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CONTENTS

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THE TORREY BOTANICAL CLUB

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Errata

Page 143, line 26, the combination *Fallugia acuminata* had been published previously (Cockerell, Proc. Acad. Nat. Sci. Phila. **1903** : 590).

Page 144, lines 26 and 27, *for* Rydb. & Smith *read* Smith & Rydb.

Page 146, line 5, the combination *Cactus similis* had been published previously (Small, Fl. S.-E. States 812. 1903).

Page 146, line 21, the combination *Anogra latifolia* had been published previously (Rydb. Bull. Torrey Club **31** : 570. 1904).

Page 149, line 25, for *Watsonii* read *Watsoni.*

Page 151, line 29, the combination *Myzorrhiza ludoviciana* had been published previously (Small, Fl. S.-E. States 1093. 1903).

Page 152, line 4, the combination *Distegia involucrata* had been published previously (Cockerell, Univ. Colo. Stud. **3** : 50. 1905).

Page 153, line 20, for *ericaefolius* read *ericoides.*

Page 155, line 2, for *Schkuria* read *Schkuhria.*

Page 15[illegible], line 19, *Tetraneuris stenophylla* had been published previously (Rydb. in Britton, Man. 1009. 1901).

Page 457, line 19, for *Elliottiana* read *Elliottii.*

Page 473, line 7, the combination *Asplenium biscaynianum* is not new.

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JANUARY, 1906

Hepaticae of Puerto Rico

VI. CHEILOLEJEUNEA, RECTOLEJEUNEA, CYSTOLEJEUNEA, AND PYCNOLEJEUNEA

Alexander William Evans

(with plates 1–3)

CHEILOLEJEUNEA

The genus *Cheilolejeunea* is not very clearly defined by writers, and some of the species which have been referred to it present but few characters in common. In Spruce's original description of the group as a subgenus, the following are the most important peculiarities to which he calls attention: the prostrate stems and branches; the more or less closely imbricated leaves; the oblong-falcate lobes, semicordate at the base, usually rounded at the apex, and entire or minutely crenulate on the margins; the inflated lobules, one fourth to one third as long as the lobes; the small and often convex leaf-cells, with trigones; the suborbicular under-leaves, one fourth to one half the size of the lobes, bifid to the middle or less with acute segments; the variability in the length of the female branch; the usual but not constant absence of a subfloral innovation; the falcate and spreading bracts, the lobe being commonly broad and rounded and the lobule narrower and acute; the oval bracteole, shortly bifid at the apex or undivided; the more or less compressed perianth with theoretically four or five keels, the antical keel being low and often obsolete, the two lateral keels sharp, the two postical keels low and blunt and often confluent into a single broad and rounded keel.* The name of the group refers to the fact that the perianth often becomes two-

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* Hep. Amaz. et And. 251. 1884.

[The Bulletin for December 1905 (32 : i–vi, 633–691) was issued 22 Ja 1906.]

lipped upon the extrusion of the capsule at maturity, a condition brought about by rupture and therefore of but slight taxonomic importance. It will be seen that certain of the characters just noted are vague and elastic, and this is especially true of those ascribed to the lobules and to the floral organs. In fact, the description as it stands would apply to certain recognized species of *Euosmolejeunea*, *Pycnolejeunea*, or *Lejeunea* proper. Two later descriptions of the genus have been published, one by Schiffner * and the other by the writer, † but these are both abridged from the original description and add no new characters of importance.

The type species of *Cheilolejeunea* is somewhat difficult to determine. The first species which Spruce mentions is *L. confluens* Lindenb.; ‡ the first species which he describes is his new *L.* (*Cheilo-Lejeunea*) *aneogyna*; the first species which Schiffner lists in raising the group to generic rank is *Cheilolejeunea heteroclada* (Spruce) Schiffn. Apparently any one of these three species has some claims to be considered the generic type. It seems most logical, however, to assign this honor to the first species which Spruce describes, namely to **Cheilolejeunea aneogyna** (Spruce) comb. nov., in spite of the fact that this particular species does not happen to be mentioned by Schiffner.

