensim in laminam transeunte, margine superiore spinulis paucis sed fortibus armato.

HAB. Klang Watercatchment Forest, Selangor, on rotten bark on the ground, 1922; Burkill (6836).

The leaves in this species are only slightly constricted above the base, and it may therefore possibly not be so closely allied to the group of *C. aeruginosum* and *C. setifolium* as I have suggested. Moreover the leaves are closely enrolled when dry, and this is contrary to the habit of most of the species of this group; the cancelline here too is rather of the Climacina outline, the juxta-costal rows of its cells being the longest, while in the two species referred to the median rows are the longest, giving the cancellina a rounded summit. The cancelline cells too are rather longer, those of *C. aeruginosum* and *C. setifolium* being sub-quadrate. The toothing of the marginal shoulder is different from that of *C. setifolium*, the upper teeth being few, and markedly rigid and spine-like, with a few much smaller ones lower down. The marginal cells of the base form a broad, pale border quite to the shoulder, which gradually narrows from there into the very narrow, thickened border of the lamina.

Whatever its exact relationship be, it is a very distinct species.

ORTHOTRICHACEAE

Macromitrium magnirete Dixon sp. nov.

§ Leiostoma. *M. Zollingeri* forsan affine. Sat robustum, dense intricatum, fuscum; caules densissime ramosi, ramis inaequalibus, .5–1 cm. longis, foliis densissime confertis, siccitate inferioribus laxiuscule, apicalibus arcte spiraliter contortis, madidis patentibus. Folia circa 1 mm. longa, oblongo-lanceolata, e medio ad apicem acutum vel subobtusum angustata, costa excurrente longiuscule cuspidata; costa ad basin sat valida, profunde carinata, supra multo angustior; margine integro, basi uno latere reflexo. Cellulae *magnae*, 12–18 μ latae, *mamillosae*, ovales, *perincrassatae*, infra sensim elongatae, basilares angustissime lineares, rectae, grosse tuberculatae. Seta circa 1.5 cm., laevis. Theca minuta, elliptica, laevis, microstoma. Calyptra laevis. Peristomium *externum nullum;* internum membrana altiuscula albida.

HAB. Gunong Tahan, Pahang, 7000 ft., 1922; Mohammed Haniff and M. Nur (7907).

Nearest to *M. Zollingeri* and *M. Blumii*, but differing in the larger, highly mamillose cells, more acute leaf apex; and apparently in the peristome, which in both these species is double. The numerous capsules I have examined of the present plant show no trace of outer teeth, although some of them are in quite good condition; they are, however, all past maturity; and it is quite possible that the outer teeth may have been lost.

MYURIACEAE

Myurium subnitens Dixon sp. nov.

Sat gracilis, statura *M. sinici* Mitt. vel *M. quinquefarii* Thér., sed ramis *longioribus*, *flexuosis*, *densissime caespitosis*, pallide fusco-viridibus. breviter cuspidatis *haud vel vix nitentibus*.

Folia conferta, imbricata, perconcava a basi cordata late ovato-orbicularia, cucullata, abrupte in acumen circa ½ longitudinem folii aequans, loriforme, acutissimum fortiter denticulatum contracta, ecostata; marginibus toto ambitu superiore argute tenerrime denticulata. Cellulae superiores sinuato-rhomboideae, parietibus incrassatis porosis sed tenerrimis, ideo cellulae velut conflatae; basilares angustiores, infimae saepe aurantiacae, alares nonnullae aurantiacae, subinflatae, auriculas parvas bene notatas instruentes. Cetera ignota.

HAB. Sempang, Fraser Hill, Pahang, 1911; Ridley (282).

With the leaf form and structure of *M. rufescens*, but more slender than any of its forms and without the glossy texture of that species; the leaf-point also is wider and more rigid than is usual there; the dense habit is also characteristic.

NECKERACEAE

Endotrichella plano-marginata Dixon sp. nov.

E *minoribus generis;* caules 3–4 cm. alti, densifolii, foliis patulis, frondes 4–5 mm. latas formantibus; folia *late cordato-ovata,* 3–3.5 mm. longa, 2 mm. lata, apice *raptim in cuspidem brevem, latam, fortiter dentatam* contracta, plicata, marginibus *omnino plania,* superne magis magisque fortiter denticulatis; costae nullae; cellulae *parvae,* superiores 40-55 μ longae, lumine 5–8 μ lato, parietibus incrassatis; basilares elongatae, angustae, alares numerosae, multo latiores, subquadratae, pellucidae, *alas minusculas conspicuas* instruentes.

Fructus ignotus.

HAB. Batu Caves, Selangor, 1896; Ridley (472). Base of a large tree in jungle, Sekong, Brit. North Borneo, 1913; Binstead (185).

The generic position of this species in the absence of fruit must remain doubtful, but whether it be an Endotrichella or a Garovaglia it is a distinct new species. Very few of the species of these genera have the leaf margin plane, and from those with this character the small size, small rounded leaves, small cells, conspicuous alar cells, and sharply toothed robust apiculus will separate it without difficulty. *Garovaglia aristata* is perhaps the most like it, but has finer, quite entire apiculus; while *G. densifolia* Thw. & Mitt. has almost entire leaves and much larger cells.

Pinnatella lingulata Dixon sp. nov. (PLATE 3, FIG. 11)

P. liguliferae (Lac.) Fleisch. affine, sed *frondibus et foliis percomplanatis*, atque foliis siccis minute transverse rugosis, siccitate quoque leniter longitudinaliter biplicatis; sine ullo limbo intramarginali.

Frondes oblongae, bipinnatae; folia stipitis *suberecta, haud reflexa*, caulina e basi latiore uno margine late inflexo concava, *late oblongo-lingulata*, apice rotundato et breviter acuto, integro vel minutissime crenulato, marginibus planis; costa infra valida, apice cito angustata ibidemque saepe bifurcata, *longe infra folii apicem desinens;* cellulae superiores minute ovato-hexagonae, incrassatae, dorso laeves, marginales magis elongatae, omnes basin versus longiores, basilares lineares. Folia ramulina minora, paullo acutiora.

Fructus in parte superiore caulis et in ramis superioribus situs; seta 1 mm. longa, laevis; theca subaequilonga, elliptica, brunnea, operculo curvato rostellato; peristomium majusculum, pallidum.

HAB. Growing horizontally on upright tree-trunks, Gunong Tampin, 1800 ft. alt., Negri Sembilan, 1917; Burkill (2864).

A rather marked species in having the leaves and branches very complanate, the marginal cells slightly elongate, and smooth. *P. Kuhliana* differs in the reflexed leaves of the stipes, smoother, more pointed, more ovate, concave leaves, and very different cells; *P. ligulifera* Fleisch. in the not or less complanate habit, and other points.

The transverse rugulosity of the leaves is minute, and best seen under the microscope, but is quite evident with the lens in the dry state.

ENTODONTACEAE

Clastobryum prionotrichum (Hampe in sched.) Dixon sp. nov. (PLATE 3, FIG. 14)

Caules secundarii brevissimi, dense caespitosi, gracillimi, fusci (? propter vetustatem), saepe *ramos flagelliformes microphyllos tenuissimos* emittentes. Folia imbricata, erecto-patentia, vix .5 mm. longa, e basi angustiore ovalia; *in acumen flexuosam subulatum subaequilongum argute denticulatum sat cito angustata;* ecostata, pellucida, concava; cellulae anguste lineares, perpellucidae, prosenchymaticae, laeves, parietibus tenuibus, infra medium folium vix mutatae, ad angulis plures magnae, vesiculosae, hyalinae, alas optime notatas triangulares instruentes. Cetera nulla.

HAB. Nullonng, 7000 ft., Burma; Kurz (2863).

This plant was sent to me from Mitten's Herbarium at The N. Y. Botanical Garden, as *Hypnum prionotrichum* Hampe ined. It seems to belong clearly to Clastobryum, but is very distinct from the published species in the oval leaves rather abruptly narrowed to a fine, flexuose, toothed subula, and in the large, vesicular, thin-walled alar cells, ascending in 2–3 series of smaller ones at margin. The microphyllous flagella are also noteworthy; a somewhat allied species from Assam (*C. surculare* Dixon ined.) has similar branchlets, but more shortly pointed leaves and small alar cells.

HOOKERIACEAE

Chaetomitrium setosum Broth. in sched. (PLATE 3, FIG. 13)

Sat robustum, habitu *C. philippinensi* subsimile; dense ramosum ramulosumque; folia *sat distincte seriata, stricta*, 1.5–2 mm. longa, oblongo-ovata, *cochlearia*, infra acumen breve acutum reflexum constricta; costis binis brevibus *bene notatis*, marginibus inflexis, e medio folio *sensim argutius denticulatis, parte superiore saepe spinulose dentatis;* cellulae perangustae, dorso *alte argute papillosae.*

Perichaetii bracteae foliis subsimiles, angustiores, minus concavae, longius acuminatae, fortius spinulose dentatae; seta circa 5 mm. alt. per totam longitudinem fere *dense praealte setosa.* Calyptra basi longe laciniata, ciliis flexuosis, e cellulis *pluriseriatis* compositis. Theca horizontalis.

HAB. Tapah, Perak, 1908; Ridley (169).

A quite distinct species, with somewhat the habit of *C. philippinense* and *C. elongatum*, but with a highly setose, short fruit-stalk. The deeply concave leaves, with the upper part of the inflexed margin often very sharply toothed, also give marked distinguishing characters.

Chaetomitrium perakense Broth. in sched. (PLATE 3, FIG. 12)

C. orthorrhyncho proximum, nec differt nisi caracteribus fructiferis; perichaetii bracteae *haud ciliatae, sed fortiter runcina-*

tae, dentibus plus minusve recurvis; seta *ad basin fere tuberculata*.

HAB. Bidor Tapah, Perak, 1908; Ridley (sine numero).

The inner perichaetial bracts in *C. orthorrhynchum* are longly ciliate-fringed in the upper margin, while here the margin—like the subula—is runcinately toothed; the lower part of the seta is in that species smooth, while here it is warted almost or quite to the perichaetium. I find no difference in the gametophyte.

HYPNACEAE

HYLOCOMIEAE

Ctenidium falcifolium Dixon sp. nov.

Laxe caespitosum, *flavo-aureum, sat robustum*. Caulis repens, ad 3 cm. longus, plusminusve *regulariter, nonnunquam dense pinnatus*, ramis circa .75 cm. longis, apicem versus caulis sensim decrescentes. Folia haud valde conferta, *plerumque falcato-decurva, flexuosa;* caulina e basi anguste oblonga sensim in subulam longam piliformem fortiter argute dentatam, saepe tortam, angustata. Folia ramea similia sed angustiora. Cellulae perangustae, longae, dorso *laeves, per totum folium fere uniformes*, basilares haud laxiores, alares vix ullae, ad angulos extremos tantum 1–2 parvae, hyalinae.

Perichaetium majusculum, foliis internis *longis*, patentibus, *sensim longe subulatis*, argute dentatis. Seta circa 1 cm. alta, *tenuis*, laevis; theca *parva*, 1 mm. longa, inclinata, oblonga, gibbosa, sub ore constricta; ad basin in setam abrupte contracta. Operculum, calyptra, ignota.

HAB. Thaiping Hills, Perak, 1903; Ridley (817).

A little obscure as to position, having some title to be considered a Stereodon rather than a Ctenidium. The general foliation, the coarsely toothed leaves, turgid capsule, &c., however, rather suggest Ctenidium. It is quite distinct from its allies in the falcate, narrow leaves without angular cells, and small capsule, with the exception of *C. stereodontoides* Dixon from South India, which has much the same habit and leaf form and structure. The colour there, however, is green, not golden, the leaves are far less sharply toothed, with more numerous and distinct alar cells.

STEREODONTEAE

Ectropothecium singapurense Dixon sp. nov.

Dioicum. E robustioribus generis, habitu *E. buitenzorgii* et *E. Dixoni* Fleisch. simile; caules elongati, *densissime pinnatim ramosi*, ramis 5–7 mm. longis, crassiusculis, *haud complanatis*. Folia *confertissima*, fortiter falcata vel hamata, *magna*, circa 2 mm. longa, ad basin 1 mm. fere lata, leniter plicata; e basi lata subdeltoidea in acumen subulatum falcatum subintegrum vel tenuiter denticulatum angustata, margine prope apicem plerumque *leniter anguste reflexo;* ecostata. Cellulae pro folii magnitudine *parvae, breviusculae, angustissimae, basin versus paullo latiores*, infimae tantum *hyalinae*, tenues, *alas decurrentes conspicuas*, majusculas instruentes.

Folia ramea minora, angustiora, latius acuminata, magis denticulata; cellulae superiores *dorso tenuissime scaberulae.*

Cetera nulla.

HAB. In grass in open, Botanical Gardens, Singapore, 1913; Binstead (78).

One of a group of closely allied species, differing, however, in quite sufficiently marked characters. *E. Dixoni* Fleisch. has much longer, smooth cells, and more strongly toothed leaves. *E. goliathense* Fleisch. from New Guinea has longer branches and much larger cells. *E. buitenzorgii* differs entirely in the basal areolation.

Hypnum malaccanum C. M. in sched.; Penang, 1896, leg. Curtis, cannot be separated from *Ectropothecium buitenzorgii* (Bél.) Jaeg.

Ectropothecium callichroides (C. M.) Jaeg.

elongatum Dixon var. nov. (PLATE 3, FIG. 15)

Caules *haud dense caespitosi, elongati*, 7 cm. longi vel ultra, *conferte regulariter pinnati*, ramis subaequalibus, 4–5 mm. longis.

HAB. Rawang, Selangor, 1896; Ridley (382). Gunong Raya, Lankawi Islands, 1921; Mohammed Haniff & M. Nur (7134).

E. callichroides was so named from its resemblance to *Hypnum callichroum* (Brid.), and like that usually grows in densely interwoven tufts, the stems being difficult to separate. In this variety the stems are not intertwined, but grow loosely, and are very regularly pectinate with short branches throughout their length.

E. callichroides has not been recorded from the mainland of Asia; its distribution has hitherto been the Philippines and Borneo.

It was described from sterile plants, and the fruit has, so far as I am aware, not been found. Perichaetia are present in the Lankawi Islands specimen; these are large, with long, spreading, rigidly loriform-subulate leaves, denticulate at the tips.

Ectropothecium siamense Dixon sp. nov. (PLATE 3, FIG. 16)

Dioicum videtur. *E. scaberulo* Broth. (*E. incubans* f. *scaberula* Fleisch.) forsan affine; mediocriter robustum; caules regulariter pinnati, ramis circa 5 mm. longis, percomplanatis; sordide viride; folia valde patentia, minuscula, circa .75 mm. longa, *valde complanata, nec curvata;* caulina e basi ovata sensim breviter argute acuminata, ramea ovata, *late breviter acuta;* omnia margine plano, *e basi fere breviter, densissime serrulata;* cellulae *parvae, laeves,* foliis caulinis medianae breviter lineares, marginalibus una serie brevioribus; omnes granulosa ideo subopacae, ad angulos paucae laxiores pellucidae, alas minimas, sat notatas formantes; areolatio foliorum rameorum sat similis sed omnes cellulae breviores, apicales *latiores, ovato-rhomboideae.* Cetera ignota.

HAB. Khan Poi Hill Kasum, Siam, 1898; Mohammed Haniff & M. Nur (3919).

There is a close resemblance between this plant and *E. scaberulum* Broth., which Fleischer considers a form of *E. incubans* (Reinw. & Hornsch.). This is enhanced by the cell ends appearing punctate under the microscope, as if projecting; they are however entirely smooth; the shortly pointed branch leaves, the rather opaque, short cells, and especially the very regularly and closely serrulated margins distinguish it from all the species I know except an unpublished species I have in my herbarium from New South Wales.

It was growing closely associated with fruiting *Taxithelium nepalense.*

Ectropothecium Moritzii (C. M.) Jaeg.

stereodontoides Dixon nov. var.

Pernitidum, albescens; folia ramea caulinis similia, *angusta, valde falcata, sensim subulata,* cellulis pellucidioribus.

HAB. Fraser Hill, Pahang, 4000–4370 ft. alt.; Burkill & Holttum (8715d). Also, same locality, on log in jungle, at 4000 ft.; Holttum (11375).

E. Moritzii is said by Fleischer to be a rare species in Java, and I have no Javan specimens in my herbarium. It is however a common plant in Borneo, and on the Malay Peninsula, and I have numerous specimens from both of these parts. While easily recognized they show a considerable amount of variation in the leaf form and direction, as well as in the degree of glossiness. One form especially has the branch leaves very different from those of the typical plant as figured in the Bry. Jav. (though it is referred to by the authors in their diagnosis—"ramulina similia vel oblonga, brevius acuminata"), being almost straight, and complanate, scarcely or not at all falcate or decurved, widely spreading, very shortly and sometimes quite widely pointed; in this case they are usually brown, scarcely at all glossy, with shorter, opaque cells and the marginal row especially short and markedly differentiated. The plant is in this case very markedly different from the type (so much so that an extreme form of it (Singapore, Ridley, No. 203) has been named *Chaetomitrium Ridleyi* Broth, MS. in sched. !); as a rule however some branches show the more normal form of leaf, and—together with the fruiting characters—establish identity with *E. Moritzii.*

E. Moritzii is described in the Bry. Jav. as "nitidula," by Fleischer as "wenig glanzend." This description is applicable to the usual forms, though here and there a plant, or part of a plant, shows a decided gloss. In the present variety the branch leaves are exceedingly glossy, and in their extreme form of a pale or quite white colour; they are much narrower than usual, and strongly decurved-falcate, with fine, subulate or almost filiform points; the areolation is much more pellucid, of longer cells, with the marginal cells not or scarcely differentiated. The first specimen I received of the variety showed only a few sterile scraps mixed with Trichosteleum, &c., and showed no resemblance whatever to *E. Moritzii;* it was in fact, to all intents and purposes a Stereodon, but it showed such an almost absolute resemblance to a South Indian species of Ctenidium recently described by me as *C. stereodontoides* that I gave it the MS. name of *Ctenidium substereodontoides;* and I had indeed actually drawn up a description of it for this article under that name, when a further consignment of mosses from Fraser Hill threw a quite unexpected light upon it. A large tuft of more or less typical *E. Moritzii* showed here and there a branch entirely identical with the new species, and I was able to find here and there a stem having some or most of the branches bearing the short, shortly pointed, complanate, brown leaves, other branches being typical, but here and there a single branch with all the "stereodontoid" characters of the present var. clearly marked (one had in fact on a single stem, *Ectropothecium Moritzii, Chaetomitrium Ridleyi*, and *Ctenidium substereodontoides*!). Further examination showed some stems with all the branches exhibiting the varietal characters, and one or two of them were fruiting. Others in the same tuft were nearly typical, and some quite so: and it is difficult therefore to draw a clear line between the variety and the type; but the extreme form being so marked and so deceptive, it seems desirable to characterize it and perhaps avoid future pitfalls by separating it as a variety.

PLAGIOTHECIACEAE

Taxithelium instratum (Brid.) Broth.

Kurzii Dixon. nov. var. (Hypnum microcladum Hampe MS. in herb. *Trichosteleum Kurzii* Sanesb.; Jaeg. Adumbr. II, 480 *nomen*).

A forma typica cellulis *minus dense, magis irregulariter papillosis* solum differt.

HAB. Yomah, Pegu; Kurz (2922).

This plant was distributed as *Hypnum microcladum* Hampe MS. (or sometimes, erroneously as it seems, as *H. microcladum* C. M. MS.). It must not be confused with *H. microcladum* Tayl. & *H. microcladum* Doz. & Molk., both of which belong to Rhaphidostegium.

It is scarcely to be distinguished from *Tax. instratum*, only the leaves are less densely, less regularly papillose.

Taxithelium isocladioides Dixon sp. nov. (PLATE 4, FIG. 1)

T. isoclado (Bry. Jav.) affine atque simile, differt foliis *angustioribus, perfecte lanceolatis* nec ovato-lanceolatis, *longius argutius acuminatis*, sat *fortiter denticulatis*, cellulis majoribus, *tenerrime, saepius indistincte* seriatim papillosis. Cetera ut in *T. isoclado*.

HAB. Bujong Malacca, Perak, 1898; Ridley (737) in herb. Mitten.

With the habit and fruiting characters of *T. isocladum* (so far as seen) this differs quite markedly in the much narrower and more narrowly acuminate leaves, the sharply denticulate margin, and the larger, pellucid cells, only very minutely and usually quite indistinctly papillose. In fact it might easily be mistaken for an Isopterygium.

Taxithelium trachaelophyllum (C. M. in sched.) Dixon sp. nov. (PLATE 3, FIG. 17)

T. Gottscheano Hampe forsan proximum; differt foliis rameis *percomplanatis, perfecte rotundato-obtusis*, rarissime latissime subacutis; cellulis *indistincte, minutissime, humillime papillosis*, alaribus *majoribus*, elongatis, incrassatis, saepe aurantiacis.

Fructum haud vidi.

HAB. Yonah, Burma; Kurz (3332).

This was determined as *Hypnum trachaelophyllum* C. M., but has not been published. It is nearest to *T. Gottscheanum* Hampe and *T. capillipes*, both of which differ in the more pointed leaves, and the smaller and less distinct alar cells, while *T. Gottscheanum* also has the cells quite distinctly seriate-papillate; in the present plant the papillae while present and seriate, 3–4 on a cell face, are extremely low and often quite indistinct and with difficulty seen.

Taxithelium subtrachaelophyllum Dixon sp. nov. (PLATE 3, FIG. 18)

T. trachaelophyllo (v. supra) affine; foliis autem *angustioribus, apice minus rotundatis*, cellulis *duplo majoribus*, parietibus *firmioribus* (eis *T. trachaelophylli* pertenuibus), alaribus *minoribus*, paucioribus; papillae perindistinctae, tenerrimae, 2–4 seriatae.

Bracteae perichaetii in acumen subrectum *rigide late loriforme* nec subulatum, subdenticulatum angustatae. Seta circa

2 mm. alta. Theca parva, elliptica, collo in setam defluente, *erecta vel suberecta.*

HAB. Borneo, Motley. Krangi, Singapore, 1895; Ridley (695). Suli Archipelago, 1898; Burbidge. Bukit Timah, Singapore, 1896; Ridley (692, 693).

This is intermediate between *T. trachaelophyllum* and *T. sumatranum;* it differs from the former in the characters detailed above, especially in the quite different cells; *T. sumatranum* has more acute, pointed leaves, and the papillae almost wanting; the inner perichaetial bracts also are much more finely subulate and flexuose.

The papillae vary greatly, being at times wanting, at others very faint and scarcely to be detected except with great care, and at others quite well marked; they vary from 1–2 on each cell surface to 3–4.

Taxithelium bilobatum Dixon sp. nov. (PLATE 4, FIG. 2)

Subgen. Anastigma. Species praeclara. Habitus *T. instraii,* caulibus ramisque *valde complanatis,* substrato arcte adpressis; (vetustate) fuscis. Folia octofaria, *heteromorpha;* ea serierum quattuor ventralium et dorsalium late oblonga, apice *rotundato,* obtuso, concava, ecostata, marginibus fere e basi *arcte denticulatis,* apice denticulis confertissimis irregularibus saepe recurvis quasi erosa. Cellulae breviter sinuoso-lineares, laeves, serie marginali *breviores, pellucidiores;* basilares infimae breviores, latiores, alares *nullae.*

Folia serierum quattuor lateralium majora, *perconcava, seu lobis duobus conduplicata, quorum uno minore breviore, altero majore longiore; a sinu plus minus profunde sejunctis; areolatio* et marginum denticulato ut in foliis dorsalibus et ventralibus.

Perichaetium *breve, turgidiusculum,* bracteis e basi latiore *breviter late* acuminatis, nec multo attenuatis, irregulariter dentatis, erecto-patentibus. Seta 2 cm. vel paullo ultra; theca (immatura) parva, brevis, basi in setam defluens; inclinata, operculo rostellato.

HAB. Bujong Malacca, Perak; Ridley (739), in herb. Mitten.

A very remarkable species, with the lateral leaves more distinctly bi-lobed than in any other moss that I know. It is most nearly allied to *T. glossoides* (Bry. jav.), and the dorsal and ventral, undivided leaves are very similar to those of that species, but the lateral leaves are entirely different.

SEMATOPHYLLACEAE

Acanthocladium polymorphum Dixon sp. nov. (PLATE 4, FIG. 3)

A. surculari Mitt. affine, statura autem robustiore. Stirps habitu, ramificatione, foliorum forma et structura valde polymorpha; caules 5 cm. longi vel ultra, nunc flexuosi, irregulariter brevissime pinnatim ramosi, nunc dense pinnati ramis strictis, .75–fere 1 cm. longis, obtusis vel breviter attenuatis *nunquam flagelliformibus*. Folia caulina eis *A. surcularis* simillima, e basi *latissime, oblongo-ovata in pilum subaequilongum flexuosum integerrimum* subito contracta, ecostata; areolatio perdensa, e cellulis angustis lineari-flexuosis laevibus, parietibus tenuibus, basin versus sensim paullo majoribus, latioribus instructa; alaribus 3–4 *magnis, elongatis, vesiculosis*, pulchre aurantiacis, supra-alaribus nonnullis multo minoribus, hyalinis vel aurantiacis.

Folia ramea *polymorpha*, nunc anguste ovato-lanceolata, longe tenuiter subfiliformiter acuminata, integra vel subintegra, nunc breviter late acuminata marginibus ad apicem reflexis, denticulatis, nunc late ovata, breviter late acuminata vel tantum acuta, marginibus ad acumen valde recurvis, argute, fortiter dentatis. Areolatio *diversa*, foliorum angustiorum e cellulis elongatis, linearibus vel anguste rhomboideo-linearibus, latiorum e cellulis brevioribus, latioribus, ovoideo-rhomboideis, instructa; cellulae aut omnino laeves, aut hic illic unipapillosae, aut, praecipue eae foliorum latiorum, unaquaque papilla magna alta medio lumine praedita.

Dioicum. Perichaetium *polyphyllum*, foliis erectis, sensim in subulam strictiusculam subintegram vel denticulatam angustatis. Seta (unica imperfecta) crassiuscula.

HAB. N. W. slopes of Mt. Mooleyit, near Moulmein, Tenasserim. Comm. W. R. Sherrin.

A remarkably polymorphous plant, as described above, the leaves of the branches being of such diverse form and structure, as to make it very difficult to believe that they all belong to one species, the margins being plane or strongly recurved above, entire or strongly, coarsely toothed, the cells sometimes narrowly linear and ten or more times as long as wide, at others ovate-rhomboid and not more than three or four times as long as wide; I have seen branches with all the cells quite smooth, others with all the leaves highly and densely papillose, and others in which they are all smooth but a few here and there slightly papillose. It is a very perplexing, but a quite distinct species. *A. surculare* Mitt. has the branch leaves scarcely toothed and smooth, and most of the branches attenuated to a caudiform apex.

Trichosteleum brachypelma (C. M.)

compactum Dixon var. nov.

Caespites humiles, *densissimae;* folia complanata, strictiuscula; folia ramea atque perichaetialia *brevius acuminata.*

HAB. Garden jungle, Singapore, 1894; Ridley (321).

Trichosteleum brachypelma appears to be a rather widely distributed plant; sometimes scarcely differing from *T. Boschii* except in the smooth seta; but often with more gradually tapering leaves and less papillose cells. These characters are evident here, but in addition the tufts are extremely compact, the leaves complanate and less flexuose, often very shortly and even widely pointed.

Trichosteleum albifolium Dixon sp. nov. (PLATE 4, FIG. 4)

Inter *Taxithelium papillatum* intertextum, dense compactum, habitu *Tr. singapurensis*, &c.; *albidum, pernitidum;* caules irregulariter ramosi, ramis inaequalibus, *percomplanatis, strictis;* folia rigide complanata, e basi subamplexicauli, contracta, patentia, ovato-lanceolata, *breviter anguste acuminata*, integra; folia ramea minora, angustiora, brevius latius acutata, apice subdenticulato; omnia ecostata; cellulae anguste lineares, parietibus *angustis, indistinctibus; omnino laeves;* alaribus 2–3 magnis, hyalinis, vesiculosis.

Perichaetium magnum, polyphyllum, foliis suberectis, *sensim in subulam rectam haud flexuosam* denticulatam angustatis. Cetera nulla.

HAB. On fallen tree in forest, seventh mile from Kluang, Mersing, Johore, 1922; Holttum (9296b).

Quite distinct in the very white, glistening, shortly pointed leaves, and quite smooth cells, though otherwise in habit and leaf form resembling several other species, e. g., *T. singapurense* Fleisch. It grew closely mixed up with a form of *Taxithelium papillatum* in fruit, but none of the fruit appears to belong to the *Trichosteleum*. *T. singapurense* has besides the papillae much longer leaf points. The leaf form and alar cells show it not to be an Isopterygium. Unfortunately the quantity is very small.

ACROPORIUM Mitt.

The genus as understood here includes the species of Sematophyllum as employed by Brotherus, with the exception of a small group of autoicous species of the Section Chaetomitriella, which appear to me better placed in Trichosteleum. American writers usually retain the arrangement of the Musci Austro-americani, i. e., they include under Sematophyllum all the species of Acroporium and also those separated by most recent authors (Jaeger, Brotherus, etc.) as Rhaphidostegium. Fleischer, on the other hand, in his recent work distributes the Javan species of the aggregate genus over ten different genera. I must confess that on the whole I prefer—with a few slight exceptions—the middle course kept by Brotherus, especially as concerns the keeping apart Rhaphidostegium and Sematophyllum. United they form a very unwieldy genus, at least 400 species having been described in the two Sections; while Rhaphidostegium, if not easy to separate by well defined structural characters, is so distinct in habit that so far as I know there has never been any doubt as to the position of any species of the whole 400 or so as to the group in which it should be placed, with the possible exception of two—*R. saproxylophilum* (C. M.) being placed among species of Acroporium in the Bry. Javanica, and *R. Schwaneckeanum* (C. M.) having been placed—for some obscure reason—in Pungentella (i. e., Acroporium) by C. Mueller himself in Hedwigia, 1898.

As regards the name, I think it is clear that Fleischer is correct in restoring Mitten's name Acroporium, in the place of Sematophyllum, the name retained by Jaeger, Paris, and Brotherus.

The genus Acroporium was validly published by Mitten in his List of Samoan Mosses in Journ. Linn. Soc., Bot., x, 182 (1868), and the diagnosis makes it clear that it is used in the restricted sense, not including the species often placed in Rhaphidostegium, and already separated from Hypnum (or Stereodon) by Mitten in 1864.

Sematophyllum Mitt. was validly published in Journ. Linn. Soc., viii, 5 (1864), for *S. auricomum* sp. nov., which is found identical with *Hypnum substrumulosum* Hampe; and this must be considered the type of the genus. Neither in that paper nor till 1869 did Mitten unite the two groups.

Sematophyllum Mitt. does not date from the Musci Austro-americani, Journ. Linn. Soc., Bot., xii, 20 (1869), as stated by Paris, nor, as it is given by Jaeger, from 1868. Jaeger wisely attempts no closer reference than "Journ. Linn. Soc. 1868," relying, no doubt, on Mitten's note on p. 474 of the M. Austr.-amer., "Sematophyllum, Mitt. in Journ. Linn. Soc., 1868." This, however, is a false reference. The only paper of that year that could be referred to is Mitten's List of Samoan Mosses, in Journ. Linn. Soc., Bot., x (1868) where Mitten founded his genus nov. Acroporium, but where Sematophyllum is not even mentioned. Mitten wrote 1868 either by error for 1864, or, wishing to widen his genus Sematophyllum (to include the species of Acroporium), he referred to the 1868 paper, but should have cited Acroporium, instead of implying that Sematophyllum was there used.

Clearly therefore Acroporium is the correct name to be used for the present group of species by those who keep the two groups separate; while Sematophyllum is the earliest name for the species of Rhaphidostegium (Schimp.) De Not. For those who still unite them the correct name would be Sematophyllum Mitt. (1864) emend. Mitt. 1869.

Fleischer has found that several of the names used in the Bry. Jav., and subsequently employed by authors under Sematophyllum are antedated by earlier valid names, especially of Reinwardt and Hornsch., and these of course must be restored. It may save trouble if I give here these equivalents for the more familiar specific names.

Bry. Jav.	Fleischer
Hypnum scabrellum Lac.	*Acroporium lamprophyllum* (*Mitt.*)
H. gracilicaule Lac.	*A. diminuium* (Brid.)
H. Braunii C. M.	*A. rufum* (Reinw. & Hornsch.)
H. strepsiphyllum Mont.	*A. secundum* (Reinw. & Hornsch.)
H. hyalinum Reinw.	*A. stramineum* (Reinw. & Hornsch.)

The exceedingly interesting genus Acroporium has its centre in the Indo-Malayan region. Of 75 species included by Brotherus in the "Musci," 42 occur in this region (including New Guinea), and are indeed confined to it; as compared with 13 in Africa, 12 in Oceania, and 8 in America. Since the publication of that work at least a dozen new species have been described in the area; the present paper describes 11 additional ones, and I have two or three further undescribed ones from Borneo, in my herbarium. Probably 60%, therefore, of the species belong to this region, very few of them, or indeed of any species of the genus having at all a wide range.

Acroporium serrulatum Dixon sp. nov. (PLATE 4, FIG. 5)

A. cuculligero (Bry. Jav.) proximum; minus; rami breviores, nec attenuati, nec gemmipari; foliis paullo latioribus, e basi fere *conferte serrulatis;* areolatio *pellucida*, nunc laevis, nunc dorso sparse papillosa, e cellulis *multo brevioribus minoribus*, parietibus *incrassatis;* bracteae perichaetii suberectae, sensim in subulam haud flexuosam, *densissime, argute serrulatam, fere spinulosam*, angustatae.

Seta plusminusve 1 cm., *crassiuscula*, superne *humillime* ruguloso-papillosa; theca paullo *major*, inclinata vel horizontalis, operculo rostello *longiore*, deflexo.

HAB. Penang Hill, Pulau Penang, 1898; Ridley (750). Ibidem, 1896 (547).

This very pretty little plant is very close to *A. cuculligerum*, and would be placed by Fleischer in his new genus Clastobryella. It differs however quite markedly from that species in several respects. The cells in *A. cuculligerum* are thin-walled, but owing to the cell contents are not translucent, and the leaves always have a rather opaque appearance. Here the cells are much smaller, and thick-walled (the lumen being only about the width of the adjoining wall) especially at the cell ends; but both wall and cell being translucent the leaf is quite pellucid. The alar cells are pale, two or three on each side, and not occupying a large proportion of the width of the base.

The margin in *A. cuculligerum* is acutely, but distantly denticulate; here the serrations are much closer, gradually increasing in size and acuteness almost from the leaf-base. The seta is stouter, and shorter than it often, at least, is in *A. cucul-*

ligerum, though it may there also be only 1 cm. long. The principal difference, however, lies in the perichaetial leaves; in *A. cuculligerum* they are slightly denticulate only; here the whole acumen is densely fringed with long, almost ciliolate teeth. The seta, as in *A. cuculligerum*, is set, in the upper part with flat, sub-discoid thickenings, such as are found here and there in various genera, e. g., in several species of Meiothecium; it would seem desirable to have a suitable term for these; and I suggest tentatively the terms platypapillae, platypapillose.

Acroporium leucophyllum Dixon sp. nov. (PLATE 4, FIG. 6)

Sat robustum, *peralbidum;* caulis longe repens, irregulariter pinnatus, ramis nunc brevioribus, subobtusis, plerumque *elongatis, rigidiusculis, valde attenuatis, ad 3 cm. longis, caudiformibus.* Caulium et rami cortex *nigricans*, inter folia albida valde conspicuus.

Folia saepe spiraliter seriatim disposita, erecta, erecto-patentia vel saepe rigide divergentia, lanceolata, *ab insertione fere* paullo angustiore *sensim angustata*, valde concava et *profunde carinata*, longiuscule *stricte* anguste acuminata, marginibus infra subrecurvis, *ad basin acuminis explanatis, acumine ipso argute denticulato fortiter late recurvis*, unde acumen *dorsaliter subconvolutum.* Folia apicem versus ramorum sensim magis magisque minora, angustiora.

Cellulae peranguste lineares, parietibus tenuibus, dorso apicibus valde prominentibus *hispide papillosae*, infra vix mutatae sed laeves, inferne aurantiacae, alares circa trinae vesiculosae, *intense purpureae, opacae.* Cetera ignota.

HAB. On wood, Gunong Tahan, Pahang, July 1911; Ridley (1032).

A very distinct and striking species, both in habit and the white colour, and in the structure of the leaves. *A. asperifolium* (Thw. & Mitt.) is perhaps the nearest, but is greener in colour, and the leaves, much less papillose at back, are very longly and gradually tapering and of quite different form. *A. ruficaule* is quite different in size, habit and colour.

The form of the acumen is rather remarkable; as in many species with concave leaves (Trichosteleum, Chaetomitrium, &c.) the base of the acumen is flattened out at the margins, with the centre hollowed out and subcucullate; but higher up in the acumen the margins become widely revolute, so as almost or quite to meet *at the back*, rendering the *back* of the acumen subtubular, a very unusual feature.

The long, attenuated branches would appear to be pendulous.

The rather small, deep purple auricles contrast very strongly and prettily with the narrow, pale, lamina cells.

The spiral arrangement of the leaves comes out rather strikingly when dry, in more than one way. On some branches the leaves are rigidly divergent and little altered when dry, in which case they give the appearance of a spiral herring-bone arrangement. At other times the leaves of each spiral become accumbent on one another, and the resulting strand is twisted spirally round the branch, in a funicular manner, not, however, crowded as in *Grimmia funalis* and many species of Macromitrium, but distantly, so that the black cortex of the branch shows distinctly and prettily in contrast with the white leaves. (I have tried to depict one of these branches on Pl. II. fig. 6b). Frequently, on the other hand, the spiral arrangement is not at all manifest.

Acroporium obscurum (Broth.) Dixon sp. nov. (*Sematophyllum obscurum* Broth. MS. in sched.) (PLATE 4, FIG. 7)

Dioicum. Sordide viride. Habitus et folia fere *A. rufi* formarum robustiorum, ramis saepe elongatis, flexuosis. Folia rigide patentia, saepe homomalla, superiora plerumque *leniter falcato-secunda*, lanceolato-subulata, e basi fere convoluta, apice tubulosa, stricta *acuta sed haud valde attenuata*, integra, superne dorso plerumque (praecipue superiora) *rugosa-papillosa*. Cellulae parietibus *valde incrassatis*, porosis, obscurae.

Flores ♂ numerosi, majusculi, caulini. Perichaetium majusculum, bracteis *angustis*, internis erectis, *sensim in subulam piliformem, flexuosam, quam laminam saepe multo longiorem, grosse dentatam*, attenuatis, 3 mm. fere longis. Seta *usque ad 3 cm. alta, laevis*. Theca immatura solum visa.

HAB. Lohore, Aug. 1908; Ridley (sine numero); det. Brotherus. Penang Hill, Pulau Penang, 1896; Ridley (538) in herb. Mitten; det. H. N. D. Oto Jungle, Upper Sarawak, Borneo; Ridley (sine numero) in herb. Mitten; det. H. N. D.

The foliation is very much that of robust *A. rufum* or the smallest forms of *A. secundum*, but the fruiting characters are quite different; the long, quite smooth seta separates it from the former, and the long perichaetial leaves with long, flexuose, strongly toothed piliform points often as long as or considerably longer than the expanded part, from all forms of *A. secundum*. The perichaetial bracts vary a good deal, however, and are sometimes much less longly piliform, and less coarsely toothed; but are still quite different from those of *A. secundum*. The perichaetium figured is one of the more shortly pointed forms.

The subula of the leaf, as in many of the allied species varies much in degree and character of papillosity; it may be quite smooth or lowly undulate-rugulose, or highly and acutely papillose. The cells are rendered rather obscure by the cell contents.

Acroporium rigens (Broth.)

dicranolomoides (Broth.) Dixon. var. nov. (PLATE 4, FIG. 10)

Sematophyllum dicranolomoides Broth. n. sp. in sched.

Folia laxiora quam in planta typica, valde patentia, minus stricta. Habitu formarum minorum specierum nonnullarum Dicranolomatis, e. g., *D. brevisetum*, *D. reflexifolium*. Sporogonium ei plantae typicae simile.

HAB. Gunong Berumban, Pahang, 1908; Ridley (131).

The more loosely set leaves, divaricate, sometimes at right angles to the stem, give this a quite different appearance to that of the densely and rigidly foliate type form, but there are no other differences in either the leaves or the fruit.

Eucamptodon Wrayi Broth. in sched. in Herb. Kew., "summit of Gunong Batu Putih, Perak, L. Wray Jr., No. 394. Herb. Mus. Perak," is the same thing. The resemblance to some of the Dicranaceous genera, e. g., Braunfelsia (Eucamptodon auct.) is quite striking, particularly of course in sterile specimens.

Acroporium denticulatum Dixon sp. nov. (PLATE 4, FIG. 8)

Dioicum videtur. Inter alios muscos intertextum, *nitidissimum, albidum, A. hamulato* Fleisch. forsan affine sed *minus, brevius*, atque colore omnino alienum. Folia circa 1.5 mm. longa, eis *A. monoico*, &c., simillima, sed apice *paullo angustiore, saepe obliquo vel leniter falcato; marginibus per totum ambitum fere minute, distanter denticulatis*. Folia ramea angustiora, longius cuspidata. Cellulae parietibus *incrassatis* valde porosis, circa dimidiam latitudinem luminis aequantibus; superne dorso saepius *rugulosae*, vel humiliter papillosae.

Cetera nulla.

HAB. Fraser Hill, Pahang, alt. 4000–4370 ft., 1922; Burkill & Holttum (8715a).

Growing densely interwoven with close masses of *A. secundum* var. *angustifolium* Fleisch., *Trichosteleum hamatum* and *T. Boschii*, so that it is very difficult to separate it or to judge of the actual habit of growth. It is however very distinct from all the allied species in the glistening white colour, and the denticulate margins. The toothing being very delicate and the margins usually strongly incurved, this may easily be overlooked, but on careful examination it will be seen to be almost constantly present, and frequently at the leaf apex very pronounced. The rugosity of the leaves also is unusual in the wider leaved species.

The cuspidate leaf-points are usually straight, but quite frequently hooked slightly, as in *A. hamulatum*.

Acroporium aciphyllum Dixon sp. nov. (PLATE 4, FIG. 9).

E majoribus generis, habitu *A. falcifolii* Fleisch. sed *multo robustius*, caespites altos, extensos, laxiusculos formans; caules 8 cm. longi vel supra, parce ramosi, apice *brevicuspidati, falcati*. Folia magna, 3–4 mm. longa, valde *falcato-secundo; e basi late ovato-oblonga parum concava sat cito in subulam subaequilongam inferne convolutam superne piliformem substrictam* contracta; integerrima, dorso laevia. Cellulae *perincrassatae*, parietibus porosis quam lumine multo latioribus, unde pori *valde conspicui, elongati*, parent; alares magnae, vesiculosae, sat *angustae, elongatae*.

Dioicum videtur. Flores feminei solum visi, apices versus ramorum siti; perichaetii bracteae *erectae, arcte adpressae*, e basi *late convoluta* superne denticulata in subulam *piliformem rectam argute denticulatam* contractae. Seta circa 2 cm. alta, inferne laevis, apice leniter rugulosa. Theca pendula, angusta.

HAB. Gunong Tahan, Pahang, 1911; Ridley (1017, 1029). Ibidem (1037), f. foliis patentibus, haud falcatis.

This fine species differs from all the known Malaysian species with broad leaf bases at once in the long, fine, often piliform subula. *A. sigmatodontium* is perhaps the nearest species, but has leaves much narrower below, less finely acuminate, with very different perichaetial leaves.

No. 1037 has the leaves quite straight, and may possibly be the type form, but only a stem or two were seen of this, while the falcate-leaved plant is present in considerable quantity, and must be presumed to be the prevailing form.

A. piliferum Broth. from the Philippines has much wider leaves, more rapidly, often quite abruptly piliferous.

Acroporium longicuspis (Broth.) Dixon sp. nov. (PLATE 4, FIG. 12)

Sematophyllum longicuspis Broth. MS. in sched.

Habitu staturaque *S. secundi* var. *angustifolii* Fleisch., sed folia parum secunda, undique patentia. Folia *breviuscula*, circa 2 mm. longa, e basi subconvoluta *ovato-lanceolata, stricte subulato-tubulosa*, integerrima; cellulae majusculae, *valde incrassatae*, lumine parietem porosam latitudine subaequante, dorso plerumque mamillose *undulato-rugosae*, saepius quoque *papilla unica media alta grosse scabrae*.

Dioicum videtur. Perichaetium sat parvum, bracteis erectis e basi late ovata in acumen subpiliforme vel loriforme *subaequilongum argute denticulatum* angustatis. Seta 1.5 cm., laevis vel apice paullo rugulosa. Theca parva, *pendula*.

HAB. Taiping, Perak, 1909; Ridley (200). Fraser Hill, Pahang, 4000–4370 ft., 1922; Burkill & Holttum (8711). Bukit Hitam, Selangor, 1896; Ridley (391).

Somewhat resembling the narrow-leaved forms of *A. secundum* this species differs in the short leaves not twisted and rarely secund; in the more incrassate cells, and especially in their papillosity. They are frequently markedly rugulose at back above, as in several species, but in addition to this in most leaves all the upper cells bear a high single median papilla so that the leaf is strongly scabrous. Curiously, however, among the normally papillose leaves there are frequently found branches with slightly longer and narrower leaves which are entirely or almost entirely smooth; a very marked example of dimorphism. A certain degree of rugulosity is frequent in the narrow-leaved species of Acroporium, and a few species have occasionally at least a distinct central papilla on the cell lumen—though this is rare—but I know of no species where it is so marked and so highly developed as here; in fact the leaf may be said to have the form of Acroporium with the papillae of Trichosteleum, e. g., *T. Boschii*.

The seta also is shorter than in *A. secundum*, and the perichaetial leaves, though similar, are not identical, having a straighter and longer, more gradually tapering subula.

The leaves in this genus, at least in the Section Eu-acroporium, fall into two groups as regards outline. In most of the larger species the general outline is oval, with a more or less cuspidate, semi-convolute tip, which however bears a very small proportion in length to that of the whole leaf. In the other group, mostly of the smaller species, but including *A. secundum* of the larger ones, the outline of the leaf is narrow throughout, and the leaves frequently taper almost from the base, often being more or less convolute throughout, or at any rate tubular and subulate for a great proportion of their length. The present plant, with *A. falcifolium* Fleisch. and *A. aciphyllum* described above, holds a somewhat intermediate position, the two latter, however, belonging rather to the first group, while the present plant is clearly of the second.

The Pahang and Selangor plants were named and distributed as *Sematophyllum perpapillosum* Dixon sp. nov. before I saw Brotherus' species.

Acroporium albidissimum Dixon sp. nov. (PLATE 4, FIG. 13)

A. longicuspidi Broth. ante descripto affine; differt colore *pulchre albido, nitido*, foliis *multo brevioribus*, latioribus, oblongis, breviter, stricte, *subobtuse, tubuloso-acuminatis; areolatio et papillae similes;* rami quoque nonnulli dimorphi foliis multo angustioribus, subcylindricis, laevibus vel sublaevibus inveniuntur.

Planta sterilis solum nota.

HAB. Among *Rhizogonium spiniforme*, Gunong Tahan, Pahang, 1911; Ridley (1023b).

The highly papillose cells are identical in this and the last species, and apart from any possible fruiting characters the difference lies entirely in the white colour, and the much broader and shortly pointed leaves. The dimorphism of the branches is quite as clearly marked here.

Acroporium Ridleyi Dixon sp. nov. (PLATE 4, FIG. 14)

Sat robustum, *albescens*, *nitidum;* caules *elongati*, ad 6 cm. longi, *complanati*, ad 4 mm. lati; *parce ramosi.* Folia plusminusve complanata, valde divergentia, saepe horizontaliter explanata, 2 mm. longa vel paullo ultra, *obovato-oblonga*, perconcava, *apice acuto*, *subconvoluta*, integerrima; areolatio *specierum duarum praecedentium*, cellulis alaribus *permagnis*, pulcherrime aurantiacis.

Cetera nulla.

HAB. Gunong Tahan, Pahang, 1911; Ridley (1039).

A very distinct species in the colour, habit, papillose cells and leaf form.

These three species, *A. longicuspis*, *A. albidissimum*, and *A. Ridleyi*, form a new and very distinct group of Acroporium, having the general leaf form of Eu-acroporium, but in the highly papillose cells coming near to Trichosteleum. The alar cells, however, are quite distinctive of Acroporium. The cell structure is identical in all three (except that in the present species I have found no dimorphic branches), and is very marked, not only in the dorsal papillae and rugulosity, but also in the uniform, highly incrassate cells. The colour of the present plant is whitish, but scarcely so marked as in the last; the leaves are quite different in form from both species, and are almost identical in outline with those of *A. monoicum* and *A. hermaphroditum*.

