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STUDIES IN THE BORAGINACEAE, XII

IVAN M. JOHNSTON

CONTENTS

1. TRIGONOTIS IN SOUTHWESTERN CHINA

THE GENUS *Trigonotis* has its greatest concentration of species and its most important center of endemism in the mountainous country of southwestern China. The present paper represents the first attempt to classify and distinguish the numerous species of the genus in that area. It is concerned with those known from Hupeh, Szechuan, Yunnan, Kweichow and Kwangsi. For its preparation I have studied the specimens of the genus preserved at the Gray Herbarium (G), the New York Botanical Garden (NY) and the Royal Botanic Garden at Edinburgh (Edinb). I have also had available for this study some critical notes on the Indian species which I made several years ago at Kew.

With the exception of one widely distributed weedy species, *T. peduncularis*, the species of *Trigonotis* in southern China are all evidently distinct from those in the region to the northward. For my work this has been fortunate for I have escaped becoming involved in the problems of classification still enveloping these northern congeners. The northern species are in great need of revision. They are so poorly understood that a number of them, even recently, have been described under the genus *Omphalodes*. The most useful work on the northern species is contained in the synopsis of the Corean and Japanese species by Nakai, Tokyo Bot. Mag. **31:** 215–218 (1917) and in the critical notes and bibliography given by Herder, Act. Hort. Petrop. **1:** 543–564 (1872).

During the study for the present paper several details concerning the morphology of the nutlets in *Trigonotis* have become clear. All the species of *Trigonotis* do not have tetrahedral nutlets. In such species as *T. heliotropifolia, T. Rockii* and *T. delicatula* the nutlets are bifacial and generally similar in gross aspect to those found in the genus *Myosotis*, having a rounded back and an obtusely angled adaxial face. A consideration of the nutlets in *T. Mairei* and *T. Rockii* has suggested how the tetrahedral form has been developed in other species of the genus. The inferior face of the truly tetrahedral nutlets is morphologically equivalent to the lower half or third of the dorsal face in the bifacial nutlets such as found in *T. heliotropifolia, T. delicatula* and *T. Mairei.* The dorsal face of the truly tetrahedral nutlets has been set off from the lower face by the formation of a medio-transverse angle across the back of an erect bifacial nutlet. The acute inner angle of the tetrahedral nutlets, that nearest to and paralleling the style, is the homologue of the obtuse medio-longitudinal angle on the ventral side of bifacial nutlets. The small attachment of nutlets in *Trigonotis* is therefore at the basal end of the ventral keel. It is not lateral nor is it at the broad base of the nutlet-body as it is in *Cryptantha* or *Lithospermum.*

KEY TO THE SPECIES

- Nutlets dark, with a pallid tumid cartilaginous margin on at least two edges of the dorsal face, faces usually muriculate; inflorescence bractless.
  - Nutlets tetrahedral, the three inner faces evidently developed and subequal, the dorsal surface nearly plane. . . 1. *T. macrophylla.*
  - Nutlets not tetrahedral, elongate, bifacial, the dorsal surface convex, rounded upward in a curve sweeping from the nutlet-attachment to the nutlet-apex, the ventral side broadly and very obtusely angled.
    - Leaves broadly elliptic or lanceolate, 2.5–5 cm. broad, sparsely strigose; corolla 4–5 mm. broad; inflorescence conspicuously pedunculate . . . . 2. *T. Mairei.*
    - Leaves lanceolate, 1–2 cm. broad, densely strigose; corolla 2.5 mm. broad; inflorescence short-pedunculate . . . 3. *T. compressa.*
- Nutlets with margins acute or rounded or winged, not tumid nor cartilaginous, faces not muriculate.
  - Nutlets (exclusive of the winged margin when present) tetrahedral, the 4 faces evident.
    - Margin of nutlet conspicuously winged and incurving; nutlets hispidulous; leaves cordate . . . . 4. *T. moupinensis.*
    - Margin of nutlets rounded, angulate or very narrowly winged.
      - Inflorescence naked, entirely devoid of bracts, racemes frequently geminate on naked peduncles.

Nutlets with acute edges, pale; calyx-lobes oblong to linear, evidently surpassing the calyx-tube which does not embrace the nutlets at maturity. . .5. *T. omeiensis.*

Nutlets with rounded edges, black; calyx-lobes broad and rounded, scarcely if at all longer than the calyx-tube, the latter embracing the nutlets at maturity.

Plant with a simple raceme; pedicels becoming only 1–2 mm. long; leaves small, 2–3 cm. long, numerous, strigose below .6. *T. brevipes.*

Plant with dichotomous racemes; pedicels becoming 2–5(–8) cm. long; leaves large, few, usually with coarse spreading hairs beneath . . . .7. *T. Cavaleriei.*

Inflorescence bearing bracts between at least the lower flowers.

Nutlets not stipitate or if stipitate the stipe not decurved.

Plant villous, with spreading hairs; stems very slender, trailing, leaf-blades suborbicular . . . . .8. *T. mollis.*

Plant strigose; stems erect or decumbent.

Plant 10–18 cm. tall; leaves mostly basal, blades orbicular to reniform, apex rounded or even retuse, veinless; corolla 6–7 mm. broad; nutlets with the lower ventral face smaller than the two upper faces . . . . .9. *T. rotundata.*

Plant 20–60 cm. tall; leaves mostly cauline, blades ovate to elliptic or lanceolate, evidently veined on lower face, apex obtuse to acute; corolla 2.5–5 mm. broad; nutlets with 3 ventral faces subequal . . . . .10. *T. microcarpa.*

Nutlets stipitate with the evident stipe abruptly bent to one side.

Plant annual; corolla inconspicuous, 1–2 mm. broad. 11. *T. peduncularis.*

Plant perennial, caespitose; corolla 4–5 mm. broad.

Stems and leaves cinereous, densely slender-strigose. 12. *T. vestita.*

Stems and leaves green, sparsely short-strigose. 13. *T. gracilipes.*

Nutlets not tetrahedral, bifacial, back flat or merely rounded off towards the attachment, obtusely angled on the ventral side, nutlet-attachment nearly basal.

Plant 2–7 dm. tall; corolla evidently strigose outside. 14. *T. heliotropifolia.*

Plant less than 2 dm. tall; corolla glabrous outside.

Inflorescence bracteate throughout; pedicels slender, recurving or contorted; stems slender, elongate, prostrate; plant apparently perennial . . . . .15. *T. delicatula.*

Inflorescence bracted only at the base; pedicels stiffly ascending; stems erect; plant a caespitose perennial. 16. *T. Rockii.*

1. **Trigonotis macrophylla** Vaniot, Monde des Plantes, sér. 2, **7:** 42 (1905); Fedde, Repert. **2:** 157 (1906). *T. pedunculata* var. *macrophylla* (Vaniot) Léveillé, Fl. Kouy-Tchéou 55 (1914).

KWEICHOW: vicinity of Kouy-yang, margin of mountain stream, July 20, 1893, *Emile Bodinier 2426* (TYPE, Edinb.).

In the type-collection the faces of the nutlets are smooth and glabrous. The following variants agree with the type in general habit of growth and in the size and shape of the nutlets, but differ in having the nutlet-surfaces characteristically roughened.

1a. **Trigonotis macrophylla** var. **trichocarpa** Handel-Mazzetti, Sinensia **5:** 18 (1934).

KWEICHOW: Tungtse, Lou-shan, May 27, 1930, *Tsiang 5147* (ISOTYPE, NY); Liang Feng Yah, Tsunyi Hsien, 1150 m., Aug. 12, 1931, *Steward, Chiao & Cheo 303* (NY).

Faces of the nutlets bearing scattered spicular trichomes.

1b. **Trigonotis macrophylla** var. **verrucosa,** var. nov.

A varietate genuina differt facie nuculae verrucosa.

KWANGSI: Chy Fang Shan, 30 li southwest of Shan Fang, N. Lucheng, 1020 m., common in woods, fl. purplish, June 9, 1928, *R. C. Ching 5888* (TYPE, NY). TONKIN: near Chapa, bank of road in damp forest, July 1930, *A. Petelot 4192* (NY).

2. **Trigonotis Mairei** (Lévl.), comb. nov. *Omphalodes Mairei* Léveillé in Fedde, Repert. **12:** 188 (1913). *T. muriculata* Johnston, Candollea **4:** 309 (1931).

SZECHUAN: Ma-pien Hsien, 1300 m., herb in waste ground, May 10, 1931, *Wang 22839* (G). YUNNAN: Lungkai, in moist woods, 700 m., perennial, evergreen, fl. blue-violet, *Maire* (TYPE, *O. Mairei,* Edinb.; TYPE, *T. muriculata,* Geneva; ISOTYPES G); mountains of Ku-long-tchang, tufted perennial, fl. white, 800 m., *Maire* (G); sine loc., *Ducloux 98* (NY).

Trigonotis Mairei and *T. muriculata* were described from duplicates of the same collection and are clearly synonymous. The nutlets of the species are similar to those of *T. compressa* but are thicker with the inner face more prominently angled. The dorsal side is convex and margined and below rounded off in a sweeping curve towards the nutlet-attachment. There is, hence, no definite basal face to the nutlet.

3. **Trigonotis compressa,** sp. nov., herbacea foliosa ascendenter graciliterque ramosa 3 dm. alta; caulibus erectis sparse strigosis; foliis lanceolatis 5–7.5 cm. longis, 1.5–2.5 cm. latis, infra medium apicem

versus gradatim attenuatis, basi obtusis vel rotundis; petiolis 0.5–3 cm. longis; racemis gracilibus ebracteatis simplicibus vel geminatis 1–3 cm. longe pedunculatis; pedicellis floriferis 1–2 mm. longis, fructiferis 3–6 mm. longis ascendentibus; calyce florifero 1–2 mm. longo, fructifero 2.5 mm. longo, lobis lanceolatis 1.5 mm. longis ascendentibus; corolla "purpurea," tubo 1 mm. longo, limbo ca. 2.5 mm. diametro; nuculis ca. 1 mm. longis erectis compressis bifacialibus nigris papillatis vel muriculatis, facie dorsali majore ovatis convexis, faciebus ventralibus obtuse angulatis.

SZECHUAN: Nanchuan Hsien, roadside, 1800–2100 m., one ft. tall, fl. purple, *Fang 1111* (TYPE, Gray Herb.; ISOTYPE, Edinb.).

Evidently related to *T. Mairei* but differing in its narrower more abundantly strigose leaves, smaller corollas, much less evidently pedunculate inflorescence, and more compressed nutlets. The nutlets are compressed perpendicularly to the floral axis and are practically bifacial. The apparent base of the nutlet (i.e. the part inferior and exterior to the point of attachment) is obscurely flattened. This narrow ill-defined basal surface is homologous to the basal face in the perfectly tetrahedral nutlets of other species. In *T. compressa* it is ill-defined and very much smaller than the other faces of the nutlet. The inner side of the nutlet is obtusely angled or in other words slopes gently towards the lateral margins from either side of the medio-longitudinal line. The two planes thus formed, which are very similar to those observable in other borages, for example in *Myosotis,* are homologous to those faces in tetrahedral nutlets which are nearest the style.

4. **Trigonotis moupinensis** (Franch.), comb. nov. *Omphalodes moupinensis* Franchet, Nouv. Arch. Mus. Paris, sér. 2, **10:** 64 (1887) and Pl. David. **2:** 102 (1888). *O. cordata* Hemsley, Jour. Linn. Soc. Bot. **26:** 148 (1890).

HUPEH: *Henry 4029* (Edinb.), *5329* (G); *Wilson 241* (Edinb.).

According to Franchet the type was collected by David in "Moupine, in silvis passim. Fl. April, 1869." Hemsley based his synonymous species upon collections from Patung, Hupeh (*Henry 1445, 4029* and *5412*) and South Wushan, Szechuan (*Henry 5610*).

The species is remarkable for the excessive development of the margin about the dorsal face of the nutlet. This thin upturned winged margin gives the nutlets a superficial resemblance to those of the European species of *Omphalodes.* Though this resemblance is striking enough to have misled Franchet and Hemsley, and recently even Brand, the present species is certainly not a member of the genus *Omphalodes.* The body of the nutlet in the species is distinctly of the tetrahedral type and very similar to that of other species of *Trigonotis*. Of greatest importance is the nature and position of the nutlet-attachment. *Omphalodes* belongs to the Cynoglosseae and in agreement with the other genera of that tribe has the nutlet-attachment places supramedially or subapically on the rounded venter of the nutlet. This is certainly not the condition in the present species.

The nutlets in *T. moupinensis* are blackish and hairy. The outer surface of the upturned margin is pale and somewhat rugose. The species is related to the Indian *T. ovalifolia* (Wall.) Benth. which has black hispidulous nutlets with a narrow wing.

5. **Trigonotis omeiensis** Matsuda, Tokyo Bot. Mag. **33:** 148 (1919).

SZECHUAN: Mt. Omei, herb about thickets, 950 m., fl. bluish, *Wang 23129* (G); Nanchuan Hsien, roadside, 1500–2700 m., 1928, *Fang 915, 1159* and *1348* (G, Edinb.). KWANGSI: Nan Kan, Lin Yuin Hsien, 1360 m., 1933, *Steward & Cheo 184* (G, NY); sine loc., *Faber 598* (NY).

The species was described from collections made on the slopes of Mt. Omei by I. Yamazuta. I have seen no authentic material of this species. The original description, however, applies very clearly to the well-marked species treated here.

6. **Trigonotis brevipes** Maximowicz, Bull. Acad. St. Pétersb. **27:** 506 (1881); Nakai, Tokyo Bot. Mag. **31:** 215 (1917). *Eritrichium brevipes* Maxim. Bull. Acad. Sci. St. Pétersb. **17:** 446; Mél. Biol. **8:** 547 (1872).

HUNAN: near Changsha, along the Linyang-ho, 350 m., in thickets, April 1915, *Handel-Mazzetti 11687* (G).

The above cited collection does not have mature fruit. As far as comparisons can be made with half mature nutlets, however, the collection does seem to agree with *T. brevipes,* a species known otherwise only from Japan.

7. **Trigonotis Cavaleriei** (Lévl.) Handel-Mazzetti, Symb. Sin. **7:** 819 (1936). *Omphalodes Cavaleriei* Léveillé in Fedde, Repert. **12:** 188 (1913). *O. Esquirolii* Léveillé in Fedde, Repert. **12:** 188 (1913) and Cat. Seu-Tchouen, tab. 6 (1918). *O. Vaniotii* Léveillé in Fedde Repert. **12:** 188 (1933). *T. Faberi* Handel-Mazzetti, Anzeiger Akad. Wiss. Wien **61:** 165 (1924), and Symb. Sin. **7:** 819 (1935).

KWEICHOW: margin of streams, Pin-fa, April 13, 1902, *Cavalerie 411* (Edinb., TYPE of *O. Cavaleriei*) and *806* (Edinb.); Tang-Tchang (Hoang-Tiao-Pa), June 21, 1909, *Esquirol 1559* (Edinb., TYPE of *O.*

Esquirolii); without locality, moist places, May 1905, *Esquirol 454* (Edinb., TYPE of *O. Vaniotii*); without locality, *Cavalerie 4272* (G). YUNNAN: Yung-shan Hsien, 2300 m., moist shaded soil, fl. sky-blue with yellow eye, June 22, 1932, *Tsai 51103* (G). SZECHUAN: Kuan Hsien, 900–1200 m., July 1928, *Fang 2224*, *2356* and *2380* (G, Edinb.); Mt. Omei, 1000 m., July 1931, *Wang 23165* (G); "Mt. Omei, 1600 m.," *Faber 671* (NY, ISOTYPE of *T. Faberi*); O-pien Hsien, 1800 m., May 1932, *Yü 797* (G).

A well-marked species with a distinctive habit. The broad leaves are usually subcoriaceous and along with the stems usually more or less shaggy with slender brown hairs. The numerous stiff naked racemes are projected from the leafy mass of the plant on a well-developed peduncle.

8. **Trigonotis mollis** Hemsley, Jour. Linn. Soc. Bot. **26:** 153 (1890).

HUPEH: Fang Hsien, under rocks, 900–1200 m., May 1907, *Wilson 3393* (G); Ichang, *Henry 1574* (G); without locality, *Henry 6735* (G, NY).

Hemsley describes this species as based upon collections from "Hupeh: Ichang, Fang, and Changyang (*A. Henry,* 630A, 1574, 6735, 7796!)."

9. **Trigonotis rotundata**, sp. nov., perennis; caulibus strigosis erectis 10–18 cm. altis e caudice procumbente gracili laxe ramoso foliis dessicatis persistentibus vestito orientibus; foliis inferioribus maxime conspicuis, lamina orbiculari vel subreniformi 6–17 mm. lata, apice rotunda vel subretusa saepe apiculata, basi rotunda vel reniformi, petiolo lamina 1–2-plo longiori gracili conspicuo; foliis mediis et superioribus caulis sparsis abrupte reductis sessilibus vel breviter petiolatis; inflorescentia terminali solitaria basim versus sparse bracteata maturitate distantiflora; calycibus ad anthesim ca. 2 mm. longis strigosis 1–2 mm. longe pedicellatis; calycibus fructiferis 3 mm. longis, lobis ascendentibus lanceolatis ca. 2 mm. longis, pedicellis 5–10 mm. longis gracilibus ascendentibus; corolla 5–7 mm. diametro coerulea; nuculis 1 mm. longis et latis angulatis sessilibus depresse tetrahedraeis faciebus interioribus minoribus.

YUNNAN: Likiang, *Handel-Mazzetti 3725* (G); Goodu Shan, 3300 m., *Forrest 20519* (TYPE, Edinb.); Litang River divide, 4200 m., *Ward 4016* (G, Edinb.).

This species of southwestern China has been confused with *T. rotundifolia* of the Indian Himalayas. That plant, however, has ebracteate geminate racemes and a distinctly tetrahedral nutlet similar to that found in *T. microcarpa*.

10. **Trigonotis microcarpa** (Wall.) Bentham ex Clarke, Fl. Brit.

India **4:** 172 (1883). *Myosotis microcarpa* Wallich, Numerical List 928 (1828). *Eritrichium microcarpum* (Wall.) De Candolle, Prodr. **10:** 123 (1846). *T. peduncularis* var. *microcarpa* (Wall.) Brand, Pflanzenr. [Heft 97] IV, **252**^{2}: 198 (1931).

YUNNAN: Likiang, *Schneider 3372* (G); Ping-pien Hsien, *Tsai 55439, 55458, 60176, 60209, 60641, 60751, 62037,* and *62368* (G); Shang-pa Hsien, *Tsai 54717* (G); Kien Shuei Hsien, *Tsai 53340* (G); Yengyueh, *Forrest 24810* (G, Edinb.); Yunnan-sen, *Maire 2244* (G, Edinb.); Mengtse, *Henry 9354* and *9755a* (NY); northwestern Yunnan, *Handel-Mazzetti 9598* (G).

The type of this species was collected by Wallich in Nepal. It agrees closely with the Chinese specimens I have cited above.

11. **Trigonotis peduncularis** (Trev.) Bentham ex Baker & Moore, Jour. Linn. Soc. Bot. **17:** 384 (1879), nomen; Hemsley, Jour. Linn. Soc. Bot. **26:** 153 (1890); Nakai, Tokyo Bot. Mag. **31:** 216 (1917). *Myosotis peduncularis* Treviranus, Mag. Ges. Naturforsch. Freunde Berlin **7:** 147, tab. 2, fig. 6–9 (1816). *Eritrichium pedunculare* (Trev.) DeCandolle, Prodr. **10:** 128 (1846); Ledebour, Fl. Ross. **3:** 153 (1846–51); Herder, Act. Hort. Petrop. **1:** 543 (1872), excl. pl. himalay.

A weedy annual with inconspicuous corollas, which is widely distributed in eastern and southern China. The nutlets vary from glabrous to hispid. In some forms one nutlet (apparently the adaxial) is glabrous and the remaining three are hispid. The calyx-tube and adjacent portion of the pedicel tend to become rather characteristically thickened at maturity. The species is established upon collections made by F. Blume in damp ground near Astrakhan between 1810 and 1812. Treviranus, in publishing it, gave a good description and several figures, of fruit, corolla and calyx, all evidently applicable to this common weedy species of China. The species, consequently, ranges from the Caspian region across central Asia to Amur and then southward into China and Japan. I have seen no specimens from India.

12. **Trigonotis vestita** (Hemsley) Johnston, Contr. Gray Herb. **75:** 47 (1925). *Trigonotis pedunculata* var. *vestita* Hemsley, Jour. Linn. Soc. Bot. **26:** 154 (1890).

YUNNAN: Ta Ho Shan, western Likiang Snow Range, 3900 m., *Rock 4237* (G). SZECHUAN: North Wushan, *Henry 7072* (G, ISOTYPE); Muli, 2700 m., *Ward 4588* (G, Edinb.); Muli, *Handel-Mazzetti 7379* (G); Muli, 3000 m., *Ward 4499* (G, Edinb.).

This species differs from *T. pedunculata* in habit, indument, calyx, and corolla. In fruit, however, it is very similar to that species.

13. **Trigonotis gracilipes,** sp. nov., caespitosa: caulibus gracilibus erectis vel decumbentibus 1–4 dm. altis simplicibus vel (saepissimae infra medium) sparse graciliterque ramosis strigosis; foliis numerosis utrinque strigosis, lamina elliptica vel oblongo-lanceolata saepe 1–3(–4) cm. longa 5–13(–20) mm. lata, inferioribus 2–4 cm. longe petiolatis, superioribus gradatim reductis subsessilibus; floribus extra-axillaribus solitariis secus (non rariter apicem usque ad basim) caulibus inter foliis dispositis, non rariter summum ad apicem caulis in racemum ebracteatum aggregatis; pedicellis gracilibus floriferis 1–5 mm. longis, fructiferis 5–25 mm. longis ascendentibus rectis vel flexuosis; calycibus ad anthesim 1–1.5 mm. longis strigosis, fructiferis 2–3 mm. longis, lobis ovatis acutis 1.5–2 mm. longis; corolla 4–5 mm. diametro; nuculis ca. 1 mm. longis tetrahedraeis angulatis non rariter sparse pubescentibus pallidis pedicellatis, pedicello deflexo.

SZECHUAN: Muli range, 4200 m., *Ward 5228* (G); northeast of Kulu, Muli, 4460 m., *Rock 17867* (TYPE, Gray Herb.; ISOTYPES, NY, Edinb.). YUNNAN: Mekong-Salwin divide, lat. 28° 20′, 2700 m., *Forrest 14168* (Edinb.); northwest Yunnan, *Mombeig 197* (G, Edinb.); east flank of Likiang range, lat. 27° 20′, 3300–3600 m., *Forrest 5783* (Edinb.); no locality given, *Tsai 57484* and *57614* (G); northern Yunnan and eastern Tibet, 3000 m., *Ward 665* and *418* (Edinb.); northern Yunnan and eastern Tibet, 3900 m., *Ward 636* (Edinb.). INDIA: Pheonp, eastern Himalaya, 4050 m., 1913, *Ribu & Rhomoo 6372* (Edinb.); Jongri, 4200 m., 1913, *Ribu & Rhomoo 6555* and *Lepcha 942* (Edinb.).

This species has been confused with *T. ovalifolia* of the Indian Himalayas, which has bractless inflorescences. One of the peculiarities of *T. gracilipes* is the occurrence of long-pedicellate flowers among the leaves on the middle and lower portions of the stem. The only other Chinese species that shows this development is *T. delicatula.*

14. **Trigonotis heliotropifolia** Handel-Mazzetti, Anzeiger Akad. Wiss. Wien **61:** 165 (1924) and Symb. Sin. **7:** 818 (1936).

SZECHUAN: Muli, lat. 28° 12′, 3000 m., *Forrest 16807* (Edinb.); southeast of Muli, lat. 27° 50′, 3300 m., *Forrest 22468* (Edinb.). YUNNAN: Yungpeh, 2675 m., *Handel-Mazzetti 3344* (Edinb., ISOTYPE); mountains between Yungpeh and Yungning, lat. 27° 20′, 3000–3300 m., *Forrest 22054* (Edinb., NY).

A very well marked species that might be passed as a coarse form of *T. microcarpa.* It is, however, abundantly distinct from that species in fruit and flowers. By having the large corollas evidently strigose outside it is easily and quickly distinguished from all other Chinese members of the genus.

15. **Trigonotis delicatula** Handel-Mazzetti, Anzeiger Akad. Wiss. Wien **62:** 26 (1925, Feb.). *T. contortipes* Johnston, Contr. Gray Herb. **75:** 46 (1925, Sept.).

YUNNAN: east slope Likiang range, 3300–4000 m., *Forrest 2619* (Edinb.), and *5954* (Edinb.), *Rock 9449* (G) and *10637* (G, TYPE of *T. contortipes;* Edinb.); district of Likiang, 3900–4800 m., *Rock 4817* and *6069* (G); Likiang, 3000–3900 m., *Schneider 1800* and *1921* (G), *Forrest 2304* (Edinb.), *Handel-Mazzetti 3724* (G). SZECHUAN: Tschescha pass, south of Muli, 4100 m., *Handel-Mazzetti 7253* (G, Edinb., ISOTYPES of *T. delicatula*).

A well-marked species. It has slender elongate subsimple prostrate stems and usually characteristically contorted slender pedicels.

16. **Trigonotis Rockii** Johnston, Contr. Gray Herb. **75:** 47 (1925).

YUNNAN: Likiang, 3300–3600 m., *Schneider 3624* and *3868* (G), *Rock 5256* (G, TYPE; ISOTYPES Edinb., NY); Likiang range, 3300–3600 m., lat. 27° 35′, *Forrest 10144* (Edinb., NY); east flank of Likiang range, 3300–3600 m., *Forrest 6301* (Edinb.). BURMA: west fork of N'Maikla-Salwin divide, lat. 26° 30′, long. 98° 48′, 3600 m., *Forrest 26918* (G, Edinb.).

Although having nutlets that are very similar to those in *T. delicatula* this species differs widely from that species in almost all other structures. In gross habit *T. Rockii* most closely approaches *T. rotundata.*

EXCLUDED SPECIES

Trigonotis Bodinieri (Lévl.) Léveillé, Fl. Kouy-Tchéou 55 (1914). *Omphalodes Bodinieri* Léveillé in Fedde, Repert. **12:** 188 (1913).

This is not a borage but a member of the Loganiaceae. The type specimen at Edinburgh, Cavalerie 6^{bis}, from Pin-fa, Kweichow, has been identified by Handel-Mazzetti as *Mitreola pedicellata* Benth.

2. NOVELTIES AND CRITICAL NOTES

Cordia cordiformis, sp. nov., arborescens 6 m. alta rufo vel fulvo indumento vestita; ramulis (et petiolis) pilis gracilibus 1–2 mm. longis hirsutis; foliis cordatis 4–15 cm. longis et latis homomorphis, apice obtusis abrupte breviterque acuminatis, basi cordatis vel rotundis in petiolum 1–4 cm. longum abrupte attenuatis, margine denticulatis, supra strigosis vel appresse minuteque hirsutulis, subtus pallidis in nervulis ramosis numerosis pilis gracilibus flexuosis 0.5–1 mm. longis appressis intertextis subtomentosis; nervis 4–5-jugatis; cymis terminalibus 1–5 cm. longe pedunculatis laxe ramosis 10–15 cm. crassis; calycibus plus minusve evidenter 10-costatis, in alabastro globoso-obovoideis ca. 3 mm. longis 2.5 mm. crassis, extus pilis brunneis 0.5–1 mm. longis curvatis appressis vestitis, intus apicem versus sparsissime strigosis, lobis deltoideis erectis ca. 0.9 mm. longis; corolla 7 mm. longa, tubo 3 mm. longo tubum calycis vix superante, faucibus vix differentiatis, lobis oblongis 3.5 mm. longis 1.3 mm. latis recurvatis apice rotundis; filamentis 2.5 mm. supra basim tubi affixis; antheris 1.5 mm. longis oblongis medio-affixis; ovario glaberrimo globoso; fructu ignoto.

GUATEMALA: Las Vacas near Guatemala, habit of apple-tree, 6 m. tall, July 1860, *Sutton Hayes 624* (TYPE, Gray Herb.); Naranjo, dept. Santa Rosa, 800 m. alt., May 1893, *Heyde & Lux 4731* (G, AA).

A very distinct species readily recognized by its combination of denticulate cordate leaves, comparatively well developed petioles, fulvous or rufous indument and stout 10-ribbed calyx. Though very different in general appearance I believe *C. cordiformis* is closely related to *C. diversifolia* Moc. and *C. salvadoriensis* Standley.

Cordia decipiens, sp. nov., "fruticosa" 12 m. alta; ramulis gracilibus dichotomis abundanter laxeque strigoso-velutinis saepe fulvescentibus; foliis ellipticis vel elliptico-ovatis 10–18 cm. longis 6–10 cm. latis ut videtur homomorphis 4–6 mm. longe petiolatis medium versus vel paullo infra medium latioribus, basi obtusis vel rotundis, apice acutis vel obtusis acuminatis, margine apicem versus manifeste pauciserratis, subtus pallidis evidenter elevato-reticulatis, supra viridibus conspicue nervatis, utrinque pilis 0.4–0.8 mm. longis erectis gracilibus vix abundantissimis velutinis, nervis 6–9-jugatis abundanter ramosis; cymis ramosis 8–10 cm. crassis, ramulis fulvescenter velutinis strigosisve flexuosis; calycibus sessilibus in alabastro obovoideis 3–3.5 mm. longis 2.5 mm. crassis extus plus minusve evidenter 10-costatis fulvescenter strigoso-velutinis, ad anthesin cupulatis, dentibus 5 deltoideis 1 mm. longis erectis aequalibus; corolla ignota; ovario dense strigoso; fructu oblique ovoideis ascendentibus dense pallide strigosis; calyce fructifero explanato.

BRAZIL: Santa Fe near Manicore, basin of Rio Madeira, Amazonas, "shrub 40 ft. high," terra firma "Chapeu de sol," Sept. 8–11, 1934, *Krukoff 6048* (TYPE, Arn. Arb.).

Much resembling and evidently related to the widely distributed *C. bicolor* DC. From that very constant species it differs in its indument of less abundant somewhat longer more erect hairs, its leaves coarsely dentate above the middle, and its costate calyx glabrous within. The indument on the leaves and calyces is very different from that in *C. bicolor*. On the lower surfaces of the leaves the veinlet-areoles are not covered by abundant appressed minute pale hairs converging from the veinlets over the areole. The calyx is not smooth with very closely appressed short hairs. I have seen many specimens of *C. bicolor* and all of them have completely entire leaves. Krukoff's specimen has only half matured fruit. These are indistinguishable from those of *C. bicolor* at a similar state of immaturity.

Cordia lomatoloba, sp. nov., arborescens 15–25 m. alta subglabra; foliis coriaceis lanceolatis vel elliptico-lanceolatis homomorphis glaberrimis vel sparsissime perinconspicueque strigosis 8–14 cm. longis 2–5.5 cm. latis utrinque reticulatis medium versus vel paullo sub medium latioribus, supra lucentibus, subtus opacis pallidioribus, margine integerrimis, apice saepe acuminatis, basi acutis in petiolum 8–15 mm. longum sparse strigosum gradatim attenuatis; nervis primariis 6–8-jugatis abundanter manifesteque ramosis; cymis saepe in furcis ramulorum ortis plus minusve brunneo-pubescentibus laxe graciliterque ramosis ca. 10 cm. crassis; calyce sessili in alabastro 2 mm. crasso 2.5 mm. longo crassipyriformi, supra medium crassiore globoso, infra medium basim 0.5 mm. crassam versus abrupte contracto, lobis 5 deltoideis 0.8 mm. longis margine evidenter puberulente excepto subglabris; corolla alba 4 mm. longa, tubo 1 mm. longo, lobis ca. 1.8 mm. latis oblongis recurvatis apice rotundis; staminibus ca. 1.8 mm. supra basim tubi corollae affixis; filamentis basim versus villosis subulatis ca. 1.1 mm. longis; ovario glaberrimo; fructu ignoto.

BRAZIL: near mouth of Rio Macauhan, tributary of Rio Yaco, Acre Terr., basin of Rio Purus, on terra firma, tree 24 m. tall, Aug. 9, 1933, *Krukoff 5345* (AA); near mouth of Rio Macauhan, terra firma, tree 18 m. tall, fl. white, Aug. 14, 1933, *Krukoff 5497* (TYPE, Arnold Arb.); Humayta near Tres Casas on restinga alta, Amazonas, basin of Rio Madeira, tree 15 m. tall, "Louro," Sept. 14–Oct. 11, 1934, *Krukoff 6291* (AA).

The collections cited have been distributed as *C. ecalyculata* Vell., a species which *C. lomatoloba* does simulate in gross aspect. From *C. ecalyculata,* a species of eastern Brazil, the proposed species differs sharply in its calyx, that being pyriform rather than globose in form, firm rather than papery in texture, regularly dehiscent by 5 equal teeth rather than bursting more or less irregularly, and, finally, pubescent along the teeth-margins rather than glabrous. There are also striking differences in the proportions of the corolla. Our plant, in fact seems to be closely related to the distinctly pubescent species of the northwestern Amazon basin and particularly so to *C. naidophila* of that region.

Cordia Mexiana, sp. nov., arborescens 5–7 m. alta; ramulis puberulentis; foliis ellipticis vel oblongo-ellipticis coriaceis utrinque reticulatis, medium versus latioribus 1.5–4 dm. longis, 8–20 cm. latis, basi rotundis vel late acutis in petiolum 1–2.5 cm. longum abrupte contractis, apice obtusis acuminatis, margine integerrimis, supra lucentibus minutissime punctatis glaberrimis, subtus pallidioribus subpuberulentis, costa falcata; nervis 5–7-jugatis prominenter ramosissimis; cymis laxe ramosissimis ca. 2.5 dm. crassis, ramulis flexuosis strigoso-puberulentis; calycibus in alabastro elongatis ca. 6 mm. longis et 2 mm. crassis apicem versus crassioribus, extus dense breviterque brunneo-strigosis, intus supra medium puberulentis, lobis deltoideis 5 ca. 1 mm. longis erectis; corolla alba elongata 12 mm. longis, tubo 1.5 mm. crasso 4 mm. longo calyci aequilongo, faucibus evidenter differentiatis 2.5–3 mm. longis ad apicem ca. 3 mm. crassis gradatim expansis, lobis oblongis 2 mm. latis 4 mm. longis recurvatis apice rotundis; filamentis 4.5–5 mm. supra basim corollae (0.5–1 mm. supra basim faucium) affixis 7–8 mm. longis longe exsertis basim versus sparse villosis; antheris 1 mm. longis; ovario glaberrimo; stylo profunde bifurcato; fructu ignoto.

Peru: left bank of Rio Marañon below Rancho Indiana, dist. Iquitos, understory overflower bank, 110 m. alt., Jan. 28, 1932, *Mexia 6459* (type, Gray Herb.). Colombia: Umbría, Com. Putumayo, lat. 0° 54′ N., 76° 10′ W., 325 m. alt., Dec. 1930, *Klug 1839* (G).

The cited collections have been distributed as *C. colombiana* Killip. The elongate calyx and the well-developed throat of the corolla separate the plant quickly from *C. colombiana* of the mountains of Ecuador and southern Colombia. The exceptionally elongate tube of the calyx and the very well-developed throat of the corolla are very unusual in the Pilicordia section. The species is very distinct and well marked.

Heliotropium Sessei, sp. nov., fruticosum ascendenter ramosissimum; ramulis foliosis pallide adpresseque villosis; foliis alternis lanceolatis firmis 1.5–4.5 cm. longis 2.5–16 mm. latis infra medium laminae latioribus, apice acutis, basi late acutis vel subrotundis in petiolum gracilem appresse villosum 2–5 mm. longum abrupte transmutatis, supra viridibus enervatis sparse graciliterque villosis, subtus albicantibus abundanter graciliterque appresse villosis, margine subplanis; floribus in cymulas saepe geminatas 1–2 cm. longas ebracteatas 5–10-floras terminales vix pedunculatas aggregatis; calyce villoso 2.5–3 mm. longo 0.5–1 mm. longe pedicellato, lobis inaequalibus lanceolatis tubum corollae superantibus; corolla flavescente 4–4.5 mm. longa 2–2.5 mm. diametro extus strigosa intus glaberrima, lobis 1.5 mm. longis 1 mm. latis recurvatis saepe plicatis basim versus latioribus; antheris oblongis obtusis ca. 0.8 mm. longis inclusis ca. 1.2 mm. supra basim tubo corollae affixis, latere puberulentis, apice leviter cohaerentibus; ovario glabro; stigmate subcylindrico 0.6–0.8 mm. longo basim versus in annulum stigmatosum incrassato; stylo 0.3–0.5 mm. longo; fructu ignoto.

MEXICO: Ixmiquilpan, Sierra de la Mesa, Hidalgo, July 1905, *Purpus 1402* (TYPE, Grey Herb.); Sierra de la Mesa, July 1905, *Rose, Painter & Rose 9122* (G).

A species related to *H. fallax* of southern Mexico and Guatemala from which it is quickly separated by its smaller more coriaceous yellow corollas, elongate recurving corolla-lobes, puberulent anthers, longer style, smaller cymes, etc.

I am of the opinion that this species is probably conspecific with that published as *Myosotis mexicana* Sesse & Mociño, Fl. Mex. 33 (1893), and given as from "in temperatis N. Hispan. montibus." I have seen in the Sesse & Mociño herbarium from Madrid two specimens (nos. 1725 and 5229) which are labeled *M. mexicana.* These agree perfectly with the description of *M. mexicana* and I believe them to be the basis of that species. They represent a plant collected late in the season and in a very mature state. The corollas, anthers and pistil in size form and pubescence are remarkable like those in the plants from Hidalgo. In fact the chief difference between the plant described by Sesse & Mociño and that which I have described above is that the former has corollas in which the tube surpasses (by ca. 0.5 mm.) the calyx and some leaves in which the nervation is impressed on the upper surface. The fruit is very pilose in *M. mexicana,* as it probably also is in *H. Sessei.* No matter what the eventual disposition of *M. mexicana* may be the name can not be transferred to *Heliotropium* for there already exists an *Heliotropium mexicanum* Sesse & Moc. (1888).

Heliotropium fallax, sp. nov., fruticosum 5–12 dm. altum laxe ramosum pallide vestitum e radice valida oriens; ramulis 1–3 mm. crassis partibus juventate tomentosis (pilis gracilibus saepe curvatis abundantibus) foliosis; foliis bicoloribus ellipticis vel late lanceolatis 1–5 cm. longis 5–20 mm. latis, medium versus laminae vel paullo infra medium latioribus, apice obtusis vel acutis, basi obtusis in petiolum gracilem 3–10 mm. longum abrupte attenuatis, margine vix revolutis, subtus albis strigoso-tomentosis saepissime prominenter paucivenosis, supra viridibus saepissime impresso-venosis sparse strigosis vel hispidulis non rariter pilos basi bulboso-incrassatos gerentibus; floribus in racemos scorpioideos saepe geminatos ebracteatos 3–7 cm. longos 5–25 mm. longe pedunculatos terminales et oppositifloros dense aggregatis; pedicellis 0.5–1 mm. longis ascendentibus; calycibus 2.5–3 mm. longis; corolla alba 4–6 mm. longa extus strigosa intus glaberrima, tubo 2–4 mm. longo quam calyce 0.8–1.5 mm. longiore, limbo patente 3–4 mm. diametro, lobis planis ovatis ascendentibus 0.8–1.2 mm. longis rotundis; antheris glabris ca. 1.6 mm. longis elongatis ca. 1.5 mm. supra basim corollae affixis inclusis, tertia parte superiore angustiore, apice obtusis pilis brevissimis coronatis cohaerentibus; filamentis subnullis; stigmate elongato puberulento 1–1.3 mm. longo basi in annulum incrassato; stylo ca. 0.1 mm. longo: fructu pallide strigoso ca. 2.5 mm. diametro 1.5 mm. alto.

Guatemala: Santa Rosa, Baja Verapaz, 1500–1600 m., rocky slopes, April 1887 and July 1908, *von Tuerckheim 1201* and *112315* (G); Cuesta de Cacgil near Salamá, Baja Verapaz, 1200–1600 m., April 1905, *Pittier 158* (G); sparsely wooded limy hill, Chaculá, Huehuetenango, Aug. 3, 1896, *Seler 2992* (G); Aguacatán, Huehuetenango, 1950 m., rocky bushy hillside, frequently rooted in rock crevices, shrub usually 6 but rarely up to 12 dm. tall, fl. white, Dec. 13, 1934, *A. F. Skutch 1922* (type, Gray Herb.). Mexico: between Hacienda Juncana and San Vicente, Chiapas, 1300–1800 m., Dec. 1895, *Nelson 3502* (G).

Heliotropium fallax var. **Hintonii,** var. nov., a varietate genuina differt radice annua; foliis et ramulis pilis rectis rigidioribus dimorphis (brevibus et duplo longioribus) manifeste vestitis; racemis valde elongatis 1–2 dm. longis.

Mexico: Ixtapan, dept. Temascaltepec, state of Mexico, in a barranca, 1000 m., March 21, 1933, *G. H. Hinton 3631* (type, Gray Herb.); Salitre, dist. Temascaltepec, along stone fence, 1300 m., Nov. 15, 1932, *Hinton 2599* (G).

This species, *H. fallax,* is a very distinct one of northern Guatemala and adjacent Mexico which has passed as *H. coriaceum* Lehm. The latter was described over a hundred years ago from plants grown at Hamburg from seeds said to have come from Mexico. A careful reading of the original description of *H. coriaceum,* however, will show that it applies much more accurately to the Peruvian, *H. arborescens* L. than to our present plant from Guatemala and Mexico. Indeed the present species seems so devoid of special grace and usefulness that one naturally doubts that it could have been selected for cultivation in Germany. What is more the region in which it grows is not one explored by botanists and plant-collectors during Lehmann's time. Whatever the case may be the species described by Lehmann as *H. coriaceum* differs from our plant of Guatemala and adjacent Mexico in its very large coriaceous rugose leaves, subcorymbose inflorescences, long-tubed colored corollas, and rugose nutlets. All details certainly applicable to the horticulturally attractive *H. arborescens* of Peru.

The variety *Hintonii* is a more herbaceous plant with short-lived root and very much longer and more loosely and abundantly flowered racemes. The indument is composed of more rigid hairs which are of two distinct sorts, one very small and usually appressed and the other longer (1–2 mm. long) and either appressed or spreading. Its geographic range is to the north of that of typical *H. fallax* and far separated for it. It is quite possible that this northern plant may deserve more than varietal recognition.

The two species of *Heliotropium* above described belong to the ebracteate group within the section Orthostachys, a natural subdivision containing nine species in South America, cf. Contr. Gray Herb. **81**: 48 (1928), and seven species in the region to the north. Below I have given a key for the identification of these latter. Synonymy has been provided and all the specimens representative of them in the herbaria at Harvard have been cited.

- Throat of corolla villous within; anthers distinctly contracted to a glandular tip, not coherent; stigma short and stout, sessile.
  - Leaves alternate; plant an annual herb; corolla-throat sparsely villous; anther-tips subulate; widely distributed in tropics .... *H. procumbens.*
  - Leaves opposite; plant a shrub; corolla-throat densely villous; anther-tips obtusish; Mexican .... *H. calcicola.*
- Throat of corolla entirely glabrous; anthers coherent apically, apex obtuse and minutely hairy; stigma elongate.
  - Plants West Indian; stigma subsessile.
    - Leaves alternate, narrowly lance-linear, 1.5–3 mm. broad. *H. dichroum.*
    - Leaves opposite, lanceolate, 4–8 mm. broad .... *H. uninerve.*
  - Plants Mexican; stigma (except in *H. fallax*) with evident style.
    - Leaves linear, subulate, lower surface nearly covered by the strongly revolute margins, 0.5–1.2 mm. broad; corollas 4.5 mm. long with plicate recurving cuneate lobes; anthers glabrous on sides .... *H. angustifolium.*
    - Leaves lanceolate to elliptic, margins plane.
      - Corolla yellowish, 4–5 mm. long; inflorescence few-flowered, less than 3 cm. long; anthers puberulent on sides; leaves usually veinless; style evident .... *H. Sessei.*
      - Corolla white, 5–7 mm. long; inflorescence abundantly flowered, 3–20 cm. long; anthers glabrous except at apex; leaves usually evidently veined; style scarcely developed .... *H. fallax.*

Heliotropium calcicola Fernald, Proc. Amer. Acad. Sci. **43**: 62 (1907). *Antiphytum mexicanum* DeCandolle, Prodr. **10**: 121 (1846) and Calq. Fl. Mex. tab. 901 (1874), not *H. mexicanum* Sesse & Moc. (1888), nor Greenm. (1898). *Symphitum fruticosum* Sesse & Mociño, Pl. Nov. Hisp. 21 (1888), not *H. fruticosum* L. *H. petraeum* Brandegee, Univ. Calif. Publ. Bot. **4:** 384 (1913). *H. pueblense* Standley, Contr. U. S. Nat. Herb. **23:** 1234 (1924).

MEXICO: San Vicente, Tamaulipas, 1926, *Reiche 1073* (G); San Miguel, Sierra de San Carlos, Tamaulipas, 1930, *Bartlett 10680* (G); Baños del Carrizal, Vera Cruz, 1912, *Purpus 6180* (G, ISOTYPE of *H. petraeum*); Tehuacan, Puebla, 1912, *Purpus 6502* (G, COTYPE of *H. pueblense*); limestone cliffs of Iguala Canyon, Guerrero, 900 m., 10–15 dm. tall, 1906, *Pringle 10334* (G); Iguala Canyon, 750 m., 6–12 dm. tall, 1905, *Pringle 10062* (G, TYPE of *H. calcicola*); Cañon de la Mano Negro near Iguala, 1905, *Rose, Painter & Rose 9368* (G).

DeCandolle's description of *Antiphytum mexicanum* is based upon one of the Mociño plates at Geneva. This plate, number 901 of the DeCandollean series, bears number 288 of the original numbering given by Sesse & Mociño and also their name, *Symphytum fruticosum*. A plant bearing this botanical name is described and their plate no. 288 is cited in their Plantae Novae Hispaniae where the plant concerned is given as having come from Chilpancingo, Guerrero. There are three collections (nos. 861, 1716 and 5256) of *H. calcicola* among the Sesse & Mociño specimens at Madrid, all determined as *Heliotropium* and one of them (no. 861) bearing the specific name "*fruticosum*." The plate at Geneva is a good representation of the moderately small-leaved form of *H. calcicola* represented by all three of the specimens mentioned.

The species *H. pueblense* is founded upon material from Tehuacan (*Rose, Painter & Rose 9979*). It is a form of the species with small revolute-margined leaves. It agrees with typical *H. calcicola* in all technical details of reproduction, habit, leaf-arrangement, pubescence, etc.

Heliotropium procumbens Miller, Dict. ed. 8, no. 10 (1768). *H. americanum* Miller, Dict. ed. 8, no. 11 (1768); Johnston, Contr. Gray Herb. **92:** 89 (1930). *H. inundatum* Swartz, Prodr. 40 (1788). *H. inundatum* var. *cubense* DeCandolle, Prodr. **9:** 540 (1845). *H. rigidulum* DeCandolle, Prodr. **9:** 540 (1845). *H. Eggersii* Urban, Symb. Ant. **5:** 481 (1908).

A weedy species in moist ground from Louisiana, Texas and Lower California southward through the tropics into South America. Common in Mexico and the West Indies.

I have given above only those names which are based upon material from north of Panama. Complete synonymy, which contains very many names, will be found in my treatment of the South American species, Contr. Gray Herb. **81:** 52 (1928). It can be noted here that I was incorrect in citing the name, *H. simplex* Meyen, as a synonym of *H. pro-*

cumbens. A restudy of Meyen's collections at Berlin has shown that the type of *H. simplex* Meyen must be a collection of *H. angiospermum* Murr. which is labeled as from "Peru-Lima 1/31." This collection bears on its label the description given by Meyen in his Reise, **1**: 436, where he gives the species as from Arica.

Heliotropium dichroum Urban, Symb. Ant. **5**: 481 (1908) and **8**: 590 (1921).

HAITI: Morne Bonpère, 500 m. alt., shrub 6–12 dm. tall, fl. white, *Buch 729* (G, part of TYPE).

This endemic of Haiti agrees with *H. calcicola* in its opposite leaves and in the general nature and distribution of its strigose indument. The floral structures, however, seem very different from those in the Mexican species.

Heliotropium uninerve Urban, Arkiv Bot. **17**: no. 7, p. 51 (1921).

HAITI: between Port à Piment and Randelle, dept. Sur., limestone hills, Aug. 12, 1917, *Ekman 675* (G, part of TYPE); Morne Rouge near Chapelle Mont Carmel, in arid calcareous hills at east end of Morne de la Hotte, dept. Sur, 600 m., Nov. 7, 1924, *Ekman 2410* (G).

The strigose indument is very similar to that of *H. dichroum.* The two collections cited are very similar. Their leaves are distinctly narrower than in *H. dichroum* and show no tendency to be opposite.

Heliotropium angustifolium Torrey, Bot. Mex. Bound. 137 (1859).

TEXAS: south of Loma Alta, McMullen Co., 1935, *Cory 17204* (G); Montell, Uvalde Co., dry limestone hills, 1917, *Palmer 12322* (G); Devils River, Valverde Co., rocky hills, 1900, *Eggert* (G); Del Rio, Valverde Co., 1930, *Jones 25639* (G); 25 mi. northeast of Dryden, Terrell Co., 1930, *Cory 3380* (G); Rio Grande Valley, 1936, *Parks* (G); Guadalupe Mts., 1882, *Havard 27* (G); western Texas, 1890, *Nealley 236* (G); head of the San Felipe, July 7, 1849, *Wright 480* (G); stony prairies on Zoquete Creek, May 18, 1851, *Wright 1546* (G). CHIHUAHUA: Cerro de Chupaderos near Jiménez, 1925, *Juzepczuk 635* (G). COAHUILA: Sierra Mojada, 1925, *Juzepczuk 667* (G); Saltillo, 1898, *Palmer 36* (G); Cerro de Zapatero, 1910, *Purpus 4558* (G); Soledad, 1880, *Palmer 880* (G); Caracol Mts. southeast of Monclova, 1880, *Palmer 879* (G); Juray, 100 mi. north of Monclova, 1880, *Palmer 881* (G). NUEVO LEON: near Monterey, *Seler 1054, Pringle 1880, Palmer 405* and *878* (G); Sabinas Hidalgo, 1933, *Mueller 330* (G); Sierra Madre, 15 mi. southwest of Galeana, 1934, *Mueller 977* and *1112* (G). TAMAULIPAS: near Victoria, 1907, *Palmer 578* (G); Jaumauve, 1932, *Rozynski 461* (G); Sierra de San Carlos, 1930, *Bartlett 10605* (G).

INDEFINITE: road between Doctor Arroyo, N. L., and Matchuala, S. L. P., 1898, *Nelson 4514* (G); no locality given, 1848–49, *Gregg 298* (G).

When he described this species Torrey gave it as based upon collections from "Western Texas and along the Rio Grande, south to Eagle Pass, March–October. Near Monterey, Mexico, *Dr. Edwards and Major Eaton* (No. 480 and 1546, *Wright*)." Among its relatives this species is quickly distinguished by its very narrow strongly revolute-margined leaves. The racemes are characteristically solitary and opposite the leaves. Occasionally a bract may be developed near the base of the inflorescence though prevailingly it is bractless. The corolla is given as greenish or cream-colored.

Heliotropium convolvulaceum var. **racemosum** (Rose & Standley), comb. nov. *Euploca racemosa* Rose & Standley, Contr. U. S. Nat. Herb. **16:** 17 (1912).

TEXAS: east of Encino, Brooks Co., 1935, *Cory 14208* (G); Atascosa County on highway near Bexar county line, 1935, *Cory 15521* (G); eleven miles northwest of Poteet, Frio Co., 1935, *Cory 11716* (G); Llano, Llano Co.?, July 1848, *Lindheimer* (G); 30 mi. west of San Antonio, Bexar Co., Sept. 1879, *Palmer 889* (G, ISOTYPE); Rio Coleto, Sept. 1885, *Thurber 12* (G).

This is a geographical variety which replaces the typical form of the species in southern Texas. It is a much more freely branched plant with more abundantly flowered denser racemes and conspicuously smaller flowers. The corollas are only 5–8 mm. in diameter.

Heliotropium Jaffuelii, sp. nov., fruticosum erectum glutinosum pilis crassis inconspicuis brevibus adpressis vestitum gracile laxe ramosum; foliis linearibus 5–10 mm. longis 0.5–0.8 mm. latis crassiusculis plus minusve fasciculatis subteretibus apice obtusis margine non rariter revolutis; floribus terminalibus in cymulas plures scorpioideas ebracteatas 1–4 cm. longas graciles rigidas dispositis; calycibus ca. 1.5 mm. longis 0–0.9 mm. longe pedicellatis carnosulis, lobis oblongis ca. 0.8 mm. longis apice obtusis dorso convexis, sinibus acutis; corolla 2.5–3 mm. longa glaberrima, limbo 2.5–3 mm. diametro, lobis rotundis ca. 0.8 mm. latis et longis; faucibus vix differentiatis; staminibus ca. 1 mm. supra basim tubi corollae affixis; antheris ca. 1 mm. longis lanceolatis glabris, apice acutis glandulosis paullo exsertis; stigmate conico ca. 0.7 mm. longo ca. 0.6 mm. crasso apice truncatulo bidentato; stylo brevissimo; ovario glabro; nuculis ignotis.

CHILE: Tocopilla, Sept. 1931, *Father Felix Jaffuel 2524* (TYPE, Gray Herb.).

A species related to *H. chenopodiaceum* Clos but differing in its copiously glutinous leaves, twigs and calyces, thicker weakly revolute leaves, smaller corollas, and stout broadly conic (rather than very elongate) stigma. The stems and leaves bear curious short appressed falcate hairs. These are scattered and are immersed in the copious clear waxy-glutinous secretion which covers all the growing vegetative parts of the plant.

It is a pleasure to associate the name of Father Felix Jaffuel with another distinctive species of the Nitrate Coast. Taking advantage of the brief halts of the coast steamers, while traveling for his Order, he has made a number of highly interesting collections about the ports of arid northern Chile and has thereby contributed much to our scanty knowledge of the flora of that region.

Heliotropium eremogenum, sp. nov., fruticosum decumbens ramosissimum griseum pilis gracilibus falcatis appressis vestitum; foliis firmis integerrimis 4–8 mm. longis 1–2 mm. latis oblanceolatis supra medium latioribus, margine revolutis, apice acutis; floribus in cymulas terminales scorpioideas 0.5–2 cm. longe pedunculatas congestis; calycibus saepissime sessilibus 3 mm. longis basim versus in lobos lineari-cuneatos erectos 5-fidis; corolla (ut videtur alba vel ochroleuca) ca. 6 mm. longa extus sparse strigosa intus glabra, limbo ca. 6 mm. diametro, tubo lobos calycis 1–1.5 mm. longe superante ca. 4 mm. longo, lobis rotundis 2 mm. diametro; antheris linearibus ca. 1.8 mm. longis inclusis 2.5 mm. supra basim tubi corollae affixis; stigmate ca. 1.5 mm. longo columnari imam ad basim in annulum stigmatosum angustum incrassato; ovario glabro.

CHILE: Antofagasta, Oct. 29, 1930, *Felix Jaffuel 1120* (TYPE, Gray Herb.); Antofagasta, Nov. 6, 1931, *Felix Jaffuel 2639* (G); Antofagasta, open rocky quebrada, 100–300 m. alt., April 3, 1925, *Pennell 13022* (G).

A relative of *H. Philippianum* Johnston, from which it differs in its decumbent habit, more copious grayish indument, very much smaller leaves, and proportionately shorter style. The incomplete collection by Pennell has been recognized for some years, cf. Contr. Gray Herb. **81:** 38 (1928) and **85:** 155 (1929), as representing what was probably an undescribed species. Happily Father Felix Jaffuel has collected the same interesting species in good flowering condition and the description of this new addition to the flora of the Nitrate Coast is now possible. The material from Iquique, which I formerly associated with Pennell's collection, appears to be conspecific with some collections recently made at Tocopilla by Father Jaffuel. The material at hand of this plant of Iquique and Tocopilla is, unfortunately, fragmentary. When good collections of it become available for study I believe that it will prove to represent a third species endemic to the Nitrate Coast.

Heliotropium anomalum var. **mediale,** var. nov., a varietate genuina differt gracilioribus erectioribus ascendente ramosis saepe 3–5 rariter 15 dm. altis; foliis gracilioribus leviter strigosis oblanceolatis vel linearibus acutis; calycibus minoribus ca. 2 mm. longis.

Christmas Island: 4 miles west of Manulu Lagoon, shrub forming rounded mass 4 dm. tall, Oct. 21, 1934, *St. John & Fosberg 17486* (type, Bishop Mus.; G, isotype), *17487* (G); Joe's Hill, prostrate, *St. John & Fosberg 17494* (G). Fanning Island: Vai Tepu, saline flat, bush 5–15 dm. tall, April 22, 1934, *St. John & Fosberg 14121* and *14122* (G); Cable Islet, coral slabs, 3–4 dm. tall, April 21, 1934, *St. John & Fosberg 14109* and *14110* (G).

Typical *H. anomalum* H. & A. of southern and eastern Polynesia is a coarser and more laxly branched prostrate or trailing plant with coarser much more loosely appressed indument, larger inflorescences and coarser calyces. The Hawaiian var. *argenteum* Gray, Proc. Amer. Acad. **5:** 339 (1861), is similar to typical *H. anomalum* except for its closely appressed lustrous silky indument. In indument, therefore, the plants of Christmas and Fanning islands much resemble the Hawaiian variety. The var. *mediale,* however, is very different from the Hawaiian form in its bushy habit, very slender leaves, smaller calyces, etc.

Echium connatum Léveillé, Cat. Pl. Yunnan 22, fig. 4 (1915).

This is not a species of the Boraginaceae, but one of the Caprifoliaceae, *Triosteum himalayanum* Wall. I have seen the type at Edinburgh.

Arnebia Hancockiana (Oliver), comb. nov. *Lithospermum Hancockianum* Oliver, Hooker's Icones **25:** tab. 2467 (1896). *Lithodora Hancockiana* (Oliver) Handel-Mazzetti, Symb. Sin. **7:** 818 (1936). *Lithospermum Mairei* Léveillé in Fedde, Repert. **12:** 286 (1913).

An examination of the type of *L. Mairei* proves it an evident synonym of Oliver's species. Recently Handel-Mazzetti has treated this endemic of Yunnan as a member of the Mediterranean genus *Lithodora.* Though fruit of this Chinese plant is unknown and it can not therefore be excluded from *Lithodora* with finality, I am positive that it is not a member of the genus *Lithodora* but rather of the great Asiatic genus *Arnebia.* Its relations are with such Asiatic species as *A. euchroma* (Royle) Johnston and *A. fimbriata* Maxim.

Lithospermum officinale Linnaeus, Sp. Pl. 132 (1753). *L. albiflorum* Vaniot, Monde des Plantes, sér. 2, **7:** 42 (1905); Fedde, Repert. **2:** 197 (1906); Léveillé, Fl. Kouy-Tchéou 54 (1914).

I have examined the type of *L. albiflorum* Vaniot, now preserved at Edinburgh, and find it inseparable from the common form of *L. officinale* growing in eastern Asia.

Amsinckia intermedia Fischer & Meyer, Ind. Sem. Hort. Petrop. **2:** 2 and 26 (1836). *Lithospermum Komarovianum* Léveillé in Fedde, Repert. **8:** 280 (1910).

Léveillé's species was based upon collections having only immature fruit. As far as comparisons can be made it seems inseparable from the common and variable *A. intermedia* of California. I suspect it is the same introduced species as that reported from Saghalin by Mayabe & Miyake, Fl. Saghalin (1915), under the name *A. tessellata*.

Onosmodium dodrantale, sp. nov., rhizomatosum; caulibus pluribus simplicibus 1.5–2.5 dm. altis erectis foliosis 2 mm. crassis hirsutis; foliis oblongis vel ovato-oblongis nervatis supra medium caulis grandioribus (3–4.5 cm. longis 6–15 mm. latis) basim versus caulis evidenter reductis pilis 1 mm. longis rectis appressis e basi pustulato-bulbosa erumpentibus vestitis, infra medium laminae latioribus apice acutis vel obtusis basi rotundis subsessilibus supra viridioribus; cymulis terminalibus solitariis ca. 5-floris foliosis; calyce ad anthesin ca. 1 cm. longo hirsuto, lobis linearibus erectis 0.5–1 mm. latis acutis tubo corollae aequilongis, pedicello 2–5 mm. longo; corolla flava 12–18 mm. longa extus in faucibus lobisque strigosa intus (lobis exceptis) glaberrima; lobis 3–3.5 mm. longis 2–2.5 mm. latis a basi apicem versus gradatim attenuatis virescentibus erectis, sinibus acutis; staminibus 9–10 mm. supra basim corollae (imam ad basim faucium plus minusve ampliatae) affixis inclusis glaberrimis, filamentis lateraliter compressis ca. 1.2 cm. longis; antheris elongatis 2–3 mm. longis apice in subulas graciles ca. 0.2 mm. longas abrupte contractis basi subcordulatis; stylo ca. 2 cm. longo filiformi 2–4 mm. longe extruso, stigmatibus minutissime geminatis; nuculis ignotis.

MEXICO: Cerro Potosi, Galeana, Nuevo Leon, scattered colonies in upper pine woods, fl. cream-yellow, July 21, 1935, *C. H. Mueller 2259* (TYPE, Gray Herb.); El Infernillo, ca. 25 km. southwest of Galeana, Nuevo Leon, 2700–3000 m. alt., common, fl. yellow with greenish lobes, July 29, 1934, *Mueller 923* (G); El Infernillo, Pablillo, southwest of Galeana, rocky summit, 3000–3100 m., fl. yellow, June 29, 1934, *Pennell 17116* (G).

A well-marked species notable for its small stature, simple stems, reduced lower leaves and small few-flowered cymes. It may be separated from *O. unicum* Macbr., of southern San Luis Potosi, and from *O. bejariense* DC., of Texas, by having a simple indument of spreading or appressed hairs. In the two relatives the indument is duplex there being fine short usually appressed hairs under the coarse hispidity clothing the stems and leaves.

Cryptantha (§ OREOCARYA) **Grahamii,** sp. nov., perennis caespitosa; caudice denso breviter ramoso e radice crasso lignoso oriente; caulibus 1–2 dm. altis erectis setosis et adpresse pubescentibus supra medium fertilibus; foliis viridibus utrinque pilis minutis inconspicuis vestitis et setis ca. 2 mm. longis (e basi pustulata orientibus) horridis, basalibus 3–4.5 cm. longis supra medium in laminam lanceolato-ovatam 5–10 mm. latam explanatis apice rotundis vel obtusis, caulinis oblanceolatis vel oblongis medis 2–2.5 cm. longis 6–7 mm. latis obtusis; inflorescentia elongata laxa; cymulis laxis 3–10-floribus setosis bracteis foliaceis suffultis; calycibus abundanter setosis et pubescentibus ad anthesim ca. 7 mm. longis, lobis lineari-lanceolatis acutis fauces corollae 0.5–1 mm. superantibus; pedicellis gracilibus 0.5–1 mm. longis; corolla alba conspicua, limbo patente 12–16 mm. lato, lobis rotundis ca. 5 mm. latis et longis, tubo cylindrico 5–6 mm. longo 1–1.3 mm. crasso; ovulis 4; nuculis ignotis.

UTAH. Uinta County: bench west of Green River north of mouth of Sand Wash, 4500 ft. alt., fl. white, May 28, 1933, *Edward H. Graham 7924* (TYPE, Gray Herb.) and *7927* (G); east slope of Big Pack Mt., west of Willow Creek near Thome Ranch, 5400 ft., on light-colored slate bench, fl. white, May 23, 1935, *Graham 8962* (G); shale breaks east of Willow Creek, 5 mi. north of Agency Draw, 5500 ft., fl. white, fragrant, *Graham 8937* (G).

A very distinct and readily recognizable species. Its conspicuous white corollas are the largest known in the genus. The immature nutlets appear to be smooth and rather similar to those of *C. confertiflora* (Greene) Payson. I can suggest no close relative for this remarkable new species.

The species is named for Dr. Edward H. Graham of the Carnegie Museum of Pittsburgh who discovered it during his intensive botanical investigation of the Uinta Basin of northeastern Utah. It is eminently fitting that his name should be associated with this remarkable endemic of the region he has studied so thoroughly.

Cryptantha (§ KRYNITZKIA) **Hooveri,** sp. nov., herbacea annua 5–15 cm. alta laete viridis; caulibus solitariis vel pluribus erectis vel non rariter basim versus subdecumbentibus gracilibus 0.5–1.2 mm. crassis strigosis infra medium simplicibus supra medium breviter ascendenterque ramosis; ramulis floriferis 1–2.5 cm. longis; foliis ascendentibus crassulis firmis pilis rigidis adpressis (vel in foliis supremis pilis ascendentibus) vestitis, subtus prominenter costatis abundanter pustulatis, supra sparse pustulatis; foliis basalibus caulis ramorumque evidenter oppositis 10–25 mm. longis angustissime spathulatis apicem obtusam versus 0.9–2.2 mm.

latis, margine saepe subplanis; foliis caulinis ramulisque mediis et superioribus alternis sublinearibus 1 mm. latis 1–2 cm. longis apice acutis margine revolutis; inflorescentia elongata dense thyrsoidea vel paniculata; floribus in axillis foliorum glomerulatis vel solitariis haud scorpioideis; calycibus fructiferis elongatis subsessilibus 4–5 mm. longis tarde deciduis; lobis calycis maturi linearibus in costa setis flavescentibus 2–3 mm. longis munitis et in marginibus dense ascendenter villosis; corolla inconspicua tubulosa 2–2.5 mm. longa ad anthesim calycem ca. 3 mm. longam vix superante; nuculis 4 homomorphis (nucula adaxillari subpersistenti?) triangulari-ovatis ca. 1.3 mm. longis ca. 0.9 mm. latis lucentibus, apice acutis, basi late truncatis, margine acutis minime incrassatis, dorso convexis prominenter papillatis, ventre obtuse angulatis sparse tuberculatis ¾ longitudinis ad gynobasim angustum ca. 1 mm. longam afixis sulco infra medium in areolam deltoideam abrupte dilatatis; stylo nuculas vix superante.

CALIFORNIA: eight miles west of Chowchilla, Madera Co., a single colony in dry coarse sand, May 7, 1935, *R. F. Hoover 558* (TYPE, Gray Herb.); Gobin Ranch, about 13 mi. east of Waterford, Stanislaus Co., in coarse sand on a flat among rolling hills, May 2, 1936, *Hoover 1103* (G); sand hills east of Antioch, Contra Costa Co., April 16, 1908, *Heller 8888* (G).

I can suggest no close relative for this very distinct species. The peculiar inflorescence, characterized by a complete lack of scorpioid cymes, is unique among the North American species of the genus. The nutlets though not aberrant are distinctive and I believe the species can be recognized from them alone. The corollas are very small and possibly may be cleistogamic though the corollas surmounting the ripening ovary have their tiny lobes expanded and not permanently closed as in the indubitably cleistogamic flowers of the South American section Eucryptantha.

I have associated with this unusual species the name of Mr. Robert F. Hoover of Modesto, Calif., to whom I am indebted for the excellent specimens here described. The material was collected by Mr. Hoover during botanical trips about the San Joaquin Valley made in furtherance of his study of the floristics of that region. It is a pleasure to associate his name with this remarkable addition to the known flora of that interesting area.

Cryptantha corollata (Johnston), comb. nov. *C. decipiens* var. *corollata* Johnston, Contr. Gray Herb. **74:** 61 (1925); Johnston in Munz, Man. So. Calif. Bot. 428 (1935).

Since this plant of the drier inner Coast Ranges of California was first distinguished over ten years ago I have seen many collections of it. Among the scores of specimens studied I have found none that give any indication that *C. corollata* and *C. decipiens* intergrade in any way, or that their geographical ranges overlap or even approach one another closely. The plant I distinguished as *corollata* is very constant and readily identifiable and has a range that is eminently natural. I now believe it should be given specific recognition.

Hackelia brachytuba (Diels), comb. nov. *Paracaryum brachytubum* Diels, Notes Royal Bot. Gard. Edinburgh **5:** 168 (1912). *Lappula Dielsii* Brand in Fedde, Repert. **14:** 147 (1915). *Hackelia Dielsii* (Brand) Johnston, Contr. Gray Herb. **68:** 45 (1923).

The type of *P. brachytubum* came from the Tali Valley (*Forrest 4474*) that of *L. Dielsii* from the Likiang Range (*Forrest 2255*), also in Yunnan. They are evidently conspecific.

Trigonotis sericea (Maxim.), comb. nov. *Omphalodes sericea* Maximowicz, Bull. Acad. Sci. St. Pétersb. **17:** 453; Mél. Biol. **8:** 558 (1872).

This species is evidently a relative of *T. Icumae* (Maxim.) Makino, *T. radicans* Maxim. and *T. myosotidea* Maxim. and not a member of the genus *Omphalodes* as it has been accepted for so long.

Antiotrema Dunnianum (Diels) Handel-Mazzetti, Anzeiger Akad. Wiss. Wien **57:** 239 (1920). *Cynoglossum Dunnianum* Diels, Notes Royal Bot. Gard. Edinburgh **5:** 168 (1912). *Cynoglossum Cavaleriei* Léveillé in Fedde, Repert. **12:** 534 (1913) and Cat. Seu-Tchouen, tab. 5 (1918). *Henreyettana mirabilis* Brand in Fedde, Repert. **26:** 171 (1929).

The type of *C. Cavaleriei* (*Cavalerie 2117*) has its flowers at anthesis and shows no fruit. It is a mediocre specimen but one clearly conspecific with the type of *A. Dunnianum*. Léveillé had other collections of the species, *Bodinier 1579* and *2160*, which do possess mature fruit but these were not associated by him with his *C. Cavaleriei*. They are in fact the basis upon which he reported, *Bothriospermum Kusnezowii* from Kweichow, Fl. Kouy-Tchéou 52–53 (1914).

In his recent treatment of this remarkable plant, Handel-Mazzetti, Symb. Sin. **7:** 825 (1936), is incorrect in stating that the nutlets and embryo are "erect." As I have already indicated, Contr. Gray Herb. **75:** 44–45 (1925), the nutlets and embryos are in fact inverted in *Antiotrema*. This is a very unusual condition in the Boraginaceae and is found in only two other genera of the family.

HERBARIUM, ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

NOTES ON THE LIGNEOUS PLANTS DESCRIBED BY H. LEVEILLE FROM EASTERN ASIA[1]

ALFRED REHDER

ROSACEAE

Rubus L.

Subgen. CYLACTIS (Raf.) Focke

Rubus fragarioides Bertol. var. **adenophora** Franchet, Pl. Delavay. 203 (1890).

Rubus Franchetianus Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 71 (1909). — Focke in Bibl. Bot. **19** (83): 16 (Spec. Rub. 240) (1914).

There is no specimen of this plant in the Léveillé herbarium. I have seen the type of this variety in the Paris herbarium and have a photograph of it before me; it does not seem to be specifically different from typical *R. fragarioides* Bertol. which is referred by Focke in 1910 (op. cit. **17**: 24) as a variety (or subspecies) to *R. arcticus* L.; in 1914 (l.c.) he enumerates *R. Franchetianus* with the synonym *R. fragarioides* var. *adenophora* Franch., a name not mentioned by him in 1910.

Rubus pseudo-japonicus Koidzumi in Bot. Mag. Tokyo, **25**: 74 (1911); in Jour. Coll. Sci. Univ. Tokyo, **34,** 2: 110 (1913).

Rubus japonicus (Maxim.) Focke in Abh. Naturw. Ver. Bremen, **4**: 192, 198 (1874); in Bibl. Bot. **17** (72^{I}): 26 (Spec. Rub.) (1910). — Non Linné f.

Rubus triflorus Rich. var. *diversifolius* Léveillé in Bull. Soc. Agr. Sci. Arts Sarthe, **40**: 58 (1905); in Fedde, Rep. Spec. Nov. **2**: 174 (1906); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 122 (1909).

Rubus pseudo-japonicus var. *diversifolius* (Lévl.) Koidzumi in Jour. Coll. Sci. Tokyo **34**, 2: 110 (1913). — Makino & Nemoto, Nippon-shokubutsu-soran, ed. 2, p. 522 (1931).

JAPAN. Hokkaido: in silvis Hakodate, *U. Faurie*, no. 6070, June 1, 1904 (holotype of *R. triflorus* var. *diversifolius;* isotype in A. A.).

Léveillé describes his variety as having simple and compound leaves

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[1] Continued from Vol. 17: 316-340; for preceding parts see Vols. **10**: 108-132, 164-196; **12**: 275-281; **13**: 299-332; **14**: 223-252; **15**: 1-27, 89-117, 267-326; **16**: 311-340; **17**: 53-82.

on the same stem, but the type specimen, which, however, does not bear Léveillé's name, has all the leaves either ternate or quinate. In 1909 Léveillé reprints under *R. triflorus* Rich. the description given by Thunberg (Fl. Jap. 216. 1784) for his *R. caesius* (non L.), but that description applies apparently to a species of the Subgen. Idaeobatus.

Rubus ikenoensis Léveillé & Vaniot in Bull. Soc. Bot. France, **53**: 549 (1906). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 130 (1909). — Koidzumi in Jour. Coll. Sci. Tokyo, **34,** 2: 109 (1931). — Focke in Bibl. Bot. **17** (72II): 165 (Spec. Rub.) (1911).

Rubus defensus Focke in Bibl. Bot. **17** (72II): 26 (Spec. Rub.) (1910). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 273 (1917).

JAPAN. Hondo: in sylvis Norikusa, 2000 m., *U. Faurie,* no. 6687, Aug. 28, 1905 (holotype of *R. ikenoensis;* photo. in A. A.).

Focke himself in 1911 identified his *R. defensus* with *R. ikenoensis*. From the preceding it differs chiefly in the setose stems and petioles and the deeply incised doubly serrate leaflets.

Subgen. MALACHOBATUS Focke

Sect. Sozostyli Focke

Rubus refractus Léveillé in Fedde, Rep. Spec. Nov. **4**: 332 (1907); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 54 (1909); Fl. Kouy-Tchéou, 359 (1915). — Focke in Bibl. Bot. **17** (72I): 62 (Spec. Rub.) (1910); **19** (83): 22, fig. 3 (Spec. Rub. 246, fig. 90) (1914). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 278 (1917).

CHINA. Kweichou: Chang-ieoumay, *J. Esquirol,* no. 356, April 1, 1905, "fleur blanche, le tout renversé en bas" (holotype; photo. in A. A.).

Cardot (l.c.) points out that this species differs from the other species of the Sozostyli in the bracts and stipules being divided into filiform lobes and that in this respect it approaches the Alceaefolii; he proposes its separation as a new section "Refracti." This section would include the following species. He also described a new variety *R. refractus* var. *latifolius* (see under *R. alceaefolius,* p. 33).

Rubus Rocheri Léveillé in Bull. Acad. Intern. Géog. Bot. **24**: 250 (1914); Fl. Kouy-Tchéou, 360 (1915); Cat. Pl. Yun-Nan, 240, fig. 60 (1917).

CHINA. Kweichou: Ta-pin, 1200 m., *J. Esquirol,* no. 3526, March 25, 1912 (holotype; photo. in A. A.).

This species is very close to the preceding, but is easily distinguished by the dense fulvous tomentum of the stem, the rhachis and pedicels of the inflorescence and of the underside of the leaves which are smaller, not or scarcely lobed, more sharply and closely serrate, appressed-pilose above and deeply cordate.

Rubus malifolius Focke in Hooker's Ic. Pl. **20:** t. 1947 (1890); in Bibl. Bot. **17** (72^{I}): 42 (Spec. Rub.) (1910). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 275 (1917).

Rubus arbor Léveillé & Vaniot in Bull. Soc. Bot. France, **51:** 217, pl. 3 (1904). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 26 (1909); Fl. Kouy-Tchéou, 357 (1915).

CHINA. Kweichou: Pin-fa, route de Siao-tchang, *J. Cavalerie,* no. 1003, May 7, 1903, "arbre, fl. blanches" (holotype of *R. arbor;* photo. in A. A.).

According to the collector's note this is a tree. However, in reality it is only a tall climber and Handel-Mazzetti (Symb. Sin. **7:** 486) calls it perhaps the tallest *Rubus* climbing on trees up to a height of 20 m.

Rubus Mairei Léveillé in Bull. Acad. Intern. Géog. Bot. **22:** 232 (1912); Cat. Pl. Yun-Nan, 239 (1917).

CHINA. Yunnan: Tong-tchouan, broussailles, 2700 m., rare, *E. E. Maire,* (Herb. Bonati, no. 7491), Aug. 1910, "un peu grimpant, fl. blanches" (holotype in Herb. Léveillé; isotype in Herb. Calif.; photo. in A. A.).

This species is closely related to *R. preptanthus* Focke, but is easily distinguished by the narrow-lanceolate leaves only 1–1.5 cm. broad, more remotely and finely serrate, by the shorter petioles 3–5 mm. long and the more copiously armed branches. Handel-Mazzetti (Symb. Sin. **7:** 486. 1933) refers *R. Mairei* to *R. Henryi* Hemsl. & Ktze.; but from that species it differs in the deciduous, thinner always undivided leaves. in the much shorter petioles and the short, almost corymbose often few-flowered racemes with pedicels 1–1.5 cm. long.

Sect. Elongati Focke

Rubus chroosepalus Focke in Hooker's Ic. Pl. **10:** t. 1952 (1891); in Bibl. Bot. **17** (72^{I}): 52, fig. 15 (Spec. Rub.) (1910); in Sargent Pl. Wilson. **1:** 49 (1911). — Léveillé, Fl. Kouy-Tchéou, 360 (1915); Cat. Pl. Yun-Nan, 236 (1917). — Handel-Mazzetti, Symb. Sin. **7:** 491 (1933).

Rubus Mouyousensis Léveillé in Fedde, Rep. Spec. Nov. **4:** 333 (1907); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 44 (1909); Fl. Kouy-Tchéou, 359 (1915). — Focke in Bibl. Bot. **17** (72^{I}): 62 (Spec. Rub.) (1910).

Rubus petaloideus Léveillé in Fedde, Rep. Spec. Nov. **12:** 506 (1913).

CHINA. Kweichou: Mou-you-se, *J. Cavalerie,* no. 1416, June 1904 (holotype of *R. Mouyousensis;* photo. in A. A.); Chouan-chang-po, à la sortie du bourg, *J. Esquirol,* no. 3141, May 1911 (holotype of *R. petaloideus;* photo. in A. A.).

Rubus Mouyousensis was identified with *R. chroosepalus* by Handel-Mazzetti (l.c.) and *R. petaloideus* was enumerated as a synonym of *R. chroosepalus* by Léveillé in 1915 (l.c.) and 1917 (l.c.).

Rubus Gentilianus Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11:** 99 (1902); **12** (no. 60): t. 3 (1903); **20** (Mém.): 35 (1909); Fl. Kouy-Tchéou, 358 (1915); in Bull. Soc. Agr. Sci. Arts Sarthe, **45:** 219, fig. 3 (Pl. Util. Orn. Kouy-Tchéou, 45, fig. 3) (1915); Cat. Pl. Yun-Nan, 239 (1917); Cat. Ill. Pl. Seu-Tchouen, pl. 60 (1918). — Focke in Bibl. Bot. **17** (72I): 53 (Spec. Rub.) (1910); **19** (83): 26, fig. 5 (Spec. Rub. 250) (1914); in Sargent, Pl. Wilson. **1:** 50 (1911). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 279 (1917). — Handel-Mazzetti, Symb. Sin. **7:** 491 (1933). — Merrill in Lingnan Sci. Jour. **13:** 28 (1934).

CHINA. Kweichou: environs de Tsin-gay, rocailles, *E. Bodinier,* no. 2367, June 27, 1899; environs de Kouy-yang, mont du Collège, rocailles, ruisseaux, *E. Bodinier,* no. 2367, June 16, 1898 (syntypes; photos. in A. A.).

This species has been collected in Kweichou also by Handel-Mazzetti (no. 10419) and by Steward, Chiao & Cheo (no. 57). It is also known from Szechuan (E. H. Wilson, no. 1127, and W. P. Fang, no. 2537) and from Kwangtung (W. T. Tsang, no. 20611).

Rubus ichangensis Hemsley & Kuntze in Jour. Linn. Soc. Bot. **23:** 231 (1887). — Focke in Bibl. Bot. **17** (72I): 55, fig. 18 (Spec. Rub.) (1910); **19** (83): 26 (Spec. Rub. 250) (1914); in Sargent, Pl. Wilson. **1:** 50 (1911). — Léveillé, Fl. Kouy-Tchéou, 360 (1915). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 279 (1917).

Rubus Papyrus Léveillé in Fedde, Rep. Spec. Nov. **4:** 332 (1907); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 30 (1909). — Focke in Bibl. Bot. **17** (72I): 56 (Spec. Rub.) (1910).

CHINA. Kweichou: Pin-fa, montagnes, *J. Cavalerie,* no. 1439, Oct. 27, 1903 (holotype of *R. Papyrus;* photo. in A. A.).

Rubus Papyrus was first identified with *R. ichangensis* by Focke in 1914 (l.c.). The species is represented in this herbarium from Kweichou, also by no. 10647 of Handel-Mazzetti and by nos. 5587, 5733, 7504 and 9230 of Y. Tsiang and by numerous specimens from Szechuan and some from Hupeh.

Sect. Acuminati Focke

Rubus Lambertianus Ser. var. **minimiflorus** (Lévl.) Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 281 (1917). — Handel-Mazzetti, Symb. Sin. **7:** 489 (1933).

Rubus minimiflorus Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 32 (1909); Fl. Kouy-Tchéou, 359 (1915). — Focke in Bibl. Bot. **17** (72I): 56 (Spec. Rub.) (1910); **19** (83): 28 (Spec. Rub. 252) (1914).

CHINA. Kweichou: Pin-fa, montagnes, *J. Cavalerie,* no. 1775, Apr. 17, 1904 (holotype of *R. minimiflorus;* photo. in A. A.).

Focke in 1914 (l.c) refers to the possible identity of his *R. pycnanthus* with *R. minimiflorus,* but the description of the former differs in several characters from the type of the latter.

Rubus paykouangensis Léveillé in Fedde, Rep. Spec. Nov. **4:** 333 (1907); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 19 (1909); Fl. Kouy-Tchéou, 359 (1915). — Focke in Bibl. Bot. **17** (72I): 110 (Spec. Rub.) (1910). — Metcalf in Lingnan Sci. Jour. **11:** 7 (1932), pro parte specim. plurim. cit. exclud. — Merrill in Lingnan Sci. Jour. **15:** 420 (1936), specim. cit. excl.

Rubus Lambertianus Ser. var. *paykouangensis* (Lévl.) Handel-Mazzetti, Symb. Sin. **7:** 489 (1933).

CHINA. Kweichou: Pay-kouang, *J. Esquirol,* no. 221, Sept. 1904, "fl. blanches" (holotype; photo. in A. A.).

This species was reduced by Handel-Mazzetti to a variety of *R. Lambertianus,* to which it certainly is more closely related than to the Ser. Rufi where Focke placed the species. From *R. Lambertianus* it is easily distinguished by the inflorescence, the stems and petioles being densely covered with pilose and setose partly gland-tipped hairs and by the larger flowers with broader sepals. Metcalf (l.c.) refers to this species a number of specimens from Fukien, Kiangsi and Yunnan which though similar in their indumentum differ markedly in the short often sub-umbellate inflorescence, in the pinnate sepals, in the broader and larger generally orbicular-ovate leaves densely pubescent or even tomentose beneath and in the unarmed branches; they are apparently referable to the Sect. Moluccani. Also W. T. Tang, no. 20791, from Kwangtung cited by Merrill (l.c.) under *R. paykouangensis* belongs to that section.

Sect. Moluccani Focke

Rubus tephrodes Hance var. **ampliflorus** (Lévl. & Vant.) Handel-Mazzetti, Symb. Sin. **7:** 492 (1933).

Rubus ampliflorus Léveillé & Vaniot in Bull. Soc. Bot. France, **51:** 218

(1904). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 52 (1909); Fl. Kouy-Tchéou, 357 (1915). — Focke in Bibl. Bot. **17** (72I): 74 (Spec. Rub.) (1910); **19** (83): 28, fig. 6 (Spec. Rub. 252, fig. 93) (1914).

CHINA. Kweichou: Tsin-gai, Tchao-se, *J. Cavalerie,* no. 1201, July 1903, "fl. blanches" (holotype; photo. in A. A.).

Variety *ampliflorus* differs from typical *R. tephrodes* chiefly in the sparingly setose eglandular branches and the very sparingly setose and very large inflorescence about 25 cm. long and 30 cm. wide. Cardot in 1914 (in Not. Syst. Paris, **3**: 294) mentions *R. ampliflorus* as being closely related to his new species *R. megalothyrsus* which by Handel-Mazzetti (l.c.) is also referred to *R. tephrodes* as a variety.

Rubus holadenus Léveillé in Fedde, Rep. Spec. Nov. **12**: 536 (1913); Fl. Kouy-Tchéou, 358 (1915).

CHINA. Kweichou: Gan-chouen, alt. 1500 m., *J. Cavalerie,* no. 3948 (holotype; photo. in A. A.).

This species seems to be nearest to *R. tephrodes* Focke, but is readily distinguished by the aciculate calyx, the dark red-brown glabrescent stem and the triangular-ovate, lobulate and acuminate middle lobe of the leaves which are dark-colored above and with dark-colored glabrescent veins beneath.

Rubus calycacanthus Léveillé in Fedde, Rep. Spec. Nov. **8**: 58 (1910); Fl. Kouy-Tchéou, 357 (1915). — Focke in Bibl. Bot. **19** (83): 34 (Spec. Rub. 258) (1914) sub *R. Labbei.* — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 282 (1917). — Handel-Mazzetti, Symb. Sin. **7**: 494 (1933).

Rubus calycacanthus var. *Buergerifolia* Léveillé in Fedde, Rep. Spec. Nov. **8**: 58 (1910).

Rubus Labbei Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **8**: 549 (1910). — Léveillé, Fl. Kouy-Tchéou, 359 (1915). — Focke in Bibl. Bot. **19** (83): 34 (Spec. Rub. 258) (1914).

Rubus Darrisii Léveillé in Fedde, Rep. Spec. Nov. **12**: 188 (1913); Fl. Kouy-Tchéou, 258 (1915). — Focke in Bibl. Bot. **19** (83): 48 (Spec. Rub. 272) (1914). — **Synon. nov.**

CHINA. Kweichou: Tchen-fong, *J. Esquirol,* no. 525, July 1905, "fl. blanche"; without locality, *J. Esquirol,* no. 894 (syntypes of *R. calycacanthus;* photos. in A. A.); without locality, *J. Esquirol,* no. 920; Houa-kiang, *J. Cavalerie,* no. 2175, June 3, 1904 (syntypes of *R. calycacanthus* var. *Buergerifolia;* photos. in A. A.); Lo-fou, *J. Cavalerie,* no. 3575, Aug. 1909, "fl. blanche" (holotype of *R. Labbei;* photo. in A. A.); without locality, *J. Esquirol,* no. 920 (holotype of *R. Darrisii,* photo. in A. A.).

The type specimens of *R. calycacanthus* var. *Buergerifolia* were enumerated by Léveillé in 1915 under the species without citation of the varietal name. *Rubus Labbei* was first identified with *R. calycacanthus* by Cardot in 1917. All the specimens cited above including *R. Darrisii* are undoubtedly conspecific and uniform in their characters. The species is characterized by the short-stalked flowers crowded in short racemes or clusters, subtended by conspicuous bracts finely divided into long subulate segments, the acicular calyx, and the palmately 5-lobed leaves with the middle lobe often somewhat elongated but not acuminate, densely soft pubescent beneath and less so above, petioles and stem tomentose with small scattered hooked prickles.

Rubus alceaefolius Poiret, Encycl. Méth. Bot. **6**: 247 (1804) "*alcaefolius.*" — Focke in Bibl. Bot. **17** (72^I): 78, fig. 29 (1910).

Rubus Mongouilloni Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11**: 101 (1902); **12** (no. 160): t. 6. (1903); **20** (Mém.): 56 (1909); Fl. Kouy-Tchéou, 359 (1915); in Bull. Soc. Agr. Sci. Arts Sarthe, **45**: 219, fig. 6 (Pl. Util. Orn. Kouy-Tchéou, 45, fig. 6) (1915). — Focke in Bibl. Bot. **17** (72^I): 106 (Spec. Rub.) (1910); **19** (83): 30 (Spec. Rub. 254) (1914). — **Synon. nov.**

Rubus fimbriiferus Focke in Bibl. Bot. **17** (72^I): 80 (Spec. Rub.) (1910); **19** (83): 29 (Spec. Rub. 253) (1914). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 282 (1917); Handel-Mazzetti, Symb. Sin. **7**: 494 (1933). — **Synon. nov.**

Rubus multibracteatus var. *Demangei* Léveillé in Fedde, Rep. Spec. Nov. **11**: 548 (1913). — **Synon. nov.**

CHINA. Kweichou: sur la route de Huang-kien, Tou-chan, Ou-pao, *J. Cavalerie,* sine no., July 5, 1897 (holotype of *R. Mongouilloni;* photo. in A. A.); Pin-fa, Leao-me-lo, au sud, *J. Cavalerie,* no. 1369, Aug. 1907 (cited under *R. Mongouilloni* in Fl. Kouy-Tchéou; photo. in A. A.).

INDOCHINA. Tonkin: Hanoi, *V. Demange,* no. 1019, March 25, 1908 (holotype of *R. multibracteatus* var. *Demangei;* photo. in A. A.).

With specimens of *Rubus alceaefolius* from Sumatra, Borneo and Java, the type region of the species, and specimens of *R. fimbriiferus* from southeastern China and Indochina, the type region of that species, and the type specimen and other specimens referred to *R. Mongouilloni* before me, I am unable to find a single constant character or combination of characters to separate these three species. Also Cardot under *R. fimbriiferus* (l.c.) refers to the close affinity of that species to *R. alceaefolius;* he mentions as a distinguishing character the bulbous hairs on the upper surface of the leaf in *R. fimbriiferus,* but there are scattered bulbous hairs on specimens from Sumatra and Borneo and the leaves of the Javanese specimen are as rough and hairy above as those of typical

R. fimbriiferus; among the Chinese material there are specimens, as Chung & Tso 43642 and Tsang 15725 from Hainan, with the leaves nearly smooth above and only slightly pilose. Though the lobes of the leaves in *R. fimbriiferus* are typically rounded, the numerous Chinese specimens show all gradations between rounded and pointed lobes and even the specimen of *R. alceaefolius* figured by Focke (l.c.) has the lobes, at least of the lower leaves, nearly rounded. *Rubus Mongouilloni* and *R. fimbriiferus* were first considered conspecific by Handel-Mazzetti (l.c.) who does not mention *R. alceaefolius* at all, and refers *R. Mongouilloni* as a synonym to *R. fimbriiferus,* though *R. Mongouilloni* has priority. He also states (l.c.) that he is inclined to refer to *R. fimbriiferus* the *R. refractus* Lévl. var. *latifolius* Cardot (in Not. Syst. Paris, **3:** 291. 1917) of which he saw at Kew a specimen of the type number, Cavalerie no. 3574, from Kweichou.

Rubus multibracteatus var. *Demangei* is not mentioned by Cardot in his treatment of the genus in Lecomte, Fl. Gén. Indochine, **2:** 629–650 (1920), but it is probable that he saw a specimen of Demange no. 1019 and referred it to *R. alceaefolius,* since he states that this species is represented by specimens from numerous localities in Tonkin and Assam.

Rubus multibracteatus Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11:** 99 (1902); **12** (no. 160): t. 5 (1903); **20** (Mém.): 57 (1909); Fl. Kouy-Tchéou, 359 (1915); in Bull. Soc. Agr. Sci. Arts Sarthe, **45:** 219, fig. 6 (Pl. Util. Orn. Kouy-Tchéou, 45, fig. 6) (1915). — Focke in Bibl. Bot. **17** (72^{I}): 103 (Spec. Rub.) (1910). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 285 (1917), sub *R. mallodes.* — Handel-Mazzetti, Symb. Sin. **7:** 496 (1933).

Rubus andropogon Léveillé in Fedde, Rep. Spec. Nov. **8:** 58 (Feb. (1910).

Rubus clinocephalus Focke in Bibl. Bot. **17** (72^{I}): 102, fig. 44 (Spec. Rub.) (1910); **19** (83): 31 (Spec. Rub. 255) (1914). — Léveillé, Fl. Kouy-Tchéou, 357 (1915); Cat. Pl. Yun-Nan, 236 (1917). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 285 (1917).

Rubus mallodes Focke in Bibl. Bot. **17** (72^{I}): 104, fig. 45 (1910); **19** (83): 34 (Spec. Rub. 258) (1914). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 285 (1917).

CHINA. Kweichou: environs de Mou-you-se, *E. Bodinier,* no. 494, July 17, 1900, "fl. blanches" (holotype of *R. multibracteatus;* photo. in A. A.); montagnes, *J. Esquirol,* June 1909 (holotype of *R. andropogon;* photo. in A. A.). Yunnan: Mengtze mountains, 6000 ft., *A. Henry,* no. 10293 (erroneously cited by Focke as 10239) "large climber, red fruits, white flowers" (holotype of *R. clinocephalus;* isotype in A. A.).

Szechuan: Min river banks, *E. H. Wilson,* Veitch Exp. no. 3479, June 1903 (holotype of *R. mallodes;* isotype in A. A.).

With the types of *R. multibracteatus* and *R. andropogon* and isotypes of *R. clinocephalus* and *R. mallodes* before me I have no doubt that all four are conspecific. Focke had placed his *R. mallodes* together with *R. multibracteatus* in his series Pacati differing from series Rugosi in the truncate middle lobe of the leaf, but the leaves on the specimens show intergradations between truncate and acute apices and these two species should be referred to the Rugosi, if the two series are maintained at all. *Rubus andropogon* was referred by Focke to *R. clinocephalus* already in 1914 (l.c.), and was enumerated by Léveillé under that species in 1915 (l.c.). *Rubus mallodes* was retained by Cardot in 1917 (l.c.) but in his discussion under that species he states that apparently *R. mallodes* is a synonym of *R. multibracteatus,* and in the same place he recommends the union of the series Rugosi and Pacati. *Rubus clinocephalus* maintained by Cardot as a distinct species was referred as a synonym to *R. multibracteatus* by Handel-Mazzetti in 1933 (l.c.).

Rubus Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **4:** 333 (1907); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 21 (1909); Fl. Kouy-Tchéou, 358 (1915). — Focke in Bibl. Bot. **17** (72^{I}): 87 (Spec. Rub.) (1910); **19** (83): 30, 35 (Spec. Rub. 254, 259) (1914).

China. Kweichou: Pin-fa, Niang-ouang, bois humides, *J. Cavalerie,* no. 2351 (holotype; photo. in A. A.).

This species which is represented only by a sterile branch seems to be related to *R. reflexus* Ker, as indicated by Léveillé. It appears closest to var. *Hui* (Diels apud Hu) Metc., but differs in the narrower leaves, ovate in outline with a triangular-ovate gradually acuminate middle lobe, several times longer than the short lateral lobes, in the sharp and close serration, each tooth with a tuft of hairs at the apex, in the longer pilose pubescence of the stem and petioles, and on the veins of the under side of the leaves, and in the more finely and deeply divided bracts.

Rubus setchuenensis Bureau & Franchet in Jour. de Bot. **5:** 46 (1891). — Focke in Bibl. Bot. **19** (83): 32 (Spec. Rub. 256) (1914). — Léveillé, Cat. Pl. Yun-Nan, 239 (1917). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 286 (1917).

Rubus Cavaleriei Léveillé & Vaniot in Bull. Soc. Bot. France, **51:** 218 (1904). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 22 (1909); Fl. Kouy-Tchéou, 357 (1915). — Focke in Bibl. Bot. **17** (72^{I}): 104 (Spec. Rub.) (1910); **19** (83): 34 (Spec. Rub. 258) (1914).

China. Kweichou: Pin-fa, bords des ruisseaux, *J. Cavalerie,* no. 1125, July 10, 1903, "fl. blanches rosées" (holotype of *R. Cavaleriei;* photo. in A. A.).

Rubus Cavaleriei was first identified with *R. setchuenensis* by Cardot (l.c.) who also refers *R. clemens* Focke and *R. Schindleri* Focke to that species.

Rubus Lyi Léveillé in Fedde, Rep. Spec. Nov. **12:** 536 (1913); Fl. Kouy-Tchéou, 359 (1915).

CHINA. Kweichou: Gan-chouen, *J. Cavalerie,* no. 3945 (holotype; photo. in A. A.).

This species seems closely related to *R. setchuenensis,* but the lobes of the leaves are almost triangular-ovate, acute or short-acuminate, more sharply serrate and lobulate, the under side is covered with a villous less close tomentum and only slightly reticulate, the petioles bear a few small prickles and the bracts are less deeply divided; the inflorescence does not differ except that it usually bears two small suborbicular leaves at the base and the flowers are slightly smaller.

Rubus Feddei Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **8:** 549 (1910); Fl. Kouy-Tchéou, 358 (1915). — Focke in Bibl. Bot. **19** (83): 27 (Spec. Rub. 251) (1914). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 286 (1917).

CHINA. Kweichou: Lo-fou, *J. Cavalerie,* no. 3576, March 1909 (holotype; photo. in A. A.).

By Focke this *Rubus* is referred to his Sect. Elongati on account of its large paniculate inflorescence, but Cardot (l.c.) prefers to place it in the Sect. Moluccani Ser. Rufi chiefly because of the presence of long pilose partly glandular hairs on the inflorescence, stems and petioles, and characterizes two of his new species of this series from Tonkin, *R. Lecomtei* and *R. polyadenus* (in Not. Syst. Paris, **3:** 302, 303), by comparison with *R. Feddei.*

Rubus amphidasys Focke in Bot. Jahrb. **29:** 396 (1901); in Bibl. Bot. **17** (72^{I}): 108 (Spec. Rub.) (1910). — Handel-Mazzetti, Symb. Sin. **7:** 485 (1933).

Rubus Chaffanjoni Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11:** 98 (1902); **12** (no. 160): f. 2 (1903). — Léveillé in op. cit. **20** (Mém.): 20 (1909); Fl. Kouy-Tchéou, 360 (1915); in Bull. Soc. Agr. Sci. Arts Sarthe, **45:** 219, fig. 5 (Pl. Util. Orn. Kouy-Tchéou, 45, fig. 5) (1915). — Focke in Bibl. Bot. **17** (72^{I}): 118 (Spec. Rub.) (1910); **19** (83): 34 (Spec. Rub. 258) (1914). — Cardot in Not. Syst. Paris, **3:** 290 (1917) sub *R. ourosepalus;* in Bull. Mus. Hist. Nat. Paris, **23:** 275 (1917).

CHINA. Kweichou: environs de Kouy-yang, mont du Collège, gorges Yang-pa, *J. Chaffanjon,* no. 240, June 1898 (holotype of *R. Chaffanjoni;* photo. in A. A.).

Cardot doubts the identity of *R. Chaffanjoni* with *R. amphidasys,* but I agree with Handel-Mazzetti that they are conspecific, which is also the opinion of Focke who erroneously makes in 1914 his species a synonym of *R. Chaffanjoni* having cited the date of publication of the letter as of 1899.

Rubus hastifolius Léveillé & Vaniot in Bull. Soc. Bot. France, **51**: 218 (1904). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 28 (1909); Fl. Kouy-Tchéou, 358 (1915). — Focke in Bibl. Bot. **17** (72^{I}): 107 (Spec. Rub.) (1910); **19** (83): 35 (Spec. Rub. 259) (1914). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 288 (1917).

CHINA. Kweichou: Pin-fa, route de Tou-chan, *J. Cavalerie,* no. 1255, March 19, 1903, "fl. blanches" (holotype; photo. in A. A.).

This species is related to *R. flagelliflorus* Focke, but easily distinguished from all species of this group by its oblong-lanceolate subpanduriform leaves.

Rubus sino-Sudrei Léveillé in Bull. Acad. Intern. Géog. Bot. **24**: 251 (1914); Fl. Kouy-Tchéou, 360 (1915); Cat. Pl. Yun-Nan, 341, fig. 61 (1917).

CHINA. Kweichou: enfoncement de Ouang-ly, *J. Esquirol,* no. 3506, March 1912, "couleur blanche" (holotype; photo. in A. A.).

Léveillé compares this species with *R. philyrinus* Focke to which it bears a close resemblance in habit and leaf-shape, but in that species the indumentum is tomentose-villous, while in *R. sino-Sudrei* the stem and the petioles are glabrous or nearly so and the under side of the leaves is closely tomentulose with appressed-pilose veins, and the teeth are terminated by a distinct conical gland.

Rubus irenaeus Focke in Bot. Jahrb. **29**: 394 (1901); in Bibl. Bot. **17** (72^{I}): 114 (Spec. Rub.) (1910); **83**: 35 (Spec. Rub. 259) (1914). — Léveillé, Fl. Kouy-Tchéou, 360 (1915). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 289 (1917).

> *Rubus Jamini* Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11**: 102 (1902); **12** (no. 160): fig. 7 (1903). — Léveillé in op. cit. **20** (Mém.): 52 (1909); Fl. Kouy-Tchéou, 358 (1915). — Focke in Bibl. Bot. **17** (72^{I}): 114 (Spec. Rub.) (1910).

CHINA. Kweichou: environs de Kouy-yang, bois de Kien-lin-chan, *E. Bodinier,* no. 2368, June 10, 1898, "fl. jaunes" (holotype of *R. Jamini;* photo. in A. A.).

Rubus Jamini was first identified with *R. irenaeus* by Focke in 1914 and this identification was recorded by Léveillé the following year (l.c. 360). The species is represented from Kweichou in this herbarium also by specimens collected by Y. Tsiang (nos. 4193, 5815).

Rubus Buergeri Miquel in Ann. Mus. Bot. Lugd.-Bat. **3:** 36 (Prol. Fl. Jap. 224) (1867). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 288 (1917). — Handel-Mazzetti, Symb. Sin. **7:** 497 (1933).

Rubus Bodinieri Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11:** 97 (1902); **12** (no. 160): t. 1 (1903). — Léveillé in op. cit. **20** (Mém.): 58 (1909). — Léveillé, Fl. Kouy-Tchéou, 357 (1915); in Bull. Soc. Agr. Sci. Arts Sarthe, **45:** 219, fig. 4 (Pl. Util. Orn. Kouy-Tchéou, 45, fig. 4) (1915). — Focke in Bibl. Bot. **17** (72^{II}): 116 (Spec. Rub.) (1910). — Cardot in Not. Syst. Paris, **3:** 297 (1916), sub *R. dolichocladus.* — Handel-Mazzetti, Symb. Sin. **7:** 497 (1933), sub *R. dolichocladus* Cardot. — **Synon. nov.**

CHINA. Kweichou: Mont du Collège, dans les herbes, *E. Bodinier,* July 20, 1898, "fl. blanches" (holotype of *R. Bodinieri;* photo. in A. A.).

It does not seem possible to separate *R. Bodinieri* by any reliable character from *R. Buergeri* except that the flowers, bracts and stipules are smaller and the calyx more closely pubescent. In the pubescence of the leaves it is near *R. Buergeri* var. *viridifolius* Handel-Mazzetti (l.c.) and perhaps referable to that variety. Specimens from Kweichou very similar to Bodinier's specimen are Y. Tsiang's nos. 5995 and 4412, the latter in fruit. Also Cardot in 1917 (l.c.) cites specimens of *R. Buergeri* from Kweichou.

Rubus Blinii Léveillé in Fedde, Rep. Spec. Nov. **7:** 258 (1909); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 112 (1909); Fl. Kouy-Tchéou, 357 (1915). — Focke in Bibl. Bot. **19** (83): 35, 36 (Spec. Rub. 260) (1914).

CHINA. Kweichou: Pin-fa, bois, *J. Cavalerie,* no. 3307, Nov. 1907, "fruits rouges" (holotype; photo. in A. A.).

This species which was compared by Léveillé with his *R. Monguilloni* (= *R. fimbriifolius* Focke) is apparently most nearly related to *R. pacificus* Hance from which it chiefly differs in the spreading pilose pubescence of the calyx and in the exserted styles.

Subgen. IDAEOBATUS Focke

Sect. Corchorifolii Focke

Rubus corchorifolius Linné f., Suppl. 263 (1781). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 65, 125 (1909); Fl. Kouy-Tchéou, 358 (1915); Cat. Pl. Yun-Nan, 236 (1917). — Focke in Bibl.

Bot. **17** (72^{II}): 131 (1911). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 289 (1917). — Nakai, Fl. Sylv. Kor. **7:** 55, t. 20 (1918).

Rubus kerriifolius Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11:** 100 (1902). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 27 (1909).

Rubus Vanioti Léveillé in Fedde, Rep. Spec. Nov. **5:** 280 (1908); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 31 (1909).