Among the many species which have been referred to *Cheilolejeunea* by various writers, at least three distinct types of lobule are represented. In the first type, which is clearly exhibited by *C. aneogyna*, the lobule is strongly inflated but is more or less abruptly contracted in the outer part, where a circular opening into the water-sac is to be seen (plate 1, figure 1). The keel is arched, and the free margin is involute to beyond the apex and then passes by a shallow sinus to the end of the keel. The apex is tipped with a single cell, at the distal base of which is a hyaline papilla in a slight depression. In *C. aneogyna* and its immediate allies the apical tooth is long and sharp (figure 4); it lies appressed to the lobe and extends nearly or quite to the end of the keel, playing an important part in the formation of the opening into the water-sac. In other species, however, the tooth is short and

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* Engler & Prantl, Nat. Pflanzenfam. 1^3: 124. 1893.

† Trans. Conn. Acad. 10: 435. 1900.

‡ G. L. & N. Syn. Hep. 365. 1845.

blunt. The lobule just described is built up on essentially the same plan as in the genera *Cyrtolejeunea* and *Euosmolejeunea*.

The second type of lobule (figure 11) is well seen in *C. versifolia* (Gottsche) Schiffn. and in *C. phyllobola* (Nees & Mont.) Schiffn.; it corresponds more nearly with that found in *Prionolejeunea* and in several other genera of the *Lejeuneae Schizostipae*. The most important difference between this type of lobule and that described for *C. aneogyna* is in the position of the hyaline papilla, which is here at the proximal base of the apical tooth. The tooth itself is subject to considerable variation, being long and sharp in *C. versifolia* and short and blunt in *C. phyllobola*; in some species it is distinctly curved, in others straight or nearly so. The papilla is usually in a distinct depression, which in some cases at least is formed by the curved base of the apical tooth (figure 15).

The third type of lobule is apparently confined to *C. lineata* (Lehm. & Lindenb.) Schiffn. (plate 3, figures 1–3). It bears a strong resemblance to the spherical lobules found in certain species of *Ceratolejeunea* and is possibly to be considered an extreme modification of the second type. It is even more strongly inflated than in the two other types described and is very abruptly contracted in the outer part, the opening into the water-sac being extremely small. The keel is so strongly arched as to be approximately semicircular in outline. The free margin is rounded and throughout its entire length is involute and appressed to the lobe; the fold of involution is also strongly arched, very much as in the keel, so that the entire lobule appears broadly ovoid or ellipsoidal in form. If the free margin is examined in the outer part, close to the end of the keel, a slight indentation may be detected from which a hyaline papilla arises (figure 8). A study of very young leaves shows that the rounded cell just beyond the papilla represents the apical tooth, although it is scarcely to be distinguished from its neighbors. The papilla, therefore, is proximal in position. The sinus is represented by the very few cells between the apical tooth and the end of the keel and is consequently unusually short. The hyaline papilla in *C. lineata* was noticed many years ago by Leitgeb.* It is, however, difficult to demonstrate

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* Unters. über Lebermoose 2: 14. 1875.

because, instead of projecting beyond the free margin of the lobule, it bends sharply backward from its base and lies closely appressed to the inner surface. This position is assumed in very immature leaves and is maintained as long as the papilla persists.

The lobular differences just described are accompanied by other differences of greater or less importance. In the opinion of the writer they form a convenient basis for the segregation of the old genus *Cheilolejeunea* into three genera. The first of these, for which the name *Cheilolejeunea* may be retained, is made up of species showing the first type of lobule. For species showing the second type, the name *Rectolejeunea* is suggested. *C. lineata*, finally, which exhibits the third type of lobule, seems sufficiently distinct to represent the new genus *Cystolejeunea.* Unfortunately the structure of the lobule has not been carefully described for all of the species which have been referred to *Cheilolejeunea*, and certain of these cannot be definitely assigned at the present time. It is even probable that some of them will fit more naturally into *Euosmolejeunea* or *Pycnolejeunea* than into any one of the proposed generic segregates.

In its restricted sense the genus *Cheilolejeunea* is best developed in the tropical and subtropical regions of America. So far as we know at present the species are all found on bark, where they sometimes form pure mats and sometimes grow mixed with other hepatics of similar habit. The only species known from Puerto Rico is *C. decidua* (Spruce) Evans.