Acroporium complanatum Dixon sp. nov. (PLATE 4, FIG. 15)

Hypno pycnophyllo C. M. (Sematophyllum Jaeg.) affine; differt ramis *complanatis*, foliis bifarie divaricatis, subula *multo latiore*, breviore, robustiore *late loriformi*, *obtusiuscula*, *rigida*, superne *dense*, *argute* serrulata. Cellulae laeves vel humiliter papillosae. Perichaetium parvum, ut in *A. pycnophyllum*, sed foliorum subula, tanquam foliis caulinis, *latiore*, *breviore*, *loriformi*. Seta .75–1 cm. longa, infra laevis, apice grosse nec alte papillosa, theca parva, horizontalis, castanea. Peristomium saturate rubrum, dentes lati, approximati, dorso fortiter dense transverse striolati, linea media irregulari, *haud sulcati*.

HAB. Base of Gunong Ledang, Malacca, 1892; Ridley (236).

Clearly allied to *Hypnum pycnophyllum* C. M., but differs at once in the leaves widely spreading almost at right angles to the branch, in one plane, so that the branches are flattened (the leaves themselves, however, not lying in that plane); and in the coarse, rigid, wide subula, instead of the long, piliform flexuose one of *H. pycnophyllum.*

That species has usually been placed in Sematophyllum (Acroporium), but is transferred to Warburgiella by Fleischer, with one or two species of somewhat near alliance. This has necessitated the widening of the generic character, especially in regard to the calyptra, which as the genus is defined by C. Mueller is campanulate or mitriform, not cucullate. The genus as enlarged appears to me rather ill-defined, and I should be inclined to keep it restricted as by C. Mueller.

Hypnum pycnophyllum is placed by Brotherus with about a dozen species more or less allied, under the Section Chaetomitriella (C. M.). Some of these certainly, as *S. palanense* (Hampe) and *S. bistrumosum* (C. M.), and others less clearly, appear to me better placed in Trichosteleum than in Acroporium. The small group to which *H. pycnophyllum,* the present and following two species belong, is however perhaps best kept in Acroporium.

Acroporium malayanum Dixon sp. nov. (PLATE 4, FIG. 16)

A. pycnophyllo (C. M.) and *A. cuspidatifolio* (Fleisch.) affine; ab illo cellulis *multo latioribus,* 6–8 μ latis, *opacioribus, incrassatis,* dorso superne *plus minus spiculosis,* foliis *angustioribus, minus cito, brevius, minus flexuose,* subulatis, ramisque *obtusis* differt; ab hoc ramis plus minus complanatis, cellulis *opacioribus,* marginalibus *haud diversis,* apice *prominente,* spiculoso, *sine papillis medianis.*

Dioicum. Planta mascula solum visa.

HAB. Botanical Gardens, Penang, 1915; Binstead (57).

Very near to *A. pycnophyllum,* but that species has more concave, wider leaves, less spreading, more abruptly contracted into a long, flexuose piliform arista, the cells there are much narrower, thin-walled, pellucid, and smooth at back. The cells here are decidedly incrassate, much wider, and opaque with the cell contents.

Warburgiella cuspidatifolia Fleisch., of which I have seen no specimen, has leaves, from the description, of a similar form, but the marginal cells are there shorter and differentiated from the inner, and the upper cells have a strong papilla in the middle of the lumen; in the present species it is the apices of the cells alone that are prominent and spiculose.

Acroporium surculare Dixon sp. nov. (PLATE 2, FIG. 11)

Caulis *longe prostratus*, sat robustus, irregulariter, subpinnatim ramosus, ramis erectis, vel patentibus, saepe subfasciculatis, complanatis, subnitidis, sordide viridibus, 2–3 mm. latis, foliorum axillis *surculos microphyllos capillares numerosos 1–3 cm. longos* emittentibus. Folia 2 mm. longa, *perconcava*, e basi contracta late oblongo-ovata, marginibus incurvatis, apice *subcucullata, raptim in acumen breviusculum latiusculum acutum denticulatum* contracta. Cellulae angustissime lineares, *laeves*, parietibus sat tenuibus, indistinctis, inferiores paullo laxiores, infimae *aurantiacae*, alares plures vesiculosae magnae.

Cetera nulla.

HAB. On twigs, Bidor Road, Tapah, Perak, 1908; Ridley (153). Penang Hill, Pulau Penang, 1896; Ridley (551).

Somewhat intermediate between *A. complanatum* (described above) and *A. pycnophyllum* (C. M.). Larger than the latter species, with complanate branches, and with the acumen of the leaf much shorter and not piliferous, but much narrower and shorter than in the former, the cells also in the present species are, so far as I have examined them, quite smooth. The flagelliform ramuli are quite different from anything I have seen in the genus.

Explanation of plate 3

The type specimen is figured in each case.
The figures indicate the magnification.

FIG. 1. *Braunfelsia longipes*—*a*, leaf, 5. *b*, alar cells, 40.
FIG. 2. *Dicranoloma brevicapsulare*—*a*, capsule, 3.
FIG. 3. *Thysanomitrium abbreviatum*—*a*, leaf, 5. *b*, section of nerve (*a* . . . *b*, width of nerve; c, central strand of nerve.), 40.
FIG. 4. *Thysanomitrium Ridleyi*—*a*, leaf apex, 20.
FIG. 5. *Fissidens subdiscolor*—*a*, stem, 1. *b*, leaf, 20. *c*, leaf apex, 40.
FIG. 6. *Fissidens amblyotis*—*a*, stem, 1. *b*, leaf, 20. *c*, cells, 200.
FIG. 7. *a*, *Syrrhopodon bornensis*, upper part of stem, dry, 4.
b, *S. Ridleyi*, upper part of stem, dry, 4.
c, *S. rufescens*, upper part of stem, dry, 4.
FIG. 8. *Syrrhopodon elimbatus*—*a*, leaf, 10. *b*, apex of leaf, 50.
FIG. 9. *Syrrhopodon perakensis*—*a*, leaf apex, 50. *b*, leaf base, 20. *c*, marginal cells of mid-leaf, 200.
FIG. 10. *Calymperes constrictum*—*a*, leaf apex, 50. *b*, margin at shoulder, 40. *c*, margin of mid-leaf, 200.
FIG. 11. *Pinnatella lingulata*—*a*, leaf, 20. *b*, apex of leaf, 40.
FIG. 12. *Chaetomitrium perakense*—*a*, apex of perichaetial leaves, 40.
FIG. 13. *Chaetomitrium setosum*—*a*, leaf, 20.

FIG. 14. *Clastobryum prionotrichum*—*a*, plant, 1. *b*, leaves, 25. *c*, alar cells, 50.

FIG. 15. *Ectropothecium callichroides* var. *elongatum*—*a*, stem, 1.

FIG. 16. *Ectropothecium siamense*—*a*, stem and branch leaves, 20. *b*, leaf apex, 50. *c*, upper marginal cells, 200.

FIG. 17. *Taxithelium trachaelophyllum*—*a*, leaf, 20. *b*, marginal cells, 200. *c*, alar cells, 40.

FIG. 18. *Taxithelium subtrachaelophyllum*—*a*, leaf, 20. *b*, marginal cells, 200. *c*, alar cells, 40. *d*, upper part of perichaetium, 20.

Explanation of plate 4

FIG 1. *Taxithelium isocladioides*—*a*, leaf, 20. *b*, upper margin, 100.

FIG. 2. *Taxithelium bilobatum*—*a*, dorsal leaf, 20. *b*, lateral leaves, 20. *b*, lateral leaves, flattened out, 20.

FIG. 3. *Acanthocladium polymorphum*—*a*, leaf, 20. *b*, *b'*, *b''*, apices of branch leaves, 40. *c*, upper cells of *b''*, 200. *d*, upper cells of *b'*, 200.

FIG. 4. *Trichosteleum albifolium*—*a*, stem leaf, 20. *b*, branch leaf, 20. *c*, alar cells, 100. *d*, upper cells, 200.

FIG. 5. *Acroporium serrulatum*—*a*, *a'*, leaves, 20. *b*, apices of perichaetial leaves, 50.

FIG. 6. *A. leucophyllum*—*a*, plant, 1. *b*, branch, 2. *c*, leaf, 20. *d*, apex of branch leaf, 50. *e*, upper cells, 200.

FIG. 7. *A. obscurum*—*a*, upper part of perichaetium, 20.

FIG. 8. *A. denticulatum*—*a*, leaf, 20. *b*, upper margin, 50.

FIG. 9. *A. aciphyllum*—*a*, leaf, 10. *b*, perichaetium, 10.

FIG. 10. *A. rigens* var. *dicranolomoides*—*a*, stem, 1.

FIG. 11. *A. surculare*—*a*, plant, 1. *b*, leaf, 10.

FIG. 12. *A. longicuspis*—*a*, leaf, 10. *b*, dorsal cells in profile, 50.

FIG. 13. *A. albidissimum*—*a*, *a'*, leaves, 10. *b*, upper cells of *a*, 200. *b'*, upper cells of *a'*, 200.

FIG. 14. *A. Ridleyi*—*a*, leaf, 10.

FIG. 15. *A. complanatum*—*a*, leaf apex, 40.

FIG. 16. *A. malayanum*—*a*, leaf, 10.

FIG. 17. *Syrrhopodon pungens*—*a*, leaf apex 40.

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Cytological Study of Living Cells of Tobacco Plants Affected with Mosaic Disease

Bessie Goldstein

As one phase of a more extensive cytological study of the diseased cells in tobacco mosaic, as well as the mosaic of Solanum sculeatissimum and other plants, I have recently spent some time in the study of the now well-known intracellular mosaic bodies in the living condition. In epidermal and hair cells mounted in water, the bodies are easily recognizable and can be studied for hours at a time under the immersion lens.

The facts as to their structure, varying sizes and shapes, and their relation to the other contents of the cell are so definite and easily demonstrable, that I am presenting a number of figures illustrating their appearance in the living cell in advance of a more extended account of their appearance and behavior as shown in fixed and sectioned material.

The epidermis of the diseased tobacco leaf is stripped off by the ordinary methods, and mounted in water. Material from the midrib and petiole is especially favorable, and such preparations mounted under zero cover slips, can be easily studied with the 1/12″ oil immersion lenses. The intracellular bodies are found in both epidermal and hair cells. I shall call them X bodies.

In such preparations, these X bodies appear at any particular moment as oval or perfectly rounded or more or less amoeboid in outline, as in figures 1, 2, and 5. They may lie in close contact with the nucleus, often as it were apparently wrapped around it, or they may be found in any other region of the cell.

Internally they may be very coarsely and unevenly granular, or they may appear very evenly and finely granular as in figure 2. They may contain several large vacuoles, or many small ones, as in figure 1. Sometimes the material of the body appears quite regularly alveolar as in figure 2.

In figure 1 is shown an epidermal cell from the midrib in which the nucleus contains three nucleoli. Scattered through the cytoplasm are small chloroplasts. The X body lies in contact with the nucleus. It is densely granular and contains several small vacuoles. Careful and prolonged observation of such bodies shows that they undergo slow changes in position and sometimes of form. The contents seem sometimes to become more vacuolar. This body closely resembles the bodies found in sectioned and stained material, as in figures 7 and 8, in its irregularly lobed or oval outline, in its compact granular structure, and in the presence of one or more vacuoles. Bodies of this kind can be seen in almost every cell of a bit of epidermal tissue stripped from the yellow area of the midrib or leaf blade.

Such bodies as this shown in figure 1 are not the result of nuclear fragmentation or direct nuclear division as Iwanowski first suggests. From his figures and mine, it is clearly evident that the finely granular and rounded nucleus could not be fragmenting or giving rise by direct division to daughter nuclei.

They do not represent migrated nuclei such as Miehe observed in stripped off epidermal tissue of Tradescantia stems and leaves of Allium. Miehe found the nuclei that had migrated through the cell walls into adjacent cells showed exactly the same finely granular content as did the original nucleus of the cell.

I have also attempted to stain preparations containing such cells as shown in figure 1, with various intra-vitam nuclear stains. I have obtained the best results with thionin. In a drop of water placed against the edge of the cover glass, a grain of the stain was dropped. This gradually dissolved and the violet color slowly diffused under the cover glass. The nucleus of the cell takes a lavender tint, while the nucleole stains violet. The X body does not take the stain as a whole but its granules seem to become more clearly differentiated.

In figure 2, the nucleus is shown, as is frequently the case, suspended in the cell by fine cytoplasmic threads in which active streaming is going on. In this cell five X bodies are lying about the nucleus. Within the bodies themselves, active motion of granules, amounting almost to circulation, was conspicuous. All five of these bodies were slowly rotating and at the same time gradually changing their positions in the cell. During the several hours in which this cell was under observation, the bodies moved up and down the cell for considerable distances, continually changing their positions relative to the nucleus and to each other.

Often as the bodies slowly rotate they seem to roll along the protoplasmic threads of the host cell. This movement seems quite independent of the rate of streaming of the cytoplasm of the host cell. The bodies do not all move along at the same rate. In fact they often pass one another. One may turn back or move across the cell, while the others continue their way lengthwise of the cell.

The general interrelations of the X bodies and the other constituents of the cell can be even better seen perhaps under lower magnifications. In the cell shown in figure 3, drawn under a magnification of 450 diameters, eight X bodies were found. Here also the nucleus is seen imbedded in a mass of cytoplasm from which streaming threads arise. Along the threads are very many small pale green chloroplasts. In this cell as noted are three large X bodies and five very small ones. They all have a finely granular structure with coarser granules which showed what was probably Brownian movement. These X bodies were constantly changing their positions in the cell. The streaming cytoplasmic threads were also constantly taking new positions, lying now across the cell, now diagonally longitudinally through the cell, or merging in the cytoplasm of the primordial utricle.

In figure 4, I have shown a normal hair cell from a healthy leaf for comparison with these cells containing the X bodies. It is obvious at once that there are no conspicuous differences in the distribution of the cytoplasm and its relations to the nucleus between such a cell and the cells with the X bodies. The position of the nucleus, the streaming and constantly changing cytoplasmic threads, and the distribution of the very small pale green plastids, resemble in general the same structures and conditions found in the cell shown in figure 3.

As noted the nucleus may lie suspended in the cell by cytoplasmic threads or be pressed close to the wall of the cell. Usually the nucleus lies in the primordial utricle against the wall of the cell. I have seen the nucleus, in a hair cell containing the rotating X bodies, move out from the wall with the radiating streaming cytoplasmic threads about it, and hang suspended in the cell vacuole without further changing its position during a period of observation lasting five hours. The nuclei of the cells in figures 3 and 4 were being carried by the streaming cytoplasm around the periphery of the cell during the whole period of several hours during which the drawings were made.

Kunkel seems to emphasize somewhat the fact that the X bodies lie in intimate association with the nucleus of the cell. My observations do not lead me to attach any very special significance to such a position, especially in the case of the hair cells. From my studies of living material, and also from the appearance of the nucleus in fixed preparations of both diseased tissue in which the bodies are present, and healthy tissue, I find no evidence that the nuclei in cells from mosaic diseased areas are at all changed in appearance by the presence of the X bodies. The bodies, as they move through the more fluid cytoplasm or cell sap, may come to rest upon the nucleus. It appears simply as an impediment to their movement. In one instance, a cell was observed in which there were several very large rounded X bodies lying about the nucleus which was thus quite obscured from view though it could be seen by carefully focusing down among the bodies. After some time, the bodies gradually moved away, so that the nucleus now came into clear view. It was then seen to be very much flattened on one side apparently where the bodies or a body had been closely pressed against it. After several minutes, the nucleus slowly rounded out and regained its normal oval outline. It showed no further changes although the cell was studied several hours.

I find no evidence from my studies that the X bodies could be considered as secretion or disorganization products arising from or in the neighborhood of the nucleus. I have studied very many preparations from healthy leaves but they have never been found to contain these bodies.

Kühne has described a balling up of the protoplasm of living stamen hairs of Tradescantia under the influence of electrical stimulation. In such electrically stimulated cells, when the charge was strong, the entire primordial utricle became loosened from the walls and hung suspended in the cell space by a few threads still attached to the walls. A weaker charge led to the breaking up of the strands of protoplasm. The fragments then rounded up into globules or rounded masses. In such preparations the balls of cytoplasm within a few hours elongated and flowed back again into the streaming cytoplasm.

The X bodies in my preparations keep their form in living preparations of tissue kept in a moist chamber for several days. Their content, however, becomes very granular, and no movements of the body or its contents were observable after the second day.

The X bodies as I have noted often exhibit distinct but sluggish amoeboid movements. They also are bounded by a definite plasma membrane as is clearly shown when the more active X bodies thrust out short rounded pseudopods. The presence of this membrane can also be demonstrated when acids or drops of fixing solutions are added to the water under the cover slip. The content of the body then contracts thus showing that it is separated from the cell sap by a definite limiting layer. The contents of the contracted X body also appears more coarsely granular and distinctly vacuolated.

In figure 5, the nucleus lies suspended in the cell vacuole. The body here is granular in structure, and showed conspicuously a sort of vibratory motion, and perhaps a circulation of its granular content. This body continually changed its form by putting out slight bulbous projections on all its surfaces which were withdrawn again after several seconds, while other projections arose in other parts. It continually showed changes of position, moving up over the nucleus, or across the striated body, and then back again to the position shown in the drawing. These motions were not easily to be associated with the streaming movements of the cytoplasm. The X body did not as long as the cell was observed, during a period of several hours, move away from the vicinity of the nucleus and the striated body.

Such amoeboid X bodies have also been observed to move through the cell. The amoeboid processes are put out in the direction of the movement, and these often show a clear hyaline area at their blunt extremities. I am not certain, however, that the entire movement of the X body is due to the thrusting out of these projections though the entire body appears to move forward at the same time that the projection is put out. When the body turns after moving forward in a certain direction, it elongates, or becomes less rounded, or oval, and this elongation is in the direction of the turning movement. The body may now appear pear shaped. The upper narrower region now swings around toward the direction in which the body will soon begin to move.

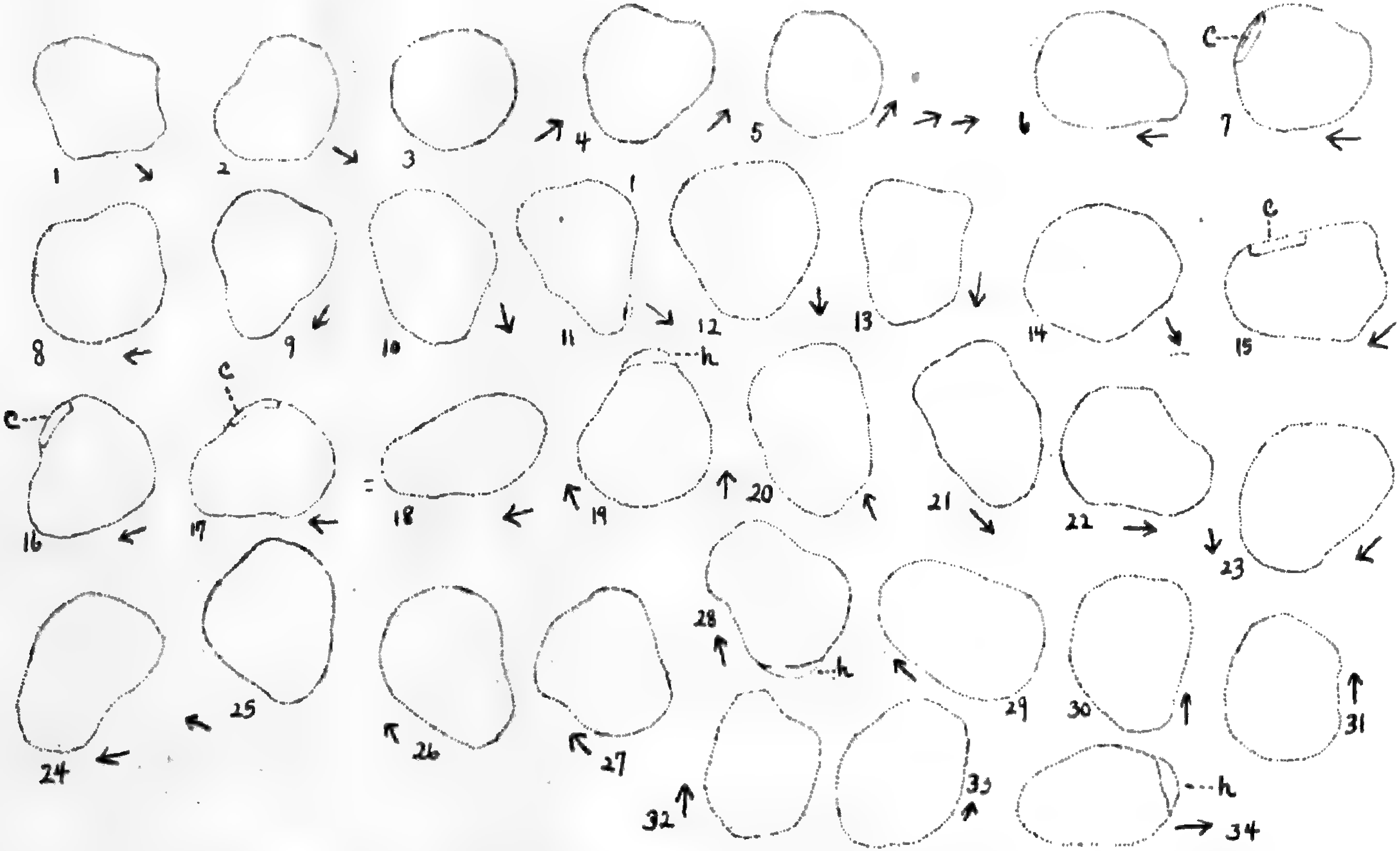

FIG. 1. Camera sketches of the changes in form of an X body as it moved through a diseased hair cell of the tobacco. Period of observation one and one-half hours. There was only one X body in the cell and in appearance it resembled the one shown in plate 1, figure 5. Magnification about 1,200.

I have diagrammed with the aid of a camera lucida the changes of form which one of these X bodies showed in the course of one and one-half hours. The stages are numbered from 1 to 34 and are shown in text figure 1. In several stages a clear hya-

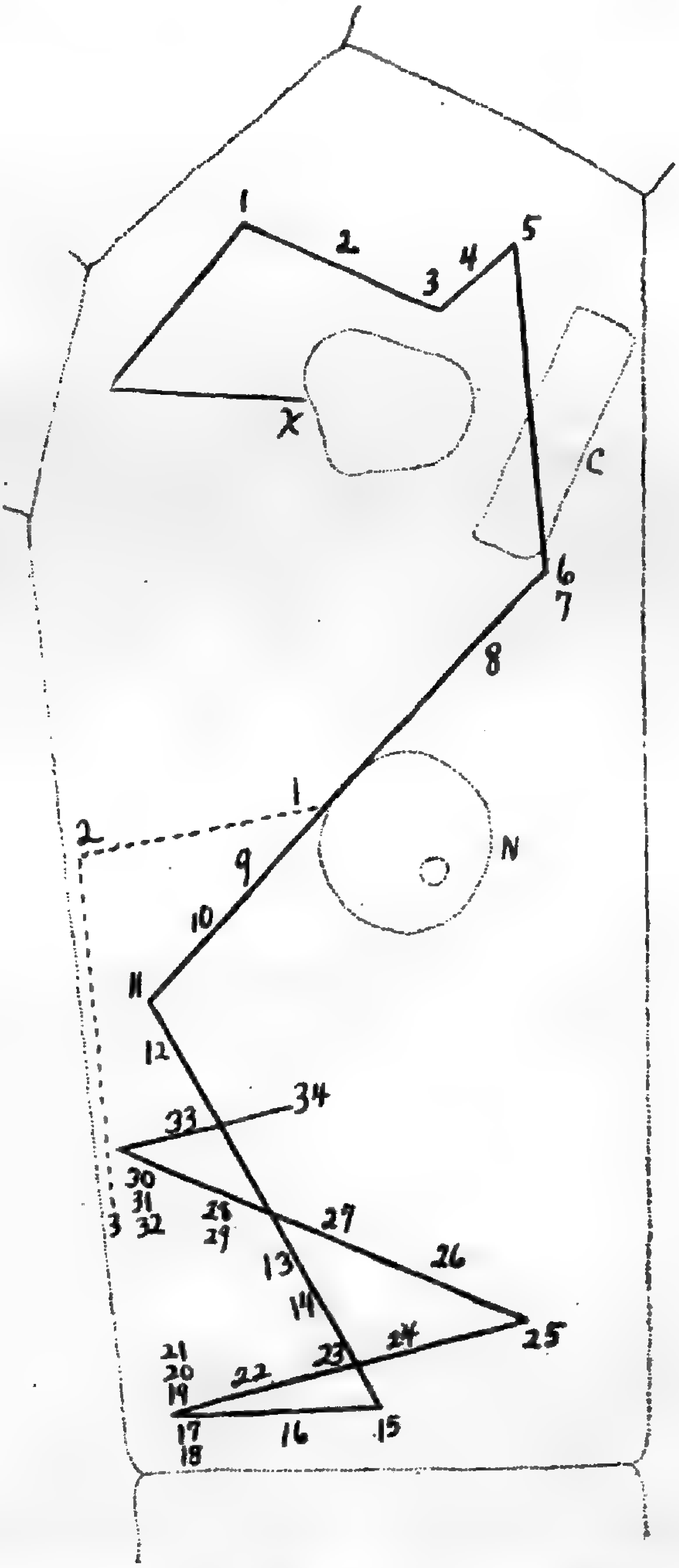

FIG. 2. Diagram of a cell from a branching trichome showing the general direction of the path followed by the X body whose changes in form are shown in text figure 1. The movement of the nucleus for the same period is also shown in the dotted line.

line ectoplasm-like cap (h) was seen on a more or less protruding portion of the X body. A small crystal (c) either adhering to its surface or embedded in the X body was also seen at several stages. The whole series of figures while not suggestive of the active pseudopod formation seen in Amoeba proteus is certainly not unlike that of more sluggish types.

The body at first was near the distal end of the trichome cell. During the stages shown in figures 1–15 it moved to the proximal end of the cell. Figures 16–34 show its later movements in the proximal end of the cell. Its general path during the whole period of observation is diagrammatically shown in text figure 2. How much of this motion is due to autonomous activity of the X body, and how much to cytoplasmic streaming in the trichome cell is not easy to determine. Certainly the movement of the nucleus in the same direction is due to cytoplasmic streaming.

Cells from the paler areas of the mosaiced leaf also show the presence of great numbers of crystals. Although similar crystals are present in healthy tissue, they are not nearly as abundant as they are in cells of diseased tissue. These crystals appear as hexagonal plates of various thicknesses, as irregular polygonal plates, or as more or less irregular elongated forms with cross striations as in figures 5 and 6. These various appearances may be due to the varying positions of the crystals in the cells as well as to the occurrence of twinning, etc. I am reserving a fuller report on the nature of these crystals for a later paper.

Figures 7 and 8 represent drawings made from fixed and stained material. In figure 7 there is present an elongated cross striated body lying within the protoplast. A similar striated body is shown in figure 8. Such bodies are very common in my sectioned material. In the diseased areas nearly every cell is found to contain such a striated body. Often there are two or three of them in a single cell.

If one adds to the fresh preparations mounted in water, Flemming's weak, medium, or strong solutions, or chromo-acetic solution, allowing the preparations to stand over night in a moist chamber, the typical crystal forms are no longer found. Instead one finds long irregularly lobed and striated masses which are stained deep yellow by the fixative. That at least many of the crystals actually become the striated bodies found in fixed material can be easily demonstrated by a few hours observation under the microscope of living preparations to which drops of the fixing solutions are added from time to time. Only the smallest thin crystalline plates will disappear entirely.

Iwanowski has figured several somewhat amoeboid bodies, "amöben erinnernde Plasmaanhäufungen," attached to nuclei, as seen in sections of living material of mosaic infected tobacco leaves. He also observed the presence of the numerous crystalline plates in the living cells, which in fixed material, according to his description, seemed to have disappeared entirely and given place to plates in which were imbedded small rod-like bodies. He concludes that these are plates of "bacteria," or zoogloea formations, which are not seen in living cells save as the smooth crystalline plates. Their true nature therefore can only be demonstrated in fixed material. Iwanowski argues that amoebae could not possibly pass through bacterial filters. He maintains that the amoeboid bodies he found are only reaction products of the cells resulting from the continued irritation by the parasite, namely, the "rod-like bacteria" in the plates.

What seem to have been similar intracellular bodies have been described by Palm as occurring in the cells of tobacco plants affected with mosaic. Palm's account of their occurrence and position in the cells agrees with what I find. He describes these bodies as frequently amoebiform, less frequently round to spherical. In structure they may be decidedly reticulate, or show very little structure at all. He finds there may be one or more cavities in the bodies which resemble vacuoles. He reports the bodies as not seeming to possess any automotive power though they change their position at times by the normal movement of the cell plasm.

Palm accepts Iwanowski's viewpoint as to the character of these amoeboid bodies, and also claims that small "granules" found in the cells of diseased tissue are the organisms responsible for the disease.

In a preliminary report by Rawlins and Johnson on "Cytological Studies on Tobacco Mosaic," these authors associate three different intracellular bodies with the disease. The first, a yellow striated mass of material, is no doubt the result of fixation and the fixing solutions upon the crystals found in fresh material as I have described above. The second type consists of small bodies about the size of a nucleole. The third, the vacuolate bodies, are no doubt the same as those I find in living and fixed preparations.

The bodies shown in my plate, figure 2, resemble very closely those figured by Kunkel for corn mosaic and drawn from stained and sectioned material, Plate 5, Fig. J. Kunkel describes the intracellular bodies found in mosaic diseased corn tissue as varying in size and form. In their reticulate or granular structure, and the presence of vacuoles, these bodies agree with those I find. The bodies are further described as showing no indication of a membrane, though the author adds that a membrane must be present since when the bodies come in contact with one another they do not fuse. Kunkel observed that the bodies in living material were often moved by the vigorous streaming of the protoplasm but never seemed to move independently or change their shape.

The intracellular bodies figured by Lyon in preparations of sugar cane affected with the Fiji disease, are strikingly similar to those I find. They have the same finely granular content and general appearance of the X bodies I am figuring. They are described as small spherical or oval plasma bodies. The larger bodies may be oblong so as to accommodate themselves to the shape of the cell. Occasionally they may appear lobed or distorted. His drawings were made from fresh material stained with various aniline dyes.

McKinney and his co-workers have described intracellular bodies in living and fixed material associated with the rosette disease and a mosaic-like leaf mottling of wheat. These bodies show considerable resemblance in form, size, and distribution to those described by other investigators of mosaic diseases.

Matz describes the presence of a granular plasmodium-like substance in cells of sugar cane tissue affected with the yellow stripe disease. Such yellow granular material may perhaps be a decomposition product. That the granules exhibit Brownian movement is further proof of such a disorganization in the cells since the contents of dying cells usually show the presence of granules exhibiting such movements.

It is possible that the disease may be transmitted over a limited area by the natural division of growing cells resulting in the formation of daughter cells each containing some of the bodies present in the original cell. Cells in stained sections of the growing tips show the presence of X bodies in cells containing mitotic nuclear division figures. This, however, could hardly account for the transmission of the disease from the point of infection to distant parts of the same plant.

For instance, I have inoculated young leaves of plants, and two months later have secured severe infections of healthy plants when the juices of the apparently healthy basal leaves of the diseased plants were used as the inoculum. Moreover, the X bodies may be found in tissue from these leaves, although not so abundantly as in the mottled leaves.

It is, of course, at first thought difficult if not impossible to conceive that such bodies as these, assuming they carry the mosaic, can pass through plant tissues as the mosaic virus has been shown to do. In this connection, however, Miehe's observations on migrating nuclei must be kept in mind. Miehe's description of the nuclei of Tradescantia and other cells, passing through the minute pores, Tongl lines, in cell walls has been confirmed by Schürhoff.

These observations certainly suggest also that such plastic bodies as the X bodies in spite of their comparatively large size may very well be able to pass through cell walls and the pores of bacterial filters as the virus has been shown to do. Still such comparisons are not very convincing in the absence of positively known cases of parasites which behave in the fashion suggested. As noted I am reserving for a further paper a fuller account of the behavior of the X bodies in growing points together with a fuller crystallographic account of the numerous bodies which accompany them, in cells suffering from mosaic.

I gratefully acknowledge my indebtedness to Professor R. A. Harper for his many valuable suggestions in this study and in the preparation of this paper.

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Explanation of plate

The drawings were made with the aid of the Abbé camera lucida. A Zeiss microscope was used with a 1/12″ oil immersion objective and a number 3 ocular. The magnification in figures 1, 2, 5, 6, 7, 8 is about 1,200 diameters. Figures 3 and 4 were drawn with the Zeiss objective D and number 3 ocular.

The magnification is about 450 diameters. All the drawings with the exception of figures 7 and 8 are from living preparations. Figures 7 and 8 are drawings from material fixed with Flemming's weak solution, cut at 10μ, and stained with Flemming's triple stain.

FIG. 1. An epidermal cell from a yellowed area on the midrib of a mottled leaf. The nucleus is finely granular and contains three nucleoli. The X body is very densely granular, and contains many vacuoles. Scattered through the cytoplasm are small oval plastids.

FIG. 2. A portion of a hair cell showing five X bodies about the nucleus which lies suspended in the cell by streaming cytoplasmic threads. Two of the bodies show a fine alveolar structure. The other three are granular. Imbedded in the bodies were highly refractive granules.

FIG. 3. A portion of a hair cell showing the distribution of many X bodies of varying size through the vacuole of the cell. Three large and five small bodies are present. Scattered through the cytoplasm are very small oval plastids. The nucleus lies imbedded in the primordial utricle, against the wall.

FIG. 4. A normal hair cell from healthy tissue. The cell contents save for the absence of the X bodies present an exactly similar appearance to that of the diseased cell shown in figure 3.

FIG. 5. A portion of a hair cell in which a single large X body, a crystal and the nucleus of the cell are shown. The X body drawn here shows the appearance of the body when very active and constantly changing its form and position. The small oval bodies are plastids.

FIG. 6. A portion of an epidermal cell of the midrib showing 2 X bodies, and 3 crystals.

FIG. 7. A portion of a cell from a petiole spine of Solanum sculeatissimum affected with tobacco mosaic. The striated body shows the appearance of the crystals after fixation. The nucleus lies against the opposite wall. The X body contains two vacuoles. The striated body and the X body are stained deep orange, the chromatin purple, and the nucleole red. The cytoplasm and cell walls are orange.

FIG. 8. An epidermal cell from the petiole near the growing region of a diseased tobacco plant. This cell contains an elongated striated body, a nucleus, and a large vacuolated X body. In the cytoplasm around the nucleus and the X body were smaller orange stained bodies each containing a single large round vacuole.

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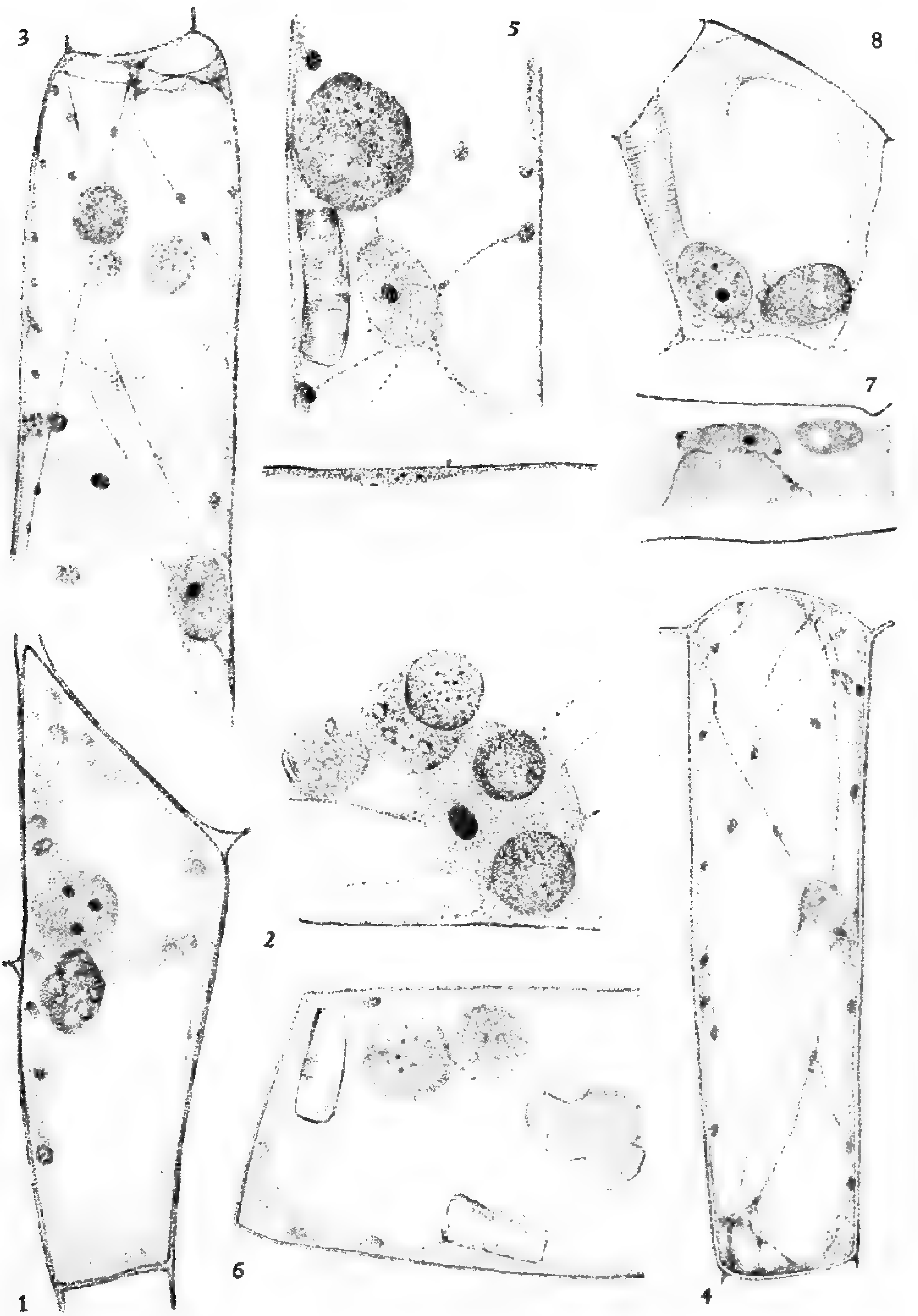
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INDEX TO AMERICAN BOTANICAL LITERATURE

1924

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 the broadest sense.

Reviews, and papers that 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 omissions, their kindness will be appreciated.

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BULLETIN

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TORREY BOTANICAL CLUB

JULY, 1924

Across the Sonoran Desert

Forrest Shreve

The type of desert so well known in southwestern Arizona extends southward into the Mexican state of Sonora for about 300 miles with relatively slight changes in the general physiognomy of the vegetation and in the local distribution of the plant communities. This natural province, which may well be termed the Sonoran Desert, is bounded on the north on the southern edge of the Colorado Plateau, in central Arizona, on the east by the Sierra Madre Occidental, and on the west by the Colorado River and the Gulf of California. To the southward it merges, at first gradually and then rapidly, into the xerophytic tropical thorn-forest which is characteristic of the west coast of Mexico south of Cape Corrientes. Many plants characteristic of the Sonoran Desert extend to the west of the Colorado River and thence northward, and many of them occur in Lower California and in the more elevated desert regions of Chihuahua and Coahuila. Considered as a whole, however, the Sonoran Desert is a very distinct area with respect to its plant life. In the variety of its plant communities, the relatively large number of species of striking growth-form, and in the abundance of succulents, it is very distinct from the Colorado and Mojave Deserts and from the deserts of Chihuahua and Coahuila.

The distinctive character and relative luxuriance of the Sonoran Desert may be attributed to the occurrence of biseasonal rainfall. Many of its characteristic plants fail to range into the Californian region of low rainfall confined to the winter and spring. The mountain barriers to the north and east offer adjacent territory with higher rainfall, but they also present

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conditions of lower temperature into which the desert forms are unable to move. To the south the slightly greater rainfall and the much higher temperature conditions are responsible for a distinct type of vegetation in which only a few of the Sonoran forms are represented. The precipitation is least along the western edge of the desert and increases with altitude toward the east, ranging from about 4 inches to about 16 inches. The temperature conditions in the northern part of the Sonoran Desert are such that at Phoenix and Tucson frost occurs several times every winter, but a freezing temperature never persists throughout the day. At Guaymas freezing temperatures are unknown.

The vegetation of the northern portion of the Sonoran Desert has been described and illustrated by several writers,* with particular reference to the Tucson region. It is the purpose of this paper to describe some of the salient features of the vegetation as observed in an expedition from the Desert Laboratory, at Tucson, to the shores of the Gulf of California at a point half way between Guaymas and the mouth of the Colorado River. This trip was made by automobile in November, 1923, immediately following the first of the winter rains. The course lay southwest from Tucson to the International Boundary, which was crossed at El Sasabe, thence south to Altar, west to Pitiquito, and then south and west to the shores of the Gulf at Libertad, thence southward to Punto Kino. The return was made by essentially the same route.

It happens that the International Boundary between El Paso and Yuma lies very close to the divide separating the drainages which run northward into the Gila River and those that flow south and southwest into the Gulf of California. The approach to El Sasabe from the north lies across the grassy plain known as the Baboquivari Valley. The entry into Mexico is made among low hills at an elevation of 3500 ft. Another extensive grassy plain is then traversed, falling gradually south and east to the Rio Seco. The coarse, granitic loam of this plain supports only

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* MacDougal, D. T. Botanical Features of North American Deserts. Pub. 99, Carnegie Inst. Washn., 1908. Hornaday, W. T. Camp Fires on Desert and Lava. New York, Scribners, 1908. Spalding, V. M. Distribution and Movements of Desert Plants, Pub. 113, Carnegie Inst. Washn., 1909.

a cover of annual and perennial summer-growing grasses, with very infrequent individuals of *Prosopis* and *Opuntia*. The elevation is too high for *Covillea*, *Parkinsonia* and *Carnegiea*, although all of these species are found in the hills near the Boundary, at a slightly higher elevation. This anomaly, which is common in many other localities, may be explained by the greater insolation and warmer soil of the south-facing slopes of the hills.

On reaching the foot of the plain at San Rafael Ranch the road follows the flood plain of the Rio Seco nearly all the way to Altar. The vegetation of this region is essentially identical with that of the flood plains near Tucson, and the new species that appear in it are not so striking as the new ecological habits exhibited by some of the familiar plants. For example, *Encelia farinosa*, a composite shrub which is confined to rocky slopes and coarse outwash in the Tucson region, always in company with other plants, may here be seen in extensive pure stands on alluvial soil. Two conspicuous cacti are first seen a few miles south of San Rafael, *Lophocereus Schottii* and *Lemaireocereus Thurberi*. These are both columnar forms with branches from 4 to 6 inches in thickness, which rise in groups of 5 to 25 and attain a height of 4 to 10 feet. Both of these plants are found in Arizona, but their northernmost outposts are naturally to be found on south slopes in sheltered positions. *Lophocereus* is first seen in the Rio Seco valley on alluvial and outwash soil, and is most commonly found in such situations throughout its range. *Lemaireocereus* is first seen on the hills that skirt the valley and its occurrence in general is confined to rocky slopes and coarse outwash.

The Rio Seco is a tributary of the Altar River, which it reaches in a number of small channels after spreading out into an alluvial delta 10 miles in width. The town of Altar is at one corner of the delta and the town of Pitiquito near the other. These old settlements are both on the Altar River, and between them this stream is joined by the Magdalena, or San Ignacio River, which drains an extensive area of hilly country in the District of Nogales. The narrow streets of these towns are lined with unbroken rows of stuccoed and tastefully tinted adobe houses, with no hint of lawn, fence or porch. The streets and the mud-walled gardens of pomegranates, oleanders, oranges and date palms give the traveler the impression of being in some Moroccan village, far from the confines of the United States.

Throughout northern Sonora the vegetation of the flood-plains and alluvial areas is more nearly like that of southern Arizona than is the vegetation of the hills and the outwash slopes or "mesas." The "Little Peaklet" from which the town of Pitiquito derives its name is the first place that the cardon, *Pachycereus Pringlei*, is detected. This is an arborescent form similar to *Carnegiea* but more massive and unlike it both in its

FIG. 1. Characteristic vegetation between Pitiquito and the Picu Mountains, Sonora. The trees are *Parkinsonia*, *Olneya*, and *Prosopis*. The cactus is *Lophocereus Schottii*.

coarser armature and in the more acute angle of insertion of its branches. *Pachycereus* grows here together with *Carnegiea* and *Lemaireocereus*, and the abundant *Opuntia Bigelovii*, making a landscape that would arrest the attention of any traveler.

After crossing the broad bed of the Magdalena River the remainder of the journey to the Gulf is across small valleys with unimportant streamways and small ranges of volcanic hills. Between Pitiquito and the Sierra Picu, the last range of hills crossed, the course lies between 1100 and 2000 ft. in elevation.

On the coarse, gravelly mesas the characteristic plants are chiefly species of wide distribution in the Sonoran Desert, such as *Covillea tridentata*, *Parkinsonia microphylla*, *Olneya tesota*, *Carnegiea gigantea, Acacia paucispina, Opuntia fulgida* and *Fouquiera splendens*. In the vicinity of Tucson *Olneya* is confined to the warmest situations, sheltered south exposures which are not subject to the influence of cold air drainage. In the valleys between Pitiquito and Libertad it is much more ubiquitous, and occurs abundantly in situations where cold air drainage operates to produce minimum temperatures that are considerably below those of the upper slopes and foothills of each valley. The behavior of *Carnegiea* remains unchanged, however. In the Tucson region it is much more abundant on the south slopes of hills than on the north, and this is true of it down to the point at which it begins to be infrequent and to yield its place in the landscape to *Pachycereus*. The latter cactus in turn, and also *Lemaireocereus*, are like *Carnegiea* in exhibiting greater abundance on south slopes than on north ones.

Parkinsonia microphylla and *Cercidium Torreyanum* are both abundant down to the Gulf, showing no change in their habitat. *Parkinsonia aculeata*, which is widely cultivated throughout the southern United States, is first seen within 60 miles of Tucson. It is nowhere a common tree but occurs singly or in small groups at widely separated localities.

The Arizona shittimwood, *Bumelia rigida*, is a tree known only from four localities in Arizona, from the Dragoon Mountains to the Baboquivari Mountains. Its foliage and the character of the localities in which it is found, indicate that it is a tree of relatively high water requirement. A closely related and very similar species, *B. occidentalis*, was detected at three places in Sonora, one of them near a natural water hole, and the second near a well. The third locality was in the center of a large valley where there are no wells, and it was interesting to note that an unsuccessful well had been dug to a considerable depth near the *Bumelia* trees, indicating that the high water requirement of the tree had not gone unobserved by the Mexican ranchers.

The valleys lying east of the Sierra Picu have a deep loam soil and a rich cover of vegetation. *Covillea* is infrequent here, and large trees of *Parkinsonia, Olneya* and *Prosopis* are intermingled with *Carnegiea, Pachycereus*, large colonies of *Lophocereus*, occasional colonies of *Lemaireocereus*, and frequent groups of a large Yucca, often reaching 25 ft. in height. Smaller cacti and numerous species of shrubs, together with mats of the gray grass, *Hilaria*, all combine to make a highly diversified community of plants that constantly gives one the impression of being in some gigantic botanical garden.

In the Sierra Picu and the lower ranges of hills which lie between it and the valley of the Magdalena River, the traveler from the north finds more plants that are new to him than in the valleys. The general groundwork of the vegetation is composed of those species that extend north to the edge of the Sonoran Desert, but a large number of shrubs, cacti, vines and

FIG. 2. *Pachycereus Pringlei*, 8 miles south of Libertad, Sonora.

herbaceous plants are already added to the vegetation here within a linear distance of 100 miles from the Boundary. One of the most striking and abundant of these is *Elaphrium microphyllum*, the copal tree, of the family *Burseraceae*. In the largest trees the trunk emerges from the rocks with a diameter of 12 to 14 inches. It branches freely and dwindles rapidly in thickness, so that the limbs 4 ft. from the ground are seldom more than 1 or 2 in. in thickness, while the twigs are of the ordinary size. The cortex is very thick, forming nearly half the thickness of the trunk, and exudes a milky and resinous sap when cut. The leaves are pinnate and dark green, the twigs a rich brownish red. The bark is stripped from the twigs by

Indians and used in weaving the colored designs of baskets. Another abundant shrub in which the branches dwindle rapidly in diameter is the terrote blanco, *Jatropha cinerea*, but the basal diameter is rarely more than 2 in. *Jatropha cordata* is abundant here, together with the similar but smaller leaved *J. cardiophylla*. An undescribed *Opuntia* of the series *Clavatae* is abundant in several localities, its erect branches giving the largest plants a resemblance to the cylindropuntias. The platyopuntias, or prickly pears, become very much less abundant in this region than they are at Tucson, both as to the number of species and individuals. This type of cactus appears to be unable to resist the adverse moisture conditions of the driest portions of the Sonoran Desert, as it is poorly represented here and also in Arizona west of the longitude of Phoenix.