CHINA. Kweichou: environs de Kouy-yang, commun dans les montagnes, *E. Bodinier,* no. 2072^{bis}, March 14, 1898, "donnant des baies excellentes, à goût de framboise" (holotype of *R. kerriifolius;* photo. in A. A.).

KOREA. Quelpaert: in sepibus prope Hong-no, *U. Faurie,* no. 1577, June 1907 (holotypes of *R. Vanioti;* isotype in A. A.).

Rubus kerriifolius and *R. Vanioti* were first identified with *R. corchorifolius* by Focke (l.c.), and his identification was accepted by Léveillé who cites the type of *R. kerriifolius* in 1915 under *R. corchorifolius,* though without quoting his name as a synonym, but in 1917 (l.c.) he cites it as a synonym of *R. corchorifolius.* In Herb. California University there is a specimen of Ducloux no. 639 from Yunnan labeled in Léveillé's handwriting *R. kerriifolius.*

Rubus Fauriei Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe, **40:** 60 (1905); in Fedde, Rep. Spec. Nov. **2:** 174 (1906); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 126 (1909). — Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 148 (1913). — Focke in Bibl. Bot. **17** (72^{II}): 132 (Spec. Rub.) (1911). — Makino & Nemoto, Nippon-shokubutsu-sôran, ed. 2, p. 512 (1931).

JAPAN. Hondo: Tottori, *U. Faurie,* no. 3172, May 22, 1899 (holotype; photo. in A. A.).

This is a distinct species with its large 3-lobed or sometimes undivided lobulate leaves and solitary large flowers on short lateral branchlets bearing one or two leaves.

Rubus crataegifolius Bunge in Mém. Div. Sav. Acad. Sci. St. Pétersb. **2:** 98 (Enum. Pl. Chin. Bor. 24) (1833). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 39, 127 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 137 (Spec. Rub.) (1911). — Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 125 (1913). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 290 (1917). — Nakai, Fl. Sylv. Kor. **7:** 57, t. 21 (1918).

Koidzumi, Cardot and Nakai refer to *R. crataegifolius* without distinguishing varieties, the following species of Léveillé: *R. makinoensis, R. itoensis, R. ouensanensis* and *R. ampelophyllus,* but these species seem to differ sufficiently from typical *R. crataegifolius* as represented by specimens from Hopei that at least the two following forms may be distinguished.

Rubus crataegifolius f. **Makinoensis** (Lévl. & Vant.) Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 125 (1913). — Makino & Tanaka, Man. Fl. Nippon, 254 (1929).

Rubus Makinoensis Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe, **40**: 60 (1905); in Fedde, Rep. Spec. Nov. **2**: 174 (1906). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 125 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 135 (1911); **19** (83): 36 (Spec. Rub. 260) (1914).

Rubus ampelophyllus Léveillé in Fedde, Rep. Spec. Nov. **5**: 279 (1908); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 49 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 135 (Spec. Rub.) (1911). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 290 (1917).

Rubus erectifolius Léveillé in litt. ex Nakai, Fl. Sylv. Kor. **7**: 57 (1918) pro synon. *R. crataegifolii.*

Rubus suberectifolius Léveillé in litt. ex Nakai, l.c., pro synon. *R. crataegifolii.*

Rubus Wrightii A. Gray var. *makinoensis* (Lévl. & Vant.) Koidzumi in Bot. Mag. Tokyo, **43**: 391 (1929). — Makino & Nemoto, Nippon-shokubutsu-sôran, ed. 2, p. 527 (1931), *"Makinoensis."*

Rubus Wrightii A. Gray var. *ampelophyllus* (Lévl.) Koidzumi l.c. (1929). — Makino & Nemoto, l.c. (1931).

JAPAN. Hondo: circa Kopu, *U. Faurie*, no. 5369, July 1903 (holotype of *R. Makinoensis;* isotype in A. A.).

KOREA. Quelpaert: *U. Faurie* (holotype of *R. ampelophyllus*; ex Léveillé). Kogendo province: in monte des diamants, *U. Faurie*, no. 302, June 1906 (in herb. Léveillé sub *R. ampelophyllus;* photo. in A. A.).

This form differs from typical *R. crataegifolius* in the large leaves pubescent on the veins beneath, in the larger flowers with narrower long-acuminate sepals, pilose outside and in the pubescent inflorescence; in *R. ampelophyllus* the pubescence is slighter, but otherwise it agrees with the type of *R. Makinoensis.* Léveillé describes the calyx of *R. ampelophyllus* as "extus . . . glabra" and so is the calyx of a detached flower in the pocket on the sheet of no. 302, but the flowers on the specimen itself have the same pubescence as *R. Makinoensis* but slighter.

Rubus crataegifolius f. **itoensis** (Lévl. & Vant.) Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 125 (1913). — Makino & Tanaka, Man. Fl. Nippon, 254 (1929).

? *Rubus crataegifolius* f. *minor* Kuntze, Meth. Spec. Rubus, 95 (1879). — Makino & Tanaka, l.c. (1929).

Rubus itoensis Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe,

40: 62 (1905); in Fedde, Rep. Spec. Nov. **2:** 175 (1906). — Focke in Bibl. Bot. **17** (72^{II}): 135, fig. 57 (Spec. Rub.) (1911).

Rubus ouensanensis Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe, **40:** 62 (1905); in Fedde, Rep. Spec. Nov. **2:** 275 (1906); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 67 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 137 (Spec. Rub.) (1911).

Rubus Wrightii A. Gray var. *ouensanensis* (Lévl. & Vant.) Koidzumi in Bot. Mag. Tokyo, **43:** 391 (1929).

JAPAN. Hondo: Kiushu, circa Takeo, *U. Faurie*, no. 5365, July 23, 1903 (holotype of *R. itoensis;* isotype in A. A.).

KOREA: Ouen-san, in collibus, *U. Faurie*, no. 33, July 1901 (holotype of *R. ouensanensis;* photo. in A. A.).

This form differs from the preceding in its much smaller leaves which resemble those of the following species, but the inflorescence and flowers are those of *R. crataegifolius. Rubus ouensanensis* is referred to f. *itoensis* with some doubt; it differs in the leaves being nearly glabrous and somewhat larger, in the very sparingly armed stem, and in the rather dense but evanescent pubescence of the calyx.

Rubus incisus Thunberg, Fl. Jap. 217 (1784). — Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 38, 128 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 138, fig. 58 (Spec. Rub.) (1911). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 291 (1917).

Rubus Grossularia Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe, **40:** 61 (1905); in Fedde, Rep. Spec. Nov. **2:** 175 (1906). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 128 (1909).

Rubus incisus Thunb. α *proprius* subvar. b. *geifolius* (O. Ktze.) Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 122 (1913).

JAPAN. Hondo: circa Kobe, *U. Faurie*, no. 5368, April 13, 1903 (holotype of *R. Grossularia;* isotype and photo. in A. A.).

Rubus Grossularia was first identified with *R. incisus* by Focke (l.c.). Koidzumi (l.c.) distinguishes under var. *proprius* the subvarieties a. *geifolius* and b. *euincisus* and refers *R. Grossularia* as a synonym to the first, but they seem to be too closely connected by intermediate forms to be kept distinct. The following variety is more distinct and usually easily separated by its much larger 3-lobed and often rather deeply 3-lobed leaves with acute or acuminate middle lobe.

Rubus incisus Thunb. var. **subcrataegifolius** (Lévl. & Vant.), comb. nov.

Rubus crataegifolius Bunge var. *subcrataegifolius* Léveillé & Vaniot in Bull. Soc. Agr. Sci. Sarthe, **40:** 61 (1905); in Fedde, Rep. Spec. Nov. **2:** 174 (1906). — Focke in Bibl. Bot. **17** (72^{II}): 137 (Spec. Rub.) (1911).

Rubus subcrataegifolius (Lévl. & Vant.) Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 127 (1909).

Rubus Koehneanus Focke, op. cit. 140, fig. 60 (1911). — **Synon. nov.**

Rubus incisus Thunb. α *proprius* subvar. c. *Koehneanus* (Focke) Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 122 (1913).

JAPAN. Hondo: Jizogatake, *U. Faurie,* no. 5370, July 1903; Asama, *U. Faurie,* no. 6074, July 1904 (syntypes of *R. crataegifolius* var. *subcrataegifolius;* isotypes in A. A.).

Cardot (in Bull. Mus. Hist. Nat. Paris, **23**: 290) and Koidzumi (in Jour. Coll. Sci. Tokyo, **34** (art. 2): 125) refer *R. subcrataegifolius* as a synonym to *R. crataegifolius;* in its foliage it resembles somewhat its var. *itoensis,* but flowers and inflorescence are clearly those of *R. incisus.*

Section Leucanthi Focke

Rubus Delavayi Franchet, Pl. Delavay. 205 (1890). — Focke in Bibl. Bot. **17** (72^{II}): 148 (Spec. Rub.) (1911). — Léveillé, Cat. Pl. Yun-Nan, 236 (1917). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 274 (1917).

Rubus Duclouxii Léveillé in Fedde, Rep. Spec. Nov. **6**: 111 (1908); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 80 (1909).

CHINA. Yunnan: mont Tchong-chan, *F. Ducloux,* no. 622, Aug. 1, 1906, "fl. blanches" (holotype of *R. Duclouxii;* photo. of the type, and of an isotype in Herb. Univ. Calif. in A. A.).

Rubus Duclouxii was referred as a synonym to *R. Delavayi* by Focke in 1911 (l.c.). Cardot (l.c.) refers this species to the subgen. Cylactis.

Sect. Rosaefolii

Rubus alnifoliolatus Léveillé in Bull. Soc. Bot. France, **53**: 549 (1906); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 77 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 152 (Spec. Rub.) (1911). — Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 150 (1913). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 294 (1917).

FORMOSA: in petrosis Kushaku, *U. Faurie,* no. 132, June 8, 1903 (holotype; photo. in A. A.).

Closely related to *R. fraxinifolius* Poir., but differing chiefly in its oblong, acute or obtusish, not acuminate leaflets.

Rubus minusculus Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe, **40**: 63 (1905). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 129 (1909). — Focke in Bibl. Bot. **17** (72^{I}): 29 (Spec. Rub.) (1910); **19** (83): 18, fig. 1 (Spec. Rub. 242, fig. 88) (1914). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 295 (1917).

Rubus rosaefolius α *tropicus* l. *minor* Makino in Bot. Mag. Tokyo, **15**: 50 (1901). — Makino & Tanaka, Man. Fl. Nippon, 254 (1927). — Makino & Nemoto, Nippon-shokubutsu-sôran, ed. 2, p. 524 (1931).

Rubus succedaneus Nakai & Koidzumi in Bot. Mag. Tokyo, **25**: 260 (1911).

JAPAN. Hondo: prope Nara, *U. Faurie*, no. 3187, May 16, 1899 (holotype; photo. in A. A.).

This species has been placed by Focke in the subgen. Cylactis on account of its diminutive stature, but I agree with Cardot, that it is more closely related to *R. rosaefolius* Sm. and may represent a depauperate form of it; as such it was described by Makino (l.c.). Makino & Nemoto in 1931 (l.c.) cite *R. minusculus* as a synonym of *R. rosaefolius* α *tropicus* l. *minor.*

A variety, *R. minusculus* var. *yakusimensis,* was described by Masumune (Prel. Rep. Veg. Yak. 83. 1929), and later elevated to specific rank: *R. yakusimensis* Masumune in Mem. Fac. Sci. Agr. Taihoku Imp. Univ. Bot. **4**: 234 (1934).

Rubus croceacanthus Léveillé in Fedde, Rep. Spec. Nov. **11**: 33 (1912) *"croceacantha."* — Nakai, Rep. Veg. Quelpaert, 53 (1914); in Bot. Mag. Tokyo, **30**: 223 (1916); Fl. Sylv. Kor. **7**: 64, t. 24 (1918). — Mori, Enum. Pl. Corea, 204 (1922). — Koidzumi, Fl. Symb. Or. As. 65 (1930).

KOREA. Quelpaert: in sepibus et silvis Setchimeri, *E. Taquet*, nos. 5554, 5555, 5556, 5557, May 1911 (syntypes; photos. of 5554 and 5557 in A. A.).

This species seems closely related to *R. rosaefolius* Sm., but is easily distinguished by the gland-tipped setae on the branchlets, petioles and calyces. It may be only a variety of the latter. The two seem to be connected by intermediate forms, as two specimens from Kwangsi collected by Steward & Cheo show, one of them, no. 192, being rather densely stipitate-glandular, while the other, no. 338 from the same region, is nearly glabrous.

Rubus marmoratus Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe, **40**: 64 (1905); in Fedde, Rep. Spec. Nov. **2**: 275 (1906). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 131 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 156 (Spec. Rub.) (1911). — Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 150 (1913). — Makino & Nemoto, Nippon-shokubutsu-sôran, ed. 2, p. 517 (1931).

JAPAN. Hondo: Jizogatake, *U. Faurie,* no. 5373, July 1903 (holotype; photo. in A. A.).

This species has been compared with *R. rosaefolius* Sm., but all the leaves except one are 3-foliate, the plant is glabrous and unarmed except a few minute prickles on the young branchlets and petioles, and there are 2–4 very young flower buds at the end of the not yet fully grown lateral branchlets.

Rubus sumatranus Miquel, Fl. Ind. Bot. Suppl. 307 (1860–61). — Merrill in Contrib. Arnold Arb. **8**: 70 (1934).

Rubus myriadenus Léveillé & Vaniot in Bull. Soc. Bot. France, **51**: 218 (1904). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 81 (1909). — Nakai in Bot. Mag. Tokyo, **30**: *223* (1916); Fl. Sylv. Kor. **7**: 62 t. *22*, fig. c (1918). — Mori, Enum. Pl. Corea, 205 (1922).

Rubus myriadenus var. *grandifoliolatus* Léveillé in Fedde, Rep. Spec. Nov. **4**: 334 (1907); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 81 (1909).

Rubus rosaefolius Sm. subsp. *sumatranus* (Miq.) Focke in Bibl. Bot. **17** (*72*II): 155 (Spec. Rub.) (1911).

Rubus asper Focke in Bibl. Bot. **17** (*72*II): 157 (Spec. Rub.) (1911). — Léveillé, Fl. Kouy-Tchéou, 357 (1915). — Nakai in Bot. Mag. Tokyo, **30**: *222* (1916); Fl. Sylv. Kor. **7**: 61, t. *22*, fig. a, b (1918). — Non D. Don.

Rubus asper var. (subspec. ?) *myriadenus* Focke in Bibl. Bot. **17** (*72*II): 158 (Spec. Rub.) (1911). — Léveillé, Cat. Pl. Yun-Nan, 236 (1917), as var.

Rubus asper var. (subspec. ?) *myriadenus* subvar. *grandifoliolatus* (Lévl.) Focke in Bibl. Bot. **17** (*72*II): 158 (Spec. Rub.) (1911).

CHINA. Kweichou: Pin-fa, Youin-ou-chan, *J. Cavalerie*, no. 60, July 15, 1902, "fl. blanches" (holotype of *R. myriadenus;* photo. in A. A.); without locality, *J. Esquirol*, no. 460, May 1905 (holotype of *R. myriadenus* var. *grandifoliolatus;* photo. in A. A.); Kiao-ran, *J. Esquirol*, no. 354, April 3, 1905 (cited in Fl. Kouy-Tchéou sub *R. asper*).

Merrill has pointed out (l.c.) that the plant referred by recent authors to *R. asper* D. Don differs from that species markedly in the copious setose gland-tipped hairs up to 4 mm. long equalling the prickles in length, while *R. asper* has short scattered glandular-capitate hairs 1 mm. long or less, and he identifies the former with *R. sumatranus* Miq. Focke (l.c.) enumerates *R. sumatranus* as a subspecies of *R. rosaefolius* Sm. and apparently by mistake cites the name also as a synonym of *R. pirifolius* Sm. (op. cit. p. 64).

The orange yellow fruits are sweet and of good flavor according to a note on W. N. & C. M. Bangham's no. 1121 from Sumatra. According to Nakai the fruits of *R. myriadenus* are white and insipid.

Rubus myriadenus was referred as a synonym to *R. asper* by Léveillé himself in 1914, but in 1917 he enumerates it as a variety of *R. asper*. Nakai in 1918 (l.c.) still maintained it as a distinct species, but cites in 1916 and 1918 two varietal manuscript names of Léveillé under *R. asper*, namely: "*R. myriadenus* v. *minor*, Lévl. in litt. fide Faurie. Nakai Veg. Isl. Wang. p. 8" and *R. myriadenus* var. *microcarpa*, Lévl. in litt. fide Taquet"; I have seen no specimens so named of either one.

It does not seem advisable to maintain *R. myriadenus* and its var. *grandifoliolatus* as varieties or even as forms. I can find no difference in the inflorescence, nor is the fruit of the type specimen of *R. myriadenus* elliptic, as Nakai describes the fruit of that species; var. *grandifoliolatus* differs only in the larger leaflets but grades imperceptibly into the more common smaller-leaved form, if one compares a large series of specimens of this widely distributed species.

Rubus Thunbergii Siebold & Zuccarini in Abh. Math. Phys. Kl. Akad. Muench. **4**: 246 (1844). — Focke in Bibl. Bot. **17** (72^{II}): 158 (Spec. Rub.) (1911). — Nakai, Fl. Sylv. Kor. **7**: 63, t. 23 (1918).

Rubus Argyi Léveillé in Fedde, Rep. Spec. Nov. **4**: 333 (1907); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 105 (1909).

Rubus talaikiaensis Léveillé in Fedde, Rep. Spec. Nov. **4**: 334 (1907); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 105 (1909).

Rubus stephanandria Léveillé in Fedde, Rep. Spec. Nov. **8**: 358 (1910). — Focke in Bibl. Bot. **19** (83): 40 (Spec. Rub. 264) (1914).

Rubus Thunbergii var. *R. Argyi* (Lévl.) Focke in Bibl. Bot. **17** (72^{II}): 160 (Spec. Rub.) (1911).

Rubus Thunbergii var. *R. talaikiensis* (Lévl.) Focke, l.c. (1911).

Rubus Thunbergii var. *Argyi* (Lévl.) Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, **12**: 560 (Caț. Pl. Kiang-Sou, 20) (1916).

Rubus Thunbergii var. *talaikiensis* (Lévl.) Léveillé, l.c. (1916).

Rubus hirsutus Thunberg, Diss. Bot.-Med. de Rubo, 7, 10 (1813), nom. dub. — Koidzumi in Bot. Mag. Tokyo, **39**: 306 (1925). — Nakai in Bot. Mag. Tokyo, **44**: 525 (1930).

Rubus hirsutus Thunb. var. *Argyi* (Lévl.) Nakai in Bot. Mag. Tokyo, **44**: 526 (1930).

KOREA. Quelpaert:* in sylvis Hallaisan, alt. 500 m., *E. Taquet*, no. 2829, May, 1909; in sepibus Hogno, rara, *E. Taquet*, no. 2850, May 1909 (syntypes of *R. stephanandria;* isotypes in A. A.).

CHINA. Kiangsu: montagnes Tchu-chan, Zuo-se, Song-kiang-fou, *d'Argy*, May [1846–66] (holotype of *R. Argyi;* photo. in A. A.); Souo-se, Talai-kiao, *d'Argy*, May [1846–66] (holotype of *R. talaikiaensis;* photo. in A. A.).

Rubus Argyi and *R. Talaikiaensis* were referred by Focke in 1911 as varieties to *R. Thunbergii,* but without varietal combinations which were published by Léveillé in 1916. *Rubus stephanandria* was cited as a synonym of *R. hirsutus* Thunb. (*R. Thunbergii* Sieb. & Zucc.) by Nakai in 1930. In the same publication Nakai enumerates *R. eustephanos* Focke, *R. Argyi* and *R. talaikiaensis* Lévl. as synonyms of *R. hirsutus*, but his description "rami et folia glabra" certainly does not apply to the two Léveillé species.

I hesitate to follow Koidzumi and Nakai in adopting *Rubus hirsutus* Thunb. as the oldest name for *R. Thunbergii*. The description given by Thunberg "foliis pinnatis hirsutis, caule, inermi, petiolis aculeatis" is certainly inadequate and also misleading in so far as the species is placed together with *R. rosaefolius* and *R. niveus* under the group "foliis pinnatis" as contrasted with the preceding group "foliis quinatis." Though the name, *R. hirsutus*, apparently represents a new species, it does not figure under "Descriptio specierum novarum" where fuller descriptions of several new species are given. Nakai's discussion in 1930 seems to infer that Thunberg himself placed his *R. caesius* later with *R. hirsutus*, but in his Dissertatio (p. 10) he cites under the Japanese species *R. hirsutus* as well as *R. caesius*. That Thunberg's types of both these species which I have seen in Upsala, and of which I have photographs before me, belong to *R. Thunbergii* I have little doubt, though *R. hirsutus* is represented only by a sterile shoot with 5-foliolate leaves; *R. caesius* is well represented by flowering branches, which agree with *R. Thunbergii*. Neither Koidzumi nor Nakai mention *R. idaeus* Thunb. which is cited by Siebold & Zuccarini as a synonym of *R. Thunbergii*.

Whether *R. hirsutus* Thunb. is accepted or rejected, it will preclude the use of the later synonyms, *R. hirsutus* Wirtg. (1841) or *R. hirsutus* Wimm. (1857) for any of these species of the subgen. Eubatus.

Rubus micranthus D. Don, Prodr. Fl. Nepal. 235 (1825). — Focke in Bibl. Bot. **17** (72^{II}): 184, fig. 75 (1911). — Léveillé, Cat. Pl. Yun-Nan, 239 (1917).

Rubus lasiocarpus Sm. var. *micranthus* Hook. f., Fl. Brit. Ind. **2**: 339 (1878). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 301 (1917).

Rubus Pyi Léveillé in Fedde, Rep. Spec. Nov. **6**: 111 (1908); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 72 (1909). — Focke in Bibl. Bot. **17** (72^{I}): 30 (1910).

CHINA. Yunnan: Yun-nan-sen, vallons du Tchong-chan, *F. Ducloux*, no. 638, Apr. 20, 1904 (holotype of *R. Pyi*; isotype in Herb. Univ. Calif.; photo. in A. A.).

Rubus Pyi was identified with *R. micranthus* by Focke in 1911.

Rubus tongchouanensis Léveillé in Fedde, Rep. Spec. Nov. **12**: 283

(1913); Cat. Pl. Yun-Nan, 242 (1917). — Focke in Bibl. Bot. **19** (83): 264 (Spec. Rub. **3:** 488) (1914).

CHINA. Yunnan: haies, plaine de Tong-chouan, alt. 2500 m., *E. E. Maire,* June 1912, "épineux grimpant, fl. roses, fruits rouges" (holotype; photo. in A. A.).

This species is apparently closely related to *R. micranthus* Don and *R. niveus* Thunb., but is easily distinguished by its 5-foliolate leaves, those below the inflorescence 3-foliolate or even simple, by the ovate or elliptic-ovate acute to obtusish leaflets, the terminal rounded or subcordate at base and sometimes slightly 3-lobed, more finely and somewhat doubly serrulate, with very short often rounded mucronulate teeth, by the appressed-pubescent petioles and branchlets, and by the slender-peduncled inflorescences in the axils of the leaves. To this species also belongs no. 408 in herb. Bonati, collected by E. E. Maire, May 1905, without locality except "rochers"; this specimen is named *R. Pyi* Lévl. in Léveillé's handwriting, but agrees exactly with the type of *R. tongchouanensis;* it is not cited by Léveillé. Here also belongs Maire's specimen distributed by the Arnold Arboretum under no. 162 as *R. micranthus;* the label agrees with that of the type of *R. tongchouanensis* except that it reads "un peu buissonant" instead of "grimpant" and "fruits rouges" is omitted; the sheet in this herbarium contains three branches, one of them representing *R. niveus* and two *R. tongchouanensis*, the latter approaching *R. micranthus* in the glabrous branches and the slightly coarser serration, one of the leaves being 7-foliolate. It also resembles *R. foliolosus* D. Don and may be a form with mostly quinate leaves and somewhat larger leaflets.

Rubus coreanus Miquel in Ann. Mus. Bot. Lugd.-Bat. **3:** 34 (Prol. Fl. Jap. 222) (1867). — Focke in Bibl. Bot. **17** (72^{II}): 184 (Spec. Rub.) (1911). — Nakai in Bot. Mag. Tokyo, **30:** 226 (1916); Fl. Sylv. Kor. **7:** 71, t. 29 (1918). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 302 (1917).

Rubus pseudosaxatilis Léveillé in Fedde, Rep. Spec. Nov. **5:** 280 (1908); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 72 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 186 (Spec. Rub.) (1911).

Rubus pseudosaxatilis var. *Kouytchensis* Léveillé in Fedde, Rep. Spec. Nov. **5:** 280 (1908); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 72 (1909); Fl. Kouy-Tchéou, 358 (1915). — Focke in Bibl. Bot. **17** (72^{II}): 186 (Spec. Rub.) (1911).

Rubus quelpaertensis Léveillé in Fedde, Rep. Spec. Nov. **5:** 280 (1908); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 72 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 186 (Spec. Rub.) (1911).

Rubus coreanus var. *Nakaianus* Léveillé in Fedde, Rep. Spec. Nov.

8: 358 (1910). — Focke in Bibl. Bot. **17** (72^{II}): 221 (1911); **19** (83): 44 (Spec. Rub. 268) (1914).

Rubus Hoatiensis Léveillé in Fedde, Rep. Spec. Nov. **11**: 32 (1912). — Focke in Bibl. Bot. **19** (83): 44 (Spec. Rub. 268) (1914).

Rubus Nakaianus Lévl. in litt. fide Taquet ex Nakai in Bot. Mag. Tokyo, **30**: 226 (1916), pro synon. *R. coreani.*

KOREA. Quelpaert: *U. Faurie,* no. 1587, June 1907 (holotype of *R. pseudosaxatilis;* photo. in A. A.); in dumosis, *U. Faurie,* nos. 1584, 1585, June and July, 1907, "tarde flores et fructus emitit [*sic*], fructibus demum nigris" (syntypes of *R. quelpaertensis;* photo. in A. A.); in sylvis Hallaisan, 600 m., *E. Taquet,* nos. 2834, 2835, 2845 (syntypes of *R. coreanus* var. *Nakaianus;* isotypes in A. A.); Hoatien, *E. Taquet,* no. 5567, May 1911 (holotype of *R. Hoatiensis;* photo. in A. A.).

CHINA. Kweichou: Pin-fa, *J. Cavalerie,* no. 1256, May 3, 1902, "fl. roses-rouges" (holotype of *R. pseudosaxatilis* var. *Kouytchensis;* photo. in A. A.).

Rubus quelpaertensis and *R. pseudosaxatilis* were appended without comment to *R. coreanus* by Focke in 1911 and *R. Hoatiensis* was inserted after *R. opulifolius* Bertol. in 1914. By Nakai in 1916 and 1918 they were cited as synonyms of *R. coreanus.* Cardot mentions only *R. quelpaertensis* as a synonym of *R. coreanus.* *Rubus Hoatiensis* apparently represents a rather extreme form with all the leaves trifoliate except a single uppermost leaf which is simple and 3-lobed; it further differs in the large, in one branch paniculate inflorescence and in the aculeolate calyx, and may possibly represent a distinct variety.

The type specimens of *R. coreanus* var. *Nakaianus* are labeled in Léveillé's handwriting "*Rubus Nakaianus.*"

Rubus parvifolius Linnaeus, Sp. Pl. 1197 (1753), excl. syn. cit. — Merrill in Trans. Am. Philos. Soc. n. ser., **24**: 181 (Comm. Lour. Fl. Cochin.) (1935).

Rubus triphyllus Thunberg, Fl. Jap. 215 (1784). — Focke in Bibl. Bot. **17** (72^{II}): 187 (Spec. Rub.) (1911).

Rubus Taquetii Léveillé in Fedde, Rep. Spec. Nov. 7: 340 (1909). — **Synon. nov.**

Rubus triphyllus Thunb. var. *Taquetii* (Lévl.) Nakai in Bot. Mag. Tokyo, **30**: 227 (1916); Fl. Sylv. Kor. **7**: 74, t. 32 (1918).

KOREA. Quelpaert: in sepibus, 600 m., *E. Taquet,* no. 765, May 12, 1908 (holotype of *R. Taquetii;* isotype in A. A.).

Nakai keeps *R. Taquetii* as a distinct variety on account of its smaller leaves and the densely prickly inflorescence. He cites under his variety also Taquet's nos. 2832, 2834, 2844, 4223 and 4225, but of these only no. 2832 has the inflorescence as prickly as Taquet no. 765. Focke does not mention *R. Taquetii* at all. According to a note on the type specimen Koidzumi identified it as *R. parvifolius* L. forma.

Rubus schizostylus Léveillé in Fedde, Rep. Spec. Nov. **5:** 280 (1908). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 83 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 207, fig. 83 (Spec. Rub. 2) (1911). — Nakai, Fl. Kor. **2:** 476 (1911); Fl. Sylv. Kor. **7:** 72, t. 30 (1918). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 303 (1917).

KOREA. Quelpaert: *U. Faurie,* no. 1590, July 1907 (holotype; photo. in A. A.).

The plant figured by Nakai differs from the type in having part of the leaves 5-foliolate and the leaflets ovate to elliptic and acute, not suborbicular and rounded at the apex; the drawing is probably based on Faurie's no. 1586, cited by Cardot with the remark that it differs from the type in having almost all the leaves 5-foliolate and pubescent only on the veins beneath. Focke's figure represents a photograph of the type specimen.

Rubus illudens Léveillé in Fedde, Rep. Spec. Nov. **12:** 283 (1913); Cat. Pl. Yun-Nan, 239 (1917). — Focke in Bibl. Bot. **19** (83): 264 (Spec. Rub. 488) (1914).

CHINA. Yunnan: vallées des montagnes derrière Tong-tchouan, alt. 2600 m., *E. E. Maire,* June, "fl. roses, fruits rouges" (holotype; photo. in A. A.).

Léveillé compares this species with *R. opulifolius* Bertol., but from that species it is readily distinguished by the glabrous branches, the ovate acuminate leaflets and the corymbose inflorescence. In the shape of the leaflets it resembles much *R. teledapos* Focke, but that species has a racemose inflorescence and partly 5-foliolate leaves. It is apparently nearest to *R. pedunculosus* D. Don, but differs in the glabrous slightly bloomy branches and in the more compact inflorescence, and much smaller flowers with the sepals about 4 mm. long. It might also be compared with *R. mesogaeus* Focke, but that species has pubescent branches, much larger leaves and white flowers.

Rubus foliolosus D. Don, Prodr. Fl. Nepal. 256 (1825). — Focke in Bibl. Bot. **17** (72^{II}): 191 (Spec. Rub.) (1911). — Léveillé, Cat. Pl. Yun-Nan, 239 (1917). — Handel-Mazzetti, Symb. Sin. **7:** 505 (1933).

Rubus Bonatii Léveillé in Fedde, Rep. Spec. Nov. **7:** 338 (1909).
Rubus Mairei Léveillé in Fedde, Rep. Spec. Nov. **12:** 283 (1913); non Léveillé (1912). — Focke in Bibl. Bot. **19** (83): 263 (Spec. Rub. 487) (1914).

Rubus Boudieri Léveillé in Fedde, Rep. Spec. Nov. **12**: 534 (1913); Cat. Pl. Yun-Nan, 236 (1917).

Rubus longistylus Léveillé in Fedde, Rep. Spec. Nov. **12**: 534 (1913); Fl. Kouy-Tchéou, 359 (1915). — **Synon. nov.**

China. Kweichou: Chouang-chan-po, *J. Esquirol*, no. 3144, May 1911, "fl. blanche" (holotype of *R. longistylus;* photo. in A. A.). — Yunnan: without locality, "partout," *E. E. Maire*, March 1904, herb. Bonati no. 405 sub nom. *R. Mairei* (holotype of *R. Bonatii* in herb. Bonati; photo. in A. A.); plaine de Tong-tchouan, haies des tertres, alt. 2500 m., *E. E. Maire*, April [1912?], "fl. et fruits roses" (in herb. Léveillé sub *R. Bonatii;* photo. in A. A.); haies de la plaine à Tong-tchouan, *E. E. Maire*, May 1912, "fl. rouges, fruits jaunes" (holotype of *R. Mairei* (1913) and *R. Boudieri;* photo. in A. A.); haies, plaine de La-kou, alt. 2400 m., *E. E. Maire*, May, "fl. roses, fr. roses" (sub *R. Boudieri* in herb. Léveillé; photo. in A. A.).

Rubus Bonatii and *R. Boudieri* were first identified with *R. foliolosus* by Handel-Mazzetti in 1933. The only specimen agreeing in citation and description with the type of *R. Bonatii* is in herb. Bonati, now in herb. Univ. Calif., but it is labeled in Léveillé's handwriting *R. Mairei*, while the specimen labeled *R. Bonatii* by Léveillé in his herbarium is not cited with the description. On the label of the type of *R. longistylus* the color of the flowers is given as white, but the specimen is in young fruit and the color note may refer to the whitish tomentum of the fruits.

Rubus adenochlamys (Focke) Focke in Bibl. Bot. **17** (72^{II}): 191 (Spec. Rub.) (1911). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 303 (1917).

Rubus Kinashii var. *coreensis* Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 80 (1909).

Korea: no specimen cited.

Léveillé & Vaniot do not cite a specimen, but Cardot (l.c.) refers Faurie no. 1580 from Quelpaert to *R. adenochlamys*.

Rubus innominatus S. Moore var. **Kuntzeanus** (Hemsl.) Bailey, Gent. Herb. **1**: 30 (1920).

Rubus Kuntzeanus Hemsley in Jour. Linn. Soc. Bot. **23**: 232 (1887). — Focke in Bibl. Bot. **17** (72^{II}): 195 (Spec. Rub.) (1911). — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 304 (1917).

Rubus xanthacantha Léveillé in Fedde, Rep. Spec. Nov. **4**: 333 (1907). — Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 99 (1909).

Rubus Kuntzeanus var. *xanthacantha* (Lévl.) Léveillé, Fl. Kouy-Tchéou, 360 (1915).

China. Kweichou: Pin-fa, *J. Cavalerie*, no. 2402, July 5, 1905, "fruits jaunes bons à manger" (holotype of *R. xanthacantha;* photo. in A. A.).

Rubus xanthacantha was first referred to *R. Kuntzeanus* by Focke in 1911 (l.c.). Léveillé four years later published it as a variety of that species. Cardot remarks that it differs from typical *R. Kuntzeanus* in the glandular calyx and forms a transition to his *R. Kuntzeanus* var. *glandulosus* (in Not. Syst. Paris, **3:** 311. 1917). That variety is very close to typical *R. innominatus* S. Moore and differs only in the consistently three-foliolate leaves. Bailey (l.c.), however, states that the type specimen of Moore's species at herb. Kew shows only ternate leaves and proposes for the form with predominately five-foliolate leaves the name *R. innominatus* var. *quinatus.*

Rubus pinfaensis Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe, **39:** 320 (Bouquet Fl. Chine, 5) (1904); in Fedde, Rep. Spec. Nov. **6:** 374 (1909). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 106 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 199, fig. 81 (1911); in Sargent, Pl. Wilson. **1:** 55 (1911). — Léveillé, Fl. Kouy-Tchéou, 359 (1915). — Handel-Mazzetti, Symb. Sin. **7:** 50 (1933).

Rubus fasciculatus Duthie in Ann. Bot. Gard. Calcutta, **9:** 39, pl. 48 (1901). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 306 (1917). — Non P. J. Mueller (1858).

CHINA. Kweichou: Pin-fa, route de Tou-chan, *J. Cavalerie,* no. 920, March 19, 1903 (holotype of *R. pinfaensis;* photo. in A. A.); environs de Kouy-yang, mont du Collège, *J. Chaffanjon,* no. 2057, Feb. 1898; grotte de Thong-thang, *J. Esquirol,* no. 2609, Feb. 25, 1911 (both cited in Fl. Kouy-Tchéou).

This is a well-marked species closely related to *R. ellipticus* Sm. It has been collected in Kweichou also by Y. Tsiang (nos. 5009 and 7794), by several collectors in Hupeh, Szechuan, Yunnan and northeastern Tibet; outside of China in the N.W. Himalaya, and according to Cardot in Formosa.

Rubus mesogaeus Focke in Bot. Jahrb. **29:** 399 (1901); in Bibl. Bot. **17** (72^{II}): 204 (Spec. Rub.) (1911).

Rubus Kinashii Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe, **40:** 66 (1905); in Fedde, Rep. Spec. Nov. **2:** 175 (1906); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 80 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 188, fig. 76 (Spec. Rub.) (1911). — Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 138 (1913). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 308 (1917). — **Synon. nov.**

Rubus eous Focke in Bibl. Bot. **17** (72^{II}): 204 (Spec. Rub.) (1911).

Rubus euleucus Focke ex Handel-Mazzetti, Symb. Sin. **7:** 503 (1933), quoad syn. *R. Kinashii.*

JAPAN. Hondo: Asama-yama, *U. Faurie,* no. 6072, July 1904 (holotype of *R. Kinashii;* photo. in A. A.).

Rubus Kinashii is placed by Focke in Ser. Nivei, but Cardot (l.c.) states that it is closely related to *R. mesogaeus* Focke, a species of Ser. Euidaei. After comparing copious material of both species, I have come to the conclusion that it is not only closely related, but identical with *R. mesogaeus.* I do not even find that the slight differences Cardot points out can be used to distinguish the Chinese and the Japanese plants. I agree with Koidzumi (l.c.) that *R. eous* is a synonym of *R. Kinashii* and consequently of *R. mesogaeus.*

Rubus kanayamensis Léveillé & Vaniot in Bull. Soc. Bot. France, **53:** 549 (1906). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 130 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 205 (1911). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 309 (1917). — Makino & Tanaka, Man. Fl. Nippon, 253 (1927). — Makino & Nemoto, Nippon-shokubutsu-sôran, ed. 2, p. 515 (1931).

Rubus strigosus Michx. var. *kanayamensis* (Lévl. & Vant.) Koidzumi, Fl. Symb. Or.-As. 56 (1930).

JAPAN. Hokkaido: forêts de Kanayama, *U. Faurie,* no. 6688, July 1905 (holotype; isotype in A. A.).

According to Focke this species is nearest to *R. idaeus* var. *strigosus* (Michx.), but differs in the glabrous under side of the leaves and the looser inflorescence.

Rubus idaeus L. var. **Yabei** (Lévl. & Vant.) Koidzumi in Bot. Mag. Tokyo, **43:** 389 (1929). — Makino & Nemoto, Nippon-shokubutsu-sôran, ed. 2, p. 515 (1931).

Rubus Yabei Léveillé & Vaniot in Bull. Soc. Agr. Arts Sarthe, **40:** 65 (1905); in Fedde, Rep. Spec. Nov. **2:** 275 (1906). — Léveillé in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 133 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 210 (Spec. Rub.) (1911). — Koidzumi in Bot. Mag. Tokyo, **30:** 78 (1916).

Rubus nipponicus (Focke) Koidzumi, Fl. Symb. Or.-As. 57 (1930), quoad syn. *R. Yabei.*

JAPAN. Hondo: Jizogatake, *U. Faurie,* no. 5374, July 1903 (holotype; isotype in A. A.).

Rubus Yabei differs from *R. idaeus* var. *nipponicus* Focke in the sharply and doubly serrate leaves with acuminate mucronate teeth and a thin grayish white tomentum beneath, in the glabrous inflorescence with slender pedicels 1–1.5 cm. long and in the calyx being glabrous outside. Faurie no. 6685 mentioned by Cardot (in Bull. Mus. Hist. Nat. Paris, **23:** 310. 1917) under *R. idaeus* is referable to this variety, but differs in the mostly 5-foliolate leaves and in the pedicels and calyx outside being appressed pubescent; also the isotype in this herbarium of *R. Yabei* has the leaves mostly 5-foliolate, but otherwise agrees with the type of which there are two specimens in the herb. Léveillé.

Rubus idaeus L. var. **Matsumuranus** (Lévl. & Vant.) Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 135 (Consp. Ros. Jap.) (1913), "subsp. *melanolasius* Focke α M.". — Nakai in Bot. Mag. Tokyo, **30**: 229 (Praecurs. Fl. Sylv. Cor.) (1916). — Makino & Nemoto, Nippon-shokubutsu-sôran, ed. 2, p. 515 (1931).

Rubus strigosus Michx. ex Koidzumi, Fl. Symb. Or.-As. 55 (1930), quoad pl. japonicam.

Rubus Idaeus L. β *strigosus* (Michx.) Maximowicz in Bull. Acad. Sci. St. Pétersb. **17**: 161 (in Mél. Biol. **8**: 394) (1872), quoad pl. japonicam.

Rubus Matsumuranus Léveillé & Vaniot in Bull. Soc. Agr. Sci. Arts Sarthe, **40**: 66 (1905); in Fedde, Rep. Spec. Nov. **2**: 176 (1906); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 131 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 208 (Spec. Rub.) (1911).

JAPAN. Hondo: in sylvis Ochiai, *U. Faurie*, no. 6071, Sept. 1904 (holotype of *R. Matsumuranus*; photo. in A. A.).

From *R. idaeus* var. *strigosus* to which it seems nearest, it differs in the densely puberulous stems and petioles, in the large simply serrate leaflets, the terminal one cordate or subcordate. This apparently represents the raspberry of Hondo and Hokkaido usually referred to *R. strigosus;* the latter probably does not occur in its typical form in Japan. From subsp. *nipponicus* Focke which it resembles in general aspect, var. *Matsumuranus* differs chiefly in the densely bristly and glandular-hirsute branches and inflorescences. To var. *Matsumuranus* belongs possibly *R. sachalinensis* var. *macrophyllus* Cardot (in Not. Syst. Herb. Mus. Paris, **3**: 315. 1917) based on Faurie no. 3122 which I have not seen.

Rubus idaeus var. **diamantinus** (Lévl.), comb. nov.

Rubus diamantinus Léveillé in Fedde, Rep. Spec. Nov. **5**: 279 (1908); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 77 (1909). — Focke in Bibl. Bot. **17** (72^{II}): 210 (Spec. Rub.) (1911). — Nakai in Jour. Coll. Sci. Tokyo, **31**: 476 (Fl. Kor. II) (1911), sphalmate "*diamanticus.*" — Cardot in Bull. Mus. Hist. Nat. Paris, **23**: 311 (1917). — Koidzumi, Fl. Symb. Or.-As. 57 (1930).

Rubus idaeus var. *microphyllus* Turcz. ex Nakai in Bot. Mag. Tokyo, **30**: 228 (Praecurs. Fl. Sylv. Cor.) (1916); Fl. Sylv. Kor. **7**: 76 (1918), quoad syn. *R. diamantiacus;* vix Turczaninov.

KOREA. Kogendo prov.: in petrosis montis des diamants, 1000 m., rara, *U. Faurie*, no. 301, June 24, 1906 (holotype of *R. diamantinus;* photo. in A. A.).

Rubus diamantinus differs from the preceding and the following varieties chiefly in the small leaflets densely pubescent on the upper surface, otherwise it seems nearest to the following variety and may perhaps be referred to it as a form. Nakai referred *R. diamantinus* as a synonym to *R. idaeus* var. *microphyllus* Turczaninov in Bull. Soc. Nat. Moscou, **16:** 682 (Fl. Baical.-Dahur. **1:** 370) (1843), but var. *microphyllus* dates back to Wallroth, Sched. Crit. 226 (1822) and applies apparently to a low small-leaved European form of *R. idaeus* subsp. *vulgatus* Focke and not to a form related to subsp. *strigosus*.

Rubus idaeus var. **aculeatissimus** Regel & Tiling, Fl. Ajan. 87 (1858).

Rubus sachalinensis Léveillé in Fedde, Rep. Spec. Nov. **6:** 332 (1909); in Bull. Acad. Intern. Géog. Bot. **20** (Mém.): 134 (1909). — Cardot in Bull. Mus. Hist. Nat. Paris, **23:** 310 (1917). — **Synon. nov.**

Rubus idaeus subsp. *sachalinensis* (Lévl.) Focke in Bibl. Bot. **17** (72^{II}): 210 (Spec. Rub.) (1911). — Koidzumi in Jour. Coll. Sci. Tokyo, **34** (art. 2): 136 (1913). — Makino & Nemoto, Nippon-shokubutsu-sôran, ed. 2, p. 515 (1931). — Hulten in Svensk Vet. Akad. Handl. **8** (no. 1): 54, 188, map 499 (Fl. Kamtch.) (1929); (no. 2): 254 (1931).

Rubus melanolasius Focke var. *discolor* Komarov ex Miyabe & Miyake, Fl. Saghal. 129 (1915).

Rubus strigosus Michx. ex Koidzumi, Fl. Symb. Or.-As. 55 (1930), quoad syn. *R. sachalinensis*.

SAGHALIN: in silvis Korsakof, *U. Faurie,* nos. 565, 566, July 30, Sept. 30, 1908; in herbidis Vladimirof, no. 597, July 1908; in montibus Takinosawa, no. 567, July 24, 1908; without special locality, no. 598, pro parte, July 1908 (syntypes of *R. sachalinensis;* isotypes of 565, 566 and 567 and photo. of 598 in A. A.).

Focke already suggested the identity of *R. sachalinensis* with *R. idaeus* var. *aculeatissimus* by citing the latter name as a synonym of his *R. idaeus* subsp. *sachalinensis* attributing it to C. A. Mey. in herb.; he apparently was not aware that the name was published by Regel & Tiling in 1858 and should take precedence over his new combination. Also Cardot (l.c.) refers to this identification and Hulten (l.c. p. 55) remarks that the two are probably identical.

Faurie no. 598 which is cited above pro parte, has four branches on the type sheet; the two lower branches belong here, while the two upper branches, one with two immature flower buds, suggest *R. kanayamensis* on account of their glabrous leaves but the branches and petioles are very sparingly armed and the inflorescence is practically unarmed.

HERBARIUM, ARNOLD ARBORETUM,
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THE CHINESE SPECIES DESCRIBED IN MEYEN'S "OBSERVATIONES BOTANICAE" (BEITRÄGE ZUR BOTANIK)

E. D. MERRILL

PARTLY because certain Chinese species described in Meyen's "Observationes botanicae (Beiträge zur Botanik)" have been overlooked, partly because others have never been definitely placed, and partly because still others have been accepted as valid, although it is reasonably clear from their descriptions that they are but synonyms of other species, it has been thought expedient to make a somewhat critical study of them. The various Philippine species of flowering plants based on Meyen's collections have for the most part been disposed of in a satisfactory manner, either as valid species or as synonyms of previously described ones, as indicated in my "Enumeration of Philippine flowering plants." The status of these Philippine species was for the most part determined by an actual examination of their types in the Berlin Herbarium.

Meyen was primarily a plant physiologist. In 1830–32 he served as surgeon on the German ship "Prinzess Louise" on a trip around the world. Wherever stops were made he took advantage of the opportunity to collect botanical material. A detailed account of his journey was published in 1834–35.[1]

In his published "Reise" Meyen included various observations on the vegetation of the countries visited, on individual species observed, and incidental to his narrative actually named and described a number of new plant species. Pages 292 to 400 of volume two of this work are devoted to his observations on China, as the result of his two stops in Kwangtung Province, August 15 to September 2, and November 11 to December 12, 1831. But a single new binomial appears in these pages, *Aralia trifoliata* Meyen, and this a *nomen nudum;* Walpers later placed it as a synonym of *Panax aculeatus* Ait. = *Acanthopanax trifoliatus* (Linn.) Merr.

The Chinese plants that Meyen collected and on which the descriptions discussed below were based, were secured mostly at Macao and on neighboring small islands, at Cape Syng-moon on Lantao Island, Hong-

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[1] **Meyen, F. J. F.** Reise um die Erde, ausgeführt auf dem Königlich Preussischen Seehandlungs-Schiffe Prinzess Louise, commandirt von Capitain W. Wendt, in den Jahren 1830, 1831 und 1832. **1**: i-viii. 1-493. *1 t.* 1 map, 1834; **2**: i-vi. 1-411, 1 map, 1835.

kong New Territory, and Lintin Island, Canton River, near Hongkong. One of the new species was collected at Canton, and one on Lippas (Lappa) Island near Macao. From Meyen's own account of his journey it is safe to assume that the considerable number of his specimens that are cited merely as coming from "China" were collected at some one of the several localities listed above, and mostly at Macao, and on Lantao and Lintin Islands. These localities are all within a few miles of Hongkong. At the time of Meyen's visit, Hongkong Colony did not exist, Hongkong Island having been ceded to Great Britain in 1841, and the Colony chartered in 1843. The foreign commerce with southeastern China, up to the time of the establishment of Hongkong, was largely through the small Portuguese colony of Macao and with Canton.

The "Observationes botanicae"[1] is a composite work published after Meyen's death. The contributors were Ratzeburg, Grisebach, Klotzsch, Flotow, J. Meyen, Miquel, Nees von Esenbeck, Schauer, Vogel, and Walpers. In some cases Meyen is given as the joint author of certain species, notably in association with Nees von Esenbeck and with Walpers. In this work six new genera and about fifty new species of Chinese plants were characterized as new. It is with these new forms that I have concerned myself in the present paper. No attempt has been made to consider those records given in the form of previously described species, as usually no descriptive data are given. Apparently most of them were correctly named.

This study is based primarily on a critical examination of the descriptions in comparison with extensive collections of plants from Kwangtung Province. In some cases, as mentioned in the text, I am under obligations to Dr. J. Mattfeld of the Berlin Botanic Garden, who kindly searched for the types of certain species and made the necessary critical comparisons. In a very few cases the actual types could not be located, either because they have been lost or misplaced, or because the species represented has been transferred to some other genus without leaving a cross reference slip.

The references to Hemsley are to Forbes and Hemsley's "An enumeration of all the plants known from China proper . . ." *Jour. Linn. Soc. Bot.* **23:** 1–521. *t. 1–14.* 1886–1888; **26:** 1–592. *t. 1–10.* 1889–1902; **36:** i–xi. 1–686. 1903–1905; those to Dunn and Tutcher to their "Flora of Kwangtung and Hongkong (China)." *Kew Bull. Add. Ser.* **10:** 1–370, map. 1912.

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[1] **Meyen, F. J. F.** Beiträge zur Botanik gesammelt auf einer Reise um die Erde. Nach dessen Tode von den Mitgleidern der Akademie fortgeführt und bearbeitet. Observationes botanicae, in itinere circum terram institutae. Opus posthumum, sociorum academiae curis suppletum. *Nova Acta Acad. Leop.-Carol. Nat. Cur.* **19:** *Suppl.* **1:** i-xxxii. 1-512. *t. 1-13.* 1843.

One of the results of this study is the reduction to synonymy of about twelve species that Hemsley accepted, usually without comment, in his enumeration of Chinese plants. *Vernonia Gomphrena* Walp. = *Blumea obliqua* (Linn.) Druce, has not been found by any collector in China since Meyen secured it on Lintin Island in 1831; it seems likely that this was a casual introduction from India or Ceylon that may not have persisted. *Scleria pratensis* Lindl. = *S. pterota* Presl is to be excluded as a Chinese species, the Chinese record apparently having been based on an erroneously localized plant. *Ferula marathrophylla* Walp., very inadequately characterized, remains of entirely doubtful status, while *Aster Walpersianus* Nees cannot at present be associated with any other known Chinese species of the genus.

LICHENES

Ramalina digitata Meyen & Flotow, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 212. *t. 3. f. 1.* 1843." Ad ramos Theae chinensis, tum in horto botanico Rio Janeiro urbis Brasiliae, tum in imperio Chinensi prope Canton."

Ramalina geniculata Hook. f. & Taylor, Lond. Jour. Bot. **3:** 655. 1844; Zahlbr. Cat. Lich. Univ. **6:** 490. 1930.

Zahlbruckner placed *Ramalina digitata* Meyen & Flotow as a doubtful synonym of *R. geniculata* Hook. f. & Tayl. J. Mueller, however, (Revisio Lichenum Meyenorum. Jahrb. Bot. Gart. Berlin **2:** 310. 1883) on the basis of an examination of the Brazilian specimen (he did not see the Canton one) cites Nylander's recognition of it as related to *R. pumila* Mont. and states: "sed planta nihil nisi var. gracilis et tenuis divisa videtur **Ramalinae geniculatae** Hook. et Tayl." In view of Mueller's eminence as a lichenologist it is believed that this disposition of the species should be accepted. Most lichenologists accept *Ramalina geniculata* Hook. f. & Tayl., but *R. digitata* Meyen & Flotow is a valid name, and is one year older than that of Hooker f. & Taylor.

FUNGI

Fusarium Caries Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 478. 1843 "In spicis Meoschii lodicularis [*Ischaemum aristatum*] Chinae: Cap-Lintin."

Saccardo, Syll. Fung. **4:** 725. 1886, merely lists this as a species of doubtful status unknown to him, erroneously crediting it to Chile. Wollenweber & Reinking, Die Fusarien 320. 1935, merely state: "non *Fusarium.*" The problem of its identity is one for some mycologist to solve.

POLYPODIACEAE

Pteris ensiformis Burm. f. Fl. Ind. 230. 1768.

Pteris ensiformis Goldm. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 457. 1843. "China" (syn. nov.).

Goldmann described this as a new species overlooking Burman's use of the same specific name for the same species. Christensen enumerated *Pteris ensiformis* Goldm. but suggested no reduction. An excellent photograph of Goldmann's type in the Berlin Herbarium, courteously supplied by Dr. Mattfeld, enables me to make this reduction with confidence as to its correctness. The type is a single fertile frond, a very few of the lower pinnules sterile. The rachis is not winged as in *P. multifida* Poir. and in *P. dimorpha* Copel. Philip. Jour. Sci. **3**: Bot. 282. 1908; Ching, Ic. Fil. Sin. **1**: 69. *t. 34*. 1930, the type of Copeland's species being from Kwangtung. Ching observes that *P. dimorpha* Copel. is more or less intermediate between *P. multifida* Poir. and *P. ensiformis* Burm. f.

LYCOPODIACEAE

Lycopodium cernuum Linn. Sp. Pl. 1103. 1763.

Lycopodium amentigerum Goldm. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 468. 1843. "China" (syn. nov.).

From the short description this seems clearly to be a form of the widely distributed Linnaean species which is very common in Kwangtung Province. Goldmann's species was not accounted for by Spring in his "Monographie de la famille des Lycopodiacées" (1842–49), nor by Baker in his "Handbook of the fern-allies" (1877).

GRAMINEAE

Andropogon intermedius R. Br. var. **Haenkei** (Presl) Hackel in DC. Monog. Phan. **6**: 486. 1889.

Andropogon Vachellii Nees in Hook. & Arn. Bot. Beechey Voy. 243. 1838; Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 188. 1843 "In vicinia urbis Macao imperii Chinensis et in insulis adiacentibus."

The description of 1838 is an ample one, but much of it is repeated in that of 1843. Hackel made the reduction of *A. Vachellii* Nees to *A. intermedius* R. Br. var. *Haenkei* (Presl) Hackel, but Rendle, Jour. Linn. Soc. Bot. **36**: 373. 1904, recognized only R. Brown's species as occurring in China, not the variety.

Arundinella setosa Trin. Gram. Pan. 63. 1826; Keng, Nat. Centr. Univ. Sci. Rep. B **2**: 56. 1936.

Miquelia barbulata Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 178. 1843 "In promontorio Syng-moon."
Berghausia barbulata Endl. in Miq. Analecta Bot. Ind. **2**: 20. 1851.
Garnotia barbulata Merr. Philip. Jour. Sci. **13**: Bot. 130. 1918; Hitchc. Lingnan Sci. Jour. **7**: 200. 1931, quoad syn. Nees, excl. spec. cit.

In 1929, on the assumption that the current reduction of *Miquelia barbulata* Nees as a synonym of *Garnotia patula* Munro was correct, I transferred the former to *Garnotia*. In 1931 Hitchcock maintained *G. patula* Munro and *G. barbulata* Merr. as distinct species. Keng, in 1936, placed *Miquelia barbulata* Nees as a doubtful synonym of *Arundinella setosa* Trin., with *Berghausia barbulata* Endl. and *Garnotia barbulata* Nees as doubtful synonyms. Dr. Mattfeld reports that Meyen's type is not in the Berlin herbarium under *Garnotia*, and Dr. Pilger failed to locate it under *Arundinella*. Mrs. Chase states that *Levine 767*, which Hitchcock placed under *Garnotia barbulata* (Nees) Merr., is apparently a *Garnotia*, although Keng thought that it might be a young specimen of *Arundinella*. It agrees with Nees' description particularly in the prominent circles of hairs below the spikelets "pedicelli . . . pilis . . . infra spiculam in speciem involucelli congeruntur," yet Trinius gives this character of *A. setosa* Trin. thus: "pedicello sub spicula pilifero," and many specimens representing his species, particularly those with young spikelets, show this character. Nees also states that the inflorescences are dense and a foot long, its branches eight inches long. These characters scarcely apply to any Chinese *Garnotia*, but do apply to specimens of *Arundinella setosa* Trin. with immature inflorescences. It is suspected that Nees had an immature specimen of *Arundinella setosa* Trin., a very common species in the region whence Meyen's plant came, with strict erect inflorescence branches.

Digitaria dispar Henrard, Blumea **1**: 97. 1934.

Panicum (Digitaria) heteranthum Nees & Meyen, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 174. 1843, non Link 1827 [China].
Digitaria heterantha Merr. Enum. Philip. Fl. Pl. **1**: 53. 1923, Lingnan Agr. Rev. **1**(2): 48. 1923.
Paspalum heteranthum Hook. f. Fl. Brit. Ind. **7**: 16. 1927, quoad syn. Nees & Meyen.
Panicum commutatum Nees in Hook. & Arn. Bot. Beechey Voy. 251. 1836, non Schult. 1824, non *Digitaria commutata* Schult. 1824.

No definite locality was given, the species being enumerated under the heading "Chinenses." Rendle placed it as a synonym of *Digitaria barbata* Willd., he being followed by Miss Camus in her treatment of the grasses of Indochina; Hitchcock, Lingnan Sci. Jour. **7**: 210. 1931, placed it as a synonym of *Digitaria sanguinalis* (Linn.) Heist. Dr. Mattfeld kindly supplied me with a fragment of the Nees & Meyen type which I transmitted to Dr. Henrard, the synonymy, as given above, following the latter's manuscript treatment. He informs me that the species extends from southeastern China to Indochina and Pahang. The Philippine *D. heterantha* var. *pachyrachis* (Hack.) Merr. is *D. longissima* Mez.

Eragrostis pilosissima Link, Hort. Berol. **1**: 189. 1827.

Eragrostis Millettii Hook. & Arn. Bot. Beechey Voy. 252. 1838; Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 206. 1843 "Ad Macao atque in insulis vicinis . . . ibidem in Promontorio Syng-moon."

The original description of Hooker & Arnott was based on specimens from Macao collected by Millett and by Vachell. Nees adds several synonyms in his consideration of the species in 1843. Link's species is a well-defined one not uncommon in southeastern China.

Eragrostis cylindrica (Roxb.) Nees in Hook. & Arn. Bot. Beechey Voy. 251. 1838.

Poa cylindrica Roxb. Fl. Ind. **1**: 335. 1820, ed. 2, **1**: 334. 1832.
Eragrostis geniculata Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 203. 1843 "In Promontorio Syng-moon."

Roxburgh's description of *Poa cylindrica* was based on specimens grown in the Calcutta Botanic Garden from Canton seeds. The species is common and widely distributed in southeastern China. *Eragrostis geniculata* Nees is safely the same as *E. cylindrica* (Roxb.) Nees.

Ischaemum aristatum Linn. subsp. **barbatum** (Retz.) Hackel var. **Meyenianum** (Nees) Hack. et var. **lodiculare** (Nees) Hack. in DC. Monog. Phan. **6**: 205. 1889.

Meoschium Meyenianum Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 197. 1843 "Ad Promontorium Syng-moon."
Meoschium lodiculare Nees in Hook. & Arn. Bot. Beechey Voy. 246. 1838, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 195. 1843. "In vicinia Macao urbis inque insulis adiectis . . . ad Promontorium Syng-moon."

The original description of 1838 is a particularly ample one, based on specimens collected by Meyen, Millett, and Vachell. While *Ischaemum aristatum* Linn. as currently interpreted is a somewhat variable, or perhaps a collective species, it may or may not be desirable to attempt to segregate subspecies and varieties. Rendle does not recognize the two varieties, reducing both of Nees' species to the subsp. *barbatum* Hack.

Pogonatherum paniceum (Lam.) Hackel, Allg. Bot. Zeitschr. **12:** 178. 1906.

Saccharum paniceum Lam. Encycl. **1:** 595. 1785.
Pogonatherum saccharoideum Beauv. Agrost. 176. *t. 11. f. 7.* 1812.
Pogonatherum refractum Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 182. 1843 "In imperio Chinensi ad Macao et in vicinis insulis . . . in diversis Indiae orientalis partibus."

This grass is common in Kwangtung Province and is of very wide geographic distribution in the Indo-Malaysian region. Hackel (DC. Monog. Phan. **6:** 193. 1889) referred *Pogonatherum refractum* Nees to *P. saccharoideum* Beauv. var. *monandrum* (Roxb.) Hack.

Thysanolaena maxima (Roxb.) O. Ktze. Rev. Gen. Pl. 794. 1891.

Melica latifolia Roxb. Fl. Ind. **1:** 330. 1820.
Panicum acariferum Trin. Ic. Gram. **1:** *t. 87.* 1828. Mém. Acad. Sci. St. Pétersb. VI. Sci. Phys. Nat. **3:** 293. 1834 (Panic. Gen. 205).
Thysanolaena Agrostis Nees, Edinb. New Philos. Jour. **18:** 180. 1835.
Thysanolaena acarifera Arn. & Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 181. 1843 "In Promontorio Syng-moon."
Thysanolaena procera Mez, Bot. Arch. **1:** 27. 1921, non *Agrostis procera* Retz.

The description by Arnott and Nees is an amplified one of this widely distributed, strongly characterized, Indo-Malaysian species. Nees enumerates the Indian *T. Agrostis* Nees as representing a distinct species but there seems to be no justification for this. *Agrostis procera* Retz. on which *Thysanolaena procera* Mez was based, is *Eriochloa procera* (Retz) Hubbard (*E. ramosa* O. Ktz.).

CYPERACEAE

Cladium chinense Nees, Linnaea **9:** 301. 1834, *nomen nudum*, Hook. & Arn. Bot. Beechey Voy. 228. 1836, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 116. 1843. "In China, circa Macao et in insulis adiacentibus."

Mariscus chinensis Fernald, Rhodora **25:** 52. 1923.
Cladium jamaicense sensu C. B. Clarke, Jour. Linn. Soc. Bot. **36:** 262. 1903, non Crantz.
Cladium japonicum Steud. Syn. Pl. Cyp. 152. 1855.

In 1923 Fernald adopted the generic name *Mariscus* (Haller) Zinn for this group and transferred a number of species from *Cladium* to *Mariscus*. In 1930 action by the Cambridge International Botanical Congress covered the points raised and settled the claims of *Cladium* B. Browne versus *Mariscus* (Haller) Zinn in favor of the former; see Sprague, Kew Bull. 217–219. 1934. *Cladium jamaicense* Crantz and

C. Mariscus Pohl have been interpreted in a collective sense as the names for a species of very wide geographic distribution. Fernald called attention to the fact that the European form, *Cladium Mariscus* (Linn.) Pohl (*Mariscus serratus* Gilib.) is distinct from the tropical one. He retained the tropical American species as *Mariscus jamaicensis* Britton = *Cladium jamaicense* Crantz, and separated the Chinese form as a third species. As Nees originally noted the achenes of *Cladium chinense* Nees are much smaller than in the European form, and Fernald states further that its pale achenes are but about one-third as large as are those of *Mariscus serratus* Gilib. = *Cladium Mariscus* Pohl, and that they are ellipsoid-ovoid and very short tipped rather than lance-ovoid and acuminate.

Cyperus compressus Linn. Sp. Pl. 46. 1753.

Cyperus Meyenii Nees & Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 57. 1843. "In Manila insula . . . in China, etc."

This is the common pantropic *Cyperus compressus* Linn. Kükenthal (Pflanzenr. **101 (IV.20)**: 158. 1935) places *C. Meyenii* Nees & Walp. as a synonym of *C. compressus* Linn. var. *pectiniformis* (Roem. & Schultes) C. B. Clarke, giving its range as India, Indochina, Java, Philippines and Mexico.

Cyperus radians Nees & Meyen, Linnaea **9**: 285. 1834, *nomen nudum,* Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 63. 1843. "Ad Promontorium Syng-moon imperii Chinensis."

Cyperus radicans Nees & Meyen ex Kunth, Enum. **2**: 95. 1837, err. typ.
Cyperus Griffithii Steud. Syn. **2**: 316. 1855.
Cyperus sinensis Debeaux, Act. Soc. Linn. Bordeaux **31**: *t. 2.* 1877, **32**: 28. 1878.

This is a strongly marked, well-known species. Technically the first published description is as *Cyperus radicans,* but in 1837, when Kunth published this binomial, he credited it to "Nees ab Esenb. et Meyen in Linnaea 9. 285 (v. s.)", and Nees & Meyen's printed *nomen nudum* in Linnaea is *C. radians.* I do not think that this can be interpreted as other than a typographical error; otherwise Kunth's non-descriptive name will replace the distinctly descriptive one of Nees & Meyen.

Fimbristylis subbispicata Nees & Meyen, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 75. 1843. "Habitat ad Macao urbem, in vicinis insulis et in Promontorio Syng-moon imperii Chinensis."

As noted by Clarke, Jour. Linn. Soc. Bot. **36**: 246. 1903, the limits and relationships of this species are not entirely clear. In Wight's Contributions (1834), and in the Botany of Captain Beechey's Voyage (1836) Nees confused this with *F. bispicata* Nees & Meyen. It is believed that the status of the binomial *F. subbispicata* Nees & Meyen should be settled on the basis of the Macao and Syng-moon plants cited in the description of 1843.

Fimbristylis sericea R. Br. Prodr. 228. 1810.

Fimbristylis decora Nees & Meyen in Wight, Contrib. Bot. Ind. 101. 1834. Hook. & Arn. Bot. Beechey Voy. 225. 1836, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 83. 1843. "In China, Julio a. 1831, Ibidem, in Herb. Lindl."

The original description of 1834 was based on Meyen's specimen and one collected by Potts, probably at Macao. The species as interpreted by Clarke is one of wide geographic distribution occurring along the seashore from India to Japan southward to Australia. Other synonyms are *Fimbristylis velutina* Franch. and *Scirpus sericeus* Poir.

Fimbristylis podocarpa Nees & Meyen in Wight, Contrib. Bot. Ind. 98. 1834, Hook. & Arn. Bot. Beechey Voy. 225. 1836, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 77. 1843, pro parte, quoad var. α. "Crescit var. α in China, (Meyen)."

In the original description in Wight's Contributions, and in the Nova Acta description, the localities cited are China, Manila, India and Himalaya, three varieties being characterized. As species are now segregated in this critical group more than one is represented in Nees & Meyen's concept, including *F. diphylla* Vahl, fide C. B. Clarke, and *F. podocarpa* Nees & Meyen. I believe under the circumstances that the species should be interpreted by the first specimen cited, and this is the Meyen specimen under variety α. Clarke's procedure in maintaining Hooker f. as the authority of the binomial *Fimbristylis podocarpa* is inadmissible under any rules; it should be *F. podocarpa* Nees & Meyen or Nees & Meyen in part.

Lepidosperma chinense Nees & Meyen, Linnaea **9:** 302. 1834, *nomen nudum*. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 117. 1843. "China, ad promontorium Syng-moon . . . in vicinia Macao urbis insulisque adiacentibus . . . in Lippas insula."

A well-known species common in Kwangtung Province. The Macao and Lappa Island specimens were collected by Vachell.

Rhynchospora chinensis Nees & Meyen, Linnaea **9:** 297. 1834, *nomen nudum*, Wight, Contrib. Bot. Ind. 115. 1834, Hook. & Arn. Bot.

Beechey Voy. 226. 1836, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 108. 1843. "In China, ad Promontorium Syng-moon . . . Meyen; in Nepalia Wallich" and in the previous line "Wall. Cat. n. 3421, Vachell in Herb. Lindl. n. 60."

Clarke's note on this species, Jour. Linn. Soc. Bot. **36:** 259. 1903, sub *Rhynchospora glauca* Vahl var. *chinensis* Clarke, should be consulted. I agree with Dr. Mattfeld that Nees & Meyen, not Boeckeler is the authority, Clarke accepting the latter. I can do no better than quote Dr. Mattfeld's statement: "*Rhynchospora chinensis* Nees et Meyen. — Das Original wurde in unserm Herbar von C. B. Clarke als *Rh. glauca* Vahl var. *chinensis* spec. Boeck. bestimmt. — Wallich no. 3421 bestimmte Clarke als typische *Rh. glauca.* — Wallich's Pflanze wird von Nees nur als Synonym zitiert. Die nomenklatorische und systematische Grundlage für *Rh. chinensis* ist also immer Meyen's Pflanze, an die der Name geknüpft bleiben muss, auch wenn die nicht ganz einheitliche *Rh. chinensis* Nees aufgeteilt wird. Nimmt man diese Sippe als Art so wäre zu zitieren: *Rh. chinensis* Nees et Meyen emend. Boeckeler; als Varietät: *Rh. glauca* Vahl var. *chinensis* (N. et M. ex parte) C. B. Cl. — Auch Kükenthal fasst die *chinensis* als Varietät von *glauca* auf. — Wallich's Pflanze wurde von Boeckeler zuerst als *Rh. Brownii* bezeichnet; diesen Namen zog er später aber, wie aus einer handschriftlichen Eintragung in dem Handexemplar seiner Monographie hervorgeht, als Synonym zu *Rh. glauca.* — Kunth zog Wallich's und Meyen's Pflanzen zu *Rh. laxa* R. Br., die er aber schon für "nil nisi forma indica R. glaucae" hielt. — Nees und Kunth hielten also die asiatische Sippe für einheitlich. Boeckeler erkannte zuerst die Unterschiede; die eine Komponente erkannte er als identisch mit der amerikanischen *glauca;* die zweite hielt er für eine besondere Art *chinensis* (Typus Meyen), die Clarke dann zur Varietät von *glauca* reduzierte." Whether we are dealing with a distinct species or with a variety is a matter of some difference of opinion. The type of *Rh. glauca* Vahl is an American plant.

Scleria pterota Presl, Oken Isis **21:** 268. 1826; Core, Brittonia **2:** 91. *t. 2. f. 18.* 1936.

> *Scleria pratensis* Lindl. ex Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 121. 1843. "var. α, in China, ad prom. Syng-moon, Julio 1831, Meyen; Bahiae . . . Guiana . . ."

Lindley's species is a synonym of *S. pterota* Presl. The Chinese record was apparently based on an erroneously localized specimen. Core cites about fifteen synonyms for the species which is widely distributed in tropical America.

COMMELINACEAE

Commelina diffusa Burm. f. Fl. Ind. 18. *t. 7. f. 2.* 1768.

Commelina nudiflora sensu Burm. f. op. cit. 17 et auct plur., non Linn.
Commelina longicaulis Jacq. Coll. **3**: 234. 1789, Ic. Pl. Rar. **2**: *t. 294.* 1786–93; Pennell, Bull. Torr. Bot. Club **43**: 100. 1916.
Commelina pacifica Vahl, Enum. **2**: 168. 1806.
Commelina cespitosa Roxb. Fl. Ind. **1**: 178. 1820, ed. 2, **1**: 174. 1833.
Commelina ochreata Schauer, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 447. 1843. "China: Lintin, Octobri; Macao, Augusto."

N. E. Brown, following C. B. Clarke, placed Schauer's species as a synonym of *Commelina nudiflora* Linn.; it is that species as currently interpreted but not the species that Linnaeus described, except as *Commelina nudiflora* Linn., as originally published, included more than one species. It should be noted that *Commelina nudiflora* Linn., currently accepted as such, is also the name-bringing synonym of *Aneilema nudiflorum* (Linn.) "R. Br." An analysis of the original Linnaean description by Mr. J. E. Dandy of the British Museum, shows that the specimens in Linnaeus' herbarium, three sheets, at least one of which was there in 1753, all represent *Aneilema nudiflorum;* that the Flora Zeylanica reference is a *Commelina,* and the form currently known as *C. nudiflora* Linn.; and that the Plukenet reference may represent the same form as the Flora Zeylanica one. There is no actual *new description* in the Species Plantarum, except as the cited Flora Zeylanica reference is modified by the addition of the words "involucro nullo." Mr. Dandy considers this to be a very significant modification, since the phrase "involucro nullo" actually applies to the material in Linnaeus' herbarium and not to the Hermann and Plukenet plants, while the specific name *nudiflora* was clearly selected because it was descriptive of the actual specimens Linnaeus had before him. The actual specimen numbered by Linnaeus as "7 nudiflora" was one collected by Osbeck (either in Java or in the vicinity of Canton), and this should, we believe, be designated as the type; it is the *Aneilema.* If further confirmation of the correctness of this interpretation be needed, the greatly amplified description of *Commelina nudiflora* Linn. Mant. **2**: 177. 1771 appertains entirely to the *Aneilema,* not to the *Commelina nudiflora* of modern authors. I believe that it is clear just what Linnaeus intended even although he referred certain pre-Linnaean items to the binomial in 1753 which represent a different species.

As I have already noted elsewhere[1] Osbeck did not return to Sweden

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[1] **Merrill, E. D.** On Poa malabarica Linnaeus. Bull. Torr. Bot. Club **60**: 633-638. 1933.

until June 26, 1752. Manifestly at that time the copy for the Species Plantarum must have been well advanced. It is possible that Linnaeus' original concept of *Commelina nudiflora* may have been based on the Flora Zeylanica and the Plukenet references. When he received Osbeck's specimens he selected the descriptive name *nudiflora* and modified the Flora Zeylanica descriptive sentence accordingly. Osbeck cites but two species of *Commelina, C. communis* and *C. chinensis,* both collected by him on Dane's Island, near Whampoa, China, October 20, 1751. See Merrill, E. D. "Osbeck's Dagbok öfwer en Ostindsk resa" Am. Jour. Bot. **3:** 571–588. 1916.

The oldest valid name for this form seems to be *Commelina diffusa* Burm. f. Pennell, Bull. Torr. Bot. Club **43:** 100. 1916, adopted *Commelina longicaulis* Jacq. (1788) as the proper binomial for this widely distributed pantropic species, considering that *Commelina diffusa* Burm. f. was unidentifiable. Burman's description is short, and his illustration is distinctly poor. Dr. Hochreutiner informs me that the only specimen of *Commelina diffusa* Burm. f. in Burman's herbarium was examined by Clarke, and was indicated by the latter as Burman's type; it is "*C. nudiflora*" as named by Clarke. He notes, however, that there is a question mark after the name *C. diffusa,* and that this was apparently added by Burman. He states that it is difficult to explain why Burman should apply the name *diffusa* to this specimen when at the same time he applied the name *C. nudiflora* Linn. to another specimen that manifestly represents the same species. Burman's rather crude figure represents a *Commelina* very similar to what is currently known as *C. nudiflora* Linn., and there seems to be no valid reason why his binomial should not be accepted.

I had noted, some years ago, this anomalous disposition of the binomial *Commelina nudiflora* Linn., first as a valid species of *Commelina,* and second as the name-bringing synonym of *Aneilema nudiflorum* "R. Br." Assuming that Clarke was correct in his interpretation of the Linnaean species as a true *Commelina,* I further assumed that *Commelina nudiflora* Linn. as redescribed in 1771 was different from the *C. nudiflora* Linn. of 1753. For this reason I adopted the binomial *Aneilema malabaricum* (Linn.) Merr. for the *Aneilema.* With the above interpretation of the type of *Commelina nudiflora* Linn. the partial synonymy of this, as an *Aneilema,* is as follows:

Aneilema nudiflorum (Linn.) Wall. List. 182. no. 5224. 1830; Kunth, Enum. **4:** 66. 1843; Clarke in DC. Monog. Phan. **3:** 210. 1881; Pennell, Bull. Torr. Bot. Club **43:** 96. 407. 1916.

Commelina nudiflora Linn. Sp. Pl. 41. 1753, pro parte, excl. syn. et ref. Fl. Zeyl. et Plukenet; Mant. **1:** 177. 1767.
Tradescantia malabarica Linn. Sp. Pl. ed. 2, 412. 1762.
Commelina nudicaulis Burm. f. Fl. Ind. 17. *t. 8. f. 1.* 1768.
Aneilema nudicaule Kunth, Enum. **4:** 67. 1843.
Commelina trichocolea Schauer, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 448. 1843.
Aneilema malabaricum Merr. Philip. Jour. Sci. **7:** Bot. 232. 1912, Fl. Manila 138. 1912, Enum. Philip. Fl. Pl. **1:** 196. 1923.

The usual authority cited for *Aneilema nudiflorum* is R. Brown, but Brown, Prodr. 271. 1810, did not publish such a binomial, merely indicating that *Commelina nudiflora* Linn. was an *Aneilema*. Pennell accepted Kunth as the authority. Wallich published an *Aneilema nudiflorum* in 1830, based, however, on *Commelina nudiflora* herb. Roxb.; Roxburgh merely accepted the Linnaean binomial, and did not independently describe it as a "new species." His description of *Commelina nudiflora* Linn., Fl. Ind. **1:** 177. 1820, is of the Linnaean species as it has been interpreted in this discussion, i.e. the *Aneilema*, and he cites *Tradescantia malabarica* Linn. as a synonym. Under the circumstances it is believed that Wallich should be accepted as the authority.

ORCHIDACEAE

Arundina chinensis Blume, Bijdr. 402. 1825; Schltr. Repert. Sp. Nov. Beih. **4:** 204. 1919.

Cymbidium Meyenii Schauer, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 433. 1843. "China: Macao."
Arundina Meyenii Reichb. f. Linnaea **25:** 227. 1852.

Rolfe's reduction seems safely to be the correct disposition of *Cymbidium Meyenii* Schauer. Blume's type was from a plant originating in China, cultivated at Buitenzorg, Java.

Cymbidium ensifolium (Linn.) Sw. Nova Acta Acad. Soc. Sci. Upsal. II **6:** 77. 1799; Schltr. Repert. Sp. Nov. Beih. **4:** 266. 1919.

Epidendrum ensifolium Linn. Sp. Pl. 954. 1753.
Cymbidium micans Schauer, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 433. 1843. "China: Macao."

This is Rolfe's reduction, it being apparently correct. The type of the Linnaean species was a specimen collected by Osbeck near Canton.

Habenaria linguella Lindl. Gen. Sp. Orch. Pl. 325. 1835; Merr. Sunyatsenia **1:** 13. *t. 4. f. 2.* 1930.

Habenaria acuifera sensu Rolfe, Jour. Linn. Soc. Bot. **36:** 57. 1903. non Wall.

Habenaria endothrix Miq. Jour. Bot. Néerl. **1**: 92. 1861.

Centrochilus gracilis Schauer, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 435. *t. 13, f. B.* 1843. "China: Promontorium Syng-moon."

Schauer described this as the type of a new genus. It was not accounted for by Rolfe in his treatment of the Orchidaceae of China in Forbes and Hemsley's Enumeration, by Dunn and Tutcher, nor by Schlechter in his Orch. Sino-Jap. Prodr. (Repert. Sp. Nov. Beih. **4**: 1–319. 1919). It seems clearly to be the same as *Habenaria linguella* Lindl., type from Kwangtung Province (probably from Macao), from which it seems to be manifest that *Habenaria endothrix* Miq., type from Hoan, a short distance north of Hongkong, is not to be distinguished.

Habenaria Meyenii, nom. nov.

Choeradoplectron spiranthes Schauer, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 436. *t. 13. f. C.* 1843. "China: Promontorio Syng-moon," non *Habenaria spiranthes* Reichb. f., nec Reichb. f. & Warming.

Peristylus chloranthus Lindl. Hook. Jour. Bot. Kew Gard. Miscel. **7**: 37. 1855, non *Habenaria chlorantha* Spreng., nec Bab.

Habenaria lacertifera Benth. Fl. Hongkong. 362. 1861, non *Coeloglossum lacertiferum* Lindl.

Rolfe, in placing Schauer's species (described by Schauer as the type of a new genus) as a synonym of *Peristylus chloranthus* Lindl. (type from Hongkong), interpreted the Chinese form as representing the same species as the Indian form described by Lindley as *Coeloglossum lacertiferum* Lindl. and as *C. acuminatum* Lindl. Schlechter, however, states that this is apparently not the case. The Chinese plant belongs in *Peristylus,* a group placed by some botanists under *Platyanthera,* by others under *Habenaria.* The type of *Coeloglossum acuminatum* Lindl. was from Nepal and the Indian material that I have seen is distinctly unlike this Chinese species. The type of *C. lacertiferum* Lindl. was from Tavoy, and this seems much closer to the Chinese form than *C. acuminatum* Lindl.

RANUNCULACEAE

Clematis Meyeniana Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 297. 1843. "China: Cap Syng-Moon"; Sprague, Kew Bull. 46. 1916.

A well-known species common in southeastern China, extending to Indochina, Formosa and northern Luzon.

MENISPERMACEAE

Cyclea hypoglauca (Schauer) Diels, Pflanzenr. **46 (IV. 94)**: 319. 1910.

Cissampelos hypoglauca Schauer, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 479. 1843. "China: Cap Syng-moon."
Cyclea deltoidea Miers, Jour. Bot. Kew Gard. Miscel. **3**: 258. 1851.

Hemsley overlooked Schauer's species and thus failed to account for it. The type of *C. deltoidea* Miers was from Hongkong. The species is a fairly common one in Kwangtung Province.

LEGUMINOSAE

Bauhinia variegata Linn. Sp. Pl. 375. 1753.

Bauhinia chinensis Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 42. 1843. "Circa Canton Chinae culta."

From Vogel's description I see no reason for doubting the correctness of this reduction. The species is not native of China, but is not uncommon in cultivation in Kwangtung Province.

Clitoria ternatea Linn. Sp. Pl. 753. 1753.

Wisteria dubia Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 324. 1843. "China: absque loco" (syn. nov.).

Walpers had only fragmentary material with a single detached flower. Hemsley admitted the species without comment, but Dunn and Tutcher did not account for it, although its type must have been from the general vicinity of Hongkong. Doctor Mattfeld informs me that Walpers' type in the Berlin Herbarium represents *Clitoria ternatea* Linn., the determination by Dr. Harms.

Crotalaria albida Heyne ex Roth, Nov. Pl. Sp. 333. 1821.

Crotalaria leiocarpos Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 8. 1843 (syn. nov.). "In Promontorio Syng-moon Chinae."

Vogel's species was admitted by Hemsley without comment, but it was not accounted for by Dunn and Tutcher. The species extends from India to southeastern China, Formosa, Indochina, Malay Peninsula and the Philippines. Vogel's description conforms with the characters of Heyne's species.

Crotalaria elliptica Roxb. Fl. Ind. ed. 2, **3**: 279. 1832.

Crotalaria Vachellii Hook. & Arn. Bot. Beechey Voy. 180. 1833.
Crotalaria splendens Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 8. 1843. "China."

This reduction of Vogel's species is apparently correct. Roxburgh's type was a specimen cultivated at Calcutta from seeds originating in China, and probably from the vicinity of Macao or of Canton; the type of *C. Vachellii* Hook. & Arn. was from Canton. The species is a rather common one in Kwangtung Province.

Desmodium heterocarpum (Linn.) DC. Prodr. **2:** 337. 1825.

Hedysarum heterocarpon Linn. Sp. Pl. 747. 1753.
Hedysarum polycarpon Poir. in Lam. Encycl. **6:** 413. 1804.
Desmodium polycarpum DC. Prodr. **2:** 334. 1825.
Desmodium nervosum Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 28. 1843. "China."

Schindler, Repert. Sp. Nov. Beih. **49:** 85, 285. 1928, placed Vogel's species as a synonym of *Desmodium siliquosum* Burm. f. In my discussion of Loureiro's species, Trans. Am. Philos. Soc. II **24**(2): 200. 1935, the problem of *Desmodium siliquosum* (Burm. f.) DC. versus *D. heterocarpum* (Linn.) DC. is extensively discussed. For the present, at least, it seems desirable to retain the Linnaean binomial for this Chinese form; Hemsley reduced Vogel's species to *D. polycarpum* DC.

Eriosema chinense Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 31. 1843. "China."

A characteristic, well-known, widely distributed, Indo-Malaysian species, for which Vogel's name is the oldest valid one. It is *Dolichos biflorus* sensu Lour. (1790), non Linn. Other synonyms are *Crotalaria tuberosa* Ham. and *Pyrrhotrichia tuberosa* Wight & Arn.

Lespedeza formosa (Vogel) Koehne, Deutsch. Dendrol. 343. 1893; Schindler, Repert. Sp. Nov. Beih. **49:** 85. 164. 1928.

Desmodium formosum Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 29. 1843. "In pratis circa Macao, Chinae."
Lespedeza viatorum Champ. Hook. Jour. Bot. Kew Gard. Miscel. **4:** 47. 1852.

This was admitted by Hemsley as *Desmodium formosum* Vogel with a statement that he had seen no Chinese material of *Desmodium* conforming to Vogel's description. It was not accounted for by Dunn and Tutcher. It is, however, clearly the same as *Lespedeza viatorum* Champ. as described in 1852, this species being correctly reduced to *Lespedeza formosa* (Vogel) Koehne, by Schindler. This is not *L. penduliflora* (Oudem.) Nakai, Bot. Mag. Tokyo **37:** 79. 1923, although Nakai cites *L. formosa* Koehne as a synonym; Koehne's binomial was based on Vogel's and thus *Lespedeza formosa* (Vogel) Koehne appertains to this species of southern China, in spite of the fact that Koehne applied the name to the more northern *L. penduliflora* (Oudem.) Nakai = *L. Thunbergii* Nakai, and erroneously cited as synonyms *L. racemosa* S. & Z. and *L. Sieboldii* Miq.

Lespedeza sericea (Thunb.) Miq. Ann. Mus. Bot. Lugd.-Bat. **3:** 49. 1867.

Hedysarum sericeum Thunb. Fl. Jap. 287 (err. typ. 289). 1784; Schindler, Sargent Pl. Wils. **2**: 105. 1914.

Indigofera chinensis Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 14. 1843. "Circa Macao in imperio Chinensi."

Vogel's species was admitted by Hemsley as a valid one of *Indigofera,* without comment. It was not accounted for by Dunn and Tutcher. Schindler's reduction of it to *Lespedeza sericea* (Thunb.) Miq. is undoubtedly correct. Most of the material from southern China is erroneously referred to *Lespedeza juncea* Pers.

Millettia nitida Benth. Hook. Lond. Jour. Bot. **1**: 484. 1842; Dunn, Jour. Linn. Soc. Bot. **41**: 161. 1912.

Marquartia tomentosa Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 35. *t. 1.* 1843. "In fruticetis promontorii Syng-moon Chinae."

Callerya tomentosa Endl. ex Jackson, Ind. Kew. **1**: 385. 1893.

Dunn states that *Millettia nitida* Benth. is unknown from outside of Hongkong Island. His distinction between this species and the closely allied *Millettia Dielsiana* Harms is by no means convincing. It is suspected that most of the Kwangtung material currently referred to *Millettia Dielsiana* Harms (1900) really represents *M. nitida* Benth. *Callerya* was proposed by Endlicher as a new generic name for *Marquartia* Vogel, *M. tomentosa* Vogel being originally described as the type of a new genus. Endlicher published no binomial (Gen. Suppl. **3**: 104. 1843), this apparently appearing first in Index Kewensis.

Pycnospora lutescens (Poir.) Schindl. Jour. Bot. **64**: 145. 1926.

Hedysarum lutescens Poir. in Lam. Encycl. **6**: 417. 1804.

Desmodium viride Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19**: Suppl. **1**: 29. 1843. "In pratis circa Macao, Chinae."

Meibomia viridis O. Ktz. Rev. Gen. Pl. 198. 1891.

Poiret's type of *Hedysarum lutescens* was from the vicinity of Canton. Vogel's species was admitted by Hemsley as a valid species of *Desmodium,* without comment. It was not mentioned by Dunn and Tutcher. Schindler's reduction of it to the common and widely distributed *Pycnospora lutescens* (Poir.) Schindl. is unquestionably correct. Other synonyms are *Pycnospora nervosa* W. & A., *Crotalaria ? nervosa* Wall., *Zornia lutescens* Steud., *Phyllodium lutescens* Desv., *Meibomia lutescens* O. Ktz., *Flemingia monosperma* Moon, *Pycnospora hedysaroides* R. Br., *Indigofera desmodioides* Benth., and *Crotalaria Tappenbeckiana* K. Schum. It is usually known as *Pycnospora hedysarioides* R. Br. It is common in Kwangtung Province and extends from India to Formosa southward through Malaysia to tropical Australia.

Tephrosia vestita Vogel, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 15. 1843. "In promontorio Syng-Moon Chinae."

A well-known strongly marked species extending from southeastern China to Java and New Guinea.

VITACEAE

Ampelopsis cantoniensis (Hook. & Arn.) Planch. in DC. Monog. Phan. **5:** 460. 1887.

Cissus cantoniensis Hook. & Arn. Bot. Beechey Voy. 175. 1833.
Vitis cantoniensis Seem. Bot. Voy. Herald 370. 1857.
Cissus diversifolia Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 314. 1843. "China: Cap Syng-moon."
Hedera hypoglauca Hance, Walp. Ann. **2:** 724. 1852.

This is the synonymy as given by Planchon, it apparently being correct. The species is common in Kwangtung Province.

MALVACEAE

Urena lobata Linn. Sp. Pl. 692. 1753.

Urena diversifolia Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 305. 1843. "China: Macao."

This seems clearly to be only a form of the very common and variable *Urena lobata* Linn. to which it was reduced by Hemsley.

MYRTACEAE

Eugenia microphylla Abel, Narr. Jour. China 181. 364. 1818; Forbes, Jour. Bot. **22:** 124. 1884.

Syzygium ? buxifolium Hook. & Arn. Bot. Beechey Voy. 187. 1833.
Syllysium buxifolium Meyen & Schauer, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 334. 1843. "China: Macao."
Eugenia sinensis Hemsl. Jour. Linn. Soc. Bot. **23:** 298. 1887.

Meyen and Schauer described this as the type of a new genus with no reference to the earlier *Syzygium ? buxifolium* Hook. & Arn., the type of the latter also from Macao or in its general vicinity. The species is common and widely distributed in southeastern China.

ARALIACEAE

Acanthopanax trifoliatus (Linn.) Merr. Philip. Jour. Sci. **1:** Suppl. 217. 1906; Schneider, Ill. Handb. Laubholzk. **2:** 427. 1909.

Zanthoxylum trifoliatum Linn. Sp. Pl. 270. 1753.
Panax aculeatum Ait. Hort. Kew. **3:** 448. 1789.
Acanthopanax aculeatum Seem. Jour. Bot. **5:** 238. 1867.
Aralia trifoliata Meyen, Reise **2:** 332. 1835 [China], *nomen nudum.*

This is the only new binomial that I have detected in Meyen's own account of his visit to China in 1831 (Reise um die Erde . . . in den Jahren 1830, 1831, und 1832. **2:** 292–400. 1835). There is no description but Walpers (Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 348. 1843) and K. Koch. (Wochenschr. Gärtn. Pflanzenk. **2:** 366. 1859) examined Meyen's specimen in the Berlin Herbarium and reduced *Aralia trifoliata* Meyen to *Panax aculeatum* Ait.

UMBELLIFERAE

Ferula marathrophylla Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 347. 1843. "China: Cap Syng-moon."

This is admitted by Hemsley as the only *Ferula* known from China, and by Dunn and Tutcher without comment. Doctor Mattfeld reports that there is no specimen in the Berlin Herbarium under *Ferula,* representing this species. Because of the description of the leaf segments as "lineari-capillaceis" I suggested search in those genera known to have representatives in Kwangtung Province having slender leaf segments but Meyen's specimen could not be found under *Apium, Foeniculum* and *Coriandrum.* There is the possibility that the Meyen specimen was erroneously localized, or again the record may have been based on an introduced plant that perhaps has not persisted. I cannot place the species on the basis of the rather short description.

LOGANIACEAE

Mitrasacme nudicaulis Reinw. ex Blume, Bijdr. 849. 1826.

Mitrasacme chinensis Griseb. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 51. 1843. "Locus natalis Cap Syng-moon Chinae."

The Chinese form does not appear to be specifically distinct from the Javan one as originally described by Reinwardt. It is therefore believed that the current reduction of Grisebach's species as a synonym of *M. nudicaulis* Reinw. is correct. The species is one of wide geographic distribution in the Indo-Malaysian region.

ASCLEPIADACEAE

Toxocarpus Wightianus Hook. & Arn. Bot. Beechey Voy. 200. 1836.

Schistocodon Meyenii Schauer, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 363. 1843. "China: Promont. Syng-moon."

Here described as the type of a new genus, but manifestly the same as *Toxocarpus Wightianus* Hook. & Arn., the type of the latter from Macao or in its immediate vicinity. The species is common in Kwangtung Province.

LENTIBULARIACEAE

Utricularia racemosa Wall. List, no. 1496. 1829, *nomen nudum;* Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 401. 1843. "China: Cap Syng-moon"; DC. Prodr. **8:** 21. 1844.

Walpers' description is one year earlier than is that of deCandolle. It was apparently based on both Wallich 1496 and on Meyen's Syngmoon specimen.

SCROPHULARIACEAE

Adenosma glutinosum (Linn.) Druce, Bot. Exch. Club Brit. Isles Rep. **3:** 413. 1914; Merr. Philip. Jour. Sci. **12:** Bot. 109. 1917.

Gerardia glutinosa Linn. Sp. Pl. 611. 1753; Osbeck, Dagbok Ostind. Resa 229. *t. 9.* 1757.
Digitalis sinensis Lour. Fl. Cochinch. 478. 1790.
Pterostigma grandiflorum Benth. Scroph. Ind. 21. 1835; Hook. & Arn. Bot. Beechey Voy. 204. *t. 45.* 1836.
Adenosma grandiflorum Benth. ex Hance, Jour. Linn. Soc. Bot. **13:** 114. 1872.
Pterostigma rubiginosum Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 393. 1843. "China: Macao."

The Linnaean type was a specimen collected by Osbeck in the vicinity of Canton; it was illustrated by Osbeck four years after it was originally characterized. The types of all the species above listed as synonyms were from the neighborhood of Macao or of Canton, where the plant is still common.

Lindernia crustacea (Linn.) F. Muell. Census 97. 1882.

Capraria crustacea Linn. Mant. **1:** 87. 1767.
Vandellia crustacea Benth. Scroph. Ind. 35. 1835.
Vandellia limosa Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 394. 1843. "China: in limosis prope Lintin"; Hemsl. Jour. Linn. Soc. Bot. **26:** 190. 1890.

Hemsley admits this as a valid species but quotes Bentham who suggested that it might be the same as *Vandellia crustacea* Benth. It was not accounted for by Dunn and Tutcher. From the short description I could see no reason for distinguishing it from the very common *Lindernia crustacea* (Linn.) F. Muell. (*Vandellia crustacea* Benth.) and Dr. Mattfeld confirms this by an examination of the type specimen in Berlin.

RUBIACEAE

Oldenlandia corymbosa Linn. Sp. Pl. 119. 1753.

Scoparia gypsophiloides Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 394. 1843. "China: Lintin" (syn. nov.).

Doctor Mattfeld reports that no specimen representing this species is to be found in the Berlin herbarium under *Scoparia*. On the basis of the short description, this works out as *Oldenlandia corymbosa* Linn., the only Kwangtung species known in any family that conforms to the characters indicated by Walpers. The above reduction is made with considerable confidence that it is correct. *Oldenlandia corymbosa* Linn. is a very common weed in Kwangtung Province, and is now of pantropic distribution. Hemsley merely listed the species, in brackets, as a Chinese plant unknown to him, realizing that no *Scoparia* was represented. Fries, in his "Systematische Übersicht der Gattung Scoparia." Arkiv Bot. **6**(9): 1–31. *t. 1–8.* 1907, places it among the *species dubiae* and merely states: "Ist mit aller Wahrscheinlichkeit keine *Scoparia*."

COMPOSITAE

Aster panduratus Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 258. 1843. "China: Lintin"; Hemsl. Jour. Linn. Soc. Bot. **23:** 415. 1888; Dunn & Tutcher, Kew Bull. Add. Ser. **10:** 141. 1912.

Aster Fordii Hemsl. Jour. Linn. Soc. Bot. **23:** 410. 1888; Dunn & Tutcher, l.c. (syn. nov.).

Hemsley admitted Nees' species without comment. Dunn and Tutcher distinguished *A. Fordii* Hemsl. and *A. panduratus* Nees (having seen no specimens representing the latter) as follows: "Upper leaves entire, obtuse, *A. Fordii*"; "Upper leaves serrate, acuminate, *A. panduratus*." Doctor Mattfeld examined Nees' type in the Berlin Herbarium and states that it represents the same species as *Hongkong herb. 2824*, distributed as *A. Fordii* Hemsl. The leaves of Nees' species are mostly entire, some with 1 to 3 small teeth in the upper one-third. Some of the leaves are blunt and mucronate, others somewhat acute.

Aster Walpersianus Nees, Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 259. 1843. "China: Lintin."

Hemsley admits this species without comment, but Dunn and Tutcher do not include it. Doctor Mattfeld reports that the type specimen consists only of a small twig, that, however, agrees with Nees' description although the label bears the statement "Macao, in convallibus montium inferiorum" not Lintin as stated in the description. The heads are hemispheric. The specimen does not conform to the characters of any of the species of *Aster* credited by Dunn and Tutcher to Kwangtung Province. It is somewhat similar to those forms of the North American *Aster laevis* Linn. that also bear larger leaves on the lateral branches. From the data at present available I am unable to associate this species with any other described species of the genus from China.

Blumea hieracifolia (D. Don) DC. in Wight, Contrib. Bot. Ind. 15. 1834, Prodr. **5:** 442. 1836.

Erigeron hieracifolium D. Don, Prodr. Fl. Nepal. 172. 1825.
Blumea chinensis Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 294, 1843. "China: Cap Syng-moon" (sub *Vernonia conyzoides* DC. p. 254), non DC. 1834.

Walpers first referred the specimen to *Vernonia conyzoides* DC., but in the *addenda* characterized it as a new species of *Blumea,* overlooking the fact that deCandolle had already applied the specific name *chinensis* to a very different species. In Index Kewensis it is reduced to *Blumea hieracifolia* DC., the species to which Walpers compared it, and Hemsley states that it is perhaps a form of *B. hieracifolia* DC. Dunn and Tutcher do not mention it, although they admit deCandolle's species as growing in Kwangtung Province. There is a portion of the type specimen in the Klatt collection at the Gray Herbarium labeled "*Blumea chinensis* Walp. China-Cap Syng-moon" and this seems safely to represent the same species as the Chinese material referred by Hemsley and by Dunn and Tutcher to *B. hieracifolia* DC.; the label bears also an unpublished binomial accredited to Dietrich. The Chinese specimens, however, are by no means identical with the Indian material on which deCandolle's species was originally based, but may still represent *Blumea hieracifolia* (D. Don) DC. sensu latiore.

Blumea obliqua (Linn.) Druce, Bot. Exch. Club Brit. Isles Rep. **4:** 609. 1917.

Erigeron obliquum Linn. Mant. **2:** 573. 1771.
Conyza obliqua Willd. Sp. Pl. **3:** 1930. 1804.
Conyza amplexicaulis Lam. Encycl. **2:** 84. 1786.
Blumea amplectens DC. in Wight, Contrib. Bot. Ind. 13. 1834. Prodr. **5:** 433. 1836.
Vernonia Gomphrena Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 253. 1843. "China: Lintin" (syn. nov.).

Hemsley admitted this as *Vernonia Gomphrena* Walp., without comment other than the slightly erroneous statement that it was from China "without locality"; Dunn and Tutcher did not account for it. Doctor Mattfeld states that Walpers' type specimen in the Berlin herbarium bears also an unpublished binomial, sub *Blumea,* proposed by Schulz-Bipontinus. He further states that it is very similar to, if not identical with, the Indian *Blumea amplectens* DC. There is an excellent sketch of Walpers' type, with fragments (a leaf and immature heads), in the Klatt collection now at the Gray Herbarium. On the basis of the data and information now available I believe that *Vernonia Gomphrena* Walp. is but a form of the Indian and Ceylon *Blumea obliqua* (Linn.) Druce (*B. amplectens* DC.), in spite of the fact that the species is not represented by any modern collections from Kwangtung. Because of the very extensive early commerce between India and Macao and Canton, it is entirely possible that here we have an introduced plant that perhaps has not persisted. Gagnepain does not admit the Linnaean species for the Indochina flora, neither does Craib record it from Siam. In attempting possibly to connect *Vernonia Gomphrena* Walp. with some one of the Indochina species of *Blumea* all of Gagnepain's descriptions were scanned; at first it was thought that possibly *Blumea hongkongensis* Vaniot might be the one sought. However Vaniot's original description does not at all apply to Walpers' species, while the Indo-China plant that Gagnepain described (Lecomte Fl. Gén. Indo-Chine **3:** 531. 1924) under Vaniot's binomial apparently does not represent the same species that Vaniot had. The original description calls for a plant with petioled leaves attenuate below into a long cuneate base; while Gagnepain described a plant with sessile and somewhat stem-clasping leaves, citing only specimens from Indochina and Siam; Vaniot's type was from Hongkong. *Blumea obliqua* (Linn.) Druce, except for this Lintin Island record for China, is known from Central India, the western Peninsula, Bengal and Ceylon, and as interpreted by Hooker f. is distinctly a collective species. The type of *Vernonia Gomphrena* Walp. closely approximates specimens of *Blumea amplectens* DC. from Madras and Ceylon.

Glossogyne tenuifolia (Labill.) Cass. Dict. Sci. Nat. **51:** 475. 1827.

Bidens tenuifolia Labill. Sert. Austr. Caled. 44. *t. 45.* 1824–25.
Bidens Meyeniana Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 271. 1843. "China: Cap Syng-moon" (syn. nov.).

Hemsley admitted *Bidens Meyeniana* Walp. as a valid species, stating that it might be referable to *B. parviflora* Willd. or *B. pinnata* Linn. It is not accounted for by Dunn and Tutcher. Cassini's species is common in southeastern China. Walpers' description conforms to its characters, and from the description alone *Bidens Meyeniana* Walp. is safely referable to *Glossogyne tenuifolia* Cass. This disposition of it is confirmed by Sherff's reference of Meyen's type in the Berlin Herbarium to Cassini's species.

Inula Cappa (Ham.) DC. Prodr. **5:** 469. 1836.

Conyza Cappa Ham. in D. Don, Prodr. Fl. Nepal. 176. 1825.
Inula pseudo-cappa DC. l.c.
Duhaldea chinensis DC. op. cit. 366.
Vernonia congesta Benth. Hook. Lond. Jour. Bot. **1:** 487. 1842.
Vernonia eriosematoides Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 254. 1843. "China: Cap Syng-moon."
Moquinia eriosematoides Walp. Repert. **6:** 317. 1846–47.

Hamilton's original description was based on Indian material. The other binomials listed above were all based on Chinese specimens. As *Inula Cappa* DC. is currently interpreted this seems to be the correct disposition of Walpers' species.

Microglossa pyrifolia (Lam.) O. Ktze. Rev. Gen. Pl. 353. 1891; Merr. Lingnan Sci. Jour. **15:** 428. 1936.

Conyza pyrifolia Lam. Encycl. **2:** 89. 1786.
Conyza volubilis Wall. List no. 3057. 1831, *nomen nudum.*
Microglossa volubilis DC. Prodr. **5:** 320. 1836.
Conyza syringaefolia Meyen & Walp. Nova Acta Acad. Leop.-Carol. Nat. Cur. **19:** Suppl. **1:** 263. 1843. "China: Cap Syng-moon. Insula Zbar."; Hemsley Jour. Linn. Soc. Bot. **23:** 420. 1888.

Conyza syringaefolia Meyen & Walp. was admitted by Hemsley who states that in many respects the description agrees with *Microglossa volubilis* DC. It was not accounted for by Dunn and Tutcher. An examination of the type by Dr. Mattfeld shows that it is the same as *Microglossa volubilis* (Wall.) DC. = *M. pyrifolia* (Lam.) O. Ktze. This is verified by an excellent sketch of Meyen and Walpers' type, together with a fragment of it in the Klatt collection now in the Gray Herbarium. The species is common and is widely distributed in the Indo-Malaysian region.