The plants belonging to this genus are pale- or bright-green in color and are never glossy; upon drying they sometimes become brownish. The stems are prostrate and loosely adherent to the substratum, the rhizoids being sparingly developed. The lobes of the leaves are plane or slightly convex and are also appressed to the substratum (plate 1, figure 1); they are falcate and vary in shape from ovate to orbicular; the apex is broad and usually rounded, and the margin, which is entire or nearly so, is also rounded but never distinctly cordate at the antical base. The leaf-cells are plane or slightly convex, with firm walls; trigones are distinct and often conspicuous, and intermediate thickenings occasionally occur (figure 2). Ocelli are not developed. The underleaves are distant and small, being scarcely twice the width of the stem; they are suborbicular in outline, bifid to the middle or less, with acute divisions, and their margins are entire or nearly so.

The female inflorescence is sometimes borne on a leading branch and sometimes on a short branch, and in the latter case the number of branch-leaves may be reduced to one or two pairs. Variations in the length of the branch are often to be observed in a single individual. In certain species the branches bearing perianths are invariably simple; in other species subfloral innovations are constantly produced. The bracts are larger than the leaves which immediately precede them, but are sometimes exceeded in size by the leaves on robust and sterile shoots; they are unequally bifid and usually distinctly complicate, the lobe being broad and rounded, and the lobule narrower and commonly acute. The bracteole is similar to the underleaves, but is larger and less deeply bifid. The perianth is distinctly compressed, the lateral keels being sharp; the antical face is plane or nearly so, and the postical keel is either rounded or two-angled; the apex is broad, varying from rounded to slightly retuse, and the beak is distinct but sometimes very short. The antheridial spike sometimes occupies a short branch and is sometimes terminal on a longer branch; the antheridia usually occur in pairs, but the bracts themselves offer no generic characters of importance.

As thus emended, *Cheilolejeunea* is apparently more closely related to *Euosmolejeunea* than to any other genus. Typical species of the two genera are, to be sure, amply distinct. Such a *Euosmolejeunea*, for example, as *E. trifaria* (Nees) Schiffn. is characterized by its yellowish-green color, by its large and cordate underleaves, by the constant presence of a subfloral innovation, and by its sharply keeled perianth. Unfortunately there are other species of the genus in which all of these differential characters are not clearly exhibited. The underleaves, for example, may be small and cuneate at the base, and the antical keel of the perianth may be low or even obsolete. It is sometimes necessary, therefore, as in other similar cases, to rely on a combination of characters rather than on a single generic difference.

CHEILOLEJEUNEA DECIDUA (Spruce) Evans

Lejeunea (*Cheilo-Lejeunea*) *decidua* Spruce, Hep. Amaz. et And. 257. 1884.

Cheilolejeunea decidua Evans, Bull. Torrey Club **32**: 188. 1905.

Pale- or brownish-green, growing in depressed mats: stems 0.12 mm. in diameter, copiously and irregularly branched, the branches obliquely to widely spreading, prostrate or ascending, sometimes like the stem but often with smaller and deciduous leaves; rhizoids present on the prostrate axes, few or wanting on the ascending branches: leaves (when well developed) imbricated, the lobe plane or slightly convex, obliquely spreading, ovate, 0.7 mm. long, 0.4 mm. wide, attached by an almost longitudinal line of insertion, antical margin arching across or just beyond the axis, strongly curved to apex, postical margin straight or nearly so, apex broad and rounded, margin entire; lobule triangular-ovate in outline, 0.17 mm. long, 0.12 mm. wide, keel slightly arched or almost straight, free margin straight or nearly so, apical tooth long, pointed and slightly curved, appressed to the lobe and forming part of the opening into the water-sac; cells of lobe plane, averaging 12 μ at the margin, 21 μ in the middle and 30 × 23 μ at the base, sometimes thin-walled throughout, but usually with small triradiate trigones and occasional intermediate thickenings: underleaves distant, plane, orbicular, 0.2 mm. long, often cuneate toward the base, bifid one third to one half, with broad, triangular, erect, acute, subacute or apiculate divisions separated by a broad and obtuse sinus; margin entire or sinuate: inflorescence dioicous: ♀ inflorescence borne on a short and usually simple branch, rarely with an innovation on one side; bracts obliquely spreading, more or less complicate, the lobe oblong to obovate, 0.65 mm. long, 0.4 mm. wide, subfalcate, rounded at the apex, entire, lobule linear, 0.3 mm. long, 0.1 mm. wide, acute to rounded at the apex; bracteole free, obovate, 0.5 mm. long, 0.35 mm. wide, bifid about one sixth with obtuse to acute lobes and sinus, margin entire; perianth broadly obovate in outline, 0.6–0.75 mm. long, 0.5 mm. wide, strongly compressed, antical face plane or slightly concave, lateral keels sharp, postical keel low and broad, rounded or bluntly two-angled, apex rounded to slightly retuse, with a short but distinct beak: ♂ inflorescence occupying a short branch or terminal on a longer branch; bracts in one to three pairs, subimbricated, strongly inflated, shortly and subequally bifid with rounded divisions, keel strongly arched; antheridia borne singly or in pairs: mature sporophyte not seen: vegetative reproduction by means of leafy propagula growing from the leaf-cells (PLATE I, FIGURES 1–9).