The last one of the low passes in the Sierra Picu is 20 miles from the Gulf coast, and its elevation is approximately 1750 ft. The very gradual descent to sea-level is made over a detrital slope on which the vegetation is at first very heavy, then rather open, and finally very scanty and low. The vegetation of the heavily covered portion of the slope presents many features which distinguish it from similar situations to the east and north. The giant *Pachycereus Pringlei* here reaches such a size that many of the individuals must weigh 20 tons, as the largest plants of the much less massive *Carnegiea* are known to weigh half that much. *Lemaireocereus Schottii*, *Opuntia fulgida* and *O. gosseliniana* are also abundant. The principal distinctive features of the area, however, are the great number of small trees and the abundance and variety of shrubs and shrub-like perennials. The commonest of the trees are *Elaphrium microphyllum*, *Olneya tesota*, *Parkinsonia microphylla*, *Prosopis glandulosa* and *Parkinsonia Torreyana*. *Prosopis velutina*, characteristic of the higher portions of the Sonoran Desert, was not detected here. The shrubby vegetation not only includes the compact type, branching freely from the ground, but numerous individuals of *Malvaceous*, and *Solanaceous* shrubs, with a single erect stem and the form of a small tree. Some of these are not woody, and their presence is a strong indication that frosts are either absent or very light in this locality. Among the shrubs and suffrutescent perennials characteristic of the upper seaward slope are *Jatropha spathulata*, *Covillea tridentata*, *Encelia farinosa*, *Franseria dumosa*, *Simmondsia californica*, *Abutilon palmeri*, *Sebastiania pavoniana*, *Acalypha adenostachya*, *Euphorbia tomentulosa*, *Franseria deltoidea*, *Solanum* sp., *Abutilon sonorae*, and *Horsfordia alata*.

After descending the slope to within 10 miles of the Gulf the vegetation becomes much poorer and more open. *Prosopis*, *Olneya*, *Covillea*, and *Fouquiera* are the most abundant of the larger plants. *Pachycereus* is much smaller and less abundant, and the only other cacti are the infrequent individuals of *Echinocactus Lecontei* and *Opuntia gosseliniana*.

The Bay of Libertad is a slight concavity in the coast line, stretching from Punto Lobos on the north to Punto Kino on the south, a distance of about 12 miles. There is a slight escarpment, of from 10 to 20 ft. along the entire coastline of the bay. The soil is a coarse loam except for a distance of about two miles just north of Punto Kino, where a belt of sand stretches for several miles inland. The surface of this area is stable and well covered with vegetation. Within half a mile of the escarpment the vegetation is very sparse, consisting of a few low individuals of *Covillea* and *Prosopis*, and occasional plants of *Ptiloria pauciflora*, *Frankinia Palmeri*, and *Psorobatus megacarpus*. Here also is to be found an interesting species of the night-blooming cactus, *Wilcoxia*, in which the storage organs are numerous enlarged portions of the root system resembling small sweet potatoes. Over 70 of these enlargements were taken from a single plant.

At Punto Kino a low range of granitic hills abuts directly on the coast. To the south the mountainous outline of Tiburon Island is plainly seen standing well out into the Gulf, and successive ranges of hills end in abrupt seaward slopes along the entire coast as far as Tiburon Island. Across the Gulf it is possible to make out the low outlines of Angel Guardia Island and to see the profile of the hills of Lower California, culminating in the San Pedro Martir Mountains. During the five days that we were within sight of the Gulf there was no evidence of human existence detected on its waters.

In sandy soil at the base of the outwash slopes which stretch north from the mountains at Punto Kino was found the heaviest stand of *Pachycereus* noted on the entire trip, accompanied by large and numerous examples of *Elaphrium microphyllum*.

Whereas the hills are the optimum habitat for arborescent cacti in the interior, at this locality they are bare of all but a few small individuals.

On approaching Punto Kino the eye is arrested by what appears to be a forest of small trees denuded of their branches and leaves, extending along the base of the hills. This proves to be the cirio, *Idria columnaris*, of the family *Fouquieraceae*, previously known only on the peninsula of Lower California. The trunk of this singular tree is from 12 to 18 in. in thickness at the base but tapers very rapidly to a slender top and rarely

FIG. 3. *Idria columnaris*, on rocky slopes near Punto Kino, Sonora. The trees in the center are *Elaphrium Macdougalii*.

exceeds 20 ft. in height. The trunk itself occasionally forks into two or three branches, all of which continue to grow in a vertical position. From base to top the trunk is beset with short slender lateral branches, growing in a horizontal position and bearing thorns and seasonal leaves after the manner of *Fouquiera*. The large racemose inflorescences are borne only at the upper end of the trunk or its branches. The trunk is smooth, of a pale salmon color, and the cortex is so soft that it can be cut with great ease. There is ligneous tissue throughout the cross section of the trunk, but the trunk also serves as a reservoir for a considerable quantity of water. The very young individuals of

Idria are globose, and all of the thickening of the stem is above ground.

The heaviest stands of *Idria* were along the base of the granitic hills. It is infrequent on the upper slopes, and nowhere grows very far away from rock in place. Unlike most plants at the northernmost limit of their occurrence, *Idria* is more abundant on north slopes than on south slopes. It was found inland from Punto Kino as far as the hills extend, and southward as far as the second ridge of hills below the point, which marked the southern limit of our exploration.

Throughout these hills *Idria* is the most conspicuous plant, *Pachycereus*, *Lophocereus* and *Lemaireocereus* are all infrequent, although they may be found in the valleys and on alluvial slopes. *Carnegiea* is confined to the hills, but nowhere reaches its customary size. *Parkinsonia* is very uncommon, and *Covillea* is confined to coarse detrital slopes at the bases of the hills. On the slopes there are few large individuals of any plants. The most characteristic forms are *Elaphrium Macdougalii*, *Olneya tesota*, *Idria columnaris*, *Jatropha cinerea*, *Simmondsia californica*, *Hyptis Emoryi*, *Opuntia Bigelovii*, *Fouquiera splendens*, *Encelia farinosa*, *Franseria dumosa*, *Trixis angustifolia*, *Verbesina chihuahuensis*, *Porophyllum gracile*, *Hibiscus denudatus*, *Stegnosperma halimifolium* and *Ptiloria pauciflora*.

The vicinity of Libertad and the hills of Punto Kino were of particular interest as examples of a pronounced desert running right down to the shores of a large body of water. While the temperature conditions here are extremely favorable there is every evidence that the precipitation is much less along the coast than it is 10 miles and more inland. In November, 1923, the writer installed non-evaporating volumetric rain gauges at Libertad and at the pass in the Sierra Picu 18 miles from Libertad. At the latter locality a Six's maximum-minimum thermometer was also installed. These instruments were read in March, 1924, by Mr. Gilbert Sykes. The precipitation at Libertad was 1.0 cm. and at Picu pass 4.8 cm., while for the same period at Tucson it was 11.2 cm. The minimum temperature at Picu Pass was 34° F., and for the same period at Tucson 27.5° F. These figures indicate the extreme aridity of the coastal belt and show that the precipitation of the hills nearest the coast is considerably higher. The minimum temperature reading shows that there are at least occasional winters without frost, a thing that can not be said of the more elevated portions of the Sonoran Desert. At Libertad and Punto Kino freezing temperatures doubtless occur only at rare intervals and for periods of very brief duration.

DESERT LABORATORY
TUCSON, ARIZONA.

Miscellaneous notes on plants of Southern California—III*

Philip A. Munz† and Ivan M. Johnston‡

In the following pages specimens cited as (B) are at the C. F. Baker Herbarium of Pomona College, and those as (G) at the Gray Herbarium of Harvard University.

Eriogonum Kennedyi Porter

A study of the type of *E. Kennedyi* Porter (Wats. Proc. Am. Acad. **12**: 263. 1877), contained in the Gray Herbarium, has shown that it differs in the shape of its calyx-lobes from those plants commonly identified as *E. Kennedyi* which grow in the San Bernardino Mts. and in the Mt. Piños region. The original material of the species, according to its label, is from "Kern County, California." It has broadly elliptical calyx-segments which are very abruptly expanded and rounded at the base, whereas the more southern material has obovate or narrowly obovate segments which are gradually contracted toward the base and cuneate. Although these two forms differ markedly in the shape of the calyx-lobes, they are indistinguishable otherwise, and it seems best to consider them only varietally distinct.

Eriogonum Kennedyi var. **austromontanum** var. nov.

Plant with the habit of the species, but differing in having obovate or oblance-obovate calyx-segments which are gradually contracted into a cuneate base.—Ventura County: Fraziers Borax Mine, Mt. Piños, *Abrams & McGregor 264* (G); Upper Lockwood Valley, Mt. Piños, *Dudley & Lamb 4675* (B). San Bernardino County: Bear Valley, San Bernardino Mts., alt. 6500 ft., July 4, 1920, *R. D. Harwood 4369* (type, Baker Herb. 9162); Bear Valley, San Bernardino Mts., *Parish 3736* and *3166* (G), *Abrams 2890* (G), *Abrams 2119* (B); summit of San Gorgonio, alt. 11500 ft., *Grant 453* (B, G), San Gorgonio Summit, 11000 to 11500 ft. alt., *Munz 6208* (B); San Gorgonio Mt., alt. 11700 ft., *Burlew 3587* (G).

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In the San Bernardino Mts. about the crest of Mt. San Gorgonio, at altitudes from 11000 to 11700 ft., the var. *austromontanum* becomes consistently much reduced in stature, having stems only 1–2 cm. high. This form, typified by *Munz 6208* (Baker Herb. 12844), may be known as the forma **alpigenum.**

Malvastrum clementinum sp. nov.

A rounded tufted shrub with many ascendingly branched stems 7–10 dm. high; stems rather coarse, tomentose when young; leaves angularly 3-lobed or orbicular or ovate, 3–5 cm. broad, base cordate, margin irregularly crenate, upper surface green but with a very sparse stellate pubescence, under surface canescent with a dense stellate tomentum, veiny; flowers many, subsessile and densely glomerate in the axils of the uppermost leaves and continuing out into an elongate naked interrupted spike 1–2 dm. long; calyx 7 mm. high, loosely stellate-tomentose; calyx-lobes broadly lanceolate, acute, enervose, 4 mm. long; bractlets filiform, well developed, nearly reaching the tips of the calyx-lobes; corolla pink, in color suggesting that of apple-blossoms, lobes oblong-obovate, about 13 mm. long; carpels 2.5–3 mm. high, 8–10, thin-walled, smooth, promptly deciduous, inner edge excised, summit stellate-tomentose, sides and base glabrous; seeds ovoid, 1.8 mm. long, short villous.

LOS ANGELES COUNTY: On walls of the canyon running into the sea from Lemon Tank, San Clemente Island, April 9, 1923, *Munz 6684* (TYPE, Baker Herb. 20491; ISOTYPE, Gray Herb.).

This beautiful Malvastrum was found to be occasional in rock-crevices and at the base of rocky walls of a very precipitous canyon on the northeast side of San Clemente Island. It is characterized by its pale dense stellate pubescence with long trichome-branches, by its conspicuously bicolored leaves, and by its very dense interrupted spicate inflorescence. It suggests typical *M. fasciculatum* (T. & G.) Greene in the contour of its bicolored leaves, but differs in its much looser pubescence of long whitish hairs, in its more crowded flowers, more deeply lobed and more loosely pubescent calyces, and very much longer bractlets. From *M. Fremonti* Torr. and allies, which it suggests in its loose tomentum and interrupted congested spikes, it differs in its longer pubescence, bicolored leaves, and longer bractlets.

Malvastrum nesioticum Robins., an endemic of Santa Cruz Island, differs from *M. clementinum* in the characters enumerated for *M. fasciculatum*, and furthermore, like **M. fasciculatum** var.

laxiflorum (Gray) n. comb.,* may be distinguished by its very branched lax inflorescence.

✓ **Styrax officinalis** var. **fulvescens** (Eastw.) comb. nov.

Styrax californica var. *fulvescens* Eastw. Bot. Gaz. **41**: 286. 1906.

SANTA BARBARA COUNTY: Santa Barbara, 1873, *Bolander* (G); Santa Inez Mts., 1891, *Dunn* (B); Painted Cave Ranch, *Eastwood 33* (G). LOS ANGELES COUNTY: "Los Angeles," 1879, *Nevin* (G). SAN BERNARDINO COUNTY: Waterman Canyon, *Parish 11389* (B), *Munz 2228* (B), 1916, *Crawford* (B); City Creek, *Johnston 2857* and *2935* (B); Devil Canyon, 1904, *Wilder* (B); San Bernardino, 1896, *Cummings* (G); *Wright 210* (G); without locality, 1876, *Parry & Lemmon 226* (G). ORANGE COUNTY: Trabuco Canyon, 1903, *Bradshaw* (B), *Peirson 3493* (B). SAN DIEGO COUNTY: Mesa Grande, *Spencer 1147* (B, G).

Perkins (Pflanzenr. iv. Fam. 241, 10 and 80. 1907) has treated *S. californica* Torr. and *S. californica* var. *fulvescens* Eastw. as identical with *S. officinalis* L., a species of the Mediterranean region of the Old World. *Styrax officinalis* is, indeed, very closely related to the Californian plants, particularly so to typical *S. californica*. The latter has the same shape of leaf and similar flowers, differing from the Mediterranean species chiefly in pubescence, being glabrate or lightly tomentose on the under side leaf-surfaces instead of closely and densely white-tomentose. In certain material from Greece, however, the pubescence is similar to the densest produced by *S. californica*. In *S. californica* var. *fulvescens*, and in the pubescent forms of *S. californica* the pubescence is dimorphic on the veins and mid-rib, dark colored trichomes (appearing as glandular atoms to the unaided eye) being scattered among and projecting above the pallid mass of the tomentum. These trichomes are present in the European material, but are not dark-colored. The style in the Mediterranean plants appears to be less compressed than in the American material and is less evidently lobed. Since the only differences detectable between the European and

* *Malvastrum Thurberi* var. *laxiflorum* Gray, Proc. Am. Acad. **22**: 291. 1887. *M. splendidum* Kell., Proc. Calif. Acad. Sci. **1**: 65. 1855. *Malacothamnus fasciculatus splendidus* Abrams, Bull. N. Y. Bot. Gard. **6**: 417. 1910.

Californian material are minor ones and relative in nature, it has been thought best to treat the two Californian forms of *Styrax* as **S. officinalis** var. **californica** (Torr.) n. comb. and as *S. officinalis* var. *fulvescens* (Eastw.) Munz & Johnston.

Styrax officinalis var. *fulvescens* differs from the var. *californica* in its broader, heavily tomentose, usually subcordate leaves, and characteristically fulvescent pubescence. It ranges along the coastal slopes of California from the mountains back of Santa Barbara to those back of San Diego, whereas the var. *californica* occurs in northern California on the hills surrounding the Sacramento valley, from Colusa and Calaveras Counties northward to Shasta County. The range of the two varieties is hence widely separated.

Phacelia (§ Eutoca) **Keckii** sp. nov.

Erect or ascending annual 1–4 dm. high, branching freely, densely short spreading viscid villous, somewhat canescent but stems more or less reddish brown in color; leaves firm, concolored, ovate or oblong, principal ones 20–35 mm. long and 9–20 mm. wide, deeply crenate-dentate, apex obtusish, base broadly cuneate; petioles of lower leaves 15–20 mm. long, of upper leaves 3–7 mm. long; flowers in rather dense terminal unilateral circinate racemes becoming 3–5 cm. long; pedicels 1–2 mm. long; sepals green, narrowly oblanceolate, acute, short viscid hirsute, becoming 7–8 mm. long; corolla tubular-funnelform, sparsely pubescent outside, 12–14 mm. long, ca. 7 mm. wide, the expanded throat and ascending limb purplish-red; lobes suborbicular, ca. 2.5 mm. long; tube cylindrical, 2.0 to 2.5 mm. thick, about 8 mm. long, yellowish with linear purplish stripes; stamens glabrous, unequal, 5–6 mm. long; appendages linear, 2–3 mm. long, adnate to corolla, united to filaments for about 2 mm.; ovary and style glandular and pubescent; style scarcely exceeding calyx, apically bifid; ovules ca. 8; capsules 4–5 mm. long, ovoid, pubescent; seeds brownish, angled, acute ovate or oblong in dorsal outline, coarsely foveolate.

RIVERSIDE COUNTY: along trail from Glen Ivy to Santiago Peak, Santa Ana Mts., alt. 4000 ft., *Munz 7056* (TYPE, Baker Herb. 20490; ISOTYPE, Gray Herb.). ORANGE COUNTY: west slope of Santa Ana Mts., alt. 4800 ft., *Munz 7763* (B).

Growing on dry slopes and ridges in the chaparral belt, between 3500 and 5000 ft. alt., on both the east and west sides of the Santa Ana Mts. The species is apparently most closely related to *P. suaveolens* Greene, and keys out to that species in

Brand's monograph (Pflanzenr. iv. Fam. 251, 113, fig. 19. 1913). It differs in its much longer narrower corolla, smaller, narrow capsule, and detached southern range. The two species are similar in gross aspect. The new species is named for Mr. David Keck, an enthusiastic young student, who helped collect the type and who has been of much assistance to the senior author in field work.

Galium gabrielense sp. nov.

A dioecious perennial herb 5–20 cm. high, dull and cinerescent throughout from a short hirsute pubescence, with a coarse taproot crowned with a small compact caudex tending to produce short stolons; stems herbaceous, in crowded tufts, simple or branched only above, evidently quadrangular, each side bisulcate; leaves in whorls of 4, linear or rarely oblongish, 5–10 mm. long, 1–2 mm. broad, acute but not cuspidate, commonly not exceeding the internodes; inflorescence cylindrical, 3–8 cm. long, 2–3 cm. thick, consisting of small cymes terminating the stem and the rather numerous short ascending laterals; corolla yellowish, short hirsute externally, with 4 oblong-ovate broadly acute spreading lobes, limb 3 mm. broad; fruit covered with long (1–1.5 mm.) white straight hairs; carpels 1.5 mm. thick, dry.

LOS ANGELES COUNTY: Baldy U. S. F. S. Lookout, alt. 7000 ft., *Johnston 1262* (B); Cow Canyon Divide, June 7, 1919, *Peirson* (B). SAN BERNARDINO COUNTY: ridge east of Ontario Peak, alt. 8400 ft., *Munz 6078* (TYPE, Baker Herb. 13691); San Antonio Canyon, alt. 5750 ft., *Johnston 1591* (B).

This species is not uncommon in the pine-belt of the eastern section of the San Gabriel Mts. in the vicinity of Mt. San Antonio. It frequents well drained gravelly situations under the pines and forms scattered open colonies 1–2 m. broad. It was reported by Johnston (Plant World **22**: 118. 1919) as doubtfully referable to *Galium siccatum* Wight. Wight's type is in the herbarium of the California Academy of Sciences, and evidently represents a bushy fruticose plant 3–12 dm. high. It suggests *G. angustifolium* Nutt. in gross habit, and may be only a cinereous-puberulent phase of the Nuttallian species. *Galium gabrielense* is, hence, not a close relative of *G. siccatum*. Its relations are probably with *G. multiflorum* Kell. and its relatives, from which the new species is readily distinguished by its tufted strict habit, narrow leaves, and dull grayish hirsute pubescence.

Downingia concolor Greene

Jepson (Madroña **1**: 101. 1922) in his excellent recent revision of the Californian Downingias does not report this species from Southern California, but the following material, which differs from the subjoined species in having two nipples and two purple spots at the faucal edge of the lower corolla-lip, as well as having the lateral corolla-sinuses cut below the plane of the limb, is either *D. concolor* Greene (Bull. Calif. Acad. Sci. **2**: 153. 1886) or a closely related undescribed form.

SAN DIEGO COUNTY: Margin of Cuyamaca Lake, *Abrams 3851* (G); in shallow water, Cuyamaca Valley, *Parish Bros. 394* (G); in pools on the mesas, May 5, 1920, *Spencer 1073* (B).

✓ **Downingia immaculata** sp. nov.

Erect glabrous annual herb, branched only at the base, 1–2 dm. high; leaves few oblong or oblong-lanceolate, 5–12 mm. long, 1.5–2.5 mm. wide; sepals linear, ascending or erect, equalling or exceeding the length of the corolla-tube; corolla predominantly blue; lower lip flat, 9–14 mm. broad, with 3 spreading broadly obovate somewhat angular mucronate lobes, with a white central field enlivened by 2 more or less confluent yellow spots and traversed by two weak plaits; upper lip cleft, the 2 lobes narrow, acute, paralleling or slightly spreading, curving backwards; lateral corolla-sinuses scarcely if at all cut below plane of limb; corolla-tube narrowly funnelform, in length about equalling the upper corolla-lobes, 3–4 mm. long; corolla-throat obscurely bidentate on lower edge, unspotted; stamineal tube partially exserted, practically straight, cylindrical, ca. 2.5 times as long as thick.

RIVERSIDE COUNTY: On desiccated clay mud-flat south of Lake Elsinore, alt. 1250 ft., April 29, 1922, *Munz 5093* (TYPE, Baker Herb. 13766); Perris, 1922, *Banning Flower Show* (B); rare on desiccating mud-flat, Menifee Valley, alt. 1350 ft., *Munz & Johnston 5380* (B). SAN DIEGO COUNTY: In clay depressions on the mesas, San Diego, *T. S. Brandegee* (*Baker distribution*) *1668* (B, G); wet places around shallow pools, 6 mi. north of San Diego, *Peirson 3394* (B); in pools on Camp Kearny road, San Diego, alt. 400 ft., April 16, 1919, *Spencer 1073* (G); exsiccated places on mesas, near San Diego, *Abrams 3445* (B, G).

This is the most common Downingia in Southern California and that which has mainly passed as *D. pulchella* (Lindl.) Torr.

That species differs, however, in having usually a larger corolla with different proportions and a lighter shade of blue and has 3 small blue spots along the faucal edge of the lower lip, in addition to having more developed, straight, strongly divergent upper corolla-lobes, a less developed corolla-tube, an evidently exserted stamineal tube, divergent sepals, and a distinct northern range.

The only material of true *D. pulchella* studied from Southern California is the specimen in the Gray Herbarium collected by J. G. Cooper in "wet ground" on the "Upper Mojave River ?." From this station and others in San Luis Obispo County, it ranges northward through the state. It is not improbable that *D. immaculata* is the same as *D. pulchella* var. *arcana* Jepson (Madroña **1**: 100. 1922), a variety based upon material collected at La Mesa, San Diego County. Since both *D. immaculata* and *D. concolor* occur in that vicinity and are equally well covered by Jepson's brief description, we are basing our *D. immaculata* upon material which we know to be characteristic of the concept we have in mind, rather than forming a binomial based upon Jepson's trinomial.

Stephanomeria Blairi sp. nov.

A coarse-stemmed, straggly, lactiferous shrub ca. 12 dm. high; flowering branch decidedly woody, 4–5 dm. long, becoming 8–10 mm. thick, lightly white-tomentose above, below lucid light-brown and studded with the persistent indurated bases of the petioles; leaves crowded, abruptly reduced up the stem, obovate to oblong-obovate, 5–13 cm. long, 4–6 cm. broad, firm but rather thin, light green, glabrate, secondary venation evident and abundant, base broadly cuneate, apex rounded, margin very coarsely and unequally sinuate or lobulate; petioles ca. 1 cm. long, frequently narrow winged, base thickened and persistent; inflorescence terminal, stiff, paniculate, 5–20 cm. long, 8–10 cm. thick, branches strict or ascending and several to many-headed; peduncles 2–4 mm. long, stiff, bracteolate; heads narrowly cylindrical, 9–12-flowered, ca. 7 mm. high; inner tegules about equal, linear rounded, pale green and somewhat tinged with rose, 6 mm. long; outer tegules short-lanceolate 1–2-seriate, 1–1.5 mm. long; ligules rose-colored, ca. 1 cm. long, somewhat puberulent outside, tip 2–3-dentate; anthers deeply sagittate, ca. 5 mm. long, auricles linear and obtusish or even subapically dilated; style-branches linear; achenes 3–3.5 mm. long, 5–6 times as long as thick, gray-brown, pentangular, faces with 1–3 shallow longitudinal grooves, apex truncate, base callous-tipped; pappus of numerous white antrorsely bearded deciduous bristles ca. 4 mm. long; receptacle low convex, glabrous, bearing umbonate scars left by the excavated bases of the achene.

LOS ANGELES COUNTY: On a rocky canyon-wall, San Clemente Island, 1923, *E. G. Blair* (TYPE, Baker Herb. 20492); on rocky walls of the canyon running from Lemon Tank, San Clemente Island, *Munz 6681* (B).

A very remarkable species, apparently without immediate relatives, differing from all its congeners in its coarse woody habit and broad herbaceous veiny leaves. Although in gross aspect strange in Stephanomeria, the reproductive structures of the plant are quite characteristic of the genus. It is a pleasure to name this plant in honor of Mr. E. G. Blair of the San Clemente Sheep Co., who extended many courtesies to a Pomona College party during a visit to San Clemente Island in 1923, and who has obligingly furnished us with a fine flowering and fruiting specimen from the cliffs where the senior author had obtained a weathered inflorescence.

Studies in the genus Lupinus—XI. Some new names and combinations

Charles Piper Smith

The lupines of California, Oregon, and Washington have not as yet been treated, as a unit, by any one writer. Numerous botanists, holding widely differing taxonomic views, have contributed much to the literature of this genus in these three States, some one hundred ten species having been described from California alone, and about fifty others from Oregon and Washington. Recently I have attempted to coordinate all of these propositions, with the natural result that I find it necessary to present some new names and combinations. Accordingly I here offer some nomenclatural adjustments, in advance of a general treatment that will necessarily, because of its bulk, appear elsewhere.

1. **Lupinus lyallii fruticulosus** (Greene) comb. nov.
Lupinus fruticulosus Greene, Muhlenbergia **8:** 117. 1912.
The stoutest form of the species, with leanings toward *L. aridus:* flowers large and banner broad.

2. **Lupinus aridus Washoensis** (Heller) comb. nov.
Lupinus pinetorum Heller, Muhlenbergia **6:** 25. 1910; not *Lupinus pinetorum* Jones, Contr. West Bot. **8:** 25. 1898.
Lupinus Washoensis Heller, Muhlenbergia **6:** 72. 1910.
Pubescence long and widely spreading.

3. **Lupinus aridus Torreyi** (Gray) comb. nov.
Lupinus Torreyi Gray, King Expl. 58. 1871.
Lupinus sellulus Kellogg, Proc. Calif. Acad. **5:** 36. 1873.
Peduncles elongated, usually exceeding the foliage.

4. **Lupinus aridus abortivus** (Greene) comb. nov.
Lupinus abortivus Greene, Muhlenbergia **8:** 117. 1912.
Pubescence mostly short and appressed; racemes slender and loosely-flowered.

5. **Lupinus aridus Cusickii** (S. Wats.) comb. nov.
Lupinus Cusickii S. Wats., Proc. Am. Acad. **22:** 469. 1887.
Peduncles shorter and racemes all equalled or surpassed by the foliage, densely-flowered.

6. **Lupinus lepidus Culbertsoni** (Greene) comb. nov.

Lupinus Culbertsoni Greene, Leaflets **1:** 73. 1904.

Stems usually short, foliage greenish, not silky; lower flowers suberect after anthesis.

7. **Lupinus lepidus confertus** (Kellogg) comb. nov.

Lupinus confertus Kellogg, Proc. Calif. Acad. **2:** 192. 1862.

Stems usually elongated and leafy; foliage usually silky, not greenish; flowers many, crowded, spreading after anthesis.

8. **Lupinus laxiflorus calcaratus** (Kellogg) comb. nov.

Lupinus calcaratus Kellogg, Proc. Calif. Acad. **2:** 195. 1862.
Lupinus multitinctus A. Nels. Bot. Gaz. **53:** 221. 1912.
Lupinus variegatus Heller, Muhlenbergia **8:** 89. 1912.

Calyx-spur 1–3 mm. long. Too near *L. laxiflorus* to be a distinct species.

9. **Lupinus inyoensis demissus** var. nov.

Plantae 1–3 dm. altitudine, racemis 3–4 cm. longis, compactis, pedicellis 2 mm. longis, floribus 8–10 mm. longis, vexillo glabro.

Plants 1–3 dm. tall, racemes 3–4 cm. long, compact, pedicels 2 mm. long, flowers 8–10 mm. long, calyx merely gibbous, not woolly, banner suborbicular, glabrous.

OREGON. Baker County: Wallowa Mountains, 3 Sept., 1915, *M. E. Peck 5329* (WSO).

10. **Lupinus caudatus subtenellus** var. nov.

Foliolis linearis pubescentibus bene viridibus, racemis laxis, floribus 8–10 mm. longis, pedicellis gracilioribus 3–5 mm. longis.

Leaflets linear, short hairy, decidedly greenish, racemes lax, flowers 8–10 mm. long, pedicels more slender, 3–5 mm. long.

OREGON. Deschutes County: Paulina Lake, 30 July, 1894, *J. B. Leiberg 591* (UO).

11. **Lupinus holosericeus amblyophyllus** (Robinson) comb. nov.

Lupinus canescens amblyophyllus Robinson, Piper, Contr. U. S. Nat. Herb. **11:** 354. 1906.

Bracts early deciduous, as in *L. holosericeus* Nutt. and to which it is certainly closer than to *L. canescens*.

WASHINGTON. Douglas County: Egbert Springs, 5 July, 1893, *Sandberg & Leiberg 402* (CA, SCW).

12. **Lupinus bingenensis dubius** var. nov.

A *L. bingenensi* differt carina ciliata in marginibus superioribus.

Differing only in the keel being constantly ciliate on more or less of the upper edges, petals blue or white.

WASHINGTON. Benton County: Prosser, 27 May, 1903, *J. S. Cotton 1106* (TYPE, SCW 14130). Yakima County: Cleman Mountain, 13 May, 1923, *E. Nelson 1467* (CPS); Naches, 10 May, 1923, *E. Nelson 1453* (CPS); Yakima, 10 May, 1923, *E. Nelson 1452* (CPS). Kittitas County: Ellensburg, 2 May, 1897, *K. Whited* (UO).

BRITISH COLUMBIA. Kaslo District: Creston, 12 July, 1920, *W. B. Anderson 5949* (CPS).

13. **Lupinus oreganus Kincaidi** var. nov.

Labio superiore calycis brevi non operto lateribus reflexis vexilli, ungue vexilli longo.

Upper calyx-lip short, not concealed by the reflexed sides of the long-clawed banner.

OREGON. Benton County: Corvallis, 8 June, 1898, *T. Kincaid* (TYPE, SCW 14281).

14. **Lupinus oreganus pusillulus** var. nov.

Plantae solum 1–2 dm. altitudine, floribus 8–9 mm. longis, pedicellis prope 3 mm. longis pilis pandentibus, labio superiore fere inoperto.

Plants 1–2 dm. tall, flowers 8–9 mm. long, pedicels about 3 mm. long, spreading-pubescent, upper calyx-lip entirely exposed.

OREGON. Josephine County: Waldo, 13 miles southwest, 1 July, 1918, *M. E. Peck 8080* (TYPE, WSO; type duplicate, CPS).

15. **Lupinus leucophyllus Belliae** var. nov.

Floribus solum 8–10 mm. longis, caulibus plus minus villosis, racemis plerumque densis.

Flowers only 8–10 mm. long, stems more or less villous, racemes usually dense.

IDAHO. Power County: Crystal Creek, Sept., 1914, *Mrs. May Bell Zundel* (TYPE, DS; type duplicate, CPS).

Very common in eastern Oregon, Washington, and Idaho; about fifty sheets examined.

16. **Lupinus leucophyllus canescens** (Howell) comb. nov.

Lupinus canescens Howell, Erythea **1:** 110. 1893.

Flowers 8–10 mm. long, racemes dense or almost lax, stems without spreading hairs.

17. **Lupinus leucophyllus tenuispicus** (A. Nels.) comb. nov.

Lupinus tenuispicus A. Nels. Bot. Gaz. **54:** 410. 1912.

Flowers only 6–7 mm. long, banner suborbicular, racemes very slender, many-flowered, pubescence very short, somewhat spreading and tangled.

18. **Lupinus albifrons flumineus** var. nov.

Frutex humilis foliis parvis, foliolis petiolo 3–4-plo brevioribus, pilis pedicelli appresso-pubescentibus.

Low shrub with small leaves, the petioles 3–4 times as long as their leaflets, pedicels appressed-pubescent.

OREGON. Marion County: Willamette River, above Salem, 24 June, 1916, *J. C. Nelson 741* (TYPE, DS 71759).

Riverbanks and mountain sides, Oregon City to Siskiyou County, California; many sheets examined. I have collected it near Salem, Eugene, Wolf Creek, Grants Pass, Gold Hill, and Ashland. This is the *Lupinus holosericeus* of Howell, Piper, and others, not of Nuttall.

19. **Lupinus lapidicola** Heller, sp. nov.

Pumilio subalpina abbreviata appresso-sericea, foliis ad basin congregatis, utrimque sericeis, petiolis gracilibus 20–45 mm. longis, foliolis 7 ad 8, oblanceolatis apice acutis prope 10 mm. longis; pedunculis scaposis erectis aut ascendentibus 5–8 cm. longis, racemis subcapitatis, verticillis 2–3 bene separatis; floribus paucis 10–12 mm. longis, pedicellis 2–3 mm. longis appresso-sericeis; calyce sericeo labio superiore subdentato inferiore paulo tridentato; petalis caerulis aut purpuratis, vexillo glabro aut paulo pubescenti exterius, carina ciliata aut eciliata; legumina seminaque non vidi.

Appressed-silky, abbreviated, subalpine dwarf, scarcely 1 dm. tall; leaves crowded basally, silky both sides, petioles slender, 20–45 mm. long, leaflets 7 to 8, oblanceolate, acute at apex, about 10 mm. long; peduncles scape-like, erect or ascending, 5–8 cm. long, racemes subcapitate, of 2 or 3 well-separated whorls, about 4 cm. long; flowers few, 10–12 mm. long, pedicels 2–3 mm. long, appressed-silky, bracts subpersistent; calyx silky, upper lip notched, lower minutely tridentate; petals blue or purple, banner with a dull-yellow center, glabrous or somewhat pubescent on the back, keel ciliate on the upper edges or non-ciliate, only the short acumen upturned; pods and seeds not seen.

CALIFORNIA. Siskiyou County: Gravelly slopes of Mount Eddy, 9 July, 1920, *A. A. Heller 13422* (TYPE, DS 113281; type duplicate, UCX).

20. **Lupinus sericeus flexuosus** (Lindl.) comb. nov.

Lupinus flexuosus Lindl., Agardh, Syn. Gen. Lup. 34. 1835.
Lupinus ornatus bracteatus Robinson, Piper, Contr. U. S. Nat. Herb. **11:** 355. 1906.
Lupinus subulatus Rydb., Bull. Torrey Club **34:** 43. 1907.

Pubescence of stems and petioles all appressed, but pedicels spreading-pubescent; floral bracts subpersistent, equalling or exceeding the buds.

21. **Lupinus ornatus obtusilobus** (Heller) comb. nov.

Lupinus obtusilobus Heller, Muhlenbergia **8:** 115. 1912.

Usually not over 3 dm. tall, subdecumbent to ascending; petioles 3–4 cm. long, pedicels more loosely appressed-pubescent, lower calyx-lip often tridentate.

22. **Lupinus latifolius columbianus** (Heller) comb. nov.

Lupinus confusus Heller, Muhlenbergia **8:** 63. 1912.
Lupinus columbianus Heller, ibid. **8:** 84. 1912.
Lupinus agninus Gandoger, Bull. Soc. Bot. France iv, **13:** 461. 1913.

Wing petals broader, outcurved on the lower free margins, covering all or most of the keel; leaflets glabrous above.

23. **Lupinus latifolius canadensis** var. nov.

A var. *columbiano* differt foliolis constanter pubescentibus super pilis brevibus appressisque.

Differing from var. *columbianus* only in having the leaflets consistently pubescent above with short appressed hairs; stems commonly branched, but sometimes simple and shortened.

BRITISH COLUMBIA. Vancouver Island: Colwood, 24 June, 1915, *C. F. Newcombe* (TYPE, DS; type duplicate, CPS); Duncan, 21 June, 1917, *W. B. Anderson* (CPS, PBC); Goldstream, 3 June, 1911, *C. F. Newcombe* (CPS); Oak Bay, 14 June, 1896, *J. R. Anderson* (CVP); Mount Benson, 27 June, 1898, *J. R. Anderson* (CPS, PBC); Palmer to Colwood, 25 July, 1922, *C. F. Newcombe*

& C. P. Smith 3677 (CPS); Sahtlam, 11 May, 1915, *E. M. Anderson* (CPS, PBC); Shawingan, 24 May, 1897, *J. R. Anderson* (CPS, CVP, PBC); same, 19 July, 1917, *C. F. Newcombe* (CPS). Yale District: Mount Cheam, 14 Aug., 1896, *J. R. Anderson* (CPS, PBC). Lillooet District; Mount McLean, 28 July, 1916, *E. M. Anderson 2962* (CPS, PBC).

I am informed by both Mr. W. R. Carter and Dr. C. F. Newcombe that this is the most common and representative lupine of Vancouver Island. It has been called *L. nootkatensis*, *L. arcticus*, *L. laxiflorus*, and *L. columbianus*.

24. **Lupinus latifolius subalpinus** (Piper & Robinson) comb. nov.

Lupinus subalpinus Piper & Robinson, Contr. U. S. Nat. Herb. **11**: 356. 1906.

This also belongs to Heller's group *Latifolii* (Muhlenbergia **8**: 63. 1912), as shown by the ciliation of the keel, and is, to me, just another of the many variations of *L. latifolius*, *sensu lato*.

25. **Lupinus Abramsi** sp. nov.

Plantae ramosae decumbentes 5–6 dm. altitudine, albilanato-villosae; foliis albilanatis utrimque, petiolis brevis 3–5 cm. longis, foliolis 8 aut 9, oblanceolatis; pedunculis 6–10 cm. longis, racemis 15–25 cm. longis; floribus 14–16 mm. longis pandentibus verticillatis, bracteis deciduis villosis 10 mm. longis, pedicellis 4–7 mm. longis lanato-villosis; calyce bracteolato lanato labio superiore bifido inferiore tridentato; petalis latis caerulis vexillo pubescente apice exterius 15–16 mm. lato, carina ciliata marginibus superioribus; ovules 8 aut 9, legumina seminaque non vidi.

White-woolly-villous, decumbent, branched, 5–6 dm. tall; leaves many, white-woolly both sides, petioles short, 3–5 cm. long, leaflets 8 to 9, oblanceolate, acute or obtuse, 20–30 by 5–7 mm.; peduncles 6–10 cm. long, racemes 15–25 cm. long, flowers 14–16 mm. long, spreading, verticillate, bracts deciduous, villous, 10 mm. long, pedicels 4–7 mm. long, woolly-villous; calyx non-gibbose, woolly, upper lip bifid, lower 3-toothed; petals broad, blue, banner suborbicular, pubescent on the back near apex, 15–16 mm. wide, with a yellow center, keel slightly curved, ciliate along acumen and middle; ovules 8 to 9, pods and seeds not seen.

CALIFORNIA. Monterey County: Los Pesares, Santa Lucia Mountains, 9 June, 1920, *L. R. Abrams 7358* (TYPE, DS 103181); same, *L. R. Abrams 7360* (DS).

This belongs to Heller's group *Arborei* (Muhlenbergia **8:** 65. 1912); but cannot, as I see it, be referred to any of the described species, though having considerable resemblance to the very villous *L. formosus Bridgesii* Greene, of the *Albicaules*.

26. **Lupinus Cottoni** sp. nov.

Caules e stirpe ligneo eramosis corpulentis fistulosis glabratis; foliis paucis nullis ad basin, petiolis inferioribus 10–18 cm. longis, foliolis 5 ad 9, oblanceolatis, lucido-viridis, glabris super subpubescentibus subter; pedunculis 4–10 cm. longis, racemis 10–20 cm. longis; floribus 11–14 mm. longis subverticillatis, pedicellis 4–5 mm. longis gracilibus pilis pandentibus; calyce bracteolato labio superiore serrato aut integro inferiore integro, petalis latis, carina curvata paulo ciliata super marginibus; leguminibus 20 × 5 mm., appresso-pubescentibus, ovulis prope 6, seminibus 4 mm. longis pallidis minute maculatis.

Glabrate, 30–50 cm. tall, few-leaved, simple, stout, fistulous, from a woody caudex; leaves cauline, none strictly basal, lower petioles 10–18 cm. long, upper shorter, stipules lance-linear, 8–20 mm. long, leaflets five to nine, oblanceolate, acute, bright green, glabrous above, minutely and sparsely pubescent beneath, 40–70 mm. long by 8–20 mm. wide; peduncles 4–10 cm. long, racemes 10–20 cm. long; flowers 11–14 mm. long, subverticillate, spreading after anthesis, bracts about 5 mm. long, appressed-pubescent, early deciduous, pedicels 4–5 mm. long, slender, spreading-pubescent; calyx bracteolate, upper lip about 4 mm. long, entire or notched, lower some 5 mm. long, entire; petals wide, banner glabrous, almost as wide as long, keel arcuate, sparsely ciliate about the middle of the upper edges; pods 20 × 5 mm., appressed-hairy, ovules 6, seeds about 4 × 3 mm., pale flesh-color, closely dotted with purplish brown.

WASHINGTON. Yakima County: Head of Hell Roaring River, Mount Rainier National Forest, 7000 feet, 6 Sept., 1903, *J. S. Cotton 1518* (TYPE, SCW 13430); Mount Adams, 10 July, 1882, *L. F. Henderson* (UO); same, 13 Aug., 1882, ———— (UO); same, 16 Aug., 1882, *T. J. Howell* (DS, UO).

Subalpine meadows, near snowline. Labelled *L. Burkei*, but evidently nearer *L. Wyethii*, as commonly interpreted.

The following list explains the abbreviations herein used in citing the specimens examined:

CA, California Academy of Science, San Francisco;
CPS, herbarium of the writer;
CVP, herbarium of Prof. C. V. Piper;
DS, Dudley Herbarium, Stanford University;

PBC, Provincial Museum, Victoria, British Columbia;
SCW, State College of Washington, Pullman;
UCX, Division of Agronomy, University of California Experiment Station;
UO, University of Oregon, Eugene;
WSO, Willamette University, Salem, Oregon.

SAN JOSE, CALIFORNIA.

INDEX TO AMERICAN BOTANICAL LITERATURE
1920–1924

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 the broadest sense.

Reviews, and papers that 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 omissions, their kindness will be appreciated.

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Aamodt, O. S. The inheritance of growth habit and resistance to stem rust in a cross between two varieties of common wheat. Jour. Agr. Research **24:** 457–470. *pl. 1, 2.* 12 My 1923.

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Abrams, L. R., & Coville, F. V. Juncaceae. In Abrams, L. R., An illustrated flora of the Pacific states **1:** 350–371. 1923. [Illust.]

Includes *Juncus macrandrus*, sp. nov.

Allen, R. F. Cytological studies of infection of Baart, Kanred, and Mindum wheats by *Puccinia graminis Tritici* forms III and XIX. Jour. Agr. Research **26:** 571–604. *pl. 1–7.* 22 D 1923.

Ames, O. Additions to the orchid flora of Central America. Sched. Orchid. **4:** 1–60. *pl. 2, 3.* 4 My 1923.

Includes *Lankasterella*, gen. and sp. nov., and new species in *Campylocentrum* (1), *Chondrorrhyncha* (1), *Cranichis* (2), *Cryptophoranthus* (1), *Dichaea*

(1), *Epidendrum* (9), *Habenaria* (1), *Malaxis* (1), *Oncidium* (1), *Ornithidium* (1), *Pleurothallis* (1), and *Stelis* (3).

Ames, O. Orchidaceae quaedam americanae. Sched. Orchid. **1:** 1–24. 18 N 1922.

Includes new species in *Elleanthus* (1), *Epidendrum* (9), *Gomphicis* (1), *Lepanthes* (1), *Physosiphon* (1), *Pleurothallis* (3), and *Stelis* (6).

Ames, O. Orchidaceae quaedam americanae II. Sched. Orchid. **2:** 1–38. *pl. 1.* 6 Ja 1923.

Includes new species in *Epidendrum* (5), *Lepanthes* (2), *Maxillaria* (1), *Ornithidium* (1), *Pelexia* (2), *Pleurothallis* (5), *Sarcoglottis* (4), *Spiranthes* (1), and *Stelis* (1).

Ames, O. New or noteworthy orchids. Sched. Orchid. **3:** 1–27. 30 Ja 1923.

Includes new American species in *Lepanthes* (3), *Ornithocephalus* (1), *Pleurothallis* (2), *Stelis* (3), *Telipogon* (1), and *Zygopetalum* (1).

Ames, O. New or noteworthy orchids from Central America and the Philippine Islands. Sched. Orchid. **5:** 1–42. *f. 1–6.* 6 Je 1923.

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Studies in Tortula as represented in Southern Arizona

Edwin B. Bartram

Viewed even in a restricted sense the species of Tortula from this region present some critical problems that are not lacking in interest and suggestion. The section Syntrichia, comprising a number of closely related species that have been interpreted in various ways by bryological students, is especially richly represented and I have been tempted to present some of the following conclusions, not as in any sense final but simply as a step toward a more complete understanding of this puzzling complex. The scarcity or absence of male flowers and sporophytes in several closely related species makes the result of critical study somewhat a matter of personal equation.

Tortula muralis (L.) Hedw. Represented by a single collection, in fruit, from the foothills of the Catalina Mts., on the shaded face of a boulder. The lower leaves mucronate and the comal leaves with the costa excurrent into a long smooth hyaline hair point two times or more the length of the leaf. Probably a form of var. *incana* (Bry. eur.).

Tortula inermis (Brid.) Mont. Common on ledges and banks in the foothills and extending up the mountain canyons to an elevation of 6500 ft. The closely folded leaves regularly spiralled with a low pitch give the dry plants a distinctive screw like aspect in the field that is very characteristic. Dozens of collections from widely separated localities are in every way uniform and indicate no transitional tendency toward *T. subulata*. The oblong ligulate, mucronate leaves with the margins strongly recurved almost to the apex are unlike anything else in the region.

[The Bulletin for July (51: 283-333) was issued July 24, 1924.]

TORTULA RURALIS (L.) Ehrh. Widely distributed over the foothills and mesas, on the shaded banks of dry washes, on slightly shaded slopes or even on the open desert where it is usually sterile and depauperate. In the mountain canyons at altitudes above 4000 ft. it is usually replaced by the following.

TORTULA MONTANA (N. v. E.) Lindb. Readily distinguished from *T. ruralis*, as a rule, by the concave, hardly carinate leaves, erect spreading when moist, the less strongly recurved leaf margins and especially the smaller more obscure leaf cells in the upper part of the lamina which rarely measure over 10 μ in diameter and often only 6 to 8 μ. Some forms show a slight tendency to intergrade with *T. ruralis* in one or more characters but in this region, at least, the species surely represents a well defined segregate that replaces *T. ruralis* almost entirely in the mountain canyons.

TORTULA ALPINA (Bry. eur.) Bruch. While this plant does not seem to have been credited to the North American flora heretofore, comparisons of various collections from Arizona with authentic European material of the species, generously supplied by Mr. Holzinger and Mr. Chamberlain, indicate that *T. alpina*, in various forms, is widely scattered through the canyons and foothills of mountain ranges in the southern part of the state. In this arid country the collections from shaded ledges below 4000 ft., in the treeless foothills, are naturally xerophytic types, somewhat dwarfed and reduced in every way. As one works up the canyons into the oak belt above 4500 ft., the plants become more typical and at 6000 ft. or above, where moisture and shade are not lacking, the collections, in part at least, approach closely to the typical form of the species. The variations seem to be of degree rather than kind and present a close series of transitional forms ranging from the xerophytic types of low altitudes with reduced leaves, broadly obtuse or emarginate at the apex as in figures 12 and 13 of the accompanying plate to well developed plants of higher altitudes with larger leaves less broadly pointed, as in figure 14, which seem to closely approximate typical *T. alpina* in every essential vegetative feature. Indeed these observations lead logically to the question of whether *T. alpina* and *T. laevipila* might not better be treated as extreme forms of a single specific aggregate, modified by environment but connected by a series of transitional forms.

Exsicc:—Holz. Musc. Ac. Bor. Am. No. 500 as *Tortula pagorum.*

Bartr. Mosses of So. Arizona No. 15 as *T. pagorum.*—No. 91 and No. 95.