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RECENT CHANGES OF CLIMATE AND VEGETATION IN SOUTHERN NEW ENGLAND AND ADJACENT NEW YORK

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INTRODUCTION

BOTANICAL STUDIES in the Hudson Highlands of southern New York State have suggested the present inquiry into changes which may have occurred in the vegetation during very recent geologic time. By "recent" is meant the past 3000 years or less. The configuration of timber types on the granitic hills in the Black Rock Forest fairly typifies the Highlands region, and is essentially as follows.[1]

Most of the slopes, which for the most part are steep and rocky, are clothed with a forest of red and chestnut oaks (*Quercus borealis* and *Q. montana,* respectively), associated with other trees in less abundance. Formerly the chestnut (*Castanea dentata*) was one of the primary species. In general, the red oaks are more abundant on the lower slopes, and the chestnut oaks on the upper; but in very rocky places the chestnut oak is likely to predominate even at low levels, while the red oak may predominate at high levels if the slopes are gradual. The intervales, or coves, have a mixed forest in which sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), linden (*Tilia glabra*), yellow birch (*Betula lutea*), tulip-tree (*Liriodendron Tulipifera*), red oak, and red maple (*Acer rubrum*) are the commonest species. Beech (*Fagus grandifolia*), American elm (*Ulmus americana*), black birch (*Betula lenta*), white oak (*Q. alba*), shagbark hickory (*Carya ovata*), and a few other species of similar requirements are usually present in smaller

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[1] General collections and field notes were made in the Black Rock Forest in the summer of 1936. This material is to be embodied in a forthcoming, more or less detailed description of the flora and types of vegetation. For a more complete description of the Forest than appears here see Tryon, '30.

numbers. Northward-facing ravines and lower north slopes usually have a larger percentage of hemlock (*Tsuga canadensis*), and in a few restricted localities the beech becomes a primary tree. Within the Forest area most of the cove timber lies between 450 and 1100 feet above sea level.

The crowns of the hills, most of which lie between 1200 and 1450 feet above the sea, are distinguished by two types of vegetation. The southwest sides usually have an open scrub of pitch pine (*Pinus rigida*) and scrub oak (*Q. ilicifolia*) interspersed with grassy areas in which *Andropogon scoparius* var. *frequens, Danthonia spicata,* and *Deschampsia flexuosa* are the commonest species, together with some small shrubs such as *Vaccinium pennsylvanicum, V. vacillans,* and *Prunus pumila* var. *susquehanae*. The northeast sides are usually covered with a rather scrubby forest of white oak and pignut hickory (*Carya glabra*). Associated with these trees is usually a dense growth of *Viburnum pubescens* var. *Deamii* which constitutes most of the shrub cover. This association is extremely limited in extent, rarely descending below the crown of the hills, and then only on warm southern slopes. The *Viburnum* is rarely met with anywhere in the region except in these restricted areas.

There is considerable evidence that this arrangement of forest types is essentially the same as that which occurred in pre-colonial times, in spite of the long period of exploitation. This evidence, which will not be discussed in detail here, is mainly in the growth-form and position of very old trees, in the general condition of the soils, and in old records.[1]

It will be readily seen that we have here representatives of three forest types whose geographic ranges are different and fairly distinct. The cove forest is clearly a modified form of the hemlock-northern hardwood type which is commonly associated with white pine and ranges throughout much of the northern Great Lakes states and New England, sending a long tongue southward along the Appalachians (Nichols, '35). The coniferous element is poorly developed in the Highlands region; and the northern hardwoods, instead of being dominated largely by beech, sugar maple and yellow birch as they are farther northward, show a mixed facies as noted above. The chestnut oak - red oak-(formerly) chestnut association of the slopes is closely related to the forests of similar situations in the southern and middle Appalachians (Weaver & Clements, '29; Shreve, Chrysler, Blodgett & Besley, '10). The white oak-hickory association on the other hand is typically middle-western, having its best development in the Mississippi basin. This western

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[1] Further discussion of this matter will be found in the writer's projected botanical report on the Black Rock Forest.

affinity is accentuated by the local abundance of *Viburnum pubescens* var. *Deamii* which is here near its eastern limit, and is a common form of the species in the middle-west.

From the standpoint of silvicultural planning it becomes of interest to know the significance of the three types. Is the present state of affairs a static one; or may it be expected to change during the succeeding generations of commercially grown trees? If the latter, may the white oak-hickory type be expected to expand over more of the slopes, with a corresponding restriction of the cove type, suggesting a warmer and drier condition; or may the commercially valuable cove timber be expected to expand up the slopes and the oak-hickory type be still further reduced than it is at present, suggesting a somewhat cooler and more moist situation? In case of the former, the chestnut oak could be expected to occupy more of the slopes than it does at present, and in case of the latter it would probably be more restricted than at present.

There is no reason to believe that the present distribution is a static one, particularly in view of the vast amount of evidence to the contrary in most of the temperate and subarctic regions of the world. To name only a few sources: the succession of vegetation shown in recent peat deposits; fossil floras of other nature involving longer periods of time; the advance of forest into prairie in middle-western United States within historic times, and the oscillation of prairie-forest boundaries in comparatively recent post-Glacial time in the same region. The major problem seems to be rather to determine which way the change is going, and its probable rate.

The present geographic ranges of the three forest types mentioned above are commonly, and probably rightly, thought to be determined by climatic and historical factors operating over very long periods of time. The climatic influences of the Appalachian Mountains on the one hand, and the increasing aridity toward the westward in the Mississippi basin on the other, acting through long periods in the evolutionary history of the deciduous forests, have led to the development of the xerophytic chestnut oak-chestnut, and white oak-hickory types respectively (Weaver & Clements, '29).[1]

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[1] There is the suggestion here that we are dealing with a group of forest associations which may be as old as the species which compose them. There is some evidence that the most ancient of the group was the more mesophytic type, consisting of beeches, with ancestral oaks and chestnuts. The scanty fossil evidence indicates that these date far back in the Cretaceous, whereas the modern lobe-leaved oaks, for instance, as well as the hickories, are not known as fossils until the early Tertiary (Berry, '23). If this is the case it is not unreasonable to consider that these xeric expressions within the deciduous forest appeared under the stimulus of the aridity which developed in the interior of America early in the Tertiary.

The persistence of such forest complexes for very long periods of geologic time has

THE PRE-COLONIAL FORESTS

Oak forests in which white, red, and black oaks are predominating elements are characteristic of southern New York and most of southern New England east of the Berkshires (Mass., R. I., Conn.) (Nichols, '13; Bray, '30; Hawley & Hawes, '12). The hickories and the tulip-tree are commonly associated with the oaks, and chestnut was formerly a primary part of the association. The whole has long been classed by foresters as "sprout hardwood"[1] on account of the abundance of reproduction by this method. Except for parts of extreme southeastern New England (S. E. Conn., R. I., and Cape Cod), these oak forests are generally regarded as of secondary origin, i.e., they have come as a result of fire or clearing (Nichols, '13 and '26; Bray, '30; Hawley & Hawes, '12; Lutz, '28; Weaver & Clements, '29; Bromley, '35). The forest type which is generally considered the "climax" in this region, that most nearly in accord with the climate, is a mixed timber of hemlock and the northern hardwoods such as beech, sugar maple, and yellow birch. The white pine (*Pinus Strobus*) is usually regarded as a characteristic tree though its abundance in the primeval forest is thought to have been local at least in New England (Fisher, '33; Nichols, '13 and '35). Arguments for the recognition of this type as climax are adequately summarized by Nichols ('35); and in spite of the fact that the forest bears many characteristics of a transition from the Canadian coniferous timber of spruce and fir to the deciduous woodlands farther south, there seem to be sufficient distinctive characters to warrant its separation.

If the oak forests are to be regarded as temporary in much of southern New England, and likewise the white oak-hickory type in the Black Rock Forest, then it appears necessary to regard the secondary influences as

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been pointed out by Chaney ('25), who has based his studies upon the redwood forests of California.

The silvicultural significance of this concept is readily seen. When type-mapping, cruising, or otherwise describing woodlands the forester commonly uses *groups* of species as units; but when working out his silvicultural methods and programs he is prone to deal in *single* species, encouraging or retarding them without much regard for their associational relationships. The final result of such a breaking up of natural associations cannot be predicted without much more knowledge of the species and their relationships than is now available, but the excellent results obtained when the natural associations are in large part preserved are becoming evident in those experimental stands where this is being tried (See Tarbox & Reed, '24; Cline & Lockard, '25). These results, coupled with the probable antiquity and relative permanence of our common forest associations, suggest that further knowledge of the bonds with which the latter are held together would be of great silvicultural value.

[1] This term will be used throughout the paper to designate an association dominated by oaks (mainly white and black), hickory, and chestnut, with the tulip-tree a common constituent. For a general discussion of eastern forest classification see Toumey, '28.

having begun before the advent of Europeans. It has already been noted that in the Hudson Highlands the present distribution of types probably antedates the colonial period. Recent studies in southern New England point to the same conclusion, as expressed in a recent paper by Bromley ('35). Unfortunately the early writers cited by Bromley do not, with one possible exception, present adequate evidence on the interior uplands of the region for which information is most needed. He relies most heavily upon John Smith (1616), Thomas Morton (1632), William Wood (1634), John Josselyn (1672 and '75), and Timothy Dwight (1821). Descriptions written by the first four of these all indicate clearly that the coastal strip was forested primarily with oak and pine, but there is no indication that any of them visited the interior or obtained reliable information on it. Dwight's travels were in the early 1800's or very late 1700's, and were not published upon until 1821. It must be remembered that at this time some of the inland settlements in the Connecticut valley were over 150 years old; and even the youngest of the upland agricultural communities of central New England were at least 50 years old, and many of them twice that age. It must be noted also that the clearing of land for cultivation and pasture was approaching its maximum in many communities (Fisher, '33). It is probable, however, that Dwight was describing remnants of the original forest in some districts, particularly in the younger towns of central Massachusetts.

With these things in view it is pertinent to examine contemporary histories written during the 1700's. A number are available, but most of those found thus far by the present writer have yielded nothing of interest in this connection. The one notable exception is Peter Whitney's *The History of the County of Worcester,* published in 1793. Whitney was a clergyman who was born in 1744 in the western part of this county, in the town of Petersham. He was educated at Harvard College and held a charge at Northborough, Massachusetts, from 1767 to the time of his death in 1816.[1] His history must have been written, therefore, while many of the towns in the county were less than 50 years old; and his observations must have extended back somewhat further than 1767. There must have been relatively large areas of primeval

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[1] The writer is indebted to Mrs. Mabel Coolidge of Petersham for references bearing upon the life of Peter Whitney. These are to be found in "An Address Delivered in Petersham, Massachusetts, July 4, 1854, in Commemoration of the One Hundredth Anniversary of the Incorporation of That Town," by Edmund B. Willson (Boston, 1855). That Whitney had an early interest in horticultural matters is shown by his note communicated to the American Academy of Arts and Sciences (See Memoirs of this organization, Vol. 1, p. 386) on the subject of a curious hybrid apple tree in his native town.

forest in the region during his lifetime. The history was written by towns, and in each description is a brief account of the existing timber, with notes on its earlier condition if such were available. Whitney's knowledge of the common forest trees was evidently quite extensive, for in no other way can we account for the detail with which his notes are given. Two checks upon his accuracy are available. One is the manner in which his records of scattered pitch pine plains agree with the known distribution of these. The other is the way in which the hemlock-northern hardwood forest of Winchendon and parts of adjoining towns stands out clearly, just as it does today, in a county otherwise described by him as dominated largely by oaks, chestnut, and "walnut."[1] His descriptions leave little doubt that in central Massachusetts at least the pre-colonial forest was primarily of "sprout hardwood" species. Although the hemlock-northern hardwood forest was predominant on the uplands in parts of the most northern towns, it seems to have been limited elsewhere to lower slopes and ravines.

The aborigines of southern New England were a semi-agricultural people, but there is no evidence that their clearings of the forest ever went beyond relatively small localized areas. Consequently, if a secondary agency is to account for the presence of the oak forests, fire is the only one conceivable. Bromley has cited the comments of several early writers on southern New England in support of the hypothesis that most of the forests of this region which were dry enough to burn (oak-chestnut-hickory and pine) were burned at least once a year by the Indians for centuries before the coming of the white man. It is his opinion that these forests were maintained in this condition by such recurring fires, although he suggests that some of the oak-chestnut-hickory forests in his present "white pine region" may have been edaphic on the drier sites (Bromley, '35, p. 74).

There is no question but that fire has always been a factor in the control of forests, whether set by lightning or by man; and there is abundant evidence that the Indians deliberately set fire to the woods on occasion. Furthermore, anyone who has observed the modern descendants of the red man living in the wild will attest to their common carelessness in putting out campfires. But to picture such a wholesale conflagration in Massachusetts, Rhode Island, Connecticut, and southern New York State as would involve most of the inflammable woods every year, or even every 10 or 20 years, is inconceivable. Even if the forest were not entirely destroyed as a whole, at least the undergrowth and herbaceous species, to say nothing of the animal life, would have been

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[1] In the early writings "walnut" was a general term for both *Juglans* and *Carya*.

nearly or quite destroyed over large areas. Yet the country was known to be teeming with game even near the coast when the colonists arrived, and there has never been any evidence of the early elimination of large populations of woodland plants in these regions.

Two sets of facts are worthy of note in this connection. First, the significance of the early writings is open to question here as it is in descriptions of the timber itself: the coastal strip is the only area for which authentic information is available.[1] It is of interest that Peter Whitney makes very few references to fire of any kind in his history of Worcester County.

The reasons assumed by the early colonists for the firing of the forests are also of interest. They appear to have been impressed first, not by the fires, but by the openness and park-like character of the woods. They attributed it at once to the efforts of the natives, usually giving as purposes either the improvement of visibility and travel by eliminating the undergrowth, or the "improvement" of pasturage for game by encouraging the growth of grasses and other herbage in the forest.[2] Without exception these writers were western Europeans whose ancestors had lived for centuries in a region continually under the influence of civilized man; consequently it was difficult or impossible for them to conceive of open, park-like woods growing naturally, without human intervention. Natural woods was for them of necessity a dense growth, either of conifers or of coppiced hardwoods such as they knew in Europe or the British Isles.

Open, park-like woods have been, from time immemorial, characteristic of vast areas in North America. Almost anywhere one chooses to look on the periphery of the great arid plains of the interior of the continent he sees this savannah or park-land extensively developed. Its occurrence far eastward in Ohio has led to some of the most interesting and far-reaching hypotheses in American plant geography (Gleason, '23; Sears, '33 and '35a; Transeau, '35). Most of the initial reactions of Europeans to these western park-lands or open woods have been identical with those expressed by the earliest New England colonists: that they had been caused by fire, usually thought to have been set by

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[1] For comment on the dearth of information about the interior of New England in 1630 see the edition of Thomas Morton's *The New English Canaan* published by the Prince Society, Boston, in 1883, with introductory matter and notes by the historian Charles Francis Adams. Morton was notably inaccurate in many lines, and was doubly so when writing of the interior. He wrote with seeming authority, but in fact quite at random, about the country around Lake Champlain, and farther south he confused the Hudson and Potomac Rivers.

[2] In addition to the early New England writers cited above see also Van der Donck (1656).

the Indians. This manner of explanation persists to the present, and recently discovered park-lands in northern Canada have been accounted for by some travellers and students in the same way.[1] No one will doubt that fire has had a significant influence in determining the presence of park-land, but wherever detailed and careful studies have been possible, fire has been slowly forced into the background as an actual *causative* factor, and fundamental climatic, edaphic, and historical factors take their rightful precedence (Sears, '33 and '35a, b; Moss, '32; Transeau, '35, p. 434).[2]

It seems necessary therefore to question rigorously or to discard in large measure the evidence of early writers for the relative openness of the woods on the inland region of New England and southern New York. Likewise it is doubtful whether the reasons they have given for the openness near the coast can be accepted at face value. Judging by what is known of park-lands and open woods in general, and particularly in view of the similarity between the southern New England oak-hickory forests and those of the middle west, it is more logical to think that the pre-colonial oak-chestnut-hickory type which prevailed in much of the region was the normal vegetational expression of the climatic-edaphic complex which had obtained here. No doubt fires helped to maintain it against the competition of the more mesophytic forests to the north and northwest, but that fires were the sole factor in maintaining it is difficult to believe.

With the antiquity of the oak-chestnut-hickory forests in this region fairly well established, the question naturally arises as to why they are almost universally regarded among foresters as temporary types except in the extreme southeastern sections. Two reasons might be suggested. One is the widespread concept that clearing and fire have caused radical changes in the composition of the forest, and that since practically all of the original forest in this region has been destroyed the present stands are very likely to be different from the original. By further reasoning along this line it is assumed that if the present stands are properly protected they should revert to this hypothetical original state. There is abundant evidence in support of this concept, particularly in southern New England where such a large percentage of the land was allowed to

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[1] For discussion and citations in this connection see Raup, '34.

[2] Gleason postulated two advances of prairie vegetation into the middle west. The first he thought was due to an extension of arid climates, but the second he accounted for by the appearance of the Indians who drove the forest back with prairie fires. The forest advance of modern times he attributed to the protection from fire which was afforded by white settlement. It seems more probable, in the light of Sears' correlations of evidence from many regions, that the recent advance (providing there were two of them) was due also primarily to a more arid climate.

return to forest after being cleared or under cultivation for several generations. The well-defined succession of facies in abandoned fields thoughout this region is enough to account for the whole idea.

Another reason which might be advanced is that there is an actual progressive elimination of the oak-hickory forests from the region, and a corresponding advance of the hemlock-northern hardwood type. A great deal of evidence has accumulated which supports this. Old field timber at the Harvard Forest in Petersham, Massachusetts, tends to develop toward a forest of northern and "transition" hardwoods rather than toward one of white and black oaks and hickory[1] (Fisher, '18 and '28; Griffith, Hartwell & Shaw, '30; Spaeth, '20; Averill, Averill & Stevens, '23; Cline & Lockard, '25). The wide extent of this tendency in the northern half of Worcester County, adjacent Franklin and Hampshire Counties, and adjacent New Hampshire is shown in a recent survey of old field pine lands by McKinnon, Hyde & Cline ('35). Of 225 stands examined, involving approximately 2023 acres, only 15 stands covering 132 acres could be classified as of white oak-hickory type, and these were all in the southern part of the district. All of the remainder were noted as of northern or "transition" hardwoods, mainly the latter in which red oak, white ash, white and black birch, red and sugar maple are the predominant trees. Over a large proportion of this very region Peter Whitney described oak-chestnut-"walnut" forests early in the history of the settlements. Towns with such woods were Petersham (part), Athol (part), Oakham, Paxton, Barre (part), Sterling, Lunenberg, Harvard, Holden, Leominster, Westminster, Hardwick and Rutland. It is of interest that in a few places he recorded that the "walnut" seemed to be increasing. This was probably due to the opening of the oak-chestnut forests and may be observed throughout the oak-hickory regions of the middle west where clearing of old growth commonly gives rise to dense stands of sprout hickory very soon afterwards.[2]

[1] It is presumed that the oak-chestnut-hickory forest described by Whitney involved white and black oaks more prominently than red. This is based upon the present known relationships of these species. The red oak is a primary constituent of the so-called transition hardwoods, in which the hickories do not play an important part; the latter are usually most abundant in association with white and black oaks in this region.

[2] An outstanding feature of the New England forests during the past 75-100 years has been the growth of white pine on abandoned farm lands. Vast acreages seeded in to nearly pure stands of pine very soon after they were abandoned, and produced a wealth of lumber during the latter part of the last century and the first of the present one. In fact most of eastern Massachusetts, northeastern Connecticut, and northern Rhode Island has come to be known as part of the "white pine region" (See Sargent, 1884; Hawley & Hawes, '12; Bromley, '35). It is thought, however, that in the hypothetical virgin forest of hemlock and northern hardwoods the white pine was "a normal, although minor, constituent," and that its presence in the climatic climax association was due to local, more or less accidental openings in the

The tendency for the hemlock and more northern hardwoods to succeed the oaks and hickories has been noted repeatedly in Connecticut. Nichols has this statement in a recent paper: "Not without significance also may be the fact that in Connecticut and elsewhere along the southern borders of this region [hemlock-white pine-northern hardwood] the hemlock and northern hardwoods gain successional ascendency over oaks and other relatively southern trees when competing with them on the better soils . . ." (Nichols, '35). Lutz ('28) concluded, on the basis of a careful study of forest successions in southern New England, that the major trend was toward a hemlock-hardwood type, and Bromley ('35) appears to be of the same opinion.

There is good evidence therefore that within the past 200–300 years some of the more southern elements in the forests of central New England, notably the hickories and walnuts, have been partially eliminated, and that the secondary forest successions in southern New England east of the Berkshires generally are trending toward a forest of hemlock and northern or transition hardwoods rather than toward one involving white and black oaks and other "sprout hardwoods." If the pre-colonial forests were primarily of oak-chestnut-hickory over most of this region, then we are confronted with the question of how this distinctly southern and western phase of the deciduous forest came to predominate in a region which now appears to be largely unsuited to it.

Although generally adhering to the idea that the sprout hardwoods in Connecticut were due to the influence of man, Nichols expressed some doubt in his early papers on the vegetation of that state as follows: "But the forest is by no means uniform in structure throughout the state. Most widely disseminated and of greatest economic importance is the "sprout hardwood" type which represents the usual climax formation over fully five-sixths of the state. . . . To what extent these modifications in forest composition should be attributed to contemporaneous factors cannot be definitely decided. In a measure the presence or

hemlock-hardwood stand (Nichols, '35; Fisher, '33). A question naturally arises as to the source of the large quantities of white pine which appear to have been available to the early settlers. With the pine so much in demand, it was the first of our forest trees to be seriously depleted in many regions. There is, therefore, a further question as to the source of the seed which produced the immense development of old field pine during the last century.

If the pre-colonial forest was mainly of oak, chestnut, and hickory, it might be expected that the white pine was far more abundant when the settlers came than is now supposed. This forest would have been relatively open and considerably drier than the hemlock-northern hardwood type, and more subject to fire. Under these conditions a considerable amount of second-growth pine could have developed during the period prior to wholesale abandonment of farms, this later to maintain a supply of lumber and to seed in the open fields. It is notable that Whitney records an abundance of white pine during the early history of many towns in Worcester County.

absence of particular species may be the result of geographic position, but it seems more likely that this scarcity or abundance is determined by physiographic or climatic factors" (Nichols, '13, p. 100). Bromley, on the theory that fire was the cause for the prevalence of the oak-chestnut forests, found it necessary to postulate extremely frequent conflagrations, extending over most of southern New England, and during centuries of time. The early colonial writers mention only the burning of oak-chestnut forests, since these were the only ones which were common near the coast; and Timothy Dwight (Letter VIII) states that the oak-chestnut and pine lands were the only ones regularly burned because only they were dry enough. If this was the case, then we must either assume that the "dry" forest of oak and chestnut was here before the Indian arrived, or that an ancient forest of hemlock and northern hardwoods very gradually succumbed to very frequent fires started on a few dry sites and encouraged by occasional dry years.

As suggested above, the absence of good evidence that such intense burning occurred on the interior uplands, or that it was significant on the coastal strip, must now be coupled with doubt as to the actual function of fire in originally *causing* the prevalence of sprout hardwoods. It seems necessary to look at climatic or edaphic influences of long standing in the region as a whole for further light on the matter, and to study the history of the vegetation with this broader aspect. Nichols suggested this in 1913, as indicated above; and Bromley has noted that climate might have been effective: "As we do not as yet have pollen analyses of peat bogs from New England, we do not know exactly how or when one forest type succeeded another. It is known, however, that in the middle west, a dry period occurred about 3000 years ago which resulted in a dominance of xeric species, principally oaks. Although there is no present evidence of such a period in southern New England, it is not unreasonable to suppose that such did occur and very probably was the basic reason for the establishment of oak and pitch pine forests which were maintained by the Indians' fires until the white occupancy" ('35, p. 68).

If a warmer and drier climate existed in southern New England within the past 3000 years it is reasonable to expect that there should be some evidence of it remaining. With this in view, and remembering that a warm-dry period in the southern Great Lakes states was first recognized entirely upon floristic grounds, without benefit of pollen analysis, the present writer has attempted to gather such evidence as could be found. Various lines of inquiry have yielded results: botanical, zoological, paleontological, and archaeological, and these will be presented in the following discussion.

ZOOLOGICAL EVIDENCE

The occurrence of a "Virginian" element in the New England-Acadian coastal fauna was pointed out as long ago as 1862 in a paper by John Willis which incorporated the observations and suggestions of Sir William Dawson. In later years the data have been greatly amplified, and various hypotheses advanced to account for them. An excellent summary of the problem to the time of its publication is in a paper by W. F. Ganong in 1890. He listed 28 species of molluscs and echinoderms, besides a group of marine algae, which are of southern affinity but scattered northward along the coasts of New England and the Maritime Provinces. The form most commonly cited as an example of this dispersal is the oyster, which now occurs only in a few places in these waters, but which was evidently much more abundant in colonial times. There are repeated references to oyster banks, for instance in the Charles River basin at Boston (Hubbard, 1680; Josselyn, 1638 and 1663; Wood, 1634; Higginson, 1629), although these have long been extinct. Their abundance at various places along the coast in former historic times is proved by other early writings and by Indian shell heaps composed almost entirely of oyster shells. One of the largest of these heaps is in the estuary of the Damariscotta River in Maine. It has been studied recently by R. P. Goldthwait who also summarizes the present distribution of oysters on the Maine coast: "In Maine oysters are restricted to rocky current swept estuaries. Although numerous oyster beds thrive in the protected Gulf of St. Lawrence, further north, the relic colonies at Oyster River almost in Maine (Durham, New Hampshire) and at Sheepscott Falls, adjacent to the Damariscotta River, live in swift water nearly ten miles from the open ocean. These are the only known beds in hundreds of potential locations, and even they threaten to expire" ('35, p. 5).

There is abundant fossil evidence that oysters as well as many other southern forms were more common and widespread in northern waters in recent geologic time. Ganong reported the common occurrence of fossil oysters brought up from beds off-shore on the coasts of the Maritime Provinces (1890, p. 175). Upham summarized data from the vicinity of Boston in 1892 as follows: "Taken as a whole, the twenty-five species comprised in the identified fauna . . . belong in their present geographic range to a somewhat more southern and warmer portion of our coast. Fourteen are distinctly southern, and reach their northern limits at Cape Cod or in Massachusetts Bay, and in one instance near Portland, Maine; excepting that several of them occur in isolated colonies far north of their general and continuous range, as in Casco and

Quahog Bays, Maine, and especially in the shallow southern part of Acadian Bay of the Gulf of St. Lawrence, from Cape Breton Island to the Bay of Chaleurs. The occurrence of these southern molluscs, which are mostly now absent, or local and rare, north of Cape Cod, shows that the sea during some part of the Recent epoch has been warmer than at the present time" (1892, p. 203). Regarding the extinction of southern forms he states: "During the time of the accumulation of the aboriginal shell-heaps . . . of Maine, and even within the 270 years since the first white settlement in Massachusetts, very significant restriction and extinction can be shown. For example, Professor Verrill, 1874, states that dredging reveals the occurrence of great beds of oyster shells a few feet beneath the harbor mud at Portland, where they are associated with the quahog (*Venus mercenaria*), scallop (*Pecten irradians*), and other southern species; and that the oysters and scallops "had apparently become extinct in the vicinity of Portland Harbor before the period of the Indian shell-heaps, for neither of these species occurs in the heaps on the adjacent islands, while the quahogs lingered on until that time, but have subsequently died out everywhere in this region, except at Quahog Bay" (1892, pp. 208–9). Upham concludes that: "The extinction of oysters, and of their southern associates has been rapidly going on from Nova Scotia to Cape Cod since the earliest settlement of the country, due probably not so much to their exhaustion by being gathered for food, or to any and all other causes, as to the progressive refrigeration of the sea; . . ." (1892, p. 209).

More recent findings corroborate the above. Shimer, reporting in 1918 on the subway excavations in the Boston Back Bay district, describes the recent submergence of the coast, and the deposit of shell muds: "The shells inclosed in the mud deposited upon the peat since its submergence beneath the sea give evidence of two climatic periods,—an earlier period (4a) warmer than the present and a later colder period (4b) extending to the present . . . 4a This fauna, representatives of which are rare or altogether wanting off our coast today, is now dominant off the coast of Virginia, though it ranges from Cape Cod to Cape Hatteras. Of the sixty some species noted . . . about half no longer occur north of Cape Cod, or only rarely in sheltered places, but find their perfect environment farther south" (Shimer, '18, p. 456; Antevs, '28a, p. 93).

J. Brooks Knight ('33) has recently summarized the facts regarding the distribution of the southern gastropod, *Littorina irrorata*. This species was formerly abundant in a few sheltered places in Long Island Sound, but apparently became extinct there about the middle 1800's.

Its shells have been found abundantly, however, in a fossil fauna underlying a salt marsh near New Haven, and have also been found in Indian shell heaps in that vicinity.

The preceding notes on the coastal faunas of this region point clearly to a comparatively recent period when the waters were warmer, permitting an extensive northern dispersal of species now more or less confined to the coasts south of Cape Cod. The effects of the refrigeration of these warmer waters appear to have continued into historic times, as shown by the progressive elimination of species to the present. Furthermore, during at least a part of this time there was a subsidence of the coast. There can be no question that the final causes for the elimination of the oyster from our shores can be laid to invading Europeans, but this will not apply to the many species of no particular food value which have also been progressively restricted or eliminated, even within historic times.[1]

The pre-colonial distribution of land animals in New England is greatly obscured by the changes which have occurred with settlement. A suggestive finding along this line is in a paper on the former distribution of the wild turkey, by Professor Glover M. Allen ('21). This southern bird extended northward along the coast at least to the Kennebec and probably to Penobscot Bay. Inland it did not range north of southern New Hampshire and Vermont, getting as far north in the former as Concord. Its northern limit is thus roughly coincident with the northern boundaries of the former oak-hickory-chestnut forests noted above. In fact, Professor Allen has suggested a definite relationship: "The limit of its range thus corresponds roughly to the transition faunal area, and was possibly more or less coextensive with the area over which red and white oaks were sufficiently abundant to furnish food in reasonable quantity. Possibly the apparent absence of the Turkey from most of Vermont is explicable through the comparative scarcity of oaks, whose place in the more limy soils seems to be in part taken by sugar maple, beech and butternut."

Many other southern birds can be cited as examples of the same range which have not been destroyed by the coming of the white man. Professor Allen ('02) notes the following in his study of the birds of New

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[1] Some recent investigations indicate cyclic fluctuations in the temperature of the inshore water on the New England coast. These studies have been made in connection with the recent increase of the shipworm, *Teredo navalis*, a boring mollusc which does great damage to marine pilings. Several other southern organisms are enumerated which also appear to be increasing in New England, but whether or not their coming may be related to minor climatic changes is not determined. The water temperatures show a rise since 1925, approaching a level which was previously held for several years prior to 1920 (See first and second progress reports of the New England Committee on Marine Piling Investigation, Boston, 1934-'35, 1935-'36).

Hampshire: green heron, bob-white, yellow-throated vireo, grasshopper sparrow, Bartramian sandpiper, and cowbird. Still others scarcely extend north of the northern boundary of Massachusetts (Forbush, '25–'29), either as residents or casual visitants: Acadian flycatcher, orchard oriole, white-eyed vireo, blue-gray gnatcatcher, yellow-breasted chat, mocking bird, golden-winged warbler, prairie warbler. The relative abundance of these species in pre-colonial times in comparison with their present condition is largely conjectural. The elimination of the wild turkey can be laid to man, but another striking disappearance from New England is that of the dickcissel, a bird having no direct food relationship to man. It is characteristic of the Great Plains region, extending westward to the Rocky Mountains. Forbush states that it "formerly bred on the Atlantic slope from Massachusetts to South Carolina and Georgia, but [is] now very rare or casual in that region." Nuttall noted that it was common in eastern Massachusetts in the early 1800's. It is not improbable that the tendency indicated here has had some effect upon the ranges and relative abundance of many other animals whose optimum living conditions are found far to the south and west.

ARCHAEOLOGICAL EVIDENCE

With a view to finding whether there have been changes in the aboriginal life of New England which might be interpreted in terms of climatic alteration, the writer has ventured into the archaeological literature touching upon the region. There is excellent proof that the Indians lived here during at least a part of the period of warm water coastal fauna as well as during the time of refrigeration. The finding of the remains of a fish weir set in the glacial clay beneath the shell muds of Boston's Back Bay has been studied and described by Shimer ('18) and Willoughby ('27). Some 3 to 4 feet of the lower section of the shell muds were deposited after the weir was built, and these contain the southern fauna noted by Shimer in his horizon "4a" (see above).

Dr. Paul B. Sears has recently advanced the hypothesis that the Mound Builder cultures of our middle western states may be correlated causally and in point of time with climatic changes in that region. These cultures were based upon the successful growth of maize, and constitute an agricultural development in a region which otherwise had supported a culture based in large measure upon the chase (Shetrone, '20). One of these cultures, the Hopewell, is known to have extended westward to Iowa, and it is suggested that the development came during a period when more arid climates caused an extension of prairie and park-land eastward into Ohio where such types of vegetation now occur only as relics (Gleason, '23; Sears, '26). Sears ('32) has summarized these suggestions as follows:

"It must be emphasized that whoever the inhabitants of the Ohio valley were at this time, or whence they came, they enjoyed the optimum conditions afforded during post-glacial time for the development of a successful agricultural civilization. Rich and varied soils of glacial origin, abundant game including the bison, open country with numerous groves of useful kinds of wood, streams easily navigable and full of fish, all favored such a development.

"The intrusive[1] character of the highest mound cultures and the subsequent repossession of their lands by Algonkians is exactly what we might expect if the eastward extension of the corn-belt conditions was a significant factor in such mound cultures."

With regard to the timing of these events Sears states: "If we may judge by the persistence of relict vegetation in favorable localities many effects of this dry period . . . may have long outlasted the actual climatic turn toward the more humid conditions of today. This is significant. Although dry conditions were at their maximum about 3000 years back, we must remember that such was their influence that any final assignment of dates for the higher cultures in Ohio up to 900 years ago is not unreasonable" (See also Sears, '32a, '35a, b, '33).

That the "intrusive" nature of the Mound Builder culture was not confined to Ohio is shown by investigations in New York and New England. There is some evidence that the mound-building people themselves reached western New York State (Parker, '20; Ritchie, '32). The aboriginal history of this state has been divided into three periods of Algonkian occupation. The earliest is represented by crude implements, and evidently featured a woodland, hunting culture. The second is characterized as follows by Ritchie ('32, p. 410): "The combination of brachycephaly with such distinctly new elements as clay and steatite pottery, the pipe, grooved ax, polished slates, and marine shell beads has compelled the writer to postulate a southern source for the Second Algonkin culture of New York. These artifacts occur together over much of the south Atlantic as well as the Mississippi-Ohio area . . ." These people also brought agriculture, and are thought to have originated in the region about Chesapeake Bay. "A later phase of this period was certainly influenced by small bodies of mound-building people entering the state through the southwestern counties"; and "The mound influence may be credited with the presence in New York of the

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[1] Judging by recent attempts at a new classification of these cultures it may be necessary to consider that they were local evolutions rather than intrusions.

following: the platform pipe, stone tubes, bar amulet, boat stone, native pearl beads and considerable copper in the form of axes, spears and beads" (Ritchie, p. 412).

The third period is related to the Iroquois invasion. "The migration [of the Iroquois] into the state through its southwest corner and probably up the Susquehanna from northern Pennsylvania brought them into contact with the Algonkin of the Second Period, and the writer believes that this influence constituted the impetus behind the cultural alterations which differentiate the Third Algonkin Period" (Ritchie, p. 413). "The elbow-type pottery pipe, noted in a crude form from the Second Period, reaches its acme of artistic perfection in the Third . . . The bone harpoon, both unilaterally and bilaterally barbed, recorded only once from a Second Period site, becomes an important implement at this time. There is, however, a total absence of the grooved ax, gouge, plummet, polished slates, ocean shell beads, and copper" (Ritchie, p. 414).

Further references to the intrusive mound cultures are as follows: "One is led to believe that the later Algonkian copied to a large extent the material culture of a more advanced division of the race that came from the south and west, but which after a certain time was either absorbed or unable to maintain itself in the eastern section" (Parker, p. 48); and "Certainly the material culture of the eastern Algonkins seems to have been considerably modified by this culture [mound], just as later New England tribes were modified by the Iroquois. It is quite possible, therefore, that the mound culture people intruded into the hunting grounds of certain Algonkin bands and established themselves" (Parker, p. 94). "The mound-building people seem to have disappeared from New York at or before the time of the coming of the Iroquois into their area of recognized occupation . . . A survey of the earliest Iroquoian sites, especially in western New York, leads us to believe that the earliest Iroquoian immigrants were measurably influenced by the mound-building culture" (Parker, p. 97). It is thought that the Iroquois did not become established in this region until 500 or 600 years ago.

The evidence just outlined suggests that in western New York State, as well as in the Ohio region, an agricultural, somewhat sedentary people who mastered the use of stone and copper for implements and ornaments succeeded a more primitive, apparently non-agricultural, nomadic people whose arts had never been so highly developed. These were in turn succeeded by the war-like Iroquois who, although they remained in large measure agricultural, apparently lost or never acquired many of the arts of their predecessors in the use of stone and copper.

The intrusion of these arts into New England has been remarked upon by several students. "That the eastern Algonkin received a great cultural impetus from the intruding strangers cannot be doubted. We have some realization of this when we note the thinning out of the polished slate objects in eastern New England, southern New York, Pennsylvania and the region north of the St. Lawrence basin . . ." (Parker, pp. 49–50).

The Europeans found the New England Indians culturally divided into two groups (Dixon, '14; Willoughby, '35). Those north of a district approximated by the northern boundary of Massachusetts (Abnaki and Pennacook groups) were mainly woodland hunters although they practiced agriculture to some extent. Their racial affinities were apparently to the north and northwest, and they made extensive use of birch bark for shelters and utensils. The tribes of Massachusetts, Rhode Island, and Connecticut on the other hand were in large measure agricultural and had a rather highly developed social organization. When the Pilgrims first came to Cape Cod these Indians had already, either directly or indirectly, been in contact with European civilization for many years, so that their actual status as a primitive race is difficult to fix (Willoughby, '35).

Willoughby makes a division of Indian history in New England not unlike that of Parker and Ritchie for New York State. He thinks that an early primitive people unacquainted with agriculture was succeeded by a group related culturally or racially to the Mound Builders west of the Appalachians. "The third culture group to occupy New England was probably an outgrowth of the second. The material culture of these later Indians underwent a marked modification during the period of their virtual separation by the Iroquois from their western kindred. Contact with the Iroquois seems to have been in a measure responsible for this, and in later times intercourse with the many European fishing and trading vessels throughout the greater part of the sixteenth century was a strong factor in the deterioration of certain of their native arts" (Willoughby, '35, p. 2). The distinction between a primitive, non-agricultural people ("pre-Algonquian") and later more highly civilized ones ("Old Algonquian") appears open to some question, although a few sites have been found which indicate a primitive culture which did not include pottery; that is, to assume a *consecutive* arrangement of "primitive" and "non-primitive" sites cannot always be done with assurance (See Delabarre, '25).

However, that there was an *evolution* in the native arts during the so-called second period in New England, influenced by western culture, seems clear. Ritchie suggests (p. 411) that "Shell middens on the Connecticut, Maine and Nova Scotia coasts, apparently related to certain inland sites, probably mark a northward extension of the Second Algonkin occupation of New York, for they contain such characteristic artifacts as stamped pottery, the grooved ax, plummet, broad-bladed projectile points, perforated animal teeth, the bone gorge, and hematite." If this relationship is correct, these people probably brought agriculture to New England, as they did to New York State, and likewise developed their culture further under such partial influence of the Mound Builder civilization as penetrated the east. A tradition of the southern New England Indians as recorded by Roger Williams (1643) was that their corn and beans had been brought from the southwest.

It has been suggested above that the Iroquois invasion had already marked a notable change in the culture of the southern New England Indians before the arrival of the Europeans. Their history seems to have had the same general pattern as that of the Indians of New York State. Possibly following an early primitive hunting culture there came southern peoples who brought agriculture. This was amplified to produce a semi-sedentary group which could live in large villages and have enough leisure to develop a degree of art. The impulses which led to this development apparently came from more southern and western tribes. The establishment of the Iroquois, as noted by Parker, was probably not over 600 years ago, so that we may regard the so-called "Old Algonquian" culture as having persisted nearly or quite into the period of European discovery.

There is considerable archaeological evidence, therefore, of a rise and decline of certain of the Mound Builder cultural influences in New York State which can be correlated with similar changes in the middle west; and in southern New England there is evidence of an evolution of agricultural civilization during approximately the same period as in New York. If the changes in the middle west can be traced to the influence of climatic and vegetational variation, we can properly expect that the same influence was effective in the east. A warmer and drier climate in southern New England would have greatly facilitated primitive agricultural development, since competition between man and the forest for the occupancy of cultivated lands would not have been so rigorous as under earlier or present conditions.

THE PROBLEM OF COASTAL SUBSIDENCE

Attempts to interpret climatic changes on the New England coast are inextricably entangled with the problem of coastal subsidence.

This is especially true of attempts at dating the changes. It is not intended to go into a detailed discussion of this problem here, but a brief statement of it is in order. There seems to be general acceptance of the idea that there has been either a relative rise of the sea with respect to the land, or an actual subsidence of the land, in comparatively recent post-Glacial time. There is, however, considerable controversy as to whether this so-called subsidence is still going on, or whether we must insert into the chronology an indefinite period of stability following the period of subsidence. In the present inquiry it is of interest to know whether the faunal and floristic changes which occurred *during* the period of subsidence were finished at some remote time when sea level is supposed to have become stabilized, or whether the changes have actually approached the present in point of time.

Evidence that subsidence has continued to the present or to very recent times has been gathered from drowned forests and freshwater peat beds, the structure of shore marshes, measurements of tide levels over a period of about 70 years, and the youthful character of rocky shores.

Drowned forests and peat deposits have been described at many sites along the New England-Acadian shore. An account of them was published by Ganong in 1903 for the region of the Bay of Fundy, where they were first described by Dawson (1855) and later by Chalmers (1895). Well-preserved stumps have been found in place more than 30 feet below high tide, and Chalmers found a peat bed 20 feet thick beneath 80 feet of marsh mud. The drowned forests range from these greater depths to more recently extinct ones which now appear between high and low tides (Bartlett, '09; Antevs, '28; Lyon & Goldthwait, '34). In general the wood in these deposits is remarkably well preserved, indicating a relatively recent origin.

An outstanding feature of most of the New England salt marshes is that the underlying peats do not contain a succession of forms representative of high and low tide floras; but the high tide forms are more apt to be found at considerable depths, often underlain by freshwater peat. This situation was interpreted many years ago by Mudge (1858), and later corroborated by Davis ('10; Bastin & Davis, '09) and Johnson ('25), as indicative of deposit during slow submergence of the land. The same conclusion was reached by Nichols ('20), studying the salt marshes of Connecticut. Marshes of the "Fundy type" (Johnson, '25) have been interpreted in the same way (Dawson, 1855; Ganong, '03), although they are formed differently, and composed largely of silt rather than peat. It was Davis's opinion that the submergence has continued to the present time ('10; Bastin & Davis, '09); and Nichols ('20) and Bartlett ('09) present evidence for the same conclusion. Nichols points out that on a stationary shore no succession of types [fresh to salt] should be apparent in the peat deposits, and that only where the rate of upbuilding exceeds that of submergence could there be a succession in peats similar to the littoral "zoning" of vegetation postulated by Shaler (1886). Since succession of a "retrogressive" or reverse order to this is common on the New England coast, there seems only one explanation: that the coast is subsiding, or at any rate is being invaded by the sea. That the invasion has been slow is shown by the absence of breaks in the deposits of plant parts *in situ,* often through several feet of depth. Furthermore, these "retrogressive" successions appear to have continued to the present time, as indicated by their presence in the most recent deposits. Bartlett has described the recent invasion of *Chamaecyparis* bog by salt marsh at Woods Hole, with fresh-water deposits a foot beneath the surface over a large area of the present marsh. Johnson ('13), on the other hand, cannot agree that such evidence is reliable, and conceives that Bartlett's bog may have reached its present condition by local shrinkage or sinking.

Records of the relationship between the heights of tides or of mean sea level, and certain "fixed" objects on the shore are open to criticism on account of the relative instability of the fixed objects. Frost action, local undermining, and various sorts of human disturbance are likely to cause movement; and since the reputed sinking of our coast line must be extremely slow, even small shifts in these bench marks are likely to greatly affect the comparison. Nevertheless, making due allowance for such factors, John R. Freeman published in 1903 an exhaustive study of the supposed subsidence at Boston. Basing his figures on records made at the dry dock of the Charlestown Navy Yard in 1831, he concluded that during the succeeding 72 years the subsidence had been 0.71 foot. Records from tide gauges at India Wharf showed approximately the same rate of subsidence over a period of 34 years, and calculations of the so-called "Boston base" showed about the same rate over 35 years. Other evidence of this nature, but less precise, comes from records of high storm tides, and from records of the depth of rocks, particularly near Salem (J. H. Sears, 1894).

There remains the evidence from shore lines on rocky coasts. A clear statement of this has been made by Flint ('30, p. 225), and will bear quoting: "The shoreline of Connecticut is in a youthful stage of development. Its status as a shoreline of submergence is indicated by its indented, ria character, and is abundantly proved by facts adduced in an earlier part of the discussion. Certain abnormalities in its aspect show that the submergence either has stopped but recently or is still in progress. For example, the bedrock along the shore, even on the most exposed promontories, has not been so much as trimmed by wave-erosion. If the sea had been standing long at its present level, the result would have been a cliffing of the headlands even by the relatively small waves generated in a body of water protected from the open sea."

Ranged against this somewhat formidable array of evidence are mainly the studies of D. W. Johnson and his coworkers at various points along the coast, and some recent investigations of the Damariscotta shell heaps. Johnson ('17; '29) has been unwilling to admit of any recent subsidence on the New Jersey coasts or in the district around New York City, and his studies of the development of the beach at Nantasket (Johnson & Reed, '10) also indicate coastal stability. He has also been inclined to discredit much of the botanical evidence of subsidence on the basis of what he calls the "fictitious appearance of changes of level" ('10; '13). These are caused by local modifications in the configuration of the shore line, mostly in the form of tidal scouring and the opening of barrier beaches during great storms. He attributes most of the cited changes in high tide levels to these causes, and not to general subsidence. Another factor emphasized by him to account for submerged peats is the advance of barrier beaches over peat beds resulting in the bending down of the latter to points below sea level.

Goldthwait ('35) has studied the relationship of the Indian shell heaps in the estuary of the Damariscotta River, in Maine, to local water levels; and he has concluded that the shore has been stable for about 1000 years. His reasons are that none of the shell heaps proper are below high tide level as they might be expected to be if submergence has occurred; and that if submergence had occurred a rocky barrier in the estuary below the heaps might have prevented the growth of the oysters. His figure of 1000 years is based upon an estimate of the time it took to build the heaps.

Without making any pretence at finality or expertness in these matters, the present writer is inclined to believe that subsidence has continued to the present or that it has just stopped (See LaForge, '32, pp. 86–7, 102). Most of the evidence for stability brought forward by Johnson is of a negative nature, and it seems that the local physiographic agencies he invokes could operate with equal facility in either direction. If the coast has been stable, then for every case of the invasion of fresh marsh by salt, we ought to find, somewhere on this complex coast, a place where high tide levels had been *lowered* by the formation of barrier beaches, so that fresh marsh could invade salt. Furthermore, if this had been the rule in ages past we should find frequent interchanges between salt and fresh peat in our sections, or at least breaks in the deposits of salt peat. Two of the outstanding features of the New England salt marshes, however, are first the common occurrence of thick beds of marine peat of a homogeneous nature extending to ten feet or more below the present marsh. These beds have been formed largely of plants whose range is only in the upper tide levels where they are reached by salt water but a short part of each day (*Spartina patens* and *Distichlis spicata*). Second, at varying depths under this deposit is commonly found a layer of fresh-water peat which rests on the mineral substratum. Local changes of tide level such as Johnson postulates might account for a small thickness of peat (2 feet or less) made out of the high tide grasses, but not for much greater depths without a general subsidence of the whole bed. The fact that salt peat almost invariably overlies fresh peat argues against the effectiveness of a reverse change such as must have occurred if Johnson's theories are correctly applied (See also Bartlett, '11). Further, these peat deposits have been formed in places where the physiographic changes suggested by Johnson have not always occurred (Davis, '10).

Johnson & Reed's conclusions from a study of Nantasket beach seem to the writer to be open to doubt because of the many uncertain physiographic variables involved. Of somewhat similar nature are Goldthwait's conclusions, but here an ingenious bit of reasoning is involved that should be noted. The great heaps of oyster shells on the Damariscotta estuary are found to be just *above* a narrow gut which has, at ordinary low tide, a depth of not over three feet and a width of about 60 feet. This barrier is composed of large stones. Goldthwait suggests that if the water stood much lower than now it would not have passed so freely up the estuary, and hence the salinity and probably the temperature of the latter would have been altered. If the current estimates of subsidence are true, then only within the past few hundred years could oysters have grown here, and Goldthwait estimates that it took somewhere between 800 and 1800 years to accumulate the shell heaps, prior to the 17th century when Europeans first arrived on the scene. Some physiographic influences do not seem to have been taken into consideration, however, and open the whole matter to question. One is the relative permanence of the rocky bottom of the gut which contains the barrier, and related to it is the possibility of a change in the rate of flow of fresh water from inland sources which would alter the channels of the estuary.

Another would be local modification of tide levels by physiographic changes farther down the estuary.

The rate of submergence has been estimated in a few cases, and although there can be no expectation of precision in the figures, yet their general agreement is significant. Freeman ('03), from his studies of tide and mean sea levels at Boston concluded that about 12 inches per century was not unreasonable. Davis ('10; Bastin & Davis, '09) set it at the same figure after an extensive study of peat sections, and probably influenced also by Freeman's findings. Bartlett ('09), basing his figures on Shaler's estimate of the rate of peat deposit, thought that the submergence at Woods Hole had been about 10 inches per century. Shimer ('18), working from the rate of mud deposit in Back Bay, at Boston, suggested about 8 inches per century.

It seems entirely justifiable, in the light of the above notes, to assume that there has been no serious break in the progress of subsidence at least during the past 2000–3000 years, and that the change has been fairly steady and slow, perhaps not exceeding a foot a century. By the same reasoning we may assume that no period of indefinite length must be inserted between the present time and the last period of warmer climate on the coast. If the approximate close of this warm period may be set, for the Boston region, at the time when the warm water fauna in the Back Bay was superseded by the present fauna characteristic of cooler waters, then the time may be estimated at about 1000 years ago. Taking the whole region into consideration, the change to a cooler climate must have been a gradual one, and its effects can very well have persisted into the 17th century when oysters were far more abundant on the New England coast than they are now, and when the gastropod *Littorina irrorata* was still common in Long Island Sound.

BOTANICAL EVIDENCE

Using the concept of the close correlation between major climatal and vegetational boundaries as a point of departure, the trends in the vegetational development of southern New England contain rather strong evidence of climatic change. One of the most significant correlations ever adduced between these boundaries is that worked out by Transeau ('05) for the ratio of precipitation to evaporation. A map of isoclimatic lines drawn up from this ratio was found to correspond remarkably well with the configuration of forest types in eastern North America. The correlation was somewhat improved by Livingston and Shreve ('21) with the insertion of a "duration factor" for the length of the average frostless season, and was further refined when a period of

30 days prior to the average frostless season was also involved. The isoclimatic line for the ratio value of 0.110 is found to follow very closely the southern limit of the northern coniferous forest in New England.[1] A glance at the map of precipitation-evaporation ratios shows, however, that the area for values *below* 0.110 in reality sends a long tongue eastward into southern New England which would be more noticeable if the line turned southward along the Appalachian Mountains. This it unquestionably does although the map fails to indicate it due to lack of data from this region. If a warmer and drier climate should develop this boundary could be expected to move northward much as the eastern boundary of the prairie must have moved eastward in the Ohio valley during the "xerothermic" period in that region.[2]

The apparent progressive elimination of the southern hickories and walnuts from central New England, and the tendency for southern hardwoods generally to be replaced by northern hardwoods and hemlock, are indications of a southward movement of climatic boundaries. Although part of the vegetational change seems to have happened during historic times, yet the climatic influences may have occurred long before, and the oak-chestnut-hickory forest was merely persisting,[3] as Bromley suggests, and has not been able to cope with exploitation by Europeans except on the drier sites. If we thus postulate a warmer and drier climate for this region in comparatively recent time, it is necessary to assume that it was intrusive following the amelioration of glacial climate, and that there may have been more than one intrusion. We have at present little evidence for similar southward shifts in other boundaries such as that between the spruce-fir forests and the northern hardwoods, but these can be expected. There is some indication of local retreat of the coniferous forests at the Straits of Belle Isle (Fernald, '11); and Abbe ('36) has suggested that the isolation of some species on the northeastern coast of Labrador may be related to recent changes of climate.

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[1] A recent classification of North American climates by Thornthwaite ('31) on the basis of temperature efficiency offers a fairly good correlation with vegetational boundaries also (See Nichols, '35, pp. 418-19).

[2] It is of interest in this connection that Gleason did not think the effects of the xerothermic climate were felt to the eastward of the Appalachians, nor in the Ozark uplands to the southwest. His conception of the consequent forest migrations apparently did not involve these regions. The vegetation of the Ozarks, however, has been studied extensively by Palmer ('21) and later by Palmer & Steyermark ('35), who find abundant evidence of prairie expansion and the movement of forest boundaries within comparatively recent geologic time.

[3] This tendency on the part of species and vegetation types to persist, or "lag," after conditions have become generally adverse to them has been noted in several lines of inquiry. For discussions of it see Cowles, '01, pp. 79 and 179; Fernald, '25; Clements, '34; Rübel, '35.

As noted above there is some evidence that the white pine was abundant in the pre-colonial forests, and that it passed through a period of decline during the early days of the settlements. Its meteoric rise to prominence in the abandoned fields of the last century can probably be laid to its habit of prolific seeding. The heavier fruited hickories and walnuts with their associates among the oaks could not do this once their sprouts had been removed from pastures and cultivated lands. It is possible to look upon the white pine as a relic of a warmer and drier climate, along with the hickories and their sprout hardwood associates. Unlike the latter, however, it had a new opportunity when the opening of western lands started the decline of New England agriculture, and a new expansion of its habitat appeared in fields abandoned and ready for its seed. Its prosperity is doomed to be short-lived if we may judge by the course of succession now seen in old field stands; and unless new openings are made on a large scale it will probably take the minor place commonly assigned to it in the hemlock-northern hardwood forest, or have a local abundance on very dry soils.

Soils, topography, and local climates in New England are so varied that no matter which way large vegetation boundaries might move, remnants of their former arrangement would be almost certain to survive in localities made favorable by special conditions. The southern remnants of northern vegetation left when the post-Glacial climates retreated have long been objects of study, particularly on the mountains and in bogs. The bogs, usually dominated by black or red spruce, are of common occurrence in most of the northern hardwood region and far southward into the sprout hardwood country. The coastal expression of the bog vegetation in southern New England is in the dominance of the southern white cedar, *Chamaecyparis thyoides*. Nichols has studied these habitats in upland southeastern Connecticut ('13, p. 99), and concluded that the cedar invaded the spruce bogs in comparatively recent geologic time. There is some indication that the white cedar has enjoyed in rather recent times a happier existence in southern New England. Bartlett studied a Chamaecyparis bog at Woods Hole, Massachusetts, and has this to say of the cedars: "Some of them, between three and four feet in diameter, were larger than any trees of this species now found in the vicinity of Woods Hole. The wood is still solid and wonderfully preserved"; and "Soundings in this part of the bog [the modern part] show that its history as a Chamaecyparis bog has been unbroken. It has never been submerged below sea level, for there is no stratification of the peat which would indicate this. In recent times, however, there have been no trees in this part of the bog as large as those found at depths of three or four feet, which correspond in age to those exposed in the peat at the edge of the salt marsh" (Bartlett, '09). Although a correlation between the above two sets of observations may be proved impossible, yet there is the suggestion that the southern coast white cedar has intruded into our bogs, particularly on the higher lands, within comparatively recent time, and that it may have passed an optimum on the coast.

There is some evidence that the Island of Nantucket "had many more forest-covered areas, when first patented, than at present, but historic and botanic evidence show that the larger portion of the main island was treeless" (Harshberger, '14). Yet there is also evidence that large oak forests formerly grew there, and a section from a large oak stump on the island is deposited in the Botanical Museum at Harvard (See Wilder, 1894).

A period of pronounced desiccation has been noted in sections of peat deposits on the New England coasts. One phase of this evidence was cited by William C. Alden, based upon a personal communication from C. A. Davis: "Certain fresh water peat beds on the New England coast that are now below sea level supported a dense forest of large white pines. These beds are widely enough distributed to warrant the assumption that in the comparatively recent time in which they were formed, the climate was drier than now for a time long enough to permit the development of two or three generations of these long-lived trees, not less than 500 years, and possibly twice as long. Under existing climate, the white pine has not been observed growing in dense old forest on peat deposits although often observed as an occasional constituent of the swamp forests" ('10, p. 363).

From a bog at Rockwood Park, near St. John, New Brunswick, G. F. Matthew described the following section: "After the sea withdrew from this valley a small pond was left which gradually passed into the condition of a marsh from the growth of grasses and sedges along its borders. The marsh changed to a peat-bog and continued thus for a length of time; eventually, however, the peat disappeared and was replaced by a brown mould or humus, forming a bed nearly a foot thick. Thus conditions favourable to the growth of peat had disappeared and a forest had replaced the peat-bog. The forest, of which this humus was the soil and débris, contained numbers of hardwood trees, and would be the result of a warmer and drier climate taking the place of the moist and cool one which had encouraged the growth of peat. . . . This mild climate, however, did not last long, for the Rockwood bog area was soon again invaded by a sphagnous growth and the hardwood forest destroyed.

There was not, however, such a continuous peaty growth as in the earlier peat-bog, as a second mould bed of some importance appears a short distance above the main one, and the oscillating border of the forest from time to time, showed that the wet climate was not so persistent as in the earlier peat-bog. In the closing stages of the growth of the bog, however, we note that the peat was encroaching on the forest growth around the margin of the bog, which would show that there would not be any amelioration of climate in later years, but rather that there had been a tendency to a moister and cooler climate" ('10, p. 380).

Dachnowski-Stokes has described a similar formation at the Lubec "heath" in southeastern Maine, and has summarized this and other findings as follows: "Toward the bottom appears a buried forest of trees consisting of stumps with numerous roots. . . . The layer is about 1½ feet thick and seems to be present over the entire peat area. The specimens examined were derived from pine, tamarack, spruce, and possibly fir. A similar basal layer of woody peat appears to prevail in the heaths of Veazie and Denbo, at Jonesport, Trescott, Columbia Falls, Pushaw Lake, and Herman Center, and the abundance of roots and stumps has been reported also for the peat deposits of northeastern Canada. The recent account of Auer ['27 (see also '30)] describes layers of stumps at the bottom of cross sections in peat deposits which are being cut away and exposed by the action of the waves in the Gulf of St. Lawrence. As layers of woody peat are present also in peat areas farther inland, it is logical to assume an extensive development of forests, spreading over wide stretches of country under conditions of environment which no longer exist. The climate, and probably coastal marine currents of this period, must have been warmer. The whole region must have passed into a drier stage throughout, and climatic conditions must have set in that were in consequence more continental and southerly in character than it is now in Maine" ('30, pp. 129–30).

Lyon and Goldthwait, in a recent unsuccessful attempt to cross-date trees in drowned forests on the New England coast, made the following observation of interest in the present study. The site was at Ft. Lawrence, Nova Scotia. "Another surprise came when the 24 trees in this collection were identified as representatives of 8 different species. Most of the trees sampled in the lower part of the tract were fir balsam, while those of the inshore and higher area were either pine or hemlock. This suggests a possible change of climate during the advance of the sea from lower to higher levels. Beech, maple, and spruce were represented by only four sections" ('34, p. 608).

F. H. Knowlton, commenting in 1910 on the post-Glacial flora of the

Atlantic coastal plain, could find no large paleontological evidence for a recent warmer climate in that region. However he cites several species (*Taxodium distichum, Pinus Taeda, Nyssa biflora, Ilex Cassine*) of which recently fossilized remains have been found considerably farther north than they now occur ('10, p. 369).

The occurrence of southern species scattered through parts of New England, the Maritime Provinces and Newfoundland has long been the object of study and hypothesis. Many of these plants are isolated from their southern relatives by hundreds of miles, while others represent straggling extensions of range. Approximately 35% of the flora of Newfoundland is of southwestern affinity, either common to the New England-Acadian coast, or to the coast south of Cape Cod (Fernald, '11). Something over 50% of the flora of the Island of Nantucket has a distinctly southern affinity (Bicknell, '19; Fogg, '30). Fernald stated in 1918 that approximately 200 isolated remnants of the more southern coastal plain flora were then known north of New Jersey, some of them extending as far as Newfoundland (Fernald '18). Most of the plants whose ranges have these northern extensions, and certainly those which have been studied in most detail, appear to be of the coastal plain flora; but if we may look upon scattered northern representatives of such a forest complex as that of oak and hickory in the same light, then a large and distinctly non-coastal element may be added to the list of isolations or northeastern extensions. A glance at the northeastern ranges of a great many plants characteristic of the more southern Alleghanian forests will show the same type of scattered distribution in New England and the Maritime Provinces. This was noted many years ago by the geologist C. H. Hitchcock (1874, vol. 1, p. 543), who cited the case of *Rhododendron maximum,* stating that "Its occurrence in insulated swamps suggests a former abundance in intermediate localities, and the presumption of a climate more like that of Pennsylvania, to enable it to flourish within our borders [New Hampshire]." Professor Glover M. Allen ('02, p. 42) has also noted this range, and adds the mountain laurel, *Kalmia latifolia,* the tupelo, *Nyssa sylvatica,* and the climbing fern, *Lygodium palmatum.* One of the more striking disrupted ranges is that of the bur oak, *Quercus macrocarpa,* which is known in eastern New England only in isolated localities such as that in the Penobscot valley near Waterville, Maine (Fernald, 1899).

The current explanation for the northern extension of the coastal plain flora is based upon an ancient emergence of the continental shelf from the sea (Fernald, '11; Nichols, '13, pp. 98–9; Barrell, '15; Martin, '25. A similar hypothesis has recently been applied to the distribution of land snails by Brooks, '36). This would give the necessary pathway along which plants could migrate as far as Newfoundland. Due to geological exigencies the time of this dispersal is now pushed back to the late Tertiary or to the early parts of the Pleistocene (Fernald, '33; Johnson, '25). But such an explanation is not easily applied to similar northern extensions of upland forest types or individual species. Whether the earlier continuous dispersal which brought about these extensions can be dated far back in the Pleistocene or late Tertiary depends upon whether it was possible for the plants to find refuge during the glaciation somewhere in this region. This is thought to have been the case with isolated remnants of the coastal plain flora in the Maritime Provinces and Newfoundland (Fernald, '33). There is reason to believe that parts of central New England were not covered by the last ice invasion (Bryan, '36); but the climate (Bryan, '28) during this late period must have been exceedingly rigorous, and it seems impossible that such southern plants as *Rhododendron maximum* and *Nyssa sylvatica* could have survived in upland regions between lobes of the ice, far removed from any ameliorating influence which the sea coast may have had upon local climates. Even in areas near the sea there is evidence of intense frost action in deposits of earth which do not appear to have been directly disturbed by the last ice. A northward extension of warm climates into New England in post-Glacial time, with a subsequent partial retreat of the same would do away with the necessity for such a long and hazardous persistence of southern forest species as is suggested above. However, even though we place the original dispersal of these species at a remote period, their present scattered and disrupted northern ranges can be interpreted in terms of a retreating warmer climate within comparatively recent time. This hypothesis gathers force with corroborative evidence for such a climatic change from several different lines of inquiry.

A discussion of the possible causes for this change of climate is beyond the scope of the present paper. Most of the theories expressed by the students of the coastal fauna have been in terms of changes in the courses of local warm or cold ocean currents, these in turn brought about by elevation or subsidence of shore lines and the continental shelf (Verrill, 1874; Ganong, 1890; Upham, 1892). It is notable that the time estimate given above is consistent with recent findings in the old Norse settlements in Greenland (Hovgaard, '25; Nörlund, '24). These studies have established beyond question the fact that when the Norsemen first went to Greenland the shores were remarkably free of ice and the ground was deeply thawed for a portion of each year. Coffins buried to a depth of several feet are found to have been penetrated by the roots of plants. At this time the Eskimo had retreated to the northward, although there were evidences that they had formerly lived on the ground occupied by the settlements. The change which occurred has been admirably summarized by Brooks ('26, p. 399) as follows: "But in the second half of this century [the 10th] the climate was already deteriorating, and about A.D. 1000 there came a foretaste of the coming ice. After this, conditions apparently improved slightly, and the colony appears to have prospered during most of the eleventh and twelfth centuries. Towards the close of the twelfth century deterioration again set in, and ice conditions rapidly became very bad. The summer thaw became shorter and shorter, and about A.D. 1400 the ground became permanently frozen. Communication with the mother-country was broken, life became too hard to bear, and the colonies finally perished."

Willoughby has already pointed out that the warm period on the New England coast which obtained when the ancient Indian fish weir was built in the Boston district can be correlated with the latest warm era in the middle western states postulated by Sears. The latter placed the climax of this era about 3000 years ago, as noted above, with a rather long subsequent period of "tapering off" in which effects were probably felt as late as 900 A.D. Similarly, there is evidence for a drier, and perhaps warmer climate in northern Europe during approximately the same time (Godwin, '34; Antevs, '25).[1]

Whether or not all these changes were due to the same set of causes, they appear to have been fairly coincident in time, and to have been effective throughout northeastern North America, northern Europe, and about the north Atlantic generally.

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[1] Smaller variations in climate have been studied from various viewpoints and shown to be, at least in part, of periodic occurrence. These variations all appear to be of a smaller order of magnitude than those discussed in the present paper, but should prove to be of considerable significance for many phases of forest management. Thus Kincer ('33) has shown that during the past 50-75 years there has been a slight but steady rise in temperature throughout temperate North America; and that for one station at New Haven, Conn., for which a long record was available (153 years), a former upward trend culminated about 120 years ago and was followed by a decline. This is compared with a somewhat similar curve for Copenhagen, Denmark, where a record of 134 years was available showing a peak about 100 years ago. Rainfall cycles of short period duration have been noted by Pack ('33) and Kincer ('34), but trends as long as those noted for temperature have not appeared. Lyon ('36) has analyzed tree ring growth in the hemlock (*Tsuga canadensis*) in New England, and has shown that notable periods of physiological dryness have occurred during the past 3 centuries, but he does not detect any cyclic effects. On the other hand cyclic changes are clearly indicated by tree ring studies in southwestern United States (See Douglas, '19, '28).

SUMMARY

The writer is fully aware that the evidence presented above is not all of equal value, and that there may be numerous errors scattered through it. This is particularly the case with regard to timing and sequences. None-the-less it has seemed worth while to gather it into one place, rather to stimulate inquiry than to arrive at conclusions.

Investigations along several lines have produced evidence of changes in general living conditions in New England and adjacent New York during the past 3000 years, with effects lasting into more recent time. (1) A "Virginian" element in the marine invertebrate fauna of the New England-Acadian coast has long been recognized, and there is abundant evidence that it was much more widely distributed in recent geologic time. Its remnants have persisted to modern times in areas especially suitable to them. (2) It is clear that Indians lived in southern New England during at least a part of the period of warm water coastal fauna. The northern boundary for the southern, more agricultural aborigines of New England was roughly coincident with the probable former northern boundary of the oak-hickory-chestnut forests, that is, northern Massachusetts-southern New Hampshire and Vermont. There is reason to believe that these southern New England Indians came from the southwest, possibly superseding an earlier nomadic, hunting people. They developed their maize culture apparently under the strong influence of peoples to the southwest of them, and under that of the agricultural Mound Builders of the middle west. This culture seems to have persisted to the time of the Iroquois invasion, probably not more than 600 years ago. Its evolution is roughly coincident with that of the Mound Builders, and might be interpreted as due to an advance toward the northeastward of conditions suitable to the easy cultivation of maize.

(3) The ecotone between the northern and southern hardwood forests appears to be moving southward, with possible attendant effects upon other forest boundaries. (4) Numerous woodland plants common to the more southern Appalachians have a scattered distribution in the uplands of New England, indicating a former, more continuous range. (5) White oak-hickory forests in restricted tracts of the Hudson Highlands have a structure characteristic of regions farther west. (6) The coast white cedar of the southern New England region, characteristic of the Atlantic coastal plain farther south, formerly grew to larger size in our region than it does now, as shown in peat bogs. (7) There is some evidence that oak trees of large size formerly grew on the island of Nantucket. (8) The presence of the remains of white pine and hardwood forests in peat deposits along the New England-Acadian coast

suggests a period of desiccation in comparatively recent times, and (9) certain drowned forests indicate a succession from fir to hardwood types in the lower part of their sections. (10) There is indication that some of the coastal plain trees had a wider range northward in comparatively recent time, as shown by recently fossilized remains in New Jersey.

From this body of evidence we may infer that a warmer and drier climate has occurred in New England within the past 3000 years. The trend since the peak of the warm dry era has been in general toward the cooler and more moist, but probably with minor variations in the opposite direction. There is evidence, further, that the warm dry climate was so recent that the effects of it are still with us in the form of disrupted ranges for southern animals, plants, and forest types. Judging by various estimates related to the rate of subsidence and of peat deposition at the shore, it is thought that the warm water fauna was still abundant on our coast about 1000 years ago, a figure which places the warm period in general coincidence with similar eras in the middle western states, in northern Europe, and in Greenland.

It is suggested that any plan for the utilization of our natural woodlands in southern New England and adjacent New York, involving as it does several generations of long-lived, slow-growing trees, should take this trend into consideration. If the climatic trend continues toward a cooler, more humid condition, or even if it remains for a time as it is, we may expect the oak-hickory and chestnut oak associations to be further restricted in area and in timber value. We may expect the northern hardwood-hemlock forest to develop greater mesophytism and to occupy a somewhat larger area than it now does, not only advancing laterally but also invading the lands within its present range which have been heretofore edaphically unsuited to it. In silvicultural planning for most of southern New England and adjacent New York initial decisions must frequently be made with regard to the ultimate, relative economic advantages of the sprout hardwoods such as white, black, and chestnut oaks, the hickories, and the tulip-tree, as against the more northern hardwoods such as sugar maple, red oak, the birches, beech, and white ash. This study suggests that the decisions should be tempered by the probability that the sprout hardwoods are persisting here under a set of conditions which have tended to become fundamentally adverse to them, and that in the normal course of succession they will be greatly restricted or eliminated over large areas.

The writer wishes to express his appreciation of the invaluable suggestions given by a number of persons during the course of this study. These gentlemen have not always agreed with his opinions and tentative

conclusions, especially with regard to the many controversial and speculative matters touched upon, but their rigorous discussion and criticism have been most helpful and stimulating. Particular thanks are due to Prof. Kirk Bryan, Prof. I. W. Bailey, Prof. M. L. Fernald, Prof. Glover M. Allen, Mr. W. J. Clench, and Mr. William Darrah, all of Harvard University at Cambridge; to Mr. A. C. Cline, Dr. P. R. Gast, and Mr. N. W. Hosley of the Harvard Forest at Petersham, Mass.; to Dr. C. F. Brooks, Director of the Blue Hill Meteorological Observatory of Harvard; to Dr. G. E. Nichols and Dr. H. J. Lutz of Yale University; to Mr. Douglas S. Byers and Mr. Frederick Johnson of the Museum of American Archaeology at Phillips Andover Academy; and to Mr. H. H. Tryon and Mr. H. L. Mitchell of the Black Rock Forest at Cornwall-on-Hudson, N. Y.

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ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

STUDIES IN THEACEAE. II
CLEYERA

CLARENCE E. KOBUSKI

With plate 201

THE ASIATIC GENUS CLEYERA, first described by Thunberg in his Nov. Gen. **3:** 69. 1783, was named in honor of the physician and botanist Andrew Cleyer, Dutch Director of Commerce during the years 1683–88. Thunberg described a single species and based his description on plants growing near Nagasaki, Japan.

Unfortunately this description was based upon two shrubs as a casual examination of the type indicates. Nearly filling the sheet is an ample specimen of *Cleyera japonica,* while in the upper right corner is a fragment or a near fragment of *Ternstroemia gymnanthera* (W. & A.) Sprague.

Thunberg named "Mokohf" or "Mukohf" of Kaempfer (Amoen. Exot. Fasc. V. p. 873, fig. p. 774. 1712) as a synonym of his new *Cleyera japonica.* Not realizing he was working with two distinct genera of the Theaceae, Thunberg, nine years later noticing the discrepancy mentioned above, came to the conclusion that *Cleyera* was congeneric with *Ternstroemia* and transferred his *Cleyera japonica* to *Ternstroemia* under the name *T. japonica.*

In 1841, Siebold & Zuccarini took up the original name *Cleyera.* They drew attention to the fact that Thunberg undoubtedly did have the two distinct elements in hand when he first described *Cleyera.* At the same time, however they emended his description and pointed out that careful study showed that regardless of what material Thunberg had, his actual generic description was based on the specimen of *Cleyera* and could refer only to *Cleyera.* True enough, in the specific description, the leaf arrangement refers to *T. japonica* (*T. gymnanthera* Sprague). However, this does not affect the status of the genus. They cleared up the whole matter and treated in detail both original elements under their respective genera giving the specific epithet "japonica" to both. Recently, Sprague realizing that *T. japonica* could not be retained, made the combination *T. gymnanthera* (W. & A.) Sprague.

With Siebold & Zuccarini's work confusion should have ended because their treatment of the whole subject seems very clear and quite final. Sprague's treatment of the generic status of *Cleyera* in Jour. Bot. **41**: 17, 83 (1923) did much to clear up the whole situation and probably directly or indirectly, caused the name *Cleyera* to be placed on the list of *"nomina conservanda"* by the International Congress of 1935.

Szyszylowicz in his treatment of *Cleyera* in Engler & Prantl, Nat. Pflanzenfam. III. Abt. **6**: 189 (1893) placed the genus under *Eurya* as a section. In a later treatment in the same publication ed. 2, **21**: 147 (1925) Melchior made *Cleyera* a subgenus of *Eurya*. Since that time botanists have vacillated between the use of the names *Eurya* and *Cleyera*. However, *Cleyera* is so markedly different from *Eurya* in character that even though students used the name *Eurya*, they were always conscious of the distinct lines of separation.

Other names applied to the genus were *Tristylium* Turczaninow (in Bull. Soc. Nat. Moscow, **31**: 247. 1858) as interpreted by Merrill (in Philipp. Jour. Sci. **13**: 148. 1918) and *Sakakia* Nakai, Fl. Sylv. Kor. (**17**: 77, t. 19. 1928).

Sakakia is clearly a true synonym of *Cleyera*, the name having been proposed by Nakai hoping to clear up the involved synonymy. Evidently unaware of the action taken by the International Congress in the case of *Cleyera*, the Japanese botanists have all rallied to Nakai and wholeheartedly accepted the change. Several new species and varieties have been described under this name. Incidentally, *Sakakia* would have been a fitting name because the plant is generally known in the Japanese empire as "Sakaki."

In the present paper a single species with several varieties is recognized. Because of the many references cited in the synonymy of the species, most of which apply to the genus as well, the author has made it a point to cite in the generic treatment only those references necessary for a clear understanding.

The institutions from which material for this study was borrowed along with the abbreviations used in this paper are as follows: herbarium of the Arnold Arboretum (AA), Gray Herbarium of Harvard University (G), herbarium of the New York Botanical Garden (NY), herbarium of the Natural History Museum, Vienna (V).

Cleyera Thunberg, Nov. Gen. **3**: 69 (1783). — Siebold & Zuccarini, Fl. Jap. 153, t. 81 (1841). — Choisy in Mém. Soc. Phys. Hist. Nat. Genève, 1854, 14 (Mém. Ternstroem. 21) (1855); as to sp. 1 & 2 (excl. sp. 3–7). — Bentham & Hooker, Gen. Pl. **1**: 183 (1862), in part. —

Sprague in Jour. Bot. **41**: 17, 83 (1923). — Internat. Rules Bot. Nomencl. ed. 3, p. 135 (1935). PLATE 201[1]

Tristylium Turczaninow, ex Bentham & Hooker, Gen. Pl. **1**: 183 (1862); as synon. of Cleyera. — Merrill in Philipp. Jour. Sci. **13**: 148 (1918).

Eurya § *Cleyera* Szyszylowicz in Engler & Prantl, Nat. Pflanzenfam. III. Abt. **6**: 189 (1893).

Eurya subg. *Cleyera* Melchior in Engler & Prantl, Nat. Pflanzenfam. ed. 2, **21**: 147 (1925).

Sakakia Nakai, Fl. Sylv. Kor. **17**: 77, t. 19 (1928).

Small tree or shrub. Leaves evergreen, alternate, variable in size and shape, from elliptic to elliptic-obovate or obovate, usually cuneate at the base, variable at the apex, petiolate, entire (except in *C. japonica* var. *lipingensis*). Flowers hermaphroditic, solitary or in fascicles in the leaf axils; peduncles thickened at apex, bibracteate, bracts minute, alternate, near apex of peduncle; sepals 5, imbricate, ciliate; petals 5, imbricate, connate at base, reflexed at anthesis; stamens about 25, anthers hispid, biloculate with longitudinal openings; ovary glabrous, 2–3-celled; ovules many; style elongate, bi- or trifid at apex. Fruit baccate, nearly spherical to ovoid-oblong in shape, many-seeded; seeds with thin endosperm and curved embryo.

Cleyera japonica Thunberg, Nov. Gen. **3**: 69 (1783), pro parte; Fl. Jap. 12 (1784), pro parte. — De Candolle, Prodromus, **1**: 524 (1824), pro parte. — Siebold & Zuccarini, Fl. Jap. 153, t. 81 (1841). — Walpers, Repert. Bot. Syst. **1**: 370 (1842). — Siebold & Zuccarini in Abh. Akad. Münch. **4**, abt. **2**: 164 (Fl. Jap. Fam. Nat. 56) (1845). — Miquel in Ann. Mus. Bot. Lugd.-Bat. **3**: 14 (Prol. Fl. Jap. 202) (1866). — Franchet & Savatier, Enum. Pl. Jap. **1**: 57 (1875). — Ito & Kaku, Fig. Descript. Pl. Koishikawa Bot. Garden, **2**: t. 18 (1883). — Matsamura, Nippon Skokubutsu meii, 53, no. 631 (1884). — Tanaka, Useful Pl. Japan, 164 (1895). — Sprague in Jour. Bot. **41**: 17, 83 (1923). — Masamune in Trans. Nat. Hist. Soc. Formosa, **25**: 250 (1935). — Internat. Rules Bot. Nomencl. ed. 3, p. 135 (1935).

Ternstroemia japonica Thunberg in Trans. Linn. Soc. **2**: 335 (1794), pro parte.

Cleyera ochnacea De Candolle in Mém. Soc. Phys. Genéve, **1**: 43 (Mém. Fam. Ternstroem. 21) (1822); Prodr. **1**: 524 (1824). — Sprengel, Syst. Veg. **2**: 596 (1825). — G. Don, Gen. Hist. **1**: 566 (1831). — Dyer in Hooker f., Fl. Brit. India, **1**: 283 (1874). — Forbes & Hemsley in Jour. Linn. Soc. Bot. **23**: 76 (1886). — A. E. Osmaston, For. Fl. Kumaon, 42 (1927).

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[1] PLATE 201. Photograph of generic type in Herbarium Thunberg at the Botanic Museum, Upsala, Sweden. Photograph taken by Prof. Alfred Rehder in 1928.

Cleyera ochnacea DC. α *Kaempferiana* De Candolle in Mém. Soc. Phys. Genève, **1**: 43 (Mém. Fam. Ternstroem. 21) (1822); Prodr. **1**: 524 (1824).

Ternstroemia Lushia Hamilton ex D. Don, Prodr. Fl. Nepal. 225 (1825).

Cleyera ochnoides Wallich ex G. Don, Gen. Syst. Bot. **1**: 566 (1831).

Cleyera Lushia Hamilton ex G. Don, Gen. Syst. Bot. **1**: 566 (1831).

Cleyera Lushia G. Don var. β *Wallichiana* G. Don, Gen. Syst. Bot. **1**: 567 (1831).

Cleyera Wallichiana Siebold & Zuccarini, Fl. Jap. **1**: 154 (1841).

Cleyera Mertensiana Siebold & Zuccarini, l.c. (1841).

Cleyera ochnacea DC. var. *Lushia* (D. Don) Dyer in Hooker f., Fl. Brit. India, **1**: 284 (1874).

Eurya ochnacea (DC.) Szyszylowicz in Engler & Prantl, Nat. Pflanzenfam. III. Abt. **6**: 189 (1893). — Shirasawa, Icon. Ess. For. Jap. **2**: t. 53, figs. 18–31 (1908). — Matsamura, Ind. Pl. Jap. **2**. pt. 2, 359 (1912). — Rehder & Wilson in Sargent, Pl. Wilson. **2**: 399 (1915). — Chun in Mem. Sci. Soc. China, **1**: 173 (Trees Shrubs China) (1924). — Melchior in Engler & Prantl, Nat. Pflanzenfam. ed. 2, **21**: 147 (1925). — Makino & Tanaka, Man. Fl. Nippon, 357 (1927). — Hozo, Kishiu shokobutsu-shi; Flora Kii Prov. 112 (1929). — Naito & Kajiwara in Bull. Kagoshima Imper. Coll. Agric. For. **1**: 392 (1934).

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DISTRIBUTION: Japan, Korea, Formosa, China, India.

SPECIMENS EXAMINED:

JAPAN: Near Nagasaki, *Thunberg* (type, photo. in AA); Nagasaki, *C. J. Maximowicz* in 1863 (AA); alt. 100–1000 m., Mt. Kirishima, Kyushu, *Z. Tashiro* for E. H. Wilson, June 24, 1927 (AA); "Hizen" *K. Sakurai,* May 11, 1910 (AA); Yakusima, *G. Masamune,* Aug. 23, 1924 (NY); temple grounds near Nakatsu-gawa, *C. S. Sargent,* Oct. 22, 1892 (tree 6–9 m.; probably cultivated) (AA); woods, Tosa Prov., Shihoku, *E. H. Wilson,* no. 7789, Nov. 17, 1914 (small tree 6–10 m. with black fruit) (AA); Kunigami-gun, Loochoo Isl., *R. Kanehira,* no. 3241, Jan. 5–6, 1934 (NY); Osima, Nozi-gawa-Yuwan, Loochoo Isl., *R. Kanehira,* no. 3394, Mar. 22, 1934 (NY); Coll. of Yokohama Nurs. Co. on Loochoo Isl., 1914 (AA).

KOREA. Quelpaert Isl.: common in ravines on south shore, *E. H. Wilson,* no. 9490, Nov. 2, 1917 (bush 1:5–2.5 m. with black fruit) (AA); in forests, *U. Faurie,* no. 495, Oct. 1906 (AA); in forests, *U. Faurie,* nos. 1641, 1642, 1643, July 1907 (AA); in forests, *E. Taquet,* no. 591, July 1908; no. 2692, July 1909; no. 2693, Oct. 1909; no. 4136, July 1, 1910 (AA).

CHINA. Chekiang: open thickets, Sui-an hsien, *Y. L. Keng,* no. 797, July 15, 1927 (AA); shady woods, Tung-yang hsien, alt. 450 m., *Y. L. Keng,* no. 932, Aug. 1, 1927 (evergreen shrub) (AA); locality lacking, *S. Chen,* no. 1546, June 1933 (AA); Tienmushan, *T. N. Liou,* no. L. 3, July 22, 1930 (NY); alongside stream, Tai-shun, *Y. L. Keng,* no. 287, Aug. 4, 1926 (glabrous evergreen tree) (AA). Fukien: under dense wood, northern part of province, alt. 1000 m., *R. C. Ching,* no. 2279, Aug. 5, 1924 (tree 10 m.) (AA, V). Anhwei: common in woods along stream, S. Chemen, alt. 250 m., *R. C. Ching,* no. 3207, Aug. 13, 1925 (small tree, 12 m. with smooth gray bark) (AA); in wood, Whang shan, alt. 450 m., *R. C. Ching,* no. 2899, July 5, 1925 (shrub 6 m. high with smooth gray bark, buds purplish green) (AA). Kiangsu: in thickets, Hai Wei, S. I-Shingon, near border of Chekiang, alt. 200 m., *R. C. Ching & Tso,* no. 512, May 17, 1926 (small shrub of stately form, 3 m. tall with gray bark; flowers nodding, petals amber) (AA); mountainous thickets, Ching-shan, I-shing, *Y. L. Keng,* no. 2649, Aug. 26, 1929 (small evergreen tree, 3 m. with dark grey smooth bark) (AA). Kiangsi: along stream in partial shade, Kuling, alt. 1000 m., *C. Y. Chiao,* no. 18707, July 27, 1928 (NY); Lushan Mts., alt. 700–800 m., *H. H. Chung & S. C. Sun,* no. 646, July 23, 1933 (NY, AA); common, side of streams, Kuling, alt. 1200 m. *E. H. Wilson,* no. 1546, July 28, 1907 (bush 1–2 m.) (AA, G); along roadside, Ta Yeh Tsun, Lu Shan, alt. 800 m., *A. N. Steward & H. C. Cheo,* no. 506, Oct. 22, 1932 (shrub 2 m.) (AA). Kwangsi: in thickets, Bin Long, Min Shan, N. Luchen, alt. 1200 m., *R. C. Ching,* no. 6019, June 14, 1928 (small tree with brownish bark, 6 m.; flowers whitish, nodding, scented) (NY). Yunnan: exact locality and date lacking, *G. Forrest,* no. 26771 (AA); *G. Forrest,* nos. 16080, 18181, coll. 1917–1919 (AA).

From ancient times this species has been known and revered in the Japanese Empire under the name "Sakaki." It grows wild in the mountainous districts and can be found planted around the homes and about Shinto shrines. It is sometimes called "Mijam Sakaki" meaning "God-of-the-high-mountains." "Tamakushige," a kind of wand, dedicated to the gods has been made from this plant explaining the name "Tree-of-God." According to Siebold & Zuccarini, the Buddhists revere the tree because their priests maintain it is a species close to the "Sara tree" under which the divine founder of their cult died. The fruit is known in Japan as "Ringan." Medically, I understand, the species is used for dysentery, consumption and for the treatment of mental diseases.

According to Ito & Kaku there are many varieties of this species such as small-leaved, long-leaved and round-leaved. A study of a large amount of material bears out their statement, variation being so great that to definitely separate varieties, to say nothing of species, seems almost hazardous. However, there are some varieties, sometimes localized, that seem worthy of recognition. These are treated below.

KEY TO THE FORM AND VARIETIES

Leaves entire

  Leaves variegated .... forma **tricolor**

  Leaves not variegated

    Leaves approximately 2 cm. wide or less, not more than 8 cm. long.

      Leaves up to 8 cm. long, oblong-lanceolate; Formosan variety .... var. a. **Hayatai**

      Leaves up to 5 cm. long, elliptic; Kwangtung variety var. b. **parvifolia**

    Leaves up to 5 cm. wide; up to 15 cm. long.

      Larger leaves 10–15 cm. long, generally acuminate at apex; Indian and western Chinese variety ... var. c. **grandiflora**

      Larger leaves usually below 10 cm. long, generally obtuse at apex; Formosan variety .... var. d. **Morii**

Leaves serrate .... var. e. **lipingensis**

Cleyera japonica Thunberg emend. Sieb. & Zucc. forma **tricolor** (Nicholson), stat. nov.

Cleyera japonica tricolor Nicholson, Ill. Dict. Gard. **1**: 342 (1885).

Cleyera japonica var. *tricolor* Hort. ex Miller in Bailey, Cyclop. Amer. Hort. **1**: 335 (1900); in Bailey Stand. Cyclop. Hort. **2**: 802 (1914).

Eurya latifolia variegata A. Verschaffelt in Exp. Gand. 1862 ex Bull. Fed. Soc. Hort. de Belgique (1887) p. 394.

Cleyera Fortunei Hooker f. in Gard. Chron. **17**: 10, fig. 1 (1895); in Bot. Mag. **121**: t. 7434 (1895). — Bean, Trees Shrubs Hardy Brit. Isles, ed. 1, **1**: 373 (1914).

Cleyera japonica foliis variegatis A. Verschaffelt in Exp. Gand. 1862 ex Bull. Fed. Soc. Hort. de Belgique (1887) p. 394.

SPECIMENS EXAMINED:

HORT. — *G. Nicholson*, no. 1782, July 19, 1880, collected in the Royal Botanic Gardens, Kew (AA). — *M. Gebhardt*, Jan. 16, 1889, collected in a greenhouse on the estate of Count Arnim, Muskau, Silesia (AA).

Both specimens cited above are without flowers or fruit. This sterile condition seems quite typical of this form. In leaf shape this form is identical with the eastern Chinese specimens giving rise to the belief that China rather than Japan is the place of origin. Hooker also seems to share this belief. The texture of the leaf in this form is much thinner than the typical species, a condition found often in variegated forms and generally associated with absence of chlorophyll in the leaf or parts of the leaf. Hooker (1895) in describing *Cleyera Fortunei* remarked that the species had been in cultivation for nearly thirty years, and until flowers were borne, was thought to be a broadleafed species of *Eurya* (*E. latifolia variegata*) having its young leaves stained with a fiery orange. In Bot. Mag. he states that the leaves are "bright green, variegated with golden yellow and scarlet towards the margins." An evergreen shrub with these color features must be a beautiful sight indeed. One would expect it to be found more often in cultivation than it is. This color variegation in the leaves is the only feature separating the form from the actual species.

Cleyera japonica Thunberg emend. Sieb. & Zucc. var. a. **Hayatai** (Masamune & Yamamoto), comb. nov.

> *Sakakia Hayatai* Masamune & Yamamoto in Jour. Soc. Trop. Agric. **5**: 350 (1933). — Yamamoto in Sylvia, **5**: 43, fig. 37 (1934).

DISTRIBUTION: Formosa.

SPECIMENS EXAMINED:

FORMOSA: in monte Buisan, *E. Matsuda*, July 1918 (leaf spec. ex herb. Yamamoto); Noka, prov. Nanto, alt. 2333–2833 m., *E. H. Wilson*, no. 10056 (bush 6–15 ft., fruit black, common) (AA).

Yamamoto during his recent American visit left at the Arnold Arboretum a leaf specimen of *Cleyera japonica* var. *Hayatai* for study. Although no number was listed the leaf undoubtedly was taken from one of the syntypes, both syntypes being collected by Matsuda during July 1918 in the same locality. On Yamamoto's label is the name "*Sakakia canicosae* (Merrill) Yamamoto." No reference to this name could be found in literature. A discussion with Merrill, the parenthetical author, concerning this name brought out the information that the name could be nothing more than an annotation on an herbarium specimen, since Merrill discredits ever describing a species under this name.

Masamune & Yamamoto in describing their species *Sakakia Hayatai* list as synonyms *Cleyera Matsudai* and *Sakakia Matsudai*. The latter synonym was cited "excl. Syn." These two synonyms belong to *Eurya Matsudai* Hayata, a recognized species of *Eurya* at the present time. *Eurya Matsudai* Hayata as described and figured is a true *Eurya*. There is nothing in the description warranting the transfer of *Eurya Matsudai* to *Sakakia*. Probably a specimen incorrectly labeled *Cleyera Matsudai* Hayata in one of the Formosan herbaria led to the transfer by Masamune to *Sakakia Matsudai*.

Cleyera japonica Thunberg emend. Sieb. & Zucc. var. b. **parvifolia,** var. nov.

A typo recedit foliis ellipticis minoribusque, 3.0–5.5 cm. longis, 1.5–2.0 cm. latis.

DISTRIBUTION: Kwangtung.

SPECIMENS EXAMINED:

KWANGTUNG: dry, level land, roadside, Chun Fa Shu, Sam Kok Shan, Tsungfa-Lungmoon Districts, *W. T. Tsang,* no. 20600 (type), May 29, 1932 (3.5 m. tall, flowers white) (NY); common in meadows and on roadsides, Tung Koo Shan, Tapu District, *W. T. Tsang,* no. 21683 (AA), Sept. 8–29, 1932 (shrub 1.5 m., fruit black) (AA, NY); Loh Fau Shan, *C. O. Levine,* no. 568, Oct. 27–30, 1916 (AA); vicinity of Canton, *C. O. Levine,* no. 1453, Aug. 17, 1917 (AA); dry ground in forest, Naam Kwan Shan, Tsengshing District, *W. T. Tsang,* no. 20323, Apr. 24, 1932 (1.75 m. tall, flowers white (NY); Loh Fau Shan, *E. D. Merrill,* no. 10686, Aug. 17, 1917 (NY); Pak-wan Cheung, Wai-yeung District, alt. 750 m., *T. M. Tsui,* no. 162, March 1932 (1.5 m. tall, flowers white) (NY).

As *C. japonica* Thunb. var. *grandiflora* (Choisy) Kobuski represents the large form of the typical species so does the variety described above represent the smaller variation. The leaves are quite elliptic, never obovate, at least in the specimens studied. It has the general number of stamens of the genus (24–25) which are hirsute. This variety is confined to the province of Kwangtung.

Cleyera japonica Thunberg, emend. Sieb. & Zucc. var. c. **grandiflora** (Wallich ex Choisy), comb. nov.

Cleyera grandiflora Wallich, Num. List, no. 1461 (1829), nom. nud.
Cleyera grandiflora Wallich ex Choisy in Mém. Soc. Phys. Genève, 1854, 14 (Mém. Ternstroem. 21) (1855).
Cleyera ochnacea DC. var. *grandiflora* (Wallich ex Choisy) Dyer in Hooker's Fl. Brit. Ind. **1**: 284 (1874).
Cleyera grandiflora Hooker f. & Thoms. ex Dyer in Hooker's Fl. Brit. Ind. **1**: 284 (1874).

DISTRIBUTION: India, Szechuan, Yunnan, Tibet.

SPECIMENS EXAMINED:

SOUTHEASTERN TIBET: Salween Valley at Champutong, Mount Kenyichumpo and region of Champutong, Salween-Irrawadi watershed, alt.

2450 m. *J. F. Rock,* nos. 10225, 10245, coll. in 1923 (woody climber; fls. cream colored) (AA). YUNNAN: data lacking, *G. Forrest,* no. 8424 (AA). EASTERN SZECHUAN: Wushan Hsien, *E. H. Wilson* (Veitch Exped.) no. 2688, Oct. 1900 (AA). INDIA: Khasia, alt. 600 m., *J. D. Hooker & T. Thomson* (probable isotype of *C. grandiflora* Hook. f. & Thoms.) (G.); below Dharmgadh in the Sarju Valley, East Almora, United Provinces, alt. 1500 m., *A. E. Osmaston,* no. 1484, Jan. 26, 1932 (shrub or small tree) (AA); Dindihat to Askot, Almora District, alt. 1500 m., *R. N. Parker,* no. 2047, Jan. 7, 1923 (AA); Upper Burma, *G. Forrest,* no. 27556, coll. 1924–25 (AA); western Nepal, *Bis Ram,* no. 573, June 25, 1929 (AA); Mausmai, Assam, alt. 1200 m. *L. R. Ruse,* no. 145, May 18, 1923 (AA).

Localized in India, western China and Tibet, this variety is distinguished from the species only in its uniformly larger size. Leaf measurement in the specimens studied vary up to a maximum of 15 cm. long and 5.5 cm. wide. The peduncles are sturdier than the normal species, and in a single instance one measuring 2 cm. was found.

This variety was first described as *Cleyera grandiflora* Choisy in 1855. Later, Dyer in Hooker's Fl. Brit. Ind. (**1**: 284. 1874) reduced Choisy's species to *Cleyera ochnacea* var. *grandiflora.* In the same publication Hooker f. & Thomson's species (not of Wallich or Choisy) *Cleyera grandiflora* was described. The synonymy became involved at this point because Hooker f. & Thomson, thinking naturally that their species was different from Choisy's now reduced species, used the same name, *Cleyera grandiflora.* Some of the differences used in separating these two in Hooker's Fl. at that time were: (1) fascicles 2–4 flowered against flowers usually solitary; (2) leaves narrower, more acuminate against leaves oblong, obtusely acuminate; (3) apex of peduncles with two almost obsolete bracts against peduncles with minute alternating bracts. Variation in these characters is, in general, too great to permit separation. As mentioned above, the only basis for even varietal distinction from the species is size.

Cleyera japonica Thunberg emend. Sieb. & Zucc. var. d. **Morii** (Yamamoto) Masamune in Trans. Nat. Hist. Soc. Formosa, **25**: 250 (1935).

Eurya ochnacea DC. var. *Morii* Yamamoto, Suppl. Icon. Pl. Formos. **3**: 40, fig. 13 (1927).

Tristylium ochnaceum Merrill var. *Morii* Sasaki, List Pl. Formosa, 294 (1928).

Sakakia Morii (Yamamoto) Yamamoto & Masamune in Jour. Trop. Agric. **2**: 34 (1930). — Yamamoto & Mori in Sylvia, **5**: 44 (1934). — Kanehira, Formosan Trees, 470 (1936).

Distribution: Formosa.

Specimens examined:

Formosa: Tam-sui, *A. Henry,* no. 1468, date lacking (NY); Tam-sui, *R. Oldham,* no. 35, April 1864 (NY); common in forests near Nanwo, Prov. Karenko, *E. H. Wilson,* no. 11117, Nov. 26, 1918 (tree 10 m. high, fruit black) (AA, NY); Kelung, *C. Ford,* no. 27, date lacking (G); Kelung, *O. Warburg,* no. 9975, Jan. 1888 (AA); vicinity of Sozan, *T. Tanaka,* no. 115, June 22, 1929 (AA).

To date this variety has been collected only on the island of Formosa. By Yamamoto it was characterized as having larger and obovate leaves. This size characterization may apply to the Formosan material but hardly to the species as a whole when one considers the Chinese and Indian material. For a generalization, the shape of the leaf might better be designated obovate-elliptic because there is usually a distinct even tapering from the center of the leaf to the base. The obovate character of the apex in this variety is very variable. In some cases, the apex is nearly subrotund, slightly contracted into a very short rounded acumen. In other instances, still obovate, the apex tapers quite abruptly to a point. Finally, in some leaves, the apex appears actually emarginate. The pedicels are quite short, seldom more than 7 mm. long. As a result of the latter, specimens with crowded immature fruits resemble *Ilex rotunda* Thunberg very closely.

Cleyere japonica Thunberg emend. Sieb. & Zucc. var. e. **lipingensis** (Handel-Mazzetti), comb. nov.

Eurya ochnacea (DC) Szyszylowicz var. *lipingensis* Handel-Mazzetti in Akad. Anz. Wiss. Wien, 1921, p. 180 (Pl. Nov. Sin. Forts. 13, p. 14) (1921); Symb. Sin. 7: 399 (1931).

Sakakia longicarpa Yamamoto in Jour. Soc. Trop. Agric. **5**: 350 (1933).

Distribution: Kweichou, Hainan and Formosa.

Specimens examined:

Kweichow: Kutschou et Liping, in silva frondosa prope vicum Dayung, alt. 700 m., *Handel-Mazzetti,* no. 10938 (isotype) July 22, 1917 (tree) (AA); in light woods, *Y. Tsiang,* no. 4133, Jan. 25, 1931, (tree, 4 meters high, bark green, leaves deep green above, pale beneath; fruit blackish) (AA, NY). Hainan: in woods, alt. 600 m., Yaichow, *F. C. How,* no. 70311, March 6, 1933 (tree 13 m. high with gray bark; leaves light green above, pale green beneath, coriaceous; fruit green when young, black when mature) (AA, NY); heavily wooded ravine, Hung Mo Mt. above Fan Ra, Hung Mo Tung, *McClure & Fung,* no. 751, August 24, 1929 (NY, AA). FORMOSA: in monte Tsugitakayam, alt. 2100 m., *Y. Simada,* Oct. 9, 1925 (leaf specimen only) (AA).

This variety is most unusual in the genus because of the serrate leaves. In all other representatives of *Cleyera,* the leaves are entire. Without flower and fruit one naturally would be inclined to place it in the closely related genus *Eurya.* Handel-Mazzetti in drawing up his description, had only a single "wilted" corolla and, judging from the isotype in the Arnold Arboretum, a few immature fruits. Tsiang's specimens in both the Arnold Arboretum and the New York Botanical Garden are sterile. Yamamoto, during his recent American visit, left with me fragments and tracings of some of the Formosan Theaceae. Of his *Sakakia longicarpa* only a leaf specimen is available. However, this leaf is a nearly perfect match with those on Handel-Mazzetti's isotype. Besides leaf serration, Yamamoto lists ciliate calyx lobes and oblong fruit as characters separating his species from *Sakakia ochnacea.* This fruit variation is not uncommon in the whole genus and ciliate calyx lobes are considered a good character of *Cleyera japonica.*

At first, having only fragmentary representation from the far removed localities, Yunnan and Formosa, one naturally would be loth to combine the two. Later, when Tsiang's Hainan specimens were studied, the related identity became more of a certainty.

EXCLUDED SPECIES

Cleyera albopunctata (Grisebach) Krug & Urban in Engler, Bot. Jahrb. **21:** 537 (1896) = **Ternstroemia albopunctata** Grisebach, Cat. Pl. Cub. 36 (1866).

Cleyera elegans (Tulasne) Choisy in Mém. Soc. Phys. Genève, **14:** 110 (1855) = **Freziera elegans** *Tulasne* in Ann. Sci. Nat. ser. 3, **8:** 336 (1847).

Cleyera integrifolia (Bentham) Choisy in Mém. Soc. Phys. Genève, **14:** 112 (1855) = **Freziera integrifolia** Benth. Pl. Hartweg. 6 (1839).

Cleyera Matsudai Hayata in Sched. Herb. Univ. Imp. Taihoku, no. H. 174, nomen nudum = **Eurya Matsudai** Hayata, Ic. Pl. Formos. **9:** 6 (1920).

Cleyera mexicana (Turczaninow) Planchon ex Hemsley, Biol. Centr. Amer. Bot. **1:** 93 (1879) = **Freziera** sp.

Cleyera Nimanimae (Tulasne) Krug & Urban in Engler, Bot. Jahrb. **21:** 540 (1896) = **Freziera Nimanimae** Tulasne in Ann. Sci. Nat. ser. 3, **8:** 338 (1847).

Cleyera serrulata Choisy in Mém. Soc. Phys. Genève, **14:** 110 (1855) = **Ternstroemia** ? sp.

CLEYERA JAPONICA THUNBERG

FULL-TONE—MERIDEN

Cleyera siphilitica Choisy in Mém. Soc. Phys. Genève, **14** 110 (1855) = **Ternstroemia** ? sp.

Cleyera theoides (Swartz) Choisy in Mém. Soc. Phys. Genève, **14:** 110 (1855) = **Freziera theoides** Swartz, Fl. Ind. Occ. 972 (1800).

Sakakia Matsudai (Hayata) Masamune in Jour. Soc. Trop. Agric. **4:** 192 (1932) = **Eurya Matsudai** Hayata, Ic. Pl. Formos. **9:** 6 (1920).

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NEW NAMES IN TIMONIUS

E. D. MERRILL

IN 1901 Britten[1] called attention to Trimen's[2] observation that the generic name *Timonius* dates only from 1830, when de Candolle gave a formal generic description and associated this old Rumphian mononomial of 1743 with the binomial system, and that rightly this generic name should be superseded by *Nelitris* Gaertner (1788). Gaertner's figure is a representation of the fruit of a *Timonius,* but in his text he confused it with some species of *Eugenia,* this leading to de Candolle's erroneous application of *Nelitris* to a genus of myrtaceous plants, properly *Decaspermum* Forster. *Nelitris* as a genus is typified by *N. Jambosella* Gaertn. = *Timonius Jambosella* Thwaites. *Timonius* (Rumph.) DC. is typified by the Moluccan form originally described by Rumphius and variously known as *T. Rumphii* DC. and as *T. sericeus* (Desf.) K. Schum. The two species are generally considered to be congeneric, but, as Alston[3] pointed out Valeton in 1909 considered the Ceylon species to be referable to *Bobea* Gaudich. If this disposition of it be correct and it still be desirable to retain *Bobea* Gaudich. as generically distinct from *Timonius* DC., then doubtless Alston is correct in retaining *Nelitris* Gaertn. in place of *Bobea* Gaudich. In retaining *Nelitris* Gaertn. in this sense Alston states: "Valeton has referred this [*Timonius Jambosella* Thw.] to *Bobea* Gaud. and though *Nelitris* Gaertn. is one of the "nomina rejicienda" of the International Rules I think that it should be adopted in preference to *Bobea* Gaud." As I understand the International Code *Timonius* DC. was protected against replacement by the earlier *Nelitris* Gaertn., but this has no bearing on the case of *Nelitris* Gaudich. versus *Bobea* Gaudich. Britten further called attention to the fact that *Erithalis Timon* Spreng. was the first published binomial for the type species of *Timonius,* and in accepting *Nelitris* to replace *Timonius* proposed the new binomial *Nelitris Timon* (Spreng.) Britten.

The genus is largely characteristic of the Malaysian region, with few representatives in Ceylon, Seychelles, Madagascar, Australia, and New Caledonia, about twelve in Micronesia and Polynesia, and twenty-five in

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[1] Jour. Bot. **39**: 69. 1901.

[2] Fl. Ceyl. **2**: 339. 1894.