On a log. El Yunque, *Evans* (*161*). The species was originally collected by *Spruce* in the region of the Amazon and has recently been collected in southern Florida.

The deciduous leaves of this interesting species are set free by a tearing across of the lobe near the lobule, sometimes leaving a complete water-sac behind, sometimes tearing away a portion of its wall; in any case the lobule is left intact (figure 7). The lobes which thus separate play an important part in the vegetative reproduction of the species. Even before they become detached they are able to produce straight and unbranched rhizoids, which grow out from scattered marginal or submarginal cells. By means of these rhizoids the lobes attach themselves to the substratum and give rise directly to leafy shoots, without the interpolation of any protonemal structures whatever. Each shoot has its origin in a single leaf-cell, and there are usually from one to three shoots developed on each lobe (figure 8). The first leaves on these shoots are very small, both lobe and lobule being extremely rudimentary. As growth proceeds the leaves gradually acquire a more normal appearance, the first parts to develop being the lobule and enough of the lobe to form the water-sac. The underleaves as a rule appear very early, but in some cases their development is postponed, and several pairs of rudimentary leaves will be found without any corresponding underleaves (figure 9). These variations in development are probably caused by differences in light and moisture.

Apparently the closest ally of *C. decidua* is *C. jamaicensis* Steph.,* a species which has not yet been reported except from Jamaica. *C. jamaicensis* is a more robust plant, larger in all its parts and with much more conspicuous thickenings in its cell-walls. The male inflorescence sometimes forms a long spike with from six to ten pairs of bracts, although it is sometimes much shorter. The leaves in this species show no evidence of being deciduous. *C. aneogyna* also retains its leaves. It differs from *C. decidua* in its smaller size and greater delicacy, in its more falcate lobes, the postical margin being distinctly rounded, and in its autoicous inflorescence.

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* Hedwigia 34: 241. 1895.

RECTOLEJEUNEA

The genus *Rectolejeunea* attains its highest development in the tropical and subtropical regions of America. In fact it is doubtful if it is represented elsewhere. In Puerto Rico four species have been collected, none of them in abundance. All of these four species occur on other West Indian islands, and two of them have been found in southern Florida. All of the known species grow on bark. The genus may be characterized as follows: —

RECTOLEJEUNEA gen. nov.

Lejeunea p. p. G. L. & N. Syn. Hep. 1845.

Lejeunea subgenus *Cheilo-Lejeunea p. p.* Spruce, Hep. Amaz. et And. 1884.

Cheilolejeunea p. p. Schiffn.; Engler & Prantl, Nat. Pflanzenfam. 1^3: 124. 1893.

Plants small to medium-sized, sometimes delicate in texture, sometimes firmer, pale- to deep-green, often becoming brownish with age, not glossy: stems prostrate and adherent to the substratum, more or less branched, the branches prostrate or ascending: leaves loosely imbricated, the lobe widely spreading, somewhat falcate, ovate to orbicular in outline, plane or nearly so, rounded at the apex or very obtuse, margin entire or sparingly and minutely crenulate; lobule inflated and forming a distinct water-sac, keel straight or slightly arched, free margin involute throughout a part of its length, tipped at the apex by a single cell bearing a marginal hyaline papilla at its proximal base; leaf-cells plane or slightly convex, the walls sometimes thin with more or less evident trigones, sometimes more uniformly thickened; ocelli frequently present: underleaves small, distant to subimbricated, orbicular to ovate, bifid to the middle or beyond with variable divisions and sinus: inflorescence autoicous or dioicous: ♀ inflorescence sometimes borne on a short branch, sometimes on a leading branch, simple or innovating on one side; bracts obliquely spreading, complicate, unequally bifid; bracteole similar to the underleaves but larger and usually less deeply bifid; perianth usually obovate in outline, compressed, the lateral keels prominent and commonly sharp, antical face plane or nearly so, postical keel low and broad, rounded or two-angled, apex truncate or slightly retuse, with a short but distinct beak: ♂ inflorescence occupying short branches or intercalary on longer branches; bracts imbricated, diandrous (so far as known): vegetative reproduction by means of deciduous leaves. (Name from ρηκτός, fragile, and

Lejeunea, in allusion to the fact that the leaves in most of the species easily become broken off.)