TORTULA ALPINA (Bry. eur.) Bruch. var. PROPAGULIFERA Limp. in Rab. Krypt. Fl. 4^1: 683. (*Tortula pagorum* (Milde.) DeNot.; *Barbula laevipila* var. *pagorum* Husn.) The presence of characteristic propagula as figured by Limpricht, Vol. 1: 682* is the only character by which it seems possible to separate this variety from the plants referred elsewhere to *T. alpina.* In the same tuft are found plants with abundant propagula, others with only a few and still others devoid of them entirely. The dry plants with leaves folded lengthwise and tightly spirally incurved into a close head, the tendency of the hair point to become reduced to a short, more or less roughened arista, colored at the base, and the apparent preference for a rock substratum even where trees are available are all characters, which as far as the collections from this region are concerned, indicate a closer relationship to *T. alpina* than to *T. laevipila.* While the absence of any plants typical of *T. laevipila* is only a negative factor it is not without suggestion when compared with the distribution of the *T. alpina* composite over the same area.

Exsicc:—Holz. Musc. Bor. Am. No. 360 as *Tortula pagorum.*

Small Mosses of So. U. S. No. 39 as *Tortula papillosa.*

TORTULA ALPINA (Bry. eur.) Bruch. var. INERMIS (Milde.) DeNot. One of the very characteristic mosses of dry shaded, vertical rock faces in canyons of the Santa Rita Mts. and the Patagonia Mts. The plants grow in loose mats so lightly attached to the substrata that when sections are removed for specimens they seem to hang from the rock face like a curtain. The lamina structure is rather tender and fragile, much as in *T. fragilifolia* but not nearly so pronounced, the leaves are wide in the upper half with a broadly rounded apex, shortly mucronate by the excurrent red-brown costa, very similar to the outline of *T. latifolia* but always distinctly mucronate or even cuspidate. A fine moss agreeing in every essential particular with E. Bauer Musc. eur. Exsicc. No. 1595a, b from Italy also with a collection

* Limpricht's figure more closely reproduces the shape and appearance of these "brood leaves" than either figure 52, p. 86, or figure 53, p. 87, in Correns Vermehrung der Laubmoose.

by Dixon and Nicholson from Meran, S. Tyrol, Aug. 15, 1904. Apparently this is the first record from North America.

Exsicc:—Bartr. Mosses of So. Arizona No. 71 and No. 94.

TORTULA FRAGILIFOLIA sp. nov. (PLATE 7) Evidently dioicous, only sterile ♀ plants found. Plants robust, from 1 to 1.5 cm. high, branched above, strongly rufous tinged and lustrous throughout in dense cushions closely matted together with red radicles. Leaves erect spreading when moist, folded lengthwise and closely spirally incurved when dry, up to 2.5 mm. long, slightly concave, oblong spatulate to ovate oblong in outline, apex obtuse, shortly mucronate by the excurrent red-brown costa, margins narrowly recurved in the middle, distinctly crenately lobed in the upper half, torn and broken in various ways so that complete leaves are rarely if ever present; leaf cells rectangular and hyaline at the base, a well defined area of larger cells with richly colored walls in the median portion on either side of the costa bordered by a marginal band of about six rows of much smaller short rectangular cells, quickly becoming shorter and hexagonal quadrate above, 10 to 12 μ in diameter, strongly papillose on both sides with 4 to 7 large C shaped or forked papillae; costa red-brown, more or less rough and papillose on the back, in cross section showing two large median guide cells, about three smaller cells in one or two layers on the ventral side and a thick stereid band of three or more layers on the dorsal side with the outer cells little or not differentiated. Reduced branches bearing ecostate, ovate acuminate, verrucose propagula in the form of imbricated brood leaves are found sparingly in the axils of the upper stem leaves.

Type:—On bark near the base of Live Oaks along Baldy Trail, Santa Rita Mts., Santa Cruz County, Arizona. 7500 ft. E. B. Bartram No. 860. February 4, 1924.

Exsicc:—Bartr. Mosses of So. Arizona No. 87.

This plant suggests some connection with *T. alpina* var. *inermis* but the habitat on tree trunks, the dense cushions closely bound together by radicles, the very fragile structure of the lamina and the strongly crenately lobed margins would seem sufficient in the aggregate to give the plant a specific identity. It seems to be well distributed over the Santa Rita Mts. on bark near the base of oak trees above 6000 ft. but is more robust and characteristically developed at altitudes of 7500 ft. and over.

TORTULA AUREA sp. nov. (PLATE 6). Probably dioicous, male flowers not found, female flowers terminal or lateral by innovations, archegonia numerous, usually shrunken and unfertilized, with slender paraphyses. Plants robust, 1 to 2 cm. high, branched above or simple, in deep rather loose cushions, yellowish green above, light brown beneath, sparingly radiculose. Leaves spirally twisted when dry, erect spreading when moist, ovate lanceolate, tapering above to a sub-acute apex, about 2 mm. long, cuspidate by the stout excurrent costa which is occasionally prolonged into a smooth yellow hair point half as long as the leaf, margins spirally once or more revolute from base to apex; leaf cells golden yellow at the base, linear in the median portion 1 to 8 or 1 to 10, broader and shorter at the extreme base and short rectangular to quadrate toward the margins with yellowish pellucid walls, gradually shorter above, in upper half quadrate hexagonal, 10 to 12 µ in diameter, highly chlorophyllose and obscure with numerous papillae on both sides. Costa light brown, strong, about 90 µ wide from base to apex, smooth, in cross section showing two large median guide cells with one layer of about three somewhat smaller cells on the ventral side and a thick stereid band of three or more layers on the dorsal side with the outer row of cells somewhat larger.

Type:—On dry shaded ledges, Bear Canyon, Santa Catalina Mts., Pima County, Arizona. 2500 ft. E. B. Bartram No. 307. January 6, 1923.

Exsicc:—Mosses of So. Arizona No. 93.

Frequent and abundant on dry shaded ledges in the foothills of the Santa Catalina Mts. and the Tucson Mts. The absence of sporophytes leaves the relative position of this species rather uncertain but the characters in the aggregate seem to indicate a relationship to *Tortula muralis*, from any form of which it is abundantly distinct in leaf outline, spirally revolute margins and in the yellow pellucid basal areolation without any suggestion of hyaline cells.

Description of plate 6

Tortula aurea

FIGS. 1 and 2. Dry plants four-fifths natural size.
FIG. 3. Upper part of moist plant × 12.
FIGS. 4 and 5. Stem leaves × 16.
FIG. 6. Leaf apex × 40.
FIG. 7. Leaf apex × 80.
FIG. 8. One side of cross-section near middle of leaf × 240.
FIG. 9. Upper leaf cells × 240.
FIG. 10. Basal margin × 240.
FIG. 11. Median basal cells next to costa × 240.

Tortula alpina

FIG. 12. Leaf from plant growing on rubble bank in Patagonia Mts., Ariz. × 16.

FIG. 13. Leaf from plant growing on shaded ledges in Santa Catalina Mts., Ariz. × 16.

FIG. 14. Leaf from plant growing on rock face in Santa Rita Mts., Ariz. × 16.

Description of plate 7

Tortula fragilifolia

FIG. 1. Moist plant four-fifths natural size.
FIG. 2. Moist plant × 4.
FIGS. 3, 4, 5, 6. Leaves × 16.
FIG. 7. Propagula × 80.
FIG. 8. Basal cells on one side of costa × 80.
FIG. 9. One side of cross-section from lower half of leaf × 240.
FIG. 10. Cross-section of costa from upper half of leaf × 240.
FIG. 11. Upper leaf cells × 480.

Tortula alpina var. *propagulifera*

FIG. 12. Leaf from plant growing on tree in Santa Rita Mts., Ariz., × 16.

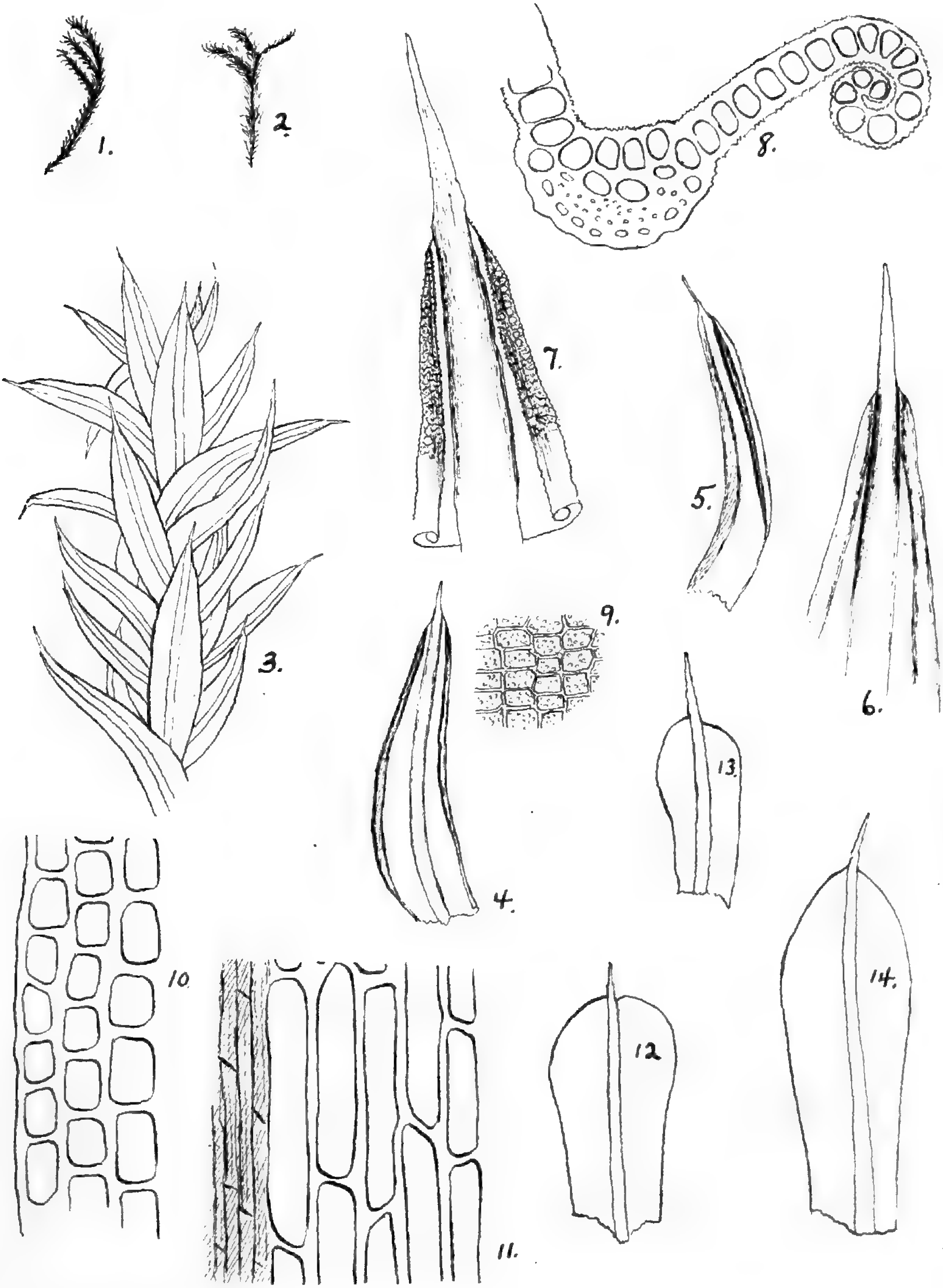
FIG. 13. Leaf from plant growing on tree in Patagonia Mts., Ariz. × 16.

FIG. 14. Leaf from plant growing on rocks at Harpers Ferry, Va. A. T. Beals' No. 3177 × 16.

FIG. 15. Leaf from plant growing on tree, Augusta, Ga. Small Mosses of Southern U. S. No. 39 × 16.

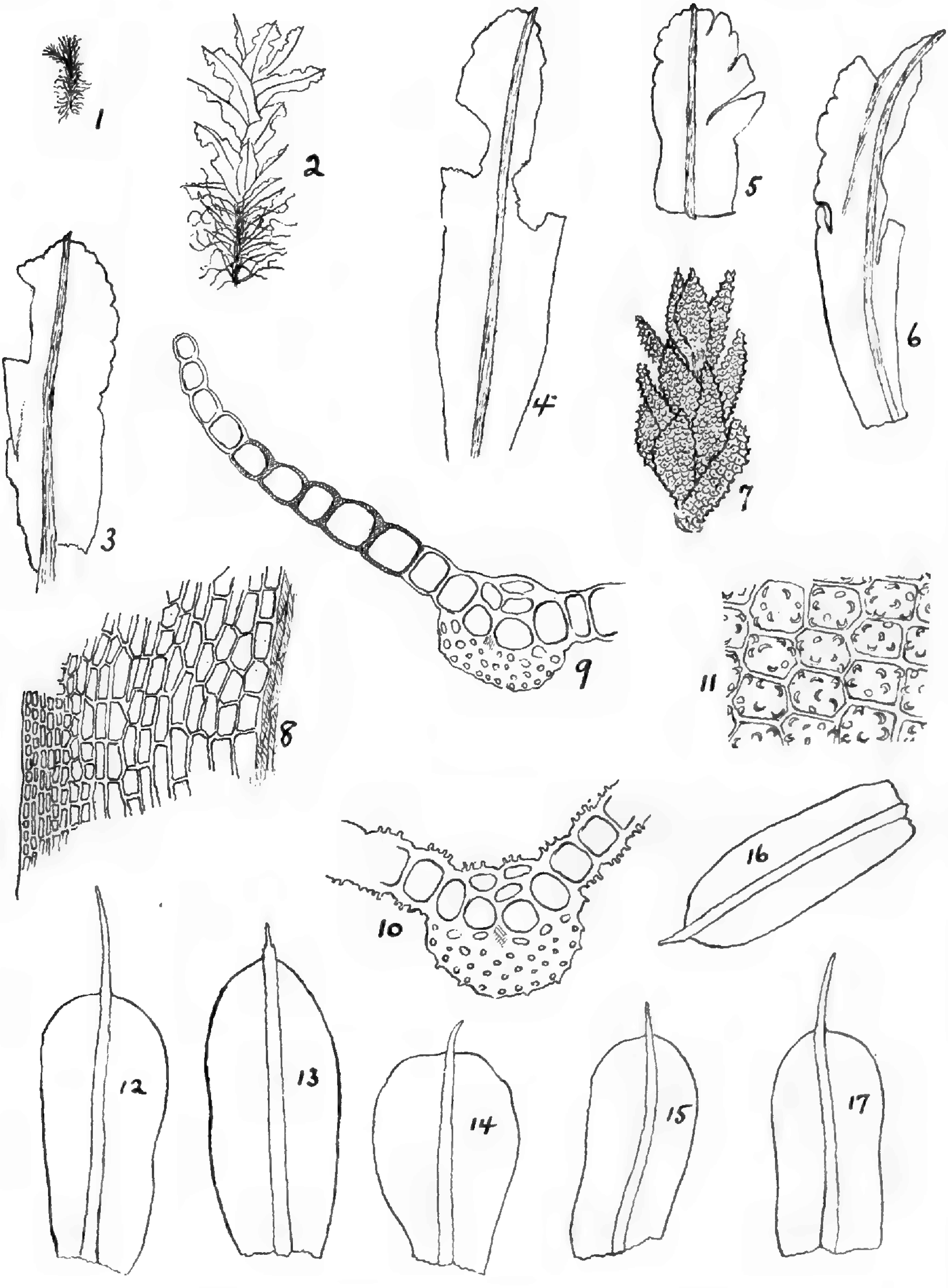
FIG. 16. Leaf from plant growing on ledges in Patagonia Mts., Ariz. × 16.

FIG. 17. Leaf from plant growing on tree, Berkeley, Calif. Holzinger Musc. Ac. Bor. Am. No. 360 × 16.



dei. E. B. Bartram.

1–11. TORTULA AUREA E. B. Bartram sp. nov.
12–14. TORTULA ALPINA (Bry. eur.) Bruch.



del. E. B. Bartram.

1–11. TORTULA FRAGILIFOLIA E. B. Bartram sp. nov.
12–17. TORTULA ALPINA var. PRCPAGULIFERA Limp.

The Gregarious Flowering of the Talipot Palm, *Corypha umbraculifera,* at Peradeniya, Ceylon *

William Seifriz

The extent to which the activities of a plant are determined or influenced by the environment has long been a subject of discussion and investigation among botanists. There are those (6) who maintain that "every life process must to some degree be dependent upon the external world," while others (11) hold to the belief that many vital phenomena are innate and, within certain limits, independent of the environment.

The problem of the possible influence of environmental factors on the activities of a plant assumes an especial interest in connection with the gregarious flowering of monocarpous plants of long life cycle. There are species of bamboo which flower gregariously over large areas after 32 years of a purely vegetative life. This habit is also characteristic of the talipot palm, *Corypha umbraculifera.*

There is a popular belief, which has received some support from scientific circles, that the phenomenon of simultaneity in flowering of monocarpous plants of long life cycles is due to drought (7). The writer has collected data bearing on this hypothesis and has found little evidence to support it. Whatever effect drought may have on gregarious flowering it is relatively slight, certainly not sufficient to be regarded as the ultimate determining factor of the phenomenon. The following data, previously collected, support this point of view:

1. The simultaneous flowering throughout the mountains of Jamaica in 1918 of the climbing bamboo, *Chusquea abietifolia,* whose vegetative life extends over a period of 32 or 33 years, was preceded not by a drought but by two years of rainfall which was above the average (8).

2. The gregarious anthesis of extensive forests of the bamboos, *Dendrocalamus strictus* and *Bambusa arundinacea,* estimated to cover in some instances areas of over a thousand square miles in India, is also not always preceded by a drought (10).

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* Contribution from the Osborn Botanical Laboratory, Yale University.

3. In 1918 there flowered simultaneously in the Peradeniya Gardens in Ceylon three species of monocarpic plants, *Corypha umbraculifera*, *Dendrocalamus giganteus*, and *D. strictus*, and a fourth species, *Bauhinia anguina*, which, while not monocarpic, flowers rarely. This remarkable instance of gregarious flowering was immediately preceded by a "drought" of such mildness that, when it is compared with other droughts of previous years which did not arouse the plants to anthesis, it cannot be regarded as the direct cause of this unusual simultaneous blossoming of three widely differing genera, all of which flower only after many years of purely vegetative growth.

4. At the time that the talipot palms, with other monocarpous and rarely flowering plants, were in blossom at Peradeniya, there was also in flower in the Buitenzorg Gardens in Java a talipot palm which had, every month of its life, been drenched in rain. Droughts are unheard of at Buitenzorg where even a normal dry season is a rarity (10).

5. There lives in Burma today a forest of *Bambusa polymorpha* covering hundreds of square miles, which has, since 1853, flowered sporadically in restricted and scattered areas. The forest *as a whole* has not flowered in these seventy years, although subjected to repeated droughts (10).

There is another case of gregarious anthesis which, though not in plants of monocarpic habit, has an interesting bearing on the problem of the possible effect of external environment on simultaneity in flowering. In the orchid, *Dendrobium crumenatum*, the time of the simultaneous appearance of the flowers is apparently due to a climatic influence occurring eight days in advance of the flowering. The environmental stimulus is commonly associated with, but not always accompanied by, rain (2 and 10). It is here suggested that this factor is possibly a humidity stress. High humidity may well occur without rainfall while it is always present with rainfall. It should be emphasized that it is the *time* of flowering rather than the simultaneity itself which the humidity stress determines. The *simultaneity* is due to an inherent characteristic of the orchids (10).

On the basis of the foregoing data it seems reasonable to conclude that gregarious flowering in bamboos and palms is not determined by drought but rather by a germinal factor. If an environmental complex exists which is responsible for simultaneous flowering, it has not yet been discovered. The following additional observations further support this conclusion.*

FIG. 1. The avenue of talipot palms in the Peradeniya Gardens, Ceylon, in December, 1920. Seven out of the twenty palms composing the avenue flowered in 1918. It will be noticed that the palm at the end of the avenue on the left is here in full foliage while in plate 8 it is in flower.

* In connection with this habit of monocarpy in long lived plants, it is of interest to note that Wieland (12) has established its presence in at least two if not six species of fossil cycads. In *Cycadeoidea Dartoni* the armour is packed with hundreds of mature cones with no trace of a succeeding foliar crown.

Among its several excellent avenues of palms, the Peradeniya Gardens in Ceylon have long had an avenue of superb specimens of the talipot palm, *Corypha umbraculifera*. The twenty palms of which this avenue formerly consisted were planted *in situ* in 1881. In June, 1918, seven of the talipots in the avenue commenced flowering and remained in blossom until the end of the year, being at their best in October–November (Fig. 1). At the same time there flowered two species of bamboo, *Dendrocalamus giganteus* and *D. strictus*, and the liane, *Bauhinia anguina*. Bauhinia had never before been seen in blossom at Peradeniya (10). It was locally suspected that the drought of January–April of that year was the cause of this remarkable case of simultaneous flowering of four species of plants all of whose flowering periods occur after many years of purely vegetative growth. In substantial support of this belief was the widespread occurrence of flowering talipots throughout Ceylon. From one observation point on the island 200 talipots were counted in flower.

When the question of the possibility of drought being the cause of the gregarious flowering of the Coryphas at Peradeniya in 1918 was discussed in a previous publication (10), it was pointed out that the remaining thirteen palms in the avenue did not flower, although of the same age and subjected to the same environmental conditions. This fact is disturbing to either hypothesis of the cause of gregarious flowering. Whether we regard the flowering as the result of an environmental stimulus, or the expression of a heritable tendency, all of the palms should have flowered simultaneously since all were of the same age and all grew in the same environment. This difficulty, however, is easily met on the basis of the hereditary hypothesis.

If a climatic factor is responsible for gregarious flowering in plants, the question arises, How long before the flowering does the stimulus occur? In the case of plants of long vegetative periods it has been suggested that the stimulus must act at least a year before flowering. If this is true, then the drought of January–April of 1918, quite aside from the fact that it was relatively mild, could not have been the cause of the flowering which followed not more than two months later. But conclusions reached on the basis of a single instance of flowering are too speculative. More convincing deductions can be formed when at least two flowerings are considered.

In June, 1922, eight more of the remaining thirteen talipot palms in the avenue at Peradeniya commenced to flower. (PLATE 8). The palms were at this time 41 years of age. The seven palms which flowered in 1918 (FIG. 1) were 37 years old. The second lot of eight Coryphas were in full flower in December, 1922. (PLATE 9.) They began to set fruit visibly in March, 1923. The fruit ripened toward the end of 1923. At the time of writing (June, 1924) the palms are still standing, but without leaves or fruit, all dead, awaiting cutting and removal.

The gregarious flowering of *Corypha umbraculifera* in the Gardens at Peradeniya in 1922 was not accompan'ed by any widespread flowering of this or any other monocarpic species of plant on the island.

A comparison of precipitation data preceding the flowering of the Coryphas at Peradeniya in 1918 and in 1922 should reveal the occurrence of a drought occurring at precisely the same length of time before each of the two flowering periods, if drought is the cause of the anthesis. (Should this prove to be true we should still be confronted with the problem of why the first drought aroused only seven of the palms to sexual activity, and failed to stimulate the remaining thirteen of the same age.) The precipitation data for several years preceding each of the two flowering periods is presented in the following table.*

The total annual rainfall is given for each year named. Since this total is of less significance than the amount of rain which falls during the dry season, there is also given the total rainfall for the months January–April. It is this dry season which is most likely to have a telling effect on the plants. During the remainder of the year there is usually a surplus of precipitation.

Precipitation at Peradeniya

	Jan.–Apr.	Yearly Total
Average†	17.67 inches	87.36 inches
1915	26.32	88.21
1916	18.14	81.42
1917	23.01	102.96

* The data given in this table are from Peradeniya where the palms were growing. In a previous publication, the data were from Kandy, a nearby station, where the rainfall does not differ greatly from that at Peradeniya.

† Averages are based on the data of 18 years, from 1905 to 1922.

Precipitation at Peradeniya (Cont'd)

	Jan.–Apr.	Yearly Total
1918*	13.60	94.97
1919	19.41	86.64
1920	19.41	103.06
1921	18.67	66.66
1922*	15.78	85.41

From the above table it is quite evident that drought cannot be the cause of the simultaneous flowering of seven of the talipot palms in 1918 and of eight of them in 1922. The precipitation during the dry season (Jan.–Apr.) for each of the three years preceding both flowering periods is above average. The total annual rainfall for the year immediately preceding the 1922 flowering is 21 inches below average while it is 15 inches *above* average for the corresponding year preceding the 1918 flowering. For the second year preceding each flowering the situation is reversed, and for the third year the annual rainfall is about average in both cases. The only possible basis for regarding drought as the cause of gregarious flowering in these talipots is to assume that the relatively mild droughts during the dry season of the two years of flowering—Jan.–Apr., 1918 and 1922—are the cause. This is quite improbable; first, it is very unlikely that a drought occurring but a month or two before flowering is the stimulus which starts anthesis; second, if drought is the cause one would expect it to affect all palms of the same age; and third, the two droughts in question are not deserving of the name, because the precipitation is but slightly below average.†

The belief that the dry season of 1918 had been the unfavorable factor which caused the palms, bamboos, and liane at Peradeniya to flower in that year, was supported by the extraordinary number of talipots which were to be seen in flower throughout the island. It seemed an almost unavoidable conclusion that some climatic factor of widespread occurrence

* The years of flowering.

† The absence of any rain during February was the fact which gave rise to the belief that the season, Jan.–Apr., 1918, was one of drought. Those locally interested forgot that no rain fell during February in 1916 and 1911 (and but 0.4 inches in 1912 and 1914) without causing any widespread flowering of talipots.

had brought on so extensive a flowering of these palms. In 1922, on the other hand, there was no report of a general flowering of Coryphas in Ceylon. In fact, between Colombo and Kandy no talipots were to be seen in flower.

If the anthesis of the talipots in the Peradeniya Gardens in 1922 was the result of an environmental factor this factor could not have been widely distributed because of the very restricted region of gregarious flowering among the palms on the island in that year.

Since our data do not permit the deduction that an environmental factor is the direct cause of gregarious flowering in *Corypha umbraculifera*, the only other conclusion is, that simultaneity in flowering is the expression of a heritable tendency, yet this hypothesis is not unequivocally supported by the behavior of the palms. If the age at which the palms mature sexually is fixed, one would rather expect all twenty of the palms in the avenue at Peradeniya to have flowered simultaneously since all were of the same age. The fact that they did not do this suggests, what is quite probable, that the parentage of the palms is different, and that the age of sexual maturity is not precisely the same in the offspring of different parents.*

The acceptance of the hereditary hypothesis of the cause of gregarious flowering in plants does not altogether preclude the

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* It has been suggested that it is not primarily the age of Corypha which determines the time of flowering, but the height of the palm. At a certain height, which Corypha normally attains in about 34 years, the plant is unable to cope with the mechanical difficulties of maintaining a water column of that height in its vascular system. The suggestion is nicely supported by the fact that 5 shorter palms (3 clearly visible in plate 8) did not flower, either at the first period in 1918 (Fig. 1) or at the second period in 1922 (plates 8 and 9), even though of the same age as all the palms making up the avenue. (The talipot palm varies considerably in rate of growth. In the young state the peasants, including Garden coolies, habitually cut the leaves for use as umbrellas or for other purposes, so that the palm may take anything up to 20 years or more before forming a stem.) As interesting and suggestive as the above speculation is, it cannot be unqualifiedly accepted in view of the fact that it seems hardly likely that the rate of growth of 7 of the palms should be so uniform as to cause them to attain the maximum height simultaneously in 1918, while 8 of the remaining palms were equally uniform in rate of growth, being all precisely two years behind the first 7. The date of planting, it will be recalled, was precisely the same (1888) for all of the 20 palms making up the avenue.

possibility of climatic influences having a slight but appreciable effect on the *exact time* of blossoming. It is an old theory that favorable environmental conditions tend to produce purely vegetative growth while unfavorable conditions tend to bring on reproductive activity. How much truth there is in this theory it is difficult to say. What may be unfavorable for one species may have no effect on another adapted to the same general surroundings as the first. If it is true that drought is an unfavorable condition which tends to bring on reproductive activity in plants, then it is possible that as plants of long life cycle approach their normal time of flowering, the occurrence of a severe drought shortly before this time would somewhat hasten the coming of the reproductive period.

One final bit of evidence which seems to utterly preclude the possibility of drought being the primary cause of gregarious flowering in plants is, that this flowering is rhythmic in certain species. This is true in some bamboos. Thus, in *Bambusa arundinacea* three successive flowering periods in India have been recorded, making the life cycle one of 32 years (7). The flowering of *Phyllostachys puberula* is recorded in old manuscripts of China and Japan as occurring every 60 years (5). The records, somewhat incomplete, go back to the year 292 A.D.

There is little reason to doubt the fact that flowering in certain bamboos is rhythmic. There is, on the other hand, no conclusive evidence to support the presence of rhythmic changes in climate which are commensurable in length with the life cycle of certain palms and bamboos. Meteorologists are generally of the opinion that climatic cycles of some 30 or more years duration do not exist. The only approximate climatic cycle of which we can be reasonably certain is that which corresponds to the sun spot cycle. This is greatly variable, with an eleven year period and probably other periods, both shorter and longer (3). The variations which this cycle occasions are negligible, being in temperature of the order of 1° C. between extremes, and often less. The other climatic changes, such as changes of precipitation, wind velocity, and the like, which are consequences of the temperature change, are correspondingly small. That there is much evidence (for example, in growth rings of old trees) that appreciable climatic changes of many years duration have occurred within historic times, is true, but these changes do not appear to have been rhythmic. The so-called Brückner (1) cycle of 35 years is very irregular in length, and is, apparently, confused with volcanic explosions. This cycle too, if indeed there really is such a one, is of small amplitude. Climatic changes of the geologic past are certain, but they are of irregular occurrence and of unequal duration (3), and of much too great a length to be of any interest to us here. So far as the cause of gregarious flowering is concerned the meteorologist has nothing to offer which appears to have any bearing on the problem.

Were we willing to accept the popular belief in the existence of climatic cycles,* we should still be confronted with the task of explaining why these cycles cause the talipot palm to flower in 34 years while certain bamboos reach sexual maturity in 32 years; and why the climatic cycle should cause *Chusquea abietifolia* and *Bambusa arundinacea* to reproduce every 32 years while other bamboos flower most irregularly (this seems to be generally true of many of the Philippine species).

The persistent attempt of some investigators to interpret rhythmic vital phenomenon in terms of environmental factors is apparently due, in part, to opposition to any hypothesis of behavior which dissociates the organism from its environment. But there is nothing mysterious in a rhythmic life cycle or an innate sexual periodicity. The rhythm in the flowering of talipot palms and bamboos is no more extraordinary than rhythmic sexual periods in animals, the rhythm of the life cycle of man, and the rhythmic beat of the heart. The causes are simply internal instead of external.

Conclusion.—All available evidence points towards a heritable tendency as the cause of gregarious flowering in the talipot palm, *Corypha umbraculifera*.

Acknowledgment.—The photographs published as Plates 8 and 9 are the work of Plâté, Ltd., Ceylon, and are published

* An interesting account of a popular belief in climatic cycles is the following from Francis Bacon (4). "There is a toy, which I have heard, and I would not have it given over, but waited upon a little. They say it is observed in the Low Countries (I know not in what part), that every five and thirty years the same kind and suit of years and weathers come about again; as great frosts, great wet, great drought, warm winters, summers with little heat, and the like, and they call it the prime; it is a thing I do the rather mention, because, computing backwards, I have found some concurrence."

with their permission. The writer wishes to express his indebtedness to Plâté, Ltd., for their kindness in keeping him posted on the condition of palms in the Peradeniya Gardens.

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Description of plate 8

The view down the avenue of talipot palms (*Corypha umbraculifera*) in the Peradeniya Gardens, Ceylon, in August, 1922. (Photo. by Plâté, Ltd.)

Description of plate 9

The avenue of talipot palms in the Peradeniya Gardens in August, 1922. The floral crowns of eight Coryphas can be counted. Five palms remain in foliage. (Photo. by Plâté, Ltd.)

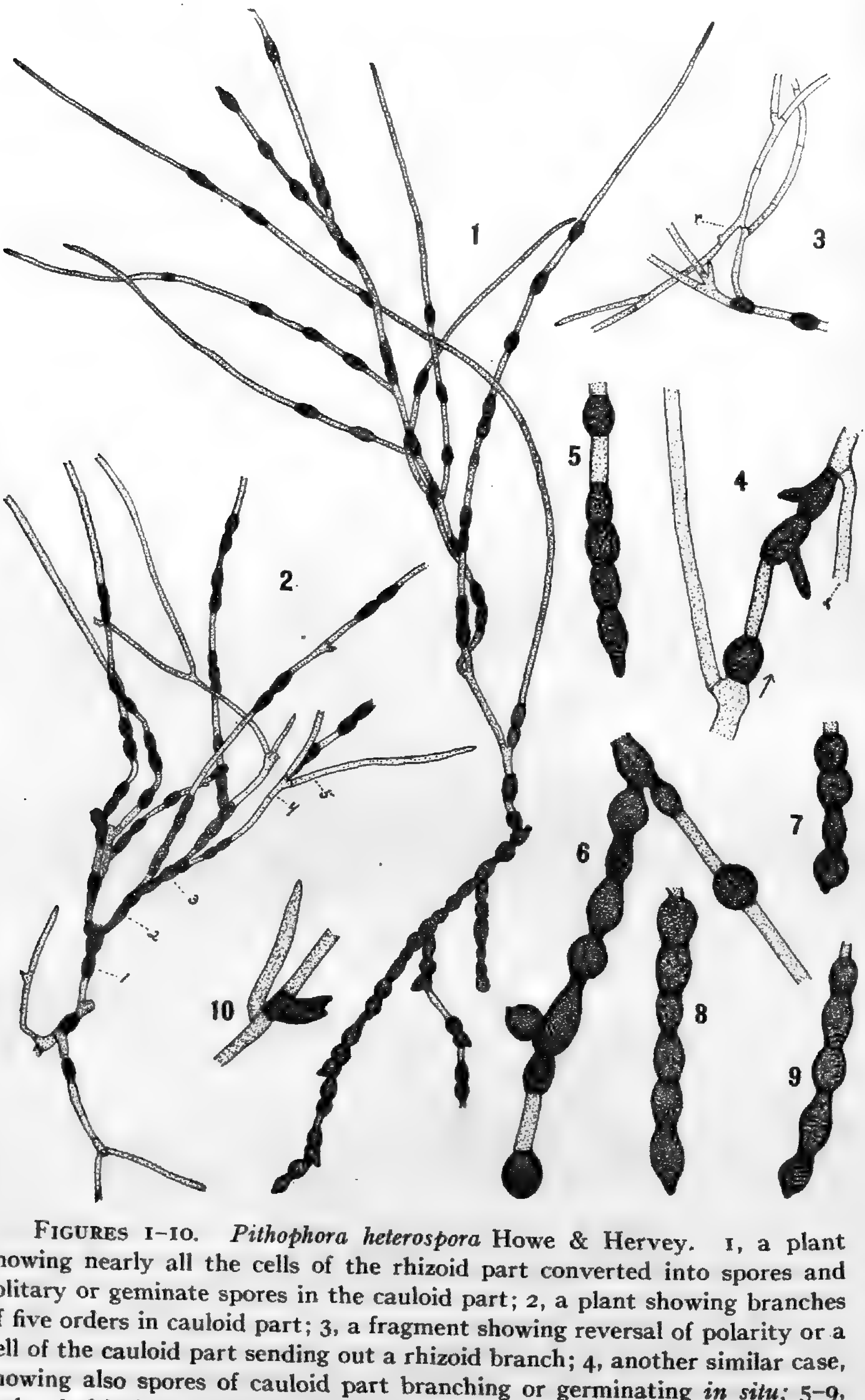
Notes on algae of Bermuda and the Bahamas

Marshall A. Howe

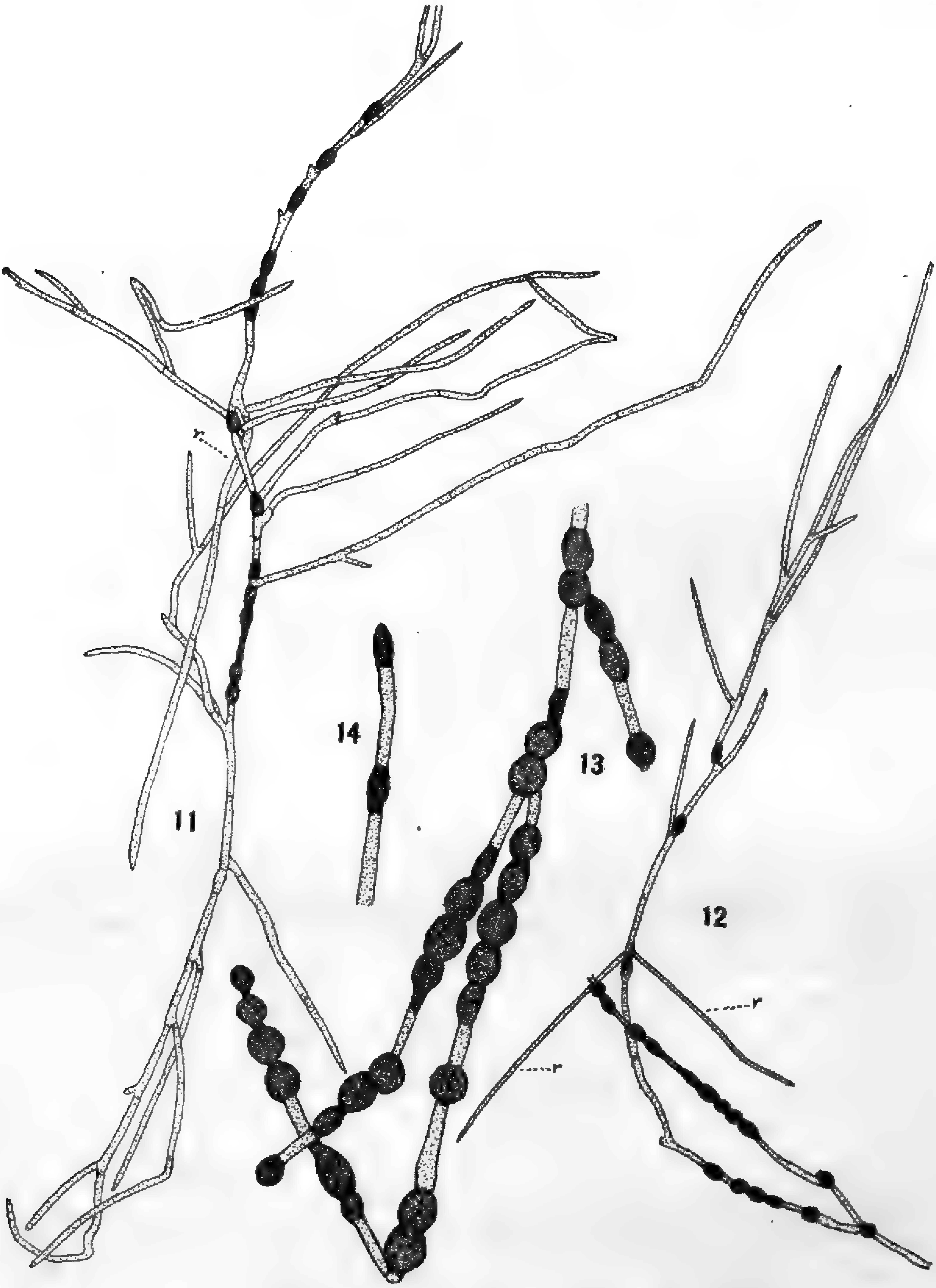
Since the publication of the author's contributions to Britton's Flora of Bermuda (1918) and Britton and Millspaugh's The Bahama Flora (1920), further collections in Bermuda by Dr. A. B. Hervey and in the Bahamas by Mr. L. J. K. Brace and more critical studies of material previously collected have resulted in the recognition of four species that are apparently new to science, one Bermudian and three Bahamian, and in the determination of three more species not before attributed to the Bahamas. The species proposed as new are a *Pithophora* (family Cladophoraceae) from Bermuda; from the Bahamas, a *Protoderma* (?) (family Chaetophoraceae), a *Chondrocystis* (family Chroococcaceae), and a *Dichothrix* (family Rivulariaceae). The diagnoses follow:

Pithophora heterospora Howe & Hervey, sp. nov.

Filaments intricately intertangled, dark green, 1–2 cm. long, rhizoid and proximal cauloid parts often not well differentiated, the rhizoid parts occasionally developing cauloid branches and the cauloid parts sometimes emitting rhizoid branches, special haptera or helicoids not seen; main fertile cauloid filaments averaging about 56 μ (45–90 μ) in diameter, the branches commonly of one or two, occasionally of three, rarely of four and even five orders, solitary or sometimes in opposite pairs, the ultimate about 50 μ in diameter; sterile cells mostly 6–20 times as long as broad, those of the ultimate branches often 30–53 times as long as broad, the cell walls 1.5–3 μ thick; rhizoid part rarely unicellular, usually equaling and similar to the cauloid in size and ramification, the cells often somewhat more rigid and with denser content; spores (akinetes) occurring in both cauloid and rhizoid parts, mostly intercalary, occasionally terminal, those of rhizoid and proximal cauloid parts solitary, geminate, or more often 3–5, sometimes up to 10–22, in a concatenate series, polymorphic, mostly cask-shaped to subglobose and 130–182 μ × 80–143 μ, occasionally fusiform-clavate or somewhat pestle-shaped and up to 286 μ long, sometimes branched, the terminal ovoid, conic-ovoid, or ellipsoid, subacute, apiculate or subrostrate, those of median and distal cauloid parts usually intercalary and solitary or geminate, rarely in threes or fours, cask-shaped or subcylindric, mostly 156–182 μ × 68–80 μ, the occasional terminal ones bullet-shaped or conic-ellipsoid. [Figures 1–14.]



FIGURES 1–10. *Pithophora heterospora* Howe & Hervey. 1, a plant showing nearly all the cells of the rhizoid part converted into spores and solitary or geminate spores in the cauloid part; 2, a plant showing branches of five orders in cauloid part; 3, a fragment showing reversal of polarity or a cell of the cauloid part sending out a rhizoid branch; 4, another similar case, showing also spores of cauloid part branching or germinating *in situ;* 5–9, ends of rhizoidal filaments, showing form and arrangement of the rhizoid spores; 10, fragment of cauloid filament, showing a proliferous or germinating spore. Figures 1–3 are enlarged 11 diameters; figures 4–10, 28 diameters.



FIGURES 11–14. *Pithophora heterospora* Howe & Hervey. 11, a plant with spores in cauloid part and with one rhizoid from a median cauloid part; 12, a plant in which the basal part, with spores characteristic of rhizoid parts, has the direction of growth of the cauloid part; 13, a rhizoid part, with spores, 14, the apical portion of a cauloid branch, showing one terminal and one intercalary spore. Figures 11 and 12 are enlarged 11 diameters; figures 13 and 14, 28 diameters.

In an old cistern, on Sound Shore Road, Bermuda, *A. B. Hervey*, December, 1920; also Jan. 15, 1921.

Pithophora heterospora, though belonging to Wittrock's section "Pithophorae Heterosporeae" and more heterosporous than any of the species that he refers to that section, shows points of contact with *P. oedogonia* (Mont.) Wittr., of his section "Pithophoreae Isosporeae." It resembles *P. oedogonia* in the usual great development of the rhizoid part of the thallus and its slight differentiation from the cauloid part. In fact, with the chlorophyll content of the two parts nearly the same and with both parts producing spores in nearly equal abundance, it is sometimes difficult to assert with confidence which is the cauloid end and which the rhizoid. In distal and median cauloid parts the spores have about the same form and arrangement as in *P. oedogonia*, though smaller (156–182 $\mu \times$ 68–80 μ vs. av. 230 $\mu \times$ 114 μ). But in the rhizoid and proximal cauloid parts the spores are often more nearly spherical, we believe, than in any previously described species and also are often in more extended chains, in one case as many as twenty-two being counted in a single unbroken concatenate series. So far as we discover, three spores in a series are the most that have hitherto been described.

In our material, preserved with formalin, there are in the cells, lying in the protoplast or extruded from it and lying between it and the cell wall, numerous irregular or subspheric dark-colored bodies, which in the older cells and the spores take the form of flocculent or substellate flecks. We have not noted these bodies in dried specimens of other species, but do not know whether they are really characteristic of *Pithophora heterospora* or may be due to mode of preservation or to transitory physiologic conditions. These bodies do not respond to the customary microchemical tests for oil.

Pithophora heterospora is associated with *Oedogonium consociatum* Collins & Hervey, which grows epiphytically upon it, in some parts densely clothing it with young filaments or with encrusting masses of attached spores, as was the case with the type of the *O. consociatum*, which was described from Bermuda as occurring on *Pithophora kewensis* (but figured, in contradiction of the text, on *Rhizoclonium*). *Closterium moniliferum* Ehrenb. also accompanies the *Pithophora* in profuse abundance.

Protoderma (?) polyrhizum sp. nov.

Thalli light green, irregular in outline, confluent or widely continuous, closely appressed and following the irregularities of the substratum, mostly 2–10 cells thick, more or less unistratose at margins, showing frequently small ventral lobes and ridges penetrating and perhaps boring out minute cavities in the substratum; cells of the dorsal surface irregularly hexagonal or pentagonal in surface view, 10–24 μ (mostly about 14 μ) in diameter, often somewhat longer at the margins, the separating walls firm, usually 1.5–4 μ thick; cells of the interior and of the ventral surface mostly somewhat elongate vertically, often 25–45 μ long; ventral rhizoids commonly numerous, lime-boring, septate, finally more or less branched, contorted or geniculate, mostly 6–20 μ in diameter; unmodified cells of the dorsal surface becoming sporangia, these apparently of two kinds, one with very numerous and minute ovoid pallescent zoospores (?) about 1 μ long, these (in dried plants) often lying in more or less coherent mucous masses on the surface of the emptied cells, other sporangia producing larger, ovoid, ellipsoid, or fusiform aplanospores (?) 2–4 μ long.

Forming a thin almost continuous green crust on an eroded oölitic or aeolian limestone pebble in a cavern, low littoral. Malcolm Road, Caicos Islands, Dec. 19, 1907 (*Howe 5686*, type), The rhizoids spring mostly from ridges or irregular ventral thickenings that fit into grooves or cavities of the substratum and they may be wholly lacking over wide areas of the smoother parts of the ventral surface. Wille (Eng. & Prantl, Nat. Pflanzenfam. 1²: Nachtr. 79. 1909) denies "rhizoidenartigen Verzweigungen" to the genus *Protoderma*.

As compared with specimens of *Protoderma marinum* Reinsch from Achill Sound, Ireland, distributed by Mr. A. D. Cotton, the cells of the dorsal surface of the Bahama plant are much larger and are much more firmly and regularly parenchymatous in their general arrangement; and the same holds true when comparison is made with specimens from Massachusetts distributed as *P. marinum* by Mr. F. S. Collins (Phyc. Bor.-Am. LIII), though the cells of the latter are larger than those of the Irish specimens.

Chondrocystis Bracei sp. nov.

Thallus cartilaginous or subcoriaceous, pinkish blue-green when living, more or less incrusted with lime, forming irregular expansions about 1.5 mm. broad (or broader through coalescence), 0.1–0.8 mm. thick, up to 5 mm. thick by overlapping (or falsely through corrugations), bullate, rugose, lacunose, or vesiculose, commonly somewhat hollow and bistratose, sometimes explanate or concave and more or less saucer-shaped, often with irregular ascending marginal or superficial lobes; colonies, in vegetative condition, mostly 25–80 μ in diameter, more or less polyhedral and forming a coherent pseudoparenchymatous thallus 2–10 colonies thick, or at the margins subglobose or ellipsoidal and rarely becoming free, the common wall 12–40 μ thick, cartilaginous, homogeneous or very obscurely and finely lamellate, the cells 2–64, bright blue-green to yellowish green, mostly ovoid or ellipsoid, 3–8 μ long, 3–5 μ broad, irregularly disposed or somewhat cubical or quadrangular-prismatic in arrangement, somewhat closely aggregated in a central space 20–40 μ in long diameter, the walls of subsidiary colonies and of the individual cells rather obscurely defined; colonies, in reproductive condition, subglobose, ovoid, or quadrangular-ellipsoid, 0.5–1.8 mm. in diameter, including numerous daughter-colonies of 64, 128, 256, or 512 cells, these 3–10 μ long, usually arranged in a cubical or quadrangular-prismatic fashion, but sometimes irregularly disposed, the mother colony becoming more or less hollow and thus giving rise to a similar condition in the succeeding pseudo-parenchymatous small-colonied vegetative state.

Moss Hill Ponds, Long Cay, Bahamas, Dec. 15, 1905, *L. J. K. Brace 4235*,—apparently forming a crust on the margin of a brackish or salt-water pond.