[3] ALSTON, A. H. G. in TRIMEN, H. Hand-book of the flora of Ceylon **6**: (Suppl.) 151. 1931.

the Philippines. In 1909 Valeton[1] published a critical consideration of the Malaysian species, not including the Philippine ones, thirty-three species being then known to him, and he estimated that a total of about fifty-five species were then known in the entire range of the genus. At the present time a total of about 150 species are known for which there have been published in *Timonius* and in reduced genera about 190 binomials. By far the richest area is New Guinea.

Timonius (Rumphius, 1743) de Candolle (1830) was fortunately conserved by the Vienna Botanical Congress over *Nelitris* Gaertner (1788), *Porocarpus* Gaertner (1791), *Polyphragmon* Desfontaines (1820), *Helospora* Jack (1823), and *Burneya* Chamisso & Schlechtendal (1829), otherwise, as *Nelitris* Gaertner is the oldest generic name, unless it be true that the Ceylon *Timonius jambosella* Thwaites is really a *Bobea,* it would be necessary to transfer from *Timonius* to *Nelitris* approximately 150 binomials, a high percentage of which have been published within the present century. The synonymy of the type species of *Timonius* is as follows:

Timonius Timon (Spreng.), comb. nov.

Erithalis Timon Spreng. Pl. Min. Cogn. Pugil. **1**: 18. 1813.
Polyphragmon sericeum Desf. Mém. Mus. Hist. Nat. Paris **6**: 6. *t. 2.* 1820.
Erithalis polygama Forst. var. *timonius* Willd. Sp. Pl. **1**: 997. 1798.
Timonius Rumphii DC. Prodr. **4**: 461. 1830.
Timonius sericeus K. Schum. Fl. Kaiser-Wilhelmsl. 131. 1889, Bot. Jahrb. **13**: 433. 1891; Valeton, Bull. Dep. Agr. Ind. Néerl. **26**: 52. 1909; Merr. Interpret. Herb. Amb. 486. 1917.
Nelitris Timon Britten, Jour. Bot. **39**: 68. 1901.
Timonius Rumph. Herb. Amb. **3**: 216. *t. 140.* 1743.

The species is recorded from Timor, Banda, Amboina, Ternate, New Guinea, the Solomon Islands, and eastern Australia. *Timonius sericeus* var. *tomentosa* Valeton, Bull. Dep. Agr. Ind. Néerl. **26**: 53. 1909 occurs in New Guinea and in Queensland and var. *grandiflora* K. Schum. in K. Schum. & Lauterb. Fl. Deutsch. Schutzgeb. Südsee 568. 1901 in New Guinea. Of the binomials cited above *Timonius Timon* Merr., *Nelitris Timon* Britten, *Erithalis Timon* Spreng., and *Timonius Rumphii* DC. are based in Rumphius' description and illustration of *Timonius* or *Timon,* there being no extant type. *Robinson Pl. Rumph. Amb. 166* from Amboina, the type locality, still known there as *timon* is an excellent representation of the plant Rumphius described and illustrated. *Timonius Rumphii* sensu Wall. List no. 6217, 1832, Hook. f. Fl. Brit.

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[1] VALETON, T. Beiträge zur Kenntniss der Gattung Timonius. Bull. Dep. Agr. Ind. Néerl. **26**: 1-61. 1909.

Ind. **3:** 127. 1880, non DC., of the Malay Peninsula, is the distinctly different *Timonius Wallichianus* (Korth.) Valeton.

In addition to the above change of name, three additional ones are indicated:

Timonius octonervius, nom. nov.

Timonius ferrugineus Valeton, Bot. Jahrb. **61:** 40. 1927, non Merr. 1915.

Timonius papuanus, nom. nov.

Timonius involucratus Valeton, Bot. Jahrb. **61:** 41. 1927, non Merr. 1917.

For the two New Guinea species here renamed, Valeton overlooked my earlier use of the same specific names for Bornean species in 1915 and 1917.

Timonius Ridleyi, nom. nov.

Timonius hirsutus Ridl. Jour. Straits Branch Roy. As. Soc. **77:** 239. 1918; Fl. Malay Penin. **2:** 115. 1923, non Merr. 1917.

Ridley's Malay Peninsula species needs a new name, as one year earlier I had published the same name for a different Bornean species.

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NOTES ON NORTH AMERICAN TREES AND SHRUBS

ERNEST J. PALMER

With two text figures

Carya texana (Le Conte) C. DC. (*C. aquatica* × *C. Pecan*). In a collection of plants received at the Arboretum several months ago from Mr. B. F. Bush was a fruiting specimen of a hickory, collected near Campbell, Dunklin County, Missouri, by Mr. John H. Kellogg, and distributed as *Carya aquatica.* The mature fruit was quite different from that of the water hickory, and it at once suggested a hybrid between that species and the pecan. No specimens recognized as such a hybrid were found in the herbarium, but upon comparing Mr. Kellogg's specimen with *Carya texana* it was found to agree very closely with certain specimens in the characters of both leaves and fruit. A further examination of all the material of *Carya texana* in the Arboretum herbarium suggests very strongly the probability that this widely distributed but rather rare hickory is in reality a hybrid between the two species referred to above.

Carya texana is found occasionally, though nowhere in abundance, throughout the common range of the water hickory and the pecan, and so far as I am aware nowhere beyond this general range. It is generally known as bitter pecan by the country people, but it is also sometimes called pignut, both of which common names are also applied to other species in the same region, the former to *Carya aquatica* and the latter to *Carya cordiformis.*

The original description of *Hickoria texana* was published by Major John Le Conte in the Proceedings of the Academy of Natural Sciences of Philadelphia, 1853, p. 402, under the title "Description of a new species of Pecane Nut." The author states that he found the plant cultivated in Georgia, but that it is a native of Texas. Amongst the characters pointed out as distinguishing the new species from "the common pecane nut" are the small size of the trees, which it is stated seldom exceeds 10 or 12 feet in height, the smaller size of the leaves and the later date at which they unfold, and particularly the shape of the nut, which is described as ovate and flattened, although protuberant on the sides, and with a rough surface as contrasted with the smooth, cylindrical nuts of the pecan. The description did not say whether the nuts of the trees cultivated in Georgia were bitter or edible, but the fact that they were in cultivation might indicate the latter. However, in other sections where the tree has been found the fruit is bitter, as the common names indicate.

Both the pecan and the water hickory are amongst the last of the broad-leaved trees to put out their foliage in spring, and from several specimens that I have seen in young leaf, it seems doubtful whether *Carya texana* is more tardy in this respect. The smaller fruit mentioned as characterizing the type plants probably has little diagnostic value, since the nuts of the native pecan vary greatly in size on different trees, and nuts of some of the specimens of *Carya texana* in the Arboretum herbarium are as large as those of almost any native pecan. The small size of the fruiting trees mentioned by the author is not readily accounted for, but this also seems to be quite variable. Sargent in the second edition of the Manual of the Trees of North America says that *Carya texana* is sometimes a tree 100 feet high. There are no notes as to size on most of the herbarium specimens, but on the label of one specimen collected by Bush at Columbia, Texas, it is stated that it is from a large tree; while a fruiting specimen collected by Geo. L. Fisher in Chambers County, Texas, is said to be from a shrub only two or three feet high.

The leaves of the water hickory and those of the pecan are quite similar, although there is a tendency for the leaflets to be slightly smaller, narrower, and more numerous in the pecan. The leaves of *Carya texana* are usually indistinguishable in form from those of the water hickory, but in some specimens they more closely resemble those of the pecan. In all three species the leaflets, though variable, are typically lanceolate or ovate-lanceolate, somewhat falcate, long acuminate at the apex, and unsymmetrical at the base in the lateral pairs. The number of leaflets ranges from seven to seventeen in the pecan, eleven to thirteen being most frequent; seven to eleven is the prevailing number in the water hickory, although rarely reduced to five; while in *Carya texana* the number is even more variable, generally being between five and fifteen. The staminate aments in *Carya pecan* are short stalked or nearly sessile, while those of *Carya aquatica* are usually distinctly peduncled. In one specimen of *Carya texana* from Texas the flowering aments are sessile and spring from growth of the season, while in another specimen from Natchez, Mississippi, they are distinctly peduncled and are born on both the new growth and on wood of the previous season. The fruit of *Carya texana* is quite variable in shape and size, as has been stated. In some specimens it is distinctly compressed and with keel-like edges, as in nuts of *Carya aquatica,* while in others it is quadrate or quadrate-cylindric to short elliptic in cross section, and is only slightly compressed. The nuts in *Carya aquatica* are roughened or irregularly corrugated on the surface, and are of a uniform dark brown color, while those of the pecan are smooth, and red-brown with darker irregular lines. Examination of the fruit from a large series of specimens of *Carya texana* shows a range of variability in these characters between the pecan and the water hickory. In the majority of specimens the fruit approaches more nearly that of the pecan in shape and in the smooth or nearly smooth surface, but in some cases the surface shows distinct signs of wrinkling or roughening, although not so pronounced as in *Carya aquatica.*

The idea that *Carya texana* may be a hybrid does not seem to be an entirely new one, although it has generally been accepted as a distinct species in manuals. Dr. William Trelease in a paper on the Hickories in the 7th Annual Report of the Missouri Botanical Garden (1896), p. 34, suggested that it is probably a hybrid of the pecan, although he did not express an opinion as to the other parent species. But in a later paragraph he referred to a paper by Dr. Charles Mohr in Garden and Forest, 1889, p. 570, in which it is said that crosses between *Carya pecan* and *C. aquatica* are often met with where the two species grow together.

The water hickory is abundant about Campbell, Missouri, where Mr. Kellogg's specimen was found. The pecan also grows in southeastern Missouri, although I have seen no specimens from the immediate vicinity of Campbell. After a full examination of the material available for study, I think that the evidence is abundantly convincing that the bitter pecan, *Carya texana* (Le Conte) C. DC., is a hybrid between *Carya aquatica* and *C. pecan,* and the specimen collected by Mr. Kellogg, no. 27036, near Campbell, Dunklin County, Missouri, Sept. 4, 1935 is referred to this hybrid.

Mr. Kellogg's discovery of *Carya texana* in Missouri extends its range greatly, and also adds another interesting tree to the flora of the state. Besides this new record, *Carya texana* is represented in the herbarium of the Arnold Arboretum by specimens from Arkansas, Mississippi, Louisiana, and Texas, and the nearest station to the Missouri locality is Van Buren, Arkansas, more than three hundred miles distant.

× **Carya Demareei,** hyb. nov. (*C. cordiformis* × *C. ovalis*). Hybrida intermedia inter parentes; folia 5-9, plerumque 7, lanceolata vel ovato-lanceolata, falcata; fructus obovatus vel oblongo-ovatus, exocarpio tenui 1.5–2.5 mm. crasso.

ARKANSAS: flat woods near Piggott, Clay Co., *Delzie Demaree,* Aug. 11, 1927 (type); low woods, foot of Crowleys Ridge, near Jonesboro, Craighead Co., *E. J. Palmer,* no. 26689, Oct. 21, 1924. Specimens in the herbarium of the Arnold Arboretum.

The intermediate character of the foliage, fruit, and winter buds of this tree, which is described from specimens collected by Dr. Delzie Demaree in Clay County, Arkansas, clearly indicates that it is a hybrid between the bitternut and the small-fruited hickory. The number of leaflets ranges from five to nine, but is usually seven as in *Carya ovalis;* while the small, tightly compressed winter-buds resemble more closely those of *Carya cordiformis.* The fruit on the type specimen is quite similar to that of *C. cordiformis* in the very thin, smooth involucre, although in the shape of the nut and in the less prominently winged sutures of the involucre there is an approach to the other parent species. In a specimen collected by the writer in Craighead County, Arkansas, which is apparently the same hybrid, the involucre and shell are slightly thicker and the sutural ridges are more prominent.

Carya Demareei has so far been recognized only in northeastern Arkansas, where it grows in low or flat woods in close proximity to the supposed parent species, but it may be expected to occur in other sections where these species are found.

Quercus Nuttallii E. J. Palmer.[1] (Text figure 1.) Since the publication of the description of this species many inquiries about it have been received and a number of specimens have been sent in to the herbarium by collectors and foresters. From these reports it appears that the tree is much more abundant in some sections than I was aware of at the time it was described. One correspondent states that it is one of the important timber trees in the lowlands of the Yazoo delta and the lower Mississippi valley, and that it is so different from any of the other oaks that the loggers and lumbermen readily distinguish it. Frequent requests have been received for the published description, but as no reprints of it were made at the time and as the number of the Journal in which it appeared has long been exhausted, it is now impossible to supply it. Recently what appears to be a small-fruited form or variety of *Quercus Nuttallii* has been discovered, and as no illustration of the typical form has been published previously, a sketch of the leaves and fruit of both this and the new variety described below are now published, which it is hoped will facilitate their identification.

Quercus Nuttallii var. **cachensis,** var. nov. A typo differt fructu minore 16–18 mm. longo 12–16 mm. lato, cupula breviore glandem circiter 1/3 includente. (Text figure 2.)

ARKANSAS: bottoms of Cache River in overflow (large trees, bark like *Q. Phellos*), Cotton Plant, Woodruff Co., *D. Demaree,* no. 10865 (type), Aug. 29, 1934; low wet woods about 2 mi. west of Wheatley,

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[1] Jour. Arnold Arb. 8: 52 (1927).

Moore Co. (2 ft. D. B. H., just cut for logs — from top of tree), *D. Demaree,* no. 10910, Sept. 1, 1934; very low ground, Clarendon, Monroe Co. (3 ft. D. B. H.), Clarendon, Monroe Co., *D. Demaree,* no. 10917, Sept. 2, 1934; Fulton (Hempstead Co.), *John H. Kellogg,* Aug. 31, 1910.

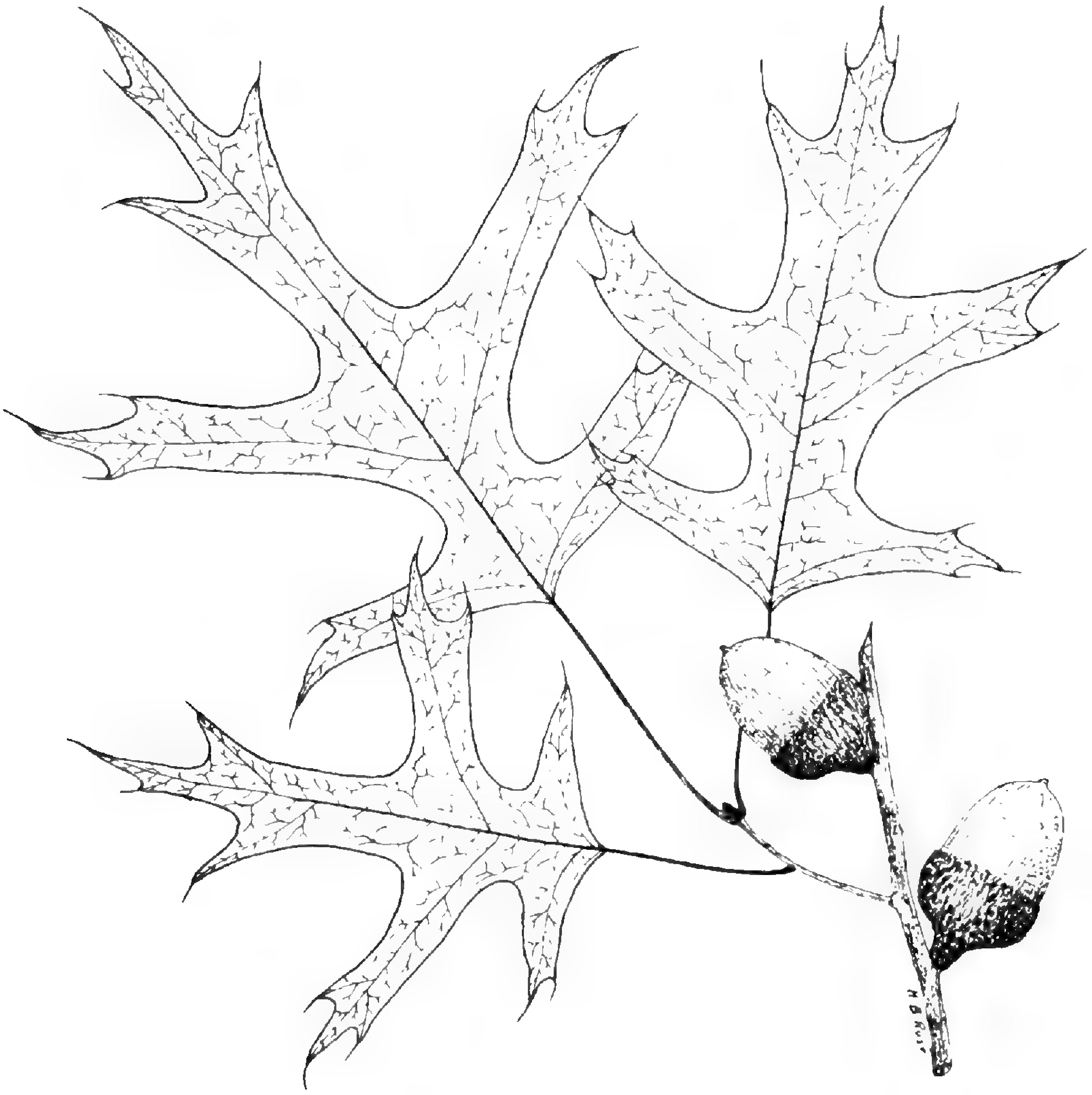

Figure 1. Quercus Nuttallii E. J. Palmer. × 3/5

In the specimen that is taken as the type of this variety and in others collected in the same vicinity, the fruit which is short-oblong or depressed-conic, with the nut about one-third enclosed in the shallow cup, has considerable resemblance to that of *Quercus palustris,* and suggests the possibility of a hybrid between *Quercus Nuttallii* and that species. But since the acorns in all respects except their shape and size indicate a close relationship to the latter species, and since the leaves and winter-buds are quite like those of the type, it seems best to treat it as a variety of *Quercus Nuttallii.*

Typical specimens of *Quercus Nuttallii* are growing in the immediate vicinity of the new variety and the species is not uncommon in the region. *Quercus palustris* is rather rare in Arkansas, and I have not seen specimens from Woodruff, Moore, or Monroe counties, although it is occasionally found in northeastern Arkansas.

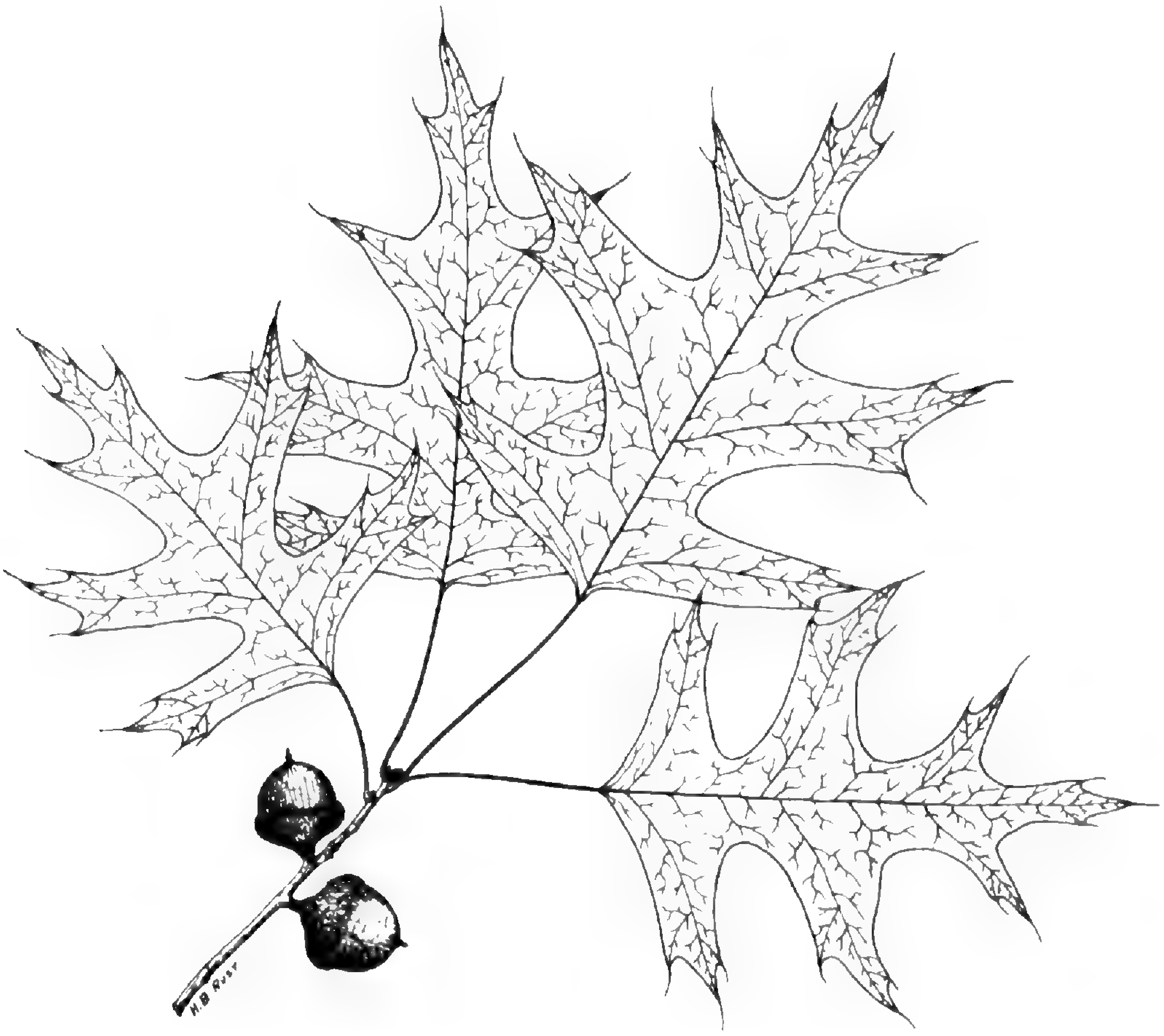

FIGURE 2. QUERCUS NUTTALLII var. CACHENSIS E. J. Palmer. × 3/5

Quercus breviloba (Torr.) Sarg. (*Q. annulata* Buckley, 1861, not J. E. Smith, 1819). In an interesting collection of plants made by Mr. George M. Merrill in the Platt National Park, near Sulphur, Oklahoma, were several specimens of *Quercus breviloba,* a species characteristic of the limestone regions of central Texas, and not previously known north of that state. The discovery of this shrubby oak in Oklahoma not only extends its known range northward, but it also adds a very interesting species to the flora of the state and furnishes another example of the incursion of species characteristic of the Edwards Plateau of Texas into the Arbuckle Mountain region, most of which is underlain by a limestone formation somewhat similar in character to that found south of Red River, although it is much older geologically.[1]

Another specimen in the same collection is an evident hybrid between *Quercus breviloba* and the post oak (*Quercus stellata*). According to notes furnished by Mr. Merrill, several small trees were found growing in a dry, exposed situation, where *Quercus breviloba* is predominant, and with *Q. stellata* in the immediate vicinity. The trees are 10 to 15 feet in height and have rough bark, similar to that of the post oak. A specimen with immature fruit was collected by the writer near Strawn, Texas, and one with leaves only, near Brownwood, Texas, several years ago, both of which appear from their characters and association to belong to this hybrid. As Mr. Merrill's specimen has mature fruit, it may be taken as the type.

× **Quercus Mahoni,** hyb. nov. (*Q. breviloba* × *Q. stellata*). Hybrida intermedia inter parentes; frutex robustus vel arbor minor ad 2–3 m. alta, foliis obovatis vel oblongo-obovatis lobatis rotundis inaequalibus 4–9 cm. longis 3–5 cm. latis.

OKLAHOMA: Platt National Park, Sulphur, *G. M. Merrill,* no. 1634 (type), Oct. 28, 1935. TEXAS: Strawn, Palopinto Co., *E. J. Palmer,* no. 14267, June 27, 1918; Brownwood, Brown Co., *E. J. Palmer,* no. 29501, Nov. 1, 1925. All specimens in the herbarium of Arnold Arboretum, and isotype in the herbarium of the Platt National Park, Sulphur, Okla. The name proposed for this hybrid is for Mr. George Mahon Merrill, collector of the type, in recognition of his valuable work in collecting and making known the plants of southern Oklahoma and of other sections.

× **Quercus stelloides,** hyb. nov. (*Q. prinoides* × *Q. stellata*). Frutex plerumque 1–2 m. altus: folia obovata, inciso-lobata, lobis ovatis utrinque 4–6 vel lobis medii paris oblongis subtruncatis, supra viridia, leviter pubescentia vel matura glabra, infra pallida, subtiliter denseque stellato-pubescentia.

MISSOURI: Greenwood, Jackson Co., *B. F. Bush,* nos. 10227 and 10227A, Oct. 3, 1923, no. 10330, Sept. 5, 1924; same locality, *E. J. Palmer,* no. 26032, Sept. 5, 1924. KANSAS: Neodesha, Wilson Co., *E. J. Palmer,* 21398, May 23, 1922, 22007 (type), Sept. 18, 1922, 24372, Oct. 31, 1923. OKLAHOMA: Muskogee, *E. J. Palmer,* no. 14285, June 30, 1918. All specimens in the herbarium of the Arnold Arboretum.

The post oak (*Quercus stellata*) is widely distributed in the southern

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[1] See Palmer, E. J., Notes on some plants of Oklahoma (Jour. Arnold Arb. **15**: 127-134. 1934).

United States south of a line from Cape Cod to southern Iowa, Kansas, and central Texas. The shrubby chestnut oak (*Quercus prinoides*), sometimes called chinquapin oak in the eastern states and shin oak throughout most of its range, occupies a belt mainly north of the range of the post oak. However, the ranges of the two species overlap widely, and in the region where they are found growing together hybrids have been observed and collected in several places. The hybrid can usually be recognized readily by the intermediate character of the leaves, which differ widely in the two parent species, both in shape and in the character of pubescence.

× **Quercus humidicola,** hyb. nov. (*Q. bicolor* × *Q. lyrata*). Hybrida intermedia inter parentes; arbor ad 15–20 m. alta; folia eis parentium similia et intermedia, subtus pallida, pubescentia.

MISSOURI: low woods, Campbell, *B. F. Bush,* no. 6365 (type), Oct. 6, 1910. ILLINOIS: low woods near Mounds, Pulaski Co., *E. J. Palmer,* nos. 16634 and 16642, Oct. 1, 1919; same locality and collector, nos. 19546, 19549, and 19550, Oct. 16, 1920.

The swamp white oak and the overcup oak grow in quite similar situations and are often found together throughout much of their range, and it is, therefore, not surprising that the two species should hybridize.

A specimen collected by Mr. B. F. Bush, near Campbell, Dunklin County, Missouri, is the best example that I have seen of this hybrid, and it may be taken as the type. Collections made by the writer near Mounds, Pulaski County, Illinois, where several specimens were found growing with the supposed parents, appear also to represent this hybrid. The leaves of the type specimen closely resemble in outline those of *Quercus lyrata,* but they are covered on the pale under surface with a close downy pubescence, as in *Q. bicolor.* The acorns of the type are 2.5–2.8 cm. long, 2–2.2 cm. thick, and are borne on peduncles about 3 cm. long. The oblong-ovoid nuts, resembling those of *Q. bicolor* in shape, though somewhat larger than is usual in that species, are one half or less enclosed in the comparatively shallow cups, the lower scales of which are thickened and corky, as in *Quercus lyrata.* The leaves and fruit on some of the other specimens vary in different degrees between those of the two parent species. In the absence of fruit the hybrid may usually be identified by the close velvety pubescence on the under surface of the leaves, which may otherwise resemble those of the overcup oak.

HERBARIUM, ARNOLD ARBORETUM,
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CHRYSOMYXA EMPETRI — A SPRUCE-INFECTING RUST

J. H. Faull

With one text figure and plates 202, 203

Chrysomyxa Empetri (Persoon) Schroeter has been known for considerably more than a century, but only on *Empetrum* and almost solely with respect to its uredo-stage. DeCandolle (5) described its uredia in 1815 from specimens distributed two years earlier in Mougeot and Nestler's Stirpes Cryptogamae Vogeso-Rhenanae and to which Persoon had attached the name *Uredo Empetri.* Link (10), Wallroth (14) and Karsten (8) in turn, and in each instance on wholly untenable grounds, transferred it to the genera *Caeoma, Erysibe* and *Thecopsora,* respectively. Schroeter (12), basing judgment on the uredia, just as did the others but with happier discrimination, placed it in the genus *Chrysomyxa.* The following year (1888) and apparently independently, Rostrup (11) also referred it to *Chrysomyxa;* but he did so with a probably better reason because he stated he had found the telia on *Empetrum nigrum* in Greenland. Rostrup did not describe the telia and what became of the collections he may have made is not known. That both Schroeter and Rostrup were right, however, was recently substantiated by Jørstad (7) who described the telia in 1935 from specimens long preserved in the Botanisk Museum, Oslo — specimens which had been collected by Axel Blytt, July 1887, at Sør-Trøndelag, Kongsvoll in Opdal, Norway. Through the courtesy of Professor Jørstad I have had the opportunity of examining this material. Unquestionably the rust is a *Chrysomyxa.*

Collections of *Chrysomyxa Empetri* on *Empetrum nigrum* have been made in most of the major areas of distribution of *E. nigrum* (6) and recently Arvidsson (3, 4) has reported it on a collection of *E. rubrum* in the Gray Herbarium of Harvard University — a collection made some years ago by W. S. Brooks in the Falkland Islands. Indeed, it occurs so frequently in both mycological and phanerogamic herbaria that it can properly be classed as a very common, widely-distributed rust. Except, however, as noted above, the uredo-stage only has been recognized. Scant as have been the findings of the telial stage, for the haploid phase there have been no claims at all. If collections have been made, they have been referred to other species. Of course it is generally assumed that there is or has been a haploid phase and that it probably would be on an alternate host. But the assumption has rested wholly on analogy, because there has been an entire absence of concrete evidence. Fortunately that evidence is now in hand and at last it is possible to present a complete account of this interesting rust and to offer explanations of the apparent rarity of its critical telial stage and the failure to recognize its haploid phase.

Thus far the telia of *Chrysomyxa Empetri* appear to have been found but three times — (a) by E. Rostrup (11) in Greenland, (b) by G. Lagerheim (9) near Tromsö, Norway, (c) by Axel Blytt (Jørstad 7) in Norway. So, regarding the occurrence of the telial stage, Sydow (13) expresses an opinion from which there has been so far no dissent, namely, "Diese wird jedenfalls nur sehr selten ausgebildet." The correctness of that opinion is now open to question in view of the fact that in June 1935, at about the time spruce buds were breaking, I discovered telia on *Empetrum nigrum* in great abundance at two stations, about 70 miles apart, on the south shore of the River St. Lawrence in the Province of Quebec — near Metis and Trois Pistoles, respectively. Revisiting these stations in June 1936 I found an equally heavy crop. Always they were the first sori to mature and only towards the end of their functional period did uredia begin to appear in large numbers. They remained active about two weeks, at the end of which time the leaves bearing them rapidly withered and their sori became no longer recognizable. It is also significant that the cultures recorded in Table 2, below, manifested the same phenomena. Judging, therefore, from these experiences, it is quite possible that telia are not rare and that they would be located in many places if the search were properly timed. They should be looked for on overwintered foliage during a brief period in the spring or early summer, according to the climate of the respective localities. To these records I would add my discovery of telia in a collection made by Professor Roland Thaxter on Mt. Washington, N. H., July 3–9, 1886 (Reliquiae Farlowianae, no. 691).

My research interest in *Chrysomyxa Empetri* was actually first aroused by the chance finding, on August 25, 1933, a profuse display of an unknown, orange-colored *Peridermium* on *Picea glauca* at Metis Beach, Quebec. *Empetrum nigrum,* rusted with *C. Empetri* in its uredostage, formed a carpet under the affected spruces. This association and the absence of other Chrysomyxa-susceptible hosts suggested that the unknown *Peridermium* belonged to the hitherto unrecognized haploid phase of *C. Empetri.* If this were true then there must have been a crop of telia on the associated *Empetrum.* I returned to the same spot on

June 30, 1934, but found that the new foliage of the spruces was already showing severe infection; the telial stage, on *Empetrum,* if there had been one, was past, leaving few tangible remains. The most that I could discover of telia, were what appeared to be exhausted sori on browned, withered leaves. The next year I arrived three weeks earlier and at an especially opportune date because the first telia to mature were just being exposed through the rupture of epidermis overlaying them. The abundance of telia was so great that upturned shoots of *Empetrum* appeared as though liberally sprinkled with miniature, yellow cushions. Yet at the end of another two weeks the telia were exhausted and for the main part had disappeared. With so much telial material available, culture experiments were at once initiated.

These experiments have comprised a total of 38 culture tests, as follows — A. From *Empetrum nigrum* to *Picea*: (1) 22 tests on *Picea glauca* in 1935; (2) 6 tests on *Picea glauca* in 1936; (3) 2 tests on *Picea rubens* in 1935. B. From *Picea glauca* to *Empetrum nigrum*: (4) 8 tests in 1935–6.

The results of the experiments listed under "A" above are recorded in Table 1. The tests were made on vigorous young trees 8 to 25 feet in height, located on the margin of pasture lands at "Green Gables," Leggatt's Point, Quebec, five miles distant from the source of the inoculum. *Empetrum nigrum* and *Chrysomyxa* rusts of all kinds were absent from the immediate neighborhood. The experiments were protected in part by screens during the period of incubation. All of the cultures were highly successful, as is shown by a photographic reproduction of one of them in plate 202. The rest of the foliage of the experimental and adjacent spruces remained entirely free from infection.

The results of the experiments listed under "B" above are recorded in Table 2. The cultures were made at the Arnold Arboretum, Harvard University, on a vigorous mat of *Empetrum nigrum* growing in partial shade between two greenhouses — the only examples of living *Empetrum* in the Arnold Arboretum. This mat of *Empetrum* originated from seed sent from Kew Gardens, England and planted in 1930 by Mr. William H. Judd, Propagator at the Arnold Arboretum, under no. 727–30. Eight shoots of the mat were inoculated — (a) 4 with aeciospores collected from natural infections at Metis Beach, Quebec and (b) 4 with aeciospores collected from my cultures on *Picea glauca* at Leggatt's Point, Quebec, in 1935. Seven of these experiments gave positive results, the infections producing a few uredia and many telia. No rust appeared elsewhere on the mat.

TABLE 1

CHRYSOMYXA EMPETRI FROM EMPETRUM NIGRUM TO PICEA, USING FIELD-COLLECTED TELIAL INOCULUM

(a) Experiments 1–5, 7–12; on *Picea glauca.*

Inoculations made June 15, 1935 on new shoots of spruce partly expanded.
Spermogonia first observed June 28, 1935.
Peridermia appeared early in August.
Materials were harvested August 24, 1935.
Heavy infection in all experiments, and on needles of current season only. Thus in no. 4 nearly all of the approximately 500 needles of the current season inclosed in the inoculation tube became infected and produced peridermia.
Controls remained free from infection.
Specimens preserved in Herb. J. H. Faull under no. 12,702 (1–5, 7–12).

(b) Experiments 13–24; on *Picea glauca.*

Inoculations made June 20, 1935 on new shoots of spruce partly expanded.
Peridermia appeared early in August.
Materials were harvested August 24, 1935.
Heavy infection in all experiments, and on needles of current season only.
Controls remained free from infection.
Specimens preserved under no. 12,703 (13–24).

(c) Experiments 25–29; on *Picea glauca.*

Inoculations made June 21, 1936 on new shoots of spruce quite fully expanded.
Peridermia appeared about August 1, 1936.
Materials were harvested August 9, 1936.
All experiments showed infection though not nearly so abundant as in the experiments of 1935. The youngest needles only of the current season became infected.
Controls remained free from infection.
Specimens preserved under no. 12,877 (25–29).

(d) Experiment 6; on *Picea rubens.*

Inoculation made June 15, 1935 on new shoots of spruce partly expanded.
Spermogonia first observed June 28, 1935.
Peridermia appeared early in August.
Material was harvested August 24, 1935.
Heavy infection.
Controls remained free from infection.
Specimens preserved under no. 12,702 (6).

(e) Experiment 30; on *Picea rubens.*

Inoculation made June 21, 1936 on new shoots of spruce quite fully expanded.
Peridermia appeared about August 1, 1936.
Material was harvested August 9, 1936.
Rather light infection and on youngest needles only of current season.
Controls remained free from infection.
Specimens preserved under no. 12,877 (30).

TABLE 2

CHRYSOMYXA EMPETRI FROM PICEA GLAUCA TO EMPETRUM NIGRUM, USING FIELD-COLLECTED AECIOSPORES IN EXPERIMENTS 1–4, AND CULTURE-PRODUCED AECIOSPORES IN EXPERIMENTS 5–8, FROM EXPERIMENTS RECORDED UNDER (A) AND (B), TABLE 1.(1, 2, 3)

No.	Date of inoculation	First appearance of sori	Kinds of sori	No. of needles infected	Date harvested
1	3.IX.35	28.XI.35 30.IV.36	II III	1 1	30.IV.36 7. V.36
2	3.IX.35		No infection		
3	3.IX.35	30.IV.36	III	4	13. V.36
4	3.IX.35	30.IV.36	III	4	5. V.36
5	3.IX.35	30.IV.36	III	15	13. V.36
6	3.IX.35	30.IV.36	II,III(4)	18	11. V.36
7	3.IX.35	X.35 30.IV.36	II II,III(5)	6 11	28. V.36 5. V.36
8	3.IX.35	X.35 30.IV.36	II III	1 7	13. V.36 13. V.36

(1) All controls remained free from infection.
(2) These experiments were conducted at the Arnold Arboretum, Harvard University, Jamaica Plain, Mass.
(3) The aeciospores used as inoculum were obtained at Metis Beach, Quebec.
(4) Four uredia and 50 telia.
(5) One uredium, 18 telia, 10 sori undetermined.

Chrysomyxa Empetri (Pers.) Schroeter in Kryptog. Flora Schles. 3^1: 372 (1887). (II). O, I, II, III.

Uredo Empetri Pers. (in litt.) in Moug. and Nestl. Stirp. Crypt. Vogeso-Rhen. no. 391. (1813). No description.
Uredo Empetri Pers. ex DC. in Fl. Fr. **6**: 87 (1815).
Caeoma Empetri (Pers.) Link in Willd. Sp. Pl. **6**^{2}: 16 (1825).
Erysibe Empetri (Pers.) Wallr. in Fl. Crypt. Germ. **2**: 199 (1833).
Thecopsora Empetri (Pers.) Karst. in Bidr. Finlands Nat. Folk, **31**: 143 (1879).
Chrysomyxa Empetri (Pers.) Rostr. in Meddel. om Grönland, Kjøbenhavn, **3**: 536 (1888).
Melampsoropsis Empetri (Pers.) Arthur in Résult. Sci. Congr. Bot. Vienne, p. 338 (1906).

O. Spermogonia on needles of current season, amphigenous, uniseriate, conspicuous, yellowish, then reddish-brown, slightly elevated, aparaphysate, immersed, subepidermal, 135–162 μ broad and 108–135 μ deep, averaging 145 × 125 μ; spermatiophores unbranched; living spermatia subglobular to ellipsoid, 5.0–7.0 × 5.5–10.0 μ; extruded in colorless, sticky liquid.

I. Aecia (peridermia) on needles of current season, yellow, amphigenous, uniseriate, on pale yellowish-discolored portions of affected needles, elliptical to subcircular in transverse section, 0.5–1.5 mm. in greatest width and 0.5–2.0 mm. high; peridium colorless, rupturing at the apex; peridial cells polygonal, elongate vertically, not imbricate or but slightly so, in a single layer, 19–54 × 32–76 μ, with outer walls smooth, about 1 μ thick, and inner walls rather coarsely verrucose, 4–6 μ thick; aeciospores yellow, ellipsoid or ovoid, rarely subspherical, 22–32 × 27–54 μ, averaging about 27 × 42 μ; walls of aeciospores closely and rather coarsely verrucose, the warts more or less dehiscent at maturity, hyaline and 1.5–2.0 μ thick.

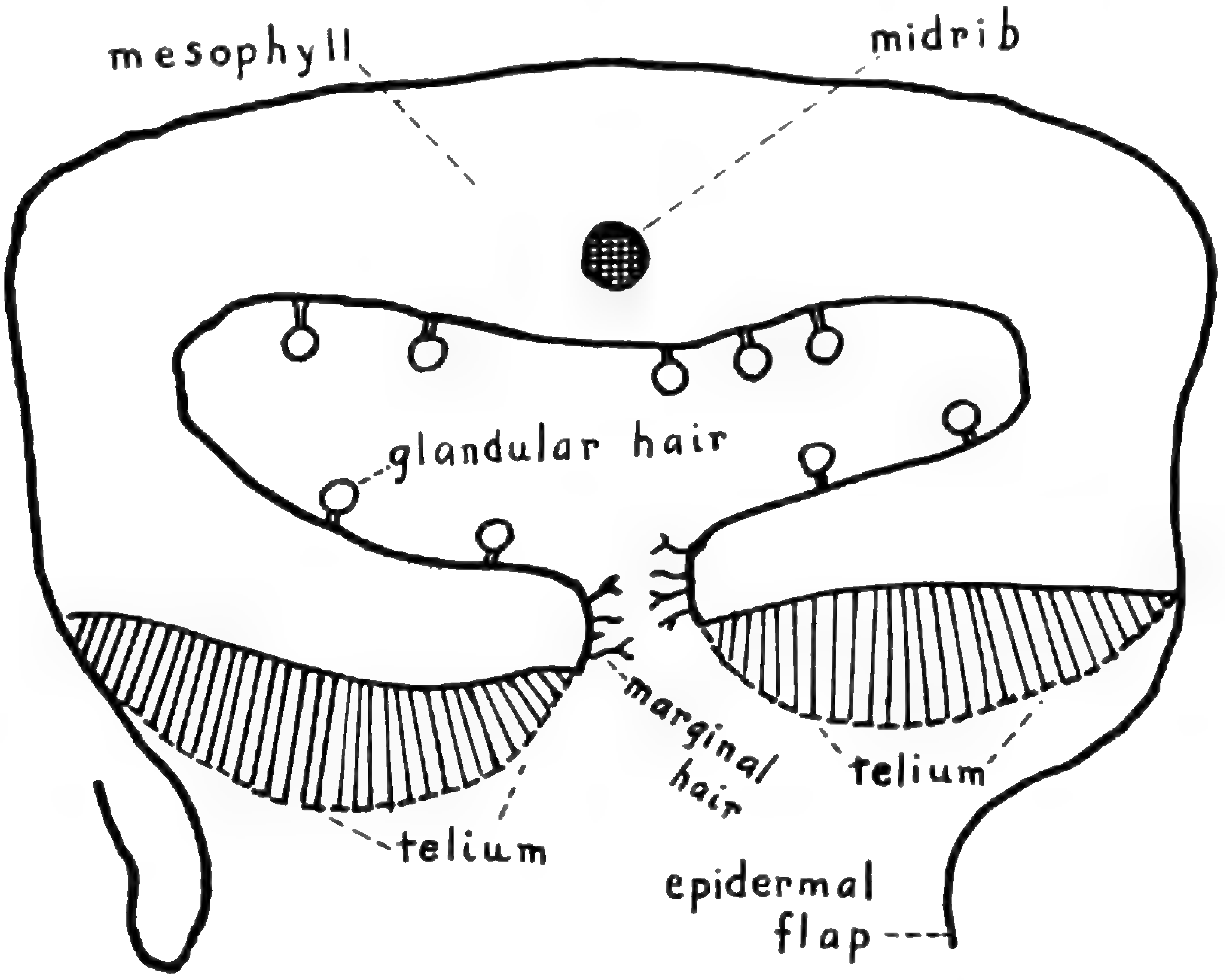

FIGURE 1. Schematic drawing of transverse section of a leaf of *Empetrum nigrum* with two mature telia of *Chrysomyxa Empetri*. Note ruptured epidermis over each telium. Drawn to scale. × 100.

II. Uredia epiphyllous, one to few on a leaf, pustular, convex before rupture, becoming concave as spores are discharged, subepidermal, round or elliptical to linear, 0.2–2.0 mm. in major axis; peridium distinct, adherent to overlying epidermis which ruptures widely at maturity, 15–17 μ thick; peridial cells in a single layer, angular, thin-walled, 10–20 μ in diameter; urediospores orange, catenulate, with intercalary cells, pulverulent, ellipsoid, ovoid or subglobose, 21–27 × 27–48 μ, averaging about 25 × 35 μ; walls of spores hyaline, closely and rather coarsely verrucose, 1.5–2.0 μ thick.

III. Telia in spring or early summer on overwintered leaves, epiphyllous, one or two to few on a leaf, yellow, cushion-shaped, waxy, subepidermal, overlying epidermis widely rupturing at maturity, exposed surface yellow to straw-colored, relatively smooth, compact and fine-textured, subcircular to mostly much elongate, often nearly as long as the leaf itself, 0.5–3.0 mm. in major axis; no peridium; teliospores with yellow contents, catenulate, 3 to 6 in a chain, without intercalary cells, smooth, thin-walled, 18–21 × 19–24 μ. The teliospores germinate promptly *in situ* at maturity, beginning with those that are terminal and the basidia soon form a dense velvety nap. Basidia pale yellow, slightly curved to strongly arched, typically 4-celled, 7–8 μ in diameter and up to 65 μ in length. Basidiospores with yellow contents, very thin-walled, subglobose to slightly ellipsoid, varying from 10–15 μ in diameter but usually about 12 μ.

HOSTS AND DISTRIBUTION

O, I. *Picea glauca* (Moench) Voss* in Quebec (nature and cultures).
Picea rubens Sarg.* in Quebec (cultures).

II. *Empetrum nigrum* L. in United States (Me., N. H., Vt.*, N. Y.), Alaska*, Canada (B. C., Alta.*, Que., N. S.*), Newfoundland*, Greenland, Latvia, Norway, Sweden, Denmark, Great Britain, France, Germany, Austria, Czechoslovakia, Hungary, Switzerland, Poland, Finland, Russia (in Europe), Siberia, Japan.
Empetrum atropurpureum Fern. & Wieg.* in Quebec.
Empetrum Eamesii Fern. and Wieg.* in Newfoundland.
Empetrum rubrum Vahl in Falkland Islands.

III. *Empetrum nigrum* L. in Greenland, Norway, Quebec*, New Hampshire*.

TYPE LOCALITY.

Vosges, France; uredia on *Empetrum nigrum*. (Moug. and Nestl., Stirpes Cryptogamae Vogeso-Rhenanae, no. 391. 1813.)

ILLUSTRATIONS.

Grove in British Rust Fungi, p. 311, fig. 235; Arthur in Manual of the Rusts in United States and Canada, p. 31, fig. 41.

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*New records.

EXSICCATI

Moug. and Nestl. Stirp. crypt. vogeso-rhen. 391; Fuckel Fg. rhen. 2697; Sydow Myc. germ. 971; Sydow Ured. 143, 2394; Thuemen Myc. univ. 1044; Racib. Myc. polon. 149; Smarods Fg. latvici 70; Eriksson Fg. par. scand. 177; Linhart Fg. hung. 342; Reliq. Farl. 691.

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EXPLANATION OF PLATES

PLATE 202

Chrysomyxa Empetri (Pers.) Schroet. Inoculation experiment No. 17 of 1935. *Picea glauca* (Moench) Voss inoculated with telial material from *Empetrum nigrum* L. collected June 20, 1935. Date of inoculation June 20; harvested August 24, 1935. × 1. Herbarium J. H. Faull no. 12,703 (17).

PLATE 203

Chrysomyxa Empetri on *Picea glauca*. Natural infection. Metis Beach, Quebec. August 25, 1935. × 1. The leafless internodes of 1934 indicate a very heavy rust infection in 1934. Herbarium J. H. Faull no. 12,704.

LABORATORY OF PLANT PATHOLOGY,
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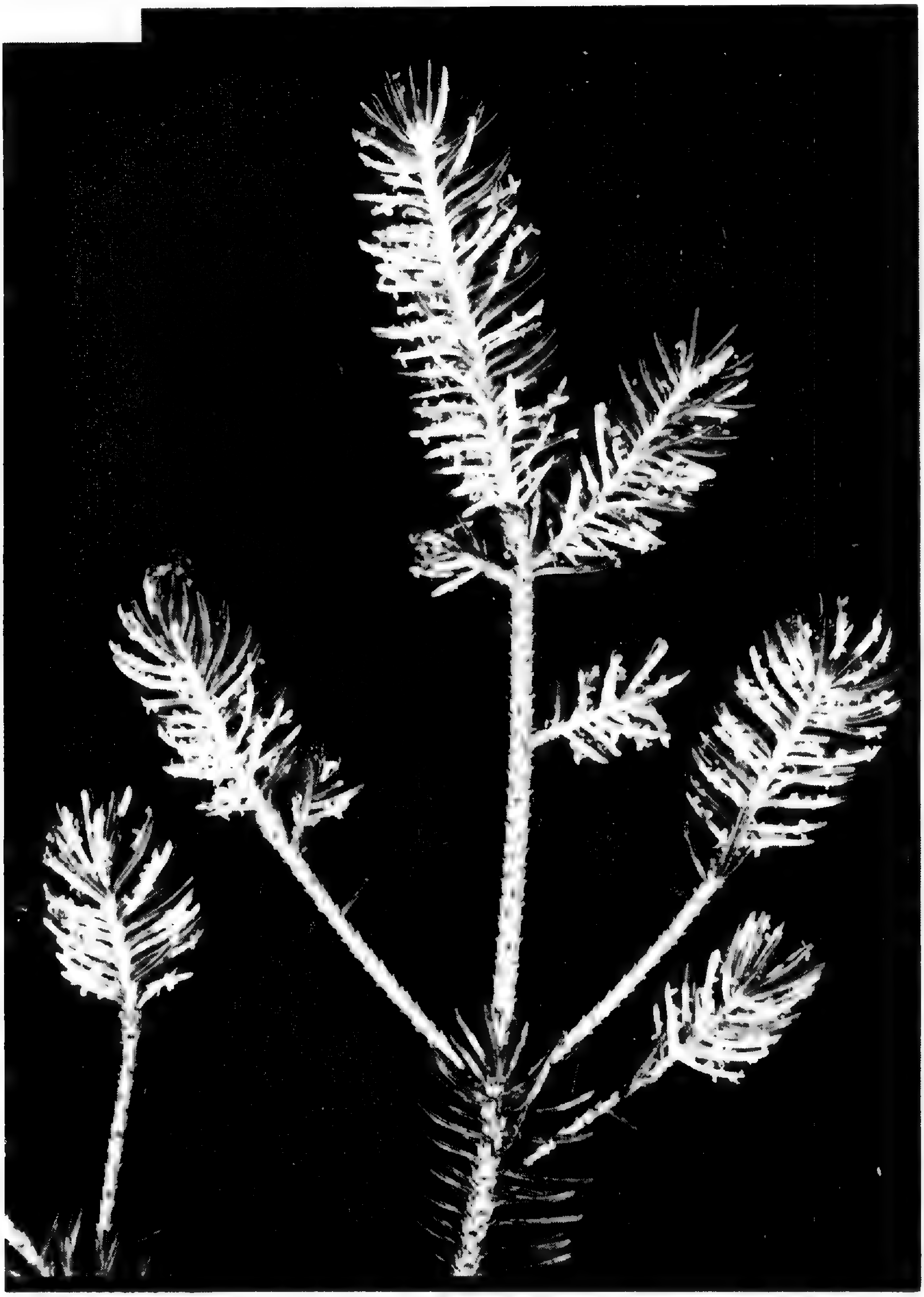
CHRYSOMIXA EMPETRI—A SPRUCE INFECTING RUST

FULL-TONE — MERIDEN



Chrysomixa Empetri—A Spruce Infecting Rust

FULL-TONE — MERIDEN

CONTROL OF THE GYMNOSPORANGIUM RUSTS BY MEANS OF SULPHUR SPRAYS

J. D. MacLachlan and Ivan H. Crowell

With plate 204

INTRODUCTION

Crowell (1934, 1935) has already demonstrated the value of a colloidal sulphur as a means of controlling *Gymnosporangium Juniperi-virginianae* Schw. on ornamental apple trees, and *G. clavipes* C. and P. on *Juniperus virginiana* L. and *Amelanchier oblongifolia* (T. and G.) Roem. Both of the writers of this paper, individually and jointly, have been studying and experimenting with sulphur sprays for several years in relation to their effectiveness as a means of controlling Gymnosporangium rusts. The results obtained are presented here, along with recommended spray schedules for the control of *G. Juniperi-virginianae*, *G. globosum* and *G. clavipes* on their respective alternate hosts.

SULPHUR SPRAYS WITH RELATION TO TOXICITY TO GYMNOSPORANGIUM SPORES

A. The toxic effect on the basidiospore

Apparently sulphur, in contact with the basidiospores of the Gymnosporangium rusts, has little toxic effect on these spores prior to their being moistened and permitted to germinate. Moreover, the germinating spores must be in close proximity to the sulphur particles to be materially affected. These phenomena were illustrated by a simple experiment. A small amount of linseed oil was mixed with "Flotation sulphur," made up at six pounds to one hundred gallons of water. The mixture was sprayed on a glass slide and allowed to dry. Fresh basidiospores of *G. Juniperi-virginianae* were obtained from germinating teliospores and permitted to fall on the prepared slide. After the spores had been in contact with the sulphur for a period of ten hours, the slide was lightly atomized with distilled water and inverted in a moist chamber. Due to the presence of the oil, the water formed in small droplets carrying some of the spores to the exposed surfaces of the droplets while the remainder of the spores remained in contact with the sulphur. Twelve hours after atomizing, no germ tubes were evident on the spores which remained in contact with the sulphur either within a droplet or at its periphery but more than seventy per cent of the spores on the exposed surfaces of the droplets and free from the sulphur exhibited normal germ tubes. This experiment indicates (1) that the sulphur has little effect on the spores until they begin to germinate and (2) that the sulphur particles must be in close proximity to the germinating spores to have a toxic effect.

B. SIZE OF SULPHUR PARTICLE WITH RELATION TO TOXICITY

It is the belief of Wilcoxon and McCallan (1931) that particle size rather than concentration is the chief factor that determines the relative efficiency of sulphur sprays; the toxic value of the sulphur varies inversely with the diameter of the particle. From this it would appear that a colloidal type of sulphur would be the most efficient. On the other hand, sulphur volatilizes when exposed in a thin layer to wind and direct sunlight, the rate of volatilization varying directly with the size of the sulphur particle. These two factors would indicate that an efficient sulphur should contain particles of active ingredients whose sizes varied from colloidal to a size that would not be completely volatilized by the time of the next spray application.

C. PARTICLE SIZE OF THE INGREDIENTS OF CERTAIN SULPHURS

The relative particle sizes of the ingredients of eight sulphur sprays were illustrated by means of photomicrographs. The sulphurs selected were Dry Lime, Flotation, Kolofog, Linco Colloidal, Liquid Lime, Magnetic Wettable, the Nova Scotia formula and Sublimated sulphur. The respective sulphurs were made up according to the schedule given in Table I. No spreader or sticker was added. Samples of the respective sulphurs were taken immediately after their preparation and sprayed by means of atomizers on glass slides and allowed to dry. Microscopic examination revealed in all cases that the spray ingredients were quite uniformly distributed over the surfaces of the prepared slides. Thus it made little difference what portion of a slide was photographed. Photomicrographs were made as silhouettes at a magnification of 545 diameters and are illustrated in Plate 204. (For further details see explanation of plate.) These photomicrographs might well represent the optimum distribution of the particles of the respective sulphurs on the surface of sprayed foliage. Within Plate 204 are shown photographs of basidiospores and aeciospores of *G. globosum,* also at a magnification of 545 diameters. One can visualize from Plate 204 how it might be possible for a basidiospore to germinate and penetrate the surface of a leaf and yet not come in contact with a particle of one of the coarser sulphurs.

TABLE I

THE SULPHUR SPRAYS, TOGETHER WITH THEIR CONCENTRATIONS, USED IN THE INVESTIGATIONS PRESENTED IN THIS PAPER

Sulphurs:	
Dry Lime	6 lbs. to 100 gallons of water.
Flotation	
Kolofog	
Linco Colloidal	
Magnetic Wettable	
Sublimated	
Liquid Lime	1 gallon to 50 gallons of water.
Nova Scotia formula	Aluminum sulphate ....4.2 lbs. Liquid Lime Sulphur ......1.4 lbs. Calcium arsenate ....1.2 lbs. Water ....48 gallons

Stickers and spreaders:

(1) "S. S. S." Sticker and Spreader, produced by the Mechling Chemical Co., Canton, New Jersey. This product contains no lime, is not designated to wet sulphur and can be used with any spray except oil. It was used in the proportion of 3 lbs. to 100 gallons of spray.

(2) Fish oil in the proportion of 1 pint to 50 gallons of spray together with dried milk in the proportion of ½ lb. to 50 gallons of spray.

D. Duration of toxicity of sulphur on sprayed foliage

An attempt was made to determine how long different types of sulphur sprays would protect the foliage from infection by the basidiospores. The sprays selected were Magnetic Wettable, Kolofog, Flotation and Linco Colloidal. The tree selected for experimentation was *Crataegus Jonesae* Sarg., a hawthorn that is very susceptible to *G. globosum*. Separate large branches of the hawthorn were sprayed with the respective sulphurs made up according to the schedule given in Table I. No spreader or sticker was added. Samples of the sprayed branches were inoculated with germinating teliospores of *G. globosum* (1) immediately after the sprays were dry, (2) three days later, (3) five days later, and (4) twelve days later. The experiment was carried out in duplicate, each inoculation on a separate twig. Parallel series of check inoculations were made on unsprayed branches of the same tree. Table II presents data on the results obtained and the following conclusions can be made. (1) The host tree was highly susceptible during the period of experimentation as indicated by the check inoculations. (2) The Flotation and Linco Colloidal sulphurs gave perfect protection for at least five days time but gave practically no protection twelve days after spray application. A somewhat similar series of experiments (Crowell, 1934) also indicates that Linco Colloidal will not protect the foliage of ornamental apples from infection by *G. Juniperi-virginianae* for a period of more than nine to ten days.

TABLE II

DURATION OF TOXICITY OF FOUR SULPHUR SPRAYS TO BASIDIOSPORES OF *G. GLOBOSUM* WHEN APPLIED TO HAWTHORN FOLIAGE

Spray	Degree of infection from successive inoculations obtained			
	Immediately after spraying	3 days later	5 days later	12 days later
Magnetic Wettable	2	1	2	2
Kolofog	1	3	2	2
Flotation	0	0	0	2
Linco Colloidal	0	0	0	3
Check (unsprayed)	3	3	3	3

Experiment begun May 19, 1933.
The degrees of infection obtained by the inoculations were graded as 0, 1, 2 and 3 where 0 — no infection obtained
1 — 1–5 lesions per leaf
2 — 5–20 lesions per leaf
3 — more than 20 lesions per leaf.

III. FIELD TESTS USING FOUR DIFFERENT SULPHURS TO CONTROL *G. JUNIPERI-VIRGINIANAE*

In view of the foregoing investigations, four sulphurs, namely, Flotation, Linco Colloidal, Liquid Lime and the Nova Scotia formula were selected for field tests. These sulphurs were used as a means to control *G. Juniperi-virginianae* on susceptible apple trees and on red cedars.

A. CONTROL OF G. JUNIPERI-VIRGINIANAE ON APPLES

A number of Wealthy apple trees were marked in a commercial orchard at Wayland, Massachusetts, in August, 1934. These marked trees exhibited severe infection by *G. Juniperi-virginianae* and were used for both spray tests and check purposes the following spring. Spraying was begun on May 2, 1935. The four sulphurs were made up according to schedule with the "S. S. S." sticker and spreader added. (See Table I.) Two trees were used for each spray test; the remaining ones served for check purposes. The spray was applied by means of a hand-pump sprayer. The dates of spray application, as well as conditions of the foliage and the weather conditions at the time of spraying, may be found in Table III.

TABLE III

SPRAY SCHEDULE ON APPLES WITH REFERENCE TO CONDITION OF FOLIAGE AND WEATHER AT THE TIME OF SPRAYING

Date	Foliar condition	Weather
May 2	Leaves ¼–½ in. long. Flower buds just beginning to show pink tips.	Cool, cloudy.
May 8	Late prepink stage. Leaves expanding.	Cool, cloudy.
May 16	Blossoms opening. Leaves well expanded. A slight frost injury evident.	Clear, warm.
May 23	Petals dropping.	Cool, cloudy. No rain since last spraying.
June 3	Many large secondary leaves.	Warm, cloudy.
June 14	No evidence of any infection.	Warm, clear.

Note: On May 23, lead arsenate (2 lbs. per 100 gallons) was added to the respective sprays to protect the foliage from insect injury. In early June, the owner of the property sprayed the trees with lead arsenate and dry lime sulphur but, as evidenced by the check trees, this spraying did not affect the results of the experiment.

Records on the results of the experiment were collected on August 9, 1935. The degree of control was based on the reduction in the number of foliar lesions on sample branches removed at random from various portions of the sprayed and checked trees. In Table IV may be found data on the results obtained.

As may be seen from Table IV, better than ninety per cent control of the rust was obtained. It may be noted that the experiment with the Nova Scotia formula in which one spray was omitted (See explanation under Table IV) apparently gave the best results of all. This indicates that the differences recorded for the sulphurs, with the possible exception of Flotation, are of no significance as to their relative value. If of any significance they indicate differences in thoroughness of spraying. It must be remembered that the spraying was done with a hand-pump sprayer.

B. Control of G. Juniperi-virginianae on red cedars

In Massachusetts, the aeciospores of *G. Juniperi-virginianae* are dispersed from about the middle of July until the leaves drop in the autumn. This factor necessitates protection to the red cedar for a much longer period than is necessary for the apple. A spray program was carried out in 1934 which involved various time intervals for spray application and extended from the time of the initial discharge of the aeciospores until December.

A large nursery at Framingham, Massachusetts, afforded an excellent opportunity for experimentation. A plantation of approximately five hundred large red cedars, arranged in five rows, runs parallel to, and about one hundred yards from, a row of *Malus ioensis plena* Rehd. Both hosts had exhibited very heavy infection by *G. Juniperi-virginianae* for at least two years prior to the initiation of the spray program.

The sprays were made up according to the schedule given in Table I. As a sticker and spreader, the fish oil and dried milk were added. For experimentation, trees were selected which exhibited an abundance of old galls of *G. Juniperi-virginianae.* Parallel spray programs were carried out for each of the four sulphurs. Eight trees, for each sulphur, were sprayed just prior to the initial discharge of the aeciospores, namely, July 25, 1934. Subsequent spray applications were made to respective pairs of these trees at time intervals of one, two, three and four weeks. Spraying was discontinued on one tree of each pair on October 31 by which time practically all the aeciospores had been dispersed. The last spray was applied on December 5. The remainder of the plantation served for check purposes.

TABLE IV

DATA ON FUNGICIDAL CONTROL OF *G. JUNIPERI-VIRGINIANAE* ON THE WEALTHY APPLE

Sulphur spray	Total leaves examined	Number of infected leaves	Total number of lesions	Number of lesions per leaf of total foliage examined	Reduction of rust on total foliage examined
Check (unsprayed)	723	223 (30.8%)	2214	3.06	——
Flotation	1109	152 (13.7%)	409	0.37	88%
Linco	998	79 (7.9%)	226	0.23	93%
Liquid Lime	760	33 (4.3%)	99	0.13	96%
Nova Scotia	569	43 (7.6%)	104	0.18	94%
Nova Scotia (less 1 spray)	511	22 (4.3%)	39	0.08	97%

Note: The data for the two trees sprayed with the Nova Scotia formula have been kept separate. Through error one tree was not sprayed on May 16. However, no rains had occurred, sufficient for basidiospore dispersal, between May 16 and the following spray application. Consequently, the omission of this spray should make no difference in the results obtained.

Records of the control obtained by this series of spray programs were collected in May 1936, following a rainy period when the galls had gelatinized and could be counted easily. Counts were made of the number of galls on each of the sprayed trees and on four unsprayed trees selected at random. In Table V may be found data on the results obtained. A comparison of the number of galls on sprayed and on unsprayed trees revealed better than ninety per cent control. This degree of control is evident throughout the entire series of spray programs. Any differences in the degree of control obtained cannot be attributed to either the particular sulphur used or the time interval of spray application. Moreover, the spray schedule which extended from the time of the initial discharge of aeciospores until the last of October gave as good control as the schedule which continued until the first of December. Such variations as do occur in the degree of control obtained may be attributed to differences in thoroughness of spraying. As in the spray experiments on the apple trees, the sulphurs were applied by means of a hand-pump sprayer.

RECORDS OF THE CONTROL OBTAINED IN COMMERCIAL AND ORNAMENTAL PLANTINGS BY MEANS OF A COLLOIDAL SULPHUR

During the past five years extensive spray programs have been conducted, using a colloidal sulphur, for the control of the Gymnosporangium rusts on their respective alternate hosts. The spraying was done on commercial and ornamental plantings in the vicinity of Boston, Massachusetts. In all cases Linco Colloidal sulphur was used in the proportion of 6 lbs. to 100 gallons of water. The "S. S. S." sticker and spreader (See Table I) was added in the proportion of 2 lbs. to 100 gallons of spray. Most of the spraying was done with a power sprayer.

In certain instances trees were left unsprayed and served as checks to indicate the degree of control obtained. Some of these instances are now recorded to illustrate the effectiveness of using a sulphur fungicide to control the Gymnosporangium rusts.

A. Control of G. Juniperi-virginianae on apples

The Apple Scab Schedule as recommended by the Massachusetts State Agricultural Experiment Station was followed while spraying a number of orchards. McIntosh, Wealthy and Ben Davis apples predominated in these orchards. During the latter part of the season, counts were made of the number of foliar lesions on approximately five hundred leaves taken as random samples from various sprayed branches in each

TABLE V

DATA ON FUNGICIDAL CONTROL OF *G. JUNIPERI-VIRGINIANAE* ON THE RED CEDAR

SULPHUR SPRAY	TIME INTERVALS OF SPRAY APPLICATION															
	One week				Two weeks				Three weeks				Four weeks			
	Series A*		Series B		Series A		Series B		Series A		Series B		Series A		Series B	
	No. galls	Control %	No. galls	Control %	No. galls	Control %	No. galls	Control %	No. galls	Control %	No. galls	Control %	No. galls	Control %	No. galls	Control %
Flotation	0	100	3	98	4	98	0	100	1	99	2	99	11	94	9	95
Linco	3	98	—**	—	9	95	1	99	6	97	7	96	4	98	4	98
Liquid Lime	1	99	1	99	1	99	1	99	2	99	0	100	5	97	–	—
Nova Scotia	0	100	0	100	2	99	1	99	0	100	2	99	2	99	5	97

The number of galls on four unsprayed trees was 90; 139; 240; 300, respectively.

By control is meant the percentage reduction in the number of galls on the sprayed trees as compared with the number on the unsprayed trees.

*The A series of trees were sprayed from July 25 to October 31; the B series from July 25 to December 1, 1934.
**In two cases the trees were removed and data could not be obtained.

of the orchards. Similar samples from adjacent and unsprayed McIntosh trees were also taken and served for check purposes. The results of the counts were indicative of better than ninety-five per cent reduction in the number of foliar lesions. The effect of the control obtained was clearly visible in the much healthier foliage and the production of a better quality and a larger quantity of fruits on the sprayed trees.

B. Control of G. Juniperi-virginianae on red cedars

Several groups of red cedars in various localities have been sprayed during the past five years. Prior to this spray program the trees had exhibited severe infection by the rust. For the first two years the spray was applied at monthly intervals during July, August and September. The schedules for the next three years was changed to three sprays at three week intervals beginning early in July. Due to the long time interval for the development of the rust, the results of this spray program are available for the first three years only. An average of one to four galls of the rust per tree was all that could be found and these infections were easily removed by hand picking. Neighboring unsprayed trees continued to exhibit large numbers of the galls.

C. Control of G. clavipes on pomaceous hosts

Gymnosporangium clavipes is primarily a fruit parasite on its pomaceous hosts. The period of susceptibility of the fruits is confined to the early stage of their development. Ornamental plantings of *Amelanchier* and *Crataegus* were sprayed for the control of this rust. Three applications gave the best and the most consistent results. The first application was made when the blossom buds were opening. The second and third applications were made at weekly intervals. On species of *Amelanchier*, as high as ninety-eight per cent of the fruits remained free from infection while ninety-five per cent of the fruits on unsprayed nearby plants were infected by the rust. On species of *Crataegus*, a comparison with neighboring unsprayed trees showed a reduction of approximately eighty per cent in the number of infected fruit.

D. Control of G. clavipes on red cedars and on common junipers (Juniperus communis)

The number of spray applications to red cedars and common junipers was determined by the length of time over which aeciospores are discharged from diseased fruits of the respective alternate hosts. The period of discharge of aeciospores from diseased Amelanchier species normally begins in late May and continues until early July when the fruits drop. On the other hand, diseased fruit of species of *Crataegus* will remain on the tree until late fall. Moreover, aeciospores have been found on diseased hawthorn fruit throughout the season.

A number of plantings of red cedars and common junipers were sprayed over a period of five years to control *G. clavipes*. These plants had all shown heavy infections by the rust. In one instance the owner had contemplated their complete removal. In localities where diseased Amelanchier species were the source of inoculum, the initial spray application was made the latter part of May. Spraying was continued at three week intervals on the common juniper, and at three to four week intervals on the red cedar, until early in July. New infections were reduced to one to four lesions per sprayed tree and at the end of the five year spray program practically all of the old perennial infections had died. In localities where diseased Crataegus fruits were the source of inoculum, spray applications were made at three week intervals from the time of the initial discharge of the aeciospores, namely, the latter part of May, until the hawthorn fruits had dropped in the fall. A comparison of the number of lesions formed on branches of the sprayed and of neighboring unsprayed trees indicated better than seventy-five per cent control.

RECOMMENDATIONS FOR FUNGICIDAL CONTROL OF THE GYMNOSPORANGIUM RUSTS

A. Selection of fungicide

The results of the investigations presented in this paper indicate that at least certain of the sulphur fungicides may be used effectively to control the Gymnosporangium rusts on any of their respective alternate hosts. The finer sulphurs proved to be the more efficient. Linco Colloidal, Liquid Lime, the Nova Scotia formula and possibly Flotation (See Table I) gave satisfactory control for the particular rusts against which they were tested. The addition of a sticker and spreader is recommended.

B. Determinant factors in the formulation of the spray schedules

The time of year for spray application

The date of initial spraying, as well as the length of time over which spray applications must be made are determined by two factors, (1) the period of time during which the respective hosts are susceptible and (2) the period of time over which the spores are dispersed from diseased alternate hosts. For a large proportion of the pomaceous hosts the period of susceptibility of the foliage is restricted to approximately two months after the leaves develop (Crowell, 1934) (MacLachlan, 1935a). Certain species of *Malus,* however, have been found to be susceptible to *G. Juniperi-virginianae* throughout the growing season (Crowell, 1934). The fruits of *Amelanchier* and *Crataegus* are resistant to *G. clavipes* one month after the blossoms open (Crowell, 1935). It is possible that Juniperus hosts are susceptible to these rusts throughout the period of dispersal of the aeciospores.

The basidiospores of these rusts are the source of infection on the respective pomaceous hosts. These spores are dispersed during or following rainy periods in the spring and are capable of causing infection immediately. Under normal conditions their initial release takes place during the latter part of April which is shortly before the leaves or fruit have appeared on the pomaceous hosts. Depending upon the number of rains, most of the teliospores will have germinated by the middle of June. In some instances ungerminated teliospores of *G. Juniperi-virginianae* have been found on the galls in July. It is doubtful, however, that such spores give rise to a sufficient degree of infection to be worthy of consideration; the foliage and fruit of most of the pomaceous hosts are resistant to infection by this late period.

The aeciospores of these rusts are the source of infection on the Juniperus hosts. These spores are dispersed during the summer and, unlike the basidiospores, their dispersal is not dependent upon periods of rainfall. The time of their dispersal varies with the different rusts and in some cases with the pomaceous hosts attacked. The aeciospores of *G. clavipes* are dispersed from diseased Amelanchier fruit from late May until the middle of July at which time the infected fruit drop and decay. Crataegus fruits, infected by *G. clavipes,* do not drop until autumn and a certain number of aeciospores may be found on these diseased fruits throughout the season. The initial release of the aeciospores of *G. Juniperi-virginianae* takes place early in July; those of *G. globosum* two or three weeks later. Aeciospores of both of the latter rusts may be found on the diseased organs of their respective pomaceous hosts throughout the summer.

The greater proportion of the aeciospores of all the rusts are dispersed within the first few weeks after their formation. A high percentage of the aeciospores of *G. clavipes* will germinate at the time of their release from the aecia. It is possible, then, that the greatest amount of infection of the Juniperus hosts by this rust takes place in June. A very low percentage of the aeciospores of *G. Juniperi-virginianae* and *G. globosum* will germinate at the time of their release from the aecia (Crowell, 1934) (MacLachlan, 1936). If, however, the aeciospores of *G. globosum* are kept for about six weeks at a temperature of 0°C., better than eighty per cent germination may be obtained. It is possible, then, that a large proportion of the Juniperus hosts are infected by *G. Juniperi-virginianae* and *G. globosum* at two rather distinct periods: (1) immediately after the aeciospores are released when low percentages of the spores germinate but spores are in great abundance and (2) later in the season by the aeciospores which required a dormant period prior to their germination but remained on the Juniperus foliage during this time interval.

The time interval between spray applications

The time interval between spray applications to the broad-leaved hosts is necessarily short. Fine sulphur volatilizes when exposed to wind and sunlight on broad-leaved foliage. Moreover, the leaves of such plants are most susceptible to the Gymnosporangium rusts during their period of rapid expansion (MacLachlan, 1935a). This period usually coincides with the time of active dispersal of the basidiospores. Consistent control of the Gymnosporangium rusts on their respective pomaceous hosts will not be obtained if the time interval between spray applications exceeds seven to ten days. A number of instances could be cited where control was not obtained although the correct number of spray applications was made. In each case an analysis of the spray schedule showed that a time interval of more than ten days had occurred in one or more instances between consecutive spray applications. Since the basidiospores of these rusts are dispersed during rainy periods, the time intervals between spray applications should be governed somewhat by the weather. The time interval between the formation of the basidiospores and infection of the pomaceous host is usually a matter of hours. Under cool moist conditions, the basidiospores may live for several days but they are subject to desiccation and are readily killed by high temperatures (MacLachlan, 1935b). The optimum time for spray application to the pomaceous host is immediately before a rainy period.

Longer intervals between spray applications may be employed with safety when spraying the Juniperus hosts. The germ tubes of the aeciospores can penetrate the leaves of the red cedar on the upper and stomatal surfaces only. The imbricated arrangement of the leaves is such that the sulphur is retained for relatively long periods of time within the axil formed by the upper surface of the leaf and the stem to which the leaf is attached. Examination of sprayed red cedars revealed that particles of the spray ingredient were still present, in the axils formed by the leaves, six months after the last spray application. Satisfactory control of the Gymnosporangium rusts may be obtained when the spray is applied at time intervals of three to four weeks.

C. Spray schedules for the control of three Gymnosporangium rusts

The spray schedules have been based on the conditions as they exist in Massachusetts with respect to host and fungus.

1. Control of *G. Juniperi-virginianae* and *G. globosum.*

On pomaceous hosts. Six applications at seven to ten day intervals. The first application should be made prior to the first rain after the young leaves emerge from the buds. The apple scab schedule will give satisfactory control under the condition that no time interval between spray applications exceeds seven to ten days. If there are not sufficient rains during May to gelatinize the telia on infected red cedars and thereby cause most of the teliospores to germinate, it may be necessary to add one extra application to the spray schedule.

On Juniperus hosts. Four applications at three to four week intervals. The first application should be made prior to the initial discharge of the aeciospores, namely, about the middle of July for *G. Juniperi-virginianae* and about the first of August for *G. globosum.*

2. Control of *G. clavipes*

On pomaceous hosts. Three applications at seven to ten day intervals. The first application should be made when the blossom buds are opening. The schedule should be arranged to avoid spraying during pollination.

On Juniperus hosts. The first application should be made during the latter part of May and continued at three to four week intervals. If diseased *Amelanchier* species are the source of the aeciospores the final spray may be made early in July. If diseased *Crataegus* species are the source of the aeciospores, spraying should be continued until September.

SUMMARY

A sulphur fungicide, in contact with viable basidiospores of a Gymnosporangium rust, has little effect on these spores prior to their germination. Moreover the sulphur particles must be in close proximity to the germinating basidiospores to have a toxic effect.

An efficient sulphur for the control of the Gymnosporangium rusts should contain particles of active ingredients whose sizes vary from colloidal to a size that would not be completely volatilized by the time of the next spray application.

From an experiment presented in this paper and from previous investi-

gations it has been concluded that the most efficient of the sulphurs tested would not protect the foliage of the pomaceous hosts for a time interval of more than seven to ten days between spray applications.

Field tests for the control of *G. Juniperi-virginianae* on the Wealthy apple and on the red cedar were made. Four different sulphur fungicides were used. Better than ninety per cent control of this rust was obtained on both of the alternate hosts.

Extensive spray programs, using a colloidal sulphur, have been conducted with successful results in commercial and ornamental plantings for the control of three Gymnosporangium rusts.

Spray schedules for the control of *G. Juniperi-virginianae, G. globosum,* and *G. clavipes* on their respective alternate hosts are presented.

ACKNOWLEDGMENTS

To Professor J. H. Faull, for his guidance and many helpful suggestions, sincere appreciation is expressed.

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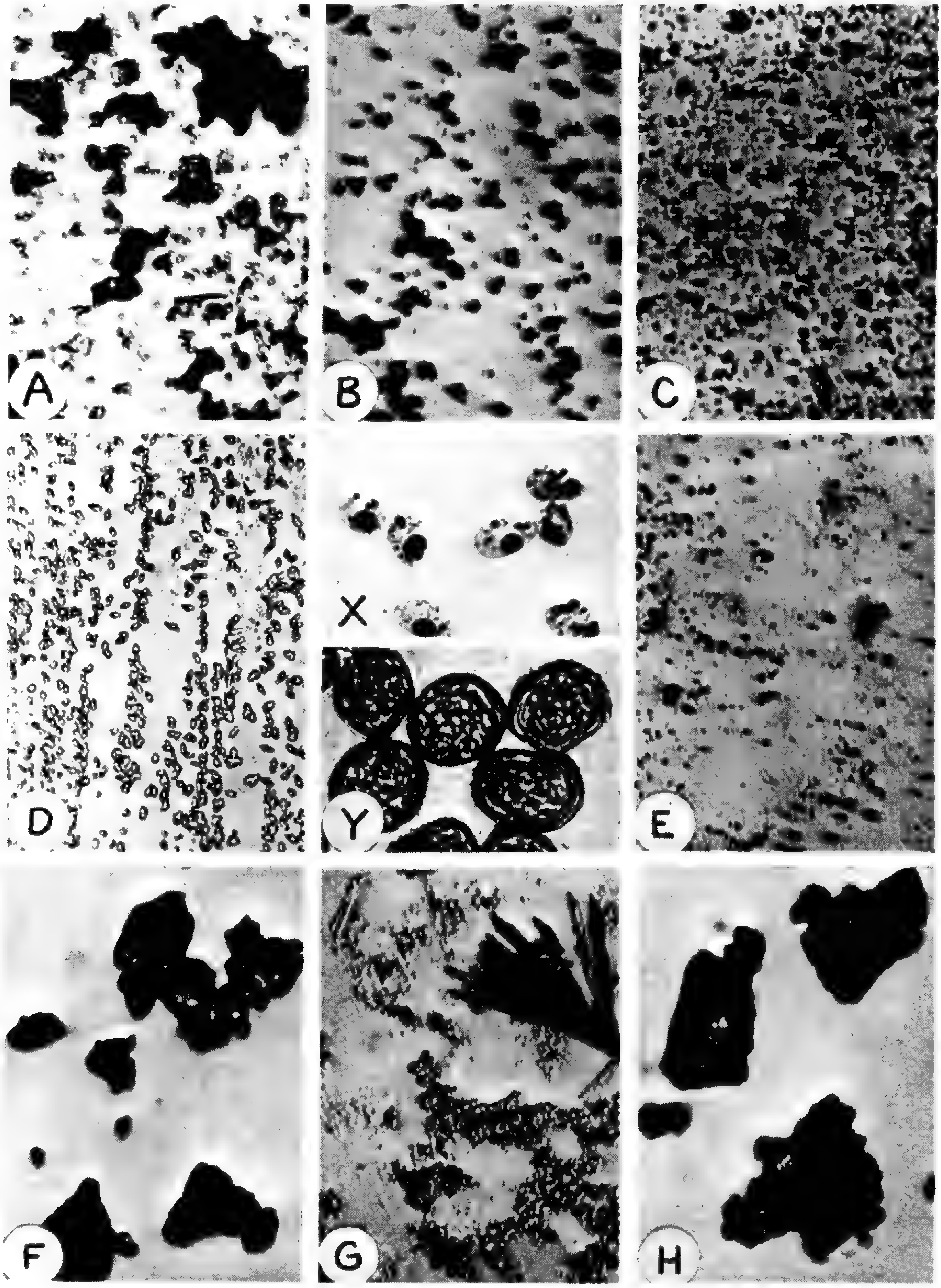
EXPLANATION OF PLATE 204

Illustration of the relative particle size of the ingredients of certain sulphurs

The sulphurs were made up according to the schedule given in Table I of the text. No spreader or sticker was added. The respective mixtures were sprayed on glass slides by means of atomizers, allowed to dry, then photographed. The illustrations show the ingredients of the sprays at a



Gymnosporangium Control by Sulphur Sprays

FULL-TONE — MERIDEN

magnification of 545 diameters. The respective sulphurs are indicated as A – Dry Lime, B – Flotation, C – Kolofog, D – Liquid Lime, E – Linco Colloidal, F – Magnetic Wettable, G – The Nova Scotia formula, and H – Sublimated. Magnetic Wettable is approximately 70% bentonite clay. Some of the finer particles of the Linco Colloidal are barely visible in the Figure. Clusters of crystals were visible on the slide that was sprayed with the Nova Scotia formula. One half of one crystal is illustrated. These crystals disappeared on spraying the slide with water. In the center of the Plate are shown photographs of the basidiospores (X) and the aeciospores (Y) of *G. globosum*. These spores are also illustrated at a magnification of 545 diameters.

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STOMATA SIZE AND DISTRIBUTION IN DIPLOID AND POLYPLOID PLANTS

KARL SAX AND HALLY JOLIVETTE SAX

With plate 205

IN BOTH PLANTS and animals the doubling of the chromosome number in a cell usually results in a corresponding increase in the size of the nucleus and cytoplasmic volume (Wilson 1925). The tetraploid races of *Solanum* examined by Winkler not only had larger stomata and pollen grains than those of the diploid, but, in addition, the chloroplasts were correspondingly larger. More recently Karpechenko (1928) found an increase in stomata size as the chromosome number increased in a series of *Raphanus* × *Brassica* hybrids, although the relationship was not linear. Navashin (1931) also found a rather close correlation between chromatin mass and cell volume in related species and polyploid races of *Crepis*. The relationship between polyploidy and cell size has provided a method for detecting induced tetraploids in *Zea* simply by examining the stomata (Randolph 1932).

In a recent review of autopolyploidy Müntzing (1936) lists fifty-eight cases of polyploidy within species or closely related species. The intraspecific chromosome races are usually differentiated both in morphological and ecological characters. The polyploid forms are generally somewhat larger, more vigorous, tend to be longer-lived, and usually have a different geographical distribution when compared with their diploid ancestors. Although autopolyploidy does not give rise to new species directly, it may be an important factor in the evolution of plant species.

The frequent occurrence of species with diploid and polyploid races, suggests that polyploids may be found in many other supposedly diploid species, as larger numbers of individuals are examined. If the relationship between cell size and chromosome number would permit the use of herbarium material in detecting polyploids, much of the survey work would be simplified. A comparison of diploid and polyploid races is also of considerable interest because the rate of development is decreased in the tetraploid, accompanied by a number of physiological changes.

We have compared the diploid and tetraploid races of *Tradescantia canaliculata* Rafinesque in some detail, and have compared the stomata distribution in diploid and polyploid races or species in both living and herbarium material in other genera. The chromosome races of *T. canali-*

culata were collected by Dr. Edgar Anderson and were grown in adjacent plots in the Arnold Arboretum. The two races are similar in size and are not easily differentiated except by cytological examination. The tetraploid plant of *Secale cereale* L. used in this work was produced from a diploid by subjecting the pre-embryonic cells to extreme temperatures (cf. Dorsey 1936). Stomata counts from living plants in the Arnold Arboretum were from individuals which had been examined cytologically to determine their chromosome numbers.

The volumes of corresponding cells in tetraploid and diploid plants show a high correlation between cell size and chromosome number in *Tradescantia* (Table I). The pollen mother cells and microspores of the tetraploid are about twice as large as those of the diploid. The microspore nucleus at late prophase is also correspondingly larger in the tetraploid. The chloroplasts of the tetraploid are twice as large as those of the diploid,— a relationship also found in *Solanum* species by Winkler.

Needle-shaped spicules are found in the cells of the stem and are obtained in viscous sap exuded from a cut stem. These spicules are much longer in the tetraploid. The stomata of the tetraploid are larger than those of the diploid, and the number per square mm. of leaf surface is closely correlated with chromosome number. This relationship would be expected where cell size is related to chromosome number, because the area of the flattened epidermal cells should be closely correlated with their volume.

TABLE I

COMPARISON OF DIPLOID AND TETRAPLOID TRADESCANTIA CANALICULATA

	n	Diploid	n	Tetraploid
Volume of PMC in cu. μ — 1st Tel.	25	5,443	25	9,204
Volume of microspore in cu. μ	25	7,620	25	12,217
Volume of microspore nucleus in cu μ	25	1,150	25	2,342
Volume of chloroplasts in cu. μ	44	76	62	139
Length of spicules from stem — in μ	35	74	28	112
Stomata per sq. mm. of leaf surface (lower)	50	39	50	19
Length of stomata in μ	50	61	50	78
Number of coils in meiotic chromosome	100	5.5	100	4.5
Cytoplasmic streaming — stamen hairs — μ per sec.	25	5.4	27	4.2
Time of most frequent meiotic divisions		A.M.		P.M.
Propagation from stem cuttings		poor		good

There is little difference in the size of diploid and tetraploid plants of *T. canaliculata,* even though the cells of the tetraploid are twice as large. This means that the tetraploid has about half as many cells as the diploid. The tetraploid does not develop more rapidly than the diploid, so that rate of cell division must be much slower in the tetraploid. The differences in rate of cell division provide an opportunity for a study of certain physiological processes.

The chromosomes of somatic cells are in the form of coiled chromonemata at all stages in the cell cycle, and about 20–25 minor coils are found in metaphase chromosomes; but at meiosis a major spiral is superimposed on the minor or somatic spiral. The occurrence of major spirals at meiosis is attributed to the slower development of the meiotic cell (Sax and Sax 1935). The slower development of the tetraploid *Tradescantia* should be reflected in the degree of major coiling of the chromonemata at meiosis. A comparison of the meiotic chromosomes of the diploid and tetraploid races of *T. canaliculata* shows that the number of coils are decreased considerably in the tetraploid meiotic chromosomes (Table I).

The rate of cytoplasmic streaming in the stamen hairs was compared in the diploid and tetraploid plants. Stamen hairs were taken from freshly-opened flowers and mounted in paraffin oil. A long strand of cytoplasm was selected for observation, and the rate of streaming was determined four times for a certain length of the protoplasmic strand under observation in each cell. Two series of observations were made. In the first series, the average rate of streaming in 15 cells of the diploid was 4.2 microns per second, while in 17 cells of the tetraploid, the rate was 3.2 microns per second. A second series of observations, taken a week later, showed an average rate of 7.1 microns for 10 diploid cells and 5.9 microns for 10 tetraploid cells. Although the rate of streaming is dependent upon environmental conditions, the differences observed suggest that there is greater cytoplasmic activity in the cells of the diploid.

Cytological studies of meiotic divisions of diploid tradescantias grown in the field and in the greenhouse show that the meiotic metaphase stages are found much more frequently in the morning. Even during the winter months, few division figures are found after 10 A. M. A comparison of diploids and tetraploids grown in the field showed that in the diploids the meiotic divisions occurred most frequently in the morning, while the same stages in the tetraploid were found to be most frequent in the afternoon,— although the time of division in the tetraploid was not so limited as in the diploid.

Müntzing (1936) has shown that the polyploid forms tend to reproduce vegetatively more frequently than the diploids. This difference is found in the diploid and tetraploid forms of *T. canaliculata.* About a dozen stem cuttings were made of each type. The diploid cutting formed few roots, and only a few survived, while most of the tetraploid cuttings produced roots and survived. However, the rooting ability of the tetraploid *T. canaliculata* is not as good as that of the diploid species, *T. paludosa.*

STOMATA COUNTS

The correlation between chromosome number and size and frequency of stomata in *Tradescantia canaliculata,* suggested the possibility that the size or distribution of stomata might be used as an index of polyploidy in certain species of plants. In *Tradescantia* the relation between chromosome number and the distribution of stomata is much more marked than the relation between chromosome number and length of stomata. In Karpechenko's (1928) series of *Raphanus* × *Brassica* polyploids, the length of the stomata in mm. × 1350 was about 7 for the diploids and 9.7 for the tetraploid. Stomata counts taken from his illustrations show about 550 per square mm. for the diploid parents, 800 for the diploid F_1, and 350 for the tetraploid hybrid. There seems to be a closer correlation between chromosome number and stomata counts than between chromosome number and stomata length, and the counts are made more easily than the measurements.

Some preliminary examinations were made from species or races of known chromosome number (Table II). The stomata frequency of the diploid *Secale* was nearly twice that of the tetraploid. Among the plants in the Arboretum, *Staphylea* was chosen because it was known to have diploid, tetraploid, and hexaploid species. The stomata counts are roughly proportional to the chromosome numbers. A similar correlation was found in the diploid and tetraploid species of *Deutzia* and in the tetraploid and hexaploid species of the Caprifolium section of *Lonicera.*

These preliminary comparisons of stomata counts in diploids and polyploids indicated that stomata counts might be used to determine the presence of polyploid races in certain species, and of polyploid species in certain genera. In talking over the possibilities of this work with Dr. Edgar Anderson, we learned that he had been making stomata counts from herbarium material at the Missouri Botanical Garden, and that Dr. G. L. Stebbins had used this method at the University of California. Dr. Stebbins informs us that, in his material, the size of stomata is a better index of chromosome number than stomata frequency. We have tried the method with a number of genera in the herbarium, and it seems to have possibilities.

TABLE II

STOMATA COUNTS FROM FRESH LEAVES

Genus	Species	Chro. No.	Stomata per sq. mm. Lower epidermis
Tradescantia	canaliculata	2n	39
"	"	4n	19
Secale	cereale	2n	34
"	"	4n	19
Staphylea	Bumalda	2n	300
"	colchica	?	290
"	pinnata	4n	157
"	trifolia	6n	121
Deutzia	gracilis	2n	382
"	reflexa	4n	168
"	scabra	5n	100
Lonicera	alseuosmoides	4n	350
"	Henryi	6n	271

The number of stomata per unit of leaf surface seems to be reasonably uniform in many species, provided the counts are made from leaves of similar size and stage of maturity, and the samples taken from corresponding areas in different leaves. Long and Clements (1934) have shown that the number of stomata varies with the position on the leaf and the environmental conditions under which the leaf was developed. Accordingly, we have selected leaves only from fruiting specimens and taken the collodion peels from an area near the center of each leaf.

A modification of the collodion peel method used by Long and Clements was adopted for this work. We have used a solution of parlodion (5 per cent) in butyl acetate plus 5 per cent of butyl alcohol, as suggested by W. C. Darrah. A small drop of the solution is dropped on the lower epidermis of the leaf. If the leaf is pubescent, the pubescence may be removed by a preliminary peel, or it can often be removed with an eraser or piece of art gum. Drying of the solution is facilitated by the use of an electric hair dryer. When the edges of the parlodion begin to dry and separate from the leaf, the peel is removed and cemented on a glass slide. The necessary data are written on the slide with a wax pencil. The stomata counts were made at a magnification of × 300 or × 450. The count for each specimen is based on an average of five records from various parts of the peel. The counts were later converted into number per square mm. of leaf surface.

The first genus selected for a study of stomata frequency in relation to polyploidy was *Malus*, a genus known to have both diploid and tetraploid species. The data obtained are shown in Table III.

TABLE III

MALUS SPECIES — STOMATA COUNTS

	Reported chr. no.	Number of specimens	Stomata per sq. mm.	
American Species				
angustifolia	4n	9	320–410 (7)	190–230 (2)
coronaria	4n	7	340–340 (2)	150–220 (5)
fusca		9	310–330 (2)	140–180 (7)
glaucescens	4n	7	310–340 (4)	180–220 (3)
ioensis	2n	6	300–390 (6)	
platycarpa		3		190–200 (3)
Asiatic Species				
baccata	2n	10	330–380 (3)	160–200 (7)
floribunda	2n	2	300–350 (2)	
Halliana		2	310 (1)	210 (1)
prunifolia	2n	3	320–430 (3)	
Sieboldii		3	320–420 (3)	
× Zumi	2n	2	330–340 (2)	

Most of the stomata counts fall into two general classes: those between 300 and 430 and those between 140 and 230. Presumably the higher counts indicate a diploid chromosome number, the lower counts a tetraploid chromosome number. Intermediate counts were found in six specimens — including *M. coronaria* and *M. Halliana* — and in the parthenogenetic triploid species *M. hupehensis*. If the stomata counts are a reliable index of polyploidy, it appears that both diploid and tetraploid races occur in *M. angustifolia, M. coronaria, M. fusca, M. glaucescens, M. baccata,* and *M. Halliana.* The tetraploid forms appear to occur more frequently in North America. There is no relation between polyploidy and geographic distribution within a species, with the possible exception of *M. fusca*. This species extends from Alaska to California. The two apparently diploid forms were collected in Alaska and British Columbia, while only "tetraploid" forms were found in Washington, Oregon, and California.

In the closely related genus *Pyrus* only diploid species have been reported. Stomata counts from sixteen specimens, including six species, were rather variable, ranging from 120 to 320; but the average count was 190 per square millimeter.

The stomata counts of *Staphylea* species were obtained from herbarium specimens for a comparison with the counts obtained from the living plants. The average stomata frequency was 360 for the diploid, *S. bumalda;* 190 for the tetraploid, *S. pinnata;* and 220 for the hexaploid species, *S. trifolia*. While these counts are not entirely in accord with those from fresh specimens, the stomata counts in the diploid are much higher than those of the polyploids in both series of observations.

A study of stomata frequency in *Vaccinium* species indicates that both diploid and tetraploid forms occur in *V. canadense* and in *V. vacillans*. The stomata counts in the diploid and tetraploid forms are about 500 and 350, respectively. All four specimens of *V. corymbosum* examined had stomata counts ranging between 340 and 390, indicating that all were tetraploids as listed by Longley (1927). According to the stomata counts, the four specimens of *V. pennsylvanicum* examined are also tetraploids. *Vaccinium virgatum,* a hexaploid, according to Longley, had a stomata count of 290 in the one specimen examined.

The relation between polyploidy and geographic distribution suggests that many geographic races may be polyploid forms of the diploid species. We have started a series of investigations on polyploidy in relation to geographic distribution. Dr. Fernald has been very cooperative in this work, and has given us many suggestions regarding geographic races which are well represented in the Gray Herbarium.

The first species selected for study by means of stomata counts was *Gaylussacia dumosa* and its variety *Bigeloviana*. The species is found from Florida to Pennsylvania, while the variety extends from New Jersey to Nova Scotia. The stomata counts of the species ranged from 220 to 290 in seven specimens, with an average of 260; while in the variety, the stomata counts ranged from 220 to 360 in ten specimens, with an average count of 270. Apparently *G. dumosa* and its variety *Bigeloviana* have the same chromosome number; and in this case polyploidy is not involved in the taxonomic and geographic differences.

CONCLUSIONS

A comparison of diploid and tetraploid races of *Tradescantia canaliculata* shows a high degree of correlation between chromosome number and size of pollen mother cells, microspores, stomata, chloroplasts, and stomata frequency. The tetraploid has about half as many cells as the diploid forms, and a corresponding difference must exist in the rate of cell division. The number of major spirals in the meiotic chromosomes is greater in the diploid. Cytoplasmic streaming in the stamen hairs seems to be more rapid in the diploid. The tetraploid roots much better from stem cuttings.

Stomata frequency was used as an index of polyploidy in several genera. A positive correlation is found in diploid and tetraploid races of *Tradescantia* and *Secale* and in species of *Staphylea, Deutzia,* and *Lonicera.* Counts from herbarium material show some correlation between stomata frequency per square millimeter of leaf surface and known chromosome numbers of the species. If the stomata counts are a reliable index of chromosome numbers, it appears that both diploid and tetraploid races exist in certain species of *Malus* and *Vaccinium.*

DESCRIPTION OF PLATE 205

Camera lucida sketches of cells from diploid and tetraploid forms of *Tradescantia canaliculata,* and stomata size and frequency in two herbarium specimens of *Malus baccata.*

TRADESCANTIA

Figs. 1 and 2. Anaphase of first meiotic division of diploid and tetraploid. × 800.

Figs. 3 and 4. Outlines of microspores and late prophase in diploid and tetraploid. × 800.

Figs. 5 and 6. Stomata from diploid and tetraploid races. × 250.

Figs. 7 and 8. Crystals from cells of stem in diploid and tetraploid respectively. × 400.

MALUS

Stomata distribution from collodion peel.

Fig. 9. Malus baccata. Collected in Manchuria by Dorsett, no. 3609. Presumably a diploid form.

Fig. 10. Malus baccata. Collected in Siberia by Sargent in 1903. Presumably a tetraploid form.

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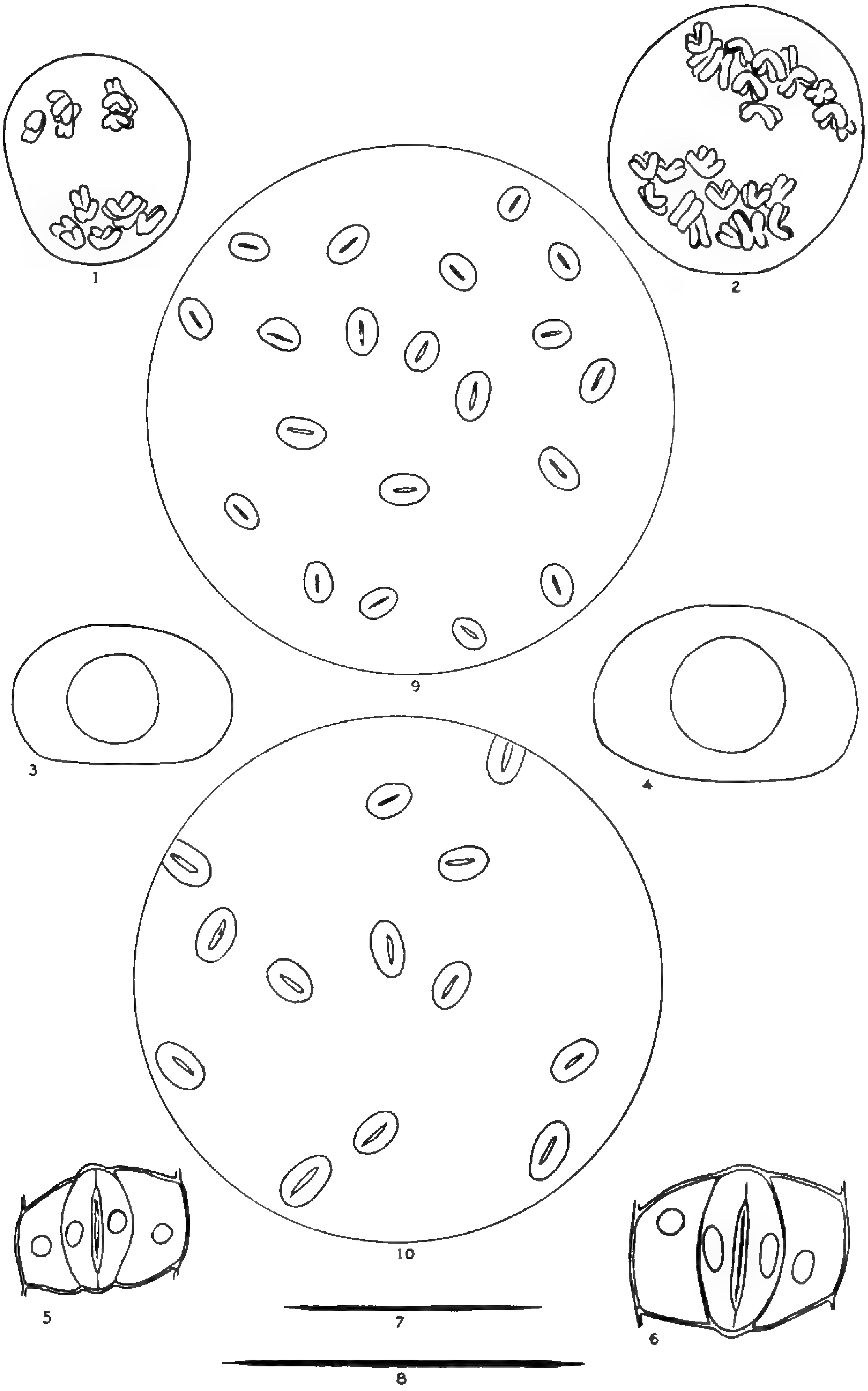

Stomata Size and Distribution in Diploid and Polyploid Plants.

ON THE TECHNIQUE OF INSERTING PUBLISHED DATA IN THE HERBARIUM

E. D. Merrill

Beginning with volume eighteen, number one, January, 1937, a small special edition of the Journal of the Arnold Arboretum has been prepared printed on one side of the paper only. The objective is to provide a form, without sacrificing two complete copies of each issue, for the preparation of "herbarium clippings" whereby pertinent taxonomic data may become available for insertion into herbaria in association with the actual specimens representing the species described or discussed. This special edition is available only on an exchange basis for similar material that may be used for preparing herbarium clippings for use at the Arnold Arboretum.

Those familiar with the older herbaria realize that individual botanists in the past have occasionally attached copies of their original descriptions to the herbarium sheets, but nowhere does one find any considerable number of these. In my own experience in the Philippines previous to 1923 I occasionally had typed and inserted into the herbarium copies of original descriptions, but like most busy botanists elsewhere I never found time to clip and insert copies of my own published descriptions. It was only after my transfer to the University of California in 1923 that it occurred to me that a more comprehensive plan of inserting actual descriptions into the herbarium would be advantageous. Thus over a period of nearly six years many thousands of such items were incorporated in the herbarium, the great advantage being that even where authentically named specimens were not available, the actual description was in place. Special attention was given to published data on the floras of China, the Philippines, and Malaysia. This trial, involving perhaps 40,000 entries, convinced me of the great utility and the eminent practicability of the scheme, although while engaged on this task I was seriously assured by some of my colleagues that the project was an impracticable one.

On my transfer to the New York Botanical Garden in 1930, I there initiated the same system on a small scale in the early part of the year, but I always had the feeling that some of my associates there considered the matter of slight value and perhaps some of them even thought that

I was to a slight degree mentally unbalanced in initiating what was a most radical innovation. In November, 1930, when unexpectedly it became possible to secure the services of numerous individuals through the privately supported Emergency Work Bureau, it became immediately necessary to plan productive projects whereby the talents of this supplementary force could be utilized to advantage. Starting with six temporary employees, the number was rapidly increased until within two months about 100 extra employees were at work. The further development of the preparation of published data for herbarium inserts was made an important project. A certain number of assistants, under supervision, were assigned to the task of preparing the clippings, utilizing two printed copies of the volume or article that it was desirable to clip. Others were assigned to the task of typing original descriptions and critical notes from the older periodical literature. Because of lack of interest on the part of certain staff members, not accustomed to the advantages of the system, the geographic areas first stressed were the same as those selected at the University of California. Later this was extended to cover all fields in which the New York Botanical Garden was actively interested, North, Central, and South America, the West Indies, Asia, Malaysia, and Polynesia.