In distinguishing *Rectolejeunea* from the genera to which it is closely allied, the most trustworthy characters are those derived from the lobule and from the perianth. The latter organ is essentially the same as in *Cheilolejeunea*, but the lobule, as has already been pointed out, is built up on an entirely different plan. In the structure of the lobule, however, *Rectolejeunea* agrees pretty closely with *Pycnolejeunea* and *Lejeunea*, and it is here that the flattened perianth with its plane antical face serves as a distinguishing mark. So far as the structure of the leaves and underleaves is concerned, the new genus is in many respects intermediate between *Pycnolejeunea* and *Lejeunea*. It would even be possible, if the perianths were left out of consideration, to divide the species of *Rectolejeunea* between these two genera, without violating to any great extent their natural relationships.

Of the four species noted below two have recently been described by the writer in another connection. It has therefore seemed unnecessary to redescribe them in full. The first species may be considered the type of the genus.

Rectolejeunea flagelliformis sp. nov.

Pale-green, becoming brownish with age, scattered or growing in depressed mats: stems 0.09 mm. in diameter, closely adherens to the substratum, sparingly and irregularly pinnate, the branchet widely spreading, not microphyllous; rhizoids numerous: leaves imbricated, the lobe plane and appressed to the substratum, slightly falcate, ovate, 0.7 mm. long, 0.4 mm. wide, antical margin rounded at the base, arching partially or wholly across the axis and outwardly curved to the apex, postical margin straight or nearly so, apex broad and rounded, margin entire or minutely and irregularly crenulate from projecting cells; lobule inflated, ovate in outline, 0.17 mm. long, 0.12 mm. wide, keel slightly arched, forming an almost continuous line with the postical margin of lobe but usually with a notch at the junction, free margin curved, involute at the base but appressed to the lobe throughout the greater part of its length, apical tooth long and sharply curved, papilla in a distinct depression, sinus lunulate; cells of lobe plane or slightly convex, averaging 9 μ at the margin, 14 μ in the middle and 18 × 16 μ at the base, rather thick-walled but without distinct trigones; ocelli mostly three to six, arranged in one or two short rows at the base of the lobe, 25 μ long, 21 μ wide: underleaves distant, orbicular, 0.2 mm. long, broadly cuneate at the base and bearing a distinct radicelliferous disc, bifid about one half with erect lobes, rounded to acute at the apex, and a narrow and usually acute sinus, margin entire or rarely angular-dentate on the sides: inflorescence autoicous: ♀ inflorescence usually borne on a short branch (with only one or two pairs of leaves), innovating on one side, the innovation simple or again floriferous; bracts obliquely spreading, complicate, the lobe plane or nearly so, oblong-ovate, 0.75 mm. long, 0.35 mm. wide, slightly falcate, mostly rounded at the apex, margin entire, keel narrowly winged, lobule ovate, 0.35 mm. long, 0.17 mm. wide, obtuse to acute at the apex, margin entire; bracteole convex when seen from below, slightly connate with both bracts, orbicular, 0.55 mm. long, apex broad, varying from rounded and undivided to sharply and acutely bidentate, margin usually entire, sometimes irregularly dentate in the upper part; perianth about half exserted, obovate in outline, 0.75 mm. long, 0.45 mm. wide, somewhat compressed, the lateral keels sharp, antical surface plane or with a very indistinct keel in the upper part, postical keel broad and two-angled, apex broad, truncate or slightly retuse, beak short, surface smooth or slightly roughened from projecting cells, especially along the keels: ♂ inflorescence occupying a short branch or terminal on a longer branch, sometimes proliferating from the apex; bracts in from two to ten pairs, imbricated, strongly inflated, shortly bifid with an arched keel, the lobe rounded at the apex, the lobule more or less pointed; bracteoles one or two at the base of the spike, similar to the underleaves; antheridia in pairs: mature sporophyte not seen (PLATE I, FIGURES 10–25).