Chondrocystis Bracei has points of contact with the genus *Placoma*, and in the often cubical arrangement of its cells in the "reproductive" stage or stage of most active division, it is suggestive of the genus *Eucapsis* of Clements and Schantz, described* from fresh-water plankton of Colorado. From *Placoma vesiculosa* Schousb., the type species of the genus *Placoma*, the plant apparently differs in the solidly coherent pseudoparenchymatous thallus formed by the colonies in their ordinary vegetative condition, in the absence of any radial, filamentous, or Entophysaloid arrangement of the colonies, and perhaps in the more excentric, unilateral or irregular development of the gelatinous or cartilaginous sheaths. In these characters it seems to resemble *Chondrocystis Schauinslandii*,† the mid-Pacific Ocean type of Lemmermann's genus, *Chondrocystis*, from which species it evidently differs in its foliaceous

* Minnesota Bot. Stud. **4**: 134. *pl. 20.* 1909.

† Abh. Nat. Ver. Bremen **16**: 353. 1900.

rather than cushion-like habit of growth, the larger cells, etc. In general habit, *C. Bracei* is slightly suggestive of small conditions of *Dictyosphaeria favulosa*.

Dichothrix Bornetiana sp. nov.

Filaments 16–52 μ in diameter, fascicled in erect anastomosing wick-like or penicillate clusters, terminating in short, stout, or elongate, often agglutinate, sometimes caducous hairs or merely acuminate, forming an extensive sordid-green or subfuscous turf or cespitose stratum 3–8 mm. thick and more or less encrusted with lime; branches mostly strict, appressed, or subparallel, often agglutinate; trichomes prasinous or dull yellowish-aeruginous, 8–14 μ in diameter, tapering out at apex and becoming obsolete in older parts; cells 2–8 μ (mostly 5–6 μ) long, soon obscure; sheaths 5–16 μ thick, yellowish, lamellated, the surface often rough and delaminating; heterocysts basal, solitary or geminate, elongate-ellipsoidal, 18–30 μ long.

Littoral; surrounding pneumatophores of *Avicennia nitida* and forming a turf on mud in association with *Avicennia* and *Rhizophora*.

Bahamas: Bimini Harbor, *Howe 3268*—type, April 17, 1904; Joulter's Cays, *3115* and *3116;* New Providence, *3087;* Shroud's Cay, Exuma Chain, *3949*.

Dichothrix Bornetiana is a plant that has evoked diverse opinions from phycologists who have examined it and it may continue to be a subject for a divergence of views. No less competent authorities than F. S. Collins and W. A. Setchell to whom specimens were submitted in 1908 have considered it be *Polythrix corymbosa* (Harv.) Grun., which "has burst the shell and run riot." The late Edouard Bornet, who also examined specimens, wrote under the date of April 27, 1908:

"Les nos. 3087, 3115, 3116, 3268, et 3949 me paraissent appartenir à la même espèce. Les différences d'aspect que présentent les échantillons ne sont pas plus grandes que dans d'autres espèces plus ou moins encroutées de calcaire. Les trichomes sont de même dimension, les gaines ont la même structure, elles bleuissent également par le chloroiodure de zinc; mais surtout les filaments sont réunis en faisceaux anastomosés comme on en voit dans le *Calothrix pannosa*. Cette plante, que m'est inconnue, ne se trouve ni dans la Révision, ni dans le Sylloge Algarum. J'ignore si des espèces nouvelles de *Dichothrix* marins ont été décrits récemment. Je la placerais dans le voisinage des *Dichothrix cyanea* et *penicillata* dont elle est d'ailleurs bien distincte."

Dichothrix Bornetiana is occasionally mixed with small quantities of undoubted *Polythrix corymbosa* and very rarely the agglutination of filaments in a terminal fascicle may be so pronounced as to suggest *Polythrix*. It is not impossible that it does represent a condition of the *Polythrix*, yet it is preponderantly so very different from *Polythrix corymbosa* that the burden of proof would seem to rest with those who would assert identity. At least until such proof is forthcoming, it seems desirable to give the plant a distinctive name.

The trichomes and filaments are coarser, (trichomes 8–14 μ vs. 3–7 μ) and the sheaths are thicker than in *Polythrix corymbosa*, but increased development along these lines is perhaps what might be expected if the filaments of the *Polythrix* really became discrete and free. The heterocysts also are larger and often more elongate, the cells are commonly about one half as long as broad, while in *P. corymbosa* they often seem longer than broad, (perhaps on account of coalescence or imperfect definition), the trichomes are usually but not always duller or more yellowish in color, and the sheaths are commonly yellower.

Dichothrix Bornetiana is somwehat suggestive of Harvey's description and figure of *Calothrix dura* (Harv. Ner. Bor.-Am. **3**: 106. *pl. 48 D*), which Bornet and Flahault make a synonym of *Calothrix pilosa* Harv., but it has more of a *Dichothrix* habit, usually well-developed apical hairs, and no suggestion of the apical hemispheric cell or "bouton," which Bornet and Flahault have considered to be a characteristic of *Calothrix pilosa*.

In addition to *Polythrix corymbosa*, the species is sometimes associated also with *Scytonema crassum* Naeg., as determined by Bornet.

Following are three more additions to the Bahama flora:

PORPHYRIDIUM CRUENTUM (Ag.) Näg.

Growing sparsely on a small portion of a much cracked pavement, Nassau, N. P. *L. J. K. Brace* (comm. Feb. 17, 1920).

LYNGBYA LUTEA (Ag.) Gomont.

Specimens agreeing fairly well with descriptions, figures, and herbarium specimens of this species have been collected on the Berry Islands, the Exuma Chain, and Atwood (Samana)

Key. (*Howe 3640, 3986, 4162,* and *5327*), and on North Pine Cay, Andros (*Bartsch 221*). The trichomes range from 2 to 6 μ in diameter.

CHROOTHECE RICHTERIANA Hansg.

New Providence, without definite locality. *L. J. K. Brace* (comm. Sept., 1921).

NEW YORK BOTANICAL GARDEN.

INDEX TO AMERICAN BOTANICAL LITERATURE
1920–1924

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 the broadest sense.

Reviews, and papers that 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 omissions, their kindness will be appreciated.

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BULLETIN

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Some Senecioid Genera—I

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Cacalia L. Sp. Pl.

Bentham & Hooker in their Genera Plantarum included in Senecio quite a number of genera proposed by various authors, among them *Ligularia* Cass., *Cacalia* L., *Psacalium* Cass., *Kleinia* Haw., etc. I shall confine myself in this paper to the genera of North America only, and especially those species which have been known as members of the so-called genus *Cacalia*.

The first questions which present themselves are: Can this genus be separated from *Senecio* and what is the reason for merging it in that genus? The characters by which it is usually distinguished are the white or cream-colored, not yellow, disc-corollas, the absence of ray-flowers, and the more elongate corolla-lobes. Several of the true Senecios have cream-colored disc-corollas, and quite a number of them are rayless. A few species, usually included in *Cacalia*, have short corolla-lobes. There is no reason therefore why the genus *Cacalia*, as usually instituted, should be excluded from *Senecio*. The trouble has arisen because botanists have included in *Cacalia* several different types which can easily be distinguished from each other and from *Senecio* if considered separate but not if taken as an aggregate.

If these groups can be separated and segregated as distinct genera, another question arises: To which group should the name *Cacalia* L. be applied?

In Species Plantarum the genus *Cacalia* contains ten species, divided in two groups. The type must be sought in the second group, for at the end of the genus Linnaeus made the statement that the two genera, *Cacalia* and *Kleinia*, should be united.

[The Bulletin for August (51: 335–368) was issued August 22, 1924.]

By the genus *Kleinia* he meant the first group of four species, which all had been known as *Kleinia.* Of the species of the second group only the last two, *Cacalia atripicifolia* and *C. alpina*, had been known as *Cacalia* before Linneaus' time. The name *Cacalia*, applied to the last one, dates back to Vaillant and L'Obel. *C. alpina* L. or *Adenostylis alpinus* is therefore the historical type of *Cacalia.*

It is true that Linnaeus did not always follow the general accepted interpretation of a name but occasionally made a quite different application of the same. Let us see how he treated the genus in the fifth edition of his Genera Plantarum. Here he credited the name to Vaillant and also cited Tournefort and gave as synonyms: *Kleinia* of former editions, *Cacalianthemum* Dill., *Porophyllum* Vaill., and questionably *Tithymaloides* Klein. The first four species of the Species Plantarum, which constituted *Kleinia*, he therefore did not regard as typical *Cacalia.* This disposes also *Cacalianthemum* Dill. and probably *Tithymaloides* Klein, which belong to the same species. *Porophyllum* Vaill. became *Cacalia Porophyllum* L. *Cacalia sonchifolia* L. and *C. hastata* L. were placed in the genus for the first time in Species Plantarum and only Linneaus himself had used *Cacalia* for *C. suaveolens* in his Hortus Upsaliensis. *C. atripicifolia* L. had been known as *Cacalia virginiana glabra*, etc., by Morrison, while *C. alpina* had been known as *Cacalia* by many authors. Furthermore Linnaeus' diagnosis of the genus points to this species especially the description of the style tips: "*Stigmata duo, oblonga, revoluta.*" This is characteristic of *Adenostylis alpinus* which on account of its oblong style branches has been placed in the tribe EUPATORIEAE, but which Dr. B. L. Robinson rightly restored to the SENECIONEAE. *C. atripicifolia* as well as *C. suaveolens* has a true *Senecioid* style, with truncate style-branches. *Cacalia alpina* L. must therefore be regarded as the type of *Cacalia*, and *Adenostylis* becomes a synonym. *Cacalia* is to be excluded from the North American flora.

PSACALIUM Cass. Dict. Sci. Nat. **43:** 461. 1826.

Cassini was one of our best students of the Composites, and it would have been well if Lessing, Bentham & Hooker, Gray, Klatt, and Hoffman had paid more attention to his genera, most of which were well founded. *Psacalium* is a very natural genus, just as well distinguished from *Cacalia* as understood by Gray as it is from *Senecio*, by the style which is practically *Vernonioid*, i. e., the branches are filiform, elongate, spirally curved, acute, neither truncate nor with a hair-pencil at the end. The same kind of style is found in *Gynura* and in some segregates of *Liaburn*. The genus differs from *Senecio* in the white or whitish corollas, with a long slender tube, a short, broadly campanulate throat and elongate lobes, several times as long as the throat. The heads are always discoid, as in so-called *Cacalia*, and the basal leaves always with peltate blades. The latter character is not found in any of the other genera, included in *Cacalia*. It is found, however, in a group of species still included in *Senecio*, but these species have radiate heads, short corolla lobes and truncate style-tips with a terminal pencil.

Bracts decidedly pubescent or puberulent.
Leaf-blades deeply cleft, the divisions again lobed or coarsely toothed.
Achenes tomentulose; heads nodding; leaves of the branches of the inflorescence linear-filiform. 1. *P. Holwayanum.*
Achenes glabrous; heads not nodding; leaves of the inflorescence foliaceous or subulate.
Heads few; involucral bracts 12–16, arachnoid-villous, 12–18 mm. long.
Stem and leaves decidedly pubescent.
Heads 20–40-flowered; bracts 15–18 mm. long; primary divisions of the basal leaves usually 5-lobed. 2. *P. Conzattii.*
Heads 12–20-flowered; bracts about 12 mm. long; primary divisions of the basal leaves 3-lobed. 3. *P. Coulteri.*
Stem and leaves glabrous. 4. *P. thyrsoideum.*
Heads numerous; involucral bracts 5–8, short-hirsute, about 10 mm. long or less.
Bracts 8–10, about 10 mm. long; flowers 8–12.
Ultimate lobes of the basal leaves rounded, obtuse, mucronate. 5. *P. peltatum.*
Ultimate lobes of the basal leaves lanceolate, acute. 6. *P. argutum.*
Bracts 5 or 6, usually less than 10 mm. long, striate; flowers 5 or 6.
Involucre 8–10 mm. long; bracts ovate-oblong; lobes of the basal leaves acute. 7. *P. megaphyllum.*
Involucre 5–6 mm. long; bracts oblong; lobes of the basal leaves rounded, obtuse and mucronate. 8. *P. obtusilobum.*

Leaf-blades sinuately lobed, the lobes broadly triangular, merely denticulate; achenes hirsute; involucre puberulent. 14. *P. Langlassei.*
Bracts glabrous or slightly puberulent.
Basal leaf-blades divided to near the center into lance-linear divisions. 9. *P. peltigerum.*
Basal leaf-blades lobed half-way to the center or less deeply into broad divisions.
Leaf-blades divided half-way to the center; divisions again lobed. 10. *P. Nelsonii.*
Leaf-blades usually divided less than half-way to the middle; divisions toothed or denticulate.
Inflorescence cymose-paniculate; bracts yellowish, obtuse or rounded at the apex. 11. *P. poculiferum.*
Inflorescence elongate-paniculate; bracts more or less purplish, acute or acutish.
Basal leaf-blades 1.5–2.5 dm. broad; lobes about 7, ovate, acute; inflorescence with many heads; leaves of the branches of the panicle subulate. 12. *P. tabulare.*
Basal leaf-blades less than 1 cm. broad; lobes not more than 5; leaves of the inflorescence foliaceous. 13. *P. laxiflorum.*

1. **Psacalium Holwayanum** (B. L. Robinson) Rydb.

Cacalia Holwayana B. L. Robinson, Proc. Am. Acad. **43:** 45. 1907.

This is characterized by its tomentose achenes and nodding heads, and by the leaves of the inflorescence, which are linear-filiform. The type came from Uruapan, Michoacán.

MICHOACÁN: *Holway 3617* (type); *Pringle 13297, 13672; Langlassé 576.**

2. **Psacalium Conzattii** (Rob. & Greenm.) Rydb. n. sp.

Cacalia peltata Conzattii Rob. & Greenm. Proc. Am. Acad. **32:** 49. 1896.

This was described as a variety of *C. peltata* but is distinguished by its few large heads with 12–16 bracts and 20–40 flowers. It is more closely related to the next, differing in its larger heads, longer bracts, more flowers, and by its more lobed leaves. The type came from San Filipe, Oaxaca.

OAXACA: *Pringle 6238; Conzatti 27.*

* This might have come from Guerrero.

3. **Psacalium Coulteri** (Greenm.) Rydb. n. sp.

Cacalia peltata Coulteri Greenm., Proc. Am. Acad. **40:** 51. 1904.

I also believe this to be specifically distinct from *C. peltata*, differing in the larger heads with 12–20 flowers and about 12 villous instead of hirsutulous bracts. The type locality is Real del Monte, Veracruz.

PUEBLA: *Purpus 3038.*
MEXICO: *Rose & Painter 7939.*
MICHOACÁN: *E. W. Nelson 6582.*
VERACRUZ: *Coulter* (type).

4. PSACALIUM THYRSOIDEUM DC. Prodr. **6:** 335. 1837.

Senecio insignis Hemsley, Biol. Cent. Am. Bot. **2:** 242. 1881.

This was described from specimens collected by Haenke in Mexico, and has not been rediscovered as far as I know. It is known to us only through De Candolle's short description, which does not fit any of the species collected in later years. Hemsley referred it to *Senecio* in which the specific name *thyrsoideum* was preoccupied.

5. PSACALIUM PELTATUM (H.B.K.) Cass. Dict. Sci. Nat. **43:** 461. 1826.

Cacalia peltata H.B.K. Nov. Gen. & Sp. **4:** 170. 1820.
Senecio peltiferus Hemsley, Biol. Cent. Am. Bot. **2:** 245. 1881.

This is the type species of the genus, and was originally collected in woods near Patzcuaro, Michoacán.

MICHOACÁN: *Humboldt; Pringle 3340; Seler 1259.*
MORELOS: *Pringle 9871.*

6. **Psacalium argutum** Rydberg sp. nov.

Stem 1 m. high or more, striate, finely crisp-hispidulous; petioles of the basal leaves 2–3 dm. long; blades 2–3 dm. broad, divided half-way to the center or deeper, strongly reticulate, hispidulous on both sides; primary lobes 7 or 8, obovate in outline, usually 5-lobed and the upper lobes again lobed, the ultimate divisions lanceolate and acute; sinuses rounded; upper stem-leaves oblanceolate, entire or with a few teeth or lobes, those of the inflorescence mostly oblong or lanceolate and entire; heads many, in a leafy panicle; involucre campanulate-turbinate, 12–13 mm. high, about 10 mm. broad, subtended by 1–3 narrowly linear leaves, scarcely longer than the bracts; bracts about 8, lance-linear, acute, hispidulous on the back; flowers 10–12; corolla-tube 7 mm. long; throat 0.5 mm. long; lobes nearly 5 mm. long; achenes glabrous; pappus 7 mm. long.

Type collected at San Luis Potosi, 1879, *Schaffner 725* (herb. N. Y. Bot. Gard.).

P. argutum is closely related to *P. peltatum* differing in the outline and cut of the leaves.

SAN LUIS POTOSI: *Schaffner 725; Parry & Palmer 543.*

DURANGO: *E. W. Nelson 4954.*

7. **Psacalium megaphyllum** (Rob. & Greenm.) Rydb.

Cacalia megaphylla Rob. & Greenm., Am. Jour. Sci. III. **50:** 157. 1895.

This is related to the two preceding, differing in the smaller 5–6-flowered heads and usually only 5 bracts. The type came from Guadalajara, Jalisco.

JALISCO: *Pringle 2490.*

MORELOS: *Pringle 6165.*

MICHOACÁN: *Arsène 2386.*

PUEBLA: *Nicolas 334; Arsène* (in 1908).

8. **Psacalium obtusilobum** (Rob. & Greenm.) Rydb.

Cacalia obtusiloba Rob. & Greenm. Am. Jour. Sci. III. **50:** 158. 1895.

It differs from the last in the round-lobed basal leaves and the smaller involucre. It is known only from the type collection from Sierra de San Filipe, Oaxaca, *Pringle 5840.*

9. **Psacalium peltigerum** (Rob. & Seaton) Rydb.

Cacalia peltigera Rob. & Seaton, Proc. Am. Acad. **28:** 111. 1893.

This is characterized by its deeply divided leaf-blades, the divisions again divided into lanceolate or lance-linear lobes; the bracts are 5 or 6, glabrous, and the flowers 5–7. Type locality, Rio Blanco, Jalisco.

JALISCO: *Pringle 9872, 4627, 5154; Palmer 171.*

10. **Psacalium Nelsonii** Rydberg sp. nov.

Stem 5 dm. high or more, sulcate, tomentulose-puberulent; basal leaves long-petioled; blades about 3 dm. broad, cleft half-way to the center, short-pubescent above, tomentose beneath; divisions 7–8, cuneate in outline, mostly 3-lobed and sinuately toothed, the ultimate lobes broadly ovate; heads numerous in an elongate panicle; involucre campanulate, about 8 mm. long, 6 mm. broad, glabrous, purplish; bracts 9–10, oblong, acute; flowers about 10; corolla-tube 5 mm. long; lobes 2.5 mm. long, linear-oblong; achenes glabrous; pappus-bristles 6 mm. long, white.

Type collected in the vicinity of Cerro San Filipe, Oaxaca, 1894, *E. W. Nelson 1111* (U. S. Nat. Herb. *no. 908018*).

This intermediate between the preceding and the next following. The leaves are divided half-way to the center into oval sinuately lobed divisions. The inflorescence is elongate-paniculate.

11. **Psacalium poculiferum** (S. Wats.) Rydb.

Cacalia poculifera S. Wats., Proc. Am. Acad. **26:** 143. 1891.

The leaf-blades are divided less than half-way to the center into broad divisions, again lobed or toothed with triangular lobes or teeth; the inflorescence is cymose-paniculate.

JALISCO: *Pringle 9874, 4414.*

TEPIC: *Rose 1935.*

12. **Psacalium tabulare** (Hemsley) Rydb.

Senecio tabularis Hemsley, Biol. Cent. Am. Bot. **2:** 248. 1881.
Cacalia tabularis A. Gray, Proc. Am. Acad. **19:** 52. 1883.
Cacalia macrota Schultz Bip.

This is related to the preceding, but with broader less lobed divisions, more elongate inflorescence and acute purplish bracts. The type was collected in the valley of Orizaba, Veracruz.

VERACRUZ: (Orizaba) *F. Mueller* (in 1855); *Bourgeau 2926* (type).

PUEBLA: *Purpus 5630.*

13. PSACALIUM LAXIFLORUM Benth. Pl. Hartw. 41. 1840.

Senecio Moreliae Hemsley, Biol. Cent. Am. Bot. **2:** 243. 1881.

This is characterized by its small blades of the lower leaves and the more foliaceous leaves of the inflorescence. The type came from Morelia, Michoacán.

MICHOACÁN: *Hartweg 318.*

DURANGO: *Rose 2337.*

14. **Psacalium Langlassei** Rydberg sp. nov.

Stem 7.5 dm. high or more, sulcate, scabrous-puberulent, brownish; basal leaves long-petioled, the petiole 1.5–2 dm. long; blade about 1.5 dm. broad, strongly veined, short-pubescent on both sides, 9–10-ribbed, 9–15-lobed; lobes broadly triangular, broader than long, mucronulate-denticulate; leaves of the inflorescence linear or linear-filiform; heads in an elongate panicle; involucre 15–17 mm. high, and nearly as broad; bracts about 10, linear, acute, glandular-puberulent, acute; flowers 15–20; corolla-tube 8 mm. long; throat scarcely 1 mm. long; lobes linear, 3 mm. long; achenes hirsute, 5 mm. long; pappus-bristles white, 10 mm. long.

Type collected in the Sierra Madre, Michoacán or Guerrero, 1898, *E. Langlasse 576* (U. S. Nat. Herb. *no. 386047*).

The species resembles somewhat the last two in its leaf-form, but the heads are larger, like those of *P. peltatum* and its relatives, the bracts about 10, puberulent, and the achenes are hirsute. It is known only from the type collection.

CACALIA CALOTRICHA Blake, Contr. Gray Herb. II. **52**: 58. 1917.

This should probably be referred to Senecio.

PERICALIA Cass. Dict. Sci. Nat. **48**: 459. 1827.

This genus has the short corolla-lobes and the style-branches of *Senecio*, but the corollas are white or nearly so, the throat is elongate, narrowly funnelform, the lobes conspicuously rolled back after anthesis. The achenes are subcylindric, strongly 10-ribbed, the pappus of barbellate white bristles, slightly clavate at the tip, and the leaves are palmately ribbed and lobed.

Leaves sessile. — 1. *P. sessilifolia.*
Leaves petioled.
  Leaves of the inflorescence conspicuous, foliaceous, ovate. — 2. *P. suffulta.*
  Leaves of the inflorescence linear or linear-filiform.
    Stem glabrous, leafy throughout. — 3. *P. ovatifolia.*
    Stem pubescent, leafy at the middle only. — 4. *P. michoacana.*

1. **Pericalia sessilifolia** (H. & A.) Rydb.

Cacalia sessifolia H. & A. Bot. Beechey Voy. 436. 1841.

Schultz Bipontinus transferred it to Senecio under the name *S. Beecheyanus.* So did also Hemsley who, however, retained the original specific name. The type was collected between San Blas and Tepic.

TEPIC: *Palmer 1832: Rose 2828.*

2. **Pericalia suffulta** (Greenm.) Rydb.

Cacalia suffulta Greenm. Proc. Am. Acad. **32:** 310. 1897.

The type was collected above Cuernavaca, Morelos.

MORELOS: *Pringle 9876, 6626* (type).

3. **Pericalia ovatifolia** (Schultz Bip.) Rydb.

Senecio ovatifolius Schultz Bip. Flora **28:** 498. 1845.

This is the type of the genus, which was based on *Cacalia cordifolia* H.B.K.,* not *C. cordifolia* L. 1781. Cassini, however, did not make the combination *Pericalia cordifolia*, which appeared for the first time as a synonym in De Candolle's Prodromus.† Hemsley transferred it to *Senecio* as *S. cardicphyllus*. The type came from Santa Rosa, Mexico.

MEXICO: *Purpus 5625; Vischer 14.*

JALISCO: *Pringle 9869, 1736; Palmer 576; Safford 1451.*

SAN LUIS POTOSI: *Palmer 47.*

MICHOACÁN: *Arsène 7347, 5729.*

4. **Pericalia michoacana** (B. L. Robinson) Rydb.

Cacalia michoacana B. L. Robinson, Proc. Am. Acad. **43:** 46. 1907.

This is known only from the type collection from Uruapan, Michoacán, *Pringle 10117.*

MESADENIA Raf.; Loud. Gard. Mag. **8:** 247. 1832.

This is the same as CACALIA section CONOPHORA of De Candolle or CONOPHORA Niewl. The genus is closely related to *Odontotrichum* but the corolla has a distinct campanulate throat and the achenes are oblong and terete. It differs from the discoid species of *Senecio* in the white or whitish corollas and the longer corolla lobes. Usually the center of the receptacle is produced into a cone-shaped prolongation which gave the name *Conophora.*

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* Nov. Gen. & Sp. **4:** 168. 1820.

† DC. Prodr. **6:** 328. 1837.

The species are all North American and have been treated by Small in his Flora of the South Eastern United States with the exception of *Mesadenia Elliottii* R. M. Harper* and the following species:

Mesadenia angustifolia Rydberg sp. nov.

Cacalia lanceolata ? Ell. Bot. S. C. & Ga. **2:** 311. 1824. Not *C. lanceolata* Nutt. 1818.

Mesadenia lanceolata Small, Fl. SE. U. S. 1301, in part. 1903.

Stem terete, glabrous, 5–15 dm. high; lower leaves petioled, the upper sessile; petioles of the lower leaves 5–15 cm. long; blades narrowly lanceolate, 1–2 dm. long, less than 2 cm. wide, 3-ribbed or indistinctly 5-ribbed, often glaucescent beneath, entire or distantly sinuate-dentate, acuminate; upper leaves reduced, linear or lance-linear, less than 1 cm. wide, acute or more commonly acuminate; involucre 9–10 mm. high, 4 mm. broad; bracts linear-oblong, acute, slightly scarious-margined; corolla-tube 4–5 mm. long; throat 1.5 mm. long; lobes lance-linear, 3 mm. long; achenes about 5 mm. long, obscurely ribbed; pappus-bristles 6–7 mm. long.

Type collected in the Everglades, between Fort Lauderdale and Miami, 1911, *Small, Carter & Small 3318* (herb. N. Y. Bot. Gard.).

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Plant Novelties from Florida*

John K. Small

The species and genera proposed and described on the following pages represent discoveries made, for the most part, in the course of exploration in peninsular Florida during the past few years by the writer and his associates in the field-work.

√**Tradescantia roseolens** Small, sp. nov. Stems tufted, 2–4 dm. tall, pubescent, especially above, with unequal ascending glandless hairs, ultimately branched; leaves elongate, the basal and lower cauline equalling or exceeding the stem, gradually tapering, mostly involute, pubescent with unequal hairs, striate, the margins reddish, the veins reddish in the sheaths: bracts elongate, slightly saccate at the base, colored like the leaves and similarly pubescent, but more copiously so: flowers numerous, rose-scented; pedicels slender-clavate, densely pubescent with short spreading gland-tipped hairs; sepals elliptic 9–10 mm. long, pubescent like the pedicels and somewhat tufted at the apex, margenta-margined; petals blue, 13–16 mm. long, orbicular-ovate, erose-crenulate; anthers lemon-yellow; ovary hirsutulous; style glabrous; capsule not seen.—Inland sand-dunes, southern peninsular Florida.

The genus *Tradescantia*, already generously represented in the southern States, is now augmented by the species described above. A species of northern peninsular and eastern Florida, *Tradescantia longifolia*, is the nearest relative of *T. roseolens*. The latter differs from its relative, not only in structural features, such as smaller flowers and glandless stem, but also in the fragrance of the flowers which resembles that of tea-roses, hence the specific name. *Tradescantia roseolens* inhabits the "scrub" or that portion of it in the southern part of the lake region. It is particularly plentiful on the ancient dunes between Avon Park and Sebring. It is often so abundant that the fragrance of its flowers fills the air in the neighborhood of the plants. Plants are sometimes found in the gardens of recently established settlements, but whether their presence there is the result of introduction or the remains of the original plant covering of the

* The type specimens of all the novelties described in this paper are in the herbarium of The New York Botanical Garden.

region is not known. The plant was first observed near Sebring, Florida, in April, 1919.

The specimens on which the above description is based were collected south of Avon Park, Florida, by the writer on May 23, 1921. Plants have been observed and collected in the same general region in successive years. Live specimens sent to The New York Botanical Garden in 1919 have flowered each succeeding year.

√ **Delopyrum basiramia** Small, sp. nov. Annual, glabrous: stems and branches few or many (10–70) from the top of a woody tap-root, slender, wiry-filiform in the inflorescence; leaves slenderly linear, mostly 1–2.5 cm. long, acute, revolute; ocreae terminated by setaceous brown bristles; ocreolae short-acuminate: hypanthium-base clavate, nearly 1 mm. long at maturity; sepals of the pistillate flowers spatulate to linear, the inner about 2 mm. long, much exceeding the outer; achene subulate, fully 2.5 mm. long, thrice as long as thick, much exceeding the loosely investing calyx.—Inland sand-dunes ("scrub"), southern end of the lake region, Florida.

The following synopsis indicates some of the characters that distinguish *D. ciliatum* and *D. basiramia.*

Achene ellipsoid-ovoid; hypanthium-base obconic; upper ocreae leaf-bearing; fruiting calyx persistent. 1. *D. ciliatum.*
Achene subulate; hypanthium-base clavate; upper ocreae leafless; fruiting calyx deciduous. 2. *D. basiramia.*

The buckwheat family, to which the above proposed species belongs, is well represented in the Florida "scrub." Several well-known genera are often abundantly in evidence, and also a new one which is proposed on a subsequent page. The type specimens of *Delopyrum basiramia* were collected by the writer on the high dunes north of Kuhlman, May 23, 1921.

√ **Kuhnistera truncata** Small, sp. nov. Plants 1 m. tall or less with rather slender glabrous branches; leaflets mostly 5–7, sometimes fewer; blades narrowly elliptic to elliptic-oblanceolate, 3–6 mm. long, obtuse, short-petioluled; spikes short and thick; lower bracts of the involucre suborbicular or orbicular-reniform, abruptly pointed; calyx villous; tube campanulate; lobes filiform-setaceous, conspicuously plumose; corolla white; standard about 7 mm. long, the blade shorter than the claw, emarginate at the apex, narrowly cuneate at the base; wings and keel-petals about 5 mm. long, slender-clawed, the blades truncate-emarginate at the apex; pod 2.5–3 mm. long, strigose.—Pine-palmetto lands, southern peninsular Florida.

The genus *Kuhnistera* embraced but one described species, until *K. adenopoda* was recently proposed. It and the above described species are rare plants compared to the abundance of the type species *K. pinnata* which also has a wide geographic range.

The present species, *K. truncata*, differs from *K. pinnata* in many respects—the larger spikes which are borne in a more open inflorescence, the broad leaflets, the long-clawed petals in which the claws are about as long as the blades, in the longer standard, and the larger pods. The petals, too, are truncate or slightly emarginate instead of rounded at the apex as they are in *K. pinnata*.

The type specimens were collected at Earman, Florida, by Fannie C. Rane, March 2, 1921. Specimens were also collected at Jupiter, Florida, many years ago by C. Hitchcock.

✓**Polygala cumulicola** Small, sp. nov. Stem arising from a coralloid root, simple below or much-branched, closely appressed-pubescent; leaf-blades spatulate to broadly linear below, elliptic to linear or elliptic-lanceolate above, sparingly fine-pubescent, short-petioled; racemes short, few-flowered; bracts lanceolate, scarious-tipped; pedicels glabrous; outer sepals green, glabrous, about 2 mm. long, slightly scarious-margined; wings rose-purple, 4–5 mm. long, not conspicuously veiny; keel about 3.5 mm. long; pod oblong-elliptic, 5–5.5 mm. long, nearly or quite as long as the wings, not stipitate, notched; seed-body 2.5 mm. long, long-hairy.—Active sand-dunes, eastern coast of southern peninsular Florida.

Heretofore nine species of *Polygala* were known to be endemic in Florida. The following proposed one adds another. It is a beautiful species restricted to the coastal dunes, mostly near the barrier beach, of the lower eastern coast of the Florida peninsula. It is characterized by the bright-green of the foliage and the deep rose-purple of the flowers. It maintains itself in the loose sand by means of deeply buried coralloid roots. The stem accommodates itself to the depth of the sand quite readily. Thus we find the leafless part of the main stem either an inch long or a foot long, according to the movements of the sands and the consequent adjustment of the stems. It differs from *Polygala grandiflora* as far as the inflorescence is concerned, by the short racemes, the deep rose-purple wings which are not conspicuously veiny at maturity, the sessile pod, and the narrower long-hairy seeds.

The type specimens were collected on the sand-dunes opposite Miami, by J. K. Small and G. K. Small, *4568*. Other specimens in the herbarium of The New York Botanical Garden from the same region, collected by the writer are: numbers *3999*, *4575*, *5872*, *6939*.

√ **Ilex cumulicola** Small, sp. nov. A shrub or a small tree with copiously fastigiate-branched stems, the head often dense, the branchlets with pale-gray or whitish bark; leaves numerous, evergreen, deep-green; blades leathery, cuneate-obovate, 2.5–4.5 cm. long, sinuate-spinescent, with the spine-tipped teeth directed forward, nearly smooth and sometimes slightly shining above, dull beneath, short-petioled; fertile flowers one or two together; sepals broadly deltoid or somewhat reniform, acute or obtusish, ciliate; petals suborbicular to ovate, 3.5–4 mm. long; stamens mostly shorter than the petals, abortive; drupe globose, about 8 mm. in diameter, deep-red; nutlets 5–5.5 mm. long, ribbed and finely cross-veined on the back.—Inland sand-dunes ("scrub"), in the southern part of the lake region, Florida.

The "scrub" of Florida not only yields new endemic herbs, but shrubs and trees as well. The following proposed species of *Ilex* is one of this class. Other woody plants are described on succeeding pages.

The discovery, on Christmas Day, 1922, of this decorative holly in the southern end of the lake region of Florida was a surprise. The plants grow on the ancient sand-dunes. They are more copiously and rigidly branched than those of *Ilex opaca*. The leaves are rather closely toothed, with the teeth directed somewhat forward. The sepals are more reniform, merely acute or even obtusish, and eciliate. The pulp of the drupe is rather dry and the shorter and thicker nutlets are less prominently ribbed. The fresh fruits when crushed have the fragrance of apples.

The specimens on which the species is based were collected by the writer on the inland sand-dunes about Lake Nancesowe (Lake Jackson) near Sebring, Florida, December 25, 1922 (fruits), and April 15, 1923 (flowers).

√ **Ilex Buswellii** Small, sp. nov. A shrub 3 m. tall or less, much-branched throughout, the branches gray, the foliage twigs glabrous, dark-purple, the flower-bearing twigs spur-like, scaly by the persistent petiole bases; leaves deciduous; blades elliptic to ovate-elliptic, 2–3 cm. long, glabrous or nearly so, acute or short-acuminate, serrulate above the middle, dark-green and somewhat shining above, slightly paler beneath, rather abruptly narrowed into short slender petioles; staminate flowers in clusters of 12–25, on short clavate pedicels; calyx 2–2.5 mm. wide in anthesis, about 4 mm. wide in fruit; lobes 4 or 5, more or less reniform in anthesis, becoming ovate or half-orbicular, ciliate; corolla white, 4–5 mm. wide; lobes 4 or 5, suborbicular or nearly so, ciliolate; stamens 4 or 5, or rarely more, 1.5–2 mm. long; anthers oval, longer than the filaments; ovary rudimentary; drupe globose, 9–11 mm. in diameter, red, shining; nutlets narrow, 4.5–5 mm. long, sharply ribbed on the back.—Near the Caloosahatchee above Fort Myers, Florida.

The above proposed new holly belongs to a section of the genus *Ilex* different from that of the preceding one. It is a relative of *Ilex caroliniana* from which it differs in the somewhat coriaceous leaf-blades, the reniform calyx-lobes of the staminate flowers, the broader anthers, and in the larger fruits.

The type specimens were collected by W. M. Buswell, October 2, 1923, in fruit. Flowering specimens were collected later, December, 1923, by the writer in company with Mr. Buswell.

Cyrilla arida Small, sp. nov. A small tree, perhaps also a shrub, with slender, usually vine-like branches with gray bark, the twigs glabrous; leaves rather approximate at the ends of the twigs; blades elliptic-spatulate, 1–3 cm. long, coriaceous, usually acute or acutish, veiny at maturity, entire, glabrous, acuminate at the base, short-petioled; raceme-like panicles narrow, 3–5 cm. long in anthesis, short-peduncled, the rachis glabrous, the bracts and the bractlets subulate; sepals lanceolate, 1–1.5 mm. long, acuminate; petals elliptic-lanceolate, 2–2.5 mm. long, somewhat acuminate; anthers notched at both ends; capsule globose-ovoid, about 2 mm. long, often depressed.—Inland sand-dunes ("scrub"), southern end of the lake region, Florida.

To anyone accustomed to see the two well-known species of *Cyrilla* (*C. racemiflora* and *C. parvifolia*) growing in their native haunts—the swamps and titi-bogs of the lowlands—the occurrence of trees of this genus growing on the dry inland dunes of white sand is surprising. The species just described is the third *Cyrilla* for Florida and for the continental United States. This *Cyrilla*, growing high up on the dry inland sand-dunes, is associated with a dozen or more novelties, of both specific and generic rank, some of which are described in this paper. It differs from *C. parvifolia* in the narrower sepals and petals and the notched anthers, as well as in the vine-like branches.

The type specimens were collected by the writer between Avon Park and Sebring, December 13, 1920.

✓**Lechea cernua** Small, sp. nov. Plants 3–6 dm. tall, the foliage pubescent; flowering stems stout, often clustered, closely fine-pubescent, widely branched above; leaves of the inflorescence-branches finely pubescent; blades elliptic or nearly so, mostly 4–6 mm. long, acute; basal shoots stout, mostly 2–5 dm. long, usually much-branched, pale-gray with short dense shaggy somewhat viscid pubescence; leaves of the shoots numerous; blades suborbicular, oval, or elliptic, 4–12 cm. long, acute or abruptly pointed, copiously pale-pubescent, sessile; bracts of the inflorescence narrower than the branch-leaves; flowers very numerous; pedicels 1.5–2 mm. long, deflexed at maturity, appressed-pubescent; outer sepals two minute scales; inner sepals three, suborbicular, 1.5–2 mm. long, appressed-pubescent; pod obovoid, 2 mm. long, slightly exserted, glabrous, smooth, shining; seeds nearly 1.5 mm. long.—"Scrub" on inland sand-dunes in the lake region and ancient dunes on the eastern coast, peninsular Florida.

The majority of the known North American species of *Lechea* occur naturally in Florida. Recent exploration indicates that several additional endemic species occur there. The above described one is the most conspicuous. The plants of this species are the most robust of any of our species of *Lechea*. Technically it is related to *Lechea racemulosa*. Its vegetative and floral parts are larger throughout. It may be distinguished from its relatives, and in fact from all our lecheas by the great development of basal shoots with broad leaves and by the nodding capsules.

The type specimens were collected by the writer on the ancient sand-dunes near Sebastian, Florida, September 6, 1922. Specimens of the same species have been collected in the "scrub" on the ancient dunes of the southern end of the lake region.

✓**Chionanthus pygmaea** Small, sp. nov. Shrub with underground stems, the branches 2–4 dm. tall, sometimes branched at the base, and sometimes also above; leaves few, remote or approximate on the short branchlets; blades thin leathery, elliptic or nearly so, 3–9 cm. long, short-petioled; flower-clusters rather dense; calyx-lobes broadly ovate or orbicular-ovate, about 1 mm. long, obtuse or minutely pointed; corolla-lobes narrowly linear, about 1 cm. long; anthers ellipsoid, less than 2 mm. long, abruptly blunt-tipped; drupe oval, 2–2.5 cm. long, purple-black; putamen ellipsoid, constricted at the base, 1.5–2 cm. long.

Inland sand-dunes ("scrub"), southern end of lake region, Florida.

Chionanthus has really been a monotypic genus, unless the Asiatic plant described as *Linociera chinensis* be actually congeneric with it. The species described above is a true *Chionanthus*, differing from the typical species as indicated in the description, appended synopsis, and note.

Corolla-lobes about 2 cm. long; anthers acuminate; drupe 1–1.5 cm. long. 1. *C. virginica.*
Corolla-lobes about 1 cm. long; anthers abruptly blunt-tipped; drupe 2–2.5 cm. long. 2. *C. pygmaea.*

The discovery of this plant adds another to the class of shrubs with underground stems—thus rendered less likely to elimination from the flora by fire. As far as we have observed, the present shrub has an average height of about a foot. In proportion to its size it is very floriferous. Curiously enough the flowers are about half the size of those of its larger relative, the well known fringe-tree (*Chionanthus virginica*), while the fruits are about twice as large or more.

The type specimens were collected by the writer on the ancient sand-dunes between Avon Park and Sebring, Florida, May 23, 1921 (flower) and August 30 and 31, 1922 (fruit).

✓**Clinopodium Ashei** (Weatherby) Small. Plants annual or biennial, but woody; stem much-branched, 1–5 dm. tall, minutely cinereous-pubescent and more or less glandular; leaves numerous, usually mainly clustered on short branchlets; blades thick, elliptic or nearly so if flattened out, strongly revolute, almost tubular, 4–9 mm. long, obtuse, entire, pubescent like the stem, glandular-punctate, sessile; flowers solitary in the leaf-axils, short-pedicelled; calyx pubescent like the leaves, 7–8 mm. long, the tube slightly longer than the lips, with a ring of hairs in the throat; upper lip reniform, slightly 3-lobed, lower lip with two subulate-lanceolate lobes; corolla lavender, 12–13 mm. long, finely pubescent without; tube pubescent within; the upper lip flattish, with the slightly 2-lobed tip curved upward, the lower lip strongly 3-lobed, with the broad middle lobe again lobed; stamens 4, exserted, the upper (posterior) pair the shorter; filaments glabrous, anthers unappendaged; style glabrous. [*Satureja Ashei* Weatherby, Rhodora **26**: 80. 1924.]—Inland sand-dunes ("scrub"), lake region, Florida.

The "scrub" has long been known to harbor a bright-red flowered calaminth. Several years ago a bright-lavender flowered species was discovered at several localities. It grows on the otherwise desert-like sands by the acre, and when in flower is very conspicuous and so plentiful as to make extensive seas of lavender in the landscape. Recently this plant was described as a new species of *Satureja*. The preceding description was made in the field in April, 1923.

This labiate technically belongs to *Clinopodium*, and it is closely related to *Clinopodium dentatum*, a rare and endemic species of the upper Apalachicola River region of Florida. It differs from that species in the more compactly branched habit, the entire tightly revolute leaf-blades, the larger upper lip of the calyx, and the less deeply notched middle lobe of the lower corolla lip. In habit, foliage, and inflorescence it may be considered as distantly related to *Clinopodium coccineum* and *C. macrocalyx*, but the proportions of the parts and colors of the flowers are quite different.

Conradina grandiflora Small, sp. nov. Shrub 2 m. tall or less, with few, irregular virgate, often long arching branches, the bark reddish, the twigs puberulent; leaves somewhat fascicled; blades spatulate, but more or less clavate on account of the revolute margins, mostly 10–25 mm. long, often puberulent and punctate above, but shining, white canescent beneath, short-petioled; flowers few together at the ends of the branches, nodding, short pedicelled, the cymes often 3-flowered; calyx becoming 6.5–7.5 mm. long, minutely pubescent and often with some slender bristly hairs; upper lip with a broad middle lobe and 2 lateral narrower curved lobes; lower lip exceeding the upper, with 2 subulate lobes; corolla showy lavender and spotted with magenta; upper lip ovate, 7–9 mm. long, rounded or truncate at the apex, sparingly pubescent without; lower lip much larger than the upper, much spotted in the center, with 2 lateral somewhat reniform lobes and a median suborbicular or orbicular-reniform notched lobe; stamens curved under the upper corolla-lip, included; style exserted; nutlets nearly 1.5 mm. long.—Inland sand-dunes, lower eastern coast region of Florida, and locally on the dunes ("scrub") in the lake region.

Lavender-shaded flowers of an odd type may be seen on shrubby plants in the "scrub" of the lower eastern coast of Florida during any month of the year. The habit of the plants of *Conradina canescens* is stiff and compact. That of *C. grandiflora* conveys the opposite impression The stem and branches are elongate and straggling, and sometimes when growing among larger woody plants the branches elongate and sprawl among the branches of shrubbery. The present species differs from *C. canescens* in the larger flower, particularly the large copiously spotted corolla with the reniform lateral lobes of the lower lip. The type specimens were collected by the writer on the ancient sand-dunes near Sebastian, Florida, April, 1921.

✓ **Borreria terminalis** Small, sp. nov. Perennial with a woody, often branched, root; stems simple or several together from the branching top of the root, 1–4 dm. tall, simple, at least above the base, or rarely branched, glabrous, or sparingly pubescent above; leaves opposite, usually with more or less prominent clusters of smaller leaves in their axils; blades spatulate to elliptic-spatulate, linear or narrowly linear-lanceolate, acute, glabrous, often revolute, narrowed to the bases which are joined with the deltoid or lanceolate stipules; flowers mainly or wholly in a terminal glomerole, sometimes also in less dense glomeroles in the upper axils; sepals in pairs, finely-pubescent, the 2 larger lanceolate or triangular-lanceolate, 1.5–2 mm. long, the 2 smaller broad and irregular; corolla white, 3.5–4 mm. long; lobes deltoid, obtuse, shorter than the tube; anthers ellipsoid, about 1 mm. long, much shorter than the filaments; fruits 2.5–3 mm. long, exclusive of the persistent sepals.—Pinelands, Everglade Keys and lower Florida Keys.

The *Borreria* here described has heretofore been referred to the little known Mexican *B. podocephala*. *Borreria terminalis* is a parallel of the Antillian *B. verticillata*. It has the same habit and exhibits nearly the same range of variation in its foliage. There are, however, decided differences in the flowers and fruits. The Floridian species differs from the Antiliean in the relatively short corolla which only slightly exceeds the sepals, the lobes of which are about as long as the tube, the short ovoid anthers, and the larger fruits.

✓ **Aster plumosus** Small, sp. nov. Stem 1 m. tall or less, branched above, finely pubescent, the branches more closely pubescent than the stem, villous-hirsute near the tips; leaf-blades various, those of the lower part of the stem not seen, those above linear or nearly so, those of the branches linear-elliptic to lanceolate, mostly 1 cm. long or less, acute, all sessile, finely pubescent on both sides; heads showy, in loose racemes: involucre turbinate-campanulate; bracts linear-acuminate to narrowly linear-lanceolate, imbricated in several series, the inner 6.5–7.5 mm. long, the loosely spreading or recurved green tip with copious long white hairs; ray-flowers about 10; ligules violet, 7–8 mm. long; pappus tawny; achenes silky-villous.—Dry woods, middle Florida.

Continued exploration in Florida has brought to our attention asters additional to those described about a decade or more ago.*

Aster plumosus is related to *Aster concolor* and it was formerly confused with that well-known species. It differs from *Aster concolor* in its more branching habit, and in the copiously loosely pubescent branches of the inflorescence. The involucre, however, is the more ready means of separation. This is larger than in *A. concolor* and has longer bracts with long, loosely spreading or recurved tips which are green, but the green tips are hidden in the dense white pubescence.

The type specimens were collected in dry sandy soil, Aspalaga, Florida, October, 1897, distributed as a duplicate from the Chapman Herbarium, by the Biltmore Herbarium, as *Aster concolor* L.

✓ **Aster simulatus** Small, sp. nov. Stem 2–15 dm. tall, wand-like or with few virgate branches, pale-pubescent, the branches, especially near the tips, villous-silky; leaf-blades linear-elliptic to lanceolate or linear-lanceolate, 1–2.5 mm. long or somewhat scale-like and smaller above, more or less silky, acute, entire, sessile; heads in virgate racemes or panicles, showy; involucre turbinate-campanulate; bracts broadly linear to linear-lanceolate, imbricated in several series, the outer with deltoid green tips, the inner 6–7 mm. long, with lanceolate green acute tip, all appressed; copiously pubescent with appressed white hairs; ray-flowers 10–13; ligules violet, 6–7 mm. long; pappus whitish; achene copiously silky.—Pinelands, Everglade Keys, Florida.

Aster simulatus is related to *A. concolor*. It differs from that species in the smaller more scale-like leaf-blades, and the more copiously long-pubescent bracts of the involucre.

The type specimens were collected in the pinelands near the homestead trail, about the Silver Palm Schoolhouse, Dade County, Florida, by the writer and George K. Small, November 26, 1913. Other specimens by number collected during the writer's exploration of the Everglade Keys are *1076, 2244, 2740, 2741*.

✓ **DENTOCERAS** Small, gen. nov. Shrub, with depressed branches, but perhaps short-lived. Leaves alternate, numerous, jointed at the top of the ocreae. Flowers in small terminal

* Small, Flora of the Southeastern United States; Flora of Miami.

panicles, crowded on the short branches. Sepals mainly white, accrescent, the outer slightly so, the inner decidedly so, but not as specialized wings, the outer appressed to and folded over the edges of the inner. Stamens 8; filaments alternately narrow and with widely dilated and shouldered bases. Achene included. (Generic name from the Latin referring to broader filaments which resemble horns with a lobe or tooth on either side at the base.)