No record of the number of items incorporated in the herbarium was kept. A very conservative estimate is that the number is now over 700,000 and it may well be greatly in excess of that number. Some idea of the extent of the operations may be gained by the statement that among the periodicals from which practically all pertinent taxonomic data have been excerpted, either by clipping or by typing, are complete sets of the following:

Bulletin de l'herbier Boissier; Journal of Botany, British and Foreign; Kew Bulletin of Miscellaneous Information; Notes from the Royal Botanic Garden, Edinburgh; Notizblatt des Botanischen Gartens und Museums, Berlin; Linnaea; Philippine Journal of Science; Sunyatsenia; Sinensia; Lingnan Science Journal; publications of the Fan Memorial Institute of Biology, Metropolitan Museum (Academia Sinica), Science Society of China, and the Peking Natural History Society; Bulletin de la Société botanique de France, Notulae Systematicae (Paris), Notulae Systematicae (Leningrad), Bishop Museum publications in botany; Field Museum publications in botany; nearly all of the official publications of the botanical garden, Buitzenzorg; all of the official publications of the New York Botanical Garden, including the North American Flora; Records of the Botanical Survey of India; Annals of the Missouri Botanical Garden; Contributions from the Gray Herbarium; Contributions from the United States National Herbarium; Journal of the Arnold Arboretum; the Hookerian series of botanical periodicals preceding the establishment of the Journal of Botany, British and Foreign; Hooker's Icones Plantarum (the first ten volumes reproduced by photostat); Proceedings of the Biological Society of Washington; Mededeelingen van's Rijks Herbarium, Leiden; Bulletin mensuel de la Société Linnéenne de Paris; Bulletin du Muséum d'histoire naturelle (Paris); Bulletin de l'Académie internationale de géographie botanique; Acta Horti Gothoburgensis; Candollea; Annuaire du Conservatoire et du Jardin botaniques de Genève; Gentes herbarum; Transactions of the Linnean Society, University of California Publications, Botany, and others.

Much of the systematic data have also been excerpted from another long series of periodicals, including the Botanische Jahrbücher, Fedde's Repertorium and its Beihefte, Beihefte zum Botanischen Centralblatt, Annales des sciences naturelles, Le monde des plantes, Botanical Gazette, Bulletin of the Torrey Botanical Club, Rhodora, Acta Horti Petropolitani, Gardeners' Chronicle, Botanische Zeitung, Bonplandia, Hedwigia, Journal de botanique (Morot), Flora, Journal of the Washington Academy of Science, Bulletin de la Société impériale des naturalistes de Moscou, Mededeelingen van het Botanisch Museum en Herbarium van de Rijks Universiteit de Utrecht, and scattered articles in a large number of other periodicals.

Supplementing these data, many thousands of clippings were prepared from miscellaneous reprints from a wide variety of sources, various modern and even some older monographs, independently published volumes, the numerous original descriptions in Kuntze's Revisio generum plantarum, and from such extensive works as those of Maximowicz on the floras of Japan and Manchuria, and the more recent ones of Handel-Mazzetti on the flora of China, Plantae Wilsonianae and similar works. The work is still being continued, now supported by federal and state relief funds.

The hundreds of thousands of items from sources indicated above, some the original printed data, some typed copies, some reproduced by the photostat method, are actually incorporated in the herbarium of the New York Botanical Garden, thus making this great reference collection a most outstanding one in which resident and visiting investigators can prosecute intensive work without the great loss of time entailed in other institutions where a very high percentage of one's time must of necessity be devoted to library search. Under this system, the library to a remarkable degree has been made an actual part of the herbarium, with original descriptions, critical notes, illustrations, redescriptions, extensions of ranges, etc., actually associated with the reference specimens. Here in many groups, and for almost entire floras in some cases, the systematist finds before him practically everything that he needs, in the way of the printed record, without the necessity of having, in each case, to spend hours, or days, or even weeks, searching for the needed references in the tremendously scattered source literature that he may need to consult in connection with the problem under investigation. In other words, within limits, the herbarium is not only an herbarium in the generally accepted sense, but it is an herbarium, a card catalogue and a library, all combined in one working unit.

Since this large scale work was undertaken, first at the University of California in 1923, later at the New York Botanical Garden in 1930, and more recently at the Arnold Arboretum, modifications or adaptations of the same idea have been adopted at the United States National Herbarium, the Philadelphia Academy of Natural Sciences, and at several institutions in China. To make currently published data available for this purpose special editions of certain periodicals are now being issued, printed on one side of the paper only, such as "Sunyatsenia," the Berlin "Notizblatt" and Fedde's "Repertorium"; to this short list is now added the "Journal of the Arnold Arboretum." In the past at least some parts of "Das Pflanzenreich" have been so printed in limited editions.

There is little agreement as to how such data should be incorporated into the herbarium. When I first commenced inserting occasional descriptions into the herbarium many years ago, they were automatically treated like herbarium specimens, and mounted on standard herbarium sheets. Occasionally they were pasted on the sheet bearing the type specimen. These are apparently the first methods that one thinks of. Both have certain obvious and serious disadvantages. I then developed the idea of pasting the description inside of the specimen cover so that in studying the included botanical material, one would have both the description and the specimen or specimens before him. Soon this scheme was found to be faulty and it was quickly abandoned for the one adopted at California, New York, and the Arnold Arboretum, i.e., to paste the description or the clipping rather lightly by its corners on the outside of the specimen cover, on the lower left hand corner of the folded sheet.

A serious objection to mounting single descriptions in the middle of a standard herbarium sheet, aside from the relatively high cost of mounting paper, is that such a sheet may become misplaced among the mounted specimens. In any case, if the first sheet of a series bears merely a printed or typed description it effectively obscures the actual specimens, a point that needs consideration when one is making hurried comparisons. If the slips are firmly pasted, as unfortunately they are in most cases, they cannot be easily removed. Again, if they are placed in the middle of a standard sheet, as is usually the case, there is inadequate space for adding other descriptions, such as those of species reduced to synonomy, redescriptions, and later critical notes; for such data as well as for original descriptions of species reduced to synonymy, one is forced to use an extra sheet for each. One could cite cases, where with one description to a sheet it might conceivably be necessary to prepare and insert not one or two or three sheets, but literally scores of them, for many "recognized" species are burdened with scores of synonyms. This system, consistently followed, adds a tremendous amount of needless paper to the herbarium and results in a very great waste of expensive herbarium storage space. The chief objection to pasting an original description on the type sheet itself is that frequently adequate space is not available unless a part of the specimen itself be obscured by the clippings.

The reason I soon abandoned pasting the descriptions on the inside of the cover was because hurried or careless herbarium workers tended to discard frayed, torn, or stained covers without glancing inside to see whether or not there were contained data in the form of clippings or typed descriptions. Specimen covers that contain no data other than a description pasted on the inside are particularly apt to be discarded, for without glancing inside, one cannot determine whether or not there are included clippings.

Having stated some of the serious objections to the first two methods, it is well to indicate the advantages of the third method with which I have now had over twelve years' experience; and not one based on a limited, or even a local use of the system, but rather with a world viewpoint, involving hundreds of thousands of items. As indicated above, one of the consistent criticisms of any method of making these herbarium inserts has been that it "adds too much paper" to the herbarium. With the herbarium sheet method I agree fully with this criticism. With the specimen cover system, utilizing a rather thin, tough, durable paper, such as Nibroc Duracel 40 lbs., and adding from one to many clippings to a single sheet, no just criticism can be made, for the space taken does not equal that needed for a single average mounted botanical specimen. The system, however, does involve the acceptance of the specimen cover plan, i.e., all sheets of a single species to be included in a single thin cover within the stiffer genus cover; few to many specimen covers with their included sheets may be inserted within a single genus cover. If this be adding too much paper, then the specimen cover system is condemned at the outset by individuals, perhaps, who have never used it. The specimen covers serve another purpose in that they very greatly protect mounted specimens from undue breakage.

In practice a high percentage of the sheets will have but a single description, this the original one. For common, widely distributed, and variable species, and especially those that have a complicated synonymy, the sheets will eventually bear from two or three to very numerous items. The first item should be placed about a half inch above the lower margin in the left hand corner of the folded sheet, lightly gummed by the corners only. Additional items are added in sequence of their preparation above the first one. To the same sheet should be attached original descriptions of species that have been reduced, if such occur, as is frequently the case. To the sheet should also be attached redescriptions, critical considerations by later authors, and especially those items that contain literature references, synonymy, and important extensions of range; in fact, all pertinent data of importance that may have been published by various authors that appertain to the species under consideration. In extreme cases a sheet may be so thoroughly covered by supplementary published data of one type or another that all available space is taken. In this case a single sheet of the same stock as the specimen cover may be utilized for the overflow, this to be inserted inside the first cover. As incorporated material relating to supposedly distinct species is found to appertain to a single species, the two covers may be "telescoped" one within the other, or the data may be removed from one sheet and attached to the other.

This brings up a most important point for those who use either the herbarium sheet method, or the species cover system. The clippings should not be pasted firmly to the carrying medium under any circumstances, but rather they should be pasted lightly by their corners so that, as necessary, they may readily be removed for transfer to other positions. Only narrow strips, that might be easily torn if pasted only by their ends, should receive more adhesive. This is a most important point and any curator adopting this clipping system or any modification of it, should give careful consideration to the simple problem of attaching the slips before a system has been adopted that may eventually be found to be very disadvantageous. Whether typed data be attached to standard herbarium sheets or to specimen covers, they should be prepared on thin paper of good quality, such as onion skin paper rather than on the heavier standard paper, this to save space in the storage cases, for when one contemplates the addition of tens of thousands of typed entries into the herbarium, the problem of space becomes distinctly important.

The general and preferred method of preparing clippings is to take two copies of the work to be clipped, arrange the sheets as page proof, and to each entry add in the text or at the margin, an abbreviated but clear reference to the author, periodical or title, volume, page and date; these to be either typed, written long hand, or stamped. For standard periodical references the citations may be greatly abbreviated, such as JOB. instead of Journ. Bot.; BG. instead of Bot. Gaz.; BJ. instead of Bot. Jahrb.; KB. instead of Kew Bull.; BTBC. instead of Bull. Torr. Bot. Club; and JLSB. instead of Journ. Linn. Soc. Bot. When only one copy of a paper desirable for clipping is available, every other page must be typed, photographed or photostated, the citations to be added as part of the typing task. For older periodicals, rare items, and important articles where reprints are unavailable, all entries should be typed. In some cases entire volumes may be reproduced by the photostat method and these sheets then clipped. Obviously the original printed data or a photographic reproduction of it, is preferable to a typed copy.

When a sufficient number of clippings or typed slips are available, they are systematized by families and genera, and then inserted into the herbarium in their proper places. Normally the best procedure to follow is for some botanist familiar with the flora, or the group, to examine the entries and indicate obvious reductions to synonymy, thus avoiding the undue scattering of items appertaining to a single species under different names in the herbarium.

In special cases, such as the preparation of a monographic work or a revision of a special group, all original descriptions and critical notes for every species may be prepared. This, however, involves a very great amount of bibliographic work, other than straight routine, and generally involves a considerable amount of supervisory time by staff members, the ordinary routine employee not being equipped to find the references needed. On the whole this method of compiling data is wasteful in the extreme, and is in general impracticable unless a trained botanist be willing and ready to devote a very large amount of time to the project.

Some curators who have recently adopted this plan restrict their herbarium insertions to copies of original descriptions. From my standpoint, and based on my own extensive experience, while this is better than nothing, yet a serious error is made in not including data where synonymy with literature references and citations of specimens are given. Not infrequently a later author's consideration of a species is distinctly more illuminating than is the original description. It is particularly important that all pertinent additional data, redescriptions, critical notes, supplementary data on type specimens, and significant extensions of range be preserved and incorporated on the sheet or sheets with the original description. Except in those cases where new names appear in current literature, important published data may be entirely overlooked, for manifestly it is impossible for the average botanist to master and keep in mind the tens of thousands widely scattered and unindexed observations. References check against each other, and automatically in examining long series of assembled data regarding this or that species, one often detects errors, some perhaps relatively unimportant, but frequently most exasperating, particularly when they include incorrect volume numbers, page references, dates of publication, and occasionally even wrong periodical titles; many botanists apparently do not check their cited references on the originals, and an error once made in a standard work may automatically be repeated over and over again. When discrepancies are noted in a series of published references, it is a simple matter to determine which is correct by consulting the original publication. As a side issue to this work scores of binomials overlooked by the compilers of Index Kewensis and its supplements were detected.

So much of the criticism of the principle of making herbarium inserts has come from individuals unfamiliar with its extensive recent development in a few institutions that I have become impervious to it. To early criticisms to the effect that the scheme was impracticable, I believe that it has been abundantly proved that the reverse is the case. To those who criticize without the basis of actual experience little attention need be given. To those who utilize the data and then criticize the system because not all the needed and published data have been incorporated, or because some non-technical assistant has filed a reference in the wrong place, the answer is obvious; cooperate in helping to complete the records. Those interested in the printed page may look on me as a vandal, because annually I clip many hundreds of pages of technical descriptions. If a library has a complete set of a periodical, I see little reason for considering that all reprints from that periodical are sacred and must be maintained on the shelves as separate items. I frankly believe that frequently the best place for the reprint is in the herbarium in association with the plants to which the data appertain rather than on the library shelf.

One great handicap is the attitude of the average herbarium worker. He has so much productive work to accomplish that he cannot afford to take the time to prosecute the necessary routine in preparing and inserting herbarium clippings covering his own contributions much less those of numerous other botanists. He forgets that what is accomplished is of benefit not only to himself but to all who in the future may have occasion to utilize the herbarium reference facilities, and that what he accomplishes, no matter how little, is a contribution to the efficiency of his own future work as well as to the efficiency of others.

When one is dealing with the problems of identification of collections coming from little known parts of the world, particularly from areas not covered by published floras or even systematic lists, one must of necessity spend a disproportionate part of his time locating the widely scattered published descriptions and critical notes, which he must, or at least should, consult and compare critically with his material. To find these data assembled and arranged in advance, and actually in the herbarium, whether specimens representing the named species are available or not, adds tremendously to one's efficiency and should tend to more accurate, complete, and dependable work.

After over twelve years' experience with this innovation in herbarium practice and particularly with the large scale demonstration as developed at the New York Botanical Garden I became more and more enthusiastic regarding its merits as the increasing number of references *in situ* in the herbarium demonstrate its extreme utility. I feel safe in asserting that no large herbarium can safely ignore the challenge and avoid the issue of incorporating in its working collections at least those current items published by its own staff members. I am convinced that this innovation is one of the most important advances made in herbarium technique in the last few decades. Objections invariably come from individuals long accustomed to standard, or better, static technique. They claim that the work cannot be done with their present resources; that of the specimens, the literature in the form of a library, and comprehensive indices are available, it is not necessary to take the time to incorporate such data in the herbarium; that the plan involves putting too much paper into the herbarium; that they have too much productive work to do to warrant taking the time to accomplish this routine task; and (never having done it) they believe that it is impracticable. These are some of the current but invalid objections.

Several years ago when I was directing the work of several typists engaged solely in copying original descriptions from the older literature, the curator of one of our large herbaria courteously but firmly declined to accept my offer to supply him gratis with a carbon copy of each description thus reproduced. He had access to extensive herbarium facilities, to a great botanical library, and to comprehensive indices and card catalogues, and could see little to be gained by having the original descriptions incorporated in the herbarium. How many thousands of steps might have been saved within a single year, and how much time have been conserved in the endless consulting of hundreds or even thousands of descriptions in the library made no impression. In searching for objections to an obviously important innovation the average herbarium executive, handicapped by a long established and static routine, forgets that those who come after him will not have his intensive knowledge of a special flora, a special group, or of a special literature, but that each worker must, to a certain degree, forge his own tools. The work of all future investigators is made infinitely easier if the current worker would but incorporate, from time to time, in association with the specimens, at least his more important contributions. It is noteworthy how objections fade when a botanist accustomed to the old method of botanical specimens plus a card-catalogue or an index, plus a library, borrows all the material in a special group, specimens and covers with incorporated printed or typed data, from an institution in which the system has been well established, and finds to his surprise that his bibliography for this or that group is largely done for him; that he has before him most of the published descriptions he needs, whether represented by authentically named specimens or not; and not infrequently he finds references from obscure sources of which he had no previous knowledge.

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BIBLIOGRAPHICAL NOTES

ETHELYN M. TUCKER

Edwards's Botanical Register. A brief note in "British and Irish Botanists" yields the following information: "Sydenham Teast Edwards a celebrated botanical artist was born at Abergavenny about 1769 and died in Chelsea in 1819. He illustrated R. W. Dickson's 'Dictionary of Practical Gardening,' 1805–07, 'Botanical Magazine,' 1786–1814, and 'Botanical Register,' 1815–19." In the *Gardeners' Chronicle,* 1898, xxiii, 340, Mr. W. Botting Hemsley gives a more extended account of Mr. Edwards, and believing this to form an interesting introduction to the study of the *Botanical Register* we quote in part:

"In 1828 Samuel Curtis then proprietor of the *Botanical Magazine,* wrote of Mr. William Curtis, its founder, as follows: 'But the artist of most use to Mr. Curtis was Sydenham Taste (sic) Edwards, who was introduced to him for the purpose of his patronage by a Mr. Denman, who being of a scientific turn of mind, and happening to be at Abergavenny, noticed Edwards whose father was a school master and the organist there. Young Edwards, whilst a boy, had copied some of the plates of the *Flora Londinensis,* which were shown to Mr. Curtis, who was so pleased with them that he sent for him to London, and had him instructed in drawing, in which he improved very rapidly, and soon became able to draw and etch the plates of the *Flora Londinensis* and the *Botanical Magazine.* The drawings for the *Magazine* were entirely his own for many years, and were executed with a correctness not before known in periodical publications. He attended Mr. Curtis on most of his excursions in search of natural history and became the companion rather than the servant of his patron.' After Mr. Curtis's death in 1799, Edwards continued sole artist for the *Botanical Magazine* until 1815, when, in conjunction with John Bellenden Ker, he founded the *Botanical Register,* on much the same lines as the *Botanical Magazine,* though he added floral analyses to some extent." Edwards and Ker were joined by Sansom the engraver and on the title-page of volume fifteen (1829) John Lindley's name is mentioned for the first time as editor.

The *Botanical Register* comprises thirty-three volumes, published in parts from 1815 to 1847, issued on the first of each month. There are eight plates to a part, often with a double plate counting as two.

The plates are dated and in volumes one to nineteen the first eight plates are dated Mar. 1 and the last eight Feb. 1 of the following year, the title-page of the volume giving only the year of the first plates. With vol. xx (1835) the practice is reversed and the date of the last plates given, until eventually the volumes comprise a complete year from Jan. to Dec. and the year on plates and title-page agree. In the absence of covers these discrepancies may easily be overlooked and the following citation of them be helpful.

Vol.	i (1815)	Mar.–Dec.	1815	(Pl. 1–76);	Jan.–Feb.	1816	(Pl. 77–90)
"	ii (1816)	" "	1816	(" 91–163);	" "	1817	(" 164–177)
"	iii (1817)	" "	1817	(" 178–248);	" "	1818	(" 249–263)
"	iv (1818)	" "	1818	(" 264–335);	" "	1819	(" 336–349)
"	v (1819)	" "	1819	(" 350–421);	" "	1820	(" 422–435)
"	vi (1820)	" "	1820	(" 436–506);	" "	1821	(" 507–520)
"	vii (1821)	" "	1821	(" 521–590);	" "	1822	(" 591–605)
"	viii (1822)	" "	1822	(" 606–675);	" "	1823	(" 676–689)
"	ix (1823)	" "	1823	(" 690–762);	" "	1824	(" 763–777)
"	x (1824)	" "	1824	(" 778–853);	" "	1825	(" 854–867)
"	xi (1825)	" "	1825	(" 868–940);	" "	1826	(" 941–955)
"	xii (1826)	" "	1826	(" 956–1029);	" "	1827	(" 1030–1043)
"	xiii (1827)	" "	1827	(" 1044–1116);	" "	1828	(" 1117–1130)
"	xiv (1828)	" "	1828	(" 1131–1202);	" "	1829	(" 1203–1216)
"	xv (1829)	" "	1829	(" 1217–1291);	" "	1830	(" 1292–1305)
"	xvi (1830)	" "	1830	(" 1306–1376);	" "	1831	(" 1377–1391)
"	xvii (1831)	" "	1831	(" 1392–1462);	" "	1832	(" 1463–1476)
"	xviii (1832)	" "	1832	(" 1477–1549);	" "	1833	(" 1550–1564)
"	xix (1833)	" "	1833	(" 1565–1637);	" "	1834	(" 1638–1652)
"	xx (1835)	" "	1834	(" 1653–1727);	" "	1835	(" 1728–1741)
"	xxi (1836)	" "	1835	(" 1742–1821);	Jan.	1836	(" 1822–1828)
"	xxii (1836)	Feb.–Dec.		(Pl. 1829–1919)			
"	xxiii (1837)	Jan.–Dec.		(" 1920–2014)			

In volumes xxiv (1838) to xxxiii (1847), like volume xxiii comprising an entire year from January to December, the plates of each volume are separately numbered. There are from 66 to 71 plates for each year.

An Appendix to the First Twenty-three Volumes, consisting of an index to the volume and nine additional undated colored plates, was published in 1839.

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THE ORIENTATION OF CELLULOSE IN THE SECONDARY WALL OF TRACHEARY CELLS

I. W. BAILEY AND MARY R. VESTAL

With plates 206–208 and three text figures

INTRODUCTION

MUCH ATTENTION has been focused, in recent years, upon the study of the arrangement of chain molecules, micelles, and fibrils in the cell walls of the cotton hair, bast fibers, tracheids, and other types of commercially important fibers. Various methods of studying the arrangements of the structural units are employed by different investigators:

1. The study of visible fibrils and striations, based upon the assumption that the long axis of the micelles is oriented parallel to these structures.
2. The study of pit-orifices and of mechanically induced cracks, based upon the assumption that these structures are oriented parallel to the fibrillar axis.
3. The study of extinction angles, of dichroism, and of other phenomena in polarized light.
4. The study of X-ray diagrams.

Each of these methods yields significant data under favorable circumstances, but each is subject to serious limitations when applied to miscellaneous types of cell walls.

Even when coarse aggregations of fibrils and striations are clearly visible in surface views of unswollen secondary walls, it frequently is difficult to determine with certainty, whether a specific orientation occurs throughout the wall or in one of its layers only. Swelling the wall to reveal its finer structure is effective in dealing with the broad central layers — provided allowances be made for distortions due to longitudinal contraction and lateral expansion — but such treatments commonly disrupt and conceal the structure of the tenuous inner and outer layers.

In the case of thick secondary walls of the 3-layered type, the long axis of the slitlike pit-orifices is oriented parallel to the fibrillar axis of the central layer, but affords no evidence regarding the fibrillar arrangements of the inner and outer layers. In thin-walled cells, the orifices of the pits commonly afford no clue regarding the fibrillar orientations of any of the layers. Similarly, mechanical cleavages or seasoning cracks may afford valuable evidence in the case of layers which have pronounced radio-longitudinal or radio-helical porosities, but are difficult to interpret accurately in the case of other layers.

Phenomena visible under the polarization microscope are significant where material can be oriented so that the polarized light passes through single layers; but accurate interpretations are difficult where the light passes through several superimposed layers of varying thickness and of different fibrillar orientations. Thus, in the case of transverse sections of 3-layered secondary walls, it is possible to demonstrate that the fibrils of the central layer are, on an average, oriented more nearly parallel to the long axis of the cell than in the case of the inner and the outer layers; but it is difficult to determine in longitudinal sections whether the orientation of the latter layers is actually at right angles to the long axis of the cell or at some intervening angle.

Similar obstacles must be overcome in the interpretation of X-ray diagrams where the rays pass through a complex of layers of markedly varying thickness and of very different structural orientations.

In view of such technical difficulties as these, it is not surprising to find many contradictory statements in the literature concerning the structural arrangement of cellulose in the walls of specific cells. It obviously is essential to develop a technique which will enable the investigator to trace the details of fibrillar orientation throughout each of the successively formed parts of the secondary wall. The method recorded in the following pages appears to be of considerable value in the study of lignified tissues.

METHOD OF DEMONSTRATING THE FIBRILLAR ORIENTATION IN LIGNIFIED WALLS

When sections of lignified tissues are chlorinated, rinsed in 95% ethyl alcohol, treated with dilute ammonia in strong ethyl alcohol, rinsed in alcohol, chlorinated, rinsed in alcohol, stained in a 2–4% aqueous solution of iodine-potassium iodide, and finally mounted under a cover glass in a drop of 60% sulphuric acid, dark brown crystals of iodine form within the layers of the secondary wall. These crystals aggregate in slender, elongated, crystalline complexes which vary in size and number, depending upon the duration and the intensity of the successive treatments and upon other factors. The crystals evidently originate within the elongated interstices of the cellulosic matrix and are oriented parallel to the long axis of the fibrils of cellulose. The crystals, or crystalline aggregates, are so conspicuous and so clearly visible, microscopically, that it is possible not only to detect such major variations in orientation of the cellulose as occur in passing from layer to layer of the secondary wall, but also to observe such fluctuations in orientation as occur within the limits of a single layer.

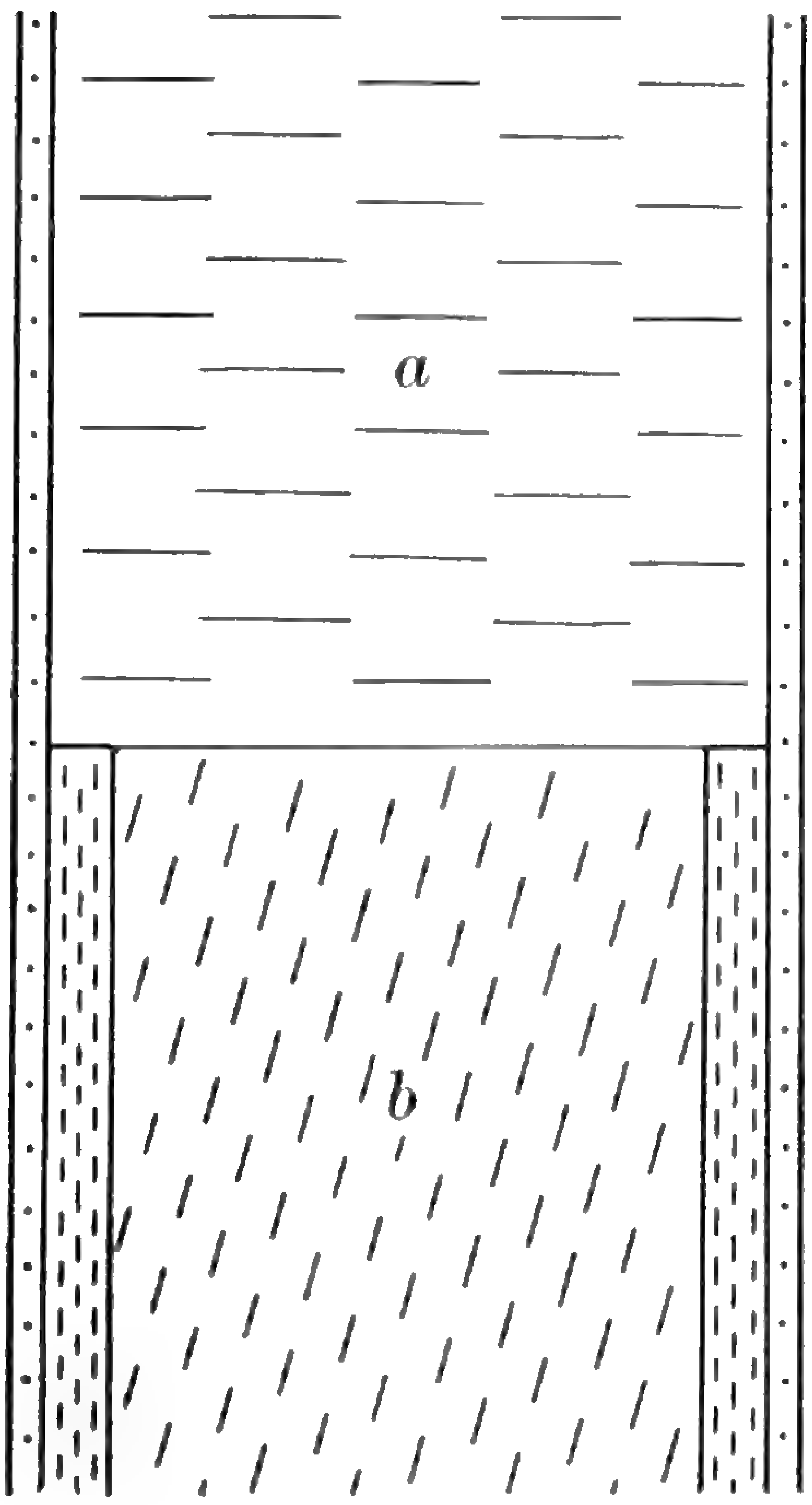
ORIENTATION OF CELLULOSE IN SECONDARY WALLS OF NORMAL CONIFEROUS TRACHEIDS

In the case of the normal 3-layered tracheids of conifers (Pl. 208, Fig. 9), it is possible, by varying the details of the technique, to induce crystals to form (1) within the central layer of the secondary wall, (2) throughout both the central layer and the outer layer, or (3) in the outer layer alone. We have not succeeded, as yet, in obtaining them within the tenuous inner layer of the secondary wall. This appears to be due, at least in part, to the fact that the iodine escapes, during the treatment, from the exposed surfaces of the wall.

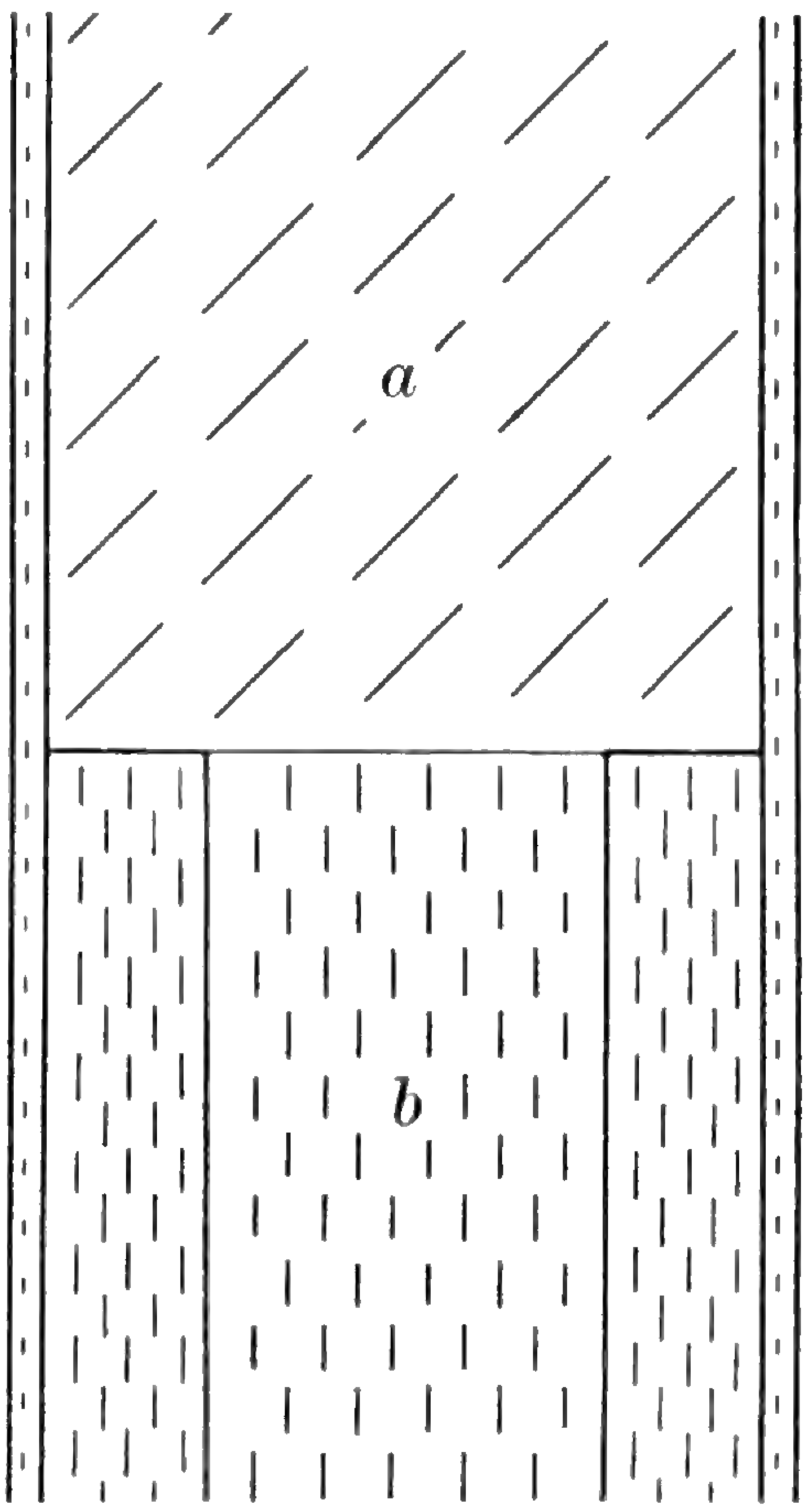
A. Orientations of the outer layer

The orientation of the cellulose in the outer layer of the secondary wall fluctuates more or less from specimen to specimen, from tracheid to tracheid of the same specimen, and in different parts of the same cell. In certain samples of wood that we have sectioned, the cellulose tends to be arranged at right angles to the long axis of the cell in the unpitted parts of the earlywood tracheids (Text fig. 1a; Pl. 206, Figs. 1 and 3), and to have a helical orientation in homologous parts of the latewood tracheids (Text fig. 2a; Pl. 206, Fig. 4, and Pl. 207, Figs. 5 and 6). In other samples of wood, the arrangement may be helical in both earlywood and latewood, or it may fluctuate from tracheid to tracheid throughout the annual ring. There is no evidence to indicate that specific orientations are characteristic of particular species. On the contrary, the available data suggest that the arrangement of the cellulose fluctuates considerably in different parts of the same tree.

Local deviations in the prevailing orientation of any specific tracheid are of common occurrence in pitted parts of the wall. Not only is there a circular arrangement of the cellulose in the embossed parts of the wall which form the borders of the pits (Text fig. 3), but there is a modified orientation in the adjacent parts of the wall as well. Such local deviations in orientation are more extensive and pronounced in large thin-walled tracheids than in small, thick-walled ones.



TEXT FIGURE 1



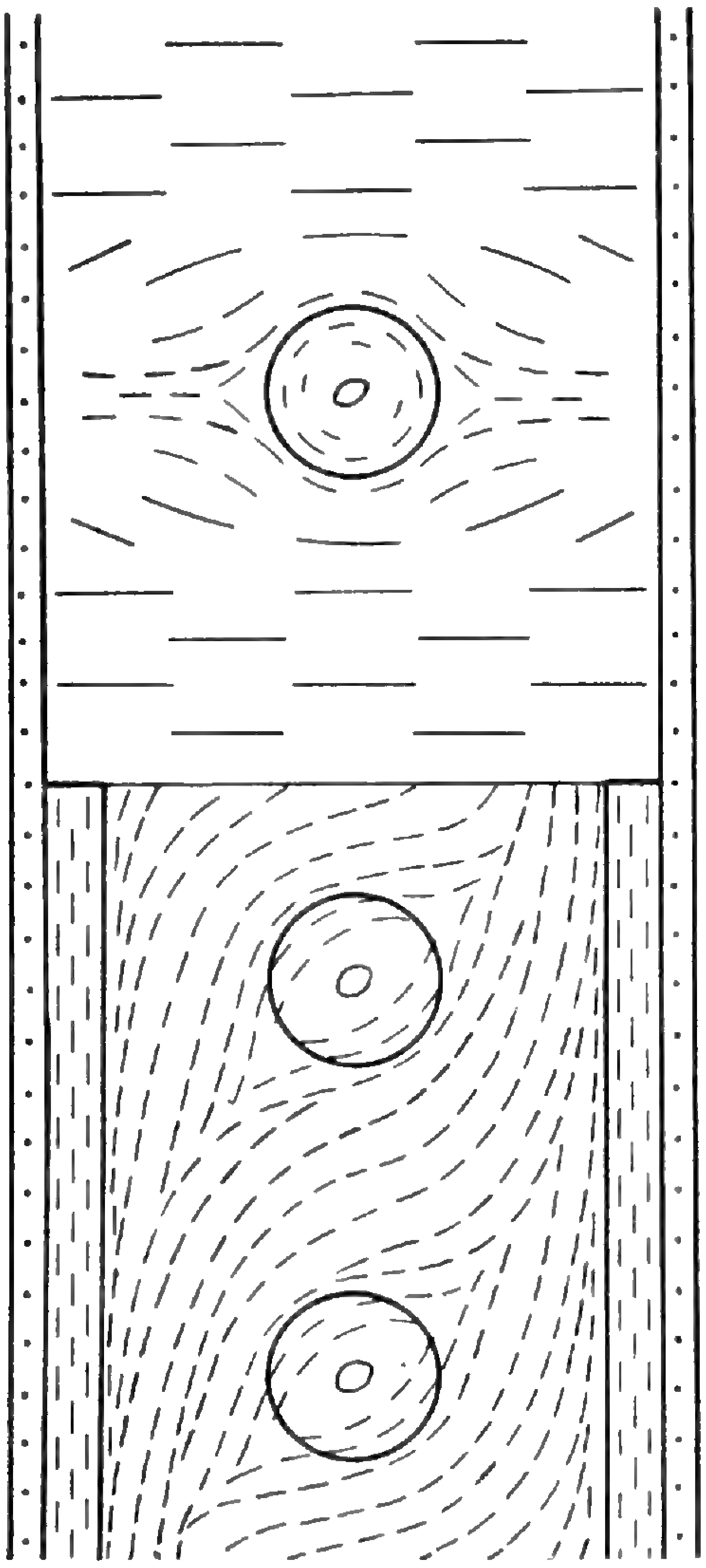
TEXT FIGURE 2

TEXT FIGURE 1. Diagrammatic illustration of the orientations of cellulose in the outer layer (a) and the central layer (b) of the unpitted tangential wall of a normal earlywood tracheid.

TEXT FIGURE 2. Diagrammatic illustration of the orientations of cellulose in the outer layer (a) and the central layer (b) of the unpitted tangential wall of a normal latewood tracheid.

B. ORIENTATIONS OF THE CENTRAL LAYER

The arrangement of the cellulose in the central layer of the secondary wall also varies more or less from specimen to specimen, from tracheid to tracheid, and in different parts of the same cell. Not infrequently the fibrils of cellulose tend to be oriented more nearly parallel to the long axis of the cell in the latewood (Text fig. 2b; Pl. 207, Fig. 5), than in the earlywood (Text fig. 1b; Pl. 206, Fig. 3), but helical arrangements are of not uncommon occurrence in latewood, and the cellulose may, at times, be oriented parallel to the long axis of the cell in earlywood. The most striking deviations in orientation occur in pitted parts of the wall, particularly in the radial walls of the earlywood tracheids (Text fig. 3; Pl. 206, Fig. 4). The fibrils do not have a circular or concentric arrangement in the embossed parts of the wall — as is the case in the outer layer of the secondary wall — but curve about and through the borders of the pits as indicated in Text fig. 3. Thus, in the earlywood, the orientation of the cellulose commonly tends to deviate more from the vertical axis in the radial walls than in the unpitted or sparsely pitted tangential walls (Text figs. 1–3).



TEXT FIGURE 3. Diagrammatic illustration of the orientations of cellulose in the outer layer and the central layer of the pitted radial wall of a normal earlywood tracheid.

The orientation of the fibrils may fluctuate, at times, in the successively formed growth rings or lamellae of the central layer, but pronounced shifts in orientation are of relatively infrequent occurrence in the tracheids of conifers. Regularly recurring changes from right-handed to left-handed helixes or *vice versa,* such as are hypothesized by various investigators, are rarely, if ever, encountered in the central layer of coniferous tracheids.

C. CORRELATIONS BETWEEN THE OUTER LAYER AND THE CENTRAL LAYER

There are four combinations of orientations that are of common occurrence in the secondary walls of normal coniferous tracheids:

(1) The cellulose of the outer layer may be oriented at right angles to the longitudinal axis of the cell, and the cellulose of the central layer may be arranged parallel to this axis.

(2) The cellulose of the outer layer may be oriented at right angles to the long axis of the cell, whereas that of the central layer has a helical arrangement.

(3) The cellulose of the outer layer may have a helical orientation, whereas that of the central layer is arranged parallel to the long axis of the cell.

(4) The cellulose of both the outer layer and the central layer may be helically oriented.

It is significant in this connection, however, that the helixes of the central layer have relatively steep slopes and rarely deviate as much as 45 degrees from the longitudinal axis of the cell, whereas those of the outer layer usually have comparatively low slopes. Thus, even when both layers have helical arrangements, the orientations rarely, if ever, are parallel. In all the material of normal coniferous tracheids that we have examined, the differences in orientation in unpitted parts of the secondary wall are of such magnitude that they may be detected when very thin (5 μ) transverse sections of the cells are examined in polarized light between crossed nicols. In other words, the central layer in such sections is either isotropic (Pl. 208, Fig. 9), or detectably less birefringent than the outer layer (Pl. 208, Fig. 13). This is due, of course, to the fact that a layer is dark in transverse sections when its cellulose is oriented parallel to the long axis of the cell but attains its maximum birefringence when the cellulose is oriented at right angles to this axis.

It should be noted, in passing, that according to Frey,[1] the micelles

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[1] FREY, A., Die submikroskopische Struktur der Zellmembranen (Jahrb. Wiss. Bot. **65**: 195-223. 1926).

of cellulose have a circular orientation in the borders of the pits, whereas Scarth and his co-workers[1] consider that the fibrils merely curve about the bordered pits, "instead of regularly circling round them." Both investigators are right or wrong, depending upon the part of the wall which is selected for observation. As we have shown, the orientation of the outer layer is circular and thus in agreement with Frey's contention, whereas that of the central layer is entirely in accord with Scarth's view.

ORIENTATION OF CELLULOSE IN THE SECONDARY WALLS OF THE TRACHEARY CELLS OF DICOTYLEDONS

A. Normal 3-layered tracheids, fiber-tracheids, and libriform fibers

The arrangement of the cellulose in secondary walls of normal 3-layered tracheids, fiber-tracheids, and libriform fibers of dicotyledons resembles that which occurs in the tracheids of conifers. Thus, the orientation of the outer layer of the secondary wall fluctuates from positions at right angles to the longitudinal axis of the cell (Pl. 207, Fig. 6), to various helical arrangements, whereas that of the central layer varies from helical to longitudinal. It is significant, however, that with the progressive reduction of bordered pits in fiber-tracheids and libriform fibers, the orientation — particularly of the central layer — tends to show less extensive local deviations, and the arrangements of the cellulose in the radial and tangential walls are more nearly uniform and comparable.

B. Aberrant types of fiber-tracheids and libriform fibers

Deviations in the orientation of cellulose in the successively formed parts of the central layer appear to be of more frequent occurrence in thick-walled fiber-tracheids and libriform fibers of dicotyledons than in the tracheids of the latewood of conifers. Not infrequently the deviations are of such magnitude that they may be detected when thin transverse sections of the cells are viewed in polarized light between crossed nicols (Pl. 208, Fig. 10). In the so-called gelatinous fibers of dicotyledons, there are abrupt transitions from concentric to radial or radio-concentric structural patterns and *vice versa*. These abrupt changes in the structural pattern of the cellulosic matrix may or may not involve concomitant modifications in the orientation of the cellulose in relation to the longitudinal axis of the cell.

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[1] Scarth, G. W., R. D. Gibbs, & J. D. Spier. The structure of the cell wall and the local distribution of the chemical constituents (Trans. Roy. Soc. Canada 5: 269-279. 1929).

c. Vessels

In the less specialized types of dicotyledonous woods, the vessel members resemble tracheids in size, form, and structure. They tend to be comparatively thin-walled, and to have secondary walls which are conspicuously 3-layered, except in heavily pitted parts where the vessel members of the same or of different vessels are in contact. The arrangement of the cellulose in such 3-layered secondary walls of vessels (Pl. 208, Fig. 11), fluctuates much as it does in normal tracheids. Thus, the outer layer may have an orientation at right angles to the long axis of the cell, or it may have a helical arrangement of comparatively low slope. As in the case of normal tracheids, the central layer has an orientation which is either parallel to the long axis of the cell or steeply helical.

As the vessels of dicotyledons become more and more highly specialized, they tend to form secondary walls of a wider range of structural complexity and diversity. Not infrequently, they tend to lose their typical 3-layered structure and to form multi-layered walls or thick walls which are more or less birefringent throughout (Pl. 208, Fig. 14), when transverse sections are viewed in polarized light between crossed nicols. In other words, the orientation of the cellulose in the more highly specialized types of dicotyledonous vessels frequently deviates markedly from that which occurs in normal tracheids.

It should be emphasized, in this connection, that variations in the thickness of the secondary walls of normal 3-layered tracheids are due primarily to variations in the width of the central layer (Pl. 208, Fig. 9), — i. e., of a layer which is dark or feebly birefringent in transverse sections. On the contrary, fluctuations in thickness of the secondary wall of vessels commonly are due to variations in the width of layers which are intensely birefringent (Pl. 208, Figs. 12 and 14), when transverse sections are examined in polarized light between the crossed nicols. Thus, the more conspicuous differences between the secondary walls of tracheids and of specialized types of vessel members are due primarily to different orientations of cellulose in the successively formed parts of the secondary wall.

DISCUSSION

The secondary wall of tracheary cells and fibers is composed of a continuous and firmly coherent matrix of anastomosing fibrils of cellulose. Lignin and other non-cellulosic substances may be deposited in the elongated, intercommunicating interstices of this matrix, thus resulting in two continuous interpenetrating systems of different chemical composition. The threadlike parts of the two interpenetrating systems have parallel orientations. Therefore, the crystals of iodine which form within the elongated interstices of the cellulosic matrix after chlorination are oriented parallel to the long axis of the fibrils of cellulose. That such is indeed the case may be demonstrated by various corroborative lines of evidence.

(1) Where aggregations of fibrils or so-called striations are clearly visible in surface views of unswollen secondary walls, the crystalline aggregates of iodine are oriented parallel to the long axes of these structures.

(2) In the case of thick secondary walls of the 3-layered type — where the slitlike pit orifices are oriented parallel to the fibrillar axis of the central layer — the crystals of the central layer are arranged parallel to the slitlike orifices of the pits.

(3) In secondary walls having a pronounced radio-longitudinal or radio-helical structural pattern — where mechanical cleavages and seasoning cracks are oriented longitudinally or radio-helically — the crystals of iodine are arranged parallel to the cleavage planes and seasoning cracks.

(4) In favorable material — where the angles of extinction and dichroic phenomena in polarized light are clearly visible and can be accurately measured — the orientation of the cellulose as determined by the crystal method is in close agreement with the data obtained by polarization techniques. In fact, the evidence secured by the crystal and polarization techniques is so strikingly complementary that our photographs of crystal orientations might be substituted for Frey's diagrams of micellar arrangements in homologous layers.

The crystal method is so significant in studying the details of fibrillar orientation in different parts of a single wall or layer that it is of interest to determine whether the technique may be modified for use in the study of unlignified secondary walls. This has been attempted by Doctor Thomas Kerr, who has succeeded in inducing crystals of iodine to form within the wall of the cotton hair. His modification of our technique consists in staining the secondary wall of the cotton hair with iodine-potassium iodide or with chloroiodide of zinc, and subsequently treating the stained preparation with a syrupy, "supersaturated" solution of zinc chloride. Thus, it is evident that the crystal method may be modified for the study of both lignified and unlignified secondary walls.

CONCLUSIONS

1. Crystalline aggregates of iodine may be induced to form within the elongated interstices of the cellulosic matrix of the secondary wall. These elongated crystals are oriented parallel to the long axis of the fibrils of cellulose and therefore of the micelles and chain molecules.
2. The crystalline aggregates are so conspicuous and so clearly visible, microscopically, that it is possible not only to detect such major variations in orientation of the cellulose as occur in passing from layer to layer of the secondary wall, but also to observe such fluctuations in orientation as occur within the limits of a single layer.
3. In the case of normal, 3-layered tracheids, fiber-tracheids, and libriform fibers, the orientation of the cellulose in the outer layer and in the central layer of the secondary wall fluctuates more or less from specimen to specimen, from cell to cell, and in different parts of the same cell.
4. Although the orientation of the cellulose may deviate, at times, in the successively formed growth rings or lamellae of the central layer, there is no regular alternation of right-handed and left-handed helixes as hypothesized by various investigators.
5. In the case of the large bordered pits of the earlywood of conifers, the cellulose has a circular orientation in the outer layer, but merely curves about the pits in the central layer.
6. The less specialized types of dicotyledonous vessels resemble normal tracheids in having a 3-layered secondary wall, whereas the more highly specialized types have walls of a much wider range of complexity and structural variability, owing to fluctuations in the orientation of the cellulose.

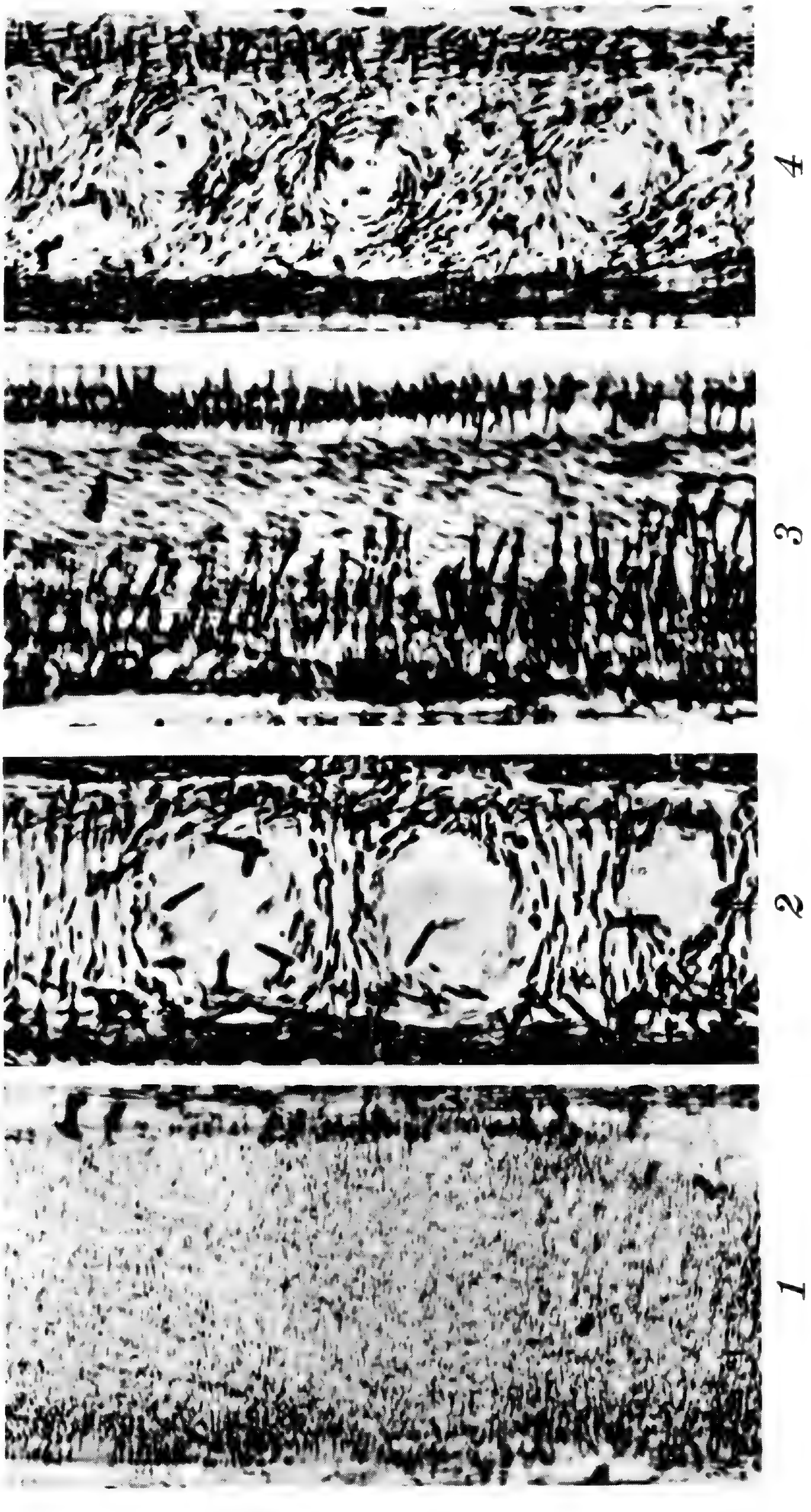
DESCRIPTION OF PLATES

PLATE 206

Fig. 1. *Sequoia sempervirens* Endl. Unpitted radial wall of earlywood tracheid, showing, in the outer layer, numerous minute crystals oriented at right angles to the long axis of the cell. × 750.

Fig. 2. *Sequoia sempervirens.* Pitted radial wall of earlywood tracheid, showing, in the outer layer, coarser crystalline aggregates oriented at right angles to the long axis of the cell except in proximity to the bordered pits. The larger irregularly oriented crystals are lying upon the exposed inner surface of the wall. × 750.

Fig. 3. *Sequoia sempervirens.* Earlywood tracheid from which part of the outer layer has been cut away (right), showing transverse orientation of crystals in the outer layer of the secondary wall (left) and steeply helical arrangement in the central layer (right). × 1000.

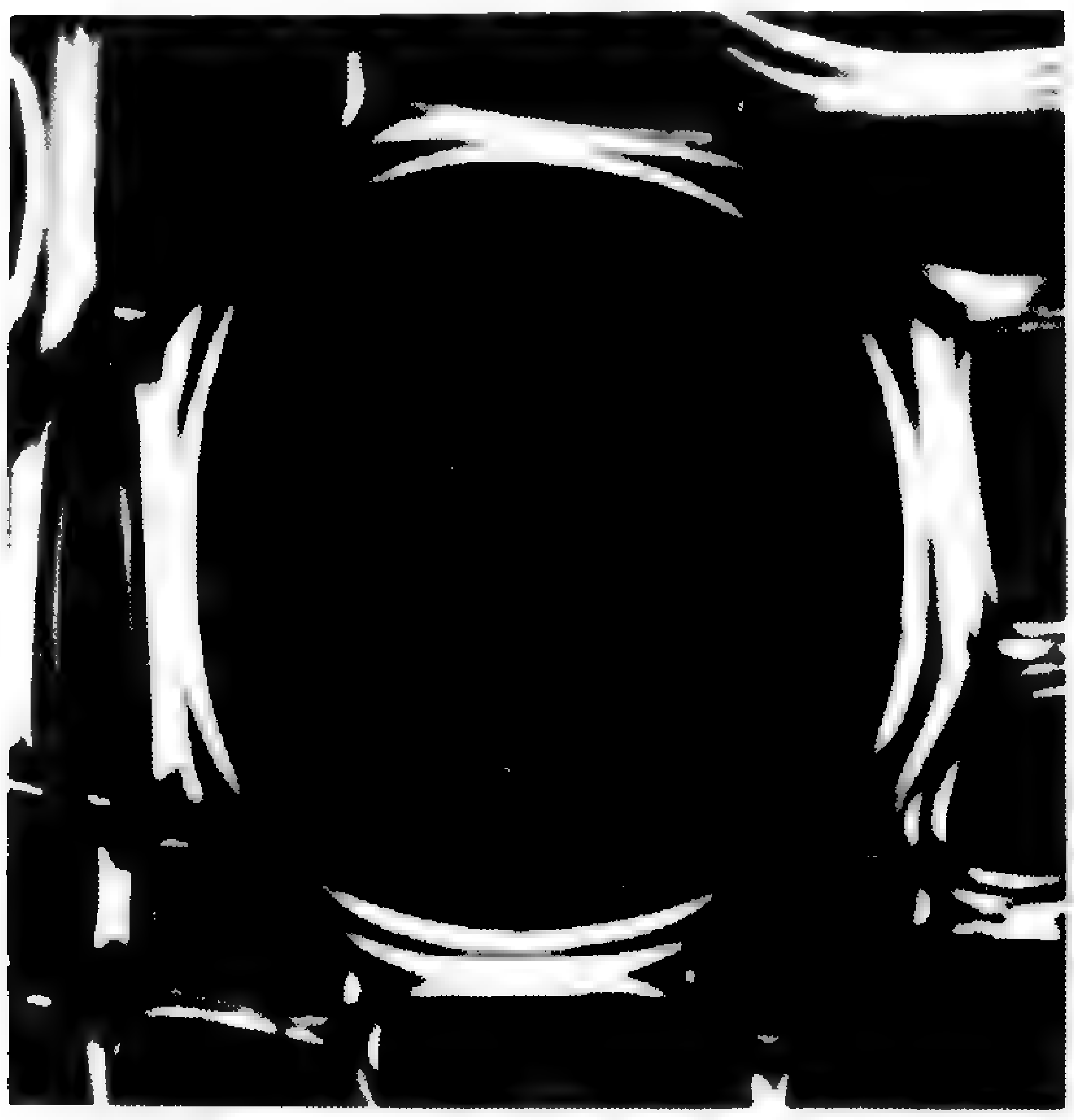


Orientation of Cellulose

FULL-TONE—MERIDEN

Orientation of Cellulose

FULL-TONE — MERIDEN



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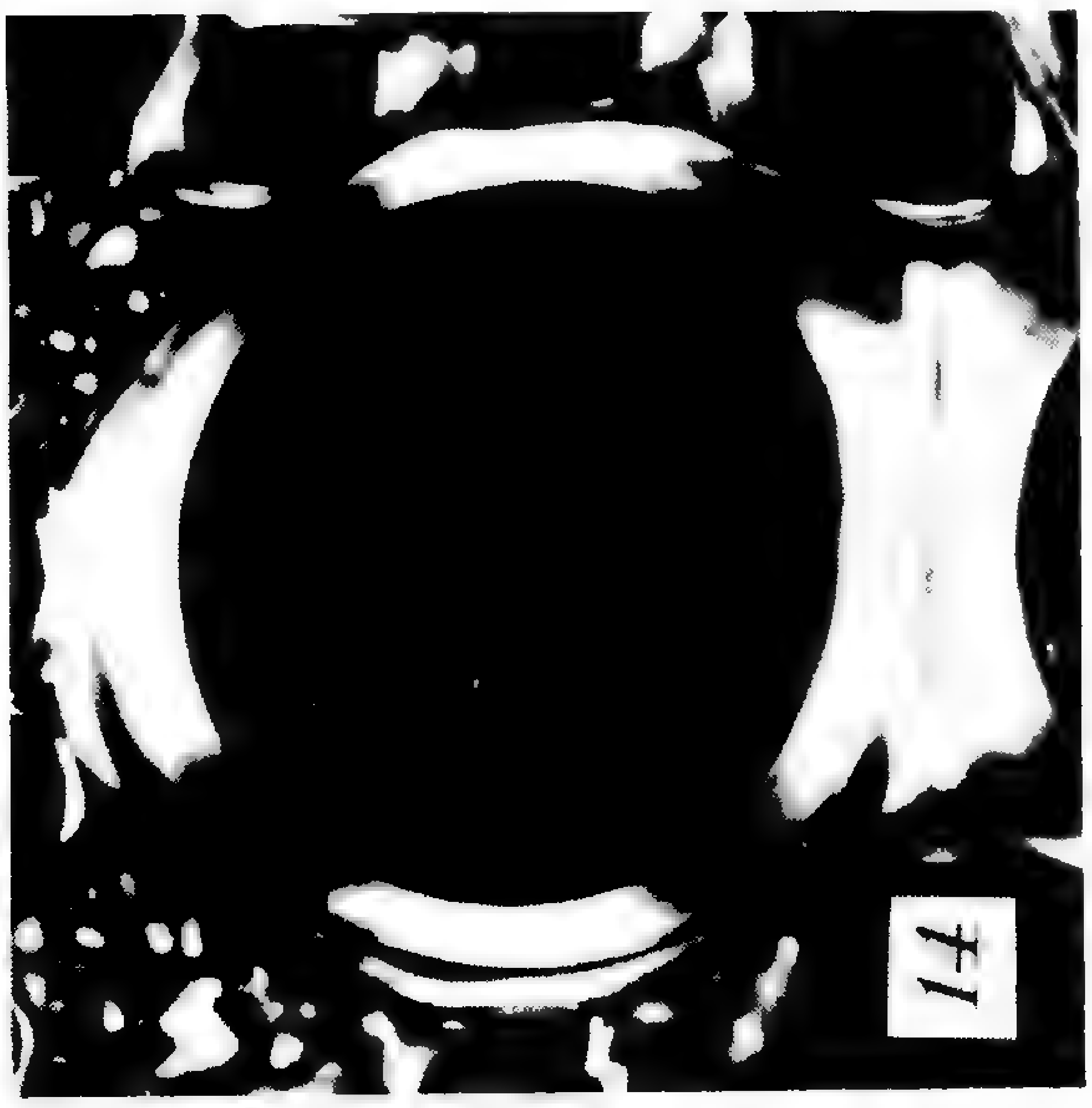

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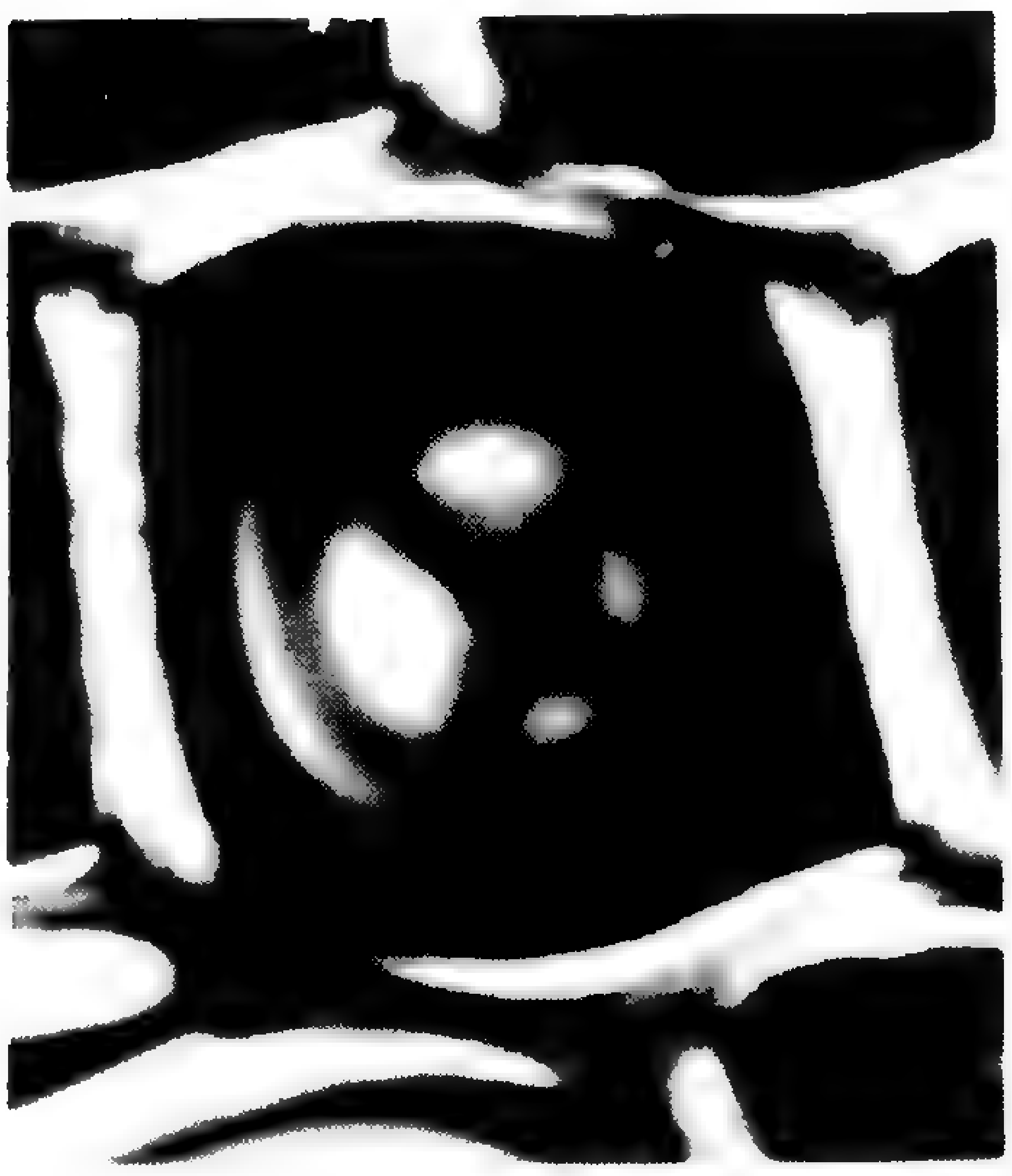

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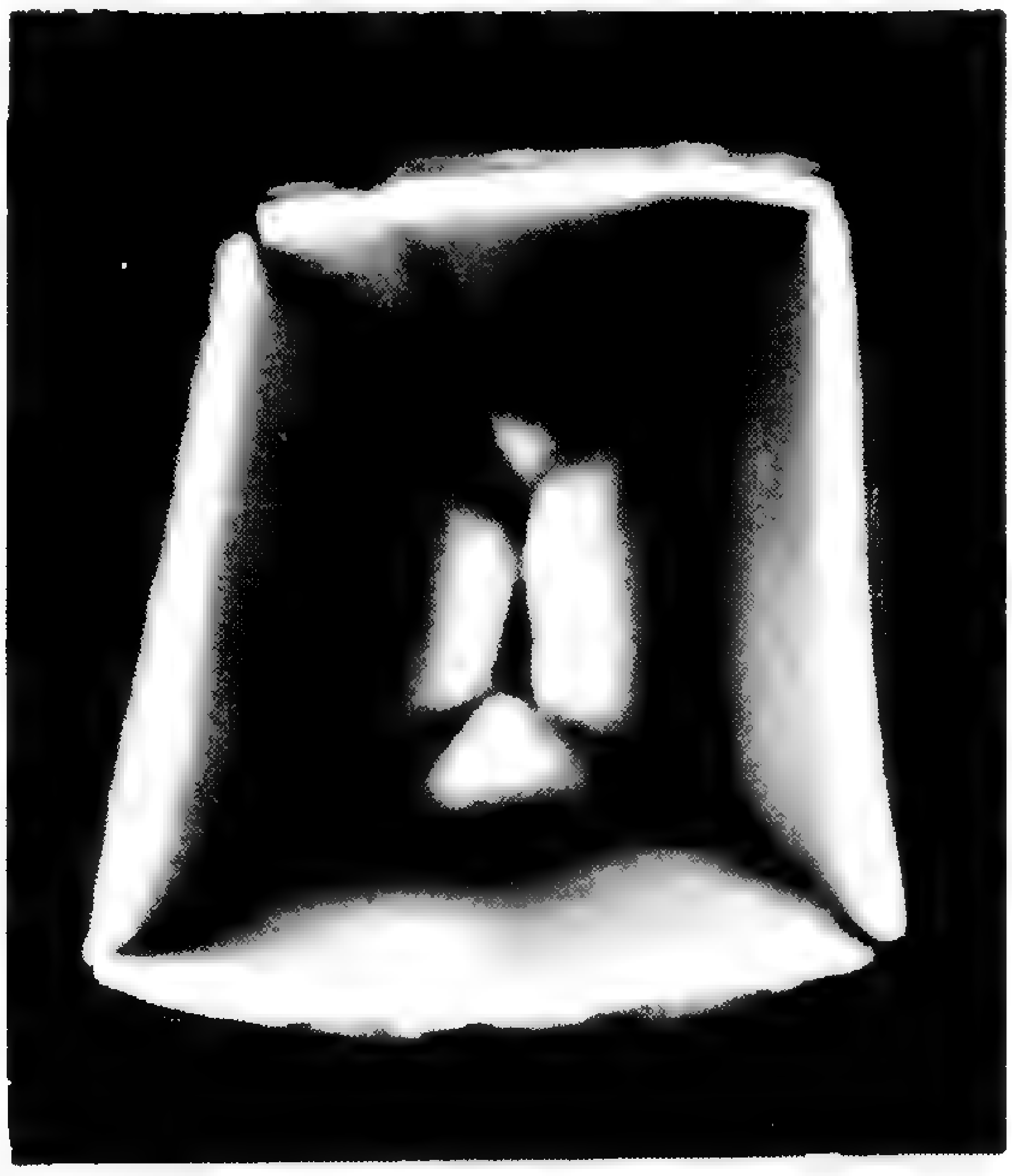

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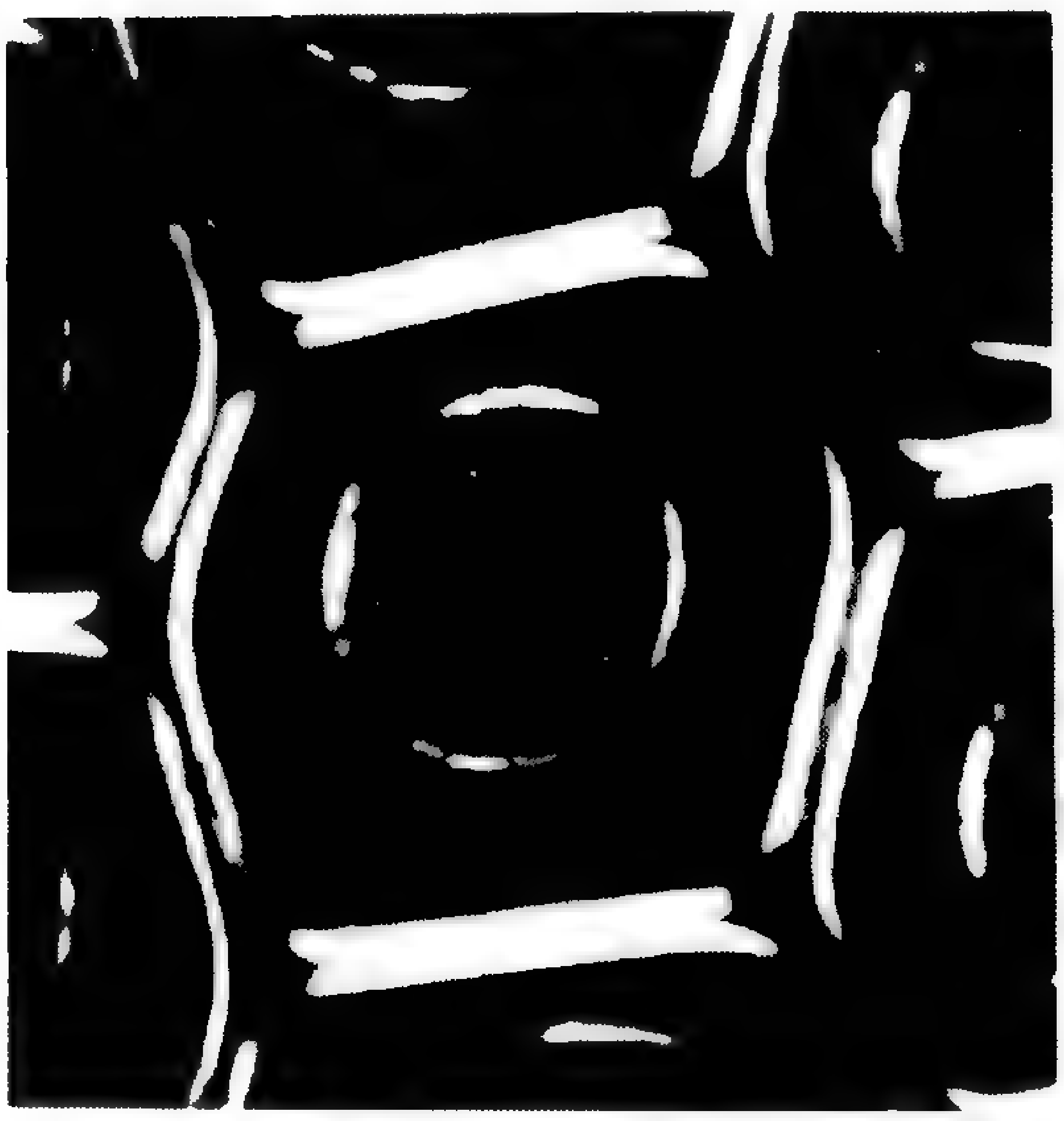

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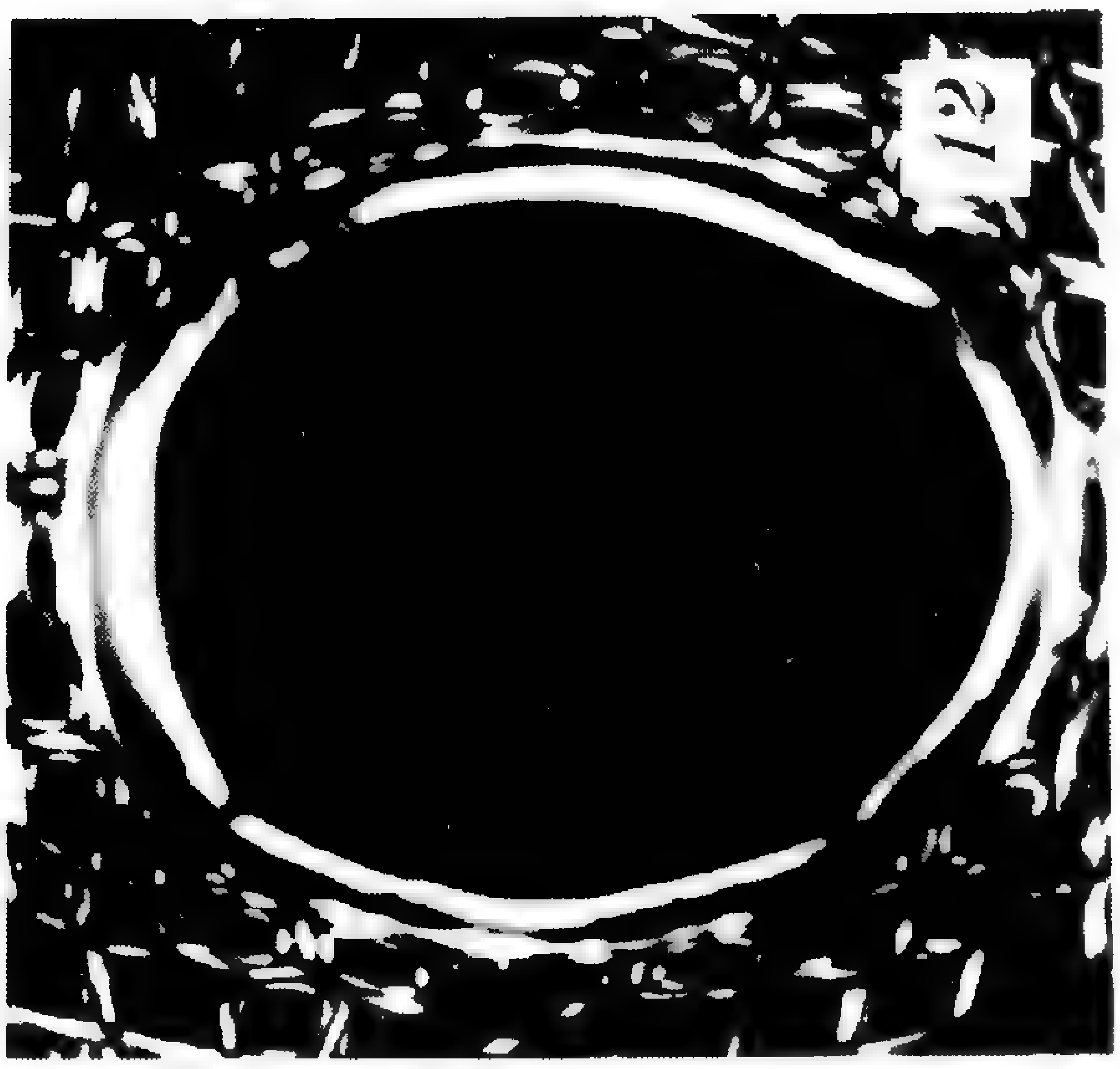

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Orientation of Cellulose

FULL-TONE — MERIDEN

Fig. 4. *Pinus Strobus* L. Pitted radial wall of earlywood tracheid, showing deviations in the helical arrangement of crystals in the central layer due to the presence of bordered pits. × 750 (compare with Text fig. 3.)

PLATE 207

Fig. 5. *Larix occidentalis* Nutt. Unpitted tangential walls of latewood tracheids, showing helical orientations of crystals in the outer layers of two adjacent superimposed cells (lower half of figure), and approximately longitudinal arrangement of crystals in a central layer (upper half of figure). × 900.

Fig. 6. *Trochodendron aralioides* Sieb. & Zucc. Longitudinal section of the secondary wall of a latewood tracheid, showing approximately transverse orientation of crystals in the outer layer and steeply helical orientation of crystals in the central layer. The central layer is seen in surface view, the outer layer in sectional view. × 750.

Fig. 7. *Larix occidentalis.* Tangential wall of latewood tracheid, showing helical orientation of crystalline aggregates in the outer layer. A few helically arranged crystals of an adjacent outer layer are visible in the lower half of the figure. × 750.

Fig. 8. *Larix occidentalis.* Tangential wall of a latewood tracheid, showing deviations in the helical orientation of crystalline aggregates in the outer layer due to the presence of bordered pits. × 900.

PLATE 208

All the figures illustrated in this plate were photographed in polarized light between crossed nicols.

Fig. 9. *Pinus longifolia* Roxb. Transverse section of the latewood, showing one entire tracheid and parts of six others. The narrow inner and outer layers of the secondary wall are intensely birefringent, whereas the broad central layer is dark. × 800.

Fig. 10. *Myodocarpus simplicifolius* Brong. & Gris. Transverse section of a thick-walled fiber-tracheid, showing internal birefringent layers of the secondary wall. × 1300.

Fig. 11. *Myodocarpus simplicifolius.* Transverse section of a relatively primitive type of vessel, showing typical 3-layered secondary wall. × 550.

Fig. 12. *Lithocarpus edulis* (Mak.) Rehd. Transverse section of a more specialized type of vessel, showing broad birefringent inner layer of the secondary wall. × 300.

Fig. 13. *Sequoia sempervirens.* Transverse section of a fiber, showing broad central layer of varying birefringence. × 1200.

Fig. 14. *Fraxinus mandshurica* Rupr. Transverse section of a highly specialized type of vessel, showing intensely birefringent secondary wall. × 550.

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THE SIGNIFICANCE OF CERTAIN WOOD-DESTROYING FUNGI IN THE STUDY OF THE ENZYMATIC HYDROLYSIS OF CELLULOSE

I. W. BAILEY AND MARY R. VESTAL

With plates 209 and 210 and three text figures

INTRODUCTION

IN 1913, one of us[1] called attention to certain wood-destroying fungi which produce helically oriented cavities within the thick secondary walls of the latewood of *Pinus Taeda* L. Subsequently, in studying the comparative anatomy of a wide range of conifers, monocotyledons, and dicotyledons, we have encountered similar fungi, not only in the wood of many different species, genera and families of the higher plants, but also in material from diverse temperate and tropical environments. The fungi evidently are ubiquitous forms which attack the woody tissues of the gymnosperms and of the angiosperms when these tissues are cut and are exposed to the air.

The fungi are characterized by the facts (1) that at least a part of their hyphae move forward within the secondary wall and (2) that their enzymes dissolve cavities which are oriented either helically or parallel to the long axis of the cell. The arrangement of the enzymatically-produced cavities suggests that hydrolysis proceeds along planes that are determined by the structural orientation of the cellulose, and, therefore, that such fungi may afford a means of securing significant information regarding predetermined planes of chemical reaction in the cellulosic matrix of the secondary wall. The results of a reconnaissance of woods that have been attacked by these fungi[2] are recorded in the following pages.

FORM AND DEVELOPMENT OF THE ENZYMATICALLY-PRODUCED CAVITIES

During their stages of elongation, the hyphae are extremely tenuous filaments which dissolve correspondingly minute, elongated cavities

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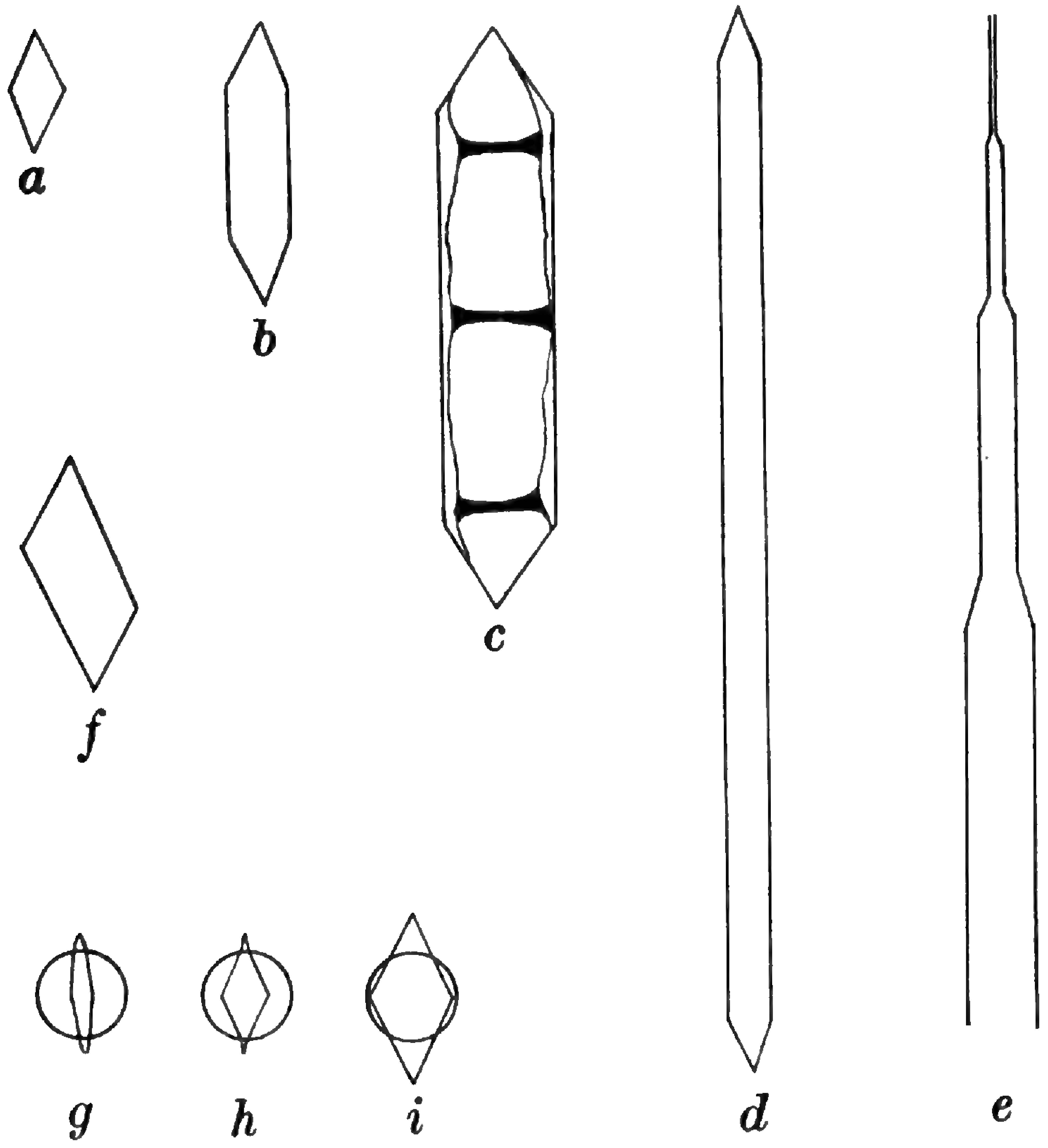
[1] BAILEY, I. W., The preservative treatment of wood. I. The validity of certain theories concerning the penetration of gases and preservatives into wood (Forestry Quarterly **11**: 5-11. 1913).

[2] We have found these fungi in 114 species, 88 genera, and 36 families of the gymnosperms and angiosperms.

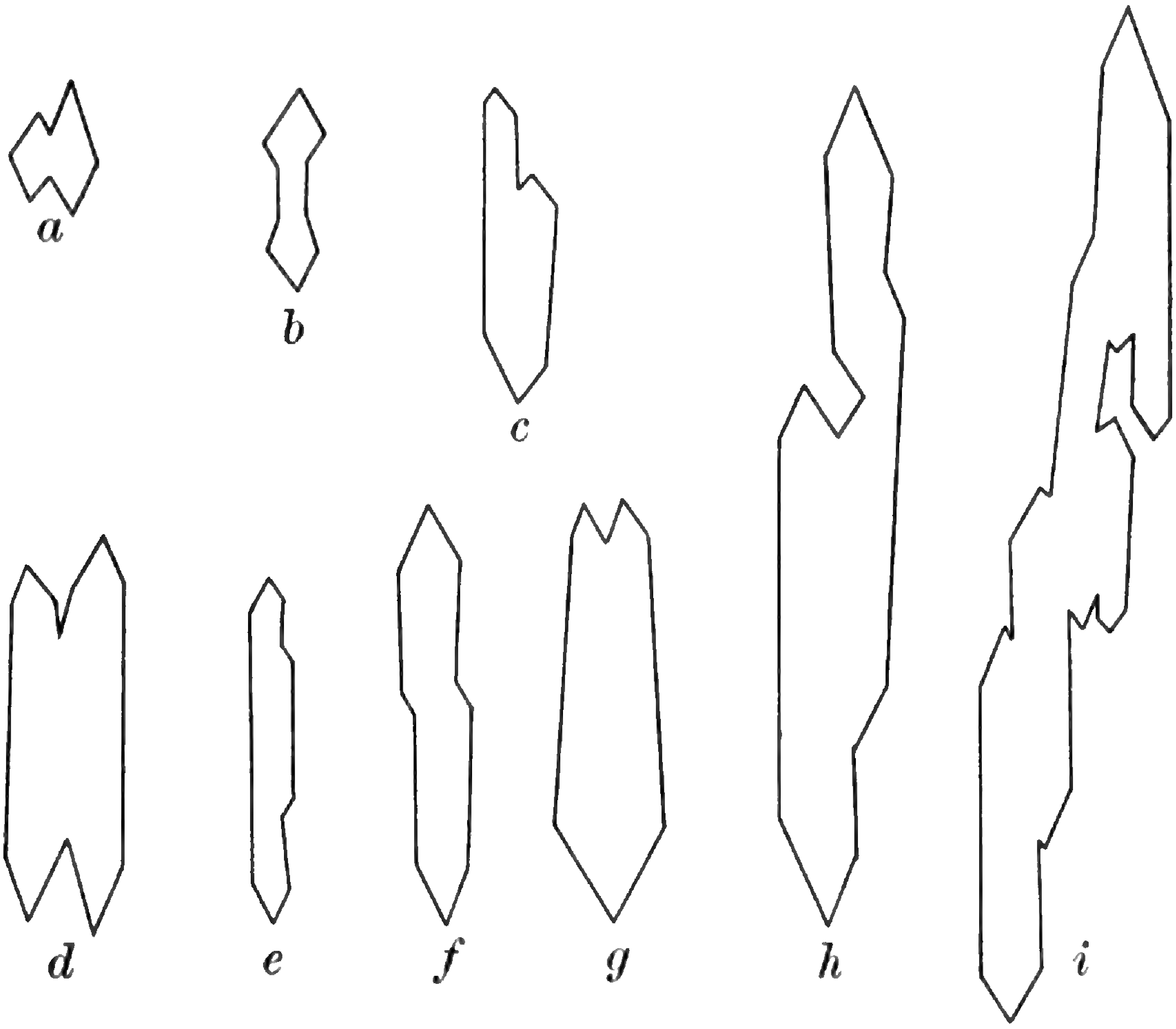
within the secondary wall (Text fig. 3). These slender, cylindrical perforations subsequently are enlarged by further enzymatic activity (Pl. 209, Figs. 1, 2, 6 and 7) which may continue until much of the secondary wall is dissolved (Pl. 209, Fig. 3). The process of lateral enlargement rarely progresses uniformly throughout the length of the cylindrical cavities, but tends to be accelerated in certain parts and to be retarded in others. Thus, as indicated in Pl. 210, Figs. 8–13, localized enzymatic activity produces more or less numerous dilations which are



Text figure 1. Enzymatically-produced cavities as seen in median longitudinal planes of optical section. (a) Biconical cavity. (b), (c) and (d) Cylindrical cavities with conical ends, (c) containing remains of dilated hypha. (e) Progressive stages in the enlargement of a slender cylindrical perforation. (f) Cavity produced by the lateral fusion of two biconical cavities. (g), (h) and (i) Successive stages in the enlargement of a pit orifice.

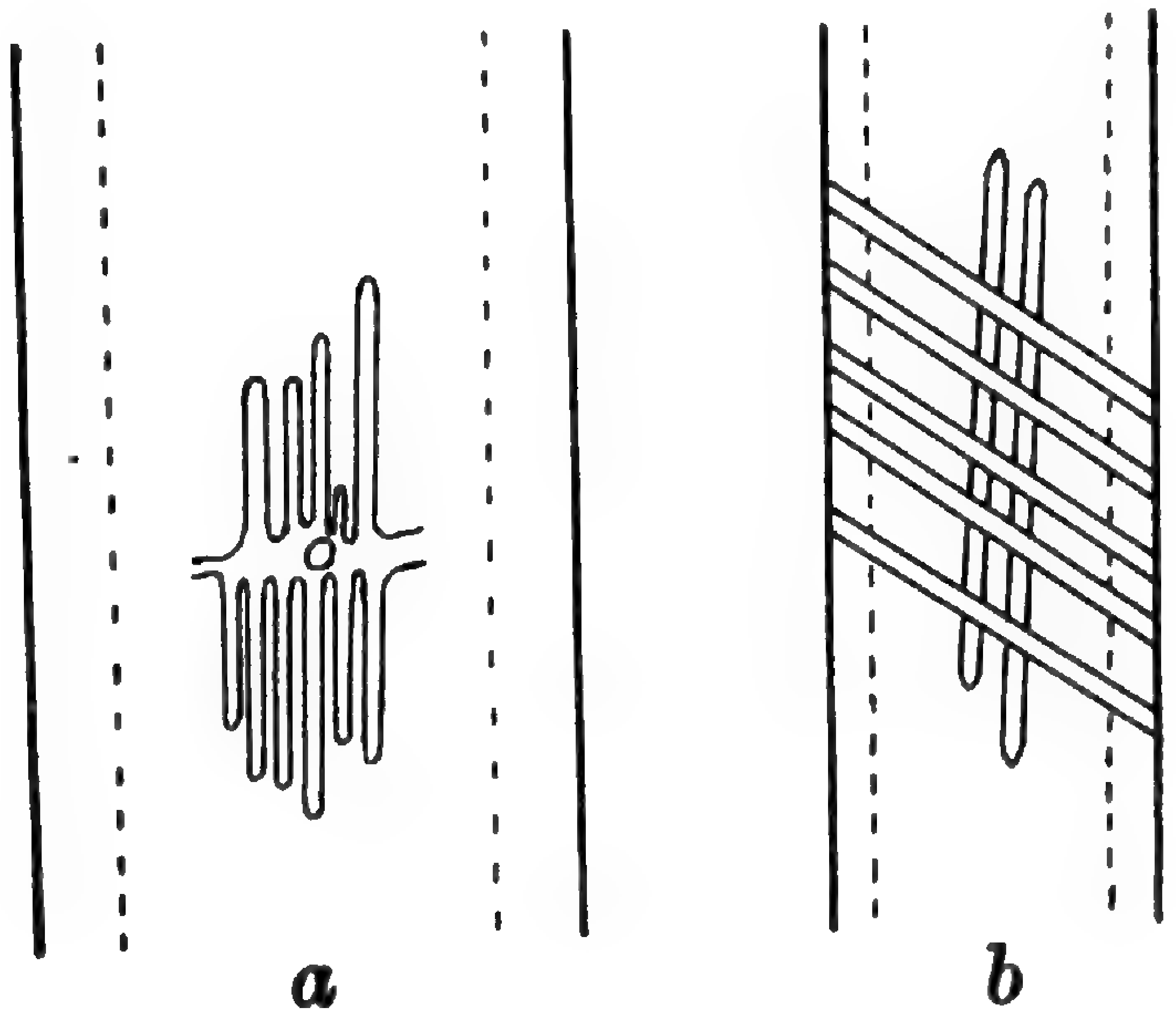
oriented in a linear series and are connected by unaltered or less modified parts of the original elongated perforation.

Although the chambers vary considerably in size, they obviously are restricted to two principal geometric forms (1) biconical or (2) cylindrical with conical ends. In perfectly median longitudinal sections, the former cavities have a diamond-shaped outline (Pl. 210, Figs. 8, 10 and 11), whereas the latter have parallel sides and terminate in acute angles (Pl. 210, Figs. 9 and 13; Text fig. 1, b, c and d). Of course, the outlines deviate considerably in other planes of section (Pl. 210, Fig. 12) and many complex forms arise during the fusion of cavities, either of the same linear series (Text figs. 1, e and 2, b) or of adjacent series (Text figs. 1, f and 2, a, c-i).



TEXT FIGURE 2. Complex types of cavities resulting from the fusion of primary forms.

Such facts as these suggest that hydrolysis of the cellulose through enzymatic activity proceeds along two clearly defined sets of planes. During elongation of the tenuous hyphae, *terminal* enzymatic activity progresses primarily along one of the sets of planes producing attenuated, cylindrical perforations, whereas subsequent *lateral* enzymatic activity develops along either or both of these sets of planes and produces biconical cavities or cylindrical chambers with conspicuously conical ends.



TEXT FIGURE 3. (a) Early stage of the growth of hyphae within the central layer of the secondary wall. (b) Helically oriented perforations in the outer layer of the secondary wall in contrast to the more nearly vertical arrangement in the central layer.

ORIENTATION OF THE PLANES OF ENZYMATIC HYDROLYSIS

As a result of varied optical and physico-chemical investigations, it is now generally recognized that, in the case of tracheids and fibers, the chain molecules of cellulose are oriented approximately parallel to the long axis of the anastomosing fibrils which constitute the secondary wall. That the long axis of the hyphal filaments and of the cylindrical perforations is oriented parallel to that of the fibrils and, therefore, to that of the chain molecules or micelles, may be demonstrated by various lines of evidence. (1) Where the fibrillar structure of the secondary wall is clearly visible, as is sometimes the case, it may be observed that the hyphae and the linear series of cavities are oriented parallel to the long axis of the fibrils. (2) In thick-walled tracheids, fiber-tracheids, and libriform fibers of the normal 3-layered type, the slitlike orifices of the pits are oriented parallel to the fibrils of the broad central layer of the secondary wall. Since most of the enzymatically-produced cavities are confined to this layer (Pl. 209, Figs. 1 and 2) the pit orifices afford a reliable means of correlating the orientations of the fibrils and of the cylindrical perforations within the central layer of the secondary wall. (3) In thin, 5 μ, longitudinal sections of favorable material, it may be demonstrated that the positions of extinction of the cellulose in polarized light are oriented parallel to the sides of the cylindrical cavities. (4) When sections of lignified secondary walls are chlorinated, treated with an aqueous solution of iodine-potassium iodide, and subsequently with a drop of 60% sulphuric acid, dark brown crystals of iodine form within the elongated interstices of the cellulosic matrix. These elongated crystals, or crystalline aggregates, are visible microscopically and are oriented parallel to the long axis of the fibrils. By means of these crystals, it is possible not only to detect such major variations in the structural orientation of cellulose as occur in passing from layer to layer of the secondary wall, but also to observe such minor fluctuations in orientation as occur within the limits of a single layer. As shown in Pl. 209, Fig. 5, the linear series of cavities and the sides of the individual cylindrical chambers are oriented parallel to the long axis of the crystals, and therefore of the fibrils and chain molecules.

These and other lines of corroborative evidence indicate that the hyphae, the cylindrical perforations, and the linear series of enzymatically-produced cavities are oriented parallel to the long axis of the cellulosic fibrils. Where the chain molecules, the micelles, and the fibrils are helically oriented, the hyphae and the cavities have a helical arrangement (Pl. 210, Figs. 12 and 13) and where they are oriented more nearly parallel to the long axis of the cell, the hyphae and the perforations have a similar arrangement (Pl. 210, Figs. 8, 9 and 10). Furthermore, where the orientation of the cellulose changes in different parts of the secondary wall, the arrangement of the hyphae and of the enzymatically-produced cavities fluctuates accordingly (Text fig. 3, b). In other words, one set of the predetermined planes of enzymatic activity is oriented parallel to the long axis of the fibrils, and, therefore, of the chain molecules of cellulose. The second set of planes obviously is oriented at an acute angle to this axis, and it is essential to measure the angle and to determine, if possible, whether it is variable or constant.

Unfortunately, there are inherent optical and other difficulties to be overcome in measuring this angle with consistent accuracy. In the first place, there is the difficulty of turning the lines of the eyepiece into exact coincidence with the two legs of the angle to be measured. The smaller the cavity, the greater this source of error becomes. In the second place, there is considerable uncertainty in determining whether a particular cavity is being viewed in a truly median longitudinal plane of optical section. This difficulty is accentuated by the fact that, in the case of helically oriented structures, the chambers are curved, and furthermore by the fact that many of the larger cavities are not truly cylindrical or biconical, i. e., they are not perfectly circular in transverse sections (Pl. 209, Figs. 1, 2 and 6). Another common source of error, particularly in dealing with the larger cavities, is local deviations in the orientation of the cellulose, which lead to the formation of asymmetrical cavities. It is significant, in addition, that the critical angles become smaller when the wall contracts, e. g., in drying, and enlarge when the the wall swells. Thus, the angles may be modified during the processes of drying, and subsequently of resoaking, softening, and dehydrating the material for microscopic examination.

The measurements recorded in Table 1 were obtained from nine species and genera of seven different families, including one gymnosperm. Although the individual measurements for particular species, and the averages for different species, fluctuate through a range of variation of from 5 to 6 degrees, it is reasonable to assume that many of these variations are due to inherent difficulties in accurately measuring the angles of intersection of the two sets of planes. Thus, there appear to be two predetermined sets of planes of enzymatic activity in the secondary walls of tracheary cells and fibers, (1) oriented parallel to the long axis of the chain molecules and fibrils and (2) oriented at an angle of from 20–25 degrees to this axis.

TABLE 1

MEASUREMENTS OF THE ANGLE OF INTERSECTION OF THE TWO PRINCIPAL PLANES OF ENZYMATIC ACTIVITY

Plant	Min.	Av.	Max.
Ilex formosana Maxim.	15.0	19.5	21.8
Myodocarpus fraxinifolius Brongn. & Gris.	16.9	19.5	22.1
Iryanthera macrophylla (Benth.) Warb.	18.9	20.5	21.8
Laurelia aromatica Juss.	18.3	22.7	24.3
Adinandra sp.	21.0	22.8	24.9
Cussonia Barteri Seem.	19.9	23.2	26.0
Osteophloeum platyspermum (A. DC.) Warb.	20.3	23.2	25.6
Pinus echinata Mill.	18.8	23.7	27.5
Brackenridgea Hookeri A. Gray	22.9	25.6	28.1
	Average	22.3	

Basis of individual averages, 20 measurements.

The second set of planes is not correlated with any visible structures of the cellulosic matrix and, therefore, is determined by submicroscopic ones. The fact that the orientation of these planes is modified during the swelling of the secondary wall, — i. e., where the spacing of the glucose residues is altered — suggests that these planes of hydrolysis are determined by specific configurations in the unit cell of cellulose.

It is possible to isolate fibers that have been attacked by these fungi, and subsequently to treat them with reagents — e. g., sulphuric acid, phosphoric acid or cuprammonium hydroxide — which dissect the wall into "fusiform bodies"[1] and other minute anisotropic fragments. By observing the phenomena in close proximity to the enzymatically-produced cavities, it may be observed that the fusiform bodies are dissected from the wall along planes that are parallel to those of these cavities. In other words, the chemical changes induced by these inorganic reagents progress along planes that are oriented parallel to the predetermined planes of enzymatic activity. As the fusiform bodies are cut free from the wall, they tend to be more or less rapidly deformed by the swelling effects of the reagents used in their production. When the walls themselves are swollen during the treatment — i. e., where the spacing of the chain molecules is altered — the angles between the two intersecting sets of planes are increased, and the shape of the enzymatically-produced cavities becomes correspondingly modified. Under such circumstances, the original cavities contract longitudinally and expand laterally. Thus, the orientation of the oblique surfaces is gradually modified.

The illustrations of partially acetylated fibers published by Hess,[2] Kanamaru,[3] and others indicate that acetylation of cellulose tends to proceed along similar planes, i. e., planes parallel to the long axis of the chain molecules or fibrils, and planes set at an acute angle to this axis. A careful study of these planes of chemical action during hydrolysis and acetylation should yield significant data regarding the submicroscopic configurations of cellulose.

MISCELLANEOUS DATA CONCERNING THE FUNGI AND THEIR HYPHAE

In view of the fact that we have not succeeded in finding any descriptions of these fungi in the literature or information concerning their identity, it seems advisable to record the following data regarding them, even though our observations, thus far, are based solely upon the study of sections of thoroughly seasoned tissues. There are two types of hyphae in a majority of the specimens that we have examined (1) delicate, colorless filaments and (2) coarse, dark brown hyphae which con-

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[1] RITTER, J. Dissection of wood fibrils by chemical means. (Ind. Eng. Chem. **21**: 289. 1929.)

[2] HESS, K. Die Chemie der Zellulose und ihrer Begleiter. Leipzig. 1928.

[3] KANAMARU, K. Die Brechungsindices von Nitrocellulose und Acetylcellulose. (Helv. Chem. Acta **17**: 1429-1440. 1934.)

nect with them. Both types of hyphae are septate, and both are devoid of obvious clamp-connections. The abundance and distribution of the hyphae vary greatly from specimen to specimen. In certain cases, the colored hyphae are confined largely to the lumina of the rays and wood parenchyma — as is true for the "blue stain" fungus — whereas in others they occur chiefly in the lumina of the vessels, fiber-tracheids or libriform fibers. The colorless hyphae perforate the secondary walls and move forward within them. As the enzymatically-produced cavities enlarge, the hyphae tend to become more or less conspicuously dilated (Text fig. 1, c) and, in dried material, frequently are encrusted both internally and externally with a granular substance which stains deeply with Haidenhain's haematoxylin (Pl. 209, Figs. 1, 2, 4 and 6).

The hyphae which move forward within the secondary wall usually attack the walls of the tracheids, fiber-tracheids or libriform fibers, and occasionally of the vessels, but rarely, if ever, of ray parenchyma or of wood parenchyma. Furthermore, they tend to develop primarily within the central layer of the secondary wall (Pl. 209, Figs. 1, 2 and 6); although in the case of certain specimens, they may perforate the outer layer as well (Text fig. 3, b). As indicated in (Pl. 209, Fig. 3), the fungi frequently dissolve the central layer of the secondary wall, leaving the inner and the outer layers intact. Such facts as these suggest that the enzymatic activity may be retarded or inhibited in walls and layers which are very intensely lignified.

In a few of the specimens, which have abundant hyphae within the lumina of the fiber-tracheids, and few, if any, hyphae within the secondary wall, the enzymes attack the inner surface of the wall, and the hydrolysis progresses centrifugally through the central layer. Although this type of enzymatic activity produces less obviously symmetrical cavities, it tends to proceed along two clearly defined sets of planes, i. e., parallel to the long axis of the fibrils and at an angle of 20–25 degrees to this axis. The latter planes of enzymatic hydrolysis are most clearly visible in walls where the orifices of the bordered pits are undergoing enlargement (Text fig. 1, g, h, i).

It should be emphasized, in conclusion, that these fungi are so significant from experimental and physico-chemical points of view that an effort should be made to isolate them, to grow them in pure cultures, and to obtain reliable information concerning their identity.

Since completing the manuscript for this paper, we have examined one of Dr. D. H. Linder's specimens of the wood of *Acer rubrum* L. which has been attacked by a species of *Brachysporium*. The hyphae of this fungus dissolve helically oriented cavities of the same geometrical forms as have been described in this paper. Dr. Linder is of the opinion, after examining our slides, that we are concerned with Pyrenomycetes or with the imperfect stages of this group.

CONCLUSION

1. There are certain fungi whose hyphae perforate and move forward within the secondary walls of tracheary cells and fibers.
2. The cavities produced by these fungi are of two geometrical forms, i. e., (1) cylindrical with conical ends or (2) biconical, and are of remarkably constant angularity, regardless of the particular group of gymnosperms or angiosperms in which they occur.
3. It is evident that the enzymatic activity of these fungi progresses along two predetermined sets of planes, (1) oriented parallel to the long axis of the fibrils and chain molecules of cellulose and (2) at an angle of from 20–25 degrees to this axis.
4. These fungi evidently are ubiquitous forms which attack the vascular and fibrous tissues of the higher plants when they are cut and are exposed to the air.
5. The fungi are so significant from experimental and physicochemical points of view that an effort should be made to isolate them, to grow them in pure cultures, and to determine their identity.

DESCRIPTION OF PLATES

PLATE 209

Fig. 1. *Poraqueiba sericea* Tul. Transverse section of the xylem, showing cavities in the central layer of the secondary wall. × 1470.

Fig. 2. *Stemonurus secundiflorus* Blume. Transverse section of the xylem, showing cavities in the secondary wall. × 580.