On bark of trees. El Yunque, *Evans* (*29*). The species has also been found in Cuba, at the base of the El Yunque Mountain, Baracoa, by *Underwood & Earle*, and *no. 346* of these collectors may be designated the type. No other localities for the plant are definitely known at the present time.

The writer's account of *R. flagelliformis* is drawn from what may be considered the normal condition of the species. Under some circumstances, however, the appearance of the plants is completely altered, owing to the development of peculiar organs of vegetative reproduction. These consist of modified leaves, which are borne on the ascending or upright prolongations of prostrate branches. Sometimes a flagelliform branch of this nature represents the continuation of an ordinary leafy axis (figure 23), sometimes the proliferation of an antheridial spike, sometimes the innovation of a female inflorescence. In any case the growth of the branch is sooner or later brought to an end, although in one observed instance as many as fifty modified leaves had been developed. The formation of these peculiar branches is apparently induced by crowding, and it is not unusual to find them in the middle region of a tuft, the marginal part of which continues to develop branches of the normal type.

The modified leaves are strikingly different from ordinary leaves in their appearance. They are densely imbricated, and the line of insertion is nearly transverse and very short, measuring but five to ten cells in length. No lobules are developed, and the lobes are ovate in shape and almost symmetrical. The margin is not entire, as on normal leaves, but bears a series of scattered hair-like teeth, which vary in number from one to ten. The teeth are irregular in arrangement, but the one at the apex is usually distinct, thus making the leaves acuminate. Each tooth is composed of a single row of cells or is rarely two cells wide at the very base; it is sometimes straight and sometimes variously curved or hooked at the tip. In the majority of cases the terminal cell is long and delicate, like a rhizoid, and occasionally the entire tooth is reduced to a cell of this character. The leaf-cells have much thinner walls than ordinary leaves and are well supplied with chloroplasts.

The leaves just described develop rapidly and become detached as soon as they attain their full size. The line of rupture is very close to the base, and the detached leaf leaves behind a narrow ridge of projecting cells, the process of separation being schizolytic in nature. A separated leaf is able to live a considerable time on account of its many chloroplasts, but it soon gives rise to one or more leafy shoots, without the interpolation of thalloid structures. Apparently any marginal cell has the power of developing into a shoot of this nature (figure 24), but the number growing from a single leaf is always very small.

The underleaves on the flagelliform branches are not deciduous; they are closely imbricated like the leaves, and are more or less squarrose, thus giving the branches a peculiar and characteristic appearance. The underleaves do, however, exhibit marked modifications. In the first place, they lose largely, if not entirely, the power of developing rhizoids. In the second place, the lateral teeth, which are sometimes vaguely indicated on normal underleaves, become very distinct, often attaining a length of three cells and a width of two cells at the base. In the third place the principal divisions become sharply pointed, usually ending in a row of from two to four cells, and the sinus becomes broad and lunulate (figure 25).

The leaves which precede the modified leaves exhibit transitional characters. They tend to become more pointed, scattered marginal cells grow out into rhizoidal processes or even into short teeth, and the lobule becomes smaller and more rudimentary. It is interesting to note that a branch which bears these transitional leaves sometimes recovers from the tendency to become flagelliform and continues its growth normally. In one case, for example, the proliferation of an antheridial spike developed first a normal leaf, then a series of transitional leaves, then a second antheridial spike. It is also probable that the dentate or ciliate bracts and bracteoles, which are occasionally to be observed on a female inflorescence, represent similar transitional conditions. In these cases the development of the archegonium, of course, terminates the elongation of the branch; but in one observed instance the innovation from a flower of this character became flagelliform almost immediately, showing that the tendency toward such development was present in a marked degree.

Rectolejeunea Berteroana (Gottsche)

Lejeunea (*Odontolejeunea*) *Berteroana* Gottsche in Stephani, Hedwigia **27**: 282. *pl. 11, f. 6.* 1888.

Lejeunea versifolia Gottsche in Wright, Hep. Cubenses (without description); Schiffner, Bot. Jahrb. **23**: 597. 1897 (as synonym).

Cheilolejeuna versifolia Schiffn. *l. c. pl. 5, f. 1–7.*

On bark of trees. Puerto Rico, *Bertero*, the type locality. The species is also known from Cuba (*Wright*), from southern Florida (*Underwood*), and from the Bahamas (*Mrs. Britton*).