In a few places in the "scrub" of the southern lake region of Florida one may find a depressed shrub forming mats of dark green foliage on the almost snow-white sand of the ancient dunes. The prostrate branches are copiously branched into slender almost innumerable branchlets all of which bear numerous small narrow leaves.

It is associated with a number of rare and local plants, such as species of *Polygonella*, *Delopyrum*, *Chionanthus*, *Cyrilla*, and *Lechea* mentioned on preceding pages.

✓**Dentoceras myriophylla** Small. Shrub with prostrate radiating branches 2–20 dm. long, copiously branched, often densely fastigiate; leaves very numerous, clavate, 3–12 mm. long, often fascicled on the short branchlets; panicles usually dense, the racemes short-stalked; outer sepals becoming ovate, boat-shaped, appressed; inner sepals much longer than the outer, oval or orbicular-ovate, often slightly obovoid, 2.5–3 mm. long; achene ovoid or ellipsoid-ovoid, about 2.5 mm. long.—Inland dunes, ("scrub"), southern lake region, Florida.

The plants are conspicuous on account of the green mats on the white sand in which the plant grows, the panicles of white flowers are small and the flowers themselves are intermediate between *Polygonella* and *Delcpyrum*. It differs from both those genera in the calyx, which closely invests the achene, and in the long styles.

The type specimens were discovered by the writer on the inland dunes south of Frost Proof, Florida, April 18, 1920.

DEERINGOTHAMNUS Small, gen. nov. A low shrub with stems clustered on the top of a long fusiform root, the buds red-hairy. Stems of two kinds, foliaceous and floriferous. Leaves alternate, not crowded on the stems; blades of a spatulate or cuneate type, somewhat coriaceous, pinnately veined and finely reticulate. Flowers perfect or polygamous, axillary to leafy bracts, pedicelled, more or less nodding, solitary, or two or three together. Sepals 2–4, green, short, imbricate, appressed. Petals 6–13, white or ochroleucous, elongate, often or a linear type, imbricate, recurved-spreading. Stamens 14–21, crowded on a flat receptacle; filaments a mere disk-like dilation; anthers parallel, adnate, surmounted by a gland-like protuberance from the connective, extrorse. Carpels 1 or 2, erect, at the center of the receptacle; style wanting; stigma subulate, shorter than the carpel-body, introrse, deciduous. Ovary 1-celled. Ovules 6–8. Fruit usually of one or two carpels, baccate, stipitate, with thin flesh, 1–4 seeded, often somewhat torulose. Seeds very turgid.—(Named for Charles Deering, generous patron of the Sciences and the Arts.)

On one of our detours across the Florida peninsula in April, 1923,* we discovered a very peculiar shrub in the uninhabited pineland wilderness between Punta Gorda and Fort Myers. It is a genus of the custard-apple family, most closely related to the genus *Asimina*. Following is a description of the genus and of the species:

The family Annonaceae has been represented in the continental United States by two genera—*Annona* and *Asimina*. *Annona* is widely distributed geographically, while *Asimina* is not known outside the eastern United States. The third genus, *Deeringothamnus* is still more restricted in range, being confined to limited areas in southern peninsular Florida. It is related to *Asimina* from which it differs in the dimorphous stems, the flat or depressed receptacle, and the narrow nearly uniform unsculptured petals.

√**Deeringothamnus pulchellus** Small, sp. nov. Shrub with clustered stems mostly 3 dm. tall or less, from a succulent-fibrous perpendicular root 3–6 dm. long; leaves bright-green; blades cuneate to spatulate, 3–11 cm. long, obtuse or rounded at the apex, sharply reticulate when dry, glabrous above, at least at maturity, with scattered fuscous hairs, especially on the yellow or orange midrib, beneath, or even glabrous beneath at maturity, acute at the base; flowering stems stouter than the leafy stems, the bracts foliaceous, ovate, oval, or elliptic, relatively broad, thus differing from the foliage leaves, sessile or nearly so; pedicels curved, mostly 1–2.5 cm. long, sparingly pubescent, mostly simple, enlarged at the top; sepals coriaceous, ovate to lanceolate, 4–8 mm. long, acute, stiff, red-pubescent; petals linear, varying to broadest above the middle or below it, recurved-spreading above the middle, usually 1–2 cm. long, (the inner the smaller), the outer finely pubescent, the inner

* To be described in full in a future issue of the Journal of The New York Botanical Garden.

glabrous; stamens 2 mm. long, the anthers much longer than the filaments, the apical gland knob-like; berry obovoid to ellipsoid, but more or less irregular or somewhat torulose, 2–5 cm. long, glaucous; seeds subglobose, but often irregularly impressed.—In low pinelands, DeSoto County, Florida.

The type specimens were collected by the writer in the uninhabited wilderness east of Punta Gorda, April 28, 1923.

✓ **SANIDOPHYLLUM** Small, gen. nov. Biennial, partly woody herbs with one or more stems from the top of a woody tap-root. Leaves opposite, approximate and decussate at the base of the stem and on short sterile branches, remote on the flower stem; blades narrow, rather subulate. Cymes with elongate spike-like wiry branches. Flowers subtended by two bracts. Sepals 5, unequal, ribbed. Petals 5, spreading, oblique and inequilateral, the blade mostly on one side of the midrib. Stamens mostly 20. Ovary 3-celled. Styles filiform. Stigmas terminal. Capsule narrowly conic, acuminate, the carpels distinct, erect. (Generic name from the Greek, meaning cross-leaf, referring to the decussate leaves of the stems.)

Sanidophyllum, a genus of *Hypericaceae*, is characterized by the short vegetative branches clothed with spreading decussate small linear leaves; the slender wiry flowering branches with small linear remote leaves except near the base of the plant; and the carpels distinct in fruit.

The petals are very inequilateral, the blade being mostly on one side of the midvein. The stamens are usually grouped in 4's.

✓ **Sanidophyllum cumulicola** Small, sp. nov. Plants with a woody tap-root; leafy branches at or near the top of the tap-root, 5 mm. long or less; flowering stems 2–7 dm. tall, wiry, usually clustered; leaves 1–6 mm. long, spreading on the lower part of the stem, appressed and scale-like above; inflorescence-branches very slender, the ultimate ones zigzag, the bracts scale-like; flowers erect; sepals leathery, broadly linear to ovate, 1–1.5 mm. long, 2–4-ribbed; petals yellow, 3–4 mm. long; capsule 5–6 mm. long, between twice and thrice as long as the calyx, brown, the carpels slender-beaked; seeds oval, less than 0.5 mm. long.—In the "scrub," southern part of lake region, Florida.

The habit of this plant, in life, is suggestive of a yellow-flax (*Cathartolinum*). It resembles several of the Mexican species of *Cathartolinum*, which also have the short basal foliage branches with the decussate leaves.

The type specimens were collected by the writer on the ancient sand-dunes between Avon Park and Sebring, August 30 and 31, 1922.

√**LITRISA** Small, gen. nov. Perennial caulescent herb, the rootstock freely branching and bearing rosettes of leaves on stout caudices from which the flower stems arise. Leaves alternate, the basal ones larger than the cauline; blades fleshy-leathery, becoming parchment-like, entire, parallel-veined. Heads corymbose. Involucre campanulate, few-flowered; bracts few, relatively broad, pubescent. Receptacle slightly chaffy. Corolla purplish, with a short tube and a cylindric throat. Androecium included. Anther-appendages ovate, entire, obtuse. Achene cuneate, ribbed. Pappus of many barbellate bristles.—(Generic name an anagram of *Trilisa*, the species of which the plant under consideration somewhat resembles in habit.)

The prairies of Florida, like the dunes of the lake region, harbor various endemic species of flowering plants. There is one composite herb that is prominent during the summer and fall, by a shade of purple in the inflorescence that is not duplicated in the flora. During the rest of the year it shows itself only by rosettes of fleshy or parchment-like leaves.

Litrisa is a member of the Eupatorieae of the Carduaceae. Its morphological associates are the genera of the group known best by the genus *Laciniaria*. Technically it is most closely related on the one hand to *Trilisa*, by its involucre, and on the other, to *Carphephorus*, by its chaffy receptacle.

√**Litrisa carnosa** Small, sp. nov. Stem 3–8 dm. tall, finely pubescent; basal leaves in a rosette; blades mostly 2–8 cm. long, linear, varying to lanceolate or spatulate, acute; cauline leaves remote; blades sessile; involucres erect; bracts mostly acute or numeronate, the outer ovate, the inner elliptic or broadly linear, about 4 mm. long; achenes 2–2.5 mm. long, pubescent.—Low pinelands and prairies, southern peninsular Florida.

The type specimens were collected by the writer on the Istokpoga Prairie, east of Lake Istokpoga, Florida, August 31, 1922, number *10658*.

√**AMMOPURSUS** Small, gen. nov. Perennial succulent herb, the stem from a long, perpendicular, fleshy root, simple or branched. Leaves alternate, fleshy; blades narrow, entire, punctate, sessile. Heads solitary or in panicles, showy, not radiate, erect. Involucre cylindric-campanulate, many-flowered; bracts broad, in six or more series, appressed, fimbriolate-ciliate. Receptacle naked, honey-combed. Flowers perfect. Corolla rose-purple; tube slender-cylindric; throat thicker than the tube, more or less urceolate; limb slightly zygomorphic, the lobes 5, spreading, about as long as the throat. Stamens included; filaments filiform-subulate; anthers linear, rounded or emarginate at the apex, cordate at the base, the lobes rounded. Style filiform. Stigmas filiform, usually longer than the style. Achene fusiform, 10–12-ribbed, pubescent. Pappus of numerous capillary barbellate bristles, longer than the achenes.—(Generic name Greek, meaning sand-torch, referring to the habitat and the blazing rose-purple flower-heads.)

The white sands of the inland dunes are an excellent background for showing off the various plants that arise from the desert-like surface from season to season. This is one of the more conspicuous plants of the summer months, chiefly on account of its bright rose-purple flower-heads.

This showy plant is confined strictly to the dry sands of the "scrub." It is well adapted to maintain itself there by a large storage root. *Ammopursas* is related to *Laciniaria*, from which it differs in the succulent foliage, the open inflorescence, the somewhat zygomorphic corollas with inflated throats, and the short pappus. As a genus it is on a par with *Garberia* and *Carphephorus*.

Ammopursus Ohlingerae (Blake) Small. Stem 2–11 dm. tall, solitary or several from the top of the root, usually paniculately branched above, minutely pubescent with pale crisped hairs; leaves fleshy, narrowly linear or linear-clavate, acute, glabrous; involucre about 2 cm. long; bracts numerous, the outer orbicular-reniform, thence gradually longer and narrower up to the linear-spatulate inner ones, all obtuse, the body deep green, punctate, the scarious margins pale; corollas bright rose-purple, about 2 cm. long; tube slender; throat cylindric-urceolate; lobes lanceolate, 5–6 mm. long, acute; achenes fusiform, 8–9 mm. long, about 10-ribbed, densely pubescent with spreading hairs; pappus whitish, much shorter than the corolla, barbellate. [*Lacinaria Ohlingerae* Blake, Bull. Torrey Club **50**: 203. *pl. 9.* 1923.]—"Scrub," southern end of lake region, Florida.

The writer first observed this plant in full flower in various parts of the "scrub" in the southern end of the lake region in August, 1922.

THE NEW YORK BOTANICAL GARDEN,
BRONX PARK, NEW YORK, N. Y.

INDEX TO AMERICAN BOTANICAL LITERATURE

1920–1924

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 the broadest sense.

Reviews, and papers that 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 omissions, their kindness will be appreciated.

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BULLETIN

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Some Senecioid Genera—II*

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Odontotrichum Zucc. Abh. Baier. Akad. Wiss. **1832:** 311. 1832.

Sciadoseris Kunze, Bot. Zeit. **9:** 349. 1851.
Mesoneuris A. Gray, Proc. Am. Acad. **8:** 661. 1873.

This genus was proposed by Zuccarini and described from a plant collected in Mexico, the type being *O. cirsiifolium*. Apparently the same plant was collected by Andrieux and described by De Candolle as *Cacalia cervariaefolia* with the remark that it perhaps should be separated generically. Hemsley transferred the latter to *Senecio*. Gray's *Mesoneuris bipinnatifida* was based on a closely related species. From the description Kunze's *Sciadoseris* seems to be the same genus, but his type *S. vaginata* was described from cultivated material in the botanic garden at Berlin. The origin was unknown but Kunze suggested Peru. If from Mexico, it might be the same as Gray's plant. In the two species, which constitute the genus as originally characterized, the style branches are oblong or slightly clavate, merely obtuse, and the terminal hair-pencil characteristic of *Senecio* is poorly developed. I hardly think that this character alone should be regarded as being enough to base a genus on. I have therefore extended the genus, rather than propose a new genus for the larger group of species with truly senecioid style, but otherwise closely related. This group includes more than half of the Mexican species referred to *Cacalia*. Most of these are of

* Continued from Bull. Torrey Club **51:** 378. 1924.

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somewhat different habit, but one species, *Cacalia decomposita* A. Gray, has the habit of the true *Odontotrichum* but the style of the other group.

As constituted in this paper the genus has the following characters distinguishing it from *Senecio:* Head always discoid; disc-corollas white or nearly so, the tube long and slender, the dilation into a distinct throat obsolete, so that the corolla is split clear to the tube, the lobes being long and linear; the achenes are elliptic in cross-section, 10–15-ribbed, obovoid, rounded above and tapering at the base; basal leaves long-petioled, strongly reticulate, firm; pappus scabrous or barbellate, in one species wanting.

Leaves twice to four times pinnatifid into linear divisions.
  Style-branches somewhat flattened, obtuse, and slightly clavate at the tip; bracts 8–15.
    Leaves of the branches of the inflorescence not conspicuously foliaceous; rachis of the primary divisions of the leaves 3–4 mm. wide; bracts 8–12. 1. *O. cirsiifolium.*
    Leaves of the branches of the inflorescence conspicuous, foliaceous; rachis of the primary division of the leaves 5–10 mm. wide; bracts 12–15. 2. *O. bipinnatifidum.*
  Style-branches truncate at the apex, with a distinct hair-brush; bracts 5 or 6.
    Basal leaf-blades 2–3 dm. long; stem 5–10 dm. high, leafy; inflorescence ample; achenes glabrous. 3. *O. decompositum.*
    Basal leaf-blades 6 cm. long or less; stem 4–5 dm. high, subscapiform; inflorescence small; achenes villous. 4. *O. filicifolium.*
Leaves not twice pinnatifid, at most deeply divided; divisions not linear.
  Leaves pinnately ribbed.
    Plant tall, 4 dm. high or more; heads corymbose or paniculate.
      Leaf-blades divided more than half-way to the mid-rib.
        Divisions of the lower leaves 5–11, divaricate, with rounded sinuses, again lobed or toothed, not acuminate.
          Involucre 12–18 mm. high; bracts 8–15; heads 40–50-flowered; achenes pubescent.
            Stem and leaves glabrous; bracts ovate. . 5. *O. platylepis.*

Stem and lower surfaces of the leaves floccose-tomentose; bracts oblong-lanceolate.......................... 6. *O. paucicapitatum.*

Involucre 5–7 mm. high; bracts 5–8; heads 5–12-flowered.

Blades of the basal leaves much longer than broad.

Achenes glabrous; leaves coriaceous, the ultimate lobes broadly triangular. 7. *O. sinuatum.*

Achenes pubescent; leaves scarcely coriaceous, the ultimate lobes lanceolate.......................... 8. *O. Pringlei.*

Blades of the basal leaves as broad as long; achenes pubescent.

Leaves not tomentose beneath.

Basal leaf-blades 1.5–2 dm. broad, slightly peltate at the base, i. e., the basal lobes slightly united across the petiole; involucre turbinate.......................... 9. *O. Schaffneri.*

Basal leaves not at all peltate, about 1 dm. broad; involucre tubular-campanulate.................. 10. *O. radulaefolium.*

Leaves tomentose beneath.......... 11. *O. tussilaginoides.*

Divisions of the leaves 3–5 (rarely 7), lanceolate or ovate, approximate, attenuate, directed forward, entire, or with a few teeth, or merely denticulate, and with acute sinuses.

Divisions of the leaves ovate; achenes hispidulous; involucre 3–4 mm. high...... 26. *O. chiapense.*

Divisions of the leaves lanceolate, acuminate; achenes glabrous; involucre 5–6 mm. high.

Divisions of the leaves 5–7, denticulate, with many teeth.................. 27. *O. napeaefolium.*

Divisions of the leaves entire or with a few large teeth.

Leaves merely pubescent on the margins and the veins beneath; divisions 5 or 7 (except on the uppermost leaves).......................... 28. *O. jatrophoides.*

Leaves tomentose beneath; divisions mostly 3.......................... 29. *O. tridactylitis.*

Leaf-blades merely lobed or toothed, the lobing not extending half-way to the mid-rib.

Petioles of the basal leaves winged; pappus half as long as the corolla-tube.......... 12. *O. brachycoma.*

Petioles of the basal leaves not winged, pappus about equaling the corolla-tube.
Basal leaf-blades decidedly longer than broad, their lobes as long as broad.
Basal leaves more or less lobed.
Leaves decidedly pubescent beneath.
Lobes of the basal leaves with a few large teeth; leaves tomentose beneath; achenes pubescent. . . . . . 13. *O. ampullaceum.*
Lobes of the basal leaves with many small teeth; leaves villous beneath; achenes glabrous . . . . 14. *O. amplifolium.*
Leaves glabrous, except on the veins beneath; achenes glabrous. . . . . 15. *O. rumicifolium.*
Basal leaves merely dentate, not lobed.
Basal leaf-blades deeply cordate at the base, doubly sinuate-dentate; corollas 9 mm. long . . . . 16. *O. silphiifolium.*
Basal leaf-blades shallowly cordate at the base, denticulate; corollas 7–8 mm. long.
Leaves glabrous and shining, thin. 17. *O. Goldsmithii.*
Leaves scabrous-puberulent, dull, thick, strongly reticulate. . . . . 18. *O. scabrum.*
Basal leaf-blades about as broad as long or broader, merely sinuately lobed, i. e., the lobes much broader than long.
Involucre 12–13 mm. high, nearly 2 cm. broad; leaves of the inflorescence foliaceous, oblong to ovate; flowers 30 or more; bracts 15–20 broadly oblong. 19. *O. amplum.*
Involucre 5–10 mm. high, 4–15 mm. broad; leaves of the inflorescence linear to filiform.
Heads 20–30-flowered; involucre 10 mm. high and 15 mm. broad; bracts 11–14. . . . . 20. *O. pachyphyllum.*
Heads 5–7-flowered; involucre 5–7 mm. high, 4–5 mm. broad; bracts 5–7.
Leaf-blades sparingly crisp-hairy, distinctly but shallowly lobed and doubly dentate; pappus half as long as the corolla. . . . . 21. *O. Palmeri.*
Leaf-blades densely scabrous-puberulent, sinuate and denticulate; pappus equalling the corolla. . . . . . 22. *O. nephrophyllum*
Plant less than 4 dm. high; leaf-blades less than 6 cm. long; the heads in dense head-like clusters.

Leaf-blades dentate or crenate, green.
Stem-leaves much reduced; base of the stem wooly; inflorescence acute at the base..... 23. *O. Purpusi.*
Stem-leaves ample; base of the stem not woolly; inflorescence globose .... 24. *O. globosum.*
Leaf-blades deeply 5-cleft, densely tomentose beneath; stem woolly at the base........... 25. *O. eriopodum.*
Leaves digitately or pedately ribbed and lobed or divided.
Leaves palmately lobed or cleft.
Basal leaf-blades about 2 dm. wide; bracts 8; flowers 8–10............................ 30. *O. Liebmannii.*
Basal leaf-blades about 5 cm. broad; bracts and flowers 5................................ 31. *O. pallescens.*
Leaves pedately divided to near the base.
Divisions of the leaves broad, the ultimate ones lanceolate.
Heads corymbose; involucre 6 mm. high; leaves 3–5-divided; achenes hairy........ 32. *O. napellifolium.*
Heads solitary; involucre about 15 mm. high; leaves 7–9-divided; achenes glabrous..... 33. *O. delphinifolium*
Divisions of the leaves narrow, linear.
Leaf-blades glabrous; primary divisions 5; pappus present......................... 34. *O. cervinum.*
Leaf-blades crisp-hairy; primary divisions 9–11; pappus wanting.................. 35. *O. calvum.*

1. ODONTOTRICHUM CIRSIIFOLIUM Zucc. Abh. Baier. Akad. Wiss. **1832**: 511. 1832.

This is the type species of the genus as stated before and the same as *Cacalia cervariaefolia* DC. and *Senecio cervariaefolium* Hemsley. An illustration is given in Biologia Centrali-Americana, *pl. 51.* The type was collected in Mexico by Karwinsky, probably in Oaxaca, in which state he spent most of the time during his first journey.

OAXACA: *Pringle 4894.*

2. **Odontotrichum bipinnatifidum** (A. Gray) Rydb.

Mesoneuris bipinnatifida A. Gray, Proc. Am. Acad. **8**: 661. 1873.

This species, the type of *Mesoneuris*, is closely related to the preceding, and when better known, they might be found to be identical. It may also be the same as *Sciadoseris vaginata* Kunze, but I prefer to use Gray's specific name as the identity of the latter is not doubtful.

CHIAPAS: *Giesbreght 805* (type).

3. **Odontotrichum decompositum** (A. Gray) Rydb.

Cacalia decomposita A. Gray, Pl. Wright **2:** 99. 1853.

As stated above, this species has the general habit of the two preceding, but the style-tips of the rest of the genus.

ARIZONA: *Goodding 784; Blumer 1378; Mearns 2219, 527, 531; Eggleston 10765; Palmer E.*

CHIHUAHUA: *Pringle 767; Townsend & Barber 158; E. W. Nelson 6095.*

SONORA: Santa Cruz, *Wright 1286* (type).

DURANGO: *E. W. Nelson 4758.*

4. **Odontotrichum filicifolium** Rydb. sp. nov.

Stem 4–5 dm. high, striate, slender, glabrous below, hirsute-puberulent above; basal leaves long-petioled, the petioles 7–10 cm. long, glabrous; blades bipinnatifid, triangular in outline, 3-6 cm. long, glabrous, purple-tinged along the margins, the rachis broadly winged, the divisions linear, acute, divaricate; stem-leaves similar but few and much reduced; leaves of the inflorescence small, filiform; inflorescence corymbiform-cymose; heads 12–20; involucre campanulate, 7–8 mm. high, about 4 mm. broad, purplish, glabrous; bracts 5 to 6, oblong, membranous-margined, acute; flowers 5 or 6; corolla-tube 4 mm. long; lobes linear, about as long; achenes 4 mm. long, densely villous with yellowish white hairs; pappus-bristles light-brown, barbellate.

Type collected between Santa Gertrudis and Santa Teresa, Tepic, August 8, 1897, *J. N. Rose 2101* (U. S. Nat. Herb. *no. 301002*).

5. **Odontotrichum platylepis** (Rob. & Seaton) Rydb.

Cacalia platylepis Rob. & Seaton, Proc. Am. Acad. **28:** 110. 1893.

This and the next species are characterized by their large heads.

JALISCO: *Pringle 1816, 9873;* Rio Blanco, *Palmer 689* (type); *Safford 1432; Jory,* in 1892.

6. **Odontotrichum paucicapitatum** (Rob. & Greenm.) Rydb.

Cacalia paucicapitata Rob. & Greenm., Am. Jour. Sci. III. **50:** 158. 1895.

This is known only from the type collection, at Sierra Clavellinas, Oaxaca, *Pringle 6018.*

7. **Odontotrichum sinuatum** (Cerv.) Rydb.

Cacalia sinuata Cerv.; Lave & Lex. Nov. Veg. Desc. **1**: 29. 1824.

The type of this species came from San Angel, near Mexico City. *Senecio albo-luteus* Schultz Bip. and *S. calophyllus* Hemsley are evidently synonyms.

CHIHUAHUA: *Goldman 132; Hartweg 125.*

DURANGO: *Palmer 651.*

MICHOACÁN: *Arsène 5740.*

MEXICO: *Vischer 58; Pringle 9875, 4274; Rose & Painter 7808.*

PUEBLA: *Arsène 93, 93a, 334, 1181.*

8. **Odontotrichum Pringlei** (S. Wats.) Rydb.

Cacalia Pringlei S. Wats., Proc. Am. Acad. **25**: 156. 1890.

JALISCO: Guadalajara, *Pringle 1811* (type), *11499.*

TEPIC: *Palmer 1892.*

COLIMA: *Palmer 1234.*

9. **Odontotrichum Schaffneri** (A. Gray) Rydb.

Cacalia Schaffneri A. Gray, Proc. Am. Acad. **19**: 53. 1883.

SAN LUIS POTOSI: *Schaffner 294–729* (type); *Pringle 4095, 3566.*

10. **Odontotrichum radulaefolium** (H. B. K.) Rydb.

Cacalia radulaefolia H. B. K. Nov. Gen. & Sp. **4**: 169. 1820.

The type was collected by Humboldt at Guanajuato, Mexico. The only specimen seen by me, which agreed with the original description, was collected in Mexico without given definite locality, *Liebmann 169.* Schultz Bipontinus transferred the species to *Senecio.*

11. **Odontotrichum tussilaginoides** (H. B. K.) Rydb.

Cacalia tussilaginoides H. B. K. Nov. Gen. & Sp. **4**: 168. 1820.

Schultz Bipontinus transferred the species to *Senecio* and Hemsley renamed it *S. farfarus.* The type came from Real del Monte, Mexico. No specimens have been seen by me.

12. **Odontotrichum brachycoma** (Blake) Rydb.

Cacalia brachycoma Blake, Contr. Gray Herb. II. **52**: 58. 1917.

It is known only from the type locality, Uruapan, Michoacán, *Pringle 10126.*

13. **Odontotrichum ampullaceum** (Greenm.) Rydb.

Cacalia ampullacea Greenm., Proc. Am. Acad. **34:** 577. 1899.
HIDALGO: *Pringle 9868*, Sierra de Pachuca, *6917* (type).

14. **Odontotrichum amplifolium** (DC.) Rydb.

Cacalia amplifolia DC. Prodr. **6:** 328. 1837.

The type came from Sierra de San Filipe, Oaxaca, *Andrieux.* Schultz Bipontinus transferred the species to *Senecio.*

OAXACA: *Pringle 4785; Purpus 3139; Smith 391; E. W. Nelson 1061.*

GUERRERO: *E. W. Nelson 2243.*

? VERACRUZ: *F. Mueller 1619.*

15. **Odontotrichum rumicifolium** (Klatt) Rydb.

Senecio rumicifolius Klatt, Leopoldina **24:** 126. 1888.

This species was based on *Liebmann 237* from Combe de Estepa, Mexico. No specimens have been seen by me, but in Klatt's herbarium, now at the Gray Herbarium, there is a tracing of the type in the herbarium of the Botanical Garden of Copenhagen. A copy of this tracing is now here.

16. **Odontotrichum silphiifolium** (Rob. & Greenm.) Rydb.

Cacalia silphiifolia Rob. & Greenm., Am. Jour. Sci. III. **50:** 158. 1895.

MEXICO: Sierra de las Crucis, *Pringle 5251* (type); *Pringle, 6453.*

MORELIA: *Rose & Hay 5311, 9080.*

17. **Odontotrichum Goldsmithii** (B. L. Robinson) Rydb.

Cacalia Goldsmithii B. L. Robinson, Proc. Am. Acad. **43:** 45. 1907.

This species may not be distinct from the preceding.

JALISCO: Hacienda San Marcos, *Goldsmith 8* (type).

HIDALGO: *Rose, Painter & Rose 9187.*

18. **Odontotrichum scabrum** Rydberg, sp. nov.

Stem about 8 dm. high, leafy, striate, scabrous-puberulent; basal leaves long-petioled, the petioles about 2 dm. long; blades broadly cordate, with an open sinus, 5–8 cm. long, 4–8 cm. wide, sinuate-dentate, thick, dull, strongly reticulate, scabrous-puberulent on both sides; lower stem-leaves with shorter petioles, dilated at the base and more ovate blades; upper stem-leaves oblong, sessile; those of the inflorescence linear or filiform; heads about 18, corymbose-cymose; involucre campanulate, 8–9 mm. high, about 6 mm. broad, glabrous; bracts about 8, oblong, acutish, thick on the back, with scarious margins; flowers 8–10; tube nearly 4 mm. long, lobes slightly longer, linear; achenes glabrous, striate; pappus-bristles white, about 3.5 mm. long; barbellate.

Type collected in Sierra Madre, Durango, August 13, 1897, *J. N. Rose 3471* (U. S. Nat. Herb. *no. 302448*).

19. **Odontotrichum amplum** Rydberg, sp. nov.

Stem stout, perhaps 1 m. high, sulcate, glabrous; basal leaves long-petioled, the petioles about 4 dm. long, sulcate; blades rounded sagittate-reniform, the distance from the apex to the basal sinus nearly 1.5 dm. and from the apex to the end of the basal lobes nearly about 2.5 dm., the extreme width 2.5 dm., sinuate dentate, strongly reticulate, thick, glabrous on both sides; lower stem-leaves unknown, the upper ones sessile and half-clasping, ovate or oval, strongly reticulate, entire at the base, dentate above; those of the inflorescence similar but smaller and less reticulate; heads many, in an ample corymbiform cyme, 30-flowered or more; involucre 12–13 mm. high, nearly 2 cm. broad, glabrous; bracts 15–20, broadly oblong acute or obtuse; corolla-tube 9 mm. long; lobes linear, 5 mm. long; achenes glabrous; pappus-bristles white, 9 mm. long, scabrous.

Type collected between Heujuquilla and Mesquitec, Jalisco, August 25, 1897, *J. N. Rose 3575* (U. S. Nat. Herb. *no. 302552* and *302739*).

20. **Odontotrichum pachyphyllum** (Schultz Bip.) Rydb.

Cacalia pachyphylla Schultz Bip.; Seem. Voy. Herald 310. 1856.

The type was collected in the Sierra Madre, in either Sinaloa or Durango, by Seemann. A specimen is in the Gray herbarium. No other has been seen.

21. **Odontotrichum Palmeri** (Greene) Rydb.

Cacalia Palmeri Greene, Pittonia **1**: 219. 1888.

The type locality is Rio Blanco, Jalisco.

JALISCO: *Palmer 168*, in 1886 type; *Pringle 2304, 11500*.

MICHOACAN: *Arsène 5112*.

22. **Odontotrichum nephrophyllum** Rydberg, sp. nov.

Stem scapiform, brown-woolly at the base, about 4 dm. high, terete, puberulent; basal petioles 6–8 cm. long, densely crisp-hairy and puberulent; blades reniform, thick, not strongly reticulate, 6–7 cm. long, about 10 cm. broad, sinuate and denticulate, scabrous-puberulent on both sides; stem-leaves much reduced, lanceolate, sessile, those of the inflorescence lance-linear; heads few, corymbose; involucre campanulate, glabrous, 5–6 mm. high, 4–5 mm. broad, bracts 5–7, oblong, obtuse; flowers 5–7; corolla-tube 4 mm. long; lobes linear, nearly 4 mm. long; achenes glabrous; pappus-bristles 4 mm. long, white, barbellate.

Type collected in the state of Durango, August 13, 1897, *J. N. Rose 2248* (U. S. Nat. Herb. *no. 301162*).

23. **Odontotrichum Purpusi** (Greenm.) Rydb.

Cacalia Purpusi Greenm., Univ. Calif. Publ. Bot. **4:** 95. 1910.

The type came from Cacalote, Puebla, *Purpus 3845*.

24. **Odontotrichum globosum** (Rob. & Fern.) Rydb.

Cacalia globosa Rob. & Fern., Proc. Am. Acad. **30:** 119. 1894.

CHIHUAHUA: Guachuchic, *Hartman 522* (type).

DURANGO: *E. W. Nelson 4769*.

25. **Odontotrichum eriopodum** (Klatt) Rydb.

Senecio eriopodus Klatt, Leopoldina **24:** 125. 1888.

The type came from Sierra Blanca, "Mexico," *Ehrenberg 1*. No specimens have been seen, but Klatt's drawing of the type in the Berlin Herbarium, is now at the Gray Herbarium and a copy of this in our collection.

26. **Odontotrichum chiapense** (Hemsley) Rydb.

Senecio chiapensis Hemsley, Biol. Centr.-Am. Bot. **2:** 238. 1881.

Dr. Gray transferred the species to *Cacalia*.

CHIAPAS: *Giesbreght 537* (type); *E. W. Nelson 3467*.

27. **Odontotrichum napeaefolium** (DC.) Rydb.

Cacalia napeaefolia DC. Prodr. **6:** 328. 1837.

The type was collected in Sierra de San Filipe, Oaxaca, by Andrieux. Schultz Bipontinus transferred it to *Senecio*.

OAXACA: *Pringle 4778; E. W. Nelson 1133*.

28. **Odontotrichum jatrophoides** (H. B. K.) Rydb.

Cacalia jatrophoides H. B. K. Nov. Gen. & Sp. **4**: 169. 1820.

The type locality is given as near Lake Cuitzeo, Michoacán. Schultz Bipontinus transferred the species to *Senecio*.

OAXACA: *C. L. Smith 388; Rose 3040.*

GUANAJUATO: *Pringle 4262.*

29. **Odontotrichum tridactylitis** (Rob. & Greenm.) Rydb.

Cacalia tridactylitis Rob. & Greenm. Am. Jour. Sci. III. **50**: 159. 1895.

OAXACA: *E. W. Nelson 2080;* Sierra de San Filipe, *Pringle 5841* (type).

MORELOS: *Pringle 9877, 6164.*

30. **Odontotrichum Liebmannii** (Buchinger) Rydb.

Senecio Liebmannii Buchinger; Klatt, Leopoldina **24**: 125. 1888.

The type was collected between San Andres and San Miguel, Mexico, *Liebmann 174.* No specimens have been seen, but Klatt's drawing of the type is at the Gray Herbarium.

31. **Odontotrichum pallescens** (Klatt) Rydb.

Senecio pallescens Klatt, Leopoldina **24**: 126. 1888.

The type was collected at Mesatlan, San Andres, Mexico, *Liebmann 235*, in the herbarium of the Botanic Garden at Copenhagen; Klatt's tracing of the type is in the Gray Herbarium.

32. **Odontotrichum napellifolium** (Schauer) Rydb.

Cacalia napellifolia Schauer, Linnaea **19**: 732. 1847.

The type was collected in Mexico by Aschenborn. Hemsley transferred the species to *Senecio*.

HIDALGO: *Pringle 10024; Salazar*, in 1913.

33. **Odontotrichum delphinifolium** Rydberg, sp. nov.

Stem scapiform, about 4 dm. high, densely brown, woolly at the base, striate, glabrous or slightly villous; basal leaves long-petioled, the petioles 1.5–2 dm. long; blades reniform in outline; pedately divided to near the base, glabrous, 5–7 cm. long, 10–13 cm. wide; divisions oblanceolate in outline, again cleft into lanceolate lobes; sinuses rounded; stem-leaves often solitary, reduced, sessile, 3-cleft at the apex; head solitary; involucres hemispheric, about 15 mm. high and nearly 3 cm. broad in fruit; bracts 15–20, lanceolate, acute, glabrous; achenes broadly obovoid, slightly compressed, striate, 4 mm. long, 3 mm. thick; pappus in the specimen seen wanting, apparently fallen.

Type collected in the Sierra Madre, Zacatecas, August 18, 1897, *J. N. Rose 2390* (U. S. Nat. Herb. *no. 301300*).

34. **Odontotrichum cervinum** Rydberg, sp. nov.

Stem about 1 m. high, slender, striate, glabrous or tomentulous-puberulent in the inflorescence; woolly at the base; basal leaves long-petioled, the petioles 1.5–3 cm. long; blades rhombic-ovate to orbicular in outline, pedately divided to near the base, glabrous, 7–9 cm. long, and nearly as broad; divisions narrow, again cleft into linear divisions and some of these with 1 or 2 lobes; stem-leaves smaller, usually twice ternate; heads rather few, paniculate; involucre campanulate, tomentulose, 6–7 mm. high; bracts 5–7; corolla tube 5 mm. long; lobes 4 mm. long, linear; achenes sparingly pubescent; pappus-bristles yellowish, 5 mm. long, scabrous.

Type collected between Pedro Paulo and San Blascito, Tepic, August 4, 1897, *J. N. Rose 1986* (U. S. Nat. Herb. *no. 300878*).

35. **Odontotrichum calvum** (Brand.) Rydb.

Cacalia calva Brand., Univ. Calif. Publ. Bot. 4: 193. 1911.

The type came from Cerro del Gavilan, Puebla. This is abnormal in the genus, as the pappus is wanting; not even the disk bearing the pappus is present.

Cacalia cirsiifolia H. & A. Bot. Beechey Voy. 436. 1841, may belong to this genus, but the incomplete description makes it very hard to locate in the key. I thought that it might be my own *Odontotrichum filicifolium*, which also came from Tepic, but the involucral bracts are given as 10, while in *O. filicifolium*, they are only 5 or 6.

NEW YORK BOTANICAL GARDEN

BU=36377

New South American Verbesinas

S. F. Blake

The synopsis of *Verbesina* published by Robinson and Greenman* in 1899 listed 109 valid species, and some 63 additional ones have since been described. The 13 new species here published bring the total number to approximately 185, making the genus by far the largest in its subtribe and, with the exception of *Bidens*, the largest in the tribe *Heliantheae*. The present paper will be followed by another presenting a rearrangement of the section *Lipactinia*, which has grown more rapidly than any other group of the genus since 1899.

Verbesina Macbridei, sp. nov.

Herbaceous (?); stem sordid-lanate; leaves alternate, large, elliptic, obscurely serrulate, scabrid above, sordidly pubescent beneath chiefly along the veins, on rather long naked petioles; heads about 12, medium-sized, yellow, radiate, about 47-flowered, long-peduncled; involucre about 4-seriate, graduate, about 8 mm. high; pappus awn 1.

"Coarse, 3 m. high;" stem stout, densely and sordidly lanate-pilose with matted hairs; petioles stout, naked or very narrowly margined above, not auriculate or decurrent, lanate-pilose, 1–3.5 cm. long; blades elliptic (or obovate-elliptic?), the main ones 18–23 cm. long or more, 4–8 cm. wide or more, acuminate at each end, minutely serrulate with remote teeth, thin, above dull green, sordidly hirsute-pilose, densely so along the veins (the hairs mostly deciduous except along the veins, the tuberculate bases persistent), beneath dull brownish green, densely sordid-hirsutulous with spreading hairs along the larger veins and costa, sparsely so elsewhere, featherveined, the chief veins about 11 pairs, prominulous on both sides, the secondaries loosely prominulous-reticulate beneath; tufts of oblanceolate leaves about 12 cm. long and 2.5 cm. wide present in the upper axils; heads in cymes of 2–4 on terminal and axillary peduncles, these 6.5–10 cm. long, the pedicels sordidly pilose-tomentose, 5.5–12 cm. long, subtended by very small linear bracts; disk about 1.2 cm. high, 1 cm. thick, in young fruit about 1 cm. high, 1.4 cm. thick; involucre about 4-seriate, graduate, about 8 mm. high, the phyllaries linear-oblong to oblong, sometimes spatulate, hispidulous-ciliolate and sparsely hirsutulous, with indurate

* Proc. Amer. Acad. **34**: 534–566. 1899.

few-ribbed base and shorter subherbaceous obtuse or rounded tip, the innermost (subtending the rays) sometimes acutish; rays about 7, yellow, pistillate, exceeding disk, the densely hirsutulous tube 1 mm. long, the lamina narrowly elliptic, 12 mm. long, 3 mm. wide, 3-denticulate, about 8-nerved, hirsutulous on back; disk flowers about 40, their corollas slender, hirsutulous below, 6.8 mm. long (tube 1.5 mm., teeth 1.3 mm.); pales acutish or obtuse, narrow, hirsutulous and ciliolate, blackish green above, about 9 mm. long; ray achenes (very immature) trigonous, epappose, somewhat hispidulous; disk achenes cuneate-obovate, very flat, 6 mm. long, 2.5 mm. wide (including wings), hispidulous above, rather narrowly 2-winged (wings 0.8 mm. wide or less, hispidulous-ciliolate above); awn 1, on the outer angle, usually lance-subulate, upwardly hispidulous, 4 mm. long, sometimes (teratologically?) reduced to a triangular or oblong lacerate squamella 0.8 mm. long.

Peru: On gravelly stream bank, Cushi, Dept. Huanuco, alt. about 1525 m., 19–23 June 1923, *J. F. Macbride* 4822 (type no. 535859, herb. Field Mus.; duplicate no. 1,191,517, U. S. Nat. Herb.).

Rather closely related to the Brazilian *V. glabrata* Hook. & Arn., of the section *Verbesinaria*. In that plant the stem is short-pubescent or glabrate, the leaves are much less pubescent beneath, and the pappus awns are 2 and subequal. The pappus of *V. Macbridei*, when reduced to a single squamella, is very similar to that of the recently described genus *Monopholis*, but the achenes and disk corollas are entirely different from those of that genus.

Verbesina malacophylla, sp. nov.

Suffrutescent, 2 m. high; stem cinereously pilose-tomentose, winged by the decurrent leaves; leaves mostly alternate, oblong-ovate, sessile, decurrent but not auriculate, serrate-dentate, velvety above, canescent-tomentose beneath; heads medium-sized, radiate, yellow, about 50-flowered, numerous in terminal panicles; outer phyllaries obovate, 8–10 mm. long, rounded, densely canescent-tomentose, the inner oblong, subequal; achenes narrowly winged.

Stems "in clumps, unbranched," rather stout, very densely and sublanately pilose-tomentose with reflexed matted hairs (these more or less deciduous in age, leaving the small tuberculate bases), narrowly winged; leaves alternate or sometimes opposite, oblong-ovate or the upper lance-ovate, 9.5–18 cm. long, 2.5–7 cm. wide, sessile, acute or acuminate, rounded at base and long-decurrent on the stem (wings 2–4 mm. wide), rather coarsely serrate-dentate (teeth deltoid, mucronulate, 1–4 mm. high), thickish, above grayish-green, densely and rather softly velvety-pubescent with spreading several-celled hairs with glandular-tuberculate bases, beneath densely and softly canescent-tomentose (the hairs along the veins somewhat yellowish, those along costa mostly reflexed), featherveined (the chief veins 4–6 pairs), reticulate beneath; heads 1.5–2.8 cm. wide, in flattish clusters of about 17–30 at ends of stem and branches, forming a large concave compound panicle 26 cm. wide; pedicels mostly 5–17 mm. long, pubescent like the stem; disk 6–11 mm. high, 7–11 mm. thick; involucre about 2-seriate, subequal or somewhat unequal, 8–10 mm. high, the outer phyllaries obovate or sometimes oblong or oblong-ovate, rounded or sometimes acute, indurate and pale below, herbaceous for their upper half, appressed, densely lanate-tomentose, the inner often shorter, oblong, less pubescent or nearly glabrous, blackish green with pale margin and short yellowish apiculation; rays 8, yellow, pistillate, the lamina oval, 3.5–9 mm. long; disk flowers 35–48, their corollas yellow, pilose on tube and base of throat, 6 mm. long; pales obtuse or apiculate, with firm erect tips, with blackish green center and yellowish white tip, sparsely pilose and ciliate, about 8 mm. long; disk achenes obovate, strongly compressed, 1-ridged on the sides, narrowly 2-winged, glabrous throughout (including wings), 6.5 mm. long, 2.8 mm. wide; awns 2, slender, finely hispidulous, subequal, 3 mm. long.

Peru: On sunny stream bank, 4.8–9.6 km. northwest of Mito, Dept. Huanuco, altitude about 3355 m., 10 Aug. 1922, *Macbride & Featherstone* 1935 (type no. 518430, herb. Field Mus.; photog. and fragm. in U. S. Nat. Herb.).

The small rays of this species would place it in Robinson and Greenman's synopsis in the section *Saubinetia*, where its closest ally would be *V. semidecurrens* Kuntze (of which *V. soratae* Schultz Bip. is a later synonym), a species very distinct in character of pubescence, shape and toothing of leaves, and color of rays. Its real affinity is rather with the *V. elegans* group of section *Verbesinaria*, from all of which it differs in its decurrent leaves, as well as in various details.

Verbesina saubinetioides, sp. nov.

Suffrutescent; stem strigillose, winged; leaves alternate, obovate, sessile, serrate, rather sparsely strigillose; heads few to many, medium-sized, whitish, radiate, on pedicels usually 1–6 cm. long; involucre about 3-seriate, barely graduate, about 5 mm. high, the outermost phyllaries linear or linear-lanceolate, acute or acuminate, the inner oblong, obtuse to acute, all rather densely hirsutulous; achenes winged.

"Low straggling shrub;" stem angulate, 3–6 mm. thick, sparsely strigillose, glabrescent, winged into the inflorescence (the wings 1–2 mm. wide), the branches winged only below, sometimes erect-hirsutulous; internodes 2–5 cm. long, usually winged throughout; leaves obovate or oblong-obovate, 8–17.5 cm. long, 2.5–5 cm. wide, acuminate, sometimes falcate at tip, long-cuneate at base, not auriculate, serrate above the lower third (teeth very acute, about 1 mm. high, mostly 3–5 mm. apart), firm-papery, above deep green, evenly strigillose or antrorse-hirsutulous with tuberculate-based, at length deciduous hairs, smooth to the touch, beneath somewhat yellowish green, evenly short-strigose or antrorse-hirsutulous along all the veins and veinlets, featherveined, the chief veins 8–11 pairs, prominulous beneath, the secondaries loosely anastomosing, the costa prominent beneath; heads 1.3–1.5 cm. wide, few to numerous in terminal cymes or cymose panicles, the bracts small, the pedicels usually 1–6 cm. long, strigillose or erect-hirsutulous, sometimes shorter and densely sordid-hirsutulous with somewhat spreading hairs; disk subglobose, 7–10 mm. high and thick; involucre about 3-seriate, slightly or not at all graduate, 5–6 mm. high, the outermost phyllaries linear to linear-oblong, acute to acuminate, with indurate 2-ribbed central portion and blackish green margin and apex, the inner similar but broader (about 2.5 mm. wide), oblong, obtuse to acute, all appressed, rather densely erect to spreading-hirsutulous and ciliolate; rays 7–9, equaling the young disk, "dirty white," pistillate, the tube densely hirsutulous, 2 mm. long, the lamina suborbicular, emarginate or 3-dentate, about 8-nerved, 4.2–5 mm. long, about 4 mm. wide; disk flowers about 55, dull white (the teeth tinged with blackish green), densely hirsutulous on tube and to middle of throat, glabrous above (the teeth papillose-margined), 4.5 mm. long (tube 1.3 mm., throat slender-funnelform, 2.2 mm., teeth ovate, 1 mm.); pales obtuse or acute, hirsutulous on keel and apex, ciliolate above, blackish green toward tip, 6.5 mm. long; ray achenes compressed, obovate, 3.5 mm. long, narrowly or rather broadly 2-winged (the wings usually unequal, sparsely ciliolate above, 0.1–0.5 mm. wide, adnate to the awns at base), 1- or 2-awned, the awns weak, unequal, 2.5 mm. long or less; disk achenes similar, 5 mm. long, always 2-awned, the wings as variable as in the ray achenes.

Peru: Obrajillo, *Wilkes Exploring Expedition* (U. S. Nat. Herb.); interior of Peru, 1862, *Mathews* 562 (N. Y. Bot. Gard.); on steep southern slope, Matucana, alt. 2440 m., 12 April–3 May 1922, *Macbride & Featherstone* 132 (type no. 516665, herb. Field Mus.; photog. and fragm. in U. S. Nat. Herb.).

Nearest *Verbesina saubinetia* Klatt (*Saubinetia helianthoides* Remy), of the Province of Coquimbo, Chile, known to me only from description. This species agrees in most features with *V. saubinetioides*, but is said to have hirsute-subvelvety leaves, tridentate pales, mostly sterile disk flowers, disk corollas pubescent throughout their length, 2-awned ray achenes, and 1-awned disk achenes. The Wilkes plant was identified doubtfully by Dr. Gray as *V. helianthoides* H. B. K. (= *V. Humboldtii* Spreng.), an entirely different species.

Verbesina altipetens, sp. nov.

Branches sordid-tomentose; leaves opposite; petioles naked; blades lance-elliptic, attenuate, acuminate at base, sparsely serrulate above, sordid-pilose beneath; heads medium-sized, yellow, about 32-flowered, small-rayed, cymose-panicled; involucre about 3-seriate, subequal, about 10 mm. high, the phyllaries loose, oblanceolate, acute, herbaceous, sordid-pilose.