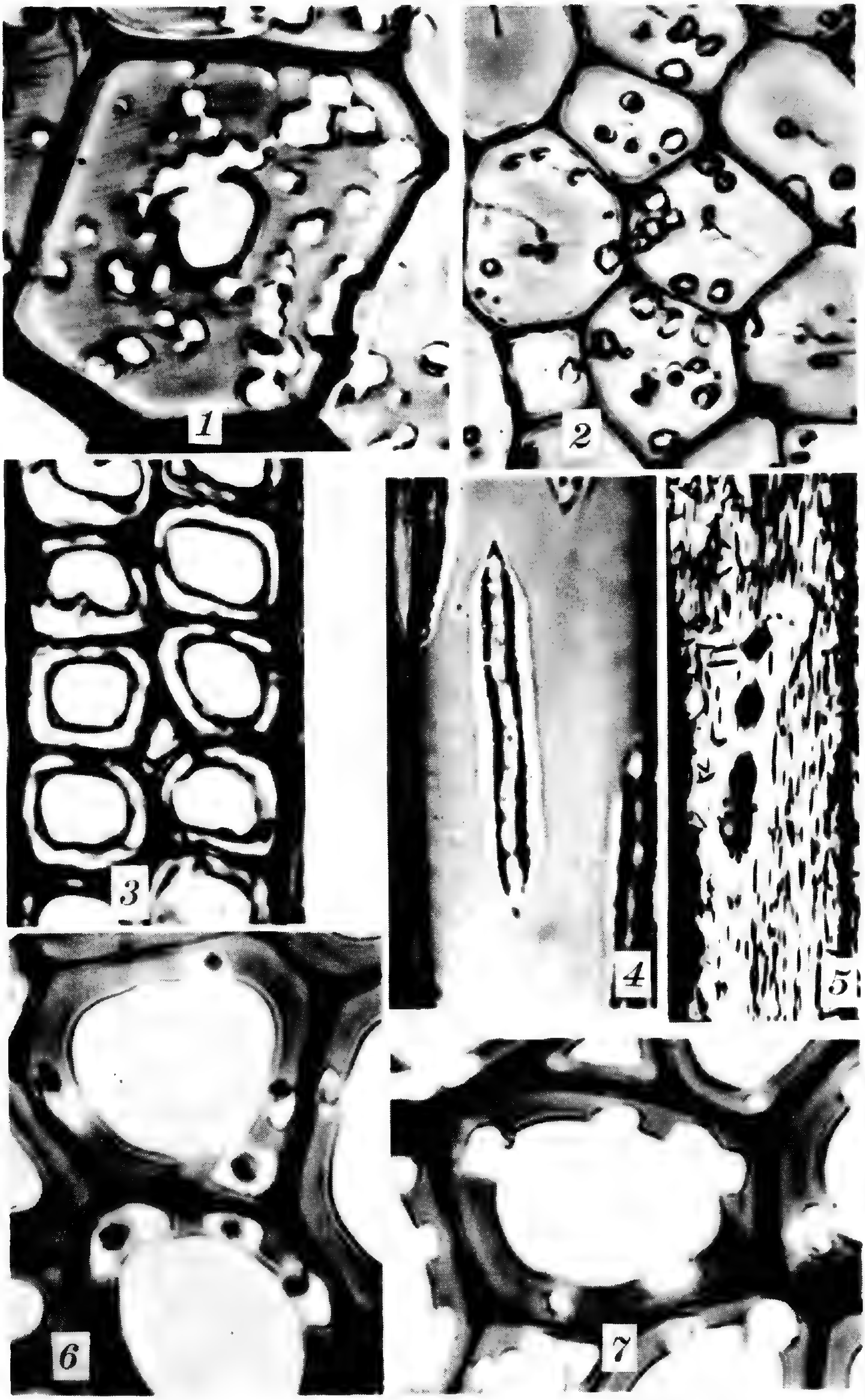
Fig. 3. *Compsoneura capitellata* (Poepp.) Warb. Transverse section of the xylem, showing an advanced stage of the decay. The central layer of the secondary wall is being removed, leaving the more heavily lignified inner and outer layers. × 760.

Fig. 4. *Iryanthera macrophylla* (Benth.) Warb. Longitudinal section of the xylem, showing enzymatically-produced cavity in the secondary wall and hypha encrusted with a deeply stainable substance. × 1470.

Fig. 5. *Brackenridgea Hookeri* A. Gray. Longitudinal section of the xylem, showing orientation of enzymatically-produced cavities and of crystalline complexes of iodine. × 760.

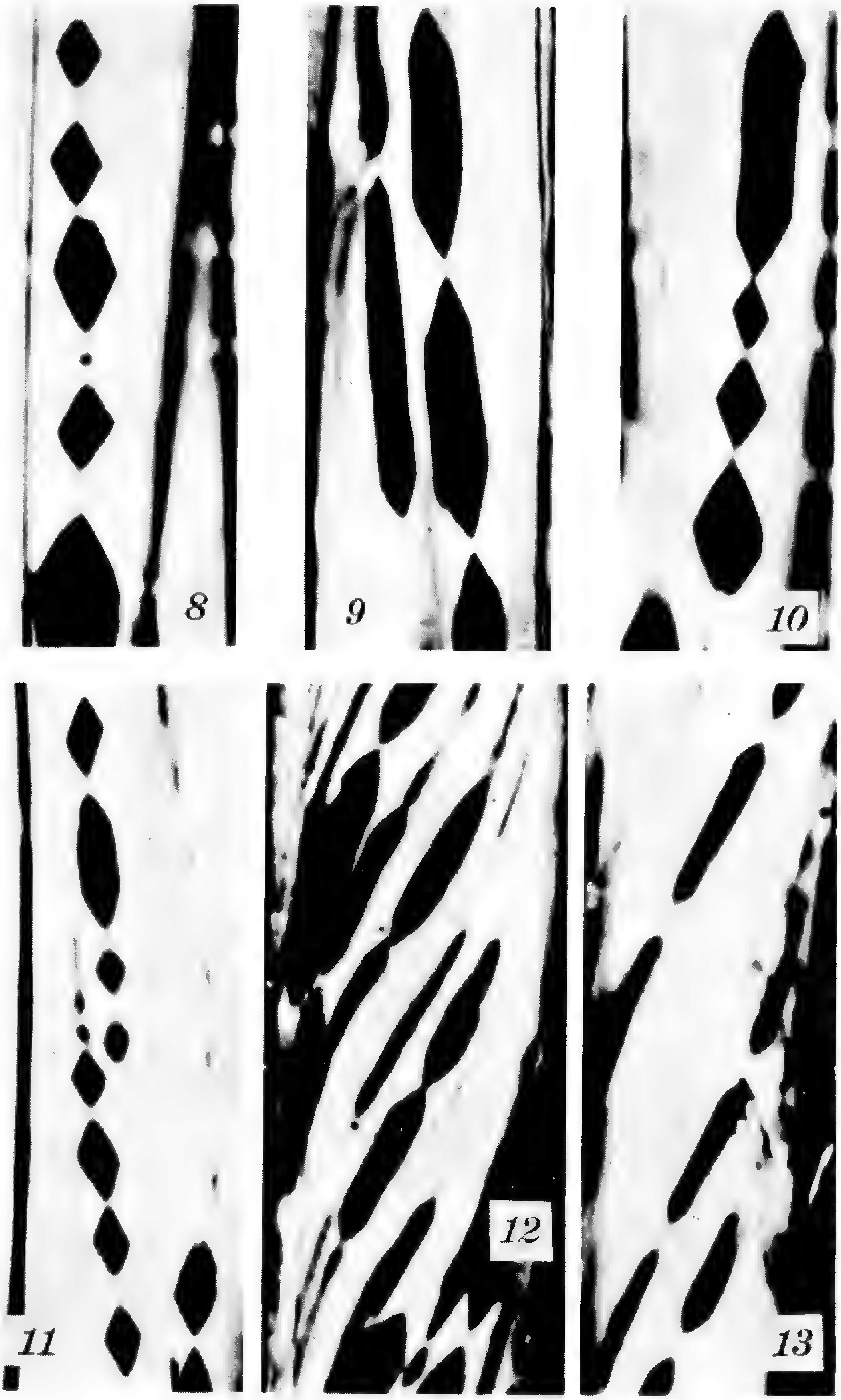
Fig. 6. *Laurelia aromatica* Juss. Transverse section of the xylem, showing hyphae and enzymatically-produced cavities in the secondary wall. × 1470.

Fig. 7. *Davidia involucrata* Baill. Transverse section of the xylem, showing cavities in the secondary wall. × 1470.



Wood-destroying Fungi

FULL-TONE — MERIDEN



Wood-destroying Fungi

FULL-TONE — MERIDEN

PLATE 210

Fig. 8. *Brackenridgea Hookeri.* Longitudinal section of the xylem, photographed in polarized light between crossed nicols, showing enzymatically-produced cavities. × 990.

Fig. 9. *Laurelia aromatica.* Longitudinal section of the xylem, showing cavities in the secondary wall. × 990.

Figs. 10 and 11. *Brackenridgea Hookeri.* Longitudinal section of the xylem, showing cavities in the secondary wall. × 990.

Fig. 12. *Pinus rigida* var. *serotina* (Michx.) Loudon. Longitudinal section of the xylem, showing helical orientation of enzymatically-produced cavities in the secondary wall. × 300.

Fig. 13. *Osteophloeum platyspermum* (A. DC.) Warb. Longitudinal section of the xylem, showing helical orientation of cavities in the secondary wall. × 990.

Arnold Arboretum,
Harvard University.

NOTES ON THE LIGNEOUS PLANTS DESCRIBED BY H. LEVEILLE FROM EASTERN ASIA[1]

ALFRED REHDER

LEGUMINOSAE[2]

Crotalaria Mairei Léveillé in Bull. Géog. Bot. **25:** 49 (1915); Cat. Pl. Yun-Nan, 153 (1916).

Suffrutex caulibus 10–30 cm. longis plerisque basi prostratis ascendentibus dense adpresseque sericeo-hirsutulis. Folia obovata vel obovato-oblonga, rarius oblanceolata, 1.5–2.5 cm. longa et 5–10 mm. lata, apice rotundata mucronulata, interdum acutiuscula, rarius leviter emarginata, basi cuneata in petiolum brevem 1–3 mm. longum attenuata, supra minute verruculosa, cinereo-viridia, pilis adpressis paucis conspersa, subtus dense adpresse albo-sericea (in sicco fulva), costa supra leviter vel vix impressa subtus leviter elevata; stipulae nullae vel minutae, subulatae. Flores in racemis plurifloris ad 4 cm. longis vel paucifloris subcapitatis, axi pedicellis bracteis bracteolis calyceque dense sericeo-hirsutis, bracteis subulatis pedicellos 2–3 mm. longos valde superantibus, bracteolis ad apicem petioli inserti subulatis circiter 5 mm. longis; calyx fere ad basin bilabiatus, 10–12 mm. longus, labio superiore quarta parte inferiore excepta in lobos 2 lanceolatos fisso, labio inferiore in lobos 3 anguste lanceolatos alte fisso, quarta vel tertia parte inferiore ventricosa excepta; corolla intense coerulea vel violacea, calycem subaequans, vexillo suborbiculari 11 mm. longo et lato basi rotundato supra unguem brevem prominenter bicalloso, alis oblongis vexillo paullo brevioribus, infra medium ad laterem corrugosis, carina curvata 8–9 mm. longa breviter rostrata; stamina antheris partim oblongis 1.25 mm. longis partim ovalibus 0.5 mm. longis, filamentis tantum basi quarta vel tertia parte connatis; ovarium oblongum, glabrum, 14–16-ovulatum: legumen calycem paullulo superans, ovoideo-oblongum, sessile, 10–12 mm. longum, 5 mm. diam., apice in rostrum curvatum contractum; semina circiter 4, reniformia, 2.5 mm. diam., brunnea, lucida.

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[1] Continued from Vol. **18**: 26-53; for preceding parts see Vols. **10**: 108-132, 164-196; **12**: 275-281; **13**: 299-332; **14**: 223-252; **15**: 1-27, 89-117, 267-326; **16**: 311-340; **17**: 53-82, 316-340.

[2] See Vol. **13**: 321.

CHINA. Yunnan: pâtures des mont. à Lan-ngi-tsin, alt. 3100 m., "plante vivace, fl. bleu de Prusse;" coteaux arides calcaires à Ta-kiao, rare, alt. 2550 m., "fl. bleues, feuilles gris en dessus, blanches veloutées en dessous;" pâturages de collines à Tche-hai "plante vivace en touffes rampantes, fl. violet sombre;" *E. E. Maire,* July to August 1912 (syntypes; photos. of specimens from Lan-ngi-tsin and Ta-kiao in A. A.).

I have not been able to identify *C. Mairei* with any described species from Yunnan. It belongs to Sect. Calycinae Benth. and to the species with included pod. It seems near *C. occulta* Grah. and *C. chinensis* L., but is easily distinguished from both by the smaller generally obovate and obtuse leaves densely strigose-silky beneath, and from the latter also by the dark blue or violet flowers; from *C. yunnanensis* Franch. it is distinguished also by the shape and pubescence of the stem and the larger dark blue flowers.

Sophora spec.

Milletia Esquirolii Léveillé, Fl. Kouy-Tchéou, 239 (1914). — Rehder in Jour. Arnold Arb. **13**: 326 (1932).

CHINA. Kweichou: Ouang-mou, *J. Esquirol,* no. 106, June 1904, "fleur blanc" (holotype of *Millettia Esquirolii;* photo. in A. A.).

As far as one can judge from the meagre and fragmentary material the specimen cited above belongs to *Sophora.*

Indigofera Esquirolii Léveillé. — Rehder in Jour. Arnold Arb. **13**: 324 (1932). — Handel-Mazzetti, Symb. Sin. **7**: 547 (1933).

Handel-Mazzetti cites also a specimen of his collection (no. 6251) from Yunnan which he states differs only in its pink flowers.

Desmodium Esquirolii Léveillé, Fl. Kouy-Tchéou, 232 (1914); Cat. Pl. Yun-Nan, 154 (1916).

Desmodium cinerascens Franchet, Pl. Delavay, 174 (1890). — Rehder in Jour. Arnold Arb. **13**: 327 (1932). — Non A. Gray (1853).
Desmodium Franchetii Rehder in Jour. Arnold Arb. **3**: 41 (1921).

CHINA. — Vide Rehder, op. cit. **13**: 327 (1932).

When reducing *D. Esquirolii* Lévl. to a synonym of *D. cinerascens* Franch. in 1932, I overlooked the fact that Franchet's name was invalidated by the earlier *D. cinerascens* A. Gray of 1853 and also that I had already in 1921 proposed the name *D. Franchetii* for that invalidated name. As *D. Esquirolii* Lévl. is seven years older than *D. Franchetii,* the former becomes the valid name of this species.

Lespedeza fasciculiflora Franchet, Pl. Delavay. 169 (1889). — Handel-Mazzetti, Symb. Sin. **7**: 572 (1933).

Lespedeza Monnoyeri Léveillé. — Rehder in Jour. Arnold Arb. **13:** 328 (1932).

Lespedeza Monnoyeri was identified by Handel-Mazzetti with *L. fasciculiflora* Franch. which was reduced by Schindler (in Fedde, Rep. Spec. Nov. **23:** 354. 1927) to a variety of *L. floribunda* Bge., but seems sufficiently distinct from that species.

Dalbergia Cavaleriei Léveillé. — Rehder in Jour. Arnold Arb. **13:** 330 (1932). — Handel-Mazzetti, Symb. Sin. **7:** 574 (1933). — Merrill in Lingnan Sci. Jour. **13:** 30 (1934).

This species was collected in Kweichou also by Handel-Mazzetti (no. 10352), and in Kwangtung by W. T. Tsang (no. 20467: see Merrill, l. c.).

Dumasia villosa DeCandolle. — Rehder in Jour. Arnold Arb. **13:** 330 (1932). — Handel-Mazzetti, Symb. Sin. **7:** 578 (1933).

Handel-Mazzetti cites *Apios Martini* Lévl. of which he has seen the type, as a synonym of *D. villosa;* he doubts the specific difference of *D. hirsuta* Craib which differs chiefly in its short racemes.

Glycine Soja Siebold & Zuccarini in Abh. Akad. Wiss. Muench. **4** (pt. 2): 119 (Fl. Jap. Fam. Nat. **1:** 11) (1845).

Glycine ussuriensis Regel & Maack, Tent. Fl. Ussur. 50, t. 7, figs. 5–8 (1861).

Rhynchosia Argyi Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, **12:** 555 (Cat. Pl. Kiang-Sou, 15) (1916). — **Synon. nov.**

CHINA. Kiangsu: without locality, *Ch. d'Argy,* nos. 200, 201 [1844–66]: Tchang-hay, route de Zi-ka-wei, dans les haies, *E. Bodinier,* Sept. 1891 (syntypes of *Rhynchosia Argyi;* photo. in A. A.).

Glycine ussuriensis is apparently not specifically different from *G. Soja* Sieb. & Zucc. which is probably the wild form of the soja or soy-bean, *G. hispida* (Moench) Maxim., much cultivated in eastern Asia.

Mucuna Birdwoodiana Tutcher in Jour. Linn. Soc. Bot. **37:** 65 (1905). — Merrill in Lingnan Sci. Jour. **13:** 30 (1934).

Mucuna Bodinieri Léveillé. — Rehder in Jour. Arnold Arb. **13:** 330 (1932).

Mucuna Bodinieri was identified by Merrill (l. c.) with *M. Birdwoodiana,* a species originally described from Hongkong.

Pueraria Thunbergiana (Sieb. & Zucc.) Bentham. — Rehder in Jour. Arnold Arb. **13:** 331 (1932). — Merrill in Lingnan Sci. Jour. **14:** 14 (1935).

All the Léveillé names are cited as synonyms by Merrill (l. c.).

Backer, Nutt. Pl. Ned. Ind. Ed. 2, **2:** 829 (1927) published *Pueraria* *triloba* as a new combination for this species, based on *Pachyrhizus trilobus* (Lour.) DC., but this combination had already been published for the same species by Makino (in Iinuma, Somoku Dzusetsu, ed. 3, **3:** 954, t. 22 [pt. 13] 1912) based on *Dolichos trilobus* Houttuyn (1779) which only partly (as to the plant figured) represents *Pueraria Thunbergiana;* otherwise it stands for the Linnean species (*Dolichos trilobus* L. = *Phaseolus trilobus* [L.] Ait.). Also *Dolichos trilobus* Lour. is a misapplication of the Linnean name since the description refers to *P. Thomsoni* Benth. (cf. Gagnepain in Lecomte, Fl. Gen. Indo-Chine, **2:** 251. 1916, and Merrill, Comm. Lour. Fl. Cochinch. 211. 1935).

OXALIDACEAE

Biophytum Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **12:** 181 (1913). — Knuth in Engler, Pflanzenreich, iv. **130** (Heft 95): 413 (1930). — Merrill in Lingnan Sci. Jour. **13:** 31 (1934). — Merrill & Chun in Sunyatsenia, **2:** 250 (1935).

> *Biophytum Reinwardtii* "Edgew. & Hook. f." ex Forbes & Hemsley in Jour. Linn. Soc. Bot. **23:** 99 (1886); non Klotzsch.

CHINA. Kweichou: *J. Esquirol,* no. 811, in 1906 (holotype of *B. Esquirolii;* photo. in A. A.).

The Chinese specimens referred to *B. Reinwardtii* (Zucc.) Klotzsch do not belong to that species; they were referred by Knuth (l. c.) partly to *B. Thorelianum* Guill. var. *sinense* Guill. and partly to *B. Esquirolii* Lévl., but Merrill (l. c.) considers Guillaumin's variety identical with *B. Esquirolii.*

RUTACEAE[1]

Zanthoxylum rhetsoides Drake in Jour. de Bot. **6:** 275 (1892). — Guillaumin in Lecomte, Fl. Gén. Indo-Chine, **1:** 640 (1911).

> *Zanthoxylum odoratum* (Lévl.) Léveillé. — Rehder in Jour. Arnold Arb. **14:** 224 (1933). — Merrill in Lingnan Sci. Jour. **13:** 33 (1934). — Chun in Sunyatsenia, **2:** 75 (1934). — **Synon. nov.**
>
> *Zanthoxylum myriacanthum* Dunn & Tutcher in Kew Bull. Misc. Inform. Add. Ser. **10:** 50 (Fl. Kwangtung) (1912). — Merrill in Lingnan Sci. Jour. **6:** 279 (1928). — Non Wallich.
>
> *Fagara odorata* (Lévl.) Handel-Mazzetti, Symb. Sin. **7:** 623 (1933).

Zanthoxylum odoratum has been identified by E. D. Merrill with *Z. rhetsoides;* a note of this identification will be published by Merrill & Chun in a later issue of Sunyatsenia. The range of the species extends now from Tonkin to Kwangtung, Hunan and Kweichou.

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[1] See Vol. **14:** 223.

Zanthoxylum Chaffanjoni Léveillé. — Rehder in Jour. Arnold Arb. **14:** 223 (1933).

> *Fagara Chaffanjoni* (Lévl.) Handel-Mazzetti, Symb. Sin. **7:** 625 (1933).

Handel-Mazzetti gives a full Latin description of this species based on the type, on Cavalerie's 640 (p.p.) and his own no. 10433, all from Kweichou.

Boenninghausenia albiflora (Hook.) Meissner, Pl. Vasc. Gen. **2:** 44 (1836). — Rehder in Jour. Arnold Arb. **14:** 225 (1933).

In 1933 I credited the publication of the binomial to Heynhold (1840), but later I found that it had been published four years earlier by Meissner.

Boenninghausenia albiflora var. **brevipes** Franchet. — Rehder in Jour. Arnold Arb. **14:** 225 (1933).

> *Boenninghausenia sessilicarpa* Léveillé. — Handel-Mazzetti, Symb. Sin. **7:** 628 (1933).

Handel-Mazzetti considers *B. sessilicarpa* specifically distinct and states that it differs not only in its fruit, but also in its open, star-shaped, not campanulate corolla.

Clausena Dunniana Léveillé. — Rehder in Jour. Arnold Arb. **14:** 226 (1933). — Handel-Mazzetti, Symb. Sin. **7:** 630 (1933).

Handel-Mazzetti refers to this species besides *C. Willdenowii* "W. & A." ex Léveillé (non Wight & Arnott), also *C. excavata* "Burm." ex Léveillé non Burm.

MELIACEAE[1]

Chukrasia tabularis A. Jussieu. — Rehder in Jour. Arnold Arb. **14:** 227 (1933), "Chickrassia."

In his China Rev. Ann. 1916, p. 23, a manuscript publication, Léveillé cites *Disoxylon* [sic] *Esquirolii* as a synonym of *Cipadessa fruticosa* Bl. = *C. baccifera* (Roth) Miq., but the rather large cylindric flower buds of the type of *Dysoxylon Esquirolii* show at once that the specimen belongs to *Chukrasia* and not to *Cipadessa* which has small subglobose buds.

Aglaia tetrapetala (Pierre) Pellegrin in Lecomte, Fl. Gén. Indo-Chine, **1:** 773 (1911).

> *Lepiaglaia ? tetrapetala* Pierre, Fl. For. Cochinch. **5:** t. 337, in textu (1899), *Aglaia ? tetrapetala* pro synon. et sub tabula.

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[1] See Vol. **14:** 227.

Ficus Ouangliense [!] Léveillé in Fedde, Rep. Spec. Nov. **4**: 66 (1907). — **Synon. nov.**

Ficus Vanioti Léveillé in op. cit. 7: 258 (1909); Fl. Kouy-Tchéou, 434 (1915), quoad specim. Cavalerie 2984. — **Synon. nov.**

CHINA. Kweichou: ouest de Lo-fou, Ouang-li, *J. Cavalerie,* no. 2568, Nov. 1905 (holotype of *F. Ouangliense;* photo. in A. A.); Lo-fou, *Cavalerie,* no. 2984, April 1908 (holotype of *F. Vanioti;* fragments in A. A.).

In his Flore de Kouy-Tchéou Léveillé cites *Ficus ouangliensis* [!] as a synonym of *F. Vanioti,* and enumerates besides the two types, two specimens from Che-chen-ha-e [?], Esquirol nos. 3077 and 3078, which represent a species of *Ficus,* but are too fragmentary for identification.

Aglaia tetrapetala has been reported also from Kwangtung and Hainan (cf. Merrill in Lingnan Sci. Jour. **7**: 311, 1931) and is represented by many specimens in this herbarium.

POLYGALACEAE

Polygala arillata Hamilton ex D. Don Prodr. Fl. Nepal. 199 (1824).

CHINA. Kweichou: forêts de Tong-tchéou, 1400 m., *J. Esquirol,* no. 3265, June 22, 1912 "fl. jaune, petite plante 0.5–2 m.; Kiang-long, Tchen-lin-tchéou, *J. Cavalerie,* no. 3796, June 1910 "fl. jaune." Yunnan: Mont Io-chan 3400 m., sous-bois; broussailles, Long-ky, brousse, 700 m., *E. Maire,* June and August 1912. (Photo. of Esquirol 3265 in A. A.).

The specimens cited above bear in Léveillé's herbarium an unpublished binomial under *Piptanthus* and later were described and figured in Léveillé's manuscript publication China Rev. Ann. 1916, p. 4, pl., as a new species of *Crotalaria,* but none of these names was ever validly published.

Polygala Dunniana Léveillé in Fedde, Rep. Spec. Nov. **9**: 326 (1911); Fl. Kouy-Tchéou, 316 (1915). — Merrill in Lingnan Sci. Jour. **13**: 34 (1934). — Merrill & Chun in Sunyatsenia, **2**: 254 (1935).

CHINA. Kweichou: Pic du Ko-tchang-keou, face Nord, *J. Esquirol,* no. 206, Sept. 1904 (holotype).

Polygala Dunniana was identified by Merrill with Chun & Tso, no. 44199, from Kwangtung.

Polygala japonica Houttuyn, Natuurl. Hist. Pt. II. **10**: 89, pl. 62, fig. 1 (1779).

Polygala Taquetii Léveillé in Fedde, Rep. Spec. Nov. **12**: 181 (1913). — **Synon. nov.**

KOREA. Quelpaert: in herbidis Polmongi, *E. Taquet*, no. 671, Apr. 1908 (holotype of *P. Taquetii;* photo. in A. A.).

EUPHORBIACEAE[1]

Andrachne Esquirolii Léveillé. — Rehder in Jour. Arnold Arb. **14**: 229 (1933). — Handel-Mazzetti, Symb. Sin. **7**: 1372 (1936).

Andrachne attenuata Handel-Mazzetti . . . add: Symb. Sin. **7**: 219 (1931).

Handel-Mazzetti (l. c. 219) gives a revised Latin description of his *A. attenuata*.

Phyllanthus Bodinieri (Lévl.), comb. nov.

Sterculia Bodinieri Léveillé, Fl. Kouy-Tchéou, 406 (1915).

Phyllanthus spec. Rehder in Jour. Arnold Arb. **14**: 231 (1933).

Frutex glaberrimus ramis strictis pallide flavo-griseis sparse lenticellatis, ramulis anguste alatis. Folia disticha, subcoriacea, brevissime petiolata, ovato-lanceolata, 2–3.5 cm. longa et 8–12 mm. lata, acuminata apice acutiuscula, basi late cuneata, margine revoluta, supra luteo-viridia, subtus pallidiora, costa media utrinque elevata, nervis utrinsecus 4–5 fere obsoletis; petioli vix 1 mm. longi. Flores monoeci, graciliter pedicellati, purpurei, in fasciculis ad 7-floris axillaribus secus ramulos laterales 3–8 cm. longos; masculi 4 mm. diam., sepalis 4 late ovatis integris, glandulis 4 distinctis horizontaliter ovalibus medio concavis, staminibus 2, in columnam brevissimam connatis apice antherarum loculos 4 horizontaliter dehiscentes et fere annulatim dispositos gerentibus, pedicellis 3–7 mm. longis; feminei 4–4.5 mm. diam., sepalis 6 rotundatis, disco cupuliformi ovarium globosum glabrum triente superiore excepto arcte cingente et tegente, stylis 3 liberis, ad medium in stigmata 2 partitis, pedicellis 6–10 mm. longis. Fructus desideratur.

CHINA. Kweichou: environs de Hoang-ko-chou, grande cascade, au bord de l'eau, *J. Seguin* in herb. *Bodinier*, no. 2194, April 1898, "arbuste, fleurs rougeâtres" (holotype of *Sterculia Bodinieri;* merotype and photo. in A. A.).

This plant apparently represents a new species of the section ERIOCOCCUS (§ Reidia [Wight] Hook. f.) and as the original description is insufficient a complete description has been given above. The species is chiefly characterized by the entire sepals, 6 in the pistillate flower, the very short staminal column, the 4 distinct glands of the disk in the staminate flower and the cupular disk of the pistillate flower, the glabrous ovary, the styles divided to the middle, and the ovate lanceolate leaves 2–3.5 cm. long and not oblique at base.

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[1] See Vol. **14**: 229.

Bischofia javanica Blume, Bijdr. 1168 (1825). — Schneider in Sargent, Pl. Wilson. **3**: 275 (1916), 455 (1917).

Celtis polycarpa Léveillé in Fedde, Rep. Spec. Nov. **11**: 296 (1912); Fl. Kouy-Tchéou, 424 (1915); China Rev. Ann. 1916, p. 29 (MS), pro synon. *Bischofiae sinensis* Bl.

CHINA. Kweichou: Gan-chouen (Choin-tang-tchiai), *J. Cavalerie*, no. 3790, May–Oct. 1910 (holotype of *Celtis polycarpa;* photo. in A. A.).

Celtis polycarpa was first identified with *Bischofia javanica* by Schneider (l. c.). Léveillé in his manuscript publication "China, Rev. Ann. p. 29 (1916)" refers it to *Bischofia,* probably having been notified of the correct identification by Schneider, to whom he had sent fragments for Schneider's study of the Chinese *Celtis.*

Bridelia spec.

Lindera spec. Léveillé, Fl. Kouy-Tchéou, 219 (1914).

CHINA. Kweichou: route de Tong-tchéou, *J. Esquirol,* no. 3747, July 1912 (fragments in A. A.).

The specimen apparently belongs in the affinity with *B. minutiflora* Hook. f., but differs in the leaves being of thinner texture, green and quite glabrous beneath and somewhat lustrous above; it agrees in these characters with Y. Tsiang 7252 from Kweichou.

Mallotus Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **9**: 327 (1911); Fl. Kouy-Tchéou, 165 (1914), specim. Esquirol 3225, (? 902), et Cavalerie 3114 exclud. — Pax & Hoffmann in Engler, Pflanzenr. IV. **147**$^{\text{vii}}$: 196 (1914), quoad Esquirol, no. 898. — Rehder in Jour. Arnold Arb. **14**: 232 (1933), exclud. Cavalerie no. 3114.

CHINA. Kweichou: without locality, *J. Esquirol,* no. 898 (holotype; photo. in A. A.); Pe-tung, *J. Esquirol,* no. 898 ?, "arbrisseau 2 mètres" (not a type; photo. in A. A.); Ouang-mou, ruisseau de Dong-á, *J. Esquirol,* no. 65, June 1904 (cited in Fl. du Kouy-Tchéou).

There are two sheets of Esquirol no. 898 in the Léveillé herbarium, one a staminate specimen which is the type with the name *Mallotus Esquirolii* Lévl. in Léveillé's hand on a printed label, but without locality, and an identification label by Pax; the other sheet bears what is apparently Esquirol's original label with the locality "Pe-tung" and a note "ne serait ce pas le fruit du no. 898?" referring evidently to detached fruits in a pocket; the specimen itself has two fruiting racemes with all the fruits fallen off. The opposite leaves are very unequal, the smaller ones only ½ or ⅓ the size of the larger ones, often ovate and subcordate or rounded at base and borne on very short petioles or nearly subsessile.

Henry's no. 13023 cited by Pax under *M. Esquirolii* differs in its slenderer pedicels of the fruit, about 1 cm. long, stouter, recurved, and only 2–4 mm. long in *M. Esquirolii* — and in the much less unequal opposite leaves, the smaller ones more than half as long as the larger ones and on petioles 5–12 mm. long. Esquirol no. 65 is very fragmentary and has neither flowers nor fruits.

Esquirol no. 3225 from Ka-riang described as a sarmentose shrub and Cavalerie no. 3114 from Lo-fou cited by Léveillé in his Flore du Kouy-Tchéou under *M. Esquirolii* belong to *Cleidion brevipetiolatum* Pax & Hoffm. Esquirol no. 902 I have not seen; it could not be located in the Léveillé herbarium.

Macaranga Esquirolii (Lévl.), comb. nov.

Morinda Esquirolii Léveillé, Fl. Kouy-Tchéou, 368 (1915). — **Synon. nov.**

CHINA. Kweichou: bois de Ta-ram, *J. Esquirol,* no. 3735, Aug. 1912 (holotype; photo. in A. A.).

This species is closely related to *M. bracteata* Merr., but differs in the elliptic-oblong to ovate-lanceolate leaves with the greatest diameter in the middle, gradually narrowed into a long caudate acumen, 3-nerved at base, entire or minutely and sparingly mucronate denticulate, the glands of the underside pale, not dark, and the midrib and petiole puberulous, not pilose.

Tragia Mairei (Lévl.), comb. nov.

Alchornea Mairei Léveillé, Cat. Pl. Yun-Nan, 94 (1916).

Traga involucrata sensu Handel-Mazzetti, Symb. Sin. **7**: 218 (1931), quoad synon. — Rehder in Jour. Arnold Arb. **14**: 234 (1933), quoad synon. — Non Linnaeus.

CHINA. Yunnan: vallon de You-fong-keou, alt. 800 m., *E. E. Maire,* July 1913, "Urtica vivace grimpante, fl. vertes" (holotype of *Alchornea Mairei;* photo. in A. A.).

When I identified *Alchornea Mairei* with *Traga involucrata,* following Handel-Mazzetti, I had only a photograph of the type specimen. I now have before me the original specimen kindly sent me on loan from Edinburgh, and find that on account of its entire sepals, it is quite different from *T. involucrata* L. It is very near *T. anisosepala* Merrill & Chun (in Sunyatsenia, **2**: 261, pl. 62. 1935), from which it differs chiefly in the smaller ovate leaves occasionally with two small lateral lobes below the middle, and it may not be specifically distinct. Merrill and Chun place their species with the Sect. TAGIRA subsect. HOLOCALYX Pax & Hoffm., but on account of the sessile anthers, it seems to fit better into the Sect. AGIRTA Baill. In the unequal sepals of the pistillate flower, however, *T. Mairei* and *T. anisosepala* differ from both sections which moreover, are restricted to Africa and Madagascar.

BUXACEAE[1]

Buxus megistophylla Léveillé. — Gagnepain in Lecomte, Fl. Gén. Indo-Chine, **5:** 661 (1927). — Rehder in Jour. Arnold Arb. **14:** 236 (1933).

In 1933, when taking up *B. megistophylla* as a distinct species, I overlooked the fact that Gagnepain (l. c.) had already recognized this species by including it in his key of the species of *Buxus*.

Buxus Myrica Léveillé. — Gagnepain in Lecomte, Fl. Gén. Indo-Chine, **5:** 662 (1927). — Rehder in Jour. Arnold Arb. **14:** 236 (1933).

When publishing a full Latin description of this species in 1933, I was not aware that Gagnepain (l. c.) had already given a detailed description, and also described a new variety, var. *angustifolia,* from Indochina and Kweichou; to that variety apparently belongs Bodinier no. 2266.

AQUIFOLIACEAE[2]

Ilex purpurea Hasskarl. — Rehder in Jour. Arnold Arb. **14:** 239 (1933).

Symplocos Courtoisii Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, **12:** 562 (Cat. Pl. Kiang-Sou, 22) (1916). — **Synon. nov.**

CHINA. Kiangsu: without locality, *Ch. d'Argy* [1844–66] (holotype of *Symplocos Courtoisii;* photo. in A. A.).

The specimen cited above is in fruit; the specimens representing the synonyms cited in 1933 are in flower and are all from Kweichou.

Ilex macrocarpa Oliver. — Rehder in Jour. Arnold Arb. **14:** 242 (1933). — Handel-Mazzetti, Symb. Sin. **7:** 659 (1933).

Handel-Mazzetti cites *Diospyros Bodinieri* Lévl. as a synonym.

CELASTRACEAE[3]

Evonymus centidens Léveillé. — Rehder in Jour. Arnold Arb. **14:** 244 (1933). — Handel-Mazzetti, Symb. Sin. **7:** 661 (1933).

Handel-Mazzetti cites a specimen from western Szechuan (Faber, Mt. Omei, in 1887, as *E. Thunbergiana* var. *oblongifolia*).

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[1] See Vol. **14:** 235.

[2] See Vol. **14:** 239.

[3] See Vol. **14:** 242; **15:** 1.

Microtropis fokienensis Dunn in Jour. Linn. Soc. Bot. **38:** 357 (1908).

Myrsine Chaffanjoni Léveillé, Fl. Kouy-Tchéou, 287 (1914). — **Synon. nov.**

CHINA. Kweichou: environs de Kouy-yang, mont du Collège, *J. Chaffanjon* in herb. *Bodinier,* no. 2048, Jan.–Feb. 1898 "grand arbuste, presque un arbre, fleurs verdâtres-jaunâtres" (holotype of *Myrsine Chaffanjoni;* photo. in A. A.).

In Chaffanjon's specimen, some inflorescences are borne at the apex of short axillary branchlets and have the appearance of pedunculate inflorescences which would make the specimen referable to var. *longipedunculata* Cheng, but in reality, these inflorescences are subsessile like the others on the same branch. It may be mentioned here that the var. *longipedunculata* has also been collected in Hainan (C. Wang, 35276, 35652 and 36559) and in Kwangsi (W. T. Tsang, 22639). The type is also known from Yunnan (Rock, 7536), from Kwangsi (W. T. Tsang 22791) and from Hainan (Chun & Tso 44040), the latter somewhat intermediate.

Trypterygium hypoglaucum (Lévl.) Hutchinson. — Rehder in Jour. Arnold Arb. **14:** 252 (1933); **15:** 1 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 665 (1933).

Handel-Mazzetti cites *Aspidopterys hypoglauca* Lévl. as a synonym.

ACERACEAE[1]

Acer Buergerianum Miq. var. **formosanum** (Hay. ex Koidz.), comb. nov.

Acer trifidum Hook. & Arn. var. *formosanum* Hayata ex Léveillé in Bull. Soc. Bot. France, **53:** 593 (1906), nom. nud. — Koidzumi in Jour. Coll. Sci. Tokyo, **32** art. 1: 30 (1911). — Hayata, Ic. Pl. Formos. **1:** 156 (1911).

FORMOSA: Kelung, in rupibus secus mare, *U. Faurie,* no. 65, June 15, 1903 (holotype of *A. trifidum* var. *formosanum;* photo. in A. A.).

This variety differs from the type in the very short obtuse or obtusish lobes of the leaves, mostly broader than high, the middle lobe 1–1.5 cm. long and about 2 cm. broad, the upper side of the lateral lobes diverging horizontally from the middle lobe and forming a right angle with the outer margin, and in the diverging wings of the fruit. Neither Hayata nor Léveillé give a description; Koidzumi's publication apparently precedes Hayata's since the latter cites Koidzumi though incorrectly, but

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[1] See Vol. **15:** 4.

Koidzumi's publication is dated Nov. 20, 1911, while Hayata's is dated Sept. 15, 1911.

SAPINDACEAE[1]

Handeliodendron Bodinieri (Lévl.) Rehder in Jour. Arnold Arb. **16:** 66, fig. 1, pl. 119 (1935).

Sideroxylon Bodinieri Léveillé, Fl. Kouy-Tchéou, 384 (1915).

CHINA. Kweichou: district de Ly-po, *J. Cavalerie* in herb. *Bodinier,* no. 2626, Sept. 1898 (fruit), May 11, 1899, "grand arbre" (holotype of *Sideroxylon Bodinieri;* photo. in A. A.).

This species has been collected in Kweichou also by Y. Tsiang (no. 6813).

Eurycorymbus Cavaleriei (Lévl.) Rehder & Handel-Mazzetti in Jour. Arnold Arb. **15:** 8 (1934); in Bot. Centrbl. Beih. **52B:** 166 (Pl. Mell. Sin.) (1934). — Radlkofer in Engler, Pflanzenr. IV. **165:** 1505 (Sapind.) (1934).

Eurycorymbus austrosinensis Handel-Mazzetti. — Hu in Bull. Fan Mem. Inst. Biol. **1:** 38 (1929). — Merrill in Lingnan Sci. Jour. **7:** 313 (1931). — Handel-Mazzetti, Symb. Sin. **7:** 638 (1933). — Radlkofer in Engler, Pflanzenr. IV. **165:** 1432 (Sapind.) (1933).

In 1934 (in Jour. Arnold Arb. **15:** 9) I gave a description of the staminate flowers based on Kanehira no. 14225. The year before Yamamoto had published (in Jour. Soc. Trop. Agr. Taiwan, **5:** 182) a complete description including staminate and pistillate flowers, but the description was apparently based on sapindaceous material other than *Eurycorymbus.* I have seen none of the material cited by Yamamoto and do not know to which plant his descripton really applies.

SABIACEAE[2]

Meliosma Oldhamii Miquel in Ann. Mus. Bot. Lugd.-Bat. **3:** 94 (Prol. Fl. Jap. 258) (1867). — Rehder & Wilson in Sargent, Pl. Wilson. **2:** 206 (1914). — Rehder in Jour. Arnold Arb. **15:** 10 (1934).

Fraxinus Fauriei Léveillé in Fedde, Rep. Spec. Nov. **8:** 285 (1910). — **Synon. nov.**

KOREA. Quelpaert: circa pagos, *U. Faurie,* no. 1867, Aug. 1907 (holotype of *Fraxinus Fauriei;* isotype in A. A.).

Faurie's no. 1867, labeled "Fraxinus" was identified by E. H. Wilson and the writer in 1914 (l. c.) with *Meliosma Oldhami,* without being aware that Léveillé had described this number four years earlier as *Fraxinus Fauriei.*

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[1] See Vol. **15:** 8.

[2] See Vol. **15:** 9.

Meliosma cuneifolia Franchet in Nouv. Arch. Mus. Paris, sèr. 2, **8**: 211 (Pl. David. **2**: 29) (1886). — P'ei in Mem. Sci. Soc. China, **1**, no. **3**: 90 (Verben. China) (1932).

Premna Mairei Léveillé, Sert. Yunnan. 3 (1916); Cat. Pl. Yun-Nan, 298 (1917).

CHINA. Yunnan: fôret de Long-ky, 700 m., *E. E. Maire*, June 1912 (holotype of *Premna Mairei;* photo. in A. A.).

The identification by the writer of *Premna Mairei* with *Meliosma cuneifolia* was recorded in 1932 by P'ei (l. c.).

RHAMNACEAE[1]

Zizyphus pubinervis, nom. nov.

Strychnos Esquirolii Léveillé, Fl. Kouy-Tchéou, 262 (1914). — **Synon. nov.**

CHINA. Kweichou: chemin de Pett-tiang, *J. Esquirol*, no. 3737, June 1912 (holotype of *Strychnos Esquirolii;* photo. in A. A.).

As Léveillé's description is inadequate and misleading, the species may be here briefly redescribed, as far as the incomplete material permits:

Arbor vel frutex ramis gracilibus inermibus; folia chartacea, oblongo-lanceolata, 5–9 cm. longa et 2–3 cm. lata, satis longe et sensim acuminata, basi valde obliqua, uno latere cuneata, altero subrotundata, usque ad apicem minute serrulata, supra glabra, subtus pallidiora et ad costam et nervos laterales praecipue basim versus pilosa vel puberula, ceterum glabra, trinervia nervis supra impressis subtus prominentibus, nervis trabecularibus supra obsoletis subtus leviter elevatis et satis distantibus; petioli 2–4 mm. longi, pilosuli. Flores desunt. Fructus nondum perfecte maturi secus ramulos ultimos racemose dispositi, axillares, plerumque solitarii vel rarius 2–4 in cyma umbelliformi brevissime pedunculata, pedicellis 3–4 mm. longis pilosulis; drupa subgloboso-ovoidea, leviter compressa, 10–11 mm. longa et 9–10 mm. lata, apice mucronata, exocarpio ruguloso, monosperma.

This species is similar to *Z. inermis* Merr. of the Philippine Islands, which differs chiefly in the larger glabrous and entire subcoriaceous leaves cuneate and less oblique at the base and in the somewhat larger not compressed fruit. Léveillé described his species as having a large inflorescence composed of long racemes; he evidently mistook the slender lateral branchlets bearing axillary fruits for parts of a paniculate inflorescence. Since there is already a *Zizyphus Esquirolii* Lévl. which is *Hovenia dulcis* Thunb. (see Jour. Arnold Arb. **15**: 17. 1934) Léveillé's

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[1] See Vol. **15**: 10.

specific epithet cannot be transferred to *Zizyphus* and the species may be called *Z. pubinervis* on account of the pilose or puberulous veins of the underside of the leaves.

Rhamnella Martini (Lévl.) Schneider. — Rehder in Jour. Arnold Arb. **15:** 11 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 673 (1933). — Chun in Sunyatsenia, **2:** 74 (1934).

Rhamnus Martini Léveillé.

According to Chun (l. c.) the species has been collected also in Kwangtung (S. P. Ko 52815).

Rhamnella rubrinervis (Lévl.) Rehder in Jour. Arnold Arb. **15:** 12 (1934). — Merrill & Chun in Sunyatsenia, **2:** 39 (1934).

Embelia rubrinervis Léveillé.

Rhamnus Esquirolii Léveillé. — Rehder in Jour. Arnold Arb. **15:** 14 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 675 (1933).

This species was collected in Kweichou also by Handel-Mazzetti (nos. 10600, 10650, 10747), by Steward & Cheo (nos. 61, 116, 510) and by Y. Tsiang (no. 5289).

Rhamnus Bodinieri Léveillé. — Rehder in Jour. Arnold Arb. **15:** 15 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 676 (1933).

This species was collected in Kweichou also by Handel-Mazzetti (no. 10365).

Rhamnus Leveilleanus Fedde. — Rehder in Jour. Arnold Arb. **15:** 17 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 676 (1933).

Rhamnus Cavaleriei Léveillé (1911, non 1910).

This species was collected in Kweichou also by Handel-Mazzetti (nos. 10110, 10260).

VITACEAE[1]

Tetrastigma obtectum (Wall.) Planch. var. β **glabrum** Gagnepain. — Rehder in Jour. Arnold Arb. **15:** 21 (1934).

Vitis Potentilla var. *glabra* Léveillé.

China. Kweichou: change line 7 of p. 21 to: *Cavalerie,* no. 1331 (May 1902), no. 1332 (June 4 and Oct. 1902), no. 3253 (Nov. 1907, May 1908).

Ampelopsis Delavayana var. **Gentiliana** (Lévl. & Vant.) Handel-Mazzetti, Symb. Sin. **7:** 682 (1933). — Rehder in Jour. Arnold Arb. **15:** 24 (1934). — Chun in Sunyatsenia, **2:** 75 (1934).

Vitis Gentiliana Léveillé & Vaniot.

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[1] See Vol. **15:** 18.

When I published this name as a new combinaton, I was not aware of Handel-Mazzetti's earlier publication of the same combination.

Ampelopsis Chaffanjoni (Lévl.) Rehder in Jour. Arnold Arb. **15:** 25 (1934). — Handel-Mazzetti in Bot. Centralbl. Beih. **52**B: 170 (1934).

Vitis Chaffanjoni Léveillé.

Ampelopsis aconitifolia Bunge in Mém. Sav. Ètr. Acad. Sci. St. Pétersb. **2:** 86 (Enum. Pl. Chin. Bor. 12) (1833).

Vitis heterophylla Thunb. var. *aconitifolia* Léveillé & Vaniot in Bull. Soc. Agr. Sci. Art. Sarthe, **40:** 39 (1905), nom. nud.

CHINA. Hopei: Pekin, au cimetière à Cha-la-Eul, et à Tchen-fou-sé, *E. Bodinier,* no. 203, June 1889 (specimen in herb. Léveillé).

Cayratia oligocarpa (Lévl. & Vant.) Gagnepain. — Rehder in Jour. Arnold Arb. **15:** 26 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 683 (1933).

Vitis oligocarpa Léveillé & Vaniot.

TILIACEAE[1]

Burretiodendron Esquirolii (Lévl.) Rehder in Jour. Arnold Arb. **17:** 48, pl. 178 (1936).

Pentace Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **10:** 147 (1911); Fl. Kouy-Tchéou, 419 (1915). — Burret in Notizbl. Bot. Gard. Mus. Berlin-Dahlem, **9:** 620 (1926).

Eriolaena Esquirolii Léveillé, Fl. Kouy-Tchéou, 405 (1915).

CHINA. Kweichou: ouest de Lo-fou (Kouai-kou), *J. Cavalerie,* no. 2648, Nov. 1905, "arbre moyen, moucilagineux" (holotype of *Pentace Esquirolii;* photo. in A. A.); same locality, *J. Esquirol,* no. 817 (cited in Fl. Kouy-Tchéou under *P. Esquirolii*): Yang-ly, *J. Esquirol,* no. 2717, Aug. 1911, "arbre 8–10 m., fleur blanche" (holotype of *E. Esquirolii,* also cited in Fl. Kouy-Tchéou under *P. Esquirolii;* photo. in A. A.).

Léveillé cites in Flore du Kouy-Tchéou Esquirol no. 2717 as the type of *Eriolaena Esquirolii* (p. 405) and again under *Pentace Esquirolii* (p. 419); the specimen itself bears no name whatever in Léveillé's handwriting. The species has been collected in Kweichou also by Y. Tsiang (no. 7290) and in Yunnan by A. Henry (nos. 9572 and 9573).

Grewia Feddei (Lévl.) Burret in Notizbl. Bot. Gart. Mus. Berlin-Dahlem, **9:** 678 (1926).

Celastrus Feddei Léveillé in Fedde, Rep. Spec. Nov. **13:** 263 (1914), excl. Esquirol, no. 3189.

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[1] See Vol. **15:** 92.

Grewia spec. Loesener in Ber. Deutsch. Bot. Ges. **32**: 543 (1914).
Grewia glabrescens Benth. ex Léveillé, Fl. Kouy-Tchéou, 419 (1915), quoad syn. *Celastrus euonymoidea.*
Celastrus euonymoidea Léveillé, l. c. (1915), pro synon. *G. glabrescentis.*
Grewia parviflora var. *glabrescens* (Benth.) Rehder & Wilson in Sargent, Pl. Wilson. **2**: 371 (1915), quoad synon. *Celastrus euonymoidea* Lévl.
Grewia biloba G. Don. — Rehder in Jour. Arnold Arb. **15**: 92 (1934), quoad synon. *Celastrus euonymoidea* Lévl.

CHINA. Kweichou: Lo-fou, *J. Cavalerie,* no. 3513, Apr. 1909, "arb. 2 m." (syntype of *Celastrus Feddei;* photo. in A. A.).

Neither of the two syntypes bears the name of *Celastrus Feddei;* Cavalerie, no. 3513, is labeled *C. euonymoideus* and Esquirol no. 3189 bears no name except *Euonymus* crossed out; the former also has an identification label "Grewia ex Schlechter."

Burret (l. c.) places *Grewia Feddei* near *C. glabra* Bl. (*G. laevigata* Auct., nec Vahl) from which it is chiefly distinguished by the scattered stellate hairs on both sides of the leaves and the less long and slender acuminate apex. From *G. biloba* G. Don it may be distinguished by the oblong, more finely serrate and only slightly stellate-pubescent leaves and by the peduncles being at least twice as long as the petioles.

As Burret mentions in his discussion of *G. Feddei* only Cavalerie no. 3513 from Lo-fou of which he saw but fragmentary material, it is apparent that his species does not include the second syntype which is identical with *G. Henryi* Burret.

Grewia Henryi Burret in Notizbl. Bot. Gart. Mus. Berlin, **9**: 674 (1926).

Celastrus Feddei Léveillé in Fedde, Rep. Spec. Nov. **13**: 263 (1914) quoad specim. Esquirol, no. 3189. — **Synon. nov.**
Grewia glabrescens Benth. ex Léveillé, Fl. Kouy-Tchéou, 419 (1915), quoad synon. *G. Esquirolii.*
Grewia Esquirolii Léveillé, Fl. Kouy-Tchéou, 419 (1915), pro synon. praecedentis.
Grewia parviflora var. *glabrescens* Rehder & Wilson in Sargent, Pl. Wilson. **2**: 371 (1915), quoad syn. *Grewia Esquirolii.*
Grewia biloba G. Don. — Rehder in Jour. Arnold Arb. **15**: 92 (1934), quoad synon., *G. Esquirolii.*

CHINA. Kweichou: Goui-reou, *J. Esquirol,* no. 3189, Dec. 1911 (syntype of *Celastrus Feddei;* photo. in A. A.); Lo-fou, *J. Esquirol,* no. 2204, Sept. 1910, and *J. Cavalerie,* no. 3492, Aug. 1909 (cited under *G. glabrescens* in Fl. Kouy-Tchéou; photos. in A. A.).

The second syntype of *Celastrus Feddei*, Esquirol no. 3189, bears no name on its label except *Euonymus* crossed out, but as the first syntype is labeled *C. euonymoideus*, the name *Grewia Esquirolii* must belong to the second syntype which differs from the first syntype in the rather densely stellate pubescent underside of the leaves and is apparently referable to *G. Henryi*. It is easily distinguished from *G. biloba* by the oblong leaves, the longer peduncles with usually only two or three long pedicels. It is more closely related to *G. Feddei* (Lévl.) Burret which chiefly differs in the leaves being only sparingly stellate-pubescent beneath, the hairs spaced and with shorter appressed rays about 0.25 mm. long (not more or less upright-spreading and about 0.5 mm. long), in the appressed setose petiole and midrib beneath, and in the less acuminate leaves.

STERCULIACEAE[1]

Paradombeya sinensis Dunn in Hooker's Ic. Pl. **28**: t.2743B (1902).

Lysimachia Mairei Léveillé in Bull. Géog. Bot. **25**: 44 (1915); Cat. Pl. Yun-Nan, 211 (1917). — **Synon. nov.**

Clematoclethra sp. Handel-Mazzetti in Not. Bot. Gard. Edinb. **16**: 122 (1928).

CHINA. Yunnan: rochers, rives du fleuve Bleu, à Kiang-pien, 350 m., *E. E. Maire*, Aug. 1912, "arbuste buissonant, fl. jaunes" (holotype of *Lysimachia Mairei*; photo. in A. A.).

I have not seen the type specimen of *P. sinensis*, but E. E. Maire's specimen agrees well with Dunn's description and plate. The same species has also been collected in Ping-shan-hsien, Szechuan, by T. T. Yü (no. 4152).

DILLENIACEAE[2]

Actinidia eriantha Bentham in Jour. Linn. Soc. **5**: 55 (1861). — Chun in Sunyatsenia, **1**: 273 (1934).

Actinidia lanata Hemsley in Ann. Bot. **9**: 146 (1895). — Rehder in Jour. Arnold Arb. **15**: 97 (1934).

Ficus hirtaeformis Léveillé & Vaniot.

Mespilus Esquirolii Léveillé.

Chun (l. c.) considers *A. lanata* Hemsl. a distinct species, but none of the distinguishing characters given by him and other authors seem to be dependable. Also *A. Davidii* Franch. belongs here according to Handel-Mazzetti (Symb. Sin. **7**: 391).

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[1] See Vol. **15**: 95.

[2] See Vol. **15**: 96.

THEACEAE[1]

Camellia[2] **Costei** Léveillé.

Thea Costei (Lévl.) Rehder in Jour. Arnold Arb. **15**: 98 (1934).
Thea sinensis Seem. var. *androxantha* Léveillé.

Camellia Grijsii Hance in Jour. Bot. **17**: 9 (1879).

Thea Grijsii (Hance) Kochs. — Rehder, l. c. (1934).
Thea Cavaleriana Léveillé.

Camellia Pitardii Cohen Stuart in Mededeel. Proefstat. Thee Buitenzorg **40**: 68 (1916); in Bull. Jard. Bot. Buitenzorg, ser. 3, **1**: 240 (1919).

Camellia japonica "L." sensu Léveillé; non Linnaeus.
Thea Pitardii (Stuart) Rehder. — Rehder in Jour. Arnold Arb. **15**: 98 (1934), excl. synon. *Thea Mairei.*

Camellia Pitardii Cohen Stuart var. **lucidissima** (Lévl.), comb. nov.

Thea Camellia var. *lucidissima* Léveillé.
Thea Pitardii (Stuart) Rehd. var. *lucidissima* (Lévl.) Rehder, l. c. (1934).

Camellia Mairei (Lévl.) Melchior in Engler & Prantl, Pflanzenfam. ed. 2, **21**: 129 (1925).

Thea Mairei Léveillé, Sert. Yunnan, 2 (1916); Cat. Pl. Yun-Nan, 271 (1917).
Thea Pitardii Rehder in Jour. Arnold Arb. **15**: 98 (1934), pro parte, quoad syn. *Thea Mairei,* non (Cohen Stuart) Rehder (1924).

Melchior (l. c.) places *C. Mairei* into the Sect. ERIANDRIA together with *C. caudata* Wall., *C. assimilis* Champ. and *C. gracilis.* It is evident that Melchior could not have seen the type specimen and has relied solely on Léveillé's description of the stamens as being densely villous, for *C. Mairei* belongs to the Sect. EUCAMELLIA and is very similar to *C. Pitardii* (C. Stuart) Rehd. but differs strikingly in its pubescent filaments, a character found in no other species of the genus except in the species of the Sect. ERIANDRIA.

Camellia oleosa (Lour.), comb. nov.

Thea oleosa Loureiro, Fl. Cochinch. 339 (1790); ed. Willd. 414 (1793). — Rehder in Jour. Arnold Arb. **15**: 98 (1934). — Merrill in Trans. Am. Phil. Soc., n. ser., **24**: 266 (Comm. Lour. Fl. Cochinch.) (1935).
Camellia drupifera Loureiro, Fl. Cochinch. 411 (1790); ed. Willd. 499 (1793).
Thea podogyna Léveillé.

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[1] See Vol. **15**: 98.

[2] Since according to Art. D. 20. of the International Rules of Nomenclature which was accepted at Amsterdam, the two volumes of Linnaeus, Species plantarum are considered of the same date, the name *Camellia* becomes the valid name according to article 56 and the correct combinations under *Camellia* are given here of the species cited in 1934 under *Thea.*

As Merrill is apparently the first author who united *Thea oleosa* Lour. and *Camellia drupifera* Lour. published simultaneously as distinct species by Loureiro, and as he in doing so adopted *Thea oleosa* and cited *Camellia drupifera* as a synonym, *Camellia oleosa* will be the correct name under *Camellia*.

Gordonia axillaris (Ker) Szyszylowicz in Engler & Prantl, Nat. Pflanzenfam. III. **6:** 185 (1893).

CHINA. Yunnan: brousse de Tchen-feng-chan, alt. 750, *E. E. Maire*, Aug. [1912–14?].

The specimen cited above was described by Léveillé in the manuscript publication China Rev. Ann. 1916, p. 6, as a new species of *Castanopsis*.

GUTTIFERAE[1]

Hypericum erectum Thunberg, Fl. Jap. 295 (1784). — Léveillé in Bull. Soc. Bot. France, **53:** 500 (1906).

Hypericum erectum var. *axillare* Léveillé, l. c. (1906).
Hypericum Vanioti Léveillé, l. c. (1906), excl. Faurie 5508.
Hypericum Matsumurae Léveillé, l. c. 501 (1906).

JAPAN. Hondo: *U. Faurie*, no. 4, July 1900, nos. 10 and 11 in 1904, no. 12 in 1905, nos. 14, 15 in 1905, no. 1350, Sept. 24, 1898, no. 5038, Aug. 1902 (syntypes of *H. Vanioti*). Hokkaido: Shakotan, *U. Faurie*, no. 1, Sept. 1904 (holotype of *H. Matsumurae*); without special locality, *U. Faurie*, no. 6, July 1905 (holotype of *H. erectum* var. *axillare;* ex Léveillé).

Hypericum erectum is a very variable species and G. Koidzumi who examined and attached identification labels to the specimens cited above, distinguished besides the typical form (Faurie nos. 4, 10, 11, 12) the following varieties: *H. erectum* var. *axillare* Lévl. (Faurie 6159), var. *obtusifolium* Bl. (Faurie, nos. 1, 1350), var. *thyrsoideum* Bl. (Faurie, nos. 14, 15); Faurie 3058 is named *H. vulcanicum* Koidz.?" which is a synonym of *H. erectum* f. *Fauriei* R. Keller.

Of the several syntypes of *H. Vanioti*, only Faurie no. 10 bears the name *H. Vanioti* in Léveillé's handwriting. On the holotype of *H. Matsumurae*, Faurie no. 1, no name appears.

Hypericum otaruense R. Keller in Bull. Herb. Boiss. **5:** 641 (1897). — Léveillé in Bull. Soc. Bot. France, **53:** 502 (1906).

Hypericum Dielsii Léveillé, l. c. 499 (1906).
Hypericum Vanioti Léveillé, l. c. 501 (1906), quoad specim. Faurie no. 5508.

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[1] See Vol. **15:** 100.

JAPAN. Hokkaido: Junsainuma, *U. Faurie*, no. 5508, Aug. 1903 (syntype of *H. Vanioti*); without precise locality, *U. Faurie*, no. 7, July 1905 (holotype of *H. Dielsii*).

Both specimens cited above have been determined by Koidzumi as *H. otaruense* which is near *H. erectum*, but seems to differ chiefly in the deeply cordate base of the leaves gradually narrowed toward the obtuse apex.

Hypericum napaulense Choisy in DeCandolle, Prodr. **1**: 552 (1924). — Handel-Mazzetti, Symb. Sin. **7**: 402 (1931).

Hypericum Bodinieri Léveillé in Bull. Soc. Agr. Sci. Sarthe, **39**: 322 (1904); Fl. Kouy-Tchéou, 198 (1914); Cat. Pl. Yun-Nan, 133 (1916).

CHINA. Kweichou: Lo-fou, Pin-fa, rare, *J. Cavalerie*, no. 2768, Apr. 1906, "fl. jaunes" (syntype of *H. Bodinieri*). Yunnan: frontière du Kouy-Tchéou, à Kian-ty, bord du fleuve, rive du Yunnan, *E. Bodinier*, no. 1517, Apr. 9, 1897, "fleurs jaunes" (syntype of *H. Bodinieri;* photo. in A. A.).

Hypericum Bodinieri was identified by Handel-Mazzetti with *H. napaulense* from an isotype of Bodinier's specimen. The plant sends up simple slender herbaceous stems from a subligneous creeping rootstock. The oval to oval-oblong obtuse leaves are about 1.5 cm. long and closely glandular-ciliate, at the clasping base they are densely setose-glandular with some of the setae up to 1.5 mm. long. The plant may represent a distinct variety of *H. napaulense;* in the Himalayan specimens I have seen, the leaves were only slightly and sometimes not at all glandular-ciliate.

PASSIFLORACEAE

Passiflora Seguini Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **17**: 174 (1902). — Handel-Mazzetti, Symb. Sin. **7**: 384 (1931).

Passiflora cupiformis Mast. ex Léveillé, Fl. Kouy-Tchéou, 312 (1915), quoad syn. *P. Seguini;* non Masters (1888).

CHINA. Kweichou: cascade de Hoang-ko-chou, sur les rochers, *J. Seguin*, no. 2350, June 11, 1898, "liane herbacée, fleurs blanches" (holotype; photo. in A. A.).

In 1915, Léveillé reduced this species to a synonym of *P. cupiformis;* Handel-Mazzetti (l. c.) keeps it as a distinct species but says that it is distinguished only by the horned sepals. Also the lobes of the leaves are much longer than in the type of *P. cupiformis,* being as long or longer than the undivided portion of the limb and ovate to nearly lanceolate.

THYMELAEACEAE[1]

Daphne Feddei Léveillé. — Rehder in Jour. Arnold Arb. **15:** 105 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 588 (1933).

Handel-Mazzetti does not cite *D. Martini* Lévl. as a synonym.

ELAEAGNACEAE

Elaeagnus umbellata Thunberg, Fl. Jap. 66, t. 44 (1784).

Elaeagnus Argyi Léveillé in Fedde, Rep. Spec. Nov. **12:** 101 (1913); in Mem. Acad. Ci. Art. Barcelona, ser. 3, **12:** 550 (Cat. Pl. Kiang-Sou, 10) (1916).

Elaeagnus coreanus Léveillé in Fedde, Rep. Spec. Nov. **12:** 101 (1913).

Elaeagnus umbellata var. *coreana* (Lévl.) Léveillé, Cat. Pl. Yun-Nan, 83 (1916).

Elaeagnus crispa Thunb. var. *parvifolia* (Royle) Nakai, Fl. Sylv. Kor. **17:** 11 (1928).

KOREA. Quelpaert: Fusan, *U. Faurie*, no. 986 in 1906; no. 2009 in 1907, *E. Taquet*, nos. 1359–1362, 3187–3190, 5936, 5937 in 1908–1911 (in herb. Léveillé, sub *E. coreanus;* syntypes; isotypes of Faurie's nos. 1359–1362, 3187–3190 and of Taquet no. 2009 in A. A.).

CHINA. Kiangsu: Zuo-se; Pou-si; montagnes, *Ch. d'Argy* [1844–66] (holotype of *E. Argyi;* isotype in A. A.). Yunnan: haies de la plaine à Tong-tchouan, alt. 2500 m., *E. E. Maire*, Apr. [1912–14] (in herb. Léveillé sub *E. coreanus;* duplicate in A. A.).

The Korean specimens have the leaves mostly elliptic oblong and not exceeding 4 cm. in length. The different branches under *E. Argyi* vary greatly in size and shape of leaves, from oblong and 3 × 1 cm. long to elliptic and 8 cm. long and nearly 5 cm. wide. Specimens with leaves of similar size and shape are Herb. Univ. Nanking, nos. 582 and 14479 (C. Y. Chiao). The Yunnan specimen does not differ from the Korean specimens.

Léveillé does not cite any numbers with the description of *E. coreanus* and none of the specimens in his herbarium are labeled *E. coreanus*, but all the specimens from Korea cited above, are in the Léveillé herbarium in covers labeled *E. coreanus*.

NYSSACEAE[2]

Camptotheca acuminata Decaisne in Bull. Soc. Bot. France, **20:** 157 (1873).

Cephalanthus Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **13:** 176 (1914); Fl. Kouy-Tchéou, 365 (1915).

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[1] See Vol. **15:** 103.

[2] See Vol. **15:** 107.

China. Kweichou: bois, route de Pin-fa à Tou-yun, ça et la, *J. Cavalerie*, no. 2963, Aug. 1908 (holotype; isotype in A. A.).

The species is represented in this herbarium from Kweichou also by Y. Tsiang no. 6286.

MELASTOMACEAE[1]

Sarcopyramis napalensis Wallich, Tent. Fl. Napal. 32, t. 23 (1826). — Guillaumin in Bull. Soc. Bot. France, **60**: 343 (1913).

Sarcopyramis Bodinieri Léveillé & Vaniot in Mem. Soc. Nat. Sci. Nat. Cherbourg, **35**: 397 (1906); in Fedde, Rep. Spec. Nov. **4**: 95 (1907).

Sarcopyramis nepalensis var. *Bodinieri* (Lévl. & Vant.) Léveillé, Fl. Kouy-Tchéou, 278 (1914).

China. Kweichou: environs de Kouy-yang, bois de Kien-lin-chan, talus moussus, *E. Bodinier*, no. 2393, July 7, 1898, "jolies fleurs roses" (holotype of *S. Bodinieri*; photo. in A. A.); environs de Tou-chan, *J. Cavalerie* in herb. Bodinier, no. 2674, July 1899; Pin-fa, *J. Cavalerie*, nos. 47, 249, July 15 and June 28, 1902 (cited in Fl. Kouy-Tchéou under *Sarcopyramis nepalensis* var. *Bodinieri*).

Guillaumin (l. c.) refers *S. Bodinieri* to *S. napalensis* as a smaller and weaker form with small leaves. Probably on the strength of Guillaumin's remarks, Léveillé reduced his species in 1914 to a variety of *S. napalensis*. The type sheet of *S. Bodinieri* contains four specimens with small more or less colored leaves and above a specimen with larger green leaves, and bears besides the identification label of Guillaumin, also a note by Diels stating that only the smaller specimens below agree with Léveillé's description, while the upper specimen is *S. nepalensis*. The other collections cited in Flore du Kouy-Tchéou are partly intermediate between the two forms.

Phyllagathis Cavaleriei (Lévl. & Vant.) Guillaumin in Not. Syst. Paris, **2**: 325 (1913); in Bull. Soc. Bot. France, **60**: 273 (1913). — Rehder in Jour. Arnold Arb. **14**: 113 (1934). — Handel-Mazzetti in Beih. Bot. Centrbl. **52B**: 163 (Pl. Mell. Sin.) (1934).

Handel-Mazzetti (l. c.) records this species from Kwangtung (Mell 390, 637).

ARALIACEAE[2]

Dendropanax morbiferus Léveillé in Fedde, Rep. Spec. Nov. **8**: 263 (1910), *"D. morbiferum."*

Gilibertia morbifera (Lévl.) Nakai in Jour. Arnold Arb. **5**: 22 (1924).

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[1] See Vol. **15**: 109.

[2] See Vol. **15**: 113.

Textoria morbifera (Lévl.) Nakai, Fl. Sylv. Kor. **16**: 41, t. 12, 13 (1927).

KOREA. Quelpaert: secus torrentes, *U. Faurie,* no. 547, Oct. 1906, "arbre qui donne la gale;" circa Hongno, *U. Faurie,* no. 1663, July 1907; in sylvis, *E. Taquet,* nos. 895, 896, Sept. 4 and 2, 1908, "l'attouchement de l'arbre provoque des eruptions; sa sève donne un bon vernis;" *E. Taquet,* no. 183 (syntypes of *Dendropanax morbiferum;* isotypes of Faurie 547 and 1663 and photo. of 547, isotypes of Taquet 895 and 896 and photo. of 895 in A. A.; Taquet 183 not seen).

This species is very close to the Japanese *D. trifidus* (Thunb.) Makino and seems to differ chiefly in the smaller ellipsoid fruit (8 × 6 mm.) subglobose and larger (10 × 9) in *D. trifidus,* in the shorter pedicels (4–6 mm.), 8–10 mm. in *D. trifidus.* According to Nakai (1924, l. c.) the Korean species yields a yellow lacquer much used in Korea, while the Japanese species contains a colorless resin. The leaves are almost indistinguishable, but in the Japanese species they seem to be more distinctly and more abruptly acuminate and more frequently lobed with the lobes distinctly acuminate.

The generic name *Gilibertia* is invalidated by the older homonym *Gilibertia* J. G. Gmelin (1791), and *Dendropanax* Dcne. & Planch. has to take its place for the American and Asiatic species, but Nakai (1927, l. c.) revives *Textoria* Miq. for the species of Eastern Asia, distinguished from the American species chiefly by the inflorescence consisting of a simple umbel.

CLETHRACEAE[1]

Clethra Bodinieri Léveillé. — Handel-Mazzetti in Sinensia, **5**: 3 (Aug. 1934). — Rehder in Jour. Arnold Arb. **15**: 267 (Oct. 1934).

Handel-Mazzetti (l. c.) refers to this species also R. C. Ching, nos. 5734 and 5804 from Kwangsi.

Clethra Cavaleriei Léveillé. — Rehder in Jour. Arnold Arb. **15**: 267 (1934). — Handel-Mazzetti, Symb. Sin. **7**: 760 (1936).

Handel-Mazzetti (l. c.) records this species also from Hunan (no. 12397), from Fukien (Chung 2923 and Ching 2300) and from Chekiang (Ching 2101); it is also represented in this herbarium from Kwangtung (Mell 883; det. Handel-Mazzetti).

Clethra kaipoensis Léveillé. — Rehder in Jour. Arnold Arb. **15**: 268 (1934). — Handel-Mazzetti, Symb. Sin. **7**: 760 (1936).

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[1] See Vol. **15**: 267.

ERICACEAE[1]

Rhododendron denudatum Léveillé. — W. W. Smith & Tagg in Jour. Arnold Arb. **15:** 269 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 780 (1936).

Handel-Mazzetti refers to this species two specimens of his from Szechuan (nos. 1471, 1666) and Maire (Arn. Arb. 494) from Yunnan.

Rhododendron irroratum Franchet in Bull. Soc. Bot. France, **34:** 280 (1887). — Handel-Mazzetti, Symb. Sin. **7:** 779 (1936).

Rhododendron Maximowiczianum Léveillé. — W. W. Smith & Tagg in Jour. Arnold Arb. **34:** 278 (1934).

Handel-Mazzetti (l. c.) refers *R. Maximowiczianum* as a synonym to *R. irroratum.*

Rhododendron rex Léveillé. — W. W. Smith & Tagg l. c. 270 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 783 (1936).

Handel-Mazzetti refers to this species three specimens of his from Szechuan (nos. 921, 1394, 1472).

Rhododendron coeruleum Léveillé. — W. W. Smith & Tagg, l. c. 273 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 773 (1936).

Handel-Mazzetti cites under this species his no. 6237 and Cavalerie no. 4629 from Yunnan and his nos. 2153, 2403 and Schneider 4107.

Rhododendron Duclouxii Léveillé (*R. spiciferum × spinuliferum*) Handel-Mazzetti, Symb. Sin. **7:** 775 (1936).

Rhododendron spinuliferum "Franchet" ex Tagg in Rhodod. Soc. Notes **3:** 228 (1928). — Hutchinson in Spec. Rhodod. 606 (1930), quoad synon. *R. Duclouxii.* — W. W. Smith & Tagg in Jour. Arnold Arb. **15:** 274 (1934), quoad synon. *R. Duclouxii.* — Non Rh. *spinuliferum* Franch.

Handel-Mazzetti describes as this hybrid his no. 8621 which he states agrees with the type of *R. Duclouxii;* he also refers here Maire nos. 1119 and 1122 in herb. Berlin.

Rhododendron Bachii Léveillé. — W. W. Smith & Tagg, l. c. 275 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 771 (1936).

Handel-Mazzetti refers to this species his no. 11077, his Pl. Sin. 4 from Hunan, and his Pl. Sin. 145 from Kiangsi.

Rhododendron Esquirolii Léveillé. — Tagg in Spec. Rhodod. 853 (1930). — W. W. Smith & Tagg, l. c. 276 (1934).

Rhododendron Vaniotii Léveillé in Fedde, Rep. Spec. Nov. **13:** 148 (1914).

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[1] See Vol. **15:** 269.

CHINA. Kweichou: Gan-chouen, *J. Esquirol,* no. 3886, April (Nov. on label) 1912, "fl. rose-violet" (holotype of *R. Vaniotii;* photo. in A. A.).

Tagg (l. c.) refers *R. Vaniotii* to *R. Esquirolii.* The type specimen in herb. Léveillé bears only the name *R. Esquirolii* in Léveillé's handwriting on the original label. Neither name appears in the Flore du Kouy-Tchéou.

Rhododendron chrysocalyx Léveillé. — W. W. Smith & Tagg, l. c. 276 (1934).

Rhododendron kouytchense Léveillé, Fl. Kouy-Tchéou, 152 (1914), pro synon. *R. chrysocalycis.*

The type of *R. kouytchense* which appears only in the synonymy of *R. chrysocalyx* is apparently an unnamed specimen without number, collected by Bodinier at Lan-uen, May 1900 (photo. in A. A.) cited under *R. chrysocalyx* in Flore du Kouy-Tchéou.

Enkianthus Dunnii Léveillé. — Rehder in Jour. Arnold Arb. **15:** 278 (1934). — Fang in Contr. Biol. Lab. Sci. Soc. China, **10:** 18 (1936).

Fang enumerates *E. Cavaleriei* and *E. xanthoxanthus* of Léveillé as synonyms of this species.

Enkianthus chinensis Franchet. — Rehder, l. c. 279 (1934). — Fang, l. c. 24 (1935).

Fang cites *Zenobia cerasiflora, Enkianthus cerasiflorus* and *Bodinierella Cavaleriei* of Léveillé among the synonyms of this species.

Leucothoë Griffithiana Clarke in Hook. f. Fl. Brit. Ind. **3:** 460 (1882).

Pieris Cavaleriei Léveillé. — **Synon. nov.**
Leucothoe spec. Rehder in Jour. Arnold Arb. **15:** 280 (1934).

Since I referred *Pieris Cavaleriei* to *Leucothoë* as "L. spec." I had the opportunity to see the type of *L. Griffithiana* at Kew and find that the calyx-teeth of that species are triangular-ovate and acute and do not differ from those of *Pieris Cavaleriei* except that the latter show a tendency to be short-acuminate; the leaves also agree in shape and size, except that those of the latter are mostly rounded or nearly so at base and are more distinctly denticulate and the veinlets beneath indistinct. Specimens from Yunnan (Rock 11520, 22036 and 22479) agree in leaf shape and serration more closely with the type.

Lyonia ovalifolia (Wall.) Drude in Engler & Prantl, Nat. Pflanzenfam. IV. **1:** 44 (1897).

Pieris Ulbrichii Léveillé.

Pieris Mairei Léveillé.
Vaccinium Mairei Léveillé.
Xolisma ovalifolia (Wall.) Rehder in Jour. Arnold Arb. **5**: 52 (1924); **15**: 281 (1934).

Since *Lyonia* Nutt. has been accepted as a nomen conservandum in 1935, *Xolisma* Raf. becomes a synonym of *Lyonia*.

Lyonia ovalifolia var. **lanceolata** (Wall.) Handel-Mazzetti, Symb. Sin. **7**: 281 (1936).

Pieris kouyangensis Léveillé.
Pieris Mairei var. *parvifolia* Léveillé.
Xolisma ovalifolia var. *lanceolata* (Wall.) Rehder in Jour. Arnold Arb. **5**: 52 (1924); **15**: 281 (1934).

Lyonia villosa (Wall.) var. **pubescens** (Franch.), comb. nov.

Pieris Henryi Léveillé.
Xolisma villosa (Wall.) Rehd. var. *pubescens* (Franch.) Rehder in Jour. Arnold Arb. **5**: 53 (1924); **15**: 281 (1934).

Vaccinium mandarinorum Diels var. **austrosinense** (Hand.-Mazz.) Metcalf in Jour. Arnold Arb. **12**: 274 (1931). — Handel-Mazzetti, Symb. Sin. **7**: 795 (1936).

Pieris longicornu Léveillé & Vaniot in Bull. Soc. Bot. France, **51**: 291 (1904); **53**: 206 (1906). — Léveillé, Fl. Kouy-Tchéou, 149 (1914).
Vaccinium Donianum Wight ex Handel-Mazzetti in Anz. Akad. Wiss. Wien, 1925, p. 146 (Pl. Nov. Sin. Forts. 35, p. 4 (1925), quoad syn. *Pieris longicornu* Lévl.
Vaccinium mandarinorum "Diels" ex Rehder in Jour. Arnold Arb. **15**: 284 (1934), quoad synon. *V. longicornu* Lévl.

Handel-Mazzetti referred in 1925 (l. c.) *Pieris longicornu* as a synonym to *V. Donianum* = *V. mandarinorum*, but in 1936 (l. c.) he is inclined to refer it to *V. mandarinorum* var. *austrosinense* chiefly on account of the long staminal appendages.

Vaccinium Duclouxii (Lévl.) Handel-Mazzetti. — Rehder in Jour. Arnold Arb. **15**: 284 (1934). — Handel-Mazzetti, Symb. Sin. **7**: 794 (1936).

Pieris Duclouxii Léveillé.

Vaccinium fragile Franch. var. *β* **myrtifolium** Franchet in Jour. de Bot. **9**: 367 (1895). — Léveillé, Cat. Pl. Yun-Nan, 94 (1916). — Handel-Mazzetti, Symb. Sin. **7**: 796 (1936).

Pieris repens Léveillé in Bull. Acad. Intern. Géog. Bot. **12**: 252 (1903); in Bull. Soc. Bot. France, **53**: 205 (1906); Fl. Kouy-Tchéou, 150 (1914); Cat. Pl. Yun-Nan, 87 (1916).
Vaccinium repens (Lévl.) Rehder in Jour. Arnold Arb. **15**: 283 (1934), excl. syn. *V. mekongense* W. W. Sm.

Handel-Mazzetti has identified *Pieris repens* with *V. fragile* var. *myrtifolium* and this identification is evidently correct. *Vaccinium mekongense,* though very similar in most of its characters to *Pieris repens* differs from it and from *V. fragile* var. *myrtifolium* in its awnless anthers and must be kept as a distinct species.

MYRSINACEAE[1]

Ardisia crispa (Thunb.) De Candolle in Trans. Linn. Soc. **17:** 124 (1834), quoad syn. *Bladhia crispa.*

Ardisia hortorum Maximowicz in Gartenfl. **14:** 363 (1865). — Handel-Mazzetti, Symb. Sin. **7:** 756 (1936).

Ardisia Dielsii Léveillé in Fedde, Rep. Spec. Nov. **9:** 461 (1911); Fl. Kouy-Tchéou, 262 (1914); Cat. Pl. Yun-Nan, 177 (1916).

Ardisia Henryi Hemsl. var. *Dielsii* (Lévl.) Walker in Jour. Arnold Arb. **15:** 290 (1934).

Handel-Mazzetti identifies *A. Dielsii* with *A. hortorum* and the type of *Bladhia crispa* Thunb. which he has seen, and discusses in detail (l. c.) the synonymy and relationship of this and related species. Though he recognizes the identity of *Bladhia crispa* with *A. hortorum,* he does not take up *A. crispa* (Thunb.) DC. for this species, but calls *A. crispa* a nomen confusum and uses *A. hortorum* for *A. crispa* (Thbg.) DC. as to the name bringing synonym and *A. crenata* for *A. crispa* DC. as to the description.

Embelia oblongifolia Hemsley. — Walker in Lingnan Sci. Jour. **10:** 475 (1931); in Jour. Arnold Arb. **15:** 291 (1934).

Embelia Bodinieri Lévl. had been already identified as a synonym of *E. oblongifolia* by Walker in 1931, a reference not cited by him in 1934.

PRIMULACEAE[2]

Lysimachia capillipes Hemsl. var. **Cavaleriei** (Lévl.) Handel-Mazzetti in Jour. Arnold Arb. **15:** 294 (1934); Symb. Sin. **7:** 731 (1936).

Andrachne Cavaleriei Léveillé.

Lysimachia Millietii (Lévl.) Handel-Mazzetti, Symb. Sin. **7:** 731 (1936).

Andrachne Millietii Léveillé in Bull. Géog. Bot. **24:** 146 (1914); Fl. Kouy-Tchéou, 158 (1914).

CHINA. Kweichou: Hin-y-fou, *J. Cavalerie,* no. 3992, June 1912, "fl. jaunes" (holotype of *Andrachne Millietii;* photo. in A. A.).

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[1] See Vol. **15:** 288.

[2] See Vol. **15:** 293.

Handel-Mazzetti states that this species belongs to the affinity of *L. capillipes* Hemsl. and *L. lancifolia* Craib, but is distinguished by thick glaucous leaves without prominent veins.

EBENACEAE[1]

Diospyros Esquirolii Léveillé. — Rehder in Jour. Arnold Arb. **15:** 294 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 802 (1936).

STYRACACEAE[2]

Pterostyrax Leveillei (Fedde) Chun. — Rehder in Jour. Arnold Arb. **15:** 295 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 805 (1936).

> *Styrax Cavaleriei* Léveillé (1911, non 1907).
>
> *Pterostyrax hispidus* Sieb. & Zucc. ex W. W. Smith in Not. Bot. Gard. Edinb. **12:** 238 (1920), non Siebold & Zuccarini.

Styrax Argyi Léveillé. — W. W. Smith in Not. Bot. Gard. Edinb. **12:** 237 (1920). — Rehder in Jour. Arnold Arb. **15:** 295 (1934).

Styrax japonicus Siebold & Zuccarini. — W. W. Smith, l. c. 238 (1920). — Rehder, l. c. 295 (1934).

Styrax Bodinieri was published as a synonym of *S. japonicus* already in 1920 (l. c.) by W. W. Smith.

Styrax grandiflorus Griffith. — W. W. Smith, l. c. 235, 238, 239 (1920). — Rehder, l. c. 296 (1934).

Styrax Cavaleriei Lévl. and *S. touchanensis* Lévl. were referred already in 1920 (l. c.) to *S. grandiflorus* by W. W. Smith, the former with some doubt.

SYMPLOCACEAE[3]

Symplocos Ernesti Dunn (1911). — Handel-Mazzetti, Symb. Sin. **7:** 806 (1936).

> *Symplocos coronigera* Léveillé. — Rehder in Jour. Arnold Arb. **15:** 296 (1934).

The name *S. Ernesti* Dunn given to replace *S. Wilsonii* Brand, a later homonym of *S. Wilsoni* Hemsl., is one year older than *S. coronigera.*

OLEACEAE[4]

Jasminum Seguini Léveillé. — Rehder in Jour. Arnold Arb. **15:** 307 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 1014 (1936).

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[1] See Vol. **15:** 294.

[2] See Vol. **15:** 295.

[3] See Vol. **15:** 296.

[4] See Vol. **15:** 302.

Jasminum Prainii Léveillé. — Rehder, l. c. 308 (1934).

Ophiorrhiza Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **13:** 177 (1914); Fl. Kouy-Tchéou, 370 (1915). — **Synon. nov.**

CHINA. Kweichou: *J. Esquirol,* no. 437, June 1905 (holotype of *O. Esquirolii;* photo. in A. A.).

The type of *J. Prainii* was collected in fruit by J. Cavalerie between Pin-fa and Ou-glan; the type of *Ophiorrhiza Esquirolii* is in flower.

LOGANIACEAE[1]

Buddleia officinalis Maximowicz in Bull. Acad. Sci. St. Pétersb. sér. 3, **26:** 496; in Mél. Biol. **10:** 675 (1880). — Handel-Mazzetti, Symb. Sin. **7:** 948 (1936).

Buddleia acutifolia C. H. Wright. — Rehder in Jour. Arnold Arb. **15:** 310 (1934).

Handel-Mazzetti refers *B. acutifolia* C. H. Wright as a synonym to *B. officinalis,* and I agree with him that the differences given by Marquand are too slight to maintain the two as distinct species. When describing *B. acutifolia,* the author, C. H. Wright, did not compare it with *B. officinalis* but only with *B. Davidii* Franch. which is a very different species. Handel-Mazzetti also cites *B. Mairei* Lévl. as one of the synonyms of *B. officinalis.*

Buddleia tibetica W. W. Sm. var. **truncatifolia** (Lévl.) Marquand. — Comber in Not. Bot. Gard. Edinb. **18:** 230 (1934). — Rehder in Jour. Arnold Arb. **15:** 310 (1934).

Buddleia truncatifolia Léveillé.

Handel-Mazzetti (Symb. Sin. **7:** 947, 1936) refers *B. truncatifolia* Lévl. and *B. tibetica* W. W. Sm. to *B. crispa* Benth. as synonyms. I have seen too little material of *B. crispa* from its type region to form a definite opinion on the relationship of these species.

APOCYNACEAE[2]

Melodinus Hemsleyanus Diels in Bot. Jahrb. **29:** 539 (1900). — Tsiang in Sunyatsenia, **3:** 130 (1936).

Trachelospermum Esquirolii Léveillé, Fl. Kouy-Tchéou, 32 (1912).

Melodinus khasianus "Hook. f." ex Woodson in Jour. Arnold Arb. **15:** 313 (1934); in Sunyatsenia, **3:** 101 (1936); non Hook. f.

The distinguishing characters of this species, *M. khasianus* and the following species are discussed at length by Tsiang (l. c.).

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[1] See Vol. **15:** 309.

[2] See Vol. **15:** 310.

Melodinus Seguini Léveillé. — Woodson in Jour. Arnold Arb. **15:** 313 (1934). — Tsiang in Sunyatsenia, **3:** 131 (1936). — Handel-Mazzetti, Symb. Sin. **7:** 989 (1936).

Carissa Carandas Linnaeus, Mant. **1:** 52 (1767). — Tsiang l. c. 122 (1936).

Damnacanthus Esquirolii Léveillé.
Arduina Carandas K. Schumann. — Woodson, l. c. 312 (1934).

Alstonia yunnanensis Diels. — Woodson, l. c. 315 (1934). — Tsiang, l. c. 138 (1936).

Acronychia Esquirolii Léveillé.
Alstonia Esquirolii Léveillé.

Alstonia Mairei Léveillé. — Woodson, l. c. 315 (1934). — Tsiang, l. c. 138 (1936).

Wikstroemia Hemsleyana Léveillé.

Tsiang refers *A. paupera* Hand-Mazz. to this species as a synonym.

Alyxia Schlechteri Léveillé. — Tsiang in Sunyatsenia, **2:** 105 (1934); **3:** 136 (1936). — Woodson in Jour. Arnold Arb. **15:** 316 (1934).

Daphne Bodinieri Léveillé.
Wikstroemia Bodinieri Léveillé.
Alyxia Bodinieri (Lévl.) Woodson in Jour. Arnold Arb. **15:** 316 (1934).

Ecdysanthera rosea Hooker & Arnott, Bot. Beechey Voy. 198, t. 42 (1836).

Antirrhaea Esquirolii Léveillé, Fl. Kouy-Tchéou, 364 (1915). — **Synon. nov.**

CHINA. Kweichou: locality illegible, *J. Esquirol,* no. 867, "fleur rouge" (holotype of *Antirrhaea Esquirolii;* photo. and isotype in A. A.).

The original label is badly torn and partly illegible, only the collector's name and number and "fleur rouge" are clear; the locality is indistinct and Léveillé in his original description cites neither locality, nor collector or number. On another label the name *Antirrhaea Martini* appears in his handwriting, while by another hand the name *Antirrhaea Esquirolii* is written on the sheet. The latter is evidently the correct name, for it agrees with Léveillé's description. The species was determined as *E. rosea* by Dr. R. E. Woodson, to whom I had sent the material when I found that the plant belonged to the Apocynaceae and not to the Rubiaceae.

Trachelospermum gracilipes Hook. f. — Woodson, l. c. 311 (1934); in Sunyatsenia, **3**: 91 (1936). — Tsiang in Sunyatsenia, **3**: 144 (1936).

Melodinus Cavalerici Léveillé in Fedde, Rep. Spec. Nov. **2**: 113 (1906) tantum quoad specimen citatum "Lo-pie" aut "Tou-chan" (specim. glabratum), descript. exclusa.

Trachelospermum rubrinerve Léveillé, Fl. Kouy-Tchéou, 32 (1914), sensu synon. praeced.

Trachelospermum gracilipes var. *Cavaleriei* Schneider in Sargent, Pl. Wilson. **3**: 332 (1916), synon. excludendis et specim. "Kouy-yang" et "Lo-pie" aut "Tou-chan" excludendis. — Tsiang in Sunyatsenia, **2**: 137 (1934), sensu Schneider.

CHINA. Kweichou: "Lo-pie, *J. Seguin* in herb. *Bodinier,*" or "Tou-chan, *J. Cavalerie*" (see remarks below and citations under *T. Dunnii.*)

The fragments of *T. rubrinerve* Lévl. (*Melodinus Cavaleriei* Lévl.) sent by Léveillé in 1916 without any further data to the Arnold Arboretum and referred by Schneider to *T. gracilipes,* probably were taken from one of the two specimens labeled *Melodinus Cavaleriei* representing two collections, one from "Lo-pie, Avril 1898, J. Seguin [herb.] E. Bodinier," and one from "Tou-chan, J. Cavalerie, June 3, 1899"; one of these specimens belongs to *T. gracilipes* and the other to *T. Dunnii* Lévl., but which is which is not possible to say since the data for both specimens are written on a single label. The fragments were evidently taken from the specimen on the upper left hand corner of the mounted sheet with which they agree, also the strip of bark adhering to the base of the petiole of the leaf sent, corresponds to the partly torn off bark at the base of that branchlet.

Schneider unfortunately took the fragments sent by Léveillé as *T. rubrinerve,* for the type of that species, though he was aware that they did not agree with Léveillé's description of *Melodinus Cavaleriei* for which *T. rubrinerve* is only a new name created by Léveillé because he published at the same place a new species as *T. Cavaleriei,* which has been identified by Tsiang with *Cryptolepis Buchanani* Roem. & Schult. (see p. 239). Schneider further complicated the matter by using "Cavaleriei" as the epithet for a new variety of *T. gracilipes* Hook. f. and based it on Wilson no. 2341 as the type, a procedure clearly against the rules of nomenclature, because by citing *Melodinus Cavaleriei* as the name bringing synonym, the type of that species automatically becomes the type of this new variety and there could be no other type. If the plant described by Schneider as *T. gracilipes* var. *Cavaleriei* is maintained as a distinct variety, it should receive another name and be based on Wilson 2341 as the type.

Trachelospermum Bodinieri (Lévl.) Woodson, l. c. (1934); in Sunyatsenia, **3:** 77 (1936). — Tsiang in Sunyatsenia, **3:** 145 (1936). — Handel-Mazzetti, Symb. Sin. **7:** 990 (1936).

Melodinus Bodinieri Léveillé.

Trachelospermum axillare Hooker f. — Woodson, l. c. (1934); in Sunyatsenia, **3:** 99 (1936). — Tsiang in Sunyatsenia, **2:** 148, fig. 16 (1934); **3:** 145 (1936).

Melodinus Chaffanjoni Léveillé.
Periploca astacus Léveillé.
Maesa scandens Léveillé.

Trachelospermum Dunnii (Lévl.) Léveillé. — Woodson, l. c. (1934); in Sunyatsenia, **3:** 98 (1936). — Tsiang in Sunyatsenia, **2:** 152, fig. 19 (1934); **3:** 148 (1936). — Handel-Mazzetti, Symb. Sin. **7:** 991 (1936).

Melodinus Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. **2:** 113 (1906), excl. specim. citatum "Lo-pie" aut "Tou-chan."
Melodium Dunnii Léveillé, op. cit. **9:** 453 (1911).
Melodinus Dunnii Léveillé, Fl. Kouy-Tchéou, 31 (1914), pro synon. *T. Dunnii.*
Trachelospermum rubrinerve Léveillé, l. c. 32 (1914), pro parte.

CHINA. Kweichou: environs de Kouy-yang, mont du Collége, rare, *J. Chaffanjon,* April 25, 1898 (syntype of *Melodinus Cavaleriei,* cited in Fl. Kouy-Tchéou under *T. Dunnii* and under *T. rubrinerve;* photo. in A. A.); environs de Lo-pie, *J. Seguin* in herb. Bodinier, April 1898; environs de Tou-chan, *J. Cavalerie,* June 3, 1899 (two branches mounted on one sheet with one label; one of the branches is a syntype of *M. Cavaleriei,* the other belongs to *T. gracilipes*); without locality and date, *J. Cavalerie* (holotype of *Melodium Dunnii;* merotype in A. A.); Pin-fa, bois, liane, *J. Cavalerie,* no. 344, Aug. 31, 1902; Pin-fa, bois de Si-tcheou-gai, rare, *J. Cavalerie,* no. 558, Sept. 29, 1902 (both cited under *T. Dunnii* in Fl. Kouy-Tchéou; photos. in A. A.).

Melodinus Cavaleriei and *Melodinus* (*Melodium*) *Dunnii* are conspecific, though they are treated in Flore du Kouy-Tchéou as distinct species under *Trachelospermum* and appear in the key under different divisions. In comparing the original descriptions, one can detect no essential difference, and the specimens cited, which are partly in fruit and partly in flower, are identical, except one branch mounted on a sheet together with a branch of *T. Dunnii;* that branch belongs to *T. gracilipes* and has given rise to considerable confusion discussed under *T. gracilipes.*

Aganosma cymosa (Roxb.) G. Don. — Woodson, l. c. (1934); in Sunyatsenia, **2:** 102 (1936). — Handel-Mazzetti, Symb. Sin. **7:** 991 (1936).

Aganosma Schlechterianum Léveillé in Fedde, Rep. Spec. Nov. **9**: 325 (1911); Fl. Kouy-Tchéou, 40 (1914), "Schlechteriana."
Trachelospermum Navillei Léveillé.

CHINA. Kweichou: rochers à Lao-ten, *J. Esquirol,* nos. 100, 915, June 1904 and July 1906 (syntypes of *Aganosma Schlechterianum;* photos. in A. A.); Lo hou, buissons, alt. 900 m., *J. Esquirol,* no. 3653, June 1912 (holotype of *Trachelospermum Navillei;* photo. and merotype in A. A.)

In his Flore du Kouy-Tchéou Léveillé enumerates under *Aganosma Schlechteriana* (p. 40) an additional specimen in fruit, Esquirol 3765, June 1912, from Tong-tcheou. This specimen, however, has a short ellipsoid fruit, very different from the long cylindrical fruit of *A. cymosa,* and has been referred, though with some doubt, to *Melodinus fusiformis* Champ. by Tsiang (in Sunyatsenia, **3:** 132. 1936).

Sindechites Henryi Oliver in Hooker, Ic. Pl. **18:** t. 1772 (1888). — Tsiang in Sunyatsenia, **3:** 151 (1936). — Handel-Mazzetti, Symb. Sin. **7:** 992 (1936).

Parameria Esquirolii Léveillé.
Sindechites Esquirolii (Lévl.) Woodson in Jour. Arnold Arb. **15:** 316 (1936).
Antirrhaea Martini Léveillé in Fedde, Rep. Spec. Nov. **13:** 178 (1914); Fl. Kouy-Tchéou, 364 (1915). — **Synon. nov.**

CHINA. Kweichou, add: environs de Gan-pin, rochers près de la ville, *L. Martin* in herb. *Bodinier,* no. 2300, June 5, 1898, "bout de corolle jaunâtre"; Pin-fa, *J. Cavalerie,* no. 1025, June 3, 1903, "fl. blanc-jaunes (fourrés)" (syntypes of *Antirrhaea Martini;* photos. in A. A.).

Antirrhaea Martini was determined as *S. Esquirolii* by Dr. R. E. Woodson to whom I sent the material after finding that the plant belonged to the Apocynaceae, but *S. Esquirolii* is considered as not specifically distinct by Y. Tsiang (l. c.) with whom I agree.

Wrightia Schlechteri Léveillé in Fedde, Rep. Spec. Nov. **11:** 67 (1912); Fl. Kouy-Tchéou, 32 (1914).

CHINA. Kweichou: ruisseau de La-jong, *J. Esquirol,* no. 111, June 1904 (holotype; ex Léveillé).

I have seen no specimen of this species but Mr. Y. Tsiang enumerates it as correctly named in a manuscript list he kindly sent me nearly two years ago. Esquirol, no. 3723, bois de La-thing, enumerated in Flore du Kouy-Tchéou (p. 32) under *W. Schlechteri,* he cites with a question mark, and 1797 enumerated by Léveillé on the same page as a doubtful Apocynacea, he cites as "*Wrightia Schlechteri* Lévl.?"

ASCLEPIADACEAE[1]

Cryptolepis Buchanani Roemer & Schultes, Syst. **4:** 409 (1819). — Tsiang in Sunyatsenia, **3:** 160 (1936).

Trachelospermum Cavaleriei Léveillé, Fl. Kouy-Tchéou, 31 (1914). "Cavaleri" — Woodson in Jour. Arnold Arb. **15:** 316 (1934); in Sunyatsenia, **3:** 101 (1936).

Wrightia spec. Woodson in Sunyatsenia, **3:** 101 (1936).

CHINA. Kweichou: ouest de Lo-fou, pente de rivière, *J. Cavalerie*, no. 2643, Nov. 1905 "liane à suc abondant (holotype of *Trachelospermum Cavaleriei;* photo. and merotype).

By Woodson *Trachelospermum Cavaleriei* was referred in 1936 (l. c.) to *Wrightia,* but Tsiang identified it with *Cryptolepis Buchanani.*

Cynanchum caudatum (Miq.) Maximowicz in Bull. Acad. Sci. St. Pétersb. **23:** 275 (Mél. Biol. **9:** 808) (1877). — Handel-Mazzetti, Symb. Sin. **7:** 996 (1936).

Tylophora Cavaleriei Léveillé, Fl. Kouy-Tchéou, 44 (1914).

Cynanchum Boudieri Léveillé & Vaniot in Bull. Soc. Bot. France, **51:** cxliv (1904). — **Synon. nov.**

CHINA. Kweichou: Pin-fa, ruisseau de In-chang, *J. Cavalerie,* no. 620, Oct. 1902 (holotype of *C. Boudieri* and *Tylophora Cavaleriei;* teste Y. Tsiang).

As Mr. Y. Tsiang who has seen the type, writes me, neither name appears on the sheet; the specimen itself consists only of two young follicles and four pairs of young leaves and represents apparently the common *C. caudatum* Maxim. *Cynanchum caudatum* Vellozo, Fl. Flum. Icon. **3:** t. 77 (1827); Fl. Flum. 114 (1881) cannot invalidate Maximowicz's name since the plate published 1827 does not have analyses showing essential characters, and the description was not published until 1881.

Cynanchum Mooreanum Hemsley in Jour. Linn. Soc. Bot. **26:** 108 (Ind. Fl. Sin. 2) (1889).

Tylophora Argyi Schter. ex Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, **12:** 544 (Cat. Pl. Kiang-Sou, 4) (1916), nomen, pro parte.

Cynanchum tylophoroideum Schter. ex Léveillé, l. c. (1916), nomen. — **Synon. nov.**

KIANGSU: *Ch. d'Argy,* no. 6 (type of *Tylophora Argyi;* teste Y. Tsiang); without data (type of *C. tylophoroideum;* teste Y. Tsiang).

According to Y. Tsiang, Argy no. 6 bears no name; the other sheet without data is named *C. tylophoroideum* by Schlechter and bears a

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[1] See Vol. **15:** 317.

description of the plant in French, but apparently no descriptions of either species were published.

Tylophora Leveilleana Schlechter ex Léveillé, Fl. Kouy-Tchéou, 44 (1914), nom. nud. — Tsiang in Sunyatsenia, **3:** 226 (1936).

CHINA. Kweichou: Ouang-mou, *J. Esquirol,* no. 31, July 1904 (holotype of *T. Leveilleana;* ex Léveillé).

Tsiang (l. c.) gives a brief characterization of this species.

Ceropegia Balfouriana Schlechter in Not. Bot. Gard. Edinb. **8:** 18 (1913).

Aristolochia Mairei Léveillé in Bull. Géog. Bot. **22:** 228 (1912); Cat. Pl. Yun-Nan, 13 (1915). — **Synon. nov.**

Aristolochia viridiflora Léveillé in Fedde, Rep. Spec. Nov. **12:** 99 (1913); Cat. Pl. Yun-Nan, 13 (1915). — **Synon. nov.**

Aristolochia viridiflora var. *occlusa* Léveillé l. c. 190 (1913); l. c. (1915). — **Synon. nov.**

Aristolochia Blinii Léveillé, l. c. 287 (1913); l. c. 11, fig. 1 (1915). — **Synon. nov.**

CHINA. Yunnan: Tcheou-kia-tse-tang, 2500 m., très rare, *E. E. Maire,* June 1910 (no. 3536 in herb. Bonati, holotype of *Aristolochia Mairei;* photo. in A. A.); La-kou, monts calcaires, 2500 m., *E. E. Maire,* Sept. 1911 (holotype of *A. viridiflora;* ex Léveillé); bois de Kin-tchong-chan, *E. E. Maire* (holotype of *A. viridiflora* var. *occlusa;* ex Léveillé); pâturages des hauts plateaux à Tai-hai, 3200 m., *E. E. Maire,* July 1912 "asclepias vivace, fl. violet sombre, pétales unis au sommet et balounés" (holotype of *A. Blinii;* photo. in A. A.).

The type specimens of *Aristolochia Mairei* and of *A. Blinii* which I have seen, have been labeled by W. W. Smith *Ceropegia* aff. *Balfouriana* Schlecht. Y. Tsiang who had seen these specimens and also *A. viridiflora* states (in litt.) that he agrees with Professor W. W. Smith in this determination.

Tylophora floribunda Miquel in Ann. Mus. Bot. Lugd.-Bat. **2:** 128 (Prol. Fl. Jap. 60) (1866). — Tsiang in Sunyatsenia, **3:** 231 (1936).

Tylophora Argyi Schter. ex Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, **12:** 544 (Cat. Pl. Kiang-Sou, 4) (1916), nomen, pro parte.

CHINA. Kiangsu: *Ch. d'Argy* [1844–66] (syntypes of *Tylophora Argyi;* ex Léveillé).

There are apparently three specimens under *T. Argyi* in the Léveillé herbarium according to Tsiang's manuscript list; one, "no. 6," is *Cynanchum Mooreanum* Hemsl., the other two unnumbered belong to *T. flori-*

bunda. Tsiang (l. c.) does not cite *T. Argyi* as a synonym, but enumerates a specimen from Kiangsu collected by d'Argy.

Tylophora Dielsii (Lévl.) Hu in Jour. Arnold Arb. **5**: 232 (1924). — Tsiang in Sunyatsenia, **3**: 230 (1936).

Hoyopsis Dielsii Léveillé in Fedde, Rep. Spec. Nov. **13**: 262 (1914).
Tylophora Hoyopsis Léveillé, Fl. Kouy-Tchéou, 44 (1914).

CHINA. Kweichou: Pin-fa, fourrés précipices, *J. Cavalerie*, no. 1046, June 3, 1903 (holotype of *Hoyopsis Dielsii*; ex Léveillé).