Shrubby (?); branch densely and sordidly pilose-tomentose with loose, many-celled, brownish hairs; leaves (only first pair below inflorescence seen) opposite; petioles 1.5 cm. long, pubescent like the branches; blades lance-elliptic, 9.5 cm. long, 2 cm. wide, subentire or with a few small sharp teeth above the middle, papery, above dull dark green, evenly but not densely hirsute-pilose (hairs many-celled, with small tuberculate bases), beneath dull green, similarly pubescent, densely so along the veins, featherveined, the chief veins about 5 pairs, prominulous beneath; heads about 1.3 cm. wide, about 13 in a terminal flattish panicle 11 cm. wide, its lowest branches subtended by somewhat reduced leaves; pedicels 0.5–3 cm. long, pubescent like the branches, naked or 1-bracteate; disk about 1.8 cm. high, 1 cm. thick; involucre about 3-seriate, subequal or slightly unequal, 10–11.5 mm. high, the two outer series of phyllaries oblanceolate (about 2 mm. wide), herbaceous, loose or spreading, acute, densely and sordidly hirsute-pilose on both faces, the innermost (subtending the rays) similar but more nearly lanceolate, not spreading; rays about 7, equaling or shorter than the mature disk, pistillate, yellow (or greenish-yellow?), the tube pilose, 2.5 mm. long, the lamina linear, 6 mm. long, 1.2 mm. wide, 3-denticulate, 3-nerved, pilose on back; disk flowers about 25, their corollas yellow (teeth apparently blackish green), pilose on tube and sparsely so on throat and teeth, at maturity 8 mm. long (tube 2.5 mm., throat 4.5 mm., teeth 1 mm.); pales acuminate, blackish green above, hispid-pilose along back and on upper margin, 11 mm. long; disk achenes (immature) linear-cuneate, obsoletely winged, glabrous, 5–6 mm. long; awns 2, slender, upwardly hispidulous, equal or unequal, 4.5–6.8 mm. long.

Colombia: In shrub zone ("paramillo"), Mt. El Derrumbo, Dept. El Cauca, Cordillera Occidental, alt. 2500–2900 m., 1 July 1922, *E. P. Killip* 7993 (type no. 1,140,323, U. S. Nat. Herb.).

A member of the section *Saubinetia*, distinguished from all other South American species of its group by its opposite leaves. The involucre is also characteristic.

Verbesina hastifolia, sp. nov.

Suffrutescent, 1.6 m. high; stem densely cinereous-puberulous; leaves opposite or subopposite; petioles short, naked; blades triangular, hastately 2-lobed at base, coarsely lobate-toothed to middle, cinereous-tomentose beneath; heads small, radiate, yellow, about 25-flowered, numerous in long-peduncled axillary and terminal cymose panicles.

Stem rather slender, terete, striatulate, very densely cinereous-puberulous with somewhat matted hairs, these more or less deciduous in age, leaving the sordid, subglandular bases; petioles similarly pubescent, stout, 1–2 cm. long, not auriculate or decurrent; blades triangular in outline, usually oblique, 10–14 cm. long, 6.5–10 cm. wide across the basal lobes, 3.5–5.5 cm. wide near middle, obtuse, at base subtruncate and very shortly decurrent on the petiole, sharply serrate, thickish, above dull green, densely hispid-pilose with several-celled spreading hairs (these mostly deciduous except along the veins, leaving the glandular-tuberculate bases), beneath densely and softly pilose-tomentose, triplinerved and reticulate beneath; panicles axillary and terminal, many-headed, 5.5–10 cm. wide, the lower on peduncles up to 20 cm. long, the bracts mostly minute, the pedicels usually 6–15 mm. long, pubescent like the stem; heads about 1.6 cm. wide; disk 8–10 mm. high, 5–7 mm. thick; involucre about 3-seriate, graduate, about 5 mm. high, rather densely and loosely pilose and ciliate with whitish hairs, the outermost phyllaries usually obovate, rounded, thickish, subherbaceous above, the others oblong or ovate-oblong, obtuse, with blackish green center and narrow yellowish margins; rays 5, pistillate, yellow, the lamina oval, 6.5 mm. long, tridenticulate, about 11-nerved, pubescent on back; disk flowers 18–23, their corollas yellow, densely pilose on limb and lower throat, 5.3 mm. long; pales obtuse, lacerate-ciliate, pilose on back, with blackish green center and yellowish tips, about 7 mm. long; achenes very flat, narrowly cuneate, 6 mm. long, obsoletely 2-winged, hispidulous on the wings, otherwise glabrous; awns 2, slender, upwardly hispidulous, unequal, 4.5 mm. long or less.

Peru: On rocky western slope, Matucana, Dept. Lima, alt. about 2440 m., 12 April–3 May 1922, *Macbride & Feather-*

stone 195 (type no. 516728, herb. Field Mus.; duplicate no. 1,185,439, U. S. Nat. Herb.).

Described on the labels as a fragrant, coarse half-shrub 4–5 ft. high. In Robinson and Greenman's synopsis of the genus, this species enters the section *Pseudomontanoa*. It is well characterized by the shape and pubescence of its leaves.

Verbesina nudipes, sp. nov.

"Shrubby;" stem angled, rather sparsely sordid-hirsutulous with mostly appressed hairs; leaves alternate, large, oval-oblong, obscurely serrulate, harsh above, sordid-hirsutulous chiefly on the veins beneath, on long naked petioles; heads small, radiate, white, about 23-flowered, very numerous in a large dense cymose panicle; involucre 3-seriate, about 5 mm. high.

Stem stout (1 cm. thick), pithy, strongly angled above, evenly but not densely hirsutulous with mostly appressed hairs to the inflorescence, glabrate below; internodes usually about 1.5 cm. long; petioles sordid-hirsutulous, slender, 4–5.5 cm. long; blades oval-oblong, 16.5–20 cm. long, 6.5–8.5 cm. wide, short-acuminate, rounded-cuneate or cuneate at base, serrulate (teeth about 0.5 mm. high, 3–6 mm. apart), firm-papery, above deep brownish green, somewhat shining, evenly and harshly hispidulous with mostly antrorse hairs with persistent tuberculate bases, beneath brownish green, hirsutulous along all the veins and veinlets with spreading, tuberculate-based, brownish hairs, featherveined, the chief veins about 10 pairs, curved-anastomosing, with the secondaries prominulous-reticulate; heads about 1.3 cm. wide, very numerous in axillary and terminal cymose panicles, forming a large rounded compound panicle 25 cm. wide or more, the axis, branches, and pedicels (these very slender, usually 8–15 mm. long) densely sordid-hirsutulous with crisped, several-celled, spreading hairs; disk about 8 mm. high, 5 mm. thick; involucre 3-seriate, graduate, about 5 mm. high, the phyllaries of the 2 outermost series linear or linear-oblong, hirsutulous, with pale base and short subherbaceous obtuse tip, the innermost (subtending the rays) oblong, acutish, sparsely hirsutulous, thin-tipped; rays 4–5, pistillate, white, about equaling the disk, the lamina oval-oblong, 5 mm. long, 3-denticulate, about 6-nerved; disk flowers 16–21, their corollas probably white, hirsute-pilose on the short tube (1 mm. long) and base of throat, hirsutulous on teeth, 5 mm. long; pales obtuse or acutish, sparsely hirsutulous, about 6 mm. long; disk achenes (very immature) cuneate, narrowly margined, essentially glabrous; awns 2, slender, upwardly hispidulous, unequal, 4–5 mm. long.

Colombia: In thicket, La Cumbre, Dept. El. Valle, Cordillera

Occidental, alt. 1500–1750 m., 7–10 May 1922, *F. W. Pennell* 5208 (type no. 1,140,129, U. S. Nat. Herb.).

A species of *Ochractinia*, allied to *V. synethes* Blake, also Colombian, which has petioles margined nearly to the base, and leaves smoothish to the touch above and with a denser and more grayish pubescence beneath. *Pennell & Killip* 8034, from the Department of El Cauca, is so similar to *V. nudipes* in nearly all features that it might easily be a more pubescent form of it, but the flowers are described as yellow.

Verbesina grandis, sp. nov.

Very tall, herbaceous (?); stem glabrous, glaucescent; leaves alternate, large, pinnately lobed, harsh above, densely hispidulous-pilosulous beneath, the long petioles winged throughout, auriculate but not decurrent at base; heads rather small, radiate, white, about 30-flowered, very numerous in large open cymose panicles.

Stout herb (?), 6 m. high, "the branchlets leafy only below;" stem and branches stout, pithy, striate, purplish, glabrous; main leaves ovate in outline, 35–48 cm. long (including petiole, this about 14 cm. long, winged to base, about 1.3 cm. wide, the wings forming auricles at base, not decurrent), 14.5–28 cm. wide, pinnately about 9-lobed (lobes lance-oblong, acuminate, often falcate, subentire or sparsely serrulate toward apex, 6.5–13.5 cm. long, 2–3.5 cm. wide, the second and third pairs usually somewhat the longest, the rachis between them 3–4 cm. wide), acuminate, cuneately narrowed into petiole, firm-papery, above deep dull green, harshly hispidulous, somewhat bullate, beneath dull grayish-green, densely and rather softly hispidulous-pilosulous with spreading straightish hairs, on costa hispid-pilose, the veins and veinlets impressed above, prominulous-reticulate beneath; panicles axillary and doubtless terminal, large and loose, up to 36 cm. long and 32 cm. wide, very many-headed, the bracts lanceolate, unlobed, with auriculate bases, the upper minute, the axis and branches wide-spreading, sordid-puberulous only on their upper half, the pedicels mostly 5–10 mm. long; heads 1.2–1.5 cm. wide; disk 7–9 mm. high, 5–7 mm. thick; involucre about 3-seriate, graduate, about 4 mm. high, the phyllaries few, the outermost small, linear to lance-ovate, obtuse, subherbaceous-tipped, sparsely hirsutulous and ciliolate, the inner (subtending the rays) whitish-stramineous, thin-tipped, acute, sparsely hirsutulous chiefly toward margin; rays about 3–5, white, pistillate, the lamina elliptic-oblong, emarginate, 5-nerved, 5.5 mm. long; disk flowers about 26, their corollas hirsute-pilose on tube and lower throat, 4 mm. long; pales obtuse or acute, sparsely hispidulous above, about 7 mm. long; achenes (ray and disk) obovate, flattish, bluntly 1-ridged on each side, very narrowly 2-winged (the wings hispidulous-ciliate, adnate to base of awns), sparsely hispidulous above, 4 mm. long, 1.8–2 mm. wide; awns 2, slender, upwardly hispidulous, unequal, 3 mm. long or less.

Peru: In gravelly, shrubby stream bottom, Yanano, Dept. Huanuco, alt. 1830 m., 13–16 May 1923, *J. F. Macbride* 3786 (type no. 534848, herb. Field Mus.; duplicate no. 1,191,467–8, U. S. Nat. Herb.).

A member of the section *Ochractinia*, nearest *V. columbiana* Robinson, in which the involucre and pales are densely pubescent, and the main axis and branches of the inflorescence densely sordid-pilosulous with lax many-celled hairs.

Verbesina pterophora, sp. nov.

Tall herb; stem essentially glabrous, glaucescent; leaves alternate, large, pinnately lobed, puberulent beneath, the long winged petioles long-decurrent; heads small, radiate, white, about 23-flowered, short-pedicelled, numerous in cymose panicles.

Stem rather stout, multistriate, whitish, sparsely branched, glabrous below, hispidulous with mostly incurved hairs towards the inflorescence; leaves ovate in outline, 16–27 cm. long (including petiole, this 5–7.5 cm. long, winged to base, and decurrent on the stem for 2–6.5 cm. in herbaceous wings 1–3 mm. wide), 9–12 cm. wide, pinnately about 9-lobed (the upper leaves merely shallowly repand-dentate or lobed) with lance-elliptic or triangular, acuminate, remotely serrulate lobes (the rachis between them 0.7–5 cm. wide), acuminate, long-cuneate at the base and decurrent the whole length of the petiole, thin, above dark green, slightly harsh with small incurved scarcely tuberculate-based hairs, beneath lighter green, evenly puberulous with curved antrorse hairs and along the veins hispidulous, featherveined (the lateral veins about 6 pairs); heads numerous, 6 mm. wide, in axillary and terminal pedunculate, bracteolate, cymose panicles 4–9 cm. wide; pedicels 1.5–5 mm. long, densely sordid-hispidulous with mostly curved ascending hairs like the upper part of the peduncles; disk (scarcely mature) 7 mm. high, 4 mm. thick; involucre about 3-seriate, graduate, about 5.5 mm. high, the outer phyllaries linear to oblong, acute or short-acuminate, the innermost (subtending the rays) oblong, acute or acuminate, all whitish-stramineous, with thin obscurely subherbaceous tips, hispidulous-puberulous chiefly above and toward margin; rays 3–4, white, pistillate, the lamina oblong-oval, 3.5 mm. long, 3-toothed, 5-nerved; disk flowers about 19, their corollas white, hispidulous with several-celled hairs chiefly on tube and lower part of throat, 3.5 mm. long; pales obtuse to acuminate, hispidulous above, whitish, about 6 mm. long; achenes (ray and disk) cuneate-obovate, hispidulous, broadly winged, 4–5 mm. long, 3–3.3 mm. wide (including the wings, these 1 mm. wide, hispidulous-ciliolate above, adnate to the awns at base); awns 2, upwardly hispidulous, unequal or subequal, 2–3 mm. long.

Colombia: Vicinity of Cartagena, 1919, *Bro. Heriberto* 228 (type no. 1,036,970, U. S. Nat. Herb.); in thicket, Sincelejo, Dept. Bolivar, alt. 250–350 m., 26 Jan. 1918, *Pennell* 4061 (N. Y. Bot. Gard.).

A species of the section *Ochractinia*, nearest the Brazilian *V. macrophylla* (Cass.) Blake,* which has a more definitely pubescent stem, and leaves with fewer lobes and more densely pubescent with longer hairs beneath. The vernacular name is "cerbatana."

Verbesina crassicaulis, sp. nov.

Tall herb; stem glabrous, glaucescent; leaves alternate, large, pinnately lobed, densely sordid-pilosulous beneath, the petioles winged, auriculate at base, not decurrent; heads rather small, white, discoid, about 21-flowered, numerous in cymose panicles.

Stem stout, 1.3 cm. thick, striate, pithy, purplish, glabrous, the branches of the inflorescence elongate, loosely and sordidly pilosulous especially above; leaves 20–30 cm. long (including petiole, this 7.5–11 cm. long, winged throughout, the wings dilated at base into rounded auricles about 1 cm. wide), 15–28 cm. wide, pinnately 7 or 9-lobed (the lobes ovate or oblong-ovate to lance-elliptic, acuminate, serrate, 7.5–14 cm. long, 3–6.5 cm. wide, the second pair usually largest, the rachis between the lobes 2–4 cm. wide), acuminate, abruptly contracted into

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* **Verbesina macrophylla** (Cass.) Blake.—*Ditrichum macrophyllum* Cass Dict. Sci. Nat. **13**: 371. 1819. *Verbesina diversifolia* DC. Prodr. **5**: 615. 1836; Baker in Mart. Fl. Bras. **6**[3]: 213. *pl. 65*. 1884. *Verbesina lancifolia* Gardn. Lond. Journ. Bot. **7**: 406. 1848, fide Baker.—This transfer is made on the basis of the equation of Cassini's and De Candolle's names by Bentham & Hooker (Gen. Pl. **2**: 380. 1873), who had examined a head from Cassini's type, and by Baker (*loc. cit.*). Cassini's description agrees fairly well with this plant, except that the heads are described as rayless and yellow. Probably the rays, which are not obvious in the young heads, were overlooked by Cassini. No yellow-flowered *Verbesina* with alternate, pinnately lobed leaves is known. The name *Ditrichum macrophyllum* is usually cited from Bull. Soc. Philom. **1817**: 33, but only the generic name appears in that paper.

the cuneate-winged petiole, thick-papery, more or less corrugate and bullate above especially along the costa, above dark green, rather harshly hispidulous-pilosulous with antrorse-curved hairs, densely so along the chief veins, beneath densely and rather softly griseous-pilosulous, featherveined, the veinlets impressed above, prominent-reticulate beneath; peduncles elongate, axillary and doubtless terminal; heads 6–10 mm. high, 4 mm. thick, numerous in a flattish cymose panicle 14.5 cm. wide, its branches and the pedicels (mostly 2–8 mm. long) densely sordid-pilosulous; involucre 2-seriate, graduate, 4 mm. high, the phyllaries few, oblong or linear-oblong, whitish-stramineous, with obtuse or rounded subherbaceous tips, sordid-pilosulous and ciliate; flowers 20–22, their corollas white, hirsute-pilose on tube and to middle of throat, 4.5 mm. long; pales obtuse to acute, hispidulous above, about 7 mm. long; achenes flat, cuneate-obovate, very narrowly 2-winged, finely hispidulous on edge of wings and sparsely so on the body, 5 mm. long, 2 mm. wide; awns 2, slender, subequal, upwardly hispidulous, about 3.5 mm. long.

Colombia: Open ground, La Cumbre, Dept. El Valle, Cordillera Occidental, alt. 1500–1750 m., 7–10 May 1922, *F. W. Pennell* 5200 (type no. 1,140,127, U. S. Nat. Herb.).

Although its discoid heads artificially place this species in the section *Lipactinia*, its real relationship is with species of the section *Ochractinia*. This is shown not only by its whole habit and the color of its florets, but by the fact that several of the outer florets sometimes have imperfect anthers, suggesting that rays may be developed at times. It is distinguished from *V. columbiana* Robinson by its perfectly glabrous stem and discoid, fewer-flowered heads (flowers about 38 in *V. columbiana*), and from *V. myriocephala* Schultz Bip. by the longer, more spreading, sordid pubescence of its lower leaf surface, as well as by the absence of rays.

Verbesina minuticeps, sp. nov.

Tall herb; stem glabrous, glaucescent; leaves alternate, large, pinnately lobed, subsericeous-hispidulous beneath, the petioles winged throughout, shortly auriculate-decurrent; heads tiny, discoid, white, about 15-flowered, very numerous in a large cymose panicle.

Herb about 4.5 m. high; stem stout, 1.2 cm. thick, striate, glabrous or with a few minute appressed hairs; main leaves broadly ovate in outline, about 38 cm. long (including petiole, this 12–14 cm. long, winged throughout, about 1.2 cm. wide, the wings obliquely decurrent on the stem for about 1 cm. as rounded auricles about 6 mm. wide), about 26 cm. wide, pinnately 9-lobed (lobes lanceolate or oblong, 7.5–13 cm. long, 2.5–7.5 cm. wide, acuminate, serrate or the lower sometimes repandly about 6-lobed, the second pair largest, the rachis between the lobes about 2.2 cm. wide), acuminate, abruptly contracted into the winged petiole, papery, above deep green, rather harshly tuberculate-hispidulous, beneath pale, very densely and somewhat harshly subsericeous-hispidulous with curved-spreading tuberculate-based hairs; leaves subtending the lower branches of the panicle similar to the main leaves, but only 7.5–9 cm. long; heads discoid, 13–15-flowered, 5 mm. high, 2.5 mm. thick, very numerous in a large rounded cymose panicle 30 cm. wide, its axis and the lower part of its branches essentially glabrous, the upper part of the branches and the pedicels (1–3 mm. long) cinereous-puberulous; involucre about 3-seriate, graduate, 3 mm. high, the phyllaries few, the outermost small, linear, subherbaceous-tipped, obtuse, hispidulous and ciliate, the inner oblong, obtuse to acute, whitish-stramineous, ciliate, sparsely hispidulous dorsally; corollas white, hirsute-pilose on tube and to middle of throat, 3 mm. long; pales obtuse to acute, whitish-stramineous, hispidulous and ciliate above, about 4.5 mm. long; achenes cuneate-oblong, obsoletely 2-winged, rather plump, 1-angled on each side, hispidulous on wings and toward apex, 2.5 mm. long; awns 2, upwardly hispidulous, unequal, about 2 mm. long.

Ecuador: Guayaquil, alt. 0–50 m., 18–26 June 1923, *A. S. Hitchcock* 20159 (type no. 1,195,177, U. S. Nat. Herb.).

Like *V. crassicaulis*, described above, this species is technically referable to the section *Lipactinia* on account of its discoid heads, but is really more closely allied to the *V. gigantea* group of section *Ochractinia*. The only closely related members of the section *Lipactinia* are *V. bipinnatifida* Baker, of Brazil, which has the leaves griseous-pubescent beneath and the achenes distinctly winged, and *V. crassicaulis*, described above, which has larger heads and leaves griseous-pilosulous beneath. Its nearest ally in the section *Ochractinia* is *V. myriocephala* Schultz Bip., which has radiate, about 20-flowered heads, and a different pubescence on the lower leaf surface.

Verbesina grandifolia, sp. nov.

Very tall; stem sordidly lanate-tomentose; leaves alternate, very large, rhombic-oval or rhombic-oblong, serrate above the cuneate entire lower portion, sordidly subtomentose beneath; petioles naked; heads small or medium-sized, yellow, radiate, about 18-flowered, very numerous in flattish cymose panicles; rays small; involucre few-seriate, about 5.5 mm. high.

Evidently shrubby, up to 7.5 m. high; stem stout, pithy, striate, densely lanate-tomentose with brownish hairs; petioles stout, not auriculate or decurrent, pubescent like the stem, 1–2.5 cm. long; blades rhombic-oval or rhombic-oblong, 15–36 cm. long, 6–17.5 cm. wide, acuminate at each end, serrate or serrulate above the entire lower third (teeth small, unequal, mucronulate, 0.5–3 mm. high, 2–4 mm. apart), papery, above deep dull green, evenly and harshly antrorse-hispidulous with ochroleucous hairs, very densely so along the veins (the hairs with persistent tuberculate bases), beneath densely and ochroleucously subtomentose-pilosulous (the hairs crisped, brownish along the veins), feather-veined, the lateral veins 10–15 pairs, prominent beneath, the secondaries prominulous; heads about 7 mm. wide in flower, very numerous in dense cymose panicles, these terminal and from the upper axils, forming a compound panicle up to 30 cm. wide; bracts small, mostly linear or oblanceolate; pedicels mostly 1–2 cm. long, densely sordid-hirsutulous; disk in anthesis 11 mm. high, 6 mm. thick; involucre about 3-seriate, graduate, about 5.5 mm. high, the outer phyllaries oblong or oblong-oblanceolate, with pale base and shorter, thickened, subherbaceous, rounded or sometimes apiculate tip, sordid-hirsutulous, the innermost (subtending the rays) similar but with thin subglabrous obtuse tips; rays about 4, pistillate, yellow, shorter than the disk, the tube densely hispidulous, the lamina oblong-oval, 3 mm. long, 1.5 mm. wide, rather deeply 3-dentate, with about 8 brown nerves; disk flowers about 14, their corollas yellow, hispid-pilose on tube and base of throat, ciliolate on inner edge of teeth, 5.3 mm. long; pales obtuse, blackish green and densely hispidulous except on the essentially glabrous, erose, subscarious, yellowish tips, about 8 mm. long; disk achenes cuneate-obovate, flat, 1-nerved on each side (the nerves sometimes narrowly winged above), 5–6 mm. long, 3–4 mm. wide (including the wings, these 1 mm. wide above), tuberculate-hispidulous, rather broadly 2-winged, the wings ciliolate, usually adnate to the awns at base; awns 2, upwardly hispidulous, unequal, 4.5 mm. long or less.

Peru: On sunny, rocky stream bank, Mito, Dept. Huanuco, alt. about 2745 m., 8–22 July 1922, *Macbride & Featherstone* 1500 (type no. 517999–518000, herb. Field Mus.; duplicate no. 1,185,980, U. S. Nat. Herb.).

The presence of small rays in this species would place it in the section *Saubinetia* in Robinson and Greenman's revision. Its proper place, however, is clearly in the section *Lipactinia*, in which several species with small rays have been described. It is related to *V. adenobasis* Blake, of Ecuador, which has opposite leaves and much less densely pubescent involucre and pales, and to *V. flavovirens* R. E. Fries of Bolivia and *V. lloensis* Hieron. of Ecuador. *V. flavovirens* is described as herbaceous, 1.5 m. high, with alternate, opposite, or ternate leaves pubescent only on the veins beneath, while *V. llcensis* has narrower leaves, linear or linear-lanceolate phyllaries, and acute pales. The label of the type collection of *V. grandifolia* describes it as reaching 25 ft. in height and gives the vernacular name as "wampu." The stem is described as branched only in the inflorescence, the new shoots being unbranched. The rays and disk corollas appear to have been greenish-yellow.

Verbesina brachypoda, sp. nov.

Stem (or branch?) winged, griseous-pilosulous; leaves alternate, broadly ovate, acute, serrate, rough above, griseous-subtomentose beneath, on short winged petioles; heads small, about 15-flowered, radiate, yellow, pedicellate, in a flattish cymose panicle; involucre about 4 mm. high, the phyllaries mostly oblong, obtuse or rounded, blackish green, ciliolate, sparsely pubescent on back; achenes distinctly winged.

Shrubby (?), 3 m. high; stem (or branch) stoutish, 5 mm. thick, pithy, griseous-pilosulous with crisped many-celled hairs, about 4-winged to the inflorescence, the wings herbaceous, 1–2 mm. wide; petioles winged to base, not auriculate, 5–15 mm. long, 4–12 mm. wide, the wings long-decurrent; blades ovate or broadly ovate, the larger 8–17.5 cm. long, 4.5–10 cm. wide, acute, apiculate, at base broadly rounded or cuneate-rounded and often unequal, decurrent on the petiole, serrate above the usually entire base (teeth low, apiculate, about 0.5 mm. high, mostly 3–6 mm. apart), firm-papery, above yellowish green, harshly tuberculate-hispidulous, beneath densely subtomentose-pilose with many-celled, mostly spreading hairs, featherveined or obscurely triplinerved, the chief veins 3–4 pairs, prominulous beneath, the veinlets prominulous-reticulate beneath; panicle terminal, ternately divided, many-headed, 12–18.5 cm. wide, densely ochroleucous-hirsutulous with spreading hairs, the bracts mostly minute, the pedicels mostly 2–8 mm. long; heads about 11 mm. wide; disk at maturity about 11 mm. high, 5 mm. thick; involucre about 2-seriate, unequal, 4 mm. high, the phyllaries few, the outer oblong, rounded, with pale obscurely ribbed base and blackish green tip, hispidulous-ciliolate and above sparsely hispidulous, the inner (subtending the rays) similar but obtuse or acute, blackish green with yellowish margin and apex, less pubescent; rays about 3, equalling disk, yellow, pistillate (styles short, included), the tube hirsute, the lamina elliptic or oval, 2–3-dentate, 4–6-nerved, 5 mm. long; disk flowers 11–12, their corollas yellow, hirsute on tube and sparsely on throat, 5.5–6 mm. long; pales acute or obtuse, blackish green with yellowish margin and apex, ciliolate and sparsely hirsutulous dorsally, about 6 mm. long; achenes cuneate, flat, sometimes 1-ridged on sides, glabrous, 2-winged, 4.5–6 mm. long, 2.5–3 mm. wide (including wings, these about 1 mm. wide above, glabrous, adnate to awns at base); awns 2, subequal, slender, slightly hispidulous, about 5 mm. long.

Ecuador: Cuenca, 12 Sept. 1920, *E. W. D. & M. M. Holway* (type in Gray Herb.; duplicate in herb. N. Y. Botanical Garden; photog. and fragm. in U. S. Nat. Herb.).

The type collection has been identified as *Verbesina arborea* H. B. K., but that plant has an unwinged stem and different pubescence. *V. brachypoda* is nearer *V. callacatensis* Hieron., which has a densely hirsutulous involucre and longer, auriculate petioles, and the wings of the stem, when present, are much less developed in that species.

Verbesina pentantha, sp. nov.

Herb, 3 m. high; stem appressed-puberulous; leaves alternate; blades elliptic, obscurely serrulate, appressed-puberulous beneath, on slender naked petioles; heads discoid, 4–5-flowered, white, cylindric, in a flattish terminal panicle; involucre very unequal, about 4.5 mm. high, its phyllaries about 6, whitish.

Stem 3.5 mm. thick, terete, striatulate, whitish; petioles appressed-puberulous, 0.4–3 cm. long; blades 8.5–12 cm. long, 2–3.2 cm. wide, acuminate at each end, minutely serrulate (teeth 1–2 mm. apart), papery, above light green, scabrid-hirsutulous with antrorse-curved, tuberculate-based hairs, beneath light green, densely subappressed-puberulous, featherveined, the chief veins about 7 pairs, with the secondaries prominulous-reticulate beneath; panicle dense, terminal, 13.5 cm. wide, its lower branches subtended by greatly reduced leaves, the other bracts minute, the branches and pedicels (these obsolete or up to 3 mm. long) densely hirsutulous with erect or ascending, several-celled, yellowish white hairs; disk in anthesis 8 mm. high, 2.5–3 mm. thick; involucre about 4.5 mm. high, very unequal, the phyllaries few (about 6), the outermost whitish, obscurely greenish above, short-ciliate and sparsely hirsutulous, obtuse, minute, linear or linear-oblong, the innermost about three times as long, linear-oblong, obtuse, without greenish tips, nearly glabrous dorsally; corollas white, hirsutulous on tube and base of throat, sparsely so above, papillose-ciliolate on inner margin of teeth, 4.5 mm. long (tube 0.8 mm., throat slender-funnelform, teeth ovate, 0.6 mm.); pales whitish, obtuse (involute above and appearing acute), short-ciliate, hirsutulous below or nearly glabrous dorsally, about 6 mm. long; achenes (immature) linear-obovate, obscurely margined but not winged, hirsutulous, 3 mm. long, 0.8 mm. wide; awns 2, slender, unequal, upwardly hirsutulous, 3–4.5 mm. long.

Ecuador: Dry brushy land, between Santa Rosa and La Chorita, Prov. Oro, alt. 0–100 m., 27 Aug. 1923, *A. S. Hitchcock* 21144 (type no., 1,195,584, U. S. Nat. Herb.).

This species is of interest from its evidently close alliance with the Argentinian species of the *Chaenocephalus macrophyllus* group. Its heads are fewer-flowered than those of any other species of *Verbesina*, those of *V. Cumingii* Schultz Bip. being 5–6-flowered, of *V. crassiramea* Blake rarely 5-flowered, and of several other species 6–10-flowered.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

INDEX TO AMERICAN BOTANICAL LITERATURE
1924

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 the broadest sense.

Reviews, and papers that 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 omissions, their kindness will be appreciated.

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Vol. 51 No. 11

BULLETIN

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TORREY BOTANICAL CLUB

NOVEMBER, 1924

Studies on the flora of northern South America—I.

H. A. Gleason

Centropogon, Section Burmeisteroides

The genus *Burmeistera* Karst. is distinguished from *Centropogon* by the possession of green or greenish-yellow corollas of peculiar and characteristic shape and by the absence of terminal appendages from the two lower anthers. In *Centropogon*, these appendages are regularly present, and may consist either of a tuft of straight, separate, erect or reflexed hairs, or of a scale composed of accrescent hairs. The section *Burmeisteroides* is here constituted to include a group of species from the Andean region of northwestern South America with green or greenish corollas and with anther-appendages of villous or tomentose hairs. Differing from other species of *Centropogon* in these two features, they are also distinguished from *Burmeistera* by the longer and more slender corolla-tube, which is lobed to about the same depth on both upper and lower sides, and from most species of *Burmeistera* by the presence of conspicuous pubescence on the stem, foliage, flowers, or anthers.

The fruit is a dry, indehiscent berry, of the type prevalent in *Centropogon* and *Burmeistera*. This feature serves to differentiate the section from some species of *Siphocampylus* with green or yellowish flowers, such as *S. giganteus* and its relatives.

The older collections seem to include relatively few species of this section, but the recent explorations of Pennell, Killip, and Hazen have brought several undescribed species to light. The following are known to me from Colombia.

Sepals 18–50 mm. long, linear.
  Calyx gamosepalous for 10–15 mm. above the base, 45–50 mm. long; sepals glabrous on the back; anthers very sparsely hirsute on the connectives near the base..... *C. Andreanus.*

[The Bulletin for October (51: 409–442) was issued October 24, 1924.]

Calyx chorisepalous, or weakly gamosepalous for 1–2 mm. above the base; anthers densely hirsute on the connectives distally.
Sepals glabrous on the back; leaf-pubescence about equally dense on the surface and veins beneath...... *C. asservatus.*
Sepals villous on the back with flat crooked hairs; leaf-pubescence chiefly along the principal veins....... *C. Lehmanni.*
Sepals not more than 11 mm. long.
Sepals oblong, united below, erect and foliaceous above... *C. caldasensis.*
Sepals linear to linear-oblong, separate, erect or spreading.
Stem appressed-pubescent........................ *C. Mutisianus.*
Stem pubescent with spreading hairs.
Sepals narrowly oblong, 2–3 mm. wide, thinly hirsute; leaves acuminate at base.................... *C. variabilis.*
Sepals linear, 1–2 mm. wide, densely hirsute; leaves broadly cuneate to obtuse below.
Leaves acuminate, acute at the base; sepals erect, 8 mm. long................................ *C. gravidus.*
Leaves obtuse, rounded at base; sepals spreading, 6 mm. long................................ *C. breviflorus.*

Centropogon Andreanus n. sp. Stem 2 m. high, the upper portion hollow, finely striate, glabrous to barely puberulent; petioles 25–45 mm. long; leaf-blades broadly elliptic-oblong, the largest 85 mm. wide and 210 mm. long, cuneate at base, abruptly acuminate at apex, broadest at the middle, finely denticulate (about 6 teeth to 1 cm. of margin) with minute, black, triangular teeth 0.5 mm. high, pubescent on the upper surface with pale, flat, crooked and contorted hairs averaging 1 mm. in length, more crowded along the midvein, pubescent beneath with similar hairs, about 0.8 mm. long and located chiefly on the veins, ciliate with hairs of the same type but with dark purple or black septa, scattered along the margin and collected in tufts of 6–12 on every serration; peduncles stout, axillary, 11–14 cm. long, essentially glabrous below, pubescent distally with hairs like those of the leaves; hypanthium depressed-globose, when pressed 12–17 mm. wide by three-fourths as high, nearly glabrous, 10-ribbed, 5 ribs prolonged into sepalar midveins, 5 forking below each sinus and entering both sepals; sepals united for the basal 10–15 mm., the lobes linear-triangular, glabrous on the surface, faintly veined, 30–35 mm. long, finely callous-denticulate, ciliate with tufts of hairs on the teeth; corolla 80 mm. long, its tube 60 mm. long, glabrous, the lobes strongly depressed and falcate; anthers barely exserted, glabrous or barely pilose on the connectives below, the two lower anthers strongly bearded at the apex.

The herbarium of the Royal Botanic Garden at Kew contains two sheets, both collected by André under his number *2799*, and agreeing precisely in every detail. One is labeled "Rio dos Brazos prope Popayan, 19 April 1876," the other "ad decliv. occident. mont. igniv. Corazon And. Ecuad. 3400 m., 10 Jun. 1876." The latter is the type, and bears a reference to the collector's illustration tab. CLXXX, but unfortunately plate CLXXXII is mounted with the plant.

Centropogon asservatus n. sp. A tall herb; stems hollow above, faintly angled, puberulent above, becoming glabrous and somewhat verrucose in age; internodes 2–3 cm. long; leaves thin, membranous, dull-green, oblong-elliptic, 8–11 cm. long, 2–3 cm. wide, acuminate, gradually cuneate at base into a narrowly winged petiole 1 cm. long, finely, sharply, and irregularly dentate (about 9 teeth per centimeter of margin) with triangular, callously mucronate teeth 0.4–1 mm. high, sparsely puberulent above with short, contorted, dark purple hairs, thinly pubescent on the venation beneath with flat, crooked, pale brown hairs, thinly ciliate with crooked hairs with black septa, veins not prominent, reticulate beneath; peduncles from the upper axils, 8–12 cm. long, thinly puberulent to nearly glabrous, erect or ascending; hypanthium obconic, 16–20 mm. high, 9–11 mm. wide at the summit when pressed, faintly nerved, nearly glabrous; sepals erect, narrowly linear above a narrowly triangular dilated base, about 5 cm. long, glabrous on the surface, remotely and minutely callous-denticulate, sparsely ciliate with crooked hairs with black septa; corolla-tube 28 mm. long, glabrous, gradually narrowed to the middle, thence dilated to the throat, the lobes narrowly triangular-falcate, depressed, 20 mm. long; filaments 10 mm. longer than the corolla-tube, subtomentose above; anthers 13 mm. long, subtomentose with white hairs below, hirsute with erect brown hairs on the connectives, the two lower strongly bearded at the apex; fruit a dry berry, ellipsoid, 3 cm. long, surmounted by the persistent sepals.

Type, *Pennell 927*, collected 3–6 Aug. 1917, in forests on the Rio Balsillas, Dept. Huila, Colombia, altitude 2000–2100 m., and deposited in the herbarium of the New York Botanical Garden. Other specimens are *Pennell 960* and *601*, Cordillera Oriental, east of Neiva, Dept. Huila, 1–8 Aug. 1917. Of these the latter has broader leaves, about three times as long as wide, with sepals 40 mm. long.

CENTROPOGON LEHMANNI Zahlbr. Four numbers in the herbarium of the New York Botanical Garden are referred to this species, although differing in some unimportant respects from each other and from the type. In *Lehmann 529*, without data, and *882*, forests of Popayán, 1700–2500 m., the leaf-blades are more than twice as long as broad and sharply cuneate at base and the thinly villous sepals are about 30 mm. long. In *Pennell and Killip 8087*, Rio Ortega, Dept. El Cauca, Colombia, 2 July 1922, and *Pennell 10,279*, Apia, Dept. Caldas, 4, 5 Sept. 1922, the leaf-blades are less than twice as long as wide and the densely villous sepals are only 20 mm. long. Zahlbruckner cited two sheets, *Lehmann 4754* and *Triana 1569*. I have seen the latter in the herbarium of the Museum at Paris and find it essentially intermediate between the two forms mentioned above.

Centropogon caldasensis n. sp. Stem herbaceous, angled, hollow, puberulent above, becoming glabrous below, bearing numerous short axillary leafy branches; petioles 20–25 mm. long, slender, minutely puberulent; leaf-blades membranous, bright green, ovate-lanceolate, 45–65 mm. long, 20–25 mm. wide, subacuminate, rounded at base, shallowly repand to subentire (4–6 teeth per centimeter of margin), glabrous above, thinly pubescent on the veins beneath, the veinlets obscurely reticulate; peduncles ascending from the upper axils, 4 cm. long, conspicuously ridged, thinly puberulent, with two basal linear bracts 8 mm. long; hypanthium obconic, 9 mm. high, 4 mm. wide at the summit when pressed, thinly puberulent, faintly ribbed; sepals 10 mm. long, united for the basal 2 mm., the lobes oblong, erect, somewhat foliaceous, short-acuminate, many-nerved, irregularly contorted along the margin or serrulate, essentially glabrous, separated by narrow acute sinuses; corolla-tube slender, 14 mm. long, puberulent, the lobes linear-falcate, depressed, 7 mm. long; filaments glabrous, equaling the petals; anther-tube strongly depressed, short and stout, 4 mm. long, glabrous, the two lower anthers densely villous at the apex.

Type, *Pennell 10,322*, collected 7–11 Sept. 1922, along the Rio San Rafael, below Cerro Tatama, altitude 2200–2400 m., Dept. Caldas, Colombia, and deposited in the herbarium of the New York Botanical Garden.

Centropogon Mutisianus (H.B.K.) n. comb. (*Lobelia Mutisiana* H.B.K.) The distinction between this and related species stated in the key above has been drawn from the type specimen in the herbarium of the Museum at Paris.

Centropogon variabilis n. sp. Stem herbaceous, strongly angled, densely pubescent or subtomentose with sordid brown hairs above, becoming glabrate with age, the internodes 1–2 cm. long; petioles angled, densely pubescent, 10–25 mm. long; leaf-blades broadly elliptic, about 9 by 18 cm., thin and membranous, bright green, abruptly acuminate, cuneate or acute at base, coarsely and irregularly repand, the larger teeth triangular, 2–4 mm. high and 10–20 mm. apart, the intermediate teeth much smaller, thinly pubescent along the midvein and laterals above and likewise on the surface when young, thinly pilose on the surface and densely so the veins beneath, the hairs straight, appressed, 0.4 mm. long, forming conspicuous belts along the veins; peduncles from the upper axils, 5 cm. long, thinly pubescent; hypanthium short-cylindric, 9 mm. high, 7 mm. wide when pressed, puberulent; sepals triangular, 6 mm. long, 2.5 mm. wide at the base, pubescent on both sides, with about three pairs of low callous teeth, separated by narrow rounded sinuses; corolla puberulent, the tube 25 mm. long, straight, slender, the lobes linear-oblong, falcate, depressed; filaments glabrous, included; anther-tube 8 mm. long, subtomentose on the sutures, the two lower anthers villous at the apex.

Type, *Pennell 10,734*, collected 18, 19 Sept. 1922, at Buenos Aires, north of Supia, Dept. Caldas, Colombia, altitude 2000–2200 m., and deposited in the herbarium of the New York Botanical Garden. Four other sheets are also referred here, which differ so much from the type as to suggest the specific name *variabilis*. These differences do not appear to warrant the recognition of additional species but indicate merely a considerable degree of variability. In *Pennell 3409*, Libano, Dept. Tolima, 26–29 Dec. 1917, the leaves are proportionately narrower and the serrations lower; in *Pennell 10,324*, Rio San Rafael, below Cerro Tatama, Dept. Caldas, 7–11 Sept. 1922, the leaves are smaller, thicker, and blunter; in *Pennell 10,325*, same place and date, the small leaves are almost obovate, while *Pennell 4397*, Cascada Chorron, south of Antizales, Dept. Bolivar, 25 Feb. 1918, is a fragmentary specimen without flowers.

I have not seen the type of Karsten's *Burmeistera tomentosula*, which was imperfectly described. It may be similar to our species.

Centropogon gravidus n. sp. Stem herbaceous, hollow, strongly angled, densely pubescent with straight spreading hairs with black septa; petioles stout, densely pubescent, 10–13 mm. long; leaf-blades elliptic-oblong, firm, dull-green, 13–23 cm. long, 3–7 cm. wide, abruptly acuminate to long-acuminate, tapering to an acute or cuneate base, coarsely, sharply, and irregularly dentate, especially above the middle, with triangular teeth as much as 5 mm. long (about 2 teeth per centimeter of margin) to subentire, pubescent above with straight, stiff, brown hairs about 0.5 mm. long, especially along the midvein, pubescent with similar hairs below, especially along the veins, where they form conspicuous belts of pubescence; peduncles numerous from the upper axils, ascending, 5–7 cm. long, pubescent like the stem, the bracts linear, 3 mm. long, deciduous; hypanthium short-cylindric, 9 mm. long, 7 mm. wide when pressed, sparsely pubescent; sepals erect, 8 mm. long, narrowly triangular, acute, irregularly serrate with 3 or 4 pairs of teeth, thinly hirsute, conspicuously ciliate with tufts of hairs with dark septa; corolla sparsely pubescent below, becoming densely so toward the apex of the lobes, the tube 27 mm. long, stout, the lobes broadly linear-falcate, depressed; filaments included, glabrous; anther-tube stout, somewhat curved, 8 mm. long, thinly pubescent, especially at the apex, the two lower anthers villous at the summit.

Type, *Killip & Hazen 11,122*, collected 9 Sept. 1922, at La Cumbre, Dept. El Valle, Colombia, altitude 1700–2100 m., and deposited in the herbarium of the New York Botanical Garden. Other collections are *Pennell 4398*, Cascada Chorron, south of Antizales, Dept. Bolivar, 25 Feb. 1918, *Pennell 5723*, La Cumbre, Dept. El Valle, 14–19 May, 1922, and *Killip 5921*, La Cumbre, 21–25 May 1922.

Centropogon breviflorus n. sp. Stem shrubby, climbing, angled, apparently solid, densely pubescent or subtomentose with septate hairs; petioles densely pubescent, stout, 3 mm. long; leaf-blades firm, spreading, dull-green or brown-green, elliptic, 5–8.5 cm. long, 3.5–4.5 cm. wide, obtuse, rounded at base, entire or barely repand, thinly puberulent above with short curved hairs, especially on the midvein, closely pubescent on the surface and veins beneath with short brown hairs, and hirsute on the midvein with longer, straight, spreading hairs; peduncles from the upper axils, stout, 2–3 cm. long, pubescent like the stem; hypanthium short-cylindric, 7 mm. high, 8 mm. wide when pressed, densely pubescent like the peduncle, especially at the base; sepals spreading, narrowly triangular-linear, 6 mm. long, somewhat involute, densely hirsute and ciliate with straight brown hairs; corolla 20 mm. long, densely pubescent with septate hairs, the tube 15 mm. long, the lobes linear-falcate, depressed, glabrous along the margin; filaments included, glabrous; anther-tube black, 5 mm. long, thinly and sparsely pubescent, the two lower anthers villous at the tip.

Type, *Pennell 7545*, collected 29, 30 June 1922, on Mount El Trueno, Dept. El Cauca, Colombia, altitude 2700–3000 m., and deposited in the herbarium of the New York Botanical Garden.

Crown gall on Bryophyllum calycinum*

MICHAEL LEVINE

(WITH PLATE 10)

In a paper on the effect of inoculations of *Bacterium tumefaciens* into the notches and midveins of detached leaves of *Bryophyllum calycinum* planted in moist sand, the present writer (Levine 1919) pointed out that in a great majority of cases the notches produced only crown galls of the common globular type without indications of leafy shoots. The inoculations into a midvein, however, invariably resulted in the development of only a crown gall. Inoculations of the crown gall organism alongside of the notches in these detached leaves yielded occasionally a crown gall with a dwarfed leafy shoot. Control leaves set out under similar conditions resulted in large and vigorously growing shoots in the time that it took the stunted leafy shoot and crown gall to develop.

Inoculations of *Bacterium tumefaciens* into the region near the axillary buds of the stem caused the formation of a crown gall and a poorly developed axillary bud. Frequently the crown gall formed over its surface a number of leaflets. The axillary bud failed entirely in its development.

Smith (1921) inoculated *Bacterium tumefaciens* into the notches of undetached leaves of *Bryophyllum calycinum*, which, he states, resulted in the development of shoots in the notches. He contends that *Bacterium tumefaciens* stimulated the development of these buds. Inoculations of the axillary bud of the stem with the same organism resulted in the two types of leafy crown galls described by me (Levine 1923). Smith's results confirm my supposition that *Bryophyllum* has many totipotent cells. He fails, however, to show that these cells may be stimulated by *Bacterium tumefaciens* to form "embryomata" or leafy shoots in any region other than that where dormant buds are known to exist.

In a later paper (Levine 1923) the writer reported studies on the effects of inoculations of *Bacterium tumefaciens* on the tobacco

* Contribution from the Cancer Laboratory, Montefiore Hospital, New York.

plant, which forms leafy crown galls readily. Three distinct types of crown galls appear here also, namely, the common globular type, the differentiated globular type which forms small and slowly growing leaflets over its surface, and the axillary leafy crown gall which consists of a crown gall and a poorly developed axillary bud. The stimulus to growth of this type of crown gall is not the direct result of *B. tumefaciens*, but is due rather to a mechanical interference with the food supply incident to the development of the mass of crown gall tissue.

In a recent paper (Levine 1924) the author reports further observations on rubber trees, which were studied for a period of over four years. The results substantiate his earlier studies made on the *Bryophyllum* and the tobacco plants.

De Vries (1891), Goebel (1908) and Loeb (1915, 1917, 1918) have claimed that the development of shoots in the notches of the *Bryophyllum* leaf was inhibited by the presence of the main root or regenerated roots on the stem. These authors further claimed that the organic separation of the leaf from the rooted part of the plant acts as a stimulus upon the leaf and induces growth of the buds in the notches. Loeb (1915) contends that this is not the only factor involved. He states that a piece of stem, even if it does not form any roots but only a shoot, will prevent or greatly delay the growth of the notches of a leaf connected with it.

Miss Braun (1918) pointed out that leaves of *Bryophyllum* attached to the plant were capable of producing leaves and roots at their notches. Loeb (1918 *b*) claims that this development occurs only in sick plants. He contends that the recumbent position of the stem acts as a partial block to normal transportation of fluids, and that such sick and bent stems behave to all purposes like isolated pieces of stems, the leaves of which will give rise to shoots. Reed (1923) holds that, while the stem and roots of the plant do not influence the development of the buds in the leaf notches, conditions, such as the absence of light, and the abundance of very moist air or water, do have such an effect.

The present report deals with further observations on the effect of inoculations of *Bacterium tumefaciens* into the notches of leaves of *Bryophyllum*. I showed that in leaves which were stimulated to shoot development by being cut from the stem and planted in moist sand, relatively few leafy crown galls developed after inoculation. It has seemed to me to be desirable to determine the effects of inoculation of the notches of these leaves undetached from the mother plant and to determine the frequency of the leafy crown galls thus formed, as compared to the number of the common globular types that appear. I have found in my cultures what appear to be mature and healthy *Bryophyllum* plants which developed leafy shoots at their notches. The number of shoots formed on these leaves resulting from an apparently unknown condition was compared with the number of leafy shoots resulting after the inoculation with *Bacterium tumefaciens.* Both plants were grown under similar conditions. Up to the present the differentiated globular crown gall with leaflets on its surface has not been observed at the margin of *Bryophyllum* leaves.