Tsiang states that this species is allied to his *T. Tengii* (p. 228) which is illustrated by a text figure and a plate and accompanied by a detailed description.

Tylophora spec. ?

Dischidia yunnanensis Léveillé, Cat. Pl. Yun-Nan, 14 (1915).

CHINA. Yunnan: sous bois de Tcheou-kia-ouan, 2550 m., *E. E. Maire*, Sept. 1911 (holotype of *Dischidia yunnanensis*; ex Léveillé).

Dischidia yunnanensis is referred by Tsiang in his manuscript list doubtfully to *Tylophora*. I have not seen the specimen and it is not enumerated by Tsiang among the 24 species of *Tylophora* recorded from China (in Sunyatsenia, **3**: 216–239).

Dischidia Esquirolii (Lévl.) Tsiang in Sunyatsenia, **3**: 183 (1936).

Hoya Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **11**: 298 (1912); Fl. Kouy-Tchéou, 42 (1914). — Woodson in Jour. Arnold Arb. **15**: 318 (1934).

CHINA. Kweichou: au bac de Pai-ouai, *J. Esquirol*, no. 2801, May 20, 1912, "pend. en long ficelles des rochers et des vieux troncs, fleur blanche;" Lou-fou, *J. Cavalerie*, no. 3484, March 1909, "sur arbre" (syntypes of *Hoya Esquirolii*; photos. in A. A.).

Hoya Lyi Léveillé in Bull. Soc. Bot. France, **54**: 369 (1907); Fl. Kouy-Tchéou, 42 (1914). — Tsiang in Sunyatsenia, **3**: 179 (1936). — Handel-Mazzetti, Symb. Sin. **7**: 1001 (1936), in nota sub *H. yuennanensis*.

Hoya carnosa "R. Br." ex Woodson in Jour. Arnold Arb. **15**: 318 (1934), quoad synon. *H. Lyi*; non (L.) R. Brown.

CHINA. Kweichou: environs de Gan-pin, sur les parois des rochers surplombant une depression en forme de cirque, *L. Martin* in herb. *Bodinier*, Sept. 20, 1897; Lo-pie, rocailles près du marché, *L. Martin* and *J. Seguin*, no. 1853, Oct. 7, 1897; Tsien-sen-kiao, *J. Ly*, no. 1879, Nov. 1904 (syntypes of *H. Lyi*; ex Léveillé).

Marsdenia stenantha Handel-Mazzetti, Symb. Sin. **7**: 1003, t. 13, fig. 10 (March 1936). — Tsiang in Sunyatsenia, **3:** 202 (May 1936).

Stephanotis yunnanensis Léveillé, Cat. Pl. Yun-Nan, 14 (1915). — Woodson in Jour. Arnold Arb. **15:** 317 (1934).

Léveillé's specific epithet cannot be transferred to *Marsdenia* on account of the older homonym *M. yunnanensis* (Lévl.) Woods. of 1934 which was referred as a synonym to *M. oreophila* W. W. Sm.

Marsdenia oreophila W. W. Smith in Not. Bot. Gard. Edinb. **8:** 193 (1914). — Handel-Mazzetti, Symb. Sin. **7:** 1002 (1936). — Tsiang in Sunyatsenia, **3:** 205 (1936).

Gongronema yunnanense Léveillé, Cat. Pl. Yun-Nan, 13 (1915).
Marsdenia yunnanensis (Lévl.) Woodson in Jour. Arnold Arb. **15:** 317 (1934).

Marsdenia tenacissima (Roxb.) Wight & Arnott in Wight, Contrib. Bot. Ind. 41 (1834). — Tsiang in Sunyatsenia, **3:** 214 (1936).

Metaplexis Cavaleriei Léveillé, Fl. Kouy-Tchéou, 42 (1914).
Marsdenia Cavaleriei (Lévl.) Handel-Mazzetti ex Woodson in Jour. Arnold Arb. **15:** 318 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 1002 (1936).

Heterostemma Esquirolii (Lévl.) Tsiang in Sunyatsenia, **3:** 189 (1936).

Pentasacme Esquirolii Léveillé, Fl. Kouy-Tchéou, 14 (1914).

China. Kweichou: trou du Heou-hay-tse, *J. Esquirol,* no. 716, Aug. 1905; Gan-chouen, *J. Cavalerie,* no. 3973, Aug. 1912 (syntypes of *Pentasacme Esquirolii;* ex Léveillé).

CONVOLVULACEAE[1]

Argyreia Seguini (Lévl.) Vaniot ex Léveillé. — Rehder in Jour. Arnold Arb. **15:** 319 (1934). — Handel-Mazzetti, Symb. Sin. **7:** 813 (1936).

Lettsomia Seguini Léveillé.

This species was collected in Kweichou also by Handel-Mazzetti (no. 10355).

Quamoclit pennata (Desrouss.) Bojer, Hort. Maurit. 224 (1837).

Incarvillea Argyi Léveillé in Bull. Géog. Bot. **24:** 292 (1914); in Mem. Acad. Ci. Art. Barcelona, ser. 3, **12:** 545 (Cat. Pl. Kiang-Sou, 5) (1916); Cat. Ill. Pl. Seu-Tchouen, pl. 4 (1918) ms. — **Synon. nov.**

China. Kiangsu: *Ch. d'Argy* [1844–66] (holotype of *Incarvillea Argyi;* isotype in A. A.).

Incarvillea Argyi was determined by Dr. E. D. Merrill as *Quamoclit pennata* from the isotype in this herbarium.

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[1] See Vol. **15:** 318.

BORAGINACEAE[1]

Ehretia acuminata R. Brown, Prodr. Fl. N. Holl. 497 (1810).

Ehretia Argyi Léveillé in Fedde, Rep. Spec. Nov. **11**: 67 (1912); in Mem. Acad. Ci. Art. Barcelona, ser. 3, **12**: 545 (Cat. Pl. Kiang-Sou, 5 (1916). — **Synon. nov.**

CHINA. Kiangsu: *Ch. d'Argy* [1844–66] (holotype of *E. Argyi;* photo. and isotype in A. A.).

Nakai (in Jour. Arnold Arb. **5**: 38. 1924) distinguished the plant of eastern Asia under the name of *E. thyrsiflora* (Sieb. & Zucc.) Nakai from *E. acuminata* R. Br., but I agree with Handel-Mazzetti (Symb. Sin. **7**: 815) that there are no reliable characters by which to separate the two.

VERBENACEAE[2]

Callicarpa Bodinieri Léveillé. — Rehder in Jour. Arnold Arb. **15**: 321 (1934). — Handel-Mazzetti, Symb. Sin. **7**: 900 (1936).

Callicarpa Bodinieri var. **Lyi** (Lévl.) Rehder, l. c. 322 (1934). — Handel-Mazzetti, l. c. (1936).

Callicarpa Lyi Léveillé.

Callicarpa Bodinieri var. **Giraldii** (Rehd.) Rehder, l. c. 322 (1934). — Handel-Mazzetti, l. c. (1936).

Callicarpa Mairei Léveillé.

Premna puberula Pampanini. — Rehder, l. c. 324 (1934). — Handel-Mazzetti, l. c. 905 (1936).

Premna Bodinieri Léveillé.

Caryopteris paniculata C. B. Clarke. — P'ei in Mem. Sci. Soc. China I, no. **3**: 176 (Verben. China) (1932). — Rehder in Jour. Arnold Arb. **15**: 326 (1934).

Callicarpa Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **9**: 325 (1911). — **Synon. nov.**

Callicarpa Martini Léveillé.

CHINA. Kweichou, add: without precise locality, *J. Esquirol,* no. 754 (holotype of *Callicarpa Esquirolii,* cited in Fl. Kouy-Tchéou under *C. Martini;* photo. in A. A.).

P'ei (l. c.) cited *Caryopteris paniculata* C. B. Clarke with the parenthetical author "(Kurz)" which is apparently an error, since *C. paniculata* is a new name, not a new combination, and is based on *Clerodendron gratum* Kurz, not Wall.

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[1] See Vol. **15**: 320.

[2] See Vol. **15**: 320.

Esquirol no. 754 cited in Flore du Kouy-Tchéou under *Callicarpa Martini* is the holotype of *C. Esquirolii,* but the type specimen bears only the name *Callicarpa Martini* in Léveillé's handwriting.

LABIATAE[1]

Teucrium palmatum Bentham in Hooker f., Fl. Brit. Ind. **4:** 702 (1885).

Caryopteris Mairei Léveillé, Sert. Yunnan, 3 (1916); Cat. Pl. Yun-Nan, *277, 298* (1917).

CHINA. Yunnan: bords des eaux, haut plateau de Ta-hai, 3200 m., *E. E. Maire,* July 1912, "Labiée vivace, dressé, fl. grises ou roses ou rouges" (holotype of *Caryopteris Mairei;* merotype in A. A.).

Caryopteris Mairei was identified with *Teucrium palmatum* by Dr. E. D. Merrill from the merotype in this herbarium.

Microtoena insuavis (Hance) Prain ex Dunn in Not. Bot. Gard. Edinb. **6:** 188 (1915). — Merrill in Lingnan Sci. Jour. **13:** 46 (1934).

Microtoena mollis Léveillé in Fedde, Rep. Spec. Nov. **9:** *222* (1911).
Microtoena Esquirolii Léveillé l. c. (1911).

CHINA. Kweichou: Lo-fou, *J. Cavalerie,* no. 3548, March 1909; Kiao-tsong, *J. Esquirol,* nos. 155, 330, Dec. 13, 1904 (syntypes *M. mollis;* ex Léveillé); route de Tchen-fong, *J. Esquirol,* no. 672, Oct. 1905 (holotype of *M. Esquirolii;* ex Léveillé).

Microtoena mollis and *M. Esquiroli* are enumerated by E. D. Merrill (l. c.) as synonyms of *M. insuavis.*

Elsholtzia heterophylla Diels in Not. Bot. Gard. Edinb. **5:** 231 (1912). — Léveillé, Cat. Pl. Yun-Nan, 137 (1916).

Pogostemon lavandulaespica Léveillé in Fedde, Rep. Spec. Nov. **13:** 344 (1914).
Elsholtzia lavandulaespica (Lévl.) Léveillé in Bull. Géog. Bot. **25:** 25 (1915).
Elsholtzia Bodinieri Vant. var. *lavandulaespica* (Lévl.) Léveillé, Cat. Pl. Yun-Nan, 137, fig. 28 (1916).

CHINA. Yunnan: plaine stagnante de Lou-pou, alt. 2000 m., *E. E. Maire,* Oct. 1913, "Labiée menthacée annuelle, fl. roses" (holotype of *Pogostemon lavandulaespica;* photo. in A. A.).

The plant figured in Cat. Pl. Yun-Nan is apparently a weak lateral stem, which usually has small elliptic or ovate leaves, while the normal more vigorous stems have oblong-lanceolate or narrow-oblong leaves about 2 cm. long. The species, which is a stoloniferous perennial, some-

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[1] See Vol. **16:** 311.

what woody at the base, seems to be fairly common in Yunnan and has been collected by Henry and Forrest.

SOLANACEAE[1]

Solanum verbascifolium Linnaeus, Sp. Pl. 184 (1753). — Léveillé, Fl. Kouy-Tchéou, 403 (1915).

Ficus corymbifera Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6**: 149 (Ficus Sp. Chin. 11) (1907); in Fedde, Rep. Spec. Nov. **4**: 67, 83 (1907).

CHINA. Kweichou: Ouang-mou, *J. Esquirol,* no. 137, June 1904 (holotype of *Ficus corymbifera;* photo. in A. A.).

Léveillé & Vaniot state in Fedde, Rep. Spec. Nov. **4**: 67 that according to new material received, the plant described as *Ficus corymbifera* has turned out to be a Solanacea, and in Flore du Kouy-Tchéou, 403, Léveillé enumerates Esquirol 137 under *Solanum verbascifolium* without citing *F. corymbifera* as a synonym.

Solanum Capsicastrum Link ex Schauer in Allg. Gartenzeit. **1**: 228 (1833).

Solanum Dunnianum Léveillé in Fedde, Rep. Spec. Nov. **9**: 324 (1911); Cat. Pl. Yun-Nan, 267 (1917). — **Synon. nov.**

CHINA. Yunnan: jardin de H. Ke-Chou et abondant aux rochers de Ting-mei, *J. Esquirol,* no. 536, June 1905 (holotype of *S. Dunnianum;* photo. in A. A.).

This Brazilian species is frequently cultivated; according to a specimen from Hopei (J. C. Liu, 2061) it is being grown in Peiping as a pot plant. The note on the label "et abondante aux rochers de Ting-mei" may indicate that it has become naturalized in that region, if it refers at all to the same plant.

Solanum cornutum Lamarck, Tabl. Encycl. Méth. **2**: 25 (1793).

Solanum Heudesii Léveillé in Fedde, Rep. Spec. Nov. **11**: 295 (1912).

CHINA. Kiangsu: Chang-hay, jardin des Jesuites à Zi-ka-wei, originaire de l'intérieur de la province, *E. Bodinier,* Aug. 1891 (holotype of *S. Heudesii;* photo. in A. A.).

The specimen agrees well with Mexican specimens of *S. cornutum.*

SCROPHULARIACEAE[2]

Brandisia racemosa Hemsley. — Rehder in Jour. Arnold Arb. **16**: 315 (1935). — Handel-Mazzetti, Symb. Sin. **7**: 831 (1936)..

Deutzia funebris Léveillé.

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[1] See Vol. **16**: 314.

[2] See Vol. **16**: 315.

GESNERIACEAE

Rhabdothamnopsis chinensis (Franch.) Handel-Mazzetti, Symb. Sin. **7:** 884 (1936).

> *Rhabdothamnopsis sinensis* Hemsley in Jour. Linn. Soc. Bot. **35:** 517 (1903).
>
> *Boea Cavaleriei* Léveillé & Vaniot in Compt. Rend. Assoc. Franç. Adv. Sci. **1905:** 429 (1906); in Fedde, Rep. Spec. Nov. **5:** 224 (1908); Fl. Kouy-Tchéou, 180 (1914). — **Synon. nov.**

CHINA. Kweichou: environs de Tou-chan, *J. Cavalerie,* June 2, 1898, "Fleurs bleues: labelle pointillé avec tache blanche, fruit sec en spirale"; route de Pin-yue à Kouy-yang, *L. Martin,* May 18, 1899 (both in herb. *Bodinier* under no. 2347 on one sheet, holotype of *Boea Cavaleriei;* photo. in A. A.).

The type sheet contains two collections, one specimen in fruit collected by Cavalerie, and two specimens in flower collected by Martin. Handel-Mazzetti (l. c.) enumerates an isotype of Léveillé's species, probably from the Paris Herbarium, but does not cite the name *Boea Cavaleriei.* There is also in this herbarium an isotype of no. 2347 from the Paris Herbarium which is dated June 27, 1899 and is identified with the fruiting specimen of the type, with only Bodinier's name as collector. In Flore du Kouy-Tchéou, Léveillé cites Cavalerie & Martin 2056 with the localities as in no. 2347, but does not mention the latter number.

Aeschynanthus spec.

> *Didymocarpus Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. **9:** 453 (1911); Fl. Kouy-Tchéou, 183 (1914); non Léveillé (1906).

CHINA. Kweichou: ouest de Lo-fou, *J. Cavalerie,* no. 2555, Nov. 1905 (holotype of *Didymocarpus Cavaleriei;* photo. in A. A.).

This species is removed from *Didymocarpus* by its 4 fertile stamens and apparently belongs to *Aeschynanthus,* but does not seem to be referable to any described species. It is characterized by the oblong-lanceolate leaves being minutely pubescent beneath, more densely so on the midrib and veins, and remotely and obscurely denticulate on the margin; the flowers are borne in twos on slender axillary peduncles, the calyx is divided to the base into oval-oblong sepals about 7 mm. long and the corolla is about 4 cm. long.

Lysionotus pauciflorus var. **linearis,** var. nov.

> *Lysionotus Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. **9:** 328 (1911); Fl. Kouy-Tchéou, 184 (1914); non Léveillé (1909).

CHINA. Kweichou: Pin-fa, rochers, très rare, *J. Cavalerie,* no. 2531, Oct. 11, 1905 (holotype of *L. Cavaleriei;* photo. in A. A.).

This variety is easily distinguished by its linear leaves, scarcely exceeding 4 mm. in width and 1.5–3.5 cm. long, colored purple or purplish on the under surface; otherwise it seems not different from *L. pauciflorus* Maxim. The peduncles are all subterminal and one-flowered and the fruits are from 3.5–8 cm. long.

The specific epithet of Léveillé's name is invalidated by the older homonym *L. Cavaleriei* Lévl. (in Fedde, Rep. Spec. Nov., **6**: 264. 1909) which judging from the description is not a *Lysionotus;* it was probably transferred to another genus and for that reason could not be located in the Léveillé herbarium.

ACANTHACEAE[1]

Strobilanthes lofouensis Léveillé in Fedde, Rep. Spec. Nov. **12**: 99 (1913); Fl. Kouy-Tchéou, 22 (1914).

China. Kweichou: Lo-fou, *J. Cavalerie,* no. 3288, Apr. 1907, "blanc rouge" (holotype; photo. in A. A.).

This species seems closely related to *S. flaccidifolius* Nees, but is easily distinguished by the entire or nearly entire leaves of firmer texture, by the shorter and narrower acuminate densely pubescent sepals and by the smaller corolla, 2.5–3 cm. long, sparingly villous outside, and more abruptly contracted into a rather short tube. It is a much branched shrub, the branches covered with light grayish brown bark split by longitudinal fissures.

RUBIACEAE[2]

Oldenlandia hedyotidea (DC.) Handel-Mazzetti, Symb. Sin. **7**: 1015 (1936).

Hedyotis Esquirolii Léveillé.

Hedyotis hedyotidea (DC.) Merrill in Lingnan Sci. Jour. **13**: 48 (1934).

Oldenlandia macrostemon (Hook. & Arn.) Kuntze. — Rehder in Jour. Arnold Arb. **16**: 316 (1935).

Wendlandia uvariifolia Hance subsp. **Dunniana** (Lévl.) Cowan. — Rehder in Jour. Arnold Arb. **16**: 318 (1935). — Handel-Mazzetti, Symb. Sin. **7**: 1016 (1936).

Wendlandia Dunniana Léveillé.

Adina rubella Hance in Jour. Bot. **6**: 114 (1868). — Nakai, Fl. Sylv. Kor. **14**: 89, t. 20 (1923).

Adina Fauriei Léveillé in Fedde, Rep. Spec. Nov. **8**: 283 (1910).

Korea. Quelpaert: in ripis torrentium prope Hongno, *U.*

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[1] See Vol. **16**: 315.

[2] See Vol. **16**: 316.

Faurie, no. 701, Oct. 1906, "1–2 m. alta"; in petrosis torrentium Hioton, *E. Taquet,* no. 1366, Aug. 22, 1908 (syntypes of *A. Fauriei;* isotypes and photo. of no. 1366 in A. A.).

Adina Fauriei was first identified with *A. rubella* by Nakai (l. c.).

Mussaenda Esquirolii Léveillé. — Rehder, l. c. 319 (1935). — Handel-Mazzetti, Symb. Sin. **7:** 1019 (1936).

Tarenna incerta Koorders & Valeton. — Rehder in Jour. Arnold Arb. **16:** 321 (1935).

Webera pallida Franchet ex Brandis, Ind. Trees, 378 (1906).
Webera Cavaleriei Léveillé.
Webera Henryi Léveillé.

When discussing this species in 1935, I had not yet seen the types of *Webera pallida* Franch. Visiting Paris later in the same year, I had the opportunity of examining the fruiting and flowering specimens of Delavay 902, labeled by Franchet *Webera pallida* which must be considered the types, though Brandis unfortunately did not cite any numbers, but only Henry and Delavay as collectors, and also a specimen or specimens from Upper Burma collected by Smales. It is probably on the last named specimen that the description of the fruit as "a yellow drupe, seeds 4–6" is based, for neither Henry's nor Delavay's specimens have fruits with as many seeds; in the former I found the number of seeds 1–3, in the latter 2–3. In the Philippine specimens, the number is usually 1 or 2, but Merrill (in Philipp. Jour. Sci. **17:** 469) states that he found as many as 5 seeds in specimens otherwise indistinguishable. Since seeing Delavay's specimens I have no further doubt that *Webera pallida* Franch. is identical with *T. incerta.*

To *Tarenna incerta* belongs Cavalerie nos. 3053 and 3585 referred by Léveillé to "*Lindera megaphylla* Brandis."

Ixora Henryi Léveillé. — Rehder in Jour. Arnold Arb. **16:** 322 (1935).

In Flore du Kouy-Tchéou, 367, Léveillé cites as a synonym *Ixora Cavaleriei,* a name apparently never validly published.

Psychotria Henryi Léveillé. — Merrill in Lingnan Sci. Jour. **5:** 176 (1927). — Rehder in Jour. Arnold Arb. **16:** 322 (1935).

Psychotria Prainii Léveillé. — Rehder in Jour. Arnold Arb. **16:** 322 (1935).

Ficus rufipes Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6:** 148 (Ficus Spec. China, 16) (1907); in Fedde, Rep. Spec. Nov. **4:** 86 (1907), pro parte, quoad specim. Esquirol 75, 76. — Handel-Mazzetti, Symb. Sin. **7:** 95 (1929), in nota.

China. Kweichou, add: Ouang-mou, *J. Esquirol,* nos. 75, 76, June 1904 (syntypes of *Ficus rufipes;* photo. in A. A.).

Handel-Mazzetti (l. c.) points out that of the syntypes of *Ficus rufipes* only Cavalerie 340 belongs to *F. foveolata,* while Esquirol 75 and 76 belong to the Rubiaceae (see also Jour. Arnold Arb. **17**: 75). Esquirol 75 and 76 consist of one branch with an inflorescence and some detached leaves in a pocket with a single label and mounted on one sheet.

Lasianthus Hartii Franchet. — Merrill in Lingnan Sci. Jour. **13**: 49 (1934). — Rehder in Jour. Arnold Arb. **16**: 323 (1935).

Canthium Dunnianum Léveillé.

Canthium Dunnianum was identified with *Lasianthus Hartii* already in 1934 by Merrill (l. c.).

Paederia scandens (Lour.) Merrill. — Rehder, l. c. 324 (1935). — Handel-Mazzetti, Symb. Sin. **7**: 1023 (1936).

Paederia Esquirolii Léveillé.
Paederia Dunniana Léveillé.
Paederia Mairei Léveillé.

Paederia yunnanensis (Lévl.), comb. nov.

Paederia tomentosa Bl. var. *purpureo-coerulea* Léveillé & Vaniot. — Vide Rehder l. c. sub *P. Wallichii.*

Paederia Bodinieri Léveillé, Fl. Kouy-Tchéou, 371 (1915), non Léveillé (1914). — Handel-Mazzetti in Sinensia, **5**: 21 (1934); Symb. Sin. **7**: 1023 (1936).

Cynanchum yunnanense Léveillé. — Vide Rehder, l. c., sub *P. Wallichii.*

Paederia Wallichii "Hook. f." ex Rehder in Jour. Arnold Arb. **16**: 325 (1935); non Hooker f.

Paederia Rehderiana Handel-Mazzetti, Symb. Sin. **7**: 1377 (1936).

When referring *P. Bodinieri* as a synonym to *P. Wallichii,* I had seen no Himalayan material of the latter and relied on a comparison made at Kew. As Handel-Mazzetti has seen the type and states (in Sinensia **5**: 21) that it differs in several good characters from *P. Bodinieri,* I follow him in accepting the latter as a distinct species.

Paederia Cavaleriei Léveillé. — Merrill in Lingnan Sci. Jour. **7**: 323 (1929). — Rehder, l. c. 326 (1935). — Handel-Mazzetti, Symb. Sin. **7**: 1023 (1936).

Prismatomeris Labordei (Lévl.) Merrill, comb. nov.

Canthium Labordei Léveillé in Fedde, Rep. Spec. Nov. **13**: 178 (1914); Fl. Kouy-Tchéou, 368 (1915).

Lasianthus Labordei (Lévl.) Rehder in Jour. Arnold Arb. **13**: 340 (1932); **16**: 323 (1935).

Dr. E. D. Merrill informs me that he has referred *Canthium Labordei* to the genus *Prismatomeris* in a paper sent some time ago for publication to Sunyatsenia; that paper is probably now in press and may be out even before the present paper is published.

CAPRIFOLIACEAE[1]

Viburnum Cavaleriei Léveillé. — Rehder in Jour. Arnold Arb. **16:** 329 (1935).

Handel-Mazzetti (Symb. Sin. 1036. 1936) refers this species as a synonym to *V. chinshanense* Graebn., but as I pointed out (l. c.), the species though closely related to *V. chinshanense,* seems to be sufficiently distinct to be maintained as a species.

Viburnum foetidum Wall. var. **ceanothoides** (C. H. Wright) Handel-Mazzetti, Symb. Sin. **7:** 1038 (1936).

Viburnum ajugifolium Léveillé.
Viburnum Valbrayi Léveillé.
Viburnum foetidum Wallich ex Rehder in Jour. Arnold Arb. **16:** 331 (1935), quoad synon. et specim. citata.

Viburnum ceanothoides C. H. Wright seemed to me always quite a distinct form, but I hesitated to publish it as a new variety of this rather polymorphous species.

Triosteum himalayanum Wallich ex Roxburgh, Fl. Ind. **2:** 180 (1824).

Echium connatum Léveillé, Cat. Pl. Yun-Nan, *22* (1915).

CHINA. Yunnan: vallées humides de Tai-Hai, 3000 m., *E. E. Maire,* July 1912, "fl. verdâtres" (holotype of *Echium connatum;* photo. in A. A.).

Lonicera Pampanini Léveillé. — Rehder in Jour. Arnold Arb. **16:** 338 (1935), synon. exclud. — Handel-Mazzetti, Symb. Sin. **7:** 1048 (1936).

Through the kindness of Sir William Wright Smith, I have recently seen the type of *L. Henryi* var. *setuligera* W. W. Sm. which I had from the description identified with *L. Pampanini,* and I find that it is indeed a variety of *L. Henryi* Hemsl. To this variety belongs Tsai 57179 from Yunnan.

COMPOSITAE[2]

Vernonia arborea Hamilton in Trans. Linn. Soc. **14:** 218 (1825).

Vernonia Vanioti Léveillé in Fedde, Rep. Spec. Nov. **12:** 531 (1913); Cat. Pl. Yun-Nan, 56 (1916). — **Synon. nov.**

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[1] See Vol. **16:** 328.

[2] See Vol. **16:** 340.

CHINA. Yunnan: collines calcaires de Lo-kou, *E. E. Maire,* July 1912, "arbuste, feuilles rugueuses caduques, fl. violettes" (holotype of *V. Vanioti;* photo. in A. A.).

Vernonia Vanioti was determined by Gagnepain as *V. arborea* Ham. forma according to his label on the type sheet but Léveillé's name is not mentioned as a synonym in his treatment of the genus in Lecomte, Fl. Gén. Indochine, **3:** 462–487 (1924). The specimen has ovate-lanceolate or oblong-lanceolate glabrescent leaves and in these characters resembles the typical form of this apparently variable species.

In his manuscript publication Cat. Ill. Pl. Seu-Tchouen (1918) Léveillé published as plate 21 a crude illustration of this plant under the name *V. Vaniotiana.*

Vernonia volkameriaefolia DeCandolle, Prodr. **5:** 32 (1836).

Vernonia Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **11:** 304 (1912), non Vaniot (1907). — **Synon. nov.**

Vernonia Leveillei Fedde ex Léveillé, Fl. Kouy-Tchéou, 109 (1914).

CHINA. Kweichou: rivière de Pa-oua, *J. Esquirol,* no. 2679, March 1911, "arbrisseau" (holotype of *V. Esquirolii;* photo. in A. A.).

Vernonia Esquirolii was identified as *V. volkameriaefolia* by Gagnepain according to a note on the type specimen dated Nov. 1920, but Léveillé's name is not cited in Lecomte, Fl. Gén. Indochine.

Vernonia saligna DeCandolle, Prodr. **5:** 33 (1836).

Vernonia Martini Vaniot in Bull. Acad. Intern. Géog. Bot. **12:** 124 (1903). — Léveillé, Fl. Kouy-Tchéou, 109 (1914). — **Synon. nov.**

Vernonia Seguini Vaniot, l. c. 241 (1903). — Léveillé, l. c. (1914). — **Synon. nov.**

CHINA. Kweichou: sous-prefecture de Tchen-lin-théou à Ou-la-gay, *L. Martin* in herb. *Bodinier,* no. 1922, Oct. 9, 1897, "fleurs violettes" (holotype of *V. Martini;* photo. in A. A.); environs de Hoang-ko-chou, dans les terres incultes, *J. Seguin* in herb. *Bodinier,* no. 2472, Oct. 9, 1898 (holotype of *V. Seguini;* photo. in A. A.).

Vernonia Martini and *V. Seguini* were identified with *V. saligna* by Guillaumin according to a note on the type sheet, but Vaniot's names are not cited as synonyms in Lecomte, Fl. Gén. Indochine.

Vernonia papillosa Franchet in Jour de Bot. **10:** 368 (1896). — Léveillé in Cat. Pl. Yun-Nan, 56 (1916).

? *Vernonia arbor* Léveillé in Fedde, Rep. Spec. Nov. **11:** 304 (1912); Fl. Kouy-Tchéou, 109 (1914). — **Synon. nov.**

CHINA. Kweichou: halte près Hoang-guy-tun, route de Long-tchong, *J. Esquirol,* no. 2729, Oct. 15, 1911, "arbre 6 m." (holotype of *V. arbor;* photo. in A. A.).

Vernonia arbor was doubtfully referred to *V. papillosa* by Gagnepain according to a note on the type specimen; however, the acuminate bracts of the involucre, described as obtuse by Franchet, are certainly not in favor of this identification.

Vernonia extensa DeCandolle, Prodr. **5:** 33 (1836).

Vernonia subarborea Vaniot in Bull. Acad. Intern. Géog. Bot. **12:** 126 (1903). — Léveillé, Fl. Kouy-Tchéou, 109 (1914). — **Synon. nov.**

CHINA. Kweichou: montèe de torrent de Koon-lin, *L. Martin* in herb. *Bodinier,* no. 2568, Feb. 14, 1899, "sous-arbrisseau de 2.5 m., fleurs rosées" (holotype of *V. subarborea;* photo. in A. A.).

Vernonia subarborea was determined by Gagnepain according to a note on the type specimen as *V. extensa* DC. with which it seems to agree very well.

Aster lofouensis Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **8:** 281 (1910). — Léveillé, Fl. Kouy-Tchéou, 86 (1914).

CHINA. Kweichou: Lo-fou, *J. Cavalerie,* March 1907 (holotype; photo. in A. A.).

This is a very distinct and well-marked species characterized by slender ligneous branches and very narrow linear leaves up to 5 cm. long and 2–3 mm. broad, sessile and auriculate at base, subcoriaceous, scabrid above with deeply impressed midrib, tomentose beneath, with strongly revolute margin. The flower heads are borne in loose panicles or corymbs at the end of slender branches; the branchlets of the inflorescence are 1.5–6 cm. long terminated by 1–3 heads.

Microglossa albescens (DC.) Clarke, Compos. Ind. 59 (1876). — Léveillé, Cat. Pl. Yun-Nan, 40 (1915).

Aster Cavaleriei Vaniot & Léveillé in Bull. Soc. Bot. France, **53:** 549 (1906). — Léveillé, Fl. Kouy-Tchéou, 82 (1914). — **Synon. nov.**

CHINA. Kweichou: pentes de la rivière Tien-sen-kiao, *J. Cavalerie,* no. 1895, Nov. 1904, "fl. bleu" (holotype of *Aster Cavaleriei;* photo. in A. A.).

Aster Cavaleriei was referred to *M. albescens* by C. C. Chang according to a note on the type specimen.

Conyza viscidula Wall. ex DeCandolle, Prodr. **5:** 383 (1836).

Blumea conyzoides Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **7:** 22 (1909). — Léveillé, Fl. Kouy-Tchéou, 89 (1914). — **Synon. nov.**

CHINA. Kweichou: Lo-fou, *J. Cavalerie,* no. 3310, April 1907 (holotype of *Blumea conyzoides;* photo. in A. A.).

According to a note on the type sheet, *Blumea conyzoides* was identified by Gagnepain in 1920 with *Conyza viscidula,* but the name is not cited as a synonym in Lecomte, Fl. Gén. Indochine. Merrill (in Lingnan Sci. Jour. **15:** 428. 1936) cites *Blumea conyzoides* as a synonym of *Microglossa pyrifolia* (Lam.) Ktze.; he apparently did not see the type specimen, since he does not mention the name *Blumea conyzoides* in the discussion.

Blumea lanceolaria (Roxb.) Druce in Rep. Bot. Exch. Club Brit. Isles, **4:** 609 (1917). — Merrill in Trans. Am. Philos. Soc. n. ser. **24**^{2}**:** 387 (Comm. Loureiro Fl. Cochinch.) (1935).

Bileveillea (*Blumea*) *granulatifolia* Léveillé in Fedde, Rep. Spec. Nov. **8:** 449 (1910); Fl. Kouy-Tchéou, 87 (1914). — **Synon. nov.**

Blumea granulatifolia Léveillé, l. c. (1914), pro synon. praecedentis.

CHINA. Kweichou: Lo-fou, *J. Cavalerie*, no. 3708, March 1909, "couleur jaune" (holotype of *Bileveillea granulatifolia*, 3 sheets; photos. in A. A.).

At the suggestion of Dr. E. D. Merrill, I compared Léveillé's species with *Blumea lanceolaria* (Roxb.) Druce (*B. myriocephala* DC.) and find that there can be little doubt of their identity.

Chrysanthemum indicum Linnaeus, Spec. Pl. 889 (1753).

Chrysanthemum indicum L. var. *coreanum* Léveillé in Fedde, Rep. Spec. Nov. **10:** 351 (1912).

KOREA. Quelpaert: in littore Syckem, *E. Taquet*, no. 4664, Feb. 1908 (holotype of *C. indicum* var. *coreanum*; photo. in A. A.).

Taquet's specimen does not seem to differ from *C. indicum* L.

Senecio Walkeri Arnott, Pug. Pl. Ind. Or. no. 103 (1836). — DeCandolle, Prodr. **6:** 364 (1837).

Senecio araneosus DeCandolle, l. c. (1837).

Vernonia spelaeicola Vaniot in Bull. Acad. Intern. Géog. Bot. **12:** 123 (1903). — Léveillé, Fl. Kouy-Tchéou, 109 (1914). — **Synon. nov.**

Vernonia Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **4:** 331 (1907). — **Synon. nov.**

CHINA. Kweichou: environs de Hoang-ko-chou, fond d'une grande grotte, *L. Martin* in herb. *Bodinier*, no. 2570, Feb. 23, 1899, "tiges lianeuses, fleurs blanches" (holotype of *Vernonia spelaeicola*; photo. in A. A.); forêts, *J. Esquirol*, no. 581, Dec. 1906, "retombant du sommet des arbres" (holotype of *Vernonia Esquirolii*; photo. in A. A.).

Vernonia spelaeicola and *V. Esquirolii* were identified with *V. araneosa* by C. C. Chang according to a note on the type sheets of the two species.

Senecio Walkeri has priority by one year over the generally accepted name *S. araneosa*.

Senecio saxatilis Wallich ex DeCandolle, Prodr. **6:** 367 (1836).

Senecio Gentilianus Vaniot in Bull. Acad. Intern. Géog. Bot. **11**: 350 (1902). — Léveillé, Fl. Kouy-Tchéou, 105 (1914).

CHINA. Kweichou: environs de Kouy-yang, dans les montagnes â Lau-tsong-koan, *S. Bodinier*, no. 1916, Aug. 1917 (holotype of *S. Gentilianus;* photo. in A. A.).

Senecio Gentilianus was tentatively identified by L. Diels in 1911 with *S. saxatilis,* a determination later confirmed by C. C. Chang according to notes on the type sheet.

ADDITIONS AND CORRECTIONS

Keteleeria Davidiana (Bertrand) Beissner. — Rehder in Jour. Arnold Arb. **10**: 109 (1929).

Keteleeria Esquirolii Léveillé. — Flous in Bull. Soc. Hist. Nat. Toulouse, **70**: 324 fig. (1936); Trav. Lab. For. Toulouse, II. 4, art. **1**: 52. fig. (1936).
Podocarpus Mairei Lemée & Léveillé.

Keteleeria Esquirolii is maintained by Miss Flous as a distinct species chiefly separated from *K. Davidiana* by the bract being abruptly contracted at the apex into a short point, not 3-lobed and by the broader rounded scales. It seems doubtful, however, whether these characters are constant and reliable, and for the present I prefer to refer *K. Esquirolii* as a synonym or perhaps a geographical form to *K. Davidiana. Podocarpus Mairei* which is based on a branch with staminate flowers, is not mentioned by Miss Flous; according to her classification, it is apparently referable to *K. Evelyniana* Mast. which resembles *K. Davidiana* in the shape of the scales and bracts, but differs in the longer, somewhat acutish and indistinctly mucronulate leaves.

Salix Wilsonii Seemen. — Rehder, op. cit. **10**: 112 (1929). — Hao in Fedde, Rep. Spec. Nov. Beih. **93**: 41, pl. 1, fig. 2 (1936).

Salix Argyi Léveillé.

The treatment of this and the following species of Chinese willows by Hao agrees mostly with that in the previous publications of the writer.

Salix dodecandra Léveillé. — Rehder, l. c. 112 (1929). — Hao, l. c. 45, pl. 4, fig. 7 (1936).

Salix anisandra Léveillé & Vaniot. — Rehder, l. c. 113 (1929).
Salix Camusii Léveillé. — Rehder, l. c. 115.

Salix Cavaleriei Léveillé. — Rehder, l. c. 113 (1929); **17**: 65 (1936). — Hao, l. c. 46 (1936).

Salix polyandra Léveillé.
Salix Pyi Léveillé.
Salix yunnanensis Léveillé.

Salix angiolepis Léveillé. — Rehder, l. c. 113 (1929). — Hao, l. c. 40, pl. 1, fig. 1 (1936).

Salix erioclada Léveillé. — Rehder, l. c. 115 (1929); **17:** 65 (1936). — Hao, l. c. 70, pl. 20, fig. 40 (1936).

Salix luctuosa Léveillé. — Rehder, l. c. 115 (1929); **17:** 66 (1936). — Hao, l. c. 78 (1936).

Salix Wallichiana Andersson. — Rehder, l. c. 116 (1929). — Hao, l. c. 92 (1936).

Salix funebris Léveillé.
Salix Mairei Léveillé.
Salix pachyclada Léveillé. — Rehder, l. c. 116 (1929).

Salix andropogon Léveillé. — Rehder, l. c. (1929). — Hao, l. c. 109, pl. 42, fig. 83 (1936).

Salix variegata Franchet in Nouv. Arch. Mus. Paris, sér. 2, **10:** 82 (Pl. David. 120) (1887). — Hao, l. c. 110 (1936).

Salix Duclouxii Léveillé. — Rehder, l. c. 117 (1929); **17:** 66 (1936).
Salix Duclouxii var. *kouytchensis* Léveillé.
Salix kouytchensis (Lévl.) Schneider. — Rehder, l. c. 117 (1929).

The close relationships of the synonyms cited above with *S. variegata* and *S. Bockii* Seemen has been discussed by all authors dealing with these species. In 1929, Handel-Mazzetti referred *S. kouytchensis* to *S. Duclouxii* as a synonym. In 1936, Hao united the species cited above as synonyms and also *S. Bockii* with *S. variegata,* since they cannot be separated by stable and reliable characters and are also quite uniform in their appearance. It may be even doubted, if *S. Schneideriana,* a new species based by Hao on Schneider no. 3273 which Schneider himself had referred (in herb. Arnold Arb.) to *S. Bockii,* is specifically different; one might consider it possibly an extreme form with much longer, narrow-oblong glabrescent leaves.

Celtis Biondii var. **heterophylla** (Lévl.) Schneider. — Rehder, l. c. 123 (1929).

Celtis Bungeana var. *heterophylla* Léveillé.
Celtis Leveillei Nakai. — Metcalf in Sunyatsenia, **3:** 114 (1936).

Ficus foveolata Wallich ex Miquel. — Rehder, l. c. 124 (1929); **17:** 75 (1936).

Ficus rufipes Léveillé & Vaniot. . . . pro parte, quoad Cavalerie 340.

On page 125, line 9, for "type of *F. rufipes*" read "syntype of *F. rufipes*." The two other syntypes, Esquirol 75 and 76 belong to *Psychotria Prainii* Lévl. (see above, p. 248).

Ficus Martini Léveillé & Vaniot. — Rehder, l. c. 127 (1929); **17:** 75 (1936). — Merrill in Sunyatsenia, **1:** 54 (1930).

Merrill had already reduced in 1930 (l. c.) his *F. kwangtungensis* to *F. Martini,* a correction I had overlooked; therefore the words "Synon. nov." line 8 on p. 76 (op. cit. vol. 17) should be deleted.

Ficus Esquirolii Léveillé & Vaniot. — Rehder, op. cit. **17:** 79 (1936). — Handel-Mazzetti, Symb. Sin. **7:** 1370 (1936).

Ficus Vanioti Léveillé, Fl. Kouy-Tchéou, 434 (1915), pro parte, not Léveillé (1909). — Rehder, l. c. 82 (1936).

In the citation of specimens for "syntype of *F. Vanioti*" read "cited in Fl. Kouy-Tchéou under *F. Vanioti.*" *Ficus Vanioti* Lévl. (1909) has been identified as *Aglaia tetrapetala* (Pierre) Pellegr. (see above p. 211).

Clematis Pavoliniana Pampanini. — Rehder, op. cit. **10:** 187 (1929). — Chun in Sunyatsenia, **1:** 231 (1934).

Clematis Finetiana Léveillé & Vaniot.

Stauntonia obovata Hemsley. — Rehder, op. cit. **17:** 320 (1936). — Wu in Notizbl. Bot. Gart. Mus. Berlin-Dahlem, **13:** 372 (1936).

Akebia Cavaleriei Léveillé.

Illigera Dunniana Léveillé in Fedde, Rep. Spec. Nov. **9:** 326 (1911); Fl. Kouy-Tchéou, 74 (1914).

Frutex scandens, caule leviter striato. Folia 3-foliata, petiolo pilosulo 6 cm. longo vel longiore; foliola ovata vel elliptico-ovata, 4.5–10 cm. longa, breviter acuminata, basi rotundata vel subcordata, supra pilis accumbentibus asperata in costa longius et densius fulvo-pilosa, subtus tota facie laxe in costa venisque elevatis densius flavo-pilosis, reticulata, nervis utrinsecus 3 vel 4 trabeculis elevatis connexis. Inflorescentia paniculata elongata, dense fulvo-pilosula, ramulis cymosis 0.5–3 cm. longis, pedicellis brevissimis; flores flavi vel rubescentes; ovarium ovoideum, dense fulvo-pilosum; sepala oblonga, 6 mm. longa, acutiuscula, extus dense pubescentia et glandulosa, intus puberula; petala sepalis similia sed paullo angustiora et breviora; stamina petalis triente breviora filamentis pilosis et glandulosis, antheris ovalibus circ. 1 mm. longis dorso glandulosis; staminodia 2 mm. longa, oblongo-lanceolata, concava, triente inferiore in stipitem attenuata; disci glandulae minimae; stylus petalis paullo breviora, satis dense pilosus, apicem versus in stigma peltatum lobulatum dilatatus.

China. Kweichou: ouest de Lo-fou, sous-bois, *J. Cavalerie,* no. 2719, Nov. 1905, "longue liane à fl. jaunâtres ou rougeâtres" (holotype; photo. and fragments in A. A.).

As *I. Dunniana* represents evidently a distinct species, a more detailed description is given above to supplement Léveillé's brief one. The type specimen is rather fragmentary; it consists of two nearly bare branchlets with detached leaflets and flowers. The species belongs to Dunn's Appendiculatae and is similar to *I. Pierrei* Gagnep. in its inflorescence and shape of leaflets, but is easily distinguished by the pubescent leaflets and flowers.

Capparis cantoniensis Loureiro. — Rehder in Jour. Arnold Arb. **17:** 332 (1936).

Cudrania Bodinieri Léveillé.

Vanieria Bodinieri (Lévl.) Chun. — Merrill in Lingnan Sci. Jour. **5:** 64 (1927).

Rosa cymosa Trattinick. — Rehder, l. c. 339 (1936).

Rosa microcarpa Lindley. — Boulenger in Bull. Jard. Bot. Bruxelles, **14:** 202 (1936).

Boulenger cites as synonyms *R. Chaffanjoni, R. Bodinieri* and *R. Esquirolii* of Léveillé & Vaniot and *R. Cavaleriei* Lévl.

Rosa lucidissima Léveillé. — Rehder op. cit. **13:** 316 (1932).

Boulenger (l. c. 196) cites *R. lucidissima* as a synonym of *R. laevigata* Michx. and he also cites as another synonym with a query *R. Argyi* Léveillé (in Bull. Soc. Bot. France **55:** 56, 1908) which I have not seen.

Rosa acicularis Lindley. — Rehder, op. cit. **13:** 317 (1932). — Boulenger l. c. 131 (1936).

Rosa korsakoviensis Léveillé.

Rosa Marrettii Léveillé. — Rehder op. cit. **13:** 318 (1932).

Boulenger (l. c. 138) cites *R. Marrettii* Lévl. as a synonym of *R. cinnamomea* L.; he also refers *R. daurica* Pallas and *R. amblyotis* C. A. Mey. to *R. cinnamomea* as synonyms.

Andrachne Esquirolii Léveillé. — Rehder, op. cit. **14:** 229 (1933). — Handel-Mazzetti, Symb. Sin. **7:** 1372 (1936).

Handel-Mazzetti refers to *A. Esquirolii* as synonyms his *A. attenuata* and *A. persicariaefolia* Lévl. He also publishes as a new combination *A. Esquirolii* var. *microcalyx* (*A. attenuata* var. *microcalyx* Hand.-Mazz.).

(To be concluded in No. 4)

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BIBLIOGRAPHICAL NOTES

ETHELYN M. TUCKER

Andrews, Henry C. Roses. Henry C. Andrews, an English artist and botanist, who resided in London, and flourished between the years 1794 and 1830, published a series of colored engravings, with descriptions of rare plants, entitled "The Botanist's Repository" (10 vol., 1797–1815?) and monographs on the heaths, geraniums and roses. Beyond this we know little of him, not even his second name.

"Roses" was apparently a very rare work not to be found in many libraries nor listed in sales catalogues, and about which little can be learned. The full title of this work is: "Roses; or, A monograph on the genus Rosa containing coloured figures of all the known species and beautiful varieties, drawn, engraved, described, and coloured from the living plants." 2 vol. London. 1805–28. 4°. [122] colored plates. The British Museum gives only the entry, no enlightening notes, but it is quite evident that the work was published in parts and that upon completion the plates were rearranged. As issued the plates were unnumbered, numbers being assigned to species and varieties only in the indexes according to the rearrangement, and although the index number of 129 is accepted by Pritzel as the number of plates there are in reality but 122 plates, more than one rose being often figured on a plate.

Redouté in the preface to his "Les Roses" speaks slightingly of Andrews' work, remarking that it is far from satisfying to naturalists and amateurs and that although the drawings are in natural size and several roses are presented in their complete form, they are for the most part grouped without art and without grace, the outlines of many presenting even a grotesque form. He grudgingly admits, however, that the monograph offers a sort of merit which in spite of its imperfections has made it eagerly received in England, as it gives drawings of a large number of roses little distributed in cultivation and which have never before been figured. While there is no doubt much truth in Redouté's criticism, it should not be taken too seriously, as the only two other works devoted exclusively to roses which preceded Redouté's own work, those of Mary Lawrance and Roessig, also received their share of caustic criticism. All three works in later years proved their importance in the literature of this genus. It is then with interest that we turn to an examination of the dates of Andrews' work.

A large number of the plates bear no date, notwithstanding the "direction of the Act" (then in force, but unfortunately allowed to lapse) that

DATES OF PUBLICATION.

Number	Date	Number	Date	Number	Date
Vol. I		45	1806	88	1806
1	n.d.	46	1805	89	n.d.
2		47	1806	90	[1804]
3	[1828]	48	[1810]	91	n.d.
4	after 1811	49	1805	92	1809
5	n.d.	50	1805	93	1805
6	1806	51	n.d.	94	1805
7	1806	52	1806	95	[1828]
8	[1824]	53	1806	96	drawn 1822
9		54	1806	97	n.d.
10	n.d.	55	[1826]	98	drawn 1826?
11	1806	56	1806	99	n.d.
12	drawn 1810	57	after 1816	100	[1817]
13	1805	58	drawn 1810	101	1860 [sic], 1806
14	1806	59	1805	102	1806
15	1806	60	1806	103	1806
16	1806	61	[1824]	104	n.d.
17	1806	62		105	[1808]
18	n.d.	63	1806	106	[1822]
19	1806	64	1805	107	[1825]
20	1806	65	drawn 1815?	108	drawn 1827
21	1805			109	n.d.
22	n.d.	Vol. II		110	[1809]
23	1805	66	1805	111	1805
24	1806	67	n.d.	112	[1821]
25	drawn 1826	68	[1805]	113	
26	n.d.	69	after 1816	114	drawn 1809
27	[1807]	70	[1817]	115	drawn 1810
28	1816? or 1817?	71	[1817]	116	1817
29	1805	72	1806	117	1806
30	drawn 1824	73	after 1826	118	1824
31	drawn 1816	74	n.d.	119	n.d.
32	[1821]	75	drawn 1819	120	after 1817
33		76	drawn 1821	121	1806
34	drawn 1810?	77	[1810]	122	[1804]
35	n.d.	78	1806	123	n.d.
36	[1817]	79	drawn 1812	124	1806
37	1805	80		125	n.d.
38	after 1823	81	after 1815	126	[1817]
39	[1810]	82	drawn 1823	127	[1817]
40	drawn 1808	83	[1805]	128	1822
41	after 1820	84	drawn 1822	129	[1807]
42	n.d.	85	[1826]		
43	[1817]	86			
44	drawn 1822	87	drawn 1827		

each should be dated. In some cases where the plates were undated the text informs us that the drawing was made on a certain date, while in other cases a watermark on either the plate itself or the accompanying page of text is our only clue. These do not definitely place the date of publication but give an approximate date and assure us that the plates could not have been published earlier. Volume one has in addition to its title-page, dated 1805, an illustrated title-page figuring a rose tree in colors, with the caption "Miniature figure of the R, villosa or Tree Rose as it flowered in the Garden of the Hon$^{\mathrm{ble}}$, W, Irby, near Farnham in, 1810." We can, therefore, place little dependence on title-page dates, as the actual dates of publication, but the dates of the drawings so inconsistent with title-page dates, showing an arbitrary grouping together of plates in the two volumes, are in themselves of interest.

It is probable that the title-page for 1805 together with Introduction were intended for the entire work and printed upon the inception of the work, that the plates were issued in fascicles as drawn and later brought together in the two volumes. Following the introduction in Volume I, we find "Remarks on the Factitious increase of the Genus Rosa," wherein Andrews writes, "Upwards of twenty years have elapsed since the commencement of this work till its conclusion. We have separated the work into two parts or volumes, the first containing all the larger roses, the second nearly all the smaller roses." Each volume, therefore, contains plates dated from 1805 to 1826 or 1827.

In the foregoing table the precise date of publication is without further indication, the date of drawing is so indicated, and the date in brackets is that of the watermark. Where two numbers are figured on one plate they are indicated by a brace.

Wallich, Nathaniel. Tentamen florae napalensis illustratae.

Only two fascicles of this rare work by Nathaniel Wallich (formerly Nathan Wolff) were ever published. They comprise 64 pages and 50 plates, the first twenty-five plates in colors. Page 64 ends abruptly in the middle of a sentence. In the Arboretum copy, the two fascicles are bound together in ½ crushed Levant, the cover of "1. Fascicle. Calcutta and Serampore. 1824," mounted on the face of the volume. There is no title-page and no cover for fascicle 2, but as catalogues consulted give the date 1826, or [1824]–26, it would appear that the second fascicle had a cover bearing the date 1826. From the arrangement of the pages and plates, the contents of each fascicle may be easily judged and the following citation safely assumed as correct:

Fasc. i, pages 1–24, plates 1–25. 1824.
" ii, " 25–64, " 26–50. 1826.

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THE STRUCTURAL VARIABILITY OF THE SECONDARY WALL AS REVEALED BY "LIGNIN" RESIDUES

I. W. BAILEY
and
THOMAS KERR[1]

With plates 211–214

INTRODUCTION

WE HAVE SHOWN in previous papers (1, 10) that the cellulosic matrix of the secondary wall is composed of a continuous and firmly coherent system of anastomosing fibrils which grade down to 0.1 μ or less in diameter. The diverse structural patterns of the secondary wall are due, primarily, to variations in the size, number, and arrangement of these anastomosing fibrils. Layers of conspicuously different optical anisotropy — i.e., in transverse or longitudinal sections of a wall — are commonly due to different orientations of the threadlike aggregations of chain molecules of cellulose in successively formed parts of the secondary wall. Lamellae of varying porosity or density are due to fluctuations particularly in the number of fibrils per unit area. In other words, the fibrils are loosely aggregated in the more porous lamellae and are closely compacted in the denser lamellae.

Lignin and other non-cellulosic substances may be deposited in the elongated, intercommunicating interstices of the cellulosic matrix, thus giving rise to two continuous, interpenetrating systems of different chemical composition. In the case of certain heavily "lignified" tissues and in cotton of the "green lint" variety, it is possible, as we have shown (1, 10), to dissolve either system without seriously modifying the con-

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[1] Parts of these investigations were made by the junior author as a National Research Council Fellow in Botany.

tinuity or the structural pattern of the remaining system. Therefore, in the case of such cells, there are three methods of studying the structural patterns of the secondary wall: (1) by direct observation of chemically untreated sections; (2) by removing the non-cellulosic constituents and carefully swelling the purified cellulose; and (3) by dissolving the cellulose with concomitant swelling of the non-cellulosic residue. The structural residues obtained by the last two methods are remarkably similar, the denser parts of one corresponding to the more porous parts of the other. Thus, the structural pattern of the cellulose may be reconstructed from the non-cellulosic residue and *vice versa*. Swollen sections of the purified cellulose afford excellent objects for critical visual examination, but "lignin" residues are easier to prepare, and are preferable for photomicrography in dealing with lignified tissues, e.g., wood.

TYPES OF LIGNIFICATION AND OF RESIDUES OBTAINED BY TREATMENT WITH 72% SULPHURIC ACID

In 1903, De Lamarlière (11) published the results of an extended investigation of Mäule's (12) test[1] for lignification. He demonstrated that the lignified tissues of the vascular cryptogams and gymnosperms, exclusive of the Gnetales, give a brown coloration with this test, whereas the lignified tissues of the angiosperms give the typical violet-red color. De Lamarlière's distinction between the behavior of the lignified tissues of the Gnetales and angiosperms, on the one hand, and of the remaining representatives of the vascular plants, on the other hand, has been confirmed by Schorger (16), Crocker (4), Sharma (17), and Schindler (15). Crocker (5) emphasized the fact, however, that certain samples of the wood of *Podocarpus amara* Bl. give a positive red coloration with the Mäule test, and Casparis (3) noted that the lignified vessels of the dicotyledonous *Aconitum Napellus* L. yield a negative brown color.

As early as 1849, Payen (13), in reporting upon the work of Vincent, called attention to the fact that the lignified fibers of certain angiosperms turn red when treated successively with chlorine and ammonia. Bevan and Cross (2) found that the yellow color of chlorinated jute fibers turns to a brilliant magenta in hot sodium sulphite, and subsequently showed (6) that chlorinated dicotyledonous woods exhibit this striking change in coloration, whereas chlorinated coniferous woods do not. Crocker (4), Harlow (7), and others are of the opinion that the chlorine-sodium sulphite reaction is essentially a Mäule test, since chlorine water may be

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[1] In a positive Mäule test, a violet-red color develops when lignified tissue is treated for five minutes in a 1 per cent solution of potassium permanganate, washed, treated with dilute hydrochloric acid, washed, and then subjected to the action of ammonia.

substituted for potassium permanganate-HCl, and sodium sulphite and other alkalis for ammonia, in the Mäule test. We have found, in our extensive surveys of many gymnosperms and angiosperms, that the chlorine-sodium sulphite and Mäule tests are quite interchangeable and yield parallel and concordant results.

The woods of the conifers do not exhibit positive colorations with either of these tests, but give intense red colorations with phloroglucinol and hydrochloric acid. Furthermore, as shown by Harlow (7), the secondary walls of the tracheids do not disintegrate upon treatment with 72% sulphuric acid. In the case of *Podocarpus amara,* which is an exception to this general rule, the parts of the secondary walls which give an intense, positive, violet-red color with the Mäule test, exhibit a feeble coloration with phloroglucinol-HCl, and tend to disintegrate upon treatment with strong mineral acids, leaving a finely granular residue of insoluble material. Conversely, the parts which give a strong coloration with phloroglucinol-HCl exhibit a feeble or negative reaction with the Mäule test and persist, upon treatment with 72% sulphuric acid or 41% hydrochloric acid, as coherent structural residues.

Macroscopically, the lignified woods of most dicotyledons exhibit a positive Mäule test, as De Lamarlière and others have shown, although the intensity of the violet-red color varies greatly from specimen to specimen. *Microscopically,* specific categories of the constituent cells may behave quite differently from the tissue as a whole. Thus, the walls of the vessels or parenchymatous cells frequently give an intense coloration with phloroglucinol-HCl, a negative or relatively feeble Mäule reaction, and coherent structural residues, upon treatment with 72% sulphuric acid; whereas the secondary walls of the fiber-tracheids or libriform fibers exhibit an intense violet-red color with the Mäule test and disintegrate upon treatment with strong mineral acids. Conversely, the walls of the wood fibers may give an intense coloration with phloroglucinol-HCl, a feeble or negative Mäule reaction, and coherent structural residues, whereas the secondary walls of the parenchymatous cells may exhibit a strongly positive Mäule test and disintegrate into a finely granular residue of insoluble material. Similarly, the central layers of the secondary wall may give an intense Mäule test and disintegrate upon treatment with 72% sulphuric acid when the inner and outer layers do not, and *vice versa.*

It is significant that, in the case of both gymnosperms and angiosperms, walls or layers which persist as coherent structural residues, when the cellulose is dissolved, usually give a very intense red coloration with phloroglucinol-HCl; whereas those which disintegrate commonly do not, although they may give a strong positive coloration with either the Mäule test or the chlorine-sodium sulphite reaction. In other words, the available cumulative circumstantial evidence suggests that, in general, lignified secondary walls, which persist as coherent structural residues upon treatment with strong mineral acids, contain a relatively high ratio of associated aromatic aldehyde. Where the walls exhibit an intense coloration with the Mäule test, but disintegrate upon treatment with 72% sulphuric acid, it is possible to obtain coherent structural residues by first soaking the sections in a solution of vanillin.

There are, however, a number of complicating factors which must be considered in dealing with these color reactions and with residues remaining after treatment with strong mineral acids. Many woods, particularly heartwoods, contain substances which seriously interfere with, or even inhibit, the color tests, and many of them are saturated with substances, other than lignin, that are insoluble in 72% sulphuric acid. Generally, if the sapwood of a species produces a granular residue after treatment with 72% sulphuric acid, the presence of heartwood substances will not change the residue into a coherent structure, but it is probable that certain of the apparent exceptions to the correlations that have been outlined in preceding paragraphs may be due to such complicating factors as these.

It should be emphasized, in this connection, that in studying the structural patterns of the secondary wall, it is immaterial whether the interstices of the cellulosic matrix are filled with lignin or with a mixture of substances that are insoluble in 72% sulphuric acid. It is essential merely that the non-cellulosic constituents persist as a coherent residue which is capable of swelling without excessive distortion of the original structural pattern. For convenience, we shall refer to the insoluble parts of the wall as "lignin" residues, regardless of their exact chemical composition.

In dealing with most coniferous woods, it is possible to obtain adequate preparations by treating sections directly with 72% sulphuric acid. In the case of dicotyledonous woods, there are three types of cell walls or walls layers, — (1) those which give coherent structural residues upon treatment with strong mineral acids; (2) those which distintegrate into a finely granular residue unless they are given pretreatments with vanillin or some equivalent reagent; and (3) unlignified or lightly lignified walls and layers which distintegrate even when given prolonged pretreatments, and whose structural patterns should be obtained from the cellulosic matrix. Certain tropical dicotyledons give uniformly coherent lignin residues, but the secondary walls of fiber tracheids and libriform fibers in most temperate species disintegrate into a finely granular mass after the action of 72% sulphuric acid.

STRUCTURAL VARIABILITY OF THE SECONDARY WALL WITHIN DIFFERENT PARTS OF THE SAME STEM

In a previous paper (1), we discussed the principal types of structural patterns that occur within the secondary walls of tracheary cells and fibers. The broad central layers of thick secondary walls exhibit a number of different patterns that are due, primarily, to varying porosities of the cellulosic matrix. Thus, there are (1) layers which have a prevailing concentric (*Fig. 3*) structure throughout; (2) layers which have a dominantly radial (*Fig. 2*) pattern; and (3) others which exhibit various complex, intermediate, or radio-concentric (*Fig. 6*) structures. In addition, the central layer of the secondary wall not infrequently has conspicuous broad zones (*Figs. 1, 8,* and *12*) which are due largely to variations in the amount of non-cellulosic material that is deposited in the interstices of successively formed parts of the wall. These zones may or may not be correlated with changes in the structural pattern or in the porosity of the cellulosic matrix.

It is of considerable interest to determine whether specific structural patterns are characteristic of particular species, or whether they fluctuate in different parts of the same individual. In order to test this point, we have examined sections of xylem from different parts of the stems of various dicotyledons from both temperate and tropical habitats. In no case have we encountered a species in which the structural patterns of the secondary walls of the tracheids, fiber-tracheids, or libriform fibers are constant throughout different parts of the same plant. On the contrary, the patterns tend to fluctuate considerably from one part of the plant to another. Not infrequently, one may encounter all transitions from prevailingly concentric to dominantly radial structural patterns within different cells of the same stem.

Figs. 3–7 illustrate various structural patterns in the secondary walls of fiber-tracheids from different parts of the stem of *Poraqueiba sericea* Tul. The structure in *Fig. 3* is prevailingly concentric, and the alternating more porous and less porous lamellae are numerous and narrow. The lamellae are wider and less numerous in *Figs. 4* and *7;* and the wall, as a whole, exhibits, in addition to the obvious concentricities, a finely radial structure that is close to the limits of microscopic visibility. In *Fig. 6,* the secondary wall has a combined radio-concentric structure throughout; whereas in *Fig. 5* there is an abrupt transition from a radio-concentric to a dominantly radial structure, in passing from the first formed to the subsequently formed part of the wall.

Figs. 8 and *10–13* illustrate fluctuations in the structural patterns of fiber-tracheids from different parts of the stem of *Siparuna bifida* (P. & E.) A. DC. *Fig. 8* shows a radio-concentric pattern of extremely fine texture; and *Fig. 12,* a similar radio-concentric pattern of coarser texture. The broad dark-colored zones are due, in both cases, to more intense "lignification" rather than to marked variations in the porosity of the original cellulosic matrix. In *Fig. 10,* there is a gradual transition from radio-concentric to coarsely radial structure, in passing from the first-formed to the last-formed parts of the wall. In *Fig. 11,* as in *Fig. 5,* the transition is abrupt. In *Fig. 13,* most of the wall has a prevailingly and conspicuously radial structure.

It is evident, accordingly, that not only may the structural pattern of the secondary wall vary greatly in different cells of the same tissue, but also in different parts of the same wall. The fluctuations are, in general, of two distinct kinds: (1) those which involve changes in the type of structural pattern, e.g., from radial to concentric or *vice versa;* and (2) those which involve merely a change in texture, e.g., from finely to coarsely radial or *vice versa.*

One of us (10) has shown that, in the case of the secondary wall of the cotton hair, each of the daily growth rings consists of two parts, a more porous and a less porous lamella. The porosity and width of the successively formed lamellae appear to be correlated with variations in environmental factors. It seems probable that many of the concentricities in the secondary walls of wood fibers may similarly be correlated, either directly or indirectly, with fluctuations in environmental factors; since cells which developed simultaneously not infrequently exhibit identical variations in their sequences of lamellae.

Although the cytological and physiological factors which lead to the formation of a radially lamellated secondary wall are at present entirely obscure, there are certain data available which are of considerable interest in any discussion of radial structural patterns.

In the case of the Coniferae, as Hartig (8) and others have shown, the peculiar tracheids of the so-called compression wood, or Rotholz, have an anomalous type of secondary wall, the broad inner part of which is composed of coarse, radio-helically oriented plates. These plates are separated laterally by corresponding radio-helical discontinuities in the cellulosic matrix, *Fig. 16.* Furthermore, the broad inner layer is separated from the narrow first-formed layer of the secondary wall by an isotropic layer of non-cellulosic composition. On the contrary, the secondary wall of normal coniferous tracheids is composed of narrow inner and outer layers, and a central layer of varying width which is characterized by having a finely concentric structure (*Fig. 14*), i.e., alternating more porous and less porous lamellae, such as occur in the cotton hair. There are no actual discontinuities in the cellulosic matrix, and the three layers of the secondary wall are due to varying orientations of the cellulose in the successively formed parts of the wall.

Rotholz is formed, apparently, in response to geotropic stimuli, and in nature is distributed largely in those parts of the stem and branches which are subjected to compression. Thus, it develops upon the under side of branches and of bent or inclined stems, and also in stems of erect trees which are subjected to forces, — e.g., prevailing winds or asymmetrical crowns — that tend to deflect the stem from a truly vertical position. That the formation of Rotholz is not due, however, to compression of the tissues may be demonstrated by bending horizontal branches. The Rotholz forms in the under side of such branches, regardless of whether the tissues are under tension or compression.

It should be emphasized, in this connection, that Rotholz is more commonly and widely distributed in the large stems of apparently erect coniferous trees than is generally recognized. Furthermore, depending upon variations in the intensity of the geotropic stimuli, one encounters, particularly in the latewood of the annual growth layers, all gradations of transitional or intermediate structures between typical Rotholz tracheids and normal 3-layered tracheids. The secondary walls of such intermediate cells may have complex combinations of both concentric and radial patterns. Where the intensity of the geotropic stimulus is reduced, but is still dominant, the broad inner layer of the secondary wall may exhibit a prevailingly and finely radial pattern (*Fig. 15*) which is devoid of actual discontinuities in the cellulosic matrix. Although this broad inner layer is composed, throughout, of a continuous system of anastomosing fibrils, it tends to develop radio-longitudinal cracks in drying, a phenomenon which has led to a number of misleading generalizations concerning the structure of normal coniferous tracheids.

In view of such facts as these, it is evident that, in tracheids which are developing under the influence of geotropic stimuli, the apposition of cellulose varies in different radio-helical planes, resulting in the formation of alternating radio-helical lamellae of varying porosity. Where the geotropic stimuli are at a maximum, no cellulose is deposited in certain of the radio-helical planes, and the inner part of the wall is composed of separate radio-helical plates (*Fig. 16*). On the contrary, in normal coniferous tracheids, the apposition of cellulose is relatively uniform in any particular circumference (*Fig. 14*), but fluctuates during successive stages of wall formation, thus giving rise to concentric lamellae of varying porosity. Where both the normal and the geotropic influences are operative within the same cell, both types of apposition may occur simultaneously, resulting in various complex radio-concentric patterns.

In the case of the dicotyledons, the secondary walls of the fiber-tracheids and libriform fibers not infrequently form layers which have been referred to as "gelatinous" or "mucilaginous." These layers were differentiated by Sanio (14) and other early investigators by their peculiar optical properties and by their violet coloration in chloro-iodide of zinc. Sanio noted that they vary in number, width, and position even in walls of adjacent cells of the same tissue, and that they may be lignified or unlignified. The unlignified gelatinous layers are extremely hygroscopic, undergo striking changes in volume during drying and tend to develop radio-helical or radio-longitudinal cracks. They also are characterized by the fact that they stain intensely in ruthenium red and in Haidenhain's haematoxylin and other basic dyes.

That such layers are not composed largely of pectinaceous, gummy, or mucilaginous substances or of hemicelluloses, but rather of alpha-cellulose, may be demonstrated by a study of their chemical solubilities. Nor do they necessarily contain a much higher ratio of polyuronides than normal secondary walls, since they do not yield higher ratios of carbon dioxide upon hydrolysis with dilute hydrochloric acid. It is a question, therefore, whether the putative physical peculiarities and the staining reactions of these so-called gelatinous layers are due to the presence of non-cellulosic constituents or to purely physical peculiarities of the cellulosic matrix. In all the typical "gelatinous" layers that we have examined, the cellulosic matrix is of relatively coarse texture and exhibits a conspicuously radial (*Fig. 2*) or radio-concentric structure. Where there is a single so-called gelatinous layer, it may form the bulk of the secondary wall and abut directly upon the first-formed narrow layer, or it may form a broad inner layer (*Fig. 2*) or a central layer of varying width. It usually is separated from the more normal layers of the secondary wall by discontinuities in the cellulose which are filled with isotropic substances. Where there are several successively formed gelatinous layers, they tend to be separated by similar discontinuities, i.e., by tenuous layers of isotropic material. We have found in a survey of the woods of a large number of dicotyledons that the so-called gelatinous layers are not always more lightly lignified than the normal layers. In many cases, especially in certain tropical species (*Fig. 2*) the reverse is true, i.e. the "gelatinous" layers form coherent residues upon treatment with 72% sulphuric acid, whereas the normal layers disintegrate.

Jaccard (9) and others have shown that, in the strongly epinastic branches of various dicotyledonous trees, the wood fibers in the upper side of the branch tend to be of the gelatinous-layered type, whereas those in the under side of the branch are of normal structure. Although the distribution of the two cell types is less diagrammatic and regular in the epinastic stems and branches of dicotyledons than is that of the two types of tracheids in the hyponastic stems and branches of conifers, the available evidence suggests that "gelatinous" layers are formed in parts of dicotyledonous stems and branches which are developing under the influence of intense geotropic or phototropic stimuli. It seems likely, therefore, that in many dicotyledons, as in the conifers, wall layers having dominantly radial structural patterns develop under the influence of tropistic stimuli. It must be admitted, however, that much additional work remains to be done upon dicotyledons, in order to determine (1) whether all normal fiber-tracheids and libriform fibers have a concentric structural pattern and (2) whether tropistic stimuli of varying intensities are actually concerned in the development of such complex radio-concentric patterns as are illustrated in *Figs. 5, 6, 10–13.*

CONCLUSIONS

1. In the wood of both gymnosperms and angiosperms, walls or layers which persist as coherent structural residues upon treatment with strong mineral acids usually give an intense coloration with phloroglucin-HCl; whereas those which disintegrate commonly do not, although they may give a strongly positive coloration with either the Mäule test or the chlorine-sodium sulphite reaction.

2. Where the walls exhibit an intense coloration with the Mäule test, but tend to disintegrate into a finely granular residue upon treatment with 72% sulphuric acid, it is possible to obtain coherent structural residues by first soaking sections in a solution of vanillin or some equivalent reagent.

3. The structural patterns of the secondary walls of tracheids, fiber-tracheids, and libriform fibers are not constant for any particular species, but fluctuate more or less in different parts of the same stem and even, at times, of the same cell.

4. Prevailingly concentric, dominantly radial, and various intermediate radio-concentric, structures occur in different parts of the stems of conifers and of many dicotyledons.

5. In the case of coniferous tracheids, radial structural patterns are formed in parts of the stem and branches which are developing under the influence of geotropic stimuli.

6. The so-called gelatinous fibers of dicotyledonous woods have a conspicuously radial or radio-concentric structure. There is some evidence to indicate that these fibers occur in parts of stems and branches that are developing under the influence of tropistic stimuli.

7. Much additional work remains to be done upon dicotyledons, in order to determine whether all normal fiber-tracheids and libriform fibers have a prevailingly concentric structure, and whether all radial and radio-concentric structures of the secondary wall are due to tropistic stimuli.

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DESCRIPTION OF PLATES

Plate 211

Fig. 1. *Tetramerista glabra* Miq. Transverse section of a fiber-tracheid, mounted in a dilute solution of iodine-potassium iodide, and photographed with a Zeiss 70-water-immersion lens. The secondary wall exhibits broad dark and light zones correlated with varying intensities of lignification. × 2000

Fig. 2. *Rhizophora Mangle* L. Transverse section of a libriform fiber, stained with safranin and Haidenhain's haematoxylin. The heavily lignified, broad inner "gelatinous" layer of the secondary wall has a coarsely radial structural pattern. × 3000.

Plate 212

Fig. 3. *Poraqueiba sericea* Tul. Transverse section of a fiber-tracheid after treatment with vanillin and 72% sulphuric acid, showing narrow concentric growth rings of the secondary wall. × 800.

Fig. 4. *The same.* Showing wider growth rings. × 800.

Fig. 5. *The same.* Showing abrupt transitions from radio-concentric to prevailingly radial structure. × 800.

Fig. 6. *The same.* Showing radio-concentric structural pattern. × 800.

Fig. 7. *The same.* Showing relatively broad concentric growth rings. × 800.

Plate 213

Fig. 8. *Siparuna bifida* (P. & E.) A. DC. Transverse section of a fiber-tracheid after treatment with 72% sulphuric acid, staining with Haidenhain's haematoxylin, and mounting in aniline oil; showing radio-concentric structure and broad light and dark zones correlated with varying intensities of lignification. × 800.

Fig. 9. *Lophopetalum* species. Transverse section of a libriform fiber after treatment with phloroglucinol and hydrochloric acid, followed by 72% sulphuric acid, staining with Haidenhain's haematoxylin, and mounting in balsam; showing residue of the more heavily lignified zones of the secondary wall. × 800. Compare *Fig. 1.*

Fig. 10. *Siparuna bifida.* Transverse section of a fiber-tracheid after treatment with 72% sulphuric acid, staining with Haidenhain's haematoxylin, and mounting in aniline oil; showing transition from finely reticulate to prevailingly radial structural pattern. × 800.

Fig. 11. *The same.* Showing abrupt transition from radio-concentric to radial structural pattern. × 800.

Fig. 12. *The same.* Showing finely reticulate structure and broad zones of varying intensities of lignification. × 800.

Fig. 13. *The same.* Showing strikingly radial structural pattern. × 800.

Plate 214

Fig. 14. *Larix occidentalis* Nutt. Transverse section of a latewood tracheid, after treatment with 72% sulphuric acid, showing alternating more porous and less porous lamellae of the secondary wall. Total enlargement due to swelling and microscopic magnification × 9000.

Fig. 15. *Pinus longifolia* Roxb. Transverse section of a latewood tracheid, after treatment with 72% sulphuric acid, showing radial structural pattern of the secondary wall. Total enlargement × 9000.

Fig. 16. *The same.* Transverse section of a "Rotholz" tracheid, after treatment with 72% sulphuric acid, showing radial discontinuities in the secondary wall. Microscopic magnification × 2000.

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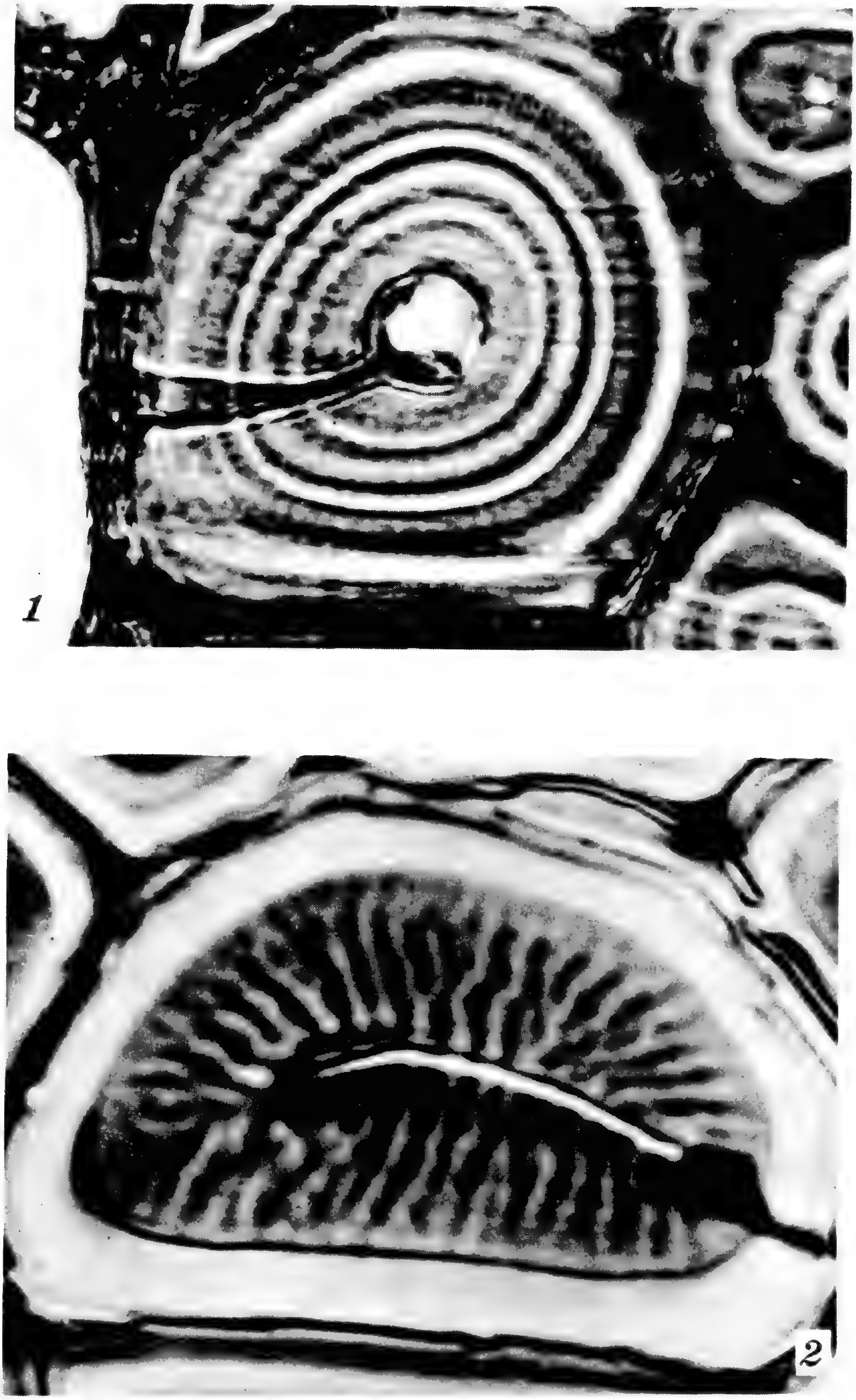
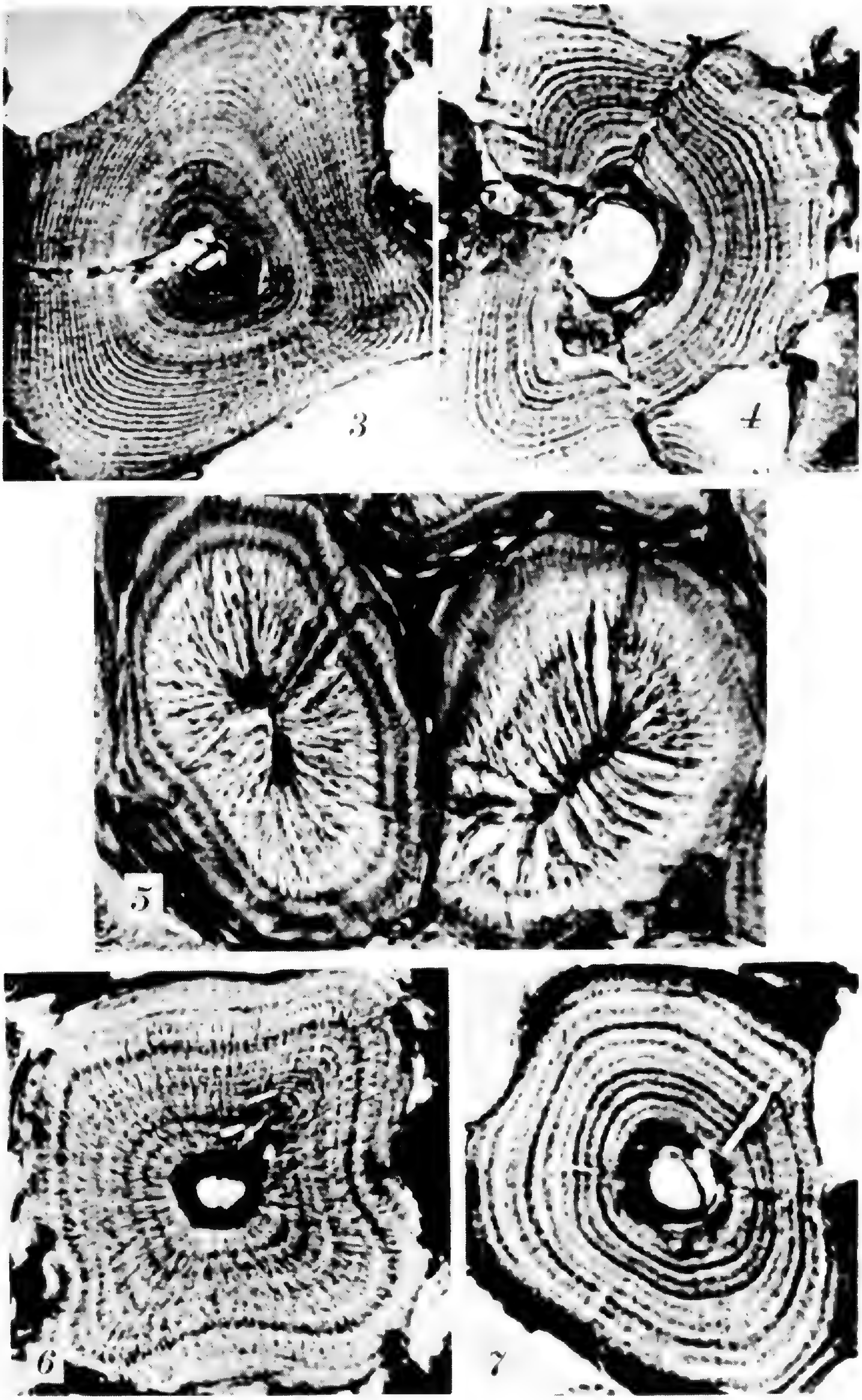


Structural Variability of the Secondary Wall

FULL-TONE—MERIDEN



Structural Variability of the Secondary Wall

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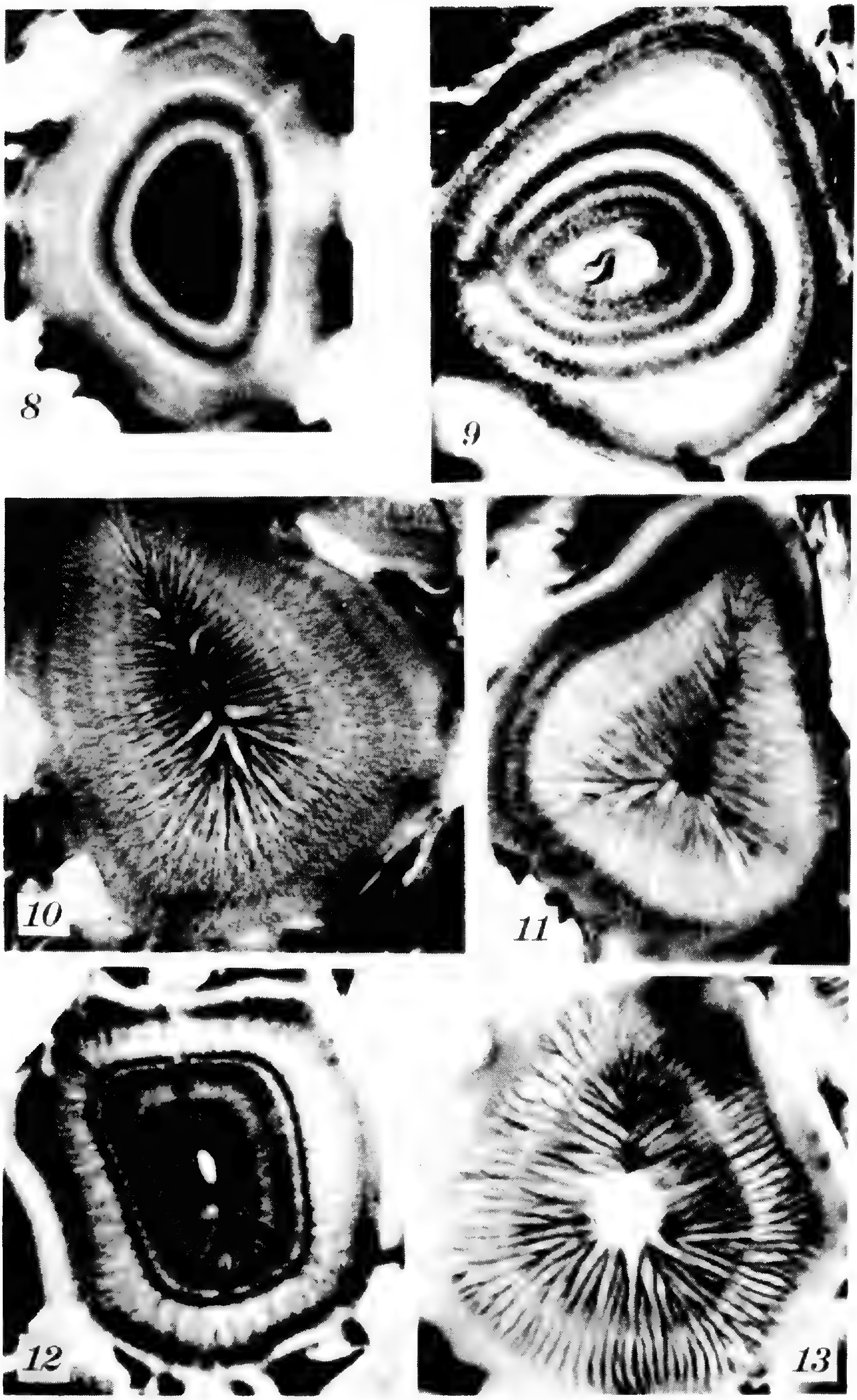
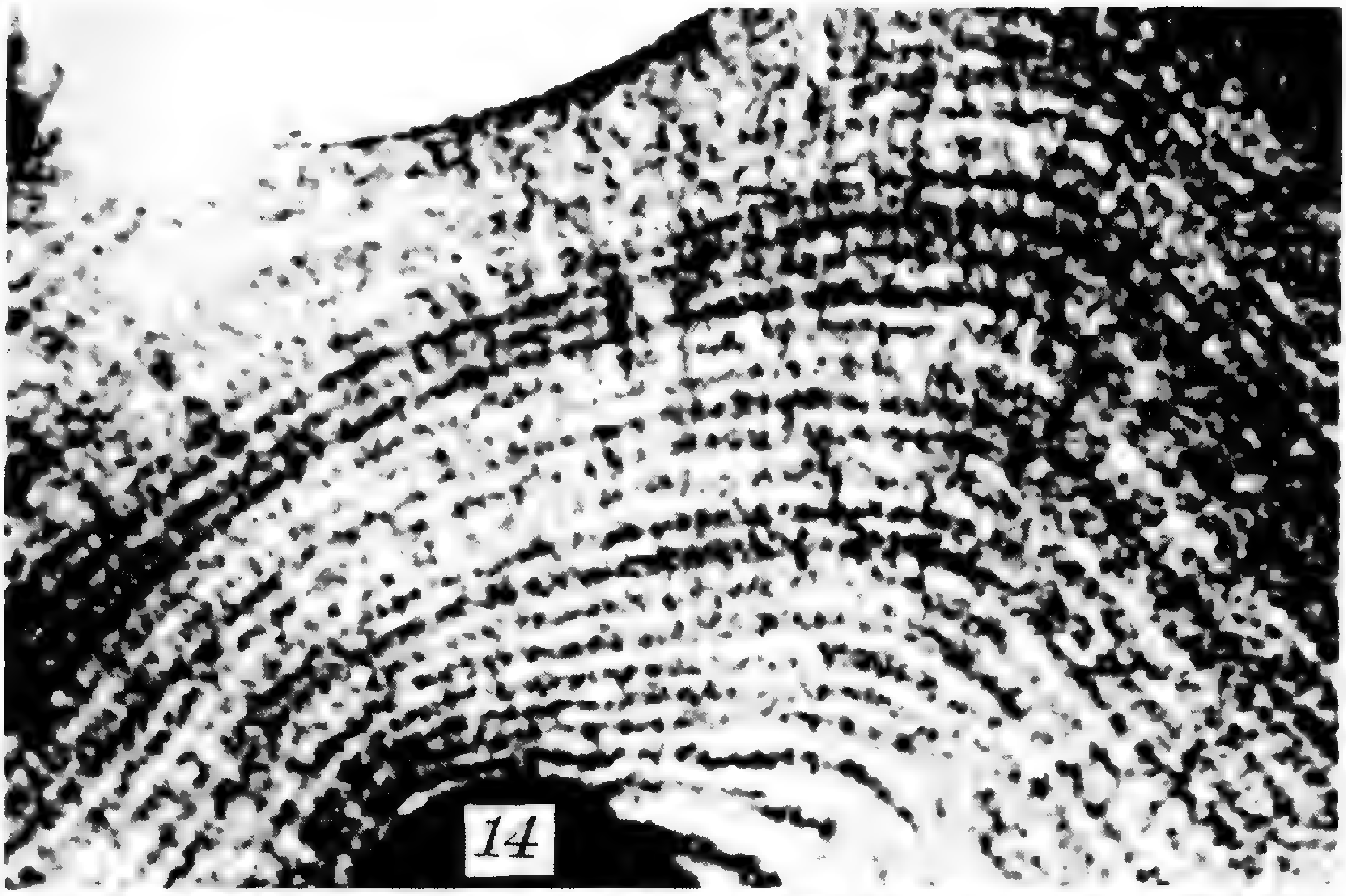
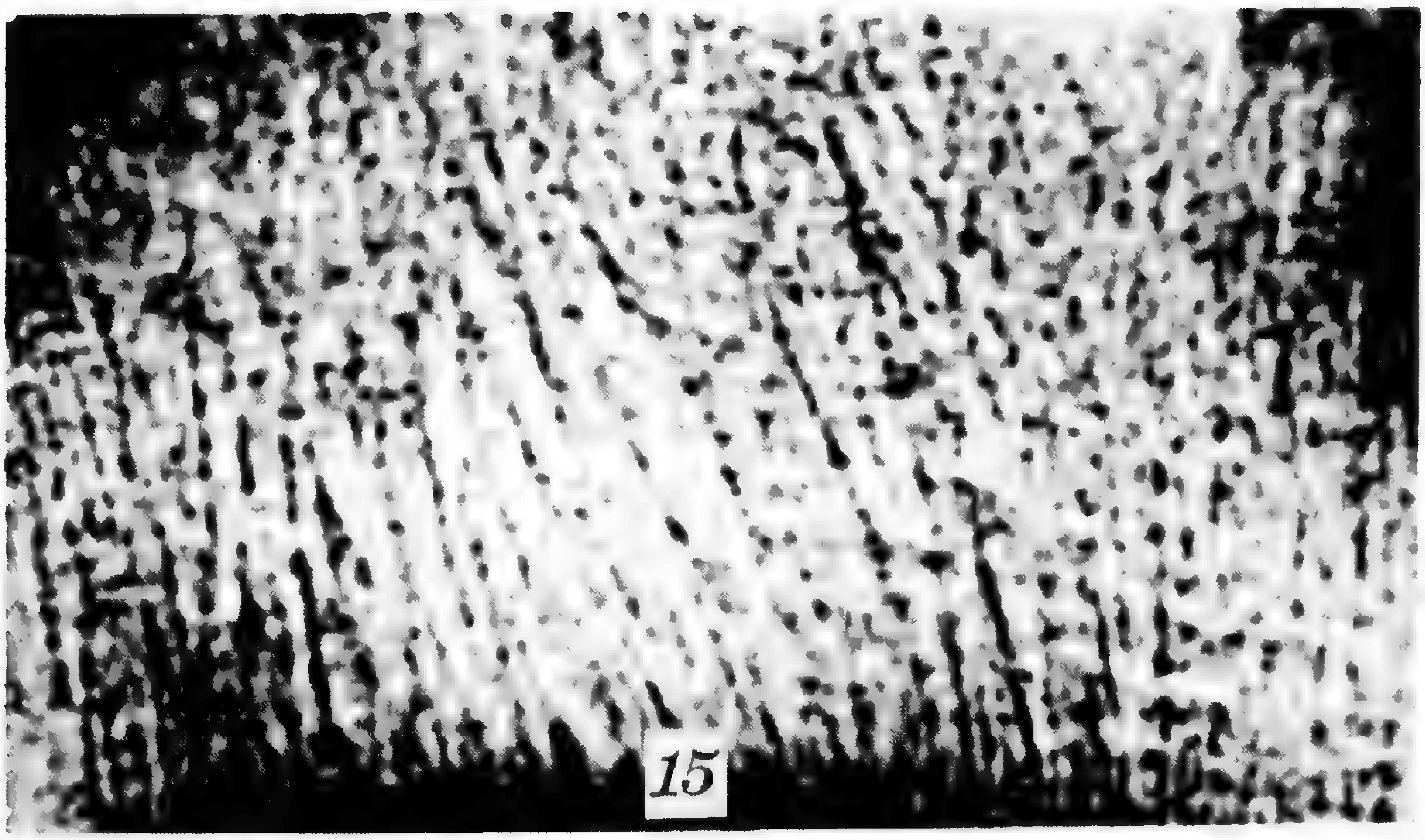
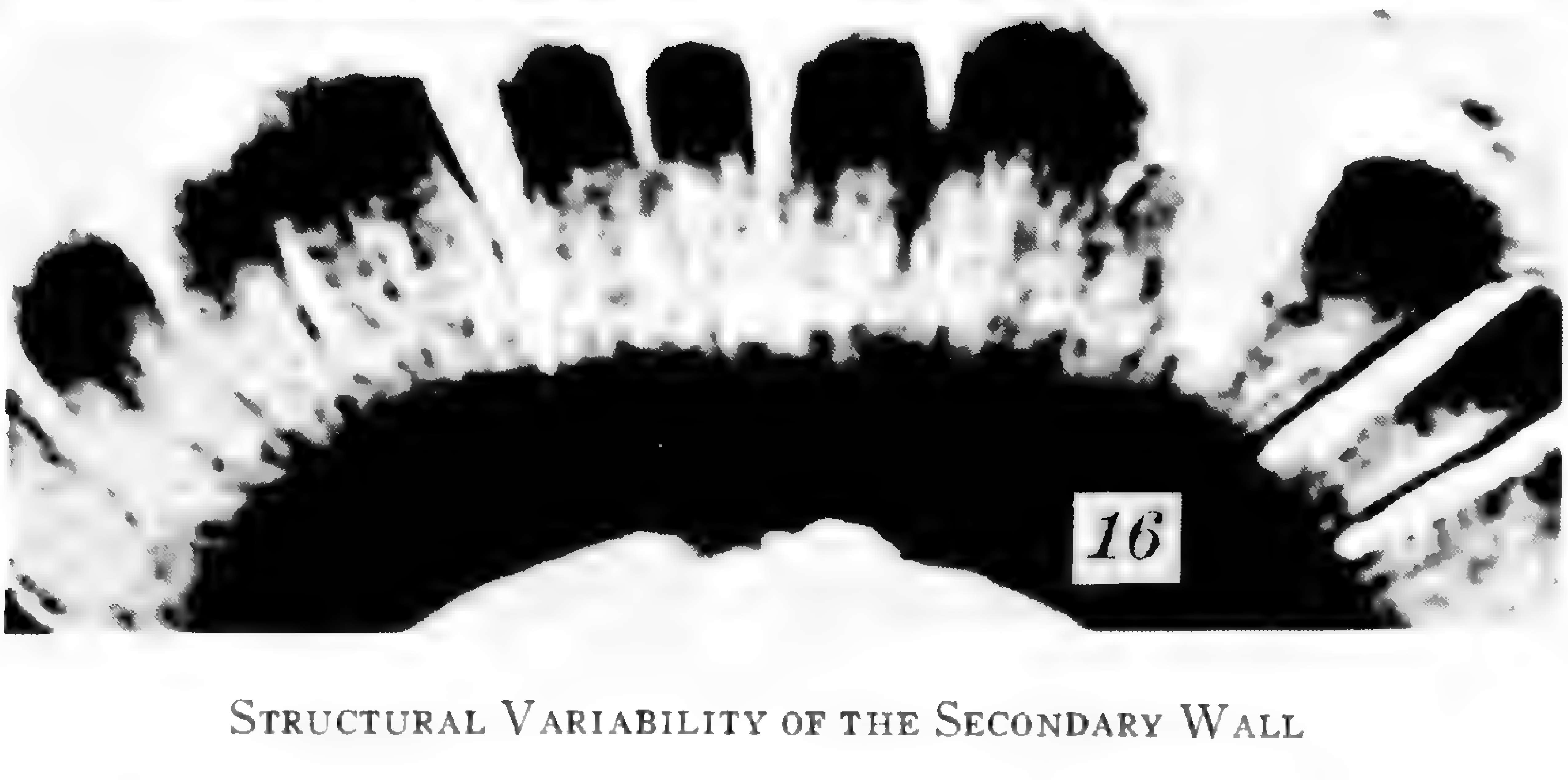


Structural Variability of the Secondary Wall

FULL-TONE — MERIDEN







Structural Variability of the Secondary Wall

FULL-TONE — MERIDEN

NOTES ON THE LIGNEOUS PLANTS DESCRIBED BY H. LEVEILLE FROM EASTERN ASIA

ALFRED REHDER

ADDITIONS AND CORRECTIONS[1]

Populus Bonatii Léveillé. — Rehder in Jour. Arnold Arb. **10:** 112 (1929). — Add: Handel-Mazzetti, Symb. Sin. **7:** 59 (1929).

Populus adenopoda Maximowicz. — Rehder in op. cit. **17:** 65 (1936). — Add as synonym:

> *Populus rotundifolia* var. *macranthela* (Léveillé & Vaniot) Léveillé, Fl. Kouy-Tchéou, 380 (1915); Cat. Pl. Yun-Nan, 250 (1917).

Salix amygdalina var. **nipponica** (Franch. & Sav.) Schneider. — Rehder in op. cit. **10:** 113 (1929).

> *Salix triandra* var. *discolor* "Andersson" ex Nakai, Fl. Kor. Sylv. **18:** 87, t. 11 (1930), vix Andersson

Nakai l. c. enumerates *S. Kinashii* Lévl. together with *S. amygdalina* var. *nipponica* as a synonym of *S. triandra* var. *discolor* [= *S. amygdalina* var. *glaucophylla* (Ser.) Seemen] but it seems doubtful if var. *discolor* is identical with var. *nipponica* which differs in the leaves being pubescent when young and usually smaller and narrower.

Salix koreensis Andersson. — Rehder in op. cit. **10:** 114 (1929). — Nakai in Bull. Soc. Dendr. France, **1928:** 51; Fl. Kor. Sylv. **18:** 164, t. 38 (1930).

> *Salix pseudo-lasiogyne* Léveillé in Fedde, Rep. Spec. Nov. **10:** 436 (1912). — Nakai in Bull. Soc. Dendr. France, **1928:** 47; Fl. Kor. Sylv. **18:** 168, t. 39 (1930).

Nakai (l. c.) enumerates *S. Feddei* Lévl., *S. pogonandra* Lévl., *S. pseudo-Gilgiana* Lévl., and *S. pseudo-jessoensis* Lévl., as synonyms, but considers *S. pseudo-lasiogyne* a distinct species which seems to differ chiefly in its linear-lanceolate to lanceolate leaves, but is hardly specifically different.

Salix hallaisanensis Léveillé in Fedde, Rep. Spec. Nov. **10:** 435 (1912). — Nakai in Tokyo Bot. Mag. **32:** 30 (1918); in Bull. Soc.

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[1] Continued from Vol. **18**: 206-257.

Dendr. France, **1928:** 46; Fl. Sylv. Kor. **18:** 129, t. 24 (1930). — Mori, Enum. Cor. Pl. 110 (1922).

Salix caprea "Linnaeus" ex Schneider in Sargent, Pl. Wilson. **3:** 149 (1916). — Rehder in Jour. Arnold Arb. **10:** 116 (1929). — Vix Linné.

Salix hallaisanensis var. *nervosa* Léveillé, l. c.

Nakai (l. c.) takes up Léveillé's name for the plant of northeastern Asia referred by most authors to *S. caprea*. He states that it differs from typical *S. caprea* in having longitudinal striations on the wood under the bark. Such elevated striations are present on the wood of 2–5-year-old branches in *S. aurita* L. and *S. cinerea* L., but are lacking in *S. caprea*. Nakai also refers to *S. hallaisanensis* as *S. hallaisanensis* var. *orbicularis* (Anderss.) Nakai, the Kamschatkan *S. Hultenii* Floderus.

Salix Blinii Léveillé. — Rehder in op. cit. **10:** 117 (1929). — Nakai in Bull. Soc. Dendr. France, **1928:** 46, 51; Fl. Sylv. Kor. **18:** 106, t. 18 (1930).

Nakai refers as Schneider did, *S. Taquetii* Lévl. as a synonym to *S. Blinii* and figures of the latter a sterile branch and a branch with pistillate flowers.

Salix Gilgiana Seemen, Salic. Jap. 59, t. 13a-d (1903). — Léveillé in Bull. Intern. Acad. Géog. Bot. **16:** 145 (1906). — Nakai, Fl. Sylv. Kor. **18:** 112, t. 19 (1930).

Salix gymnolepis Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **3:** 22 (1907). — Matsumura, Ind. Pl. Jap. **2,** pt. 2: 10 (1912).

Salix purpurea L. subsp. *gymnolepis* (Lévl.) Koidzumi in Tokyo Bot. Mag. **27:** 267 (1913).

Salix Makinoana Seemen, p. p.

Nakai refers *S. gymnolepis* Lévl., which was placed by Schneider under *S. Makinoana* Seemen as a synonym, to *S. Gilgiana*. He also cites *S. Makinoana* Seemen, p. p., as a synonym of *S. Gilgiana*. I cannot see any difference between *S. gymnolepis* Lévl. represented in this herbarium by an isotype, and Nakai's illustration of *S. Gilgiana*, nor with the specimens of that species in this herbarium. *Salix Makinoana* is not represented in this herbarium; as long as its staminate flowers are unknown, its position must remain doubtful.

Quercus glandulifera Blume, Mus. Bot. Lugd.-Bat. **1:** 295 (1850).

Quercus serrata Thunberg. — Rehder in op. cit. **10:** 120 (1929).

Quercus coreana Léveillé.

Since *Quercus serrata* Thunb. is being proposed as a nomen ambiguum and will in all probability be accepted as such, the correct name for this species will be *Q. glandulifera* Bl.

Cudrania tricuspidata (Carr.) Bureau in Lavallée, Arb. Segrez. 243 (1877).

Vanieria tricuspidata (Carr.) Hu. — Rehder in op. cit. **17**: 72 (1936).
Morus integrifolia Léveillé & Vaniot.

Since *Cudrania* Tréc. has been proposed as a nomen conservandum and was accepted by a majority vote of the former Committee (cf. Internat. Rules Bot. Nomencl. ed. 3, p. 133, no. 1942. 1935), a vote which will doubtless be finally confirmed, the valid name of the genus will be *Cudrania*.

Lindera communis Hemsley in Jour. Linn. Soc. Bot. **26**: 387 (1891).

Benzoin commune (Hemsl.) Rehder in op. cit. **1**: 144 (1919) ; **10**: 194 (1929). — Allen in Jour. Arnold Arb. **17**: 330 (1936).

Since *Lindera* Thunb. has been proposed as a nomen conservandum and was accepted by a majority vote of the present Committee (cf. Internat. Rules Bot. Nomencl., ed. 3, p. 134, no. 2821. 1935) this and the two following species will be transferred to *Lindera*, and the synonyms *Litsaea Esquirolii* Lévl., *Litsea Cavaleriei* Lévl., *Lindera Bodinieri* Lévl. and *L. yunnanensis* Lévl. will be referred to *Lindera communis*.

Lindera glauca (Sieb. & Zucc.) Blume, Mus. Bot. Lugd.-Bat. **1**: 325 (1850).

Benzoin glaucum Siebold & Zuccarini. — Rehder in op. cit. **10**: 195 (1929). — Allen in op. cit. **17**: 331 (1936).
Pirus brunnea Léveillé.

Lindera megaphylla Hemsley in Jour. Linn. Soc. Bot. **26**: 389 (1891).

Benzoin grandifolium Rehder in op. cit. **1**: 145 (1919).
Benzoin touyunense (Lévl.) Rehder in op. cit. **10**: 194 (1929), pro parte.
Benzoin touyunense f. *megaphyllum* (Hemsl.) Rehder in op. cit. **11**: 158 (1930). — Allen in op. cit. **17**: 331 (1936).