MATERIAL AND OBSERVATIONS

In the present experiment twelve young *Bryophyllum calycinum* plants were set out on benches in the greenhouses at Columbia University. These were rapidly growing plants with numerous leaves of all ages, although none were very old. Only the young leaves in the middle portion of the plant were used. Five to ten of these leaves in each plant were selected. The inoculations were made by piercing the notches of the middle portion of the leaves where shoots most frequently develop (Loeb 1918 *a*) with a needle dipped into a sub-culture of the hop strain of *Bacterium tumefaciens.* The inoculations were made on September 25, 1923. The leaves were carefully labeled. They were examined from time to time and all changes were noted. On April 21, 1924 it was observed that the inoculated leaves were becoming old and dying. The leaves were detached and the numbers and kinds of crown galls were recorded.

FIG. 1 represents a crown gall with four leafy shoots resulting from the inoculation of *Bacterium tumefaciens* into the notches of the leaf. It is quite clear from this photograph that where the inoculations were made globular crown galls developed, with the exception of one case shown here, where the bud at the notch developed into four shoots. At the bases of these shoots a large crown gall is to be seen. Such leafy crown galls are like those that sometimes develop when the axillary bud of the stem is inoculated with *B. tumefaciens*, such as shown by

Smith (1921, *f. 101*) and in my own studies on tobacco (Levine 1923, *f. 13, 14*). To test whether or not these shoots are diseased or only stunted, owing to interference with their water and other food supplies by the crown gall tissue, I removed them from the leaf. All parts of the mother leaf were trimmed away from the crown gall and the leafy shoots attached to it. No roots were at this time visible. The adventitious leafy crown gall was then planted in a pot. FIG. 2 represents this leafy crown gall two months later. It shows the leaf and stem portion of the crown gall developed into an apparently normal plant with four stems, at the bases of which may still be seen the globular portion of the crown gall. Long, fibrous roots have developed not only from the surface of the crown gall tissue but also from the lower nodes of the stems. The plants grew rapidly and are still growing in the experimental garden at Montefiore Hospital.

The other types of crown gall are represented in FIG. 3—at *a*, the globular type, and at *b*, the differentiated leafy crown gall. The crown gall at *b* first appeared as a mass of globular tissue. Later the leaves began to make their appearance, as described previously in my studies on tobacco. These leafy shoots are not due to injury of the dormant bud at the notch of the leaf. When the bud is cut into a number of parts at the time of inoculation, each part develops into a shoot, as I have pointed out and figured before (Levine 1923, *f. 16*). In the present instance, as in the case of Smith's FIG. 103 (1921) the crown gall cells became differentiated and developed into the small leaves and stems shown there. Under moist atmospheric conditions roots may also appear. It is barely possible that five pricks of the inoculating needle will cut up the bud into fifty or more parts which develop into small leaves frequently sessile.

Smith (1921) believes these leafy crown galls are embryomata comparable to embryomata in human cancer. He considers the internal differentiated tissues of the crown gall comparable to the stroma of cancer. The stroma of human and of animal cancers arises from muscle, nerve, blood vessel, and other connective tissue elements, which occur in the region of the neoplasm. By resumption of growth of these tissues the stroma is formed. Vessels and tracheids in plants once formed cannot resume growth. The meristematic tissue which forms vessels and tracheids is stimulated to proliferate through the agency of the crown gall organism. These cells, on differentiation, form isolated parts of a poorly organized fibro-vascular system. In benign crown galls there is frequently a considerable increase in the thickness of the wood. This is likewise due to stimulated meristematic tissue with subsequent differentiation. The cortical cells are capable of responding to the stimulus to divide. They eventually become mature cortical cells.

FREQUENCY OF LEAFY CROWN GALLS

The following table shows the number of crown galls that are formed at the notches of leaves of *Bryophyllum* when inoculated with *Bacterium tumefaciens*. The fourth column shows the number of leafy crown galls formed when the notches of the longitudinal half of the leaf are inoculated. The figures in the third column do not include the leafy crown galls.

TABLE 1

RESULTS OF INOCULATIONS OF BACTERIUM TUMEFACIENS INTO THE NOTCHES OF LEAVES OF BRYOPHYLLUM CALYCINUM.

No. of leaves	No. of globular crown galls per long half of leaf	Total	No. of leafy crown galls
17	4	68	13
9	6	54	4
9	5	45	8
8	3	24	4
3	2	6	0
2	1	2	2
48		199	31

An analysis of the results obtained from these inoculations shows that 17 leaves produced 68 globular crown galls. Seven of these leaves produced in addition one leafy crown gall each, while three leaves produced two leafy crown galls each; the remaining seven leaves produced no leafy crown galls at all. Another group of leaves, nine in number, produced 54 globular crown galls, and only four leaves produced one leafy crown gall each. In another group of nine leaves 45 crown galls of the globular type were formed. Four of these produced one leafy crown gall each; two other leaves produced two leafy crown galls each. Eight leaves in another group showed 24 globular crown galls; in addition, two of the leaves showed four leafy crown galls. In two smaller groups made up of five leaves, eight globular crown galls with two leafy crown galls were formed.

In all, 230 crown galls were formed at the notches. Of these, 199 were of the globular type without any indication of leafy shoots of any form. Thirty-one were of the leafy type, of which 12 were like axillary leafy crown galls and 19 were of the differentiated type. That is, in 48 counted leaves, with one-half of the notches inoculated, the globular crown gall without leaves or roots appeared 7.4 times more frequently than the leafy crown galls of either the differentiated type or the axillary bud type. A number of notches failed to develop crown gall of any form. The inoculation induced necrosis of the leaf in the region of inoculation.

I have studied the development of the notches of *Bryophyllum* leaves uninoculated and attached, that were growing on the same bench with the inoculated plants. The conditions which induced the notches of all the uninoculated plants to proliferate appeared later. My observations on detached leaves are in accord with Loeb (1918 *a*) on the position of the developing notches. Few apical and basal notches develop, although in my cultures I have seen apical notches form shoots. Loeb (1918 *b*) contends that attached leaves of *B. calycinum* which show sprouting notches are sick plants. The specimens I have under observation are not bent nor growing in pots. FIG. 4 shows a very young plant with numerous sprouting notches on lower leaves. It appears to be an actively growing plant. The conditions that induced the notches to develop in these uninoculated plants were apparently equally active in the inoculated plants also, for, as mentioned above, all these plants were growing on the same bench.

In TABLE 2, column 2 gives the number of notches in each of twelve leaves. Under column 3 is given the number of shoots that appeared on each leaf. Of 195 leaf notches of *Bryophyllum*, 106 produced shoots.

TABLE 2

UNINOCULATED NOTCHES OF LEAVES OF BRYOPHYLLUM CALYCINUM

No. of leaf	No. of notches per leaf	No. of sprouting buds
1	17	14
2	18	9
3	16	11
4	15	6
5	17	10
6	18	9
7	17	7
8	15	6
9	14	11
10	15	5
11	16	10
12	17	8
	195	106

It appears from these data that *Bacterium tumefaciens* does not stimulate bud development, even in the presence of conditions which favor it. *B. tumefaciens*, it appears, induces a neoplasm which offers mechanical obstruction to the transportation of fluids, which, in turn, calls forth bud proliferation, as shown in the rubber plant (Levine 1924). If bent stems induce partial interference in the conducting system, which is responsible for the development of shoots in the notches of leaves of *Bryophyllum calycinum*, as held by Loeb (1918 *b*), it appears to be reasonable to suppose that a disturbance induced by a mass of invading meristematic tissue may at least have a similar effect on these buds one in 8.4 chances.

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Explanation of plate 10

FIG. 1. Attached leaf of *Bryophyllum calycinum* inoculated with *Bacterium tumefaciens* showing crown gall and bud development similar to the axillary leafy crown gall resulting from the inoculation of an axillary bud.

FIG. 2. The leafy crown gall shown in FIG. 1 after growing in soil for two months.

FIG. 3. Globular crown gall at *a.* Differentiated crown gall showing small leaves growing out of crown gall at *b.*

FIG. 4. Young uninoculated *B. calycinum* plant showing developed marginal notches.

BRYOPHYLLUM WITH CROWN GALL

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BULLETIN

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A preliminary account of the influence of light and temperature on growth and reproduction in Chara fragilis*

JOHN S. KARLING

(WITH PLATES 11-13)

The fruiting in nature of the different species of the Characeae is reported by Migula (25), Allen (3), and Robinson (30) to occur during the summer and early fall. In undertaking a cytological study of nuclear and cell division and fertilization in the Characeae three cultures of *Chara fragilis* Desvaux were placed on an east window-sill in the laboratory on September 24, 1923, to determine whether the stimulus of higher temperature and more favorable illumination would lead to the development of reproductive organs at other than normal times. The vegetative growth of these cultures was vigorous, but no antheridia and oogonia were formed. In view of results recently described by Garner and Allard (17), Adams (1), and Harvey (19) it was thought worth while to test the cultures as to photoperiodism. Consequently on January 8, 1924, as a preliminary experiment, two of the cultures were placed under a 60-watt 120-volt electric light suspended 15 cm. above them and given continuous illumination throughout the night. Within a few days antheridia and oogonia appeared in abundance on these plants, while the control culture remained entirely free from reproductive organs. It was then determined to make a further preliminary study of the response of *Chara fragilis* to changes in illumination periods and temperature with the particular purpose of obtaining material for cytological study. The

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results so far obtained in these experiments are here reported. A further, more extensive series of experiments is now being made with controlled temperature and light intensities.

The problem of the periodicities in the life cycles of the algae has been widely studied both in the field and under laboratory conditions. The literature in this field is extensive, and I shall summarize only those results that deal more directly with the problem of photoperiodism as related to sexual reproduction. Klebs (23) aimed to demonstrate complete environmental control over the life cycles of various algae and fungi which he studied, but his results have not been generally confirmed. Many of his experiments involve environmental conditions which are scarcely ever realized in nature and are hardly applicable to the explanation of the normal periodicity of algae. Similar studies by a large number of investigators both in the field and laboratory have yielded diverse results and consequent views regarding the underlying causes of algal periodicities. The results of these studies, however, cannot be said to have been decisive either for the internal or environmental periodicity theories. Danforth (13), Copeland (11), Hoyt (22), Williams (35), and Transeau (31) hold that the periodic changes in the life cycles of the algae that they studied resulted not so much from external as from internal conditions and hereditary tendencies. Comère (10), Benecke (7), Fritsch and Rich (16), West and West (34), Brown (9), and Hodgetts (21), on the other hand, take the opposite view and account for the periodic changes on the basis of change in external environment.

For the higher plants many observers, including Corbett (12), Bailey (4), Rane (28), Bonnier (8), and Vöchting (32), have held that increased illumination led to rapid growth and to early production of flowers and seed. Results recently described by Garner and Allard (17), Hendricks and Harvey (20), and Adams (1) relating to a wide variety of flowering plants show that the relative length of the day is a primary factor in growth and development, and particularly in determining the occurrence of sexual reproduction.

Relatively few investigations have been made on the response of Characeae to light changes. In 1894, Richter (29), using *Chara fragilis* and *C. hispida*, found that the shoots were positive and the rhizoids negative in their response to light. In cultures of *C. hispida* grown a meter or more from a window, Müller (26) found plants in which some of the internodes were without corticating cells. He also grew cultures of *C. foetida* in dark and half-dark rooms and in full daylight. In many of the plants grown in reduced illumination the corticating cells were either absent or abnormally arranged about the internodes. In such cases, the corticating cells, instead of adhering closely to the internodal cell, formed a loose sheath. Müller, however, made no experiments involving the lengthening or shortening of the period of illumination.

Nonweiler (27) grew *Chara strigosa* with peat and sand as substrata in sodium chloride solutions of various concentrations in full and reduced illumination. Increased concentration of the solution reduced the length but increased the diameter of the internodes. He observed that high temperature and light intensity hindered length growth. Ernst (14) reports that the length of the oospores of *Chara crinita* varied considerably with changes in temperature and light intensity, culture medium, and substratum on which the cultures were grown. Cultures grown under double-walled bell-jars with potassium bichromate and with ammoniacal cuprous oxide solution, or in reduced illumination, produced shorter oospores than in normal cultures. Hodgetts (21) in his study of the periodicity of fresh-water algae in nature reports that *Nitella flexilis* develops most rapidly when the temperature is moderately high, and that abundant bright sunshine is very necessary for oospore-production.

CHARA FRAGILIS GROWING IN NATURE

The plants used in the following experiments were secured from a small, shallow pond in Van Cortlandt Park, New York City, during the interval between September, 1923 and April, 1924. This is apparently an unreported locality for *Chara* in the vicinity of New York City. The water in this pond during winter of 1923 and the early summer of 1924 was shallow (5–20 cm. deep) and during June and July when the vegetative growth appeared most vigorous, the plants did not attain a length over 45 cm. The growth from October to March was negligible. It seems probable that when the winter is severe the tops of the plants may be killed by freezing. In such an instance, the nodes and other parts of the plants buried in the soil give rise to the next year's growth.

In the mild winter of 1923–24 the plants did not die down but remained alive under the ice when the pond was frozen over. Healthy green plants were secured throughout the entire winter. On several visits to the pond it was frozen over with a thin sheet of ice, and when the ice was broken away the plants were found to be in a dormant, healthy condition with a deep green color. The temperature under the ice was approximately 2° C. The plants at that time were only about 15 cm. in length, including the dead basal end. The internodes were 13 to 15 mm. in length and .75 mm. in diameter. The leaves and main axis were covered with brownish-colored plankton forms.

The formation of antheridia and oogonia in *Chara fragilis*, according to Migula (25) and Robinson (30), occurs generally from July until September. When this bed of *Chara* was discovered on September 19, 1923, there were no indications of reproductive organs. The plants were examined carefully throughout the winter for the appearance of these structures The first antheridia and oogonia occurring spontaneously were observed on May 26, 1924. The plants were still partly covered with brownish plankton, but they had increased several inches in length and branched freely.

EXPERIMENTAL METHODS

Large masses of plants were brought into the laboratory and grown in shallow pots with sand loam as a substratum and placed in battery jars. The battery jars were of various sizes, ranging from 15 to 30 cm. in diameter and 30 to 45 cm. in depth. The taller jars were found to be more favorable than the smaller ones. Tap water was used in every case. Very little difficulty was encountered from invasion of algae. A small crustacean was introduced into the jars to keep down the growth of the algae whenever they became abundant. When necessary the pots were lifted out and the jars were cleaned. Fresh water was added once or twice every month.

The cultures were placed in north, east, south and west windows in the laboratory where they received varying degrees of illumination. All cultures with the exception of those in the north windows received the direct rays of the sun several hours each day. The reponse to this increase in illumination and temperature was immediate in every culture. The plants began to grow vigorously and branch freely. Two cultures of the plants and a control were used in each of these preliminary experiments. The plants were allowed to acquire a good vegetative development by leaving them in their positions for several days to weeks before they were subjected to experimental conditions. For increasing the period of illumination a 60-watt 120-volt mazda lamp was placed approximately 8 cm. above the battery jars. In every case the light bulbs were immersed in a battery jar of water to prevent an increase in temperature when they were burning. In all experiments the light was turned on at sunset; and the daylight period was reckoned from sunrise to sunset. The intensity of illumination when the sun was not shining directly on the cultures was measured rather roughly each week with a foot-candle meter. The controls in every case were covered with blackened bell-jars at sunset. The electric light was used only to supplement the normal daylight of the period of each experiment, and was not turned on until sunset. At the time that *Chara fragilis* began to fruit out-of-doors on May 26, 1924, the period of daylight had increased more than five hours over that in January when the experiments were begun. Thus the last cultures studied were receiving relatively more daylight and less electric illumination. The increase of the daylight period is shown in CHART 2.

A thermometer was placed in each battery jar, and temperature readings were made at intervals of four hours. Each culture was examined daily with a hand lens, and when there were indications of antheridia and oogonia the plants were examined with the low power of a microscope to determine with certainty the presence of reproductive organs. Photographs were made as soon as the first antheridia and oogonia had reached full size. Representative plants from each culture were selected and photographed. Records of the cultures are here reported, covering the period from October 18, 1923 to November 6, 1924.

OBSERVATIONS AND RESULTS

SERIES 0, CULTURES 0–1 AND 0–2

Collected in park pond......Culture 0–1, Oct. 18; Culture 0–2, Dec. 28
Outside on east window-sill............................Oct. 18 to Jan. 11
Inside on shelf before east window with all-night electric illumination
Jan. 11 to March 26
On shelf in east window with only daylight illumination..March 26 to Nov. 6

SERIES 0, CULTURE 0–3

Collected 1922
Grown in greenhouse .... 1922 to Jan. 22, 1924
Grown in greenhouse under all-night electric illumination. Jan. 22 to April 23
Grown in north window of laboratory with only daylight illumination
April 23 to Nov. 6

Series 0, Culture 0–1 consisted of three jars with a control. The plants were brought from the field on October 18 and grown outside on an east window-sill. The plants were there subject to alternate chilling and warming as the weather changed. On bright days the morning sunlight fell directly on the cultures. The plants were green and healthy but grew slowly. They had increased about three inches in length when on January 11 the culture was placed on a shelf inside of the window under electric illumination during the night. A more vigorous growth was immediately evident. The internodes increased in length, and the leaves spread out at right angles to the main axis. As the experiment continued there was a noticeable difference in growth as compared with the control. The control plants were shorter and stockier and deeper green in color. On January 21 antheridia and oogonia appeared, ten days after the all-night illumination was begun. There was no indication of fruiting in the control. The electric illumination was discontinued on March 8. Photographs were made on March 26. The development of antheridia and oogonia was slow in comparison with that in some of the later cultures. FIG. 1, PLATE 11 shows the result of the continuous illumination in contrast with the condition of the control culture shown in FIG. 4, PLATE 11. When the electric illumination was discontinued, the culture with its control was left in the same place in the east window. It continued to grow and fruit moderately throughout the summer, but by September 12 the whole culture was dead except for the tips of the plants. A few antheridia and oogonia were present in the two upper whorls of leaves. The tips, 10 cm. long, were transplanted to a new pot of sand loam where they subsequently began a rapid vegetative growth. By October 19 the plants were approximately 25 cm. in length, but no reproductive organs were present on the new growth. Since that time, until November 6, a few sporadic antheridia and oogonia have been formed on the upper whorls of leaves.

The control culture began to fruit on June 7. The fruiting continued throughout the summer, and on September 12 tips

10 cm. long were transplanted to a pot of fresh sand and loam. A good vegetative growth followed, and on October 13 a few antheridia and oogonia were observed on this new growth. By November 6, however, these had fallen off.

The plants of Series 0, Culture 0–2, consisting of a single jar, were brought in from the park on December 28, 1923 and grown in the east window alongside Culture 0–1. Its growth, however, had not been as vigorous when on January 18 it was placed inside of the window under the same light and temperature conditions as 0–1. Antheridia and oogonia were formed twenty-one days later, on February 9. No reproductive organs were present in the control culture at that time. Culture 0–2 continued to fruit during the summer, but the plants were very slender with long internodes and short leaves. On September 12 a number of 10 cm.-long tips of these plants were transplanted. Growth was very slow, and by the first of November the entire culture was dead. The original culture, pruned down on September 12, began to grow rapidly, and on October 19 the new growth was approximately 8.5 cm. long. Antheridia and oogonia were abundant on the new growth. By November 6, the longest plants were about 25 cm. long, with a few reproductive organs in the apical whorl of leaves.

Series 0, Culture 0–3, consisting of two jars, contained about seventy-five plants of *Chara fragilis* which were collected in 1922 and had been growing in the greenhouse for two years without forming reproductive organs. This culture had been subject to usual greenhouse conditions in a house used for ordinary herbaceous annuals. On January 22, 1924, the jars were placed under a 75-watt 120-volt light suspended 1 meter above. The light was kept burning throughout the entire night. On March 14, fifty days later, antheridia and oogonia appeared in the two uppermost leaf whorls of the plants. The night temperatures in the greenhouse were considerably lower than in the laboratory in which Cultures 0–1 and 0–2 were grown. FIG. 2, PLATE 11 shows this culture in contrast with its control. Nearly every oogonium formed in this culture developed mature oospores, while from the thousands of antheridia and oogonia formed in 0–1 and 0–2, less than twenty-five mature oospores were developed. In these latter cultures the oogonia turned white in color and dropped off after attaining full size.

Culture 0–3 continued to fruit until July. By September 12 the plants had increased fully 24 cm. in length, were healthy and deep green in color. No antheridia and oogonia were present on this new growth, however. At the end of October the plants had died, but a new growth was beginning at the base of the old plants. No reproductive organs have been observed on this culture since June 28. The control grew slowly but did not fruit during the spring and summer.

SERIES A

Collected from under the ice in the park pond..............March 15
Grown on east window-sill in laboratory..................March 15–19
In east window under electric light daily from sunset to 1 a. m.
March 19–April 22
Grown In north window with only daylight illumination..May 4–Nov. 6

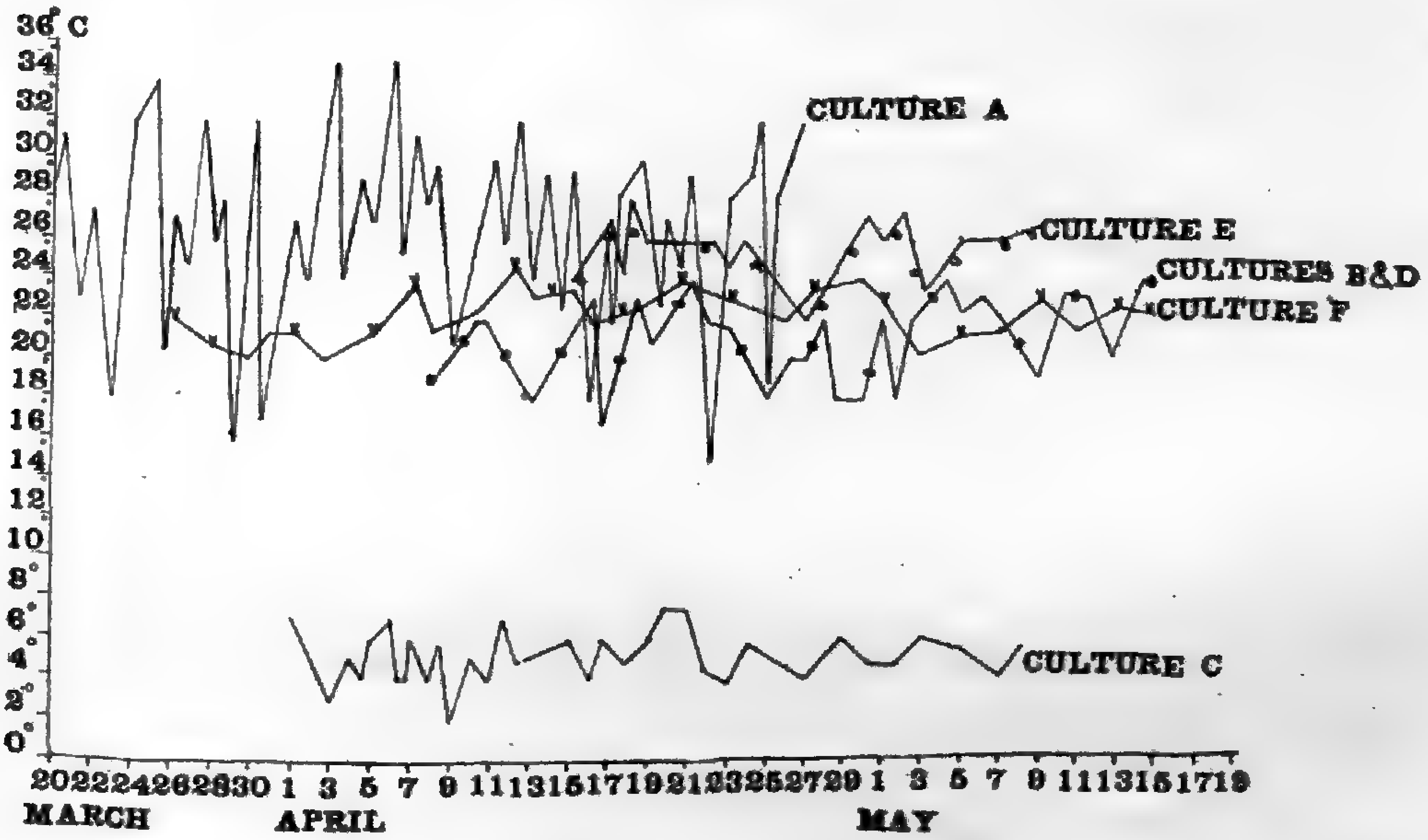
This culture consisted of three jars of plants brought indoors on March 15, at a time when the pond in the park was frozen over. As soon as the cultures were placed in the east window in the laboratory they began to grow. On March 19 two jars were placed under electric light, which was kept burning until 1 a. m. The vegetative growth was more rapid than in the third jar, the control. On March 30, eleven days later, antheridia and oogonia appeared in abundance in the two jars which had been under the electric light, while there was no indication of fruiting in the control. On April 22 the experiment was terminated. Photographs of typical plants made on April 13 are shown in FIG. 3, PLATE 11.

The temperature at which this culture was grown was 15° to 35° C., as shown in CHART 1. In some periods the daily range was as much as eighteen degrees. This wide daily variation in temperature may have been in part the cause of the abortion of the oogonia and the subsequent etiolation of the plants. As the experiment continued, the plants became light green in color, and by the end of April the basal nodes, internodes and leaves were almost white in color.

Owing to the advancing season this culture was receiving almost two hours additional daylight above that of the preceding one. On March 19 when this experiment was begun the daylight period was approximately 12 hours. When the fruiting was first observed on March 30, it had increased to 12½ hours, and at the time of photographing the period of daylight was about 13½ hours. Since the artificial light was not turned on until sunset and then turned off at 1 a. m. there was a constant decrease in the period of electric illumination corresponding to the increase in daylight period.

The growth in length of the plants subjected to artificial illumination was generally greater and more rapid as noted, but etiolation developed as the experiment continued. The internodes were considerably longer than those of the control, and the leaves were shorter in proportion. By the end of April

CHART 1. Showing the temperature variations of the cultures of *Chara fragilis* throughout the period of experiments.



the control culture, left to itself, was overrun with filamentous algae, and at the end of May the *Chara* plants had completely disintegrated. The two cultures which had been subjected to the electric illumination were placed on a north window shelf away from the electric light on May 4. The subsequent growth of these plants was slow. A few antheridia and oogonia appeared on the new growth throughout the summer. FIG. 3, PLATE 13, shows three typical plants of Culture A photographed June 11. By the end of September one of these cultures was dead. Tips 10 cm. long from the remaining culture were transplanted to a pot of fresh sand loam. By November 6 a new vegetative growth was beginning, but no antheridia and oogonia were visible.

SERIES B

Collected from park pond.......................................March 26
Grown on shelf in south window....................March 26–April 8
Grown on shelf in south window under daily electric illumination from sunset to 10 p. m.................................April 8–May 11
Grown on shelf in south window with only daylight illumination May 11–Nov. 6

Culture B consisted of two jars containing approximately two hundred shoots which had been brought indoors on March 26 and kept in a south window where the direct sunlight fell on the jars from 9 a. m. until 4 p. m. The control cultures were placed beside the two jars. The intensity of illumination in the early morning and late afternoon when the sun was not shining on the cultures, was measured with a photometer and found to be approximately 50 foot-candles. The electric light supplied was the same as in the preceding cultures, with the exception that it was turned off at 10 p. m. Antheridia and oogonia appeared four days after the artificial illumination was started. Photographs were made 33 days after the first reproductive organs appeared. FIG. 3, PLATE 12 shows the extent of fruiting at that time. The length of day, in the meantime, had increased one hour and ten minutes.

The production of antheridia and oogonia in this culture was not as abundant as in the preceding one. About half of the plants had formed no reproductive organs when the photographs were made. The vegetative growth, however, was striking. In nature, according to Migula, *Chara fragilis* does not reach much more than 75 cm. in length. In one jar of this culture, however, the plants attained a length of over a meter. The internodes were approximately 10 cm. long, but less than normal in diameter. All plants in the culture grew well during the summer. There was no apparent etiolation such as was so characteristic of the preceding culture. Fruiting throughout the summer was moderate. On September 12, tips of the plants about 10 cm. long were cut off and transplanted. By October 19 these transplanted tips had grown to a length of 30 cm., and of the hundred or more plants in the culture three showed a few antheridia and oogonia. On November 6, the plants were growing vigorously with occasional reproductive organs in eight of the plants. The stock culture from which the tips were taken put out new branches after being pruned and grew rapidly. A few antheridia and oogonia were present on the new growth on November 6.

The temperature of the water of this culture was more constant than that of Culture A. The range of temperature extended between 16° and 25° C., and the variation within any 24 hours was not over nine degrees, as shown in CHART 1. This fairly low temperature appears to be the most favorable for continuous growth of the plants.

SERIES C

Collected from park pond.............................March 26
Grown in south window...............................March 26–31
Transferred to glass case containing ice in west window and grown under all-night electric illumination....................March 31–May 7

The plants of this culture were of the same lot as those of Culture B, collected at the same time and kept in a south window under the same conditions. On March 31 one jar with a control was transferred to a glass case in a west window where there was direct sunlight from 3 p. m. until sunset. The dimensions of the case were 50 × 60 × 100 cm. The sides and top were of thin clear glass that allowed full passage of light. Fifty pounds of ice was placed between the two jars each day. The temperature did not go above 7° C. throughout the experiment, and on several days it ran down as low as 2° C. The illumination in the glass case in the early forenoon was about 25 foot-candles. Electric illumination was continuous throughout the night with the light bulb in the same position as in the preceding experiments. On April 15, seven days after the all-night illumination was begun, antheridia and oogonia appeared.

The vegetative growth in this case during the time of the experiment was hardly noticeable. There was no elongation of the internodes, and scarcely any new leaves were formed. The antheridia and oogonia grew slowly, and at the time of photographing, May 28, were only one-fourth full size. FIG. 2, PLATE 12 shows a typical plant of this culture beside a control plant. The length of day for the period of this culture had increased about three hours and forty minutes beyond that for cultures 0 and A. Culture C was receiving several hours additional daylight and correspondingly less electric illumination.

When the refrigeration and electric illumination were discontinued the plants began to grow rapidly, and by the middle of June the plants were 18 cm. long, with abundant antheridia and oogonia.

SERIES D

Collected from park pond....................................March 26
Grown in south window..........................March 26–April 8
Grown in south window under two hours electric illumination in addition to daylight.......................................April 8–May 7
Grown in south window with only daylight illumination..May 7–Nov. 6

Culture D consisted of three jars of about 500 plants collected at the same time as those of Cultures B and C. They were kept alongside of Culture B in a south window in the laboratory and had the same temperature and light conditions up to April 8. On this date two of the jars were placed under electric illumination each night until 8:30 p. m., while the third jar was kept as a control. Antheridia and oogonia appeared on April 17, nine days after the experiment was begun. No reproductive organs were formed in the control culture. FIG. 1, PLATE 12 shows the extent of fruiting in contrast to that attained by Culture B in FIG. 1, B, PLATE 12.

The temperature conditions and length of day for the period of this culture were the same as for Culture B. The vegetative growth of the plants was rapid and vigorous throughout. By the middle of June the plants were about 55 cm. long and of a deep green color. The internodes were longer than those of plants growing in nature. No etiolation was evident.

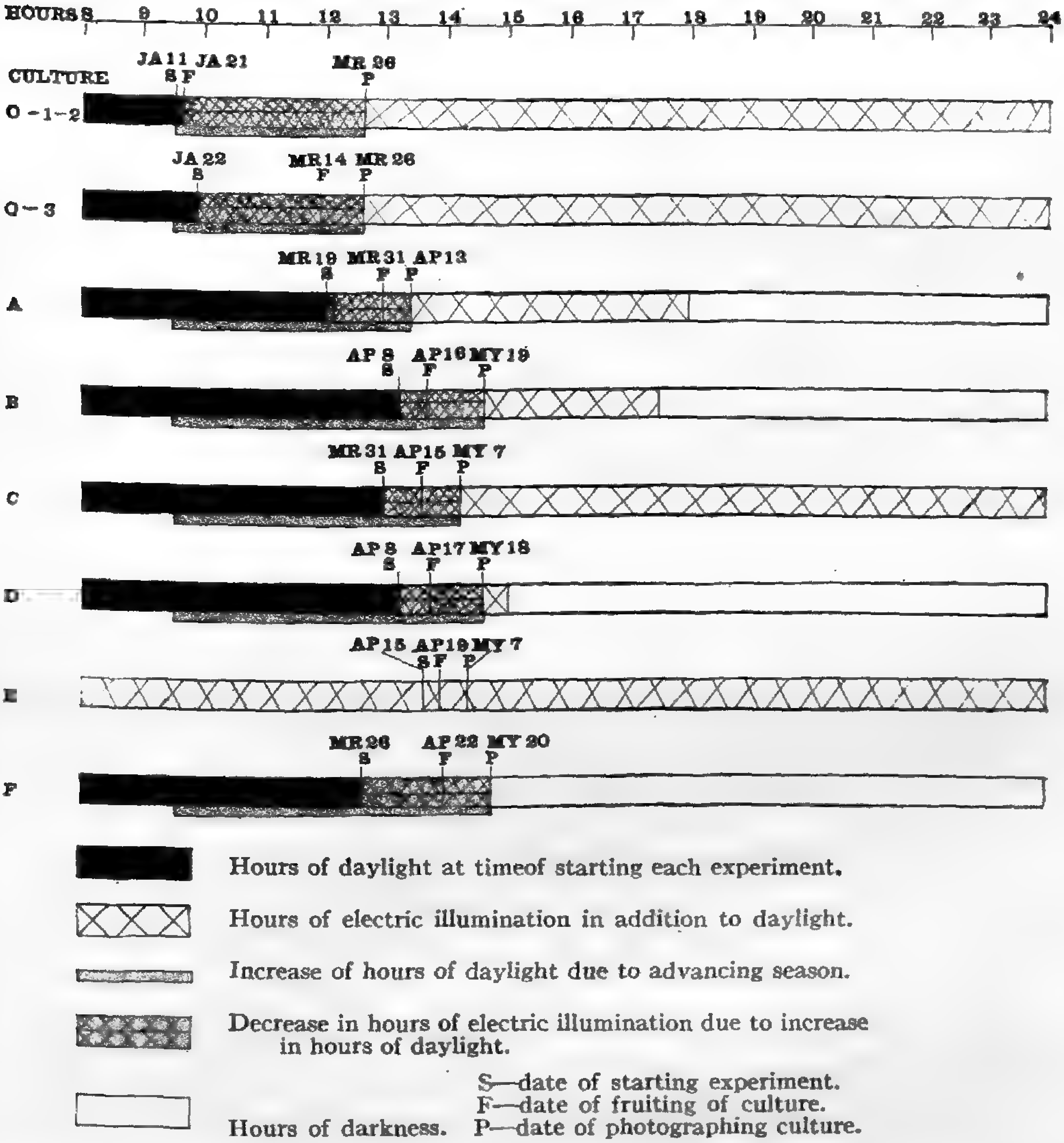
Culture D continued in a healthy growing condition throughout the summer and fall, but fruited only sparingly. The plants were approximately .75 meter long by September 12. On that date one of the cultures was pruned, and about fifty tips 10 cm. long were transplanted to a new jar with fresh soil, thus making four cultures in all. The transplanted tips as well as the pruned plants immediately began to grow. The other jars also showed vigorous growth. By October 19 the new growth in all the cultures was about 15 cm., and by November 6 most of the plants had abundant antheridia and oogonia.

SERIES E

Collected from park pond....................................March 26
Grown in south window.........................March 26–April 15
Grown in photographic dark room under electric illumination. April 15–May 7
Grown in east window......................................May 7–Nov. 6

Culture E consisted of a jar of about one hundred and fifty shoots collected at the same time as those of Cultures B, C and D. It had been kept in the south window of the laboratory under the same light and temperature conditions as the three preceding cultures up to April 15. On that date the jar was transferred to a photographic dark room. The plants were il-

CHART 2. Summary and comparison of cultures of *Chara fragilis*.



luminated with electric light continuously from April 15 to May 7, receiving no daylight whatever. On April 19, four days after starting the experiment, rudimentary antheridia and oogonia were visible. By the end of the month they were full-sized and had begun to drop off and disintegrate. The production of antheridia and oogonia was more abundant than in any of the preceding cultures. Practically every leaf axil was full of reproductive organs; whereas in the other cultures the antheridia and oogonia were developed only at the four uppermost nodes. None of the oogonia, however, developed mature oospores. The appearance of the antheridia and oogonia was normal in every respect. Motile antherozoids were produced in abundance, and the eggs were completely filled with large starch grains.

The vegetative growth was quite striking in appearance. At the time the culture was placed in the dark room the plants were only 15 cm. in length, but when the photographs were made on May 7 they had increased about 10 cm. FIG. 3, PLATE 12 shows the character of the vegetative growth and the extent of fruiting. When compared with the plants of the other cultures it is evident that the leaves are longer and the internodes shorter. It does not follow, however, that this is solely due to light and temperature differences. The plants of Culture E reached the surface of the water, bent over and continued to grow. It has been observed in other instances that when this occurs the internodes are shorter and the leaves longer than in normal cultures. Such behavior is frequently observed in *Chara* growing in shallow ponds and lakes.

The temperature of the water was fairly constant throughout the period of this experiment. The range of temperature extended between 23° and 27° C., and the fluctuation, as shown in CHART 1, was not over three degrees. This culture throws interesting light on the relation of intensity of illumination to the formation of antheridia and oogonia. The intensity of a 60-watt 120-volt lamp is less than ten foot-candles, while that of the direct sunlight at midday might be as high as 12,000. Yet the plants in Culture E produced antheridia and oogonia in greater abundance and in shorter time than plants which had been grown in the direct rays of sunlight for several hours each day. These results are in harmony with those of Garner and Allard, who found that the soy bean grown under one-fourth and one-third natural light intensity matured and produced seed in the same length of time as plants which had been grown in full sunlight. Klebs secured somewhat similar results with *Vaucheria* when the cultures were shaded. Using artificial light, he found zoospore and gamete production to be more abundant in an illumination equivalent to forty foot-candles than in higher intensities.

On May 12 Culture E was removed from the dark room to an east window in the laboratory. There it continued to grow slowly all summer, producing numerous antheridia and oogonia on the new growth. By September 12 the plants were about .75 meter in length. The culture was transferred to a clean jar on that date; and from that time to November 6 it grew steadily, until the plants were curled around in the jar several times. Antheridia and oogonia were abundant on all plants.

SERIES F

Collected in park pond	March 26
Grown in full sunlight in a greenhouse at 22°–25° C.	March 26–May 18
Grown in full sunlight in a greenhouse	May 18–Nov. 6

Since the response of *Chara fragilis* to increased periods of illumination in the laboratory was so direct, a series of cultures was run to determine the results of growing cultures in battery jars in a greenhouse where the plants would receive sunlight from sunrise to sunset during the spring months. On March 26, six large cultures with approximately 200 plants in each jar were started in a room in a greenhouse on which the direct rays of the sun fell the greater part of the day. The plants began to grow vigorously as soon as they were planted, but considerable difficulty was encountered in preventing them from being overrun by algae. The cultures were cleaned, and fresh water added several times, but by the end of May all but three of the cultures were dead. In the meantime, antheridia and oogonia appeared in the three remaining cultures on April 22. The length of day, reckoned from sunrise to sunset, at the time of fruiting was thirteen hours and fifty-five minutes. The temperature in the greenhouse in which Series F was grown was fairly constant and high. The variation was between 22° and 25° C. The growth at this temperature is rapid, but the plants become very slender and deteriorate in a short time. FIG. 1, PLATE 13 shows the variation of fruiting in different plants in these cultures on May 18.

On May 18, the three cultures were removed to a room with lower temperature. The plants continued to grow and fruit vigorously throughout the summer, and by September 12 some of the plants were .75 meter in length, with antheridia and oogonia in as many as six whorls of leaves. A large number of mature oospores were present on the plants. On September 12 the cultures were cleaned and fresh water added. The growth from that time to November 6 was about 6 cm. A few antheridia and oogonia appeared on the new growth.

It is apparent from these results that a relatively long daily period of illumination is necessary to initiate the process of sexual reproduction in *Chara fragilis* in the spring months. The limit of the most favorable illumination period has not been determined, but it apparently falls beyond twelve hours.

SERIES G

Collected from the park pond.................................March 19
Grown in south window of laboratory.................March 19–May 7

The great sensitiveness of these reactions to light is suggested by the record of three cultures growing in a south window of the laboratory. These cultures were started on March 19 and had the same temperature conditions as Series B and D. About 50 feet across from this window was a building with windows generally lighted as late as 11 p. m. This light was sufficiently intense to enable a person to read coarse print at the window where the cultures were standing. The reaction to this diffuse light was quite striking. On April 15, twenty-six days after the cultures were started, antheridia and oogonia appeared. In view of the results of other cultures like A, B, C, D and E, where an intensity of illumination of only a few foot-candles was sufficient to induce sexual reproduction, it seems probable that even this diffuse light had an appreciable effect in favoring the formation of antheridia and oogonia.

CONCLUSIONS

These experiments as noted were started mainly for the purpose of obtaining material for cytological study. It is apparent, however, that the sexual reproduction of *Chara fragilis* under the conditions described is in a considerable degree photoperiodic. The occurrence of the reaction is also independent, within a certain range, of the intensity of the illumination. These limits have not yet been determined, but an illumination of less than ten foot-candles was found sufficient under the conditions given to induce the formation of antheridia and oogonia in four days. Growing at the bottom of ponds and lakes as *Chara* is generally found, the illumination is mostly from above, and relatively little lateral light reaches the plants. When grown in battery jars in the laboratory, however, the plants may receive light equally from all sides. As to the effects of intensity, it remains to be tested whether there is a quantitative difference in the response.

Under the conditions of my experiments temperature, within the minimum and maximum limits for vegetative growth, did not appear to be a primary factor in bringing out the tendency to reproduction. It does, however, have a marked effect on the rapidity of development of the antheridia and oogonia. In only one case, Series A, did the control culture form reproductive organs. Yet the controls had the same temperature conditions as the other cultures. Under the conditions given the formation of antheridia and oogonia can be induced at a temperature as low as 2° C. with continuous illumination. With my material and conditions the optimum temperature for continuous vegetative growth and gamete production varied between 18° and 25° C. At a constant temperature over 32° the plants soon deteriorated and died. These limits, however, are set only tentatively. Further experiments are necessary for definite proof.

It is not certain whether the failure of the eggs in most cases to develop into mature oospores is due to the unnatural conditions of the experiments or whether it is inherent in this particular form of *Chara fragilis*. This question remains to be studied in connection with observations on plants growing in nature. Culture 0–3 formed an abundance of mature oospores. The temperature for this culture was not as high as in the other experiments, and the out-of-doors conditions were perhaps more closely simulated. It is not clear whether the resulting sterility was due to the incompatibility of the gametes or to the abortion of the fertilized eggs.

SUMMARY

Under the conditions of the experiments described, length of day appears to be a primary factor in inducing the formation of antheridia and oogonia in *Chara fragilis*. A few hours of artificial illumination in addition to the daylight is sufficient to induce the development of antheridia and oogonia in mid- and late winter, whereas in nature *C. fragilis* fruits only from June to September, according to Migula (25) and Robinson (30).

Within wide limits the response is not dependent on the intensity of illumination under the conditions observed. A continuous illumination of less than ten foot-candles is sufficient to induce the development of antheridia and oogonia within four days.

Growth under artificial illumination, as used in my experiments, led to the lengthening of the internodes, shortening of the leaves, reduced branching, etiolation, and a general spindling habit in the plants. Very few of the eggs developed into mature oospores.

Under the conditions studied, the temperature, within the minimum and maximum limits for vegetative growth, is apparently a secondary factor in determining the production and functional activity of antheridia and oogonia in *Chara fragilis*.

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Explanation of plates 11–13

PLATE 11

FIG. 1. Typical plant of Cultures 0–1 and 0–2 made 65 days after antheridia and oogonia first appeared, × 3.

FIG. 2. Typical plant of Culture 0–3 made 70 days after fruiting began, natural size.

FIG. 3. Typical plant of Culture A made 14 days after antheridia and oogonia first appeared, × 2.

FIG. 4. Typical control plant of Culture A, × 3½.

PLATE 12

FIG. 1. Typical plants of Cultures D and B made 34 days after antheridia and oogonia were first formed, × 1¼.

FIG. 2. Typical plant of Culture C and its control made 50 days after fruiting began, × 2.

FIG. 3. Typical plant of Culture E made 27 days after fruiting began, × 2.

PLATE 13

FIG. 1. Typical plant of Culture F made 47 days after the culture was started, natural size.

FIG. 2. A typical distal node of plants in the control of Culture A after it had been left uncovered in the laboratory light 22 days, × 2.

FIG. 3. Typical plants of Culture A made two months after the experiment was terminated, × 1¼.

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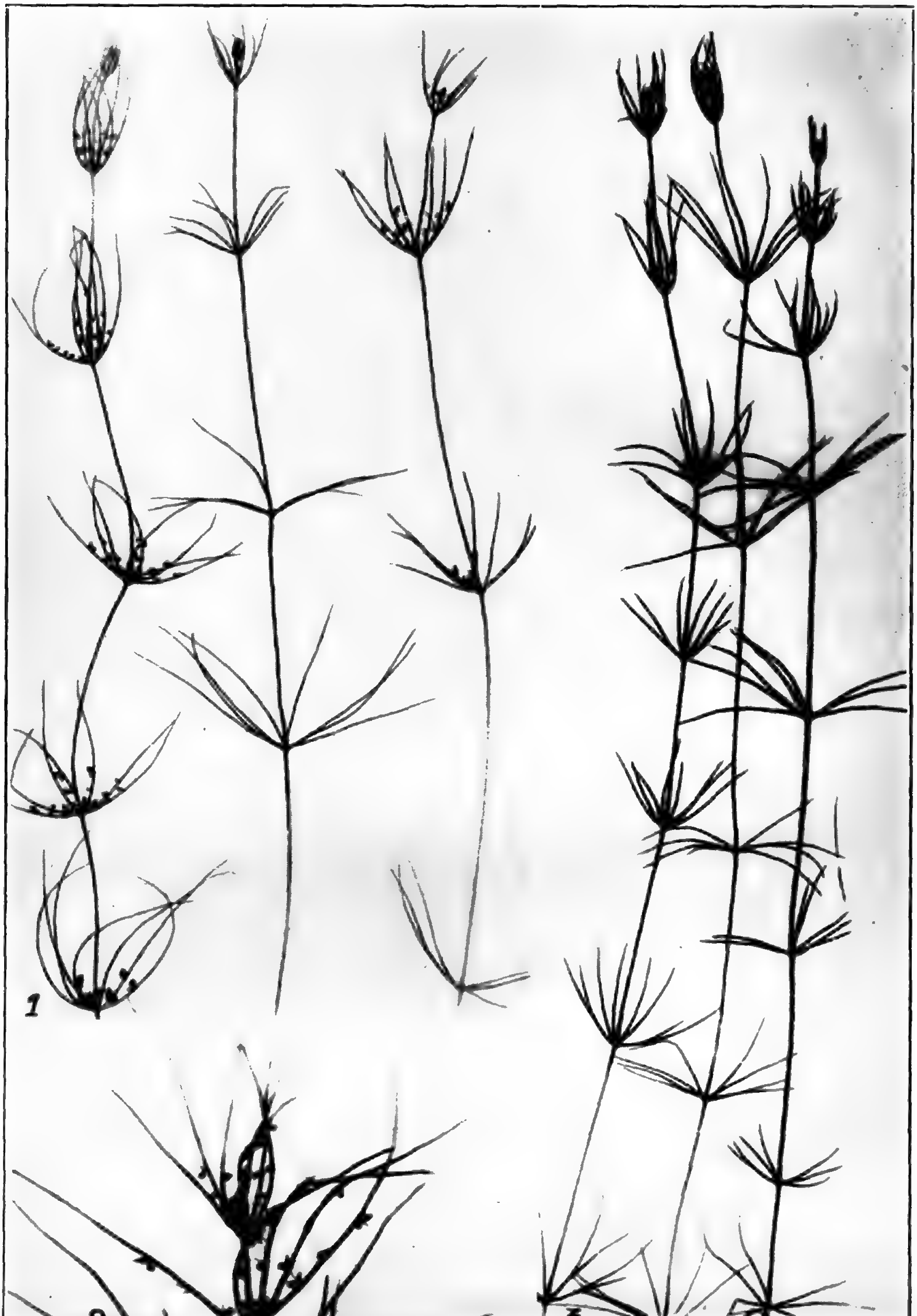

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INDEX TO AMERICAN BOTANICAL LITERATURE
1924

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N. B. See new installment of Index beginning on page 494.

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