Under the genus *Lindera*, the oldest specific epithet *L. megaphylla* remains valid, but in transferring the species to *Benzoin*, the epithet had to be changed on account of the older homonym *B. megaphyllum* Kuntze.

Lindera megaphylla f. **touyunensis** (Lévl.), comb. nov.

Litsea touyunensis Léveillé in Fedde, Rep. Spec. Nov. **11**: 63 (1912) ; Fl. Kouy-Tchéou, 220 (1914).
Benzoin touyunense (Lévl.) Rehder in op. cit. **10**: 194 (1929) ; **11**: 158 (1930). — Allen in op. cit. **17**: 331 (1936).

This form differs from typical *L. megaphylla* in the pubescent underside of the leaves and is, as I have stated (l. c. **11**: 158–159) less widely distributed than the typical glabrous form.

Dumasia villosa De Candolle. — Rehder in op. cit. **13:** 330 (1932); **18:** 208 (1937). — Handel-Mazzetti, Symb. Sin. **7:** 578 (1933). — Add as a synonym:

Apios Martini Léveillé, Fl. Kouy-Tchéou, 225 (1914).

CHINA. Kweichou: Gan-pin, haies, *L. Martin* in herb. *Bodinier* no. 1825, Aug.–Sept. 1897 (holotype of *Apios Martini;* ex Léveillé et ex Handel-Mazzetti).

Apios Martini was identified with *Dumasia villosa* by Handel-Mazzetti who saw the type.

Campylotropis polyantha (Franch.) Schindler. — Rehder in op. cit. **13:** 329 (1932).

For *Lespedeza dichromocalyx* read:

Lespedeza dichromoxylon Léveillé, Fl. Kouy-Tchéou, 236 (1914); Cat. Pl. Yun-Nan, 157 (1916).

Also in the enumeration of specimens line 2, 4 and 6, change *L. dichromocalyx* to *L. dichromoxylon.*

Pueraria Thunbergiana (Sieb. & Zucc.) Bentham. — Rehder in op. cit. **13:** 331 (1932).

For *Pueraria coerulea* read:

Pueraria caerulea Léveillé & Vaniot in Bull. Soc. Bot. France, **55:** 427 (1908).

Iodes ovalis Blume. — Rehder in op. cit. **15:** 2 (1934).

For *Vitis Seguini* . . . read as follows:

Vitis Seguini Léveillé, Fl. Kouy-Tchéou, 28 (1914), pro parte, specimine typico exclud.

Buddleia officinalis Maxim. f. **albiflora** (Lévl.) comb. nov.

Buddleia Mairei f. *albiflora*, Léveillé, Cat. Pl. Yun-Nan, 171 (1916).
Buddleia acutifolia C. H. Wright f. *albiflora* (Lévl.) Rehder in op. cit. **18:** 234 (1936).

Alstonia Mairei Léveillé. — Rehder in op. cit. **18:** 235 (1937).

Léveillé in his Cat. Pl. Yun-Nan, 279 (1917), refers *A. Mairei* as a synonym to *A. venenata* R. Br. which belongs to a different section.

Triosteum himalayanum Wallich. — Léveillé, Cat. Pl. Yun-Nan, 281 (1917). — Johnston in Jour. Arnold Arb. **18:** 21 (1937). — Rehder in op. cit. **18:** 250 (1937).

Echium connatum Léveillé.

Vernonia arborea Hamilton. — Gagnepain in Bull. Soc. Bot. France, **67:** 364 (1921). — Rehder in op. cit. **18:** 250 (1937).

Vernonia Vanioti Léveillé.

Vernonia volkameriaefolia DeCandolle. — Gagnepain in op. cit.

67: 363 (1921). — Rehder in op. cit. **18**: 250 (1937).
Vernonia Esquirolii Léveillé.

Vernonia saligna DeCandolle. — Gagnepain in op. cit. **67**: 363, 364 (1921). — Rehder in op. cit. **18**: 250 (1937).
Vernonia Martini Vaniot.
Vernonia Seguini Vaniot.

Vernonia arbor Léveillé. — Gagnepain in op. cit. **67**: 363 (1921).
Vernonia papillosa "Franchet" ex Rehder in op. cit. **18**: 251 (1937), quoad syn. *V. Arbor* Lévl.; non Franchet.

Vernonia extensa DeCandolle. — Gagnepain in op. cit. **67**: 363 (1921). — Rehder in op. cit. **18**: 252 (1937).
Vernonia subarborea Vaniot.

Conyza viscidula Wall. ex DeCandolle. — Gagnepain in op. cit. **67**: 363 (1921). — Rehder in op. cit. **18**:252 (1937).
Blumea conyzoides Léveillé.

Inula indica L. var. **hypoleuca** Handel-Mazzetti, Symb. Sin. **7**: 1107 (1936).
Aster lofouensis Léveillé & Vaniot. — Rehder in op. cit. **18**: 252 (1937).

According to Dr. Handel-Mazzetti (in litt.) *Aster lofouensis* is identical with his *Inula indica* var. *hypoleuca.*

Senecio spelaeicola (Vant.) Gagnepain in Bull. Soc. Bot. France, **67**: 364 (1921) "spelaeicolus," in nota.
Senecio Walkeri "Arnott" ex Gagnepain in op. cit. **67**: 363 (1921). — Rehder in op. cit. **18**: 253 (1937). — Quoad syn. *Vernonia spelaeicola*; non Arnott.
Vernonia spelaeicola Vaniot. — Vide Rehder l.c.

In a foot-note, Gagnepain states that *Vernonia spelaeicola* in the Museum herbarium is his *Senecio spelaeicola* and that the labels in the Léveillé herbarium had been interchanged. Doctor Handel-Mazzetti informs me (in litt.) that his *Senecio yalungensis* (Symb. Sin. **7**: 1124) is a synonym of *S. spelaeicola.* The name *Senecio spelaeicola* does not appear in Index Kewensis.

Senecio Hoi Dunn in Jour. Linn. Soc. Bot. **35**: 506 (1933).
Senecio Walkeri "Arnott" ex Gagnepain in op. cit. **67**: 363 (1921). — Rehder in op. cit. **18**: 253 (1937). — Quoad syn. *Vernonia Esquirolii;* non Arnott.
Vernonia Esquirolii Vaniot. — Vide Rehder, l.c.

According to Doctor Handel-Mazzetti (in litt.) *Vernonia Esquirolii* is identical with *Senecio Hoi* Dunn.

INDEX
TO
NOTES ON THE LIGNEOUS PLANTS DESCRIBED BY H. LEVEILLE FROM EASTERN ASIA[1]

Alfred Rehder

The Index contains all Léveillé's names mentioned in the "Notes on the ligneous plants described by Léveillé from Eastern Asia," beginning in Vol. 10 (1929) and concluded in the present number. The majority of these names proved to be synonyms and these are followed by the name considered correct with reference to the page or pages of Vols. 10–18 of this Journal where the identification was published or additional information given. Author citations are appended to the names, so that the Index can be used to ascertain the identification without looking up the original publication which only needs to be consulted for the discussions and further statements and details. The author citations have been made more complete by the insertion of the parenthetical author citation which was not yet obligatory when most of the notes were published.

Synonyms are printed in *italics;* accepted names in roman.

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[1] See Vols. **10**: 108-132, 184-196, 282; **12**: 275-281; **13**: 299-332, 464; **14**: 223-252, 426; **15**: 1-27, 89-117, 267-326, 377; **16**: 311-340; **17**: 53-82, 316-340, 371; **18**: 26-53, 206-257, 273-277, 361

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— *Esquirolii* Lévl. = L. Potanini Batal. 16:326
— *Mairei* Lévl. (1914) = L. pilosa (Fr.) Diels var. glabrescens Winkl. 16:327
— *Mairei* Lévl. in herb. = Wendlandia longidens (Hance) Hutchins. 16:318
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— *dichromoxylon* Lévl. = Campylotropis polyantha (Franch.) Schindl. 13:329; 18:276
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— *Cavaleriei* Lévl. = M. japonica (Thbg.) Moritzi ex Zoll. 15:288

— *Dunniana* Lévl. = M. japonica (Thbg.) Moritzi ex Zoll. 15:288

— *Esquirolii* Lévl. = M. japonica (Thbg.) Moritzi ex Zoll. 15:288

— *Labordei* Lévl. = M. japonica (Thbg.) Moritzi ex Zoll. 15:288

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— *singuliflora* Lévl. = Quercus phillyreoides Gray, 10:121

— *spec.* Lévl. = Sarcococca Hookeriana Baill. var. humilis Rehd. & Wils. 14:235

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— *Duclouxii* Lévl. = Jasminum Duclouxii (Lévl.) Rehd. 15:307
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— — *tomentosa* "Bl." ex Lévl., non Bl. = P. Cavaleriei Lévl. 16:326

— var. *Mairei* (Lévl.) Lévl. = P. scandens (Lour.) Merr. 16:324

— — var. *purpureo-coerulea* Lévl. & Vant. = [*P. Wallichii* Hook. f. 16:325] = P. yunnanensis (Lévl.) Rehd. 18:249

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— — var. *longevaginans* [= *P. tabulaeformis* Carr. 10:109] = P. Massoniana Lamb. 17:54

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— — var. *Potentilla* (Lévl. & Vant.) Lévl. = Tetrastigma obtectum var. Potentilla (Lévl. & Vant.) Gagnep. 15:21

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ARNOLD ARBORETUM
HARVARD UNIVERSITY

REINSTATEMENT AND REVISION OF CLEISTOCALYX BLUME (INCLUDING ACICALYPTUS A. GRAY), A VALID GENUS OF THE MYRTACEAE

E. D. Merrill and L. M. Perry

With plate 215

The genus *Cleistocalyx,* proposed by Blume, Mus. Bot. Lugd.-Bat. **1**: 84. 1849, with two species, *C. nitidus* Blume and *C. nervosus* Blume, very soon (Miq. Fl. Ind. Bat. **1**(1): 442. 1855) dropped into synonymy under *Eugenia* (Micheli) Linnaeus, and has since remained more or less in obscurity. The reasons for this are various. Generic lines are somewhat uncertainly drawn in the Myrteae, and *Cleistocalyx* is but one of several genera proposed by Blume which most modern authors have included in *Eugenia* Linn. *sensu latiore.* The latter, thus interpreted, is admittedly heterogeneous, including not only the American forms, section *Eueugenia,* but also *Jambosa* DC., *Syzygium* Gaertn. and other proposed segregates, which may or may not be separable by definite generic characters.

Cleistocalyx is known to most workers only by the original generic description and that of the type-species. In both the generic and the specific descriptions, although Blume's paper is illustrated by an excellent plate, the description of the outstanding character of the genus is partly misleading, "Calyx . . . limbo supero, primum clauso, sub anthesi in lobos 4 v. 5 irregulares longitudinaliter fisso, deciduo." The closed calyces are easily found in an inflorescence with buds, yet of these, none in our material open by splitting longitudinally into four or five irregular lobes, but rather by an irregular transverse dehiscence (really a rupturing of the tissue) between the calyptra and the rest of the calyx, often leaving a ragged margin which, in older flowers of more than one species, has led botanists to describe the calyx as lobed; cf. descriptions of *C. barringtonioides* (Ridl.), *C. nicobaricus* (King) and *C. operculatus* (Roxb.). This evidence would have been sufficient to place *Cleistocalyx* beyond consideration as the proper generic name for the calyptrate species of *"Eugenia,"* except that Merrill, in his study of the Bornean types of *Eugenia* at the Rijks Herbarium in 1930, had written on one of the specimens which he had with him for comparison, "This *is* Jambosa nitida Korthals." *Jambosa nitida* Korth. is the basis of *Cleistocalyx* *nitidus* Blume and hence the standard-species of the genus. Bentham, Jour. Linn. Soc. **10:** 165. 1869, intimated that Blume's description may have been drawn from something "accidental in a single detached calyx, or even conjectural; for, if well ascertained as an essential character, it would have been represented in the figure (of *C. nitidus* Blume)." Through the kindness of Professor H. J. Lam, Rijks Herbarium, we have since had the privilege of re-examining the type-collection of *Jambosa nitida* Korth. and of verifying the previous identification; the specimens show immature inflorescences and fruits, no flower even approaching anthesis, and, so far as we can see, no evidence of the longitudinal splitting which Blume described. It may be that Blume was influenced in his description of the calyx-lobes by his erroneous inclusion of *Eugenia nervosa* Lour. in *Cleistocalyx,* as Loureiro definitely described his species as having 4-lobed calyces. In all our specimens representing species of this group the circumscissile calyptra is entire after separation and, at least in early anthesis, remains attached at one side and this is the case with *Jambosa nitida* Korth. = *Cleistocalyx nitidus* Blume. The one constant character by which *Cleistocalyx* can always be distinguished from *Eugenia, sensu latiore,* and from the numerous Old World species of *Syzygium* and *Jambosa* is in its calyptrate calyces, the undivided, often more or less indurated upper parts of which fall as a lid. Blume's detailed illustration of *Cleistocalyx nitidus* (Korth.) Blume shows the undifferentiated calyptra with no indication whatever of calyx-lobes.

Miquel's treatment of the genus *Eugenia* contains four sections, the third of which is characterized thus, "Thyrsi terminales. Calycis tubus e basi leviter constrictâ semi-globosus, limbus in alabastris valde juvenilibus concreto-clausus, dein in lacinias 4–5 fissus." This is comparable to the extract from Blume's generic description above quoted; moreover, the section has only one species, *Eugenia nervosa* Lour., with *Cleistocalyx nervosus* Blume and *C. nitidus* Blume in synonymy. It is not clear to us why both Blume and Miquel should place a species with calyx described as "superus, 4-partitus, magnus: laciniis, obtusis, concavis" (Lour. Fl. Cochinch. **1:** 308. 1790), in a section or genus featuring the upper part of the calyx entirely closed; yet, since Loureiro's type is not extant we can only point out what appears to be a discrepancy. Further, Miquel certainly erred in reducing *Cleistocalyx nitidus* Blume to *Eugenia nervosa* Lour.

After reducing *Cleistocalyx* to *Eugenia,* Miquel, op. cit. 460, established the section *Symphysion* in the genus *Syzygium* on the following basis, "calyx adultus vertice membranaceo totus occlusus, tanquam operculum demum inferne lacerum cum operculo corollino (quod proprium haud discernendum) ut videtur intime connatum circumscisse dejectum." The floral feature here delineated is the distinctive character of *Cleisto calyx* (Pl. 215). Miquel described two species, *Syzygium occlusum* Miq. and *S. javanicum* Miq. and added a note on *S. fruticosum* DC. Although our material of the first, *Horsfield 10,* is a mixture of branchlets bearing both flowers and leaves, and of separate inflorescences, the latter are not distinguishable from those of *C. operculatus* (Roxb.); we cannot say from the fragmentary type of *S. javanicum* Miq. whether it is characterized by an operculate calyx or not, but the description surely indicates this group. The observation on *S. fruticosum* DC., as we understand the species, should be excluded.

In 1854, A. Gray, Bot. U. S. Expl. Exped. **1**: 551, established the genus *Acicalyptus* for a species from the Fiji Islands with a very distinctive subulate-operculate quadrangular calyx. He indicated that its probable relationship was with *Calyptranthes* or *Eucalyptus,* depending on whether the fruit, then unknown, was a berry or a capsule. Among Seemann's collections from Fiji he found a second species with a short-apiculate calyptra. Seemann himself discovered a third species with the fruit a berry and the calyptra "just as it is in the ordinary American *Calyptranthes,"* and therefore reduced *Acicalyptus* A. Gray to *Calyptranthes* Swartz. Bentham, op. cit. 144, discussing *Acicalyptus* pointed out that the seed was unknown but that the habit and the arrangement of the petals of Seemann's species, *C. eugenioides,* were more like those of *Eugenia* than of *Calyptranthes.* Later, under *Cleistocalyx,* he noted that its bud was that of *Acicalyptus* and if the latter should "really prove to have a Eugenioid embryo, it might be united with *Cleistocalyx* in a genus closely allied to *Eugenia* but differing . . . by the operculate calyx." Baron von Mueller, Bot. Centralbl. **28**: 149. 1886, also pointed out that "it would appear, that *Acicalyptus* ought to be reduced to *Cleistocalyx,* published five years earlier by Blume." ¶In his Second Systematic Census of Australian Plants, pt. 1. 102. 1889, he lists *Acicalyptus* thus, "Calyptranthes partly, Cleistocalycis subgenus," showing that he was still convinced of their very close relationship.

We now have *Acicalyptus myrtoides* A. Gray in fruit, collected by Gillespie and described by him, Bishop Mus. Bull. **83**: 21, *f. 25.* 1931. We find it necessary to emend his description from "endosperm . . ." to: cotyledons two, large and hemispherical enclosing the hypocotyl and epicotyl attached near the centre of each of the opposing faces of the cotyledons, hypocotyl exceeding epicotyl in length; and correspondingly, on his legend of *f. 25,* we prefer the following: *a,* enlarged embryo showing cotyledons separated from hypocotyl and epicotyl; *b, c,* plantlet minus cotyledons much enlarged. Fruits of the other Fijian species which are represented by herbarium material are similar. All are ellipsoid or oblong with the angles of the calyx (usually appearing as a narrow ridge) more or less marked on the fruit. The structure of the embryo, so far as we can interpret it from dried and immature fruits, does not differ materially from the general type of that in *Cleistocalyx*: cotyledons with the two opposing and almost flat or concave (perhaps from shrinkage) faces attached to the minute hypocotyl and epicotyl. A variation in the type appears in *C. operculatus* (Roxb.) and *C. Fullageri* (F. v. Muell.); the embryo of these consists of two cotyledons with *interlocking* faces attached near the middle with a long hypocotyl between, extending from the point of attachment near the centre to the outer surface of the embryo (Pl. 215, f. 32, 43). Possibly we might be inclined to look upon these as two distinct types of embryo were it not for the fact that in *Syzygium* these two extremes blend to such an extent that it is impossible to distinguish the two except in the extremes as shown in this genus.

With only the original species, *A. myrtoides* A. Gray, at hand, the smooth and sharply angled calyx and the long rostrate calyptra appear very distinctive; but, with more material for comparison, these are manifestly the extreme form of the characters of the genus and, only when modified, applicable to species which must be considered congeneric; furthermore, the several species placed herein are separable from *Cleistocalyx* only by two minor characters, the angular calyx and to a less degree the angular and elongated fruit. These are good sectional characters but scarcely of generic worth; hence, we find ourselves unable to maintain the genus *Acicalyptus* A. Gray as distinct from *Cleistocalyx* Blume, the latter having nomenclatural precedence. However, since the Fijian species apparently represent a natural group distinguished by the angular calyx and the less angled and elongated fruit, we propose to treat *Cleistocalyx* as having two fairly distinct sections, ACICALYPTUS (A. Gray) and EUCLEISTOCALYX, the latter to include all species characterized by a terete calyx and globose to subglobose, rarely somewhat elongated, but not angled, fruit.

As we have already stated, the genus *Eugenia* in its broadest sense includes many diverse forms. From these we propose to segregate those species with calyptrate calyces, re-establishing the genus *Cleistocalyx* to take care of what we believe to be a distinct entity worthy of generic rank. *Acicalyptus* was originally known only from Fiji but later species were described from New Caledonia and Lord Howe Island. *Cleistocalyx* was described from a Bornean specimen. As we now interpret Blume's genus, *Acicalyptus* falling as a synonym, the group is represented by twenty-one species extending from Chittagong, Burma, Indo-China, Hainan and southeastern China to Sumatra, Java, Borneo, the Philippines, New Guinea, northern Australia, Lord Howe Island, New Caledonia and Fiji. Thus, instead of *Acicalyptus* A. Gray being a "Polynesian" genus, *Cleistocalyx* Blume as we interpret it is primarily an Indo-Malaysian one that has extended to Fiji.

This study is based primarily on the material in the herbaria of the Arnold Arboretum, Gray Herbarium, New York Botanical Garden, and the Botanical Garden at Buitenzorg, with special loans of essential specimens from the Washington, Kew, Leiden, Utrecht, Brisbane, and Melbourne herbaria. To the administrative heads of the institutions involved we are under obligations for the courtesies extended in the loan of important material essential to this study. The actual preparation of the paper was rendered possible through a grant from the Milton Fund of Harvard University. The primary purpose of this grant was to make possible a general study of the Bornean species of *Eugenia,* but as the latter study developed it was found desirable to recognize certain generic segregates. In two cases we have found it expedient to segregate certain species from EUGENIA (including *Jambosa* and *Syzygium*) and to recognize these as of generic rank. Thus it became necessary to examine all recognized species in each group for the entire geographic range of the unit, as generic limits could not with safety be determined solely on the basis of the Bornean species alone. In this paper we consider the recognized species in the first of these two groups.

Cleistocalyx Blume, Bot. Mus. Lugd.-Bat. **1**: 84. 1849.

Acicalyptus A. Gray, Bot. U. S. Expl. Exped. **1**: 551. 1854.
Eugenia § 3, Miq. Fl. Ind. Bat. **1**(1): 442. 1855.
Syzygium § *Symphysion* Miq. op. cit. 460, excl. *Syzygium fruticosum* DC.
Calyptranthes sensu Seemann, Fl. Vit. 81. 1865, non Swartz.
Acicalyptus (*Calyptranthes* partly, *Cleistocalyx* subgenus) F. v. Mueller, Second Syst. Census Austral. Pl. pt. **1**: 102. 1889.

KEY TO SPECIES

A. Calyx-tube definitely 4-angled; fruit ± obscurely 4-angled, crowned by the very narrow but usually deep limb of the calyx (section *Acicalyptus*: Fiji).
  B. Calyptra subulate-rostrate; fruit 4-ridged ....1. *C. myrtoides.*
  B. Calyptra not subulate-rostrate, ± conical and obtusely apiculate.
    C. Leaves elliptic to oblong or ovate, apex distinctly acuminate.
      D. Flowers obviously pedicellate, pedicels up to 3 mm. long. 2. *C. longiflorus.*

D. Flowers sessile or, in part, very short-pedicellate, pedicels not longer than 1 mm.

E. Submarginal veins 2, the inner 2–3 mm. within the margin; flower-buds 3.5–4 mm. long. . . . . . .3. *C. ellipticus.*

E. Submarginal vein 1 mm. within the margin; flower-buds 4.5–6 mm. long (more attenuate toward base than in *C. ellipticus*) . . . . .4. *C. Seemanni.*

C. Leaves obovate, apex obtuse or rounded . . . . . .5. *C. eugenioides.*

A. Calyx-tube terete and smooth, ± wrinkled-sulcate on drying; fruit not angled, crowned by the broad and usually ± shallow limb of the calyx (section *Eucleistocalyx*).

F. Flowers long, calyx-tube (after calyptra has fallen) ± 18 mm. long (Lord Howe Island) . . . . .6. *C. Fullageri*

F. Flowers shorter, calyx-tube (after calyptra has fallen) usually not exceeding 12 mm. long.

G. Inflorescence axillary and terminal.

H. Venation open, primary veins 5 mm. or more apart, secondary veins often obvious but not as prominent as the primary ones.

I. Leaves rounded or slightly cordate at base, practically sessile . . . . .7. *C. paradoxus.*

I. Leaves obtuse or cuneate at base, or if somewhat rounded, distinctly petiolate.

J. Branchlets 4-angled.

K. Midrib somewhat sharply keeled on lower surface; leaves thinly coriaceous, copiously pellucid-punctate; submarginal vein ± 1 mm. within the margin (New Guinea) . . . . . . .8. *C. Baeuerlenii.*

K. Midrib roundish, not keeled, on lower surface; leaves coriaceous, obscurely, if at all, pellucid-punctate; submarginal vein 2–4 mm. within the margin.

L. Inflorescence short (3–5 cm. long) and compact; leaves densely glandular-puncticulate beneath; primary veins impressed above, sharply prominent beneath (Borneo).
9. *C. perspicuinervius.*

L. Inflorescence longer (up to 15 cm.) and open; leaves obscurely puncticulate; primary veins not impressed above, prominent beneath.

M. Leaves narrowly oblong; flowers with a long pseudostalk [5–7(–9) mm.] (Borneo).
10. *C. barringtonioides.*

M. Leaves oblong-elliptic; flowers with a short pseudostalk [± 2.5 mm. long] (Borneo).
11. *C. nitidus.*

J. Branchlets terete or sulcate.

N. Leaves acuminate and often twisted at the apex.

O. Submarginal veins not more than two, the inner usually not more than 4 mm. within the margin; calyptra mostly short-apiculate.
  P. Flowers with a long pseudostalk (5–7 mm.); leaves narrowly oblong (Borneo). 10. *C. barringtonioides.*
  P. Flowers with a short pseudostalk (2.5–3 mm.); leaves oblong- to narrowly ovate-elliptic.
    Q. Leaves oblong-elliptic; secondary venation manifest but not obvious.
      R. Leaves 10–20 cm. long; primary veins 15–22; secondary submarginal vein mostly obscure (Borneo). 11. *C. nitidus.*
      R. Leaves 8–12 cm. long; primary veins 8–13; secondary submarginal vein present (Philippines). 12. *C. arcuatinervius.*
    Q. Leaves broad- to ovate-elliptic; secondary venation obvious and tending to be prominent (Indo-China). 13. *C. retinervius.*
O. Submarginal veins often more than two (three in larger leaves), the inner (usually prominent) 4–7(–12) mm. within the margin; calyptra conspicuously apiculate or short-rostrate (Queensland) . . . 14. *C. gustavioides.*

N. Leaves obtuse or rounded with a short and abrupt acumen.
  S. Branchlets light-brown or grayish; petiole ± 2 cm. long; leaves with large and scattering pellucid punctations; ultimate branchlets of inflorescence narrowly winged (Hainan). 15. *C. conspersipunctatus.*
  S. Branchlets whitish; petiole less than 1 cm. long; leaves minutely puncticulate, not pellucid; ultimate branches of the inflorescence compressed or obscurely angled (Borneo). 16. *C. leucocladus.*

H. Venation close, primary veins scarcely 2 mm. apart (*C. Brongniartii* not seen, but described as "creberrime penninervia").
  T. Leaves subcaudate-acuminate (Philippines). 17. *C. paucipunctatus.*
  T. Leaves abruptly short-acuminate to obtuse.
    U. Leaves distinctly petiolate; calyptra not sulcate (Indo-China) . . . . 18. *C. nigrans.*
    U. Leaves sessile or very short-petiolate; calyptra sulcate (New Caledonia) . . . . 19. *C. Brongniartii*

G. Inflorescence lateral in the axils of old or fallen leaves below the new leafy shoots, rarely axillary and terminal.
  V. Petiole short (5–8 mm. long) and thickish, the older often of the same color as the branchlets (whitish-gray); leaves chiefly obtusish; calyx-tube abruptly narrowed into short pseudostalk (Borneo) ....16. *C. leucocladus.*
  V. Petiole longer (1–2 cm. long) and not thickened; branchlets gray to brownish; leaves obtusely short-acuminate; calyx-tube gradually tapering to the base.
    W. Calyx-tube broadly attenuate at the base; primary veins of leaves obvious; inflorescence with many branches and numerous flowers (southern China, Indo-Malaysia and northern Australia) ....20. *C. operculatus.*
    W. Calyx-tube scarcely attenuate at base; primary veins of leaves inconspicuous; inflorescence with few branches and sparsely flowered (Nicobar Islands). 21. *C. nicobaricus.*

1. **Cleistocalyx myrtoides** (A. Gray), comb. nov. Pl. 215, f. 6–8.

Acicalyptus myrtoides A. Gray, Bot. U. S. Expl. Exped. **1:** 551. *t. 67.* 1854, Bonplandia **10:** 35. 1862; Drake, Ill. Fl. Mar. Pacific. 168. 1890; Gillespie, Bishop Mus. Bull. **83:** 20. *f. 25.* 1931.

Calyptranthes myrtoides Seemann, Fl. Vit. 81. 1865.

Fiji: *Herb. U. S. Expl. Exped. 1838–42* (type-collection of *A. myrtoides*); Viti Levu, Tholo North Province, Nandarivatu, *Gillespie 3971,* stream-bed down the escarpment north of Government Station.

This species is readily separable from the others, which we have seen, by the strongly angled calyx which does not wrinkle much on drying, and by the subulate-rostrate beak of the calyptra. In 1886, Baron von Mueller, Bot. Centralbl. **28:** 149, stated, "Regretably the name Acicalyptus, derived from an exceptional characteristic of the original species discovered, does not apply to most of the other forms, which must be considered congeneric." That is still true for the specimens which we have examined.

2. **Cleistocalyx longiflorus** (A. C. Smith), comb. nov. Pl. 215, f. 1–2.

Acicalyptus longiflora A. C. Smith, Bishop Mus. Bull. **141:** 109, *f. 57.* 1936.

Fiji: without definite locality, *Storck s. n.,* June, 1883 (type-collection of *A. longiflora*); Viti Levu, *Gillespie 2277,* August 15, 1927, slopes of Korombamba mountain, at 300 m. alt.; Viti Levu, *Gillespie 3962,* Nandarivatu, secondary wood, valley of the Singatoka.

Not very closely related to the other Fijian species. In its foliar characters *C. longiflorus* is most like *C. ellipticus* (A. C. Smith); in the angularity of the calyces it approaches *C. myrtoides* (A. Gray); but, in size of flowers and characters of the calyptra, it is unquestionably nearest *C. Seemanni* (A. Gray).

3. **Cleistocalyx ellipticus** (A. C. Smith), comb. nov. Pl. 215, f. 9.

Acicalyptus elliptica A. C. Smith, Bishop Mus. Bull. **141**: 107, *f. 57.* 1936.

FIJI: southern portion of Seatovo Range, *A. C. Smith 1567,* April 20–May 2, 1934, ridge forest at 100–350 m. alt. (type of *A. elliptica*).

Perhaps most closely related to *Cleistocalyx Seemanni* (A. Gray) from which it is separable by the larger leaves and the flowers slightly smaller and less narrowed toward the base.

4. **Cleistocalyx Seemanni** (A. Gray), comb. nov. Pl. 215, f. 3–5.

Acicalyptus Seemanni A. Gray, Bonplandia **10**: 35. 1862; Drake, Ill. Fl. Mar. Pacific. 168. 1890; A. C. Smith, Bishop Mus. Bull. **141**: 107. 1936.
Calyptranthes Seemanni Seemann, Fl. Vit. 81. 1865.
Eugenia prora Burkill, Kew Bull. **1906**: 4. 1906.

FIJI: *Seemann 168* (type of *A. Seemanni*); Mount Mbuke Levu, *A. C. Smith 241;* Mount Ndikeva, *A. C. Smith 1876;* Viti Levu, *Gillespie 2866,* ridges southeast of Namosi village on the overland trail to Navau at 600 m. alt.; without definite locality, *Horne 774.*

The two collections *Gillespie 2866* and *Horne 774* have slightly glandular-punctate leaves.

4a. **Cleistocalyx Seemanni** var. **punctatus,** var. nov.

A typo differt foliis utrinque dense minuteque subpustulato-glandulosis, calycibus leviter pustulatis.

FIJI: without definite locality, *Graeffe s. n.* (type, Gray Herb.).

The glands of the leaves are so abundant that the secondary venation is more or less obscure, the flowers too are minutely pustulate and the operculum is scarcely apiculate.

5. **Cleistocalyx eugenioides,** nom. nov.

Calyptranthes eugenioides Seemann, Fl. Vit. 81. 1865, non Cambessed., in St. Hilaire, Fl. Bras. Merid. **2**: 370. 1829.
Acicalyptus eugenioides Drake, Ill. Fl. Mar. Pacific. 168. 1890; Niedenz. in Engler & Prantl, Nat. Pflanzenfam. **3**(7): 86. 1893.

FIJI: Viti Levu, Nadarivatu, *Gillespie 4335,* December 13, 1927, summit of Loma laga, at 1200 m. alt.

When Seemann described this species he noted the similarity in habit to that of *Eugenia confertiflora* A. Gray. Gray had already pointed out that Seemann's collection had longer leaves less pale beneath, larger flowers with longer and striate-angled calyx-tubes, but he did not describe it, probably because he had inadequate material, for he stated, "the means of comparison are not complete." We have not yet found the material which Gray had for comparison, nor have we seen any representative of this species except the specimen above cited. It is easily separated from the other Fijian members of *Cleistocalyx* by its obovate leaves.

6. **Cleistocalyx Fullageri** (F. v. Muell.), comb. nov. Pl. 215, f. 29–33.

Acicalyptus Fullageri F. v. Muell. Fragm. Phytogr. Austral. **8**: 15. 1873, **9**: 193. 1875; Moore, Census Pl. New S. Wales, 28. 1884, Handbk. Fl. New S. Wales, App. **1**: 519. 1893; Hemsl. Ann. Bot. **10**: 236. 1896; Maiden, Proc. Linn. Soc. New S. Wales, **23**: 129. 1898; Oliver, Trans. New Zeal. Inst. **49**: 144, *f. 1a.* 1917.

LORD HOWE ISLAND: authentic specimen, without data; *Moore, Fullagar & Lind* (type, Melbourne Nat. Herb., not seen).

The specimen generously donated to our collection by Mr. F. J. Rae, Director of the Melbourne Botanic Gardens, has greatly aided us in our interpretation of this species. Although Baron von Mueller gave a very detailed description of *A. Fullageri,* pointing out how it differs chiefly from its Fijian allies, we here add a short summary of the distinctive characters: Very long flowers (Pl. 215, f. 30), the mature calyx-tube ± 18 mm. long, the longest known in the genus; ellipsoid or somewhat pyriform fruits; short-petiolate obovate, obtuse leaves, and branchlets ± angled or sulcate. *C. Fullageri* (F. v. Muell.) appears to be more closely connected with § *Eucleistocalyx* than with § *Acicalyptus,* although it is very distinct within the genus.

The collector's name is given as Fullagar, but F. von Mueller in the binomial used the form *Fullageri* which we accept; other authors cited use the form *Fullagari.*

7. **Cleistocalyx paradoxus** (Merr.), comb. nov. Pl. 215, f. 37–38.

Eugenia paradoxa Merr. Jour. Str. Branch Roy. As. Soc. **77**: 210. 1917, Enum. Born. Pl. 432. 1921.

BORNEO: Sarawak, without locality, *Native collector 365* (type of *E. paradoxa* Merr.); near Kuching, *Haviland 2327/1832*: Dutch Borneo, Soengei Sambas, *Hallier 1160;* Soengei Landak, *Teysmann s. n.;* Pontianak, *Teysmann s. n.;* Kapuas, *Teysmann 8224;* without locality, *Teysmann?;* near Poetat, *Mondi 54.*

The only species of the genus known to us with rounded or slightly cordate, practically sessile leaves.

8. **Cleistocalyx Baeuerlenii** (F. v. Muell.), comb. nov. Pl. 215, f. 21.

Eugenia Baeuerlenii F. v. Muell. Australas. Jour. Pharm. June, 1886, Bot. Centralbl. **28**: 149. 1886; Diels, Bot. Jahrb. Engler **57**: 379. 1922.

NEW GUINEA: Strickland River, *Baeuerlen s. n.* (type); Fly River (Branch), *Baeuerlen 538,* November, 1885.

Diels, l. c. (Die Myrtaceen von Papuasien), merely notes that the description of *Eugenia Baeuerlenii* F. v. Muell. was insufficient to determine its place within the genus (*Jambosa*).

Mr. F. J. Rae, Director of the Melbourne Botanic Gardens very kindly loaned for our study the two specimens cited above. In general aspect the species is very distinct; the venation of the leaves approaches subtransverse, the blade is somewhat reddish-brown, shining, and, although it is scarcely, if at all, punctate, against a strong light it is copiously pellucid-dotted. The calyx is cupulate with a pseudostalk and dries with distinct ridges.

9. **Cleistocalyx perspicuinervius** (Merr.), comb. nov.
Pl. 215, f. 10–11.

Eugenia perspicuinervia Merr. Univ. Calif. Pub. Bot. **15**: 218. 1929.

BORNEO: British North Borneo, Tawao, *Elmer 20600, 21682* (type of *E. perspicuinervia* Merr.).

A species which suggests *C. nitidus* Blume in the large and prominently veined leaves, but which is easily distinguished by its short (up to 5 cm. long) and few-flowered axillary and terminal inflorescences.

10. **Cleistocalyx barringtonioides** (Ridl.), comb. nov.
Pl. 215, f. 25–28.

Eugenia barringtonioides Ridl. Jour. Bot. **68**: 12. 1930.

BORNEO: British North Borneo, without definite locality, *Villamil 406,* on river banks; Tenom, *Tahir 787;* Lokan River, *Evangelista 906;* Sandakan, *Panching 817;* Pangie, Beaufort, *Bakar (B. N. B. Forestry Dept. 2472),* river-bank; Melobang, *Balajadia (B. N. B. Forestry Dept. 2849),* plain, sea level: Sarawak, Trusan, *Haviland 52/118;* Upper Baram, Sio Malit, *Moulton 6740* (type-collection of *E. barringtonioides* Ridl.): Dutch Borneo, Sedalir, *Amdjah 248;* Batoe Oeloe Seboekoe, *Amdjah 527;* Gunong Djempanja *Amdjah 734;* Western Koetai, near Batoe Bong, *Endert 2195;* near Boloet, *Endert 4042.*

A distinctive species of river-banks readily recognized at anthesis by the open panicles bearing flowers with long (5–7(–9) mm.) pseudostalks and long (± 2 cm.) stamens. The leaves are mostly lanceolate or narrowly oblong.

Eugenia barringtonioides Ridl. was based on *Moulton 6740* from

Upper Baram, indicated by Ridley as *Jambosa.* He describes the calyx as having "lobis obscuris brevibus, rotundatis." This statement applies to the persistent fragments of the calyptrate calyx, as an examination of the type shows that in the bud the calyx has a calyptra which breaks off and falls as a whole, leaving a torn irregular margin which was misinterpreted by Ridley as calyx-lobes.

11. **Cleistocalyx nitidus** Blume, Mus. Bot. Lugd.-Bat. **1:** 84, *f. 56.* 1849. Pl. 215, f. 19–20.

Jambosa nitida Korth. Nederl. Kruidk. Arch. **1:** 202. 1847, non Cambessed. et al.

Eugenia nervosa sensu Miq. Fl. Ind. Bat. **1**(1): 442. 1855, non Lour.

Eugenia cleistocalyx Merr. Philip. Jour. Sci. Bot. **13:** 98. 1918, Enum. Born. Pl. 427. 1921.

BORNEO: British North Borneo, Tawao, *Elmer 20836, 21702;* Kinabatangan, *Evangelista 861;* Lihak, *Agullana (B. N. B. Forestry Dept. 1946),* plain: Sarawak, Rejang, Kapit, *Haviland 2921*: Dutch Borneo, Kampong Lemoe, Taloek Gansioeng forest, Oeloe Doesoen, *Dachlan 2407;* Soengei Magne, *Jaheri 664;* Soengei Tepoetiz, *Jaheri 901;* Banjermasin, Mount Bahay, *Korthals s. n.* (carbon imprint of leaf; type, Rijks Herb.); *Winkler 3744.*

This, the type-species of the genus *Cleistocalyx,* and *C. barringtonioides* (Ridl.) very closely resemble each other but apparently are distinct. *C. nitidus* Blume differs in having broader leaves and the flowers, with short (2–3 mm. long) pseudostalk and short anthers, closely clustered at the tips of the branches of the inflorescence. The collection from Lihak differs somewhat in its narrowly winged branchlets and its very shiny and pale brown leaves.

12. **Cleistocalyx arcuatinervius** (Merr.), comb. nov. Pl. 215, f. 16–18.

Eugenia arcuatinervia Merr. Philip. Jour. Sci. **1:** Suppl. 104. 1906; C. B. Rob. Philip. Jour. Sci. Bot. **4:** 380. 1909; Elmer, Leafl. Philip. Bot. **4:** 1418. 1912; Merr. Enum. Philip. Pl. **3:** 158. 1923.

PHILIPPINE ISLANDS: Luzon: Bataan Province, Lamao River, Mount Mariveles, *Whitford 1227, Meyer (For. Bur. 2598);* Cagayan Province, *Klemme (For. Bur. 6669), Barros (For. Bur. 21760, 21777), Fischer (For. Bur. 21747);* Laguna Province, *Mabesa (For. Bur. 23792);* Rizal Province, *Maneja (For. Bur. 23963);* Sorsogon Province, Irosin, *Elmer 16220;* Mindoro, *Ramos (Bur. Sci. 39380);* Leyte, *Wenzel 726, 755, 886, 1524;* Mindanao, Surigao Province, *Wenzel 2661, 2787, 2960, Sherfesee, Cenebre & Ponce (For. Bur. 21664).*

There is a pronounced resemblance between this species and *C. nitidus*

Blume. Technically *C. arcuatinervius* (Merr.) may be distinguished by its foliar characters. The leaves are smaller and long-acuminate, the primary veins are fewer and a secondary submarginal nerve is always present.

13. **Cleistocalyx retinervius,** sp. nov. Pl. 215, f. 12–15.

Arbor parva; ramulis ultimis fuscis, teretibus vel ad nodos leviter compressis, 2–3 mm. diametro; foliis ellipticis vel oblongo-ovatis, 9–14 cm. longis, 5.5–7 cm. latis, basi late obtusis, fere rotundatis, apice late obtuseque acuminatis et recurvis, epunctatis, olivaceis vel atro-brunneis, subtus pallidioribus vel rubro-brunnescentibus, costa supra impressa subtus leviter elevata, venis primariis perspicuis numerosis 4–8 mm. remotis patulis, plerumque ad marginem leviter curvatis, vena intramarginali (interdum duplici) 2–3 mm. a margine conjunctis, venulis laxe reticulatis perspicuis; petiolo circiter 1.5 cm. longo, nigrescente vel brunneo, transverse ruguloso; inflorescentiis terminalibus axillaribusque, ramis brevibus, floribus ± confertis, sessilibus, alabastris ± 7 mm. longis, apice ovoideo-globosis, basi stipitatis; calyce in alabastro clauso leviter apiculato, per anthesin calyptriformi-circumscisso, marginem subintegrum relinquente, petalis liberis?, staminibus numerosis, antheris ellipticis; fructibus subglobosis, circiter 1.5 cm. diametro, apice calycis limbo coronatis.

INDO-CHINA: Annam, Tourane and vicinity, *Clemens 3777* (type), 3395, May–July, 1927, in thickets near the seashore. The holotype is in the herbarium of the Arnold Arboretum, with isotypes in the New York and Washington herbaria.

Although this species was collected in a region where *Eugenia nervosa* Lour. might be expected to occur, we have carefully compared the description with our material of which we have both flowers and fruit, and we particularly note the following discrepancies between *Eugenia nervosa* Lour. and *Cleistocalyx retinervius* Merr. & Perry both in the calyx and in the fruit. In the former, the calyx is lobed, the fruit "nervosa" (probably the equivalent of *ribbed*); in the latter, the calyx is calyptrate and the fruit is practically smooth.

14. **Cleistocalyx gustavioides** (F. M. Bail.), comb. nov. Pl. 215, f. 50–53.

Eugenia gustavioides F. M. Bailey, Queensl. Agric. Jour. **5**: 389. 1899; J. F. Bailey, Queensl. Agric. Jour. **5**: 399, *t. 140.* 1899; F. M. Bailey, Queensl. Fl. **2**: 658. 1900, Cat. Queensl. Pl. 208. 1913.

AUSTRALIA: Queensland, without data, *J. F. Bailey s. n.* (type); near Lake Barrine, Atherton Tablelands, *J. F. Bailey s. n.* (fruit only);

Atherton Tableland, Range Road, *Kajewski 1185;* Forest Reserve 310, Galgarra, *Dreghorn s. n.;* Daintree River, *Brass 2256, Kajewski 1398.*

Mr. C. T. White, government botanist at Brisbane, has obligingly loaned us the type and Dreghorn's collection, also the fruit; these are the only specimens of this species at Brisbane apart from the other collections above cited.

The leaf-venation of this species is rather unusual. The largest and most conspicuous intramarginal vein is from 4 to 7 (to 12) mm. within the margin; in the blade between may be found one (or sometimes two) similar vein(s), the outer(most) being the fainter(est) and 1 to 2 mm. within the margin. The fruit available is fully mature (Pl. 215, f. 50, 51). J. F. Bailey noted that he picked this up under a tree. Only a fragment of the hypocotyl remains, but unquestionably the fruit is similar in structure to that found in a large number of species of *Syzygium.*

15. **Cleistocalyx conspersipunctatus,** sp. nov. Pl. 215, f. 34–36.

Arbor 15–40 m. alta, glabra; ramulis novellis obscure tetragonis, demum teretibus vel compressis, brunneo-viridibus; foliis obovato-ellipticis, basi cuneatis, apice rotundatis, acumine brevi obtusoque, 5–13 cm. longis, 3–7 cm. latis, consperse pellucido-punctatis (glandulis magnis, interdum sine lente manifestis), costa supra impressa subtus prominula, venis primariis utrinque perspicuis, 4–8 mm. remotis, ad marginem anastomosantibus, venulis laxe reticulatis; petiolo 1.5–2 cm. longo, gracili, ruguloso; inflorescentiis terminalibus axillaribusque, 7–10 cm. longis, rachide quadrangulari, ramulis tetrapteris; alabastris sessilibus, 7 mm. longis 4.5 mm. diametro, apice globosis basi breviter stipitatis, consperse glanduloso-pustulatis; calyce clauso, apice breviter apiculato, parte superiore sub anthesi circumscisse decidua, antheris 0.6–0.8 mm. longis, ellipticis, glanduloso-mucronatis; fructibus subglobosis, immaturis 1.5–2 cm. diametro.

CHINA: Hainan, without locality, *Wang 33524, 33687, 34214,* in mixed woods, August and September, 1933; Po-ting, *How 73248, 73332* (type); Ah Ping, *Chun & Tso 44145,* October 24, 1932, in forested ravine, about 900 m. alt.; Yaichow, *Liang 62200,* July 19, 1933, in forests. The holotype is preserved in the Arnold Arboretum herbarium.

This species is readily distinguished from *C. operculatus* (Roxb.), the other known Chinese species of the genus, by the blunt leaves with short obtuse acumen and with scattered glands occasionally large enough to be seen with the naked eye, and by the terminal and axillary inflorescences. The flowers are larger and with a few glands similar to those on the leaves; the cotyledons of the embryo are somewhat concave and the hypocotyl is short, closely resembling that of the Bornean *C. barringtonioides* (Ridl.).

16. **Cleistocalyx leucocladus,** sp. nov. Pl. 215, f. 39–40.

Eugenia subrufa sensu Ridl. Jour. Bot. **68**: 15. 1930, non King.

Glabra; ramis ramulisque albido-cinereis, teretibus; foliis ellipticis, basi late cuneatis, apice obtusis vel brevissime obtuseque acuminatis, 6–10 cm. longis, 3–5.5 cm. latis, coriaceis, olivaceis, crebre puncticulatis, costa supra impressa, subtus elevata, venis primariis gracilibus, patulis, haud perspicuis, utrinque 10–18 inter se 5–9 mm. distantibus, in venam intramarginalem ± 2 mm. a margine distantem confluentibus, secundariis inconspicuis; petiolo crasso, 5–7 mm. longo; inflorescentiis terminalibus et in ramulis annotinis axillaribus, ± 6 cm. longis, pedunculo communi ad 5 cm. longo, ramis ± 1.5 cm. longis, floribus in apice ramulorum ultimorum ternis, sessilibus, alabastris 6 mm. longis, 3.5 mm. diametro; calycis parte superiore sub anthesin calyptratim decidua, staminibus numerosis, antheris minutis.

BORNEO: Sarawak, near Kuching, *Haviland & Hose 3382 A, E, L, M,* holotype at Gray Herbarium, isotypes at Kew, Leiden, and Buitenzorg.

In general habit this species suggests *C. conspersipunctatus* Merr. & Perry of China, but it is readily distinguished by the much shorter and thickish petioles, the broader leaf-base, the smaller flowers and the obtusely angled branches of the inflorescence.

17. **Cleistocalyx paucipunctatus,** nom. nov. Pl. 215, f. 22–23.

Eugenia paucipunctata Merr. Philip. Jour. Sci. Bot. **10**: 215. 1915, non Koord. & Val.

PHILIPPINE ISLANDS: Luzon, Benguet Subprovince, *Merrill (Philip. Pl. 1709),* distributed as *E. calcicola* Merr.

The habit of this species resembles *Eugenia calcicola* Merr., although technically it clearly belongs to the genus *Cleistocalyx.* The close venation of the leaves, the conspicuous acumen and the compact inflorescence suggest an alliance with the smaller flowered species of the *Acicalyptus* section, but the flowers are not at all angular. The species probably is most nearly related to *C. nigrans* (Gagnep.) but, in the latter, the venation is finer and not only more evenly distributed but also not elevated on the lower surface; the leaves are much more glandular-punctate.

18. **Cleistocalyx nigrans** (Gagnep.), comb. nov. Pl. 215, f. 24.

Eugenia nigrans Gagnep. Not. Syst. **3**: 329. 1917, Fl. Gén. Indo-Chine, **2**: 814. 1920.

COCHIN-CHINA: Caï-cong, Ongien, *Pierre 1934* (type, Herb. Paris). Doctor F. Gagnepain very generously sent us fragments of a number of his types of *Eugenia,* among others, *E. nigrans* Gagnep. In the original description of this species the calyx is characterized as perfectly truncate, neither lobed nor undulate. This is quite accurate for a full-blown flower, but in the bud of our fragments the apex of the calyx is entirely closed; the latter is the distinctive feature of *Cleistocalyx.*

C. paucipunctatus (Merr.), of the Philippine Islands, is somewhat similar in the size and the shape of the flower-buds as well as in the close venation of the leaves; the latter, however, really differ in outline and in type of venation. The leaves of *C. paucipunctatus* (Merr.) are subcaudate-acuminate with somewhat unevenly distributed veins; whereas, those of *C. nigrans* (Gagnep.) are acuminate-obtuse with more finely reticulate and more evenly arranged venation.

19. **Cleistocalyx Brongniartii,** nom. nov.

Acicalyptus nitida Brongn. & Gris, Ann. Sci. Nat. V. Bot. **3**: 227. 1865, Bull. Soc. Bot. France, **12**: 186. 1865; Däniker, Vierteljahrssch. Naturf. Gesellsch. Zürich, **78**: Beibl. **19**: 307. 1933.

NEW CALEDONIA: near Balade, *Vieillard 534, 538* (not seen).

The characteristic features of the genus *Cleistocalyx* are well portrayed in the original description of the above species. It is not easy to determine, without material, which are the best specific characters, but possibly they are the very short-petiolate leaves, the congested inflorescences and the perceptibly narrowed (rather than hemispheric) and sulcate calyptras. Brongniart and Gris' specific name is invalid in *Cleistocalyx.*

20. **Cleistocalyx operculatus** (Roxb.), comb. nov. Pl. 215, f. 41–48.

Eugenia operculata Roxb. Hort. Bengal. 37. 1814, *nomen nudum,* Fl. Ind. ed. 2, **2**: 486. 1832; Wight, Ic. **2**(3): 4. *t. 552.* 1843; F.-Vill. Novis. App. Fl. Filip. 85. 1880; Koord. & Val. Meded. Lands Plant. **40**: 148. 1900 (Bijdr. Boomsoort. Java, **6**: 148); Koord. Exkursionsfl. Java, **2**: 679. 1912; Koord.-Schumach. Syst. Verzeichn. Herb. Koord. **1**(1^{222}): 58. 1912; Koord. & Val. Atlas Baumart. Java, **3**: *f. 503.* 1915.

Syzygium nervosum DC. Prodr. **3**: 260. 1828, Mém. Myrt. **2**: *t. 16.* 1842, excluding interpretation of genus p. 41.

Calyptranthes Makal Blanco, Fl. Filip. 419. 1837, non Raeusch.

Calyptranthes Zuzygium Blanco, op. cit. ed. 2, 293. 1845, ed. 3, **2**: 179. 1878, non Sw.

Calyptranthes mangiferifolia Hance ex Walp. Annal. **2**: 629. 1851–52.

Syzygium nodosum Miq. Fl. Ind. Bat. **1**(1): 447. 1855.

Syzygium angkolanum Miq. op. cit. 448.

Eugenia Holtzei F. v. Muell. Australas. Jour. Pharm. June, 1886, Bot. Centralbl. **28**: 148. 1886.

Syzygium operculatum Niedenz. in Engler & Prantl, Nat. Pflanzenfam. **3**(7): 85. 1893; Gamble, Fl. Madras, **1**: 481. 1919.
Eugenia Holtzeana F. v. Muell., Maiden, Dept. Agric. Sydney, N. S. Wales, Misc. Publ. **282**: 22. 1899 (Native Food Plants).
Eugenia clausa C. B. Rob. Philip. Jour. Sci. Bot. **4**: 380. 1909; Merr. Sp. Blanco. 288. 1918, Enum. Philip. Pl. **3**: 162. 1923.
Eugenia divaricato-cymosa Hayata, Icon. Pl. Formos. **3**: 118. 1913.
Eugenia Holteana F. v. Muell., Ewart & Davies, Fl. North. Terr. Austral. 202. 1917.

INDIA: type described from tree, cultivated in Royal Bot. Gard., Calcutta, said to be native of Amboina; copy of original Roxburgh plate ex herb. Calcutta (also reproduced in Wight Ic. t. 552); sketch of leaf, and flower of authentic material of *E. operculata* Roxb. (DeCandolle's Prodromus Herb.); Chittagong Hill Tracts, *King's collector 315;* North Arakan, *Hildebrand 13*: CHINA, Kwangtung, *S. Y. U. 50364, 89693, Wang 9421 (S. Y. U. 67781);* Canton and vicinity, *Levine 1288, 2126, Tsiang 11047;* Honam Island, *Levine 1050;* Lofoushan, *Chun 8297, 40792;* Naam Hoi District, *Levine 3024;* White Cloud Mountain, *Levine 3129;* Weishang, Sunyi District, *Tsiang 2721,* side of stream; Ting Wu Shan, Kao-Yao District, *Tsiang 775, 1496, Liang 60737, Lau 20275;* Ying-Tak, Wentongshan, *Tso 22242;* Shi-wan-da-shan, *Tso 23371;* Hongkong, *Bodinier 613, Wright s. n.;* North Point, *Ford s. n.,* July 29, 1895; Tai-O, New Territory, *Wang 3189;* Ma Au Shan, Shatin, *Tsiang 215;* Upper Aberdeen Road, *Gibbs (Hb. Hongkong 10261);* Kwangsi, Lungchau, *Morse 625;* Hainan, without locality, *Wang 32834, 34169;* Lin Fa Shan, Lam Ko District, *Tsang 166 (L. U. 15665), 343 (L. U. 17092);* Hung Mo Shan, *Tsang & Fung 458 (L. U. 17992);* Dung Ka, *Chun & Tso 43430,* along stream at about 500 m. alt.; Yaichow, *How 70840, 71120, Liang 61996;* Yeung Ling Shan, Ngai District, *Lau 78;* Pak Shik Ling and vicinity, Ching Mai District, *Lei 697, 918;* Tai-too, Seven Finger Mountain, *Liang 61722;* Liamui (Leng Mun), *Gressitt 1165*: INDO-CHINA, Annam, Nghe-An, (*no collector given*) *4,* June 21, 1930; Cochin-China, without locality, *Pierre s. n.*: SUMATRA, Sigamata, near Rantau Parapat, Bila, *Rahmat Si Toroes 3196;* Upper Angkola, *Junghuhn* (Rijks Herb., type of *Syzygium angkolanum*): JAVA, Batavia, Tjitjadas, *v. Steenis 5407;* Preanger, Tjibodas, *v. Woerden 163, 178;* Pengalengan Forest, *Junghuhn* (Rijks Herb., type of *S. nodosum*): BORNEO: British North Borneo, Banguey Island, *Castro & Melegrito 1490;* Mount Kinabalu, Tenompok, *Clemens 28336;* Beaufort, *Bakar (B. N. B. Forestry Dept. 3302);* Dallas, *Clemens 27542, 27562;* Penibukan, *Clemens 30478;* Kiau, *Clemens 10101;* Sarawak, Mount Matang, *Clemens 20959;* Sibu, Rejang River, *Haviland 2845;* Mount Lingga, *Beccari 3943;* Dutch Borneo, Pladjoe, *Amdjah 27;* Ben. Dajak, S. Betilap, *van Tuil 10 (Boschproefstation bb: 11607);* Hayoep, *Winkler 2431;* Soengei Landak, *Teysmann 11248, 11250;* Goenoeng Kenepai, *Hallier 1684:* PHILIPPINE ISLANDS, Luzon, Ilocos, *Paraiso (For. Bur. 25453);* Rizal Province, *Ramos (For. Bur. 13606),* Antipolo, *Ahern's collector (For. Bur. 470), Merr. Sp. Blancoan. 978, Ramos 314, Ramos & Edano (Bur. Sci. 29527);* Bosoboso, *Merrill 2806;* Palawan, *Danao (For. Bur. 21596)*: AUSTRALIA, Port Darwin, *Holtze.*

Of all the known species of the genus *Cleistocalyx,* this is the commonest, the most widely distributed and perhaps the most misinterpreted. Its habit is generally assumed to be distinctive and certainly the copy of Roxburgh's original plate received through the courtesy of Dr. C. C. Calder, Superintendent of the Royal Botanic Garden, Calcutta, would confirm this idea. In the floral details in Roxburgh's original drawing the first figure (Wight, Icones t. 552, f. 2) shows a calyx with the characteristic calyptra with the corolla inside, explained by Wight as "a flower, petals separating," and the second figure (Wight, Icones t. 552, f. 3) a flower with the petals forcibly opened; this is manifestly schematic. However, there is in India at least one species of like habit with flower-buds similar in outline and such minute calyx-lobes that more than half our collections of these two species are identified as *Eugenia operculata* Roxb. This fact led us to question which was true *E. operculata* Roxb. A bud and a sketch of a half-open flower and a leaf from an authentic *Roxburgh* specimen in the Prodromus Herbarium very kindly supplied us by Professor B. P. G. Hochreutiner, Director of the Botanic Garden, Geneva, confirm the identification of botanists who have accepted Roxburgh's species as having flowers with calyptrate calyces. At the same time it should here be noted that in a number of floras (Benth. Fl. Hongk. 119. 1861; Brandis, For. Fl. 234. 1874; Kurz, For. Fl. Brit. Burma, **1:** 482. 1877; Duthie in Hook. f. Fl. Brit. Ind. **2:** 498. 1879; Trimen, Handbk. Fl. Ceylon, **2:** 179. 1894; King, Jour. As. Soc. Bengal, **70**(2): 129. 1901 (Mater. Fl. Malay. Pen. **3:** 559); Gagnep. in Lecomte, Fl. Gén. Indo-Chine, **2:** 817. 1920; Ridl. Fl. Malay Pen. **1:** 754. 1922) the calyx is described by such phrases as, "truncate," "with short obtuse lobes or nearly truncate," "not distinctly toothed," or "with short obtuse marginate teeth." Even Roxburgh's original description, "Calyx entire; corol operculate," which was followed by de Candolle in the Prodromus, is not too clear. De Candolle, Mém. Myrt. 41. 1842, points out very carefully that the difference between *Calyptranthes* and *Syzygium* is that the former has the operculum formed by the calyx lined by the petals, whereas the latter has the operculum formed by the petals cohering at the top and the calyx is very short, sometimes truncate, sometimes 5-dentate visible below the operculum of the corolla; yet, op. cit., *t. 16* (*Syzygium nervosum* DC.), which is one of four plates de Candolle used to illustrate the genus *Syzygium,* is practically perfect as to the detail of *Cleistocalyx operculatus* (Roxb.) except that in the younger buds the line of dehiscence between the calyptra and the calyx-tube is *not definitely marked* unless it be assumed from the color. This is an interesting feature of the bud. In dried material, the upper part of the calyx forming the calyptra becomes lighter than the lower part, in fact, much the same color as the corolla in the buds of other species. This may be the explanation of the misinterpretation of the calyx which has been so generally accepted.

Hance ex Walp. Annal. **2:** 629. 1851–52, in his description of *Calyptranthes mangiferifolia* very clearly points out the calyptrate character of the calyx. Hance's description was based on a specimen from Macao, he believing that he had a true *Calyptranthes* introduced by the Portuguese from South America. Koorders & Valeton, Meded. Lands Plant. **40:** 351. 1901 (Bijdr. Boomsoort. Java **6:** 351) give an excellent description, "Calyx in alabastro clausus et saepe apiculatus per anthesin calyptriformi-circumscissus, marginem subintegrum vel pseudo-crenulatum relinquens."

As is to be expected of any wide-ranging species, *Cleistocalyx operculatus* (Roxb.) shows some variation in size of both leaves and flowers, and, since we have not found any constant characters in the material at hand for separating specimens from different regions, we are inclined to believe that a single species is represented.

The type of *Syzygium angkolanum* Miq. is one of the rare instances, in this species ordinarily characterized by lateral inflorescences, where the panicles appear to be axillary and terminal but apparently on leafy shoots of last season, and hence, lateral.

We are unable to maintain *Eugenia Holtzei* F. v. Muell. as a separate species. We strongly suspected this from the description and after examining the fragments of the type generously supplied by Mr. F. J. Rae, Director of the Melbourne Botanic Gardens, we are convinced that here is another collection of the wide-ranging *C. operculatus* (Roxb.).

A Ceylon specimen, *Thwaites, C. P. 2801,* distributed as *Syzygium firmum* Thwaites, Enum. Pl. Zeyl. 116. 1859, with a note, "cf. Enum. pp. 116, 417," in our herbarium seems to be without question *C. operculatus* (Roxb.). It surely does not belong to either of the above species referred to in the Enumeration (*C. P. 2801* is cited under *S. polyanthum,* p. 116, i. e. *Eugenia polyantha* Wight), as we understand them.

21. **Cleistocalyx nicobaricus** (King), comb. nov. Pl. 215, f. 49.

Eugenia nicobarica King, Jour. As. Soc. Bengal, **70**(2): 130. 1901 (Mater. Fl. Malay. Pen. **3**: 560).

Eugenia occlusa sensu Duthie in Hook. f. Fl. Brit. Ind. **1**: 498. 1879; Koord. & Val. Meded. Lands Plant. **40**: 152. 1900 (Bijdr. Boomsoort. Java, **6**: 152); Koord. Exkursionsfl. Java, **2**: 679. 1912; Koord. & Val. Atlas Baumart. Java, **3**: *f. 504*. 1915, non *E. occlusa* Kurz.

NICOBAR ISLANDS: *Kurz* (Herb. Calcutta; fragm.).

That Kurz apparently erred in naming his collection from the Nicobar Islands *Eugenia occlusa* (*Syzygium occlusum* Miq.), seems to be the opinion of botanists who have had access to his collection and to authentic material representing Miquel's species. Such erroneous identification, however, does not alter the fact that, since he based the combination *Eugenia occlusa* on Miquel's earlier name, nomenclaturally it can belong only to the species represented by Miquel's material. Koorders & Valeton likewise erred in applying the name to the species represented by Kurz's collection and in giving a new name to Miquel's species. King noted that Kurz's specimen differed so much from Miquel's description and an authentic specimen of Miquel's species (coll. *Horsfield*) that he gave it a new name.

The Superintendent of the Royal Botanic Gardens, Calcutta, very generously gave permission for Mr. Narayanaswami to send us a fragment of Kurz's collection. The leaf is epunctate and not pellucid-dotted, about 6 cm. long, on either side of the midrib are 7–8 inconspicuous primary veins somewhat arcuately anastomosing to form a submarginal vein about 1 mm. within the margin. The calyx does not appear so tapering toward the base as in *C. operculatus* (Roxb.). There is no evidence that *C. nicobaricus* occurs in Java.

UNIDENTIFIED AND EXCLUDED SPECIES

SYZYGIUM COSTATUM Miq. Fl. Ind. Bat. **1**(1): 451. 1855.

This species is to be excluded from the synonymy of *C. operculatus* (Roxb.). The *Junghuhn* collection, Kupa Manok, Java, very kindly loaned for study by Professor Lam, Rijks Herbarium, is a foliar specimen which, as far as we can tell, is a reasonable match as to leaves and twigs for another collection labeled *S. costatum* by Miquel. The second specimen shows only a young infructescence, at times a difficult stage to interpret in the genus *Cleistocalyx*. However, within the limb of the calyx of one young fruit and apparently a part of the same flower is an evidently operculate corolla. This is a character of *Syzygium*, but in *Cleistocalyx* the corolla does not appear intact after the flower opens unless associated with the calyptra of the calyx which often adheres to the calyx-tube even after the corolla has fallen.

SYZYGIUM FRUTICOSUM DC. Prodr. **3:** 260. 1828, Mém. Myrt. *t. 19.* 1842.

In a note following *Syzygium javanicum* Miquel, Fl. Ind. Bat. **1**(1): 462. 1855, it is suggested that *Syzygium fruticosum* DC. belongs to the section *Symphysion,* op. cit. 460, which, according to our interpretation, is a part of *Cleistocalyx.* Our herbarium material of *S. fruticosum* DC. has a definitely open lobed calyx and hence could not possibly belong in the genus under consideration.

SYZYGIUM JAVANICUM Miq. Fl. Ind. Bat. **1**(1): 461. 1855.

Doctor A. Pulle generously loaned us the type and another specimen labeled *S. javanicum* by Miquel. The latter, we are sure, does not belong to *Cleistocalyx.* The type is very fragmentary, one leaf and a detached inflorescence. The leaf is not a match for any of the species of this group. The flowers except for one shriveled and one maturing bud have all passed anthesis; unfortunately, the one bud which might reveal the distinctive character of the genus is pressed in such a way that it is impossible for us to say without removing it whether or not it is calyptrate. This, we have hesitated to do, hoping that, at some later date, it will be possible to examine a more complete specimen of the type-collection, *Horsfield,* near Soerakarta, Java.

EUGENIA NERVOSA Lour. Fl. Cochinch. **1:** 308. 1790; DC. Prodr. **3:** 284. 1828; Miq. Fl. Ind. Bat. **1**(1): 442. 1855 excl. syn.; Merr. Trans. Am. Philos. Soc. **24**(2): 285. 1935.

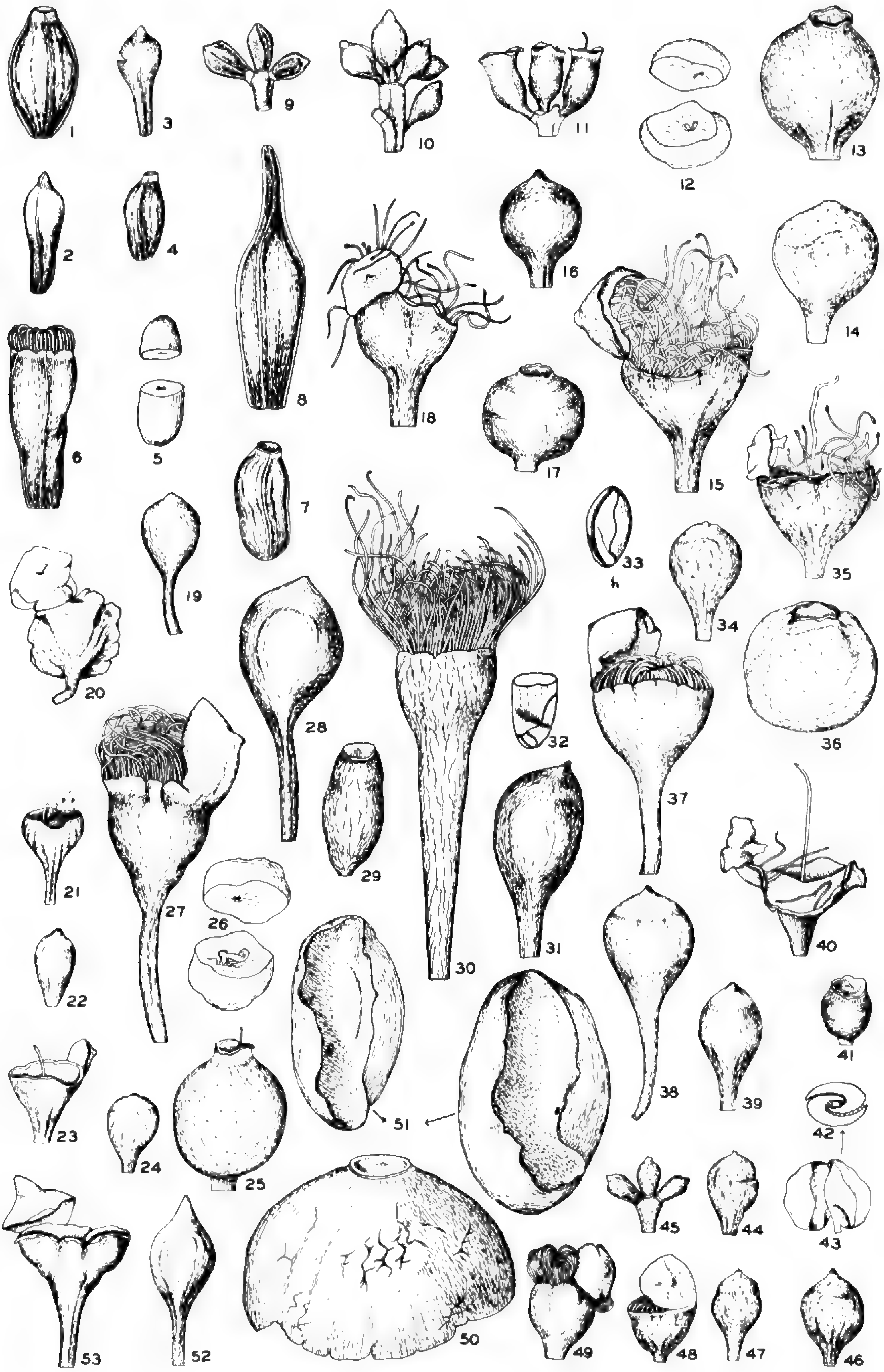
Myrtus Loureiri Spreng. Syst. Veg. **2:** 488. 1825.
Cleistocalyx nervosus Blume, Mus. Bot. Lugd.-Bat. **1:** 85. 1849.

If we interpret Loureiro's *Eugenia nervosa,* the basis of *Cleistocalyx nervosus* Blume, by the original description of the calyx, "Cal. superus, 4-partitus, magnus: laciniis, obtusis, concavis," there is no indication that the species belongs either to *Cleistocalyx* as defined by Blume or to the section of *Eugenia* in which it is placed by Miquel. Loureiro's type is not extant.

SYZYGIUM OCCLUSUM Miq. Fl. Ind. Bat. **1**(1): 460. 1855.

Eugenia occlusa Kurz, Jour. As. Soc. Bengal, **45**(2): 130. 1876, quoad syn.; Duthie in Hook. f. Fl. Brit. Ind. **2:** 498. 1879, quoad syn., excl. desc.
Eugenia symphysipetala Koord. & Val. Meded. Lands Plant. **40:** 153 (in nota), 161 (descr.). 1900 (Bijdr. Boomsoort. Java, **6:** 153, 161).

Miquel's species was based on *Horsfield 10* from Java. Koorders and



Cleistocalyx

Valeton, after examining a fragment of the type in the Utrecht Herbarium, suggest that *Syzygium occlusum* Miq. was based on a mixture of *Eugenia lineata* Duthie and *Eugenia operculata* Roxb. remarking, p. 161, "S[yzygium] species dubia (forsitan e foliis *E. lineatae* cum floribus *E. operculatae* composita)." The specimen of *Horsfield 10* in the Gray Herbarium consists of detached inflorescences of *C. operculatus* (Roxb.) and leafy branches with attached inflorescences of *Eugenia polyantha* Wight. Miquel's species was manifestly based on a mixture of *C. operculatus* (Roxb.) (flowers) and the leaves of *Eugenia lineata* Duthie or *E. polyantha* Wight.

EXPLANATION OF PLATE 215

All fruits and embryos are × 1; the only fruit which we are reasonably sure is mature is that of *C. gustavioides* (F. M. Bailey) picked up under the tree; the embryos except those of *C. Fullageri* (F. v. Muell.) and *C. operculatus* (Roxb.) are shown with the cotyledons as they usually separate when the pericarp is removed.

All buds and flowers are × 2.5; the flowers are in various stages of development to show that the calyptra may or may not remain attached to the calyx-limb.

C. longiflorus: f. 1, fruit; f. 2, bud.
C. Seemanni: f. 3, partly open bud; f. 4, fruit; f. 5, embryo.
C. myrtoides: f. 6, flower (calyptra fallen); f. 7, fruit; f. 8, bud.
C. ellipticus: f. 9, cluster of buds.
C. perspicuinervius: f. 10, cluster of buds; f. 11, very young fruits.
C. retinervius: f. 12, embryo; f. 13, fruit; f. 14, bud; f. 15, flower.
C. arcuatinervius: f. 16, bud; f. 17, fruit; f. 18, flower.
C. nitidus: f. 19, bud; f. 20, flower.
C. Baeuerlenii: f. 21, flower.
C. paucipunctatus: f. 22, bud; f. 23, flower.
C. nigrans: f. 24, bud.
C. barringtonioides: f. 25, fruit; f. 26, embryo; f. 27, flower; f. 28, bud.
C. Fullageri: f. 29, fruit; f. 30, flower; f. 31, immature bud; f. 32, embryo; f. 33, cotyledon (one removed) showing inner face and long hypocotyl.
C. conspersipunctatus: f. 34, bud; f. 35, flower; f. 36, fruit.
C. paradoxus: f. 37, flower; f. 38, bud.
C. leucocladus: f. 39, bud; f. 40, flower.
C. operculatus: f. 41, fruit; f. 42, cross section of embryo; f. 43, embryo; f. 44, bud of *Eugenia Holtzei* F. v. Muell.; f. 45, buds of *Syzygium angkolanum* Miq.; f. 46, bud from Chinese material; f. 47, bud from Javan material; f. 48, flower from authentic collection of Roxburgh in the de Candolle Prodromus Herbarium.
C. nicobaricus: f. 49, flower.
C. gustavioides: f. 50, fruit (remnant of pericarp); f. 51, embryo; f. 52, bud; f. 53, flower.

Arnold Arboretum,
Harvard University.

PHYTOPHTHORA CROWN ROT OF DOGWOOD

D. B. Creager

With plate 216

A disease, which has been responsible for the disfiguration and ultimate death of flowering dogwood trees (*Cornus florida* L.) in various localities on Long Island, New York, was called to the attention of the writer during the summer of 1934. Early observations soon revealed that apparently healthy trees may be attacked and badly damaged within a year or so after becoming infected. Some may be killed in a relatively short time while others may remain alive much longer; however, in either case their ornamental value is soon impaired. In several instances where a diseased tree had been removed and replaced by a healthy one from the nursery or woods, it too became infected and died. Thus far the disease is known to occur only in trees planted on lawns and in gardens; it has not been observed in natural woodland stands.

During the past three years numerous field observations, culture studies and inoculation tests have been made, the results of which demonstrate for the first time the general nature and cause of this disease.

SYMPTOMS

The most obvious symptoms of the crown rot disease of dogwood constitute those associated with a general weakening of the top (Plate 216, Figure 1). The leaves are few, small, light green or chlorotic, usually drooped and their edges rolled. The tips of twigs and branches die, finally involving the larger ones and eventually the entire top. Commonly a severely infected tree bears an abnormal abundance of fruit for several years before it is completely killed.

A more careful examination of such a tree reveals that the seat of the trouble is a characteristic necrotic lesion at the crown; the weakened top is only an indirect expression of the condition of the bark and sapwood of the trunk. At first the lesion is quite obscure and may not be seen without the removal of the outer bark. Eventually, as the extent of the lesion increases, the bark over the older affected parts breaks and sap frequently oozes from the openings in the form of a slime-flux (Plate 216, Figure 2). Such lesions have a marked odor of fermentation and are attractive to bees and other insects. The bark over the older areas dies, becomes dry and finally falls from the trunk.

Internally the affected tissues of the bark and sapwood are markedly discolored (Plate 216, Figure 3). In older areas the affected tissue is dark brown while at the edge, or more "active" part of the lesion, it is often pinkish, purplish to blue, or light brown and frequently it appears as a streaked variegated zone of all these colors.

When the bark over a typical lesion is removed, the full extent of the affected area is clearly demonstrated. From the level of the soil surface upwards the shape of the lesion is commonly that of a parabola and its surface is characteristically zonate (Plate 216, Figure 3). These zonations apparently represent the progressive advances of the lesion due to alternate favorable and unfavorable periods for growth of the pathogene. The lesion finally involves the greater part of the crown before the tree is eventually killed. Since the typical necrotic lesion at the crown is the seat of the trouble, "crown rot" is proposed for the name of this disease.

THE PATHOGENE

A phycomycetous fungus has been consistently isolated from the characteristic lesions of affected crowns. Tissue plantings made from bark or sapwood of the outer zone of the rotted area commonly yield pure cultures of the fungus. On potato dextrose agar the pathogene grows from such plantings within three days and forms a mat of white, cottony, aërial mycelium.

Based on the works of Tucker (1931), Leonian (1934), and Tompkins, Tucker and Gardner (1936), this fungus has been identified as *Phytophthora cactorum* (L. and C.) Schroet. The mycelium grows rapidly on all ordinary nutrient agar media at room temperature (20° to 25° C.), but on corn meal agar growth was still better at 27.5°C. Oogonia, accompanied by paragynous antheridia, form in great profusion on oat agar in petri dishes within a few days after a new culture is started. The thick-walled oospores are yellowish and average 25.0 microns in diameter with a range of 21.3 to 30.5 microns (500 measurements). Sporangia develop quite abundantly on a synthetic nutrient agar medium prepared from a modified Richard's Solution in which sugar was omitted. They are borne on slender sporangiophores arising from the larger vegetative hyphae; they are ovate, definitely papillate, and average 35.4 by 44.2 microns with a range of 23.2 to 43.5 by 29.0 to 68.1 microns (100 measurements). Two methods of sporangial germination have been observed, namely, by germ tubes and zoospores. In liquid medium the zoospores are quite active at first; but they soon become quiescent and within a short time germinate by germ tubes. These observations concerning the development and morphology of the various spore forms are similar to those more fully described and illustrated by Rosenbaum (1915) for the same species, *P. cactorum,* isolated from ginseng.

The pathogenicity of this phycomycetous organism was strongly indicated by its consistent association with the typical necrotic lesions at the crown of affected trees. To determine its pathogenicity experimentally, inoculation tests were conducted on plants both in the greenhouse and in the field. For the greenhouse test 35 seedlings of *Cornus florida,* approximately one-quarter of an inch in diameter at the base and 24 to 30 inches in height, were used. All were separately established in pots and were fully in leaf at the time inoculations were made. A wound was made with a sterile scalpel in the stem of each plant at the soil surface by a downward diagonal incision through the bark to the cambium area. Mycelium from an actively growing culture of the suspected pathogene on potato dextrose agar was inserted into the wounds of 25 plants, while sterile potato dextrose agar was placed in the wounds of the remaining 10 plants to serve as checks. A piece of water-saturated absorbent cotton was wrapped about the inoculated wound of each plant and, to retain the moisture, a layer of sphagnum moss was placed over the soil surface of each pot.

Four weeks after the seedlings were inoculated, external symptoms of infection began to appear and at the end of seven weeks 16 of the 25 plants inoculated were dead, while all check plants remained perfectly healthy. The first symptom to appear was a sudden wilting of the foliage. Within a day or so wilting was followed by a drying and browning of all the leaves. When the bark was removed from the basal portion of the stem of such plants, the bark and sapwood above and below the point of inoculation was discolored brown, the discoloration commonly extending into the root bases below and up the stem four to six inches above the soil surface. Not only were the bark and the outer surface of the sapwood discolored, but the discoloration extended through the wood into the pith. The typical phycomycetous hyphae and oogonia were abundantly present in the affected tissues of the bark, wood and pith. The pathogene was consistently reisolated from the discolored wood of these infected seedlings, plantings made from the upper limits of the lesion usually yielding pure cultures of the pathogene.

Similar results were obtained from inoculation tests conducted on larger trees in the field. Typical lesions in the bark and sapwood followed inoculations through wounds at the crown, and the pathogene was readily reisolated from all parts of such lesions.

The results of these studies, therefore, demonstrate that the crown rot disease of flowering dogwood is caused by ***Phytophthora cactorum*** (L. and C.) Schroet. Even though forms of this pathogene have been reported on various members of at least 30 different families of higher plants (Tucker, 1933), apparently this is the first report of its occurrence on *Cornus florida* L. or any other member of the Cornaceae. Nevertheless, *P. cactorum,* as well as several other species of *Phytophthora* are known to cause quite similar diseases in other woody plants, for example, trunk canker of apple (Bains, 1935), crown rot of walnut (Barrett, 1928), crown canker of peach and prune (Smith and Smith, 1925), crown rot of avocado trees (Fawcett, 1916), foot rot and canker of *Citrus* (Fawcett, 1915), Phytophthora canker of *Hevea* (Petch, 1911), and still others. The general nature and symptoms which have been described for these diseases by the various writers are strikingly comparable with those of the crown rot disease of dogwood.

ACKNOWLEDGMENTS

Deep appreciation is expressed to Mr. George Van Yahres for his stimulating cooperation and material aid throughout, to Professor J. H. Faull for helpful advice, and to the Arnold Arboretum and the Biological Laboratories of Harvard University for their laboratory and greenhouse facilities.

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EXPLANATION OF PLATE 216

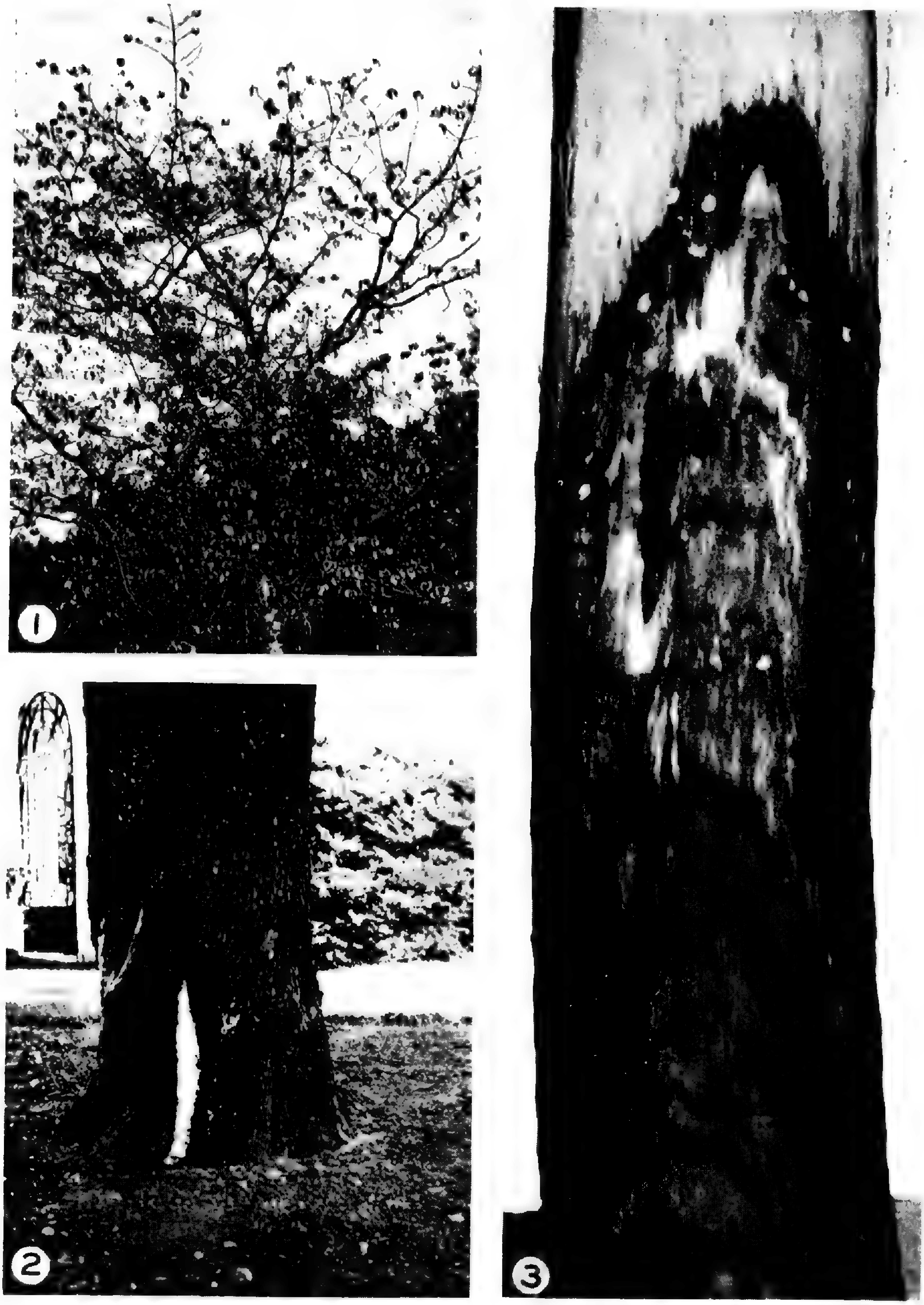
Symptoms of the crown rot disease of dogwood

Fig. 1. A severely infected tree, exhibiting a weakened top with reduced foliage, dying twigs and branches, and an abundance of fruit.

Fig. 2. Trunk of an infected tree (approximately 12 inches in diameter), showing rotted crown; the necrotic lesion had been partially removed at the left, but at the right of the excision the bark over the portion of the lesion which still remains has broken and the sap is exuding in the form of a white, foamy, slime-flux.

Fig. 3. Trunk of an infected tree with bark removed (approximately 6 inches in diameter), exposing the typical, discolored, concentrically zoned lesion in the sapwood.

Laboratory of Plant Pathology,
Arnold Arboretum, Harvard University.



PHYTOPHTHORA CROWN ROT OF DOGWOOD

THE ARNOLD ARBORETUM DURING THE FISCAL YEAR ENDED JUNE 30, 1937

WHILE the funded resources of the institution remain as at the close of the previous year, the establishment of the Maria Moors Cabot Foundation for Botanical Research in June, 1937, enables us to amplify our work in certain fields. The initial endowment of this Foundation, the munificent gift of Doctor Godfrey L. Cabot of Boston, is $615,773.00. The income from this fund is allocated to support special investigations in various parts of Harvard University, the Harvard Forest, the Biological Laboratory, the Arnold Arboretum, and the Bussey Institution.

The numerous friends of the Arboretum, scattered all over the United States and Canada have responded generously to its needs. Gifts for cultural purposes up to the end of the fiscal year amounted to about $10,560.00. The appeal this year, the first one made since 1930, was to provide supplementary library funds, to permit the amplification of botanical-horticultural exploration, and to develop a larger nursery on the Walter Street tract. Supplementing these unrestricted gifts, available for immediate use, $6500.00 has been received or promised for special purposes, particularly to cover publication costs. On the basis of what has been received, it is possible to plan a somewhat amplified program during the coming year. We are particularly grateful to the donors of these special small and large gifts, as these funds, being extra-budgetary, enable us to accomplish much-needed investigations, or to undertake needed improvements that it was impossible to finance on the basis of the regular institutional income.

Building and Grounds. — Fortunate in having an unusually mild winter with little or no winter killing of buds, the floral displays at the Arboretum in May and June were unusually attractive. These are the months when the institution is most extensively visited by the public, and within recent years there has been a very noticeable increase in visitors. A careful check of visitors on lilac Sunday, May 23, 1937, indicated an approximate attendance of 40,000 on that one day.

The usual program has been followed in the maintenance of grounds and plantings, involving some thinning and transplanting, the removal of overgrown and moribund plants, and spraying for protection against noxious insects and fungus diseases. Necessary repairs have been made to buildings as required, the most extensive operations being on the administration building, involving roof and gutter repairs and the pointing up of all masonry construction. A new trellis was constructed for the Wisteria collection.

Horticulture. — In an attempt to make the Arboretum more useful to the community and to the horticulturally minded public in the country at large, considerable progress has been made. Over fifty illustrated lectures were given to various groups on the scope and work of the institution. In the spring, personally conducted tours were arranged for thirty organizations. For use in connection with these lectures, approximately 400 new natural color slides have been prepared, bringing our collection up to about 700. Preliminary work has been done on a series of natural color films, planned to illustrate the attractions of the Arboretum at various seasons. It is anticipated that these will be completed during the coming year.

During the year the hedge demonstration planting was completed, involving plantings averaging 20 feet in length, covering 115 different species. The Wisteria collections were removed from the old site near the Forest Hills entrance, a new trellis was constructed, and all species were replanted near the Bussey Institution building; in close proximity to this planting a collection of 35 named varieties of tree peonies, generously presented by Mr. John Wister, was installed.

The extensive use of fertilizers is being continued, and the response of the treated plantings is noticeable. It is believed that this policy should be consistently followed to compensate, in some degree, for the relatively poor soil characteristic of much of the arboretum area.

The spring plantings involved the actual placing of 521 new plants in various parts of the grounds. In connection with this work the old nursery was entirely rearranged, those shrubs and trees destined for planting in our own grounds being arranged in one area, and the duplicates and material not needed, destined for gifts or exchange purposes, arranged in another section. To take care of urgent additional nursery needs, arrangements have been made to establish a large supplementary nursery on the undeveloped Walter Street tract. New beds were prepared for the willow collection, the Rubus material was removed from the shrub collection to the Peters Hill area, the very badly overgrown Forsythia collection was cut back, this being the only possible way of eliminating a bad fire hazard by the removal of all dead wood.

In an attempt to check the identifications of the very extensive living collections about 500 new labels with changed names were added, and about 400 broken labels were replaced by new ones. Approximately

2000 metal labels, and 2500 wooden display labels were prepared and placed during the year.

Accessions during the year include 2693 living plants received from various sources within the United States and 263 from foreign countries. Cuttings and scions added 193 to this list. Two hundred packets of seeds were received from eighteen foreign countries. Distributions from the Arboretum included 1831 living plants, 980 cuttings and scions, and 772 packets of seeds, to individuals and institutions in the United States and various foreign countries.

The card index list of living plants in the Arboretum has been thoroughly revised, various records eliminated, and others added. There are now approximately 6500 named species and varieties represented in the living collections, an extraordinarily large number when one considers that the institution handles only woody plants, and again when one considers the local climatic limitations. There is still a list of about 1100 additional species that at one time or another have been in cultivation at the Arboretum but which have been lost for one reason or another, that are worthy of re-trial. Arrangements have been made to re-acquire as many of these lost species as possible.

Cooperation has been extended to the Massachusetts Horticultural Society in connection with four exhibits sponsored by that organization. Assistance has been granted to the American joint committee on horticultural nomenclature in the revision of its "Standardized Plant Names." Many data have been supplied to the press on plants and plant problems. Work has been initiated on the much-needed task of revising and completing the detailed base map of the entire Arboretum, showing the exact location of each planted species and variety.

The circulation of the "Bulletin of Popular Information," one of the means whereby horticultural data are made available to the public, has been increased from 612, with 190 paid subscribers early in 1936, to 1500, of which 1200 are actual subscribers.

Plant Pathology. — The extension work of the laboratory of plant pathology has been especially heavy during the past year. This is particularly true with reference to requests for information and help on disease problems. Our interest in the Dutch elm disease situation in the United States has been actively maintained. There are indications that the disease is being controlled and to some extent the infected area being reduced, especially in the State of New York.

Our work on elm diseases at the adjunct field laboratory on Long Island was brought to a conclusion, and an account of the investigation made there and at the Arboretum by Dr. D. B. Creager is to be published in July as Contribution no. 10 from the Arnold Arboretum.[1] This is a well-rounded piece of research on the cause, means of spread and control of a common, destructive, hitherto little understood, native wilt disease of the American elm caused by a fungus tentatively referred to the genus *Cephalosporium*. It constitutes a fine addition to the literature of elm diseases. Its publication was made possible by generous gifts from Mrs. Harold I. Pratt, Miss Helen C. Frick, Mr. George Van Yahres, and the Massachusetts Society for Promoting Agriculture.

Other significant investigations have been advanced and some publications on them issued. Among these mention should be made of the following: — (1) The physical basis of mycotrophy in *Pinus* by Dr. A. B. Hatch. This is an outstanding piece of work in that it demonstrates the helpful rôle of mycorrhizae in the growth of white pine and it explains that the value of mycorrhizae resides in the ability of the root-associated fungi to collect mineral salts where there is a lack of balance of them in the soil. (2) The control of *Gymnosporangium* rusts by means of sulphur sprays by Drs. J. D. MacLachlan and I. H. Crowell. This represents a valuable, practical conclusion of an admirable series of papers issued from the Arboretum on *Gymnosporangium* rusts harmful to *Juniperus* and various members of the Pomoideae. It is the first practical demonstration of the fact that the disease caused by these fungi can be controlled without having to resort to the radical practice of host eradication. The value of this method has been confirmed by New York State Agricultural Experiment Station and the procedure modified so as, at the same time, to control apple scab. (3) *Chrysomyxa Empetri* — a spruce-infecting rust. This adds another rust to the list known to attack spruces and it rounds out the life-history of a fungus long known only on species of *Empetrum*.

Cytology. — The cytological work during the past year has included two major projects. The first was a study on the effect of temperature on cell division. Extreme temperature changes may cause chromosome division without nuclear division, nuclear division without cell division, and cell division without nuclear division in the microspore development of *Tradescantia*. Chromosome aberrations also were caused by heat treatment.

The effect of temperature changes in causing chromosome division without nuclear division has been used to induce artificial polyploidy. Preliminary work has produced a tetraploid form of *Secale cereale* which

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[1] See cover page iii of this number.

is partially self-fertile, and a small population is being grown for experimental purposes. Similar work is being conducted with many of the shrubs in the Arboretum in order to produce polyploid forms of greater hardiness and vigor.

The second cytological project was a study of polyploidy in relation to geographic distribution. A study of the genus *Spiraea* confirms the earlier suggestions that the polyploid forms and species tend to occupy the periphery of the range of distribution. A comparison of diploid and tetraploid races shows a close relationship between chromosome number and cell size in many genera. This effect is reflected in the number of stomata per unit of leaf surface, and stomata counts can be used as a test of polyploidy in closely related forms and species grown under similar conditions. Stomata counts from herbarium material may be of value in indicating the extent of polyploidy in certain genera.

The Herbarium. — During the past fiscal year 24,410 specimens were inserted in the herbarium bringing the total to 454,472 mounted sheets. Of these accessions, 16,300 came from China and 600 from the rest of Eastern Asia, 4300 came from Malaysia, India and Indo-China, 759 from North America, 568 from Central and South America, and 582 from Australia.

Among the more important collections received during the last fiscal year may be mentioned 3337 specimens from Hainan received from the New York Botanic Garden, and an even larger collection from the same Island received from Sun Yatsen University; about 9000 specimens of Japanese plants from the herbarium of Kenzo Shiota representing 3240 species; 2194 specimens from San Domingo collected by Fuertes, received from the Berlin Botanical Museum; 1050 Mexican plants collected by Hinton; about 1000 Sumatran plants received from Prof. H. H. Bartlett, University of Michigan; 734 Australian plants collected by A. Morrison, received from Kew; 612 Mexican plants collected by F. L. Wynd; 602 specimens from the Belgian Congo; 533 Japanese plants collected by Kakuo Uno of Kobe; 335 plants from Greenland and Denmark, received from the Botanical Museum at Copenhagen; 222 plants from East Africa collected by H. J. Schlieben; 450 specimens from Shantung and Anhwei received from the University of Nanking; over 1000 specimens from F. G. Dickason, Rangoon, Burma; and 221 New Guinea plants collected by O. Warburg. Some of this material was acquired by exchange, some by purchase, and some for identification.

The collection of photographic negatives and critical specimens, chiefly Chinese, now amounts to 3513 numbers, 201 having been added during the fiscal year. An alphabetical list has been prepared and will be sent on application to institutions desiring to exchange or purchase prints.

During the year only about 800 duplicates were distributed, owing to pressure of other work, but a general distribution of duplicate material will take place before the end of 1937. On loan to specialists in this country, Europe and Asia 3911 specimens were sent out.

Besides the constant use of the herbarium by members of the staff of the Arboretum, and also of other departments of the University for special studies, and for the determination of collections, and of plants sent in for identification, the facilities of the herbarium have been used by visitors, among whom may be mentioned: Dr. L. H. Bailey, Ithaca, New York; Professor Rodney True, University of Pennsylvania; Professor Wayne E. Manning, Smith College, Northampton, Mass.; Mr. E. H. Walker, National Herbarium, Washington, D. C.; Dr. G. L. Stebbins, University of California; Professor H. P. Brown, College of Forestry, Syracuse, New York; Dr. A. Gundersen, Brooklyn Botanic Garden; Professor Harold St. John, Honolulu; Dr. Rudolf Florin, Naturhistorisk Riksmuseum, Stockholm; Mr. F. G. Dickason, Judson College, Rangoon, Burma; Professor K. Kominami, Tokyo Imperial University. Dr. Lawrence Ames of the U. S. Department of Agriculture, Washington, is continuing his study of the species of *Berberis* at the Arboretum and their resistance to wheat-rust.

Members of the staff have been engaged in work on special subjects. Dr. E. D. Merrill has continued his work on the floras of Sumatra, Indo-China, and southern China, and in association with Dr. L. M. Perry has undertaken a critical revision of the species of *Eugenia* of China and of Borneo. In association with Miss Florence Freeman material has been assembled for a general revision of the known species of *Microtropis*.

Professor A. Rehder has concluded his study of the ligneous plants described by Léveillé from Eastern Asia and has participated in the identification of collections of Chinese plants. Dr. I. M. Johnston is continuing his studies of Boraginaceae and is actively engaged in identifying a very large and important collection, approximating 5000 numbers, made for the University of California Botanic Garden in Peru, Bolivia, Chile, and Argentina. Dr. C. E. Kobuski has continued his study of the genus *Eurya* and expects to publish the result of his studies before the end of the year. Dr. Caroline K. Allen has pursued her work on the Chinese Lauraceae and will publish a synopsis of the species of *Litsea, Neolitsea* and *Actinodaphne* of China and Indo-China before the end of 1937. Dr. H. M. Raup has studied during the summer of last year the ecological conditions of the Black Rock Forest in the Hudson

Highlands of southern New York and has made general collections in that region; these studies are partly incorporated in his paper in the April number of this Journal. Mr. E. J. Palmer is continuing his study of *Crataegus* and has started to make a complete collection of herbarium material of all the trees and shrubs growing in the grounds to aid in a more intensive study of the cultivated forms.

Grants to support botanical exploration of China during 1936 have again been made to the Fan Memorial Institute of Biology in Peiping, and to the Botanical Department of Lingnan University in Canton. In behalf of the former, Dr. H. H. Hu had sent out an expedition under Mr. C. H. Wang to Yunnan; while for the Lingnan University, Prof. F. P. Metcalf had sent an expedition under Mr. W. Y. Tang to Hunan, Kwangtung and adjoining Indo-China. Late in the year a grant was made to Sun Yatsen University, Canton, to enable Prof. W. Y. Chun of that institution to explore certain parts of southern China. In association with the Farlow Herbarium, financial assistance was granted to Prof. B. B. Mundkur to cover the cost of field work in northern India.

The Library. — During the past academic year there have been added to the Library 424 bound volumes, 527 pamphlets and 87 photographs, the total number of accessions now comprising 42,971 bound volumes, 12,003 pamphlets, 17,809 photographs, and 300 unbound volumes. A total of 9,590 cards were distributed in the various indices, and 1,894 slips were filed in the supplement to the author and subject catalogue of the library, making the number of slips now ready for publication 24,699. One hundred and ninety-three volumes have been bound, and one hundred and forty pamphlets put in pamphlet binders. The number of interlibrary loans has been large and 123 photographs have been sold for reproduction in various publications. Visitors registered in the library number 168, including many from foreign countries as well as from all parts of our own country. A short sketch of the Library from its beginning to the present was published in the Bulletin of Popular Information for June 11, 1937.

Atkins Institution of the Arnold Arboretum, Soledad, Cienfuegos, Cuba. — During the summer of 1936 much time and attention was given to the renovation of the plantings injured by the great hurricane of 1935. Badly injured plants had to be severely pruned to remove dead or dying parts and where root damage had resulted from root twisting, tops had to be cut back to give proper balance between roots and tops and to stimulate new growth. The results have been excellent. Much thinning has been done to permit the development of better specimen plants, and where the same species was represented by scattered specimens, the inferior plants were eliminated.

Scattered representatives of the ferns, lilies, vines, etc. have been assembled in central locations where they can be given better attention, and in the vine section the old wooden supports have been replaced by metal arches. The pipe system has been rearranged with more numerous outlets to facilitate irrigation and watering. The acquisition of a power mower has greatly reduced labor costs in the maintenance of lawns.

In the *seburuco,* an area characterized by native vegetation, grass has been removed to provide places for planting selected native timber trees, the native orchids have been assembled in one place, while the exotic orchids have been assembled in another place. A special area has been cleared for the cactus and succulent garden. East of the *seburuco* the swampy area has been drained in preparation for planting, four acres to the southeast, and an additional twelve acres west of the garden towards Harvard House have been cleared, fenced and partly planted.

The living collections were increased by the addition of 390 species. In exchange 721 packets of seeds, 762 plants (including 173 orchids) and 138 cuttings were received. During the year 1292 packets of seeds were distributed.

Students and investigators at the Atkins Institution during the year included Dr. Lyman Smith and Mr. A. R. Hodgdon of the Gray Herbarium, for the purpose of prosecuting general botanical field work, Mr. O. Tippo, Mr. Charles Heimsch, and Demorest Davenport of the Biological Laboratory, and Mr. Harold A. Senn, of the University of Virginia. Professor J. G. Needham of Cornell University was in residence for several weeks working on the life history of certain dragon flies, and Mr. D. E. Davis spent several months at Soledad working on the life history of the *ani,* a bird having communal nesting habits. The garden was visited in May by Major Johnstone, an English amateur specializing in the study of palms. Professor Thomas Barbour, Custodian, as usual, spent considerable time at Soledad in the early part of 1937, conferring with the resident staff on desirable changes and improvements. A number of other visitors were entertained at Harvard House for shorter periods, chiefly those interested in one type of research or another.

Of particular interest to those who visit Soledad is the fact that the new road from Cienfuegos, passing the Atkins Institution is finished, and on the occasion of its opening the President of Cuba was to attend and visit the Garden.

Publications. — The usual issues of the "Journal" and the "Bulletin of Popular Information" have been issued, but no other special publications have appeared. A number of technical, semitechnical, and popular articles prepared by staff members have been published in extra-institutional serials. Late in the year arrangements were perfected for the very extensive Merrill-Walker "Bibliography of Eastern Asiatic Botany." This extensive work containing approximately 23,000 author entries has been in the course of preparation since 1927. It was to have been published by the Smithsonian Institution, but funds were not available to cover the rather large printing bill. It became possible for the Arboretum to publish this large volume, estimated at 600 pages, quarto, through a generous grant made by the Harvard-Yenching Institute, and a smaller donation from the Smithsonian Institution. These two grants provided slightly in excess of one-third of the amount required, but with this support in hand, an anonymous friend of the Arboretum generously offered to supply the balance required to meet the bill. The volume is expected to be off the press late in 1937 or early in 1938.

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E. D. Merrill, Director.

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CONSTANCE M. GILMAN, Business Secretary.

LOUIS VICTOR SCHMITT, Superintendent.

WILLIAM HENRY JUDD, Propagator.

CORRECTIONS

Page 4, line 2, for *pedunculata* read *peduncularis*

“ 8, line 8 from below for *pedunculata* read *peduncularis*

“ 14, line 4, *for* Grey *read* Gray

“ 139, line 14, for **Mahoni** read **Mahloni**
line 16 from below, *for* Mahon *read* Mahlon

“ 226, line 1 from below, add — **Synon. nov.**

“ 227, line 8 from below, for **14** read **15**

“ 229, line 10, for **34** read **15**
line 17, for **coeruleum** read **caeruleum**

“ 231, line 17 from below, for *V.* read *P.*

“ 234, line 7 from below, *for* (1912) *read* (1914)

“ 235, line 20 from below, *before* Léveillé *insert* (Lévl.)

“ 237, line 1, *before* (1934) *insert* 312
line 5, *before* (1934) *insert* 310
line 11, *after* l.c. *insert* 311
line 3 from below, *before* 1934 *insert* 315

“ 238, line 9 from below, *add* — Woodson in Jour. Arn. Arb. **15**: 312 (1934)

“ 244, line 8, after (1917) insert — **Synon. nov.**
line 12 from below, after (1914) insert — **Synon. nov.**

“ 245, line 9 from below, after (1912) insert — **Synon. nov.**

“ 250, line 12 from below, for **Pampanini** read **Pampaninii**
line 7 from below, for *Pampanini* read *Pampaninii*

“ 253, line 12 from below, *for* Léveillé *read* Vaniot
line 5 from below, for *V. araneosa* read *S. araneosa*

“ 255, line 12, *before* (1929) *insert* 117

“ 257, line 6 from below, for *persicariaefolia* read *persicariifolia*

INDEX

Synonyms are printed in *italics;* new names in **bold-face** type