R. Berteroana and the preceding species are very closely related. They agree in the shape of their leaves and underleaves, in the peculiarities of the lobule with its long apical tooth and proximal papilla, in the structure and measurements of the leaf-cells, in the presence of basal ocelli and in the possession of subfloral innovations. Both species, moreover, develop flagelliform branches with deciduous leaves. An excellent account of these branches in *C. versifolia* is given by Schiffner, who assumes that they are leafless from the beginning. The Florida specimens, however, recently recorded by the writer, * clearly show that the development of these branches is the same here as in *R. flagelliformis* and that the narrow and ring-like thickenings, which Schiffner notes, are simply the bases of the leaves which have fallen away. These deciduous leaves in *R. Berteroana* are also destitute of lobules and almost symmetrical, but their margins differ from those of *R. flagelliformis* in being either entire or only sparingly and indistinctly dentate instead of ciliate. The margins of the corresponding underleaves are also either entire or very bluntly unidentate on the sides. Aside from these differences in the flagelliform branches, which are among the most important in distinguishing the two species, *R. Berteroana* differs in its smaller size and dioicous inflorescence.

Stephani's figure of *Lejeunea Berteroana* shows a portion of a sterile stem and brings out clearly the normal peculiarities of the leaves and underleaves. Although there is no indication either here or in the original description of flagelliform branches, the type material in the Gottsche herbarium exhibits a branch of this character and proves conclusively that *L. Berteroana* and *Cheilolejeunea versifolia* are to be considered synonyms. The perianth of the species is still unknown, but its close relationship to *R. flagelliformis* seems to warrant placing it in the same genus. At any rate the structure of the lobule and the entire leaves would exclude it from *Odontolejeunea*, and the latter character would also remove it from *Cyclolejeunea*.

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* Mem. Torrey Club 8: 145. 1902. A full description of the species, largely compiled from Schiffner, may also be found here.

Rectolejeunea emarginuliflora (Gottsche)

Lejeunea emarginuliflora Gottsche in Wright, Hep. Cubenses (without description); Schiffner, Bot. Jahrb. **23**: 585. 1897 (as synonym).

Cheilolejeunea emarginuliflora Schiffn. *l. c.*

Pale-green: stems scattered, 0.05 mm. in diameter, loosely adherent to the substratum, sparingly and irregularly pinnate, the branches widely spreading, not microphyllous but often with deciduous leaves; rhizoids few: leaves loosely imbricated, the lobe plane, slightly falcate, ovate, 0.5 mm. long, 0.35 mm. wide, antical margin rounded at the base, arching partially across the axis and outwardly curved to the apex, postical margin straight or nearly so, apex broad, rounded to very obtuse, margin entire or slightly and irregularly crenulate from projecting cells; lobule inflated, ovate in outline, 0.17 mm. long, 0.1 mm. wide, keel slightly arched, free margin curved, involute near the base, apical tooth curved but variable in length and sometimes short and blunt, papilla in a slight depression, sinus lunulate; cells of lobe plane, averaging 10 μ at the margin, 12 μ in the middle and 16 μ at the base, rather thick-walled but without distinct trigones; ocelli 23 × 16 μ, one or two at the base of the lobe, usually indistinct or obsolete: underleaves distant, plane, orbicular, 0.2 mm. long, broadly cuneate at the base and without a distinct radicelliferous disc, bifid about one half with erect divisions, rounded or obtuse at the apex and separated by a narrow and usually acute sinus, margin either entire or vaguely angular-dentate on the sides: inflorescence dioicous: ♀ inflorescence on a more or less elongated branch, innovating on one side, the innovation often floriferous; bracts and bracteoles similar to those of *R. flagelliformis*: perianth, ♂ inflorescence and sporophyte unknown (PLATE 2, FIGURES 1–8).

On bark of trees. North slope of the Luquillo Mountains, *Heller* (*4741 p. p.*). The original specimens were collected by *Wright* in Cuba, and no other stations for the species are at present known.

R. emarginuliflora is based on somewhat negative characters and is still too imperfectly known to be considered a well-established species. It agrees with *R. Berteroana* in its dioicous inflorescence and in the general characters derived from leaves and underleaves. Even the leaf-cells are of about the same size in the two species and agree with each other in the characters derived from their cell-walls. The ocelli, however, which form a characteristic feature of *R. Berteroana*, are either indistinct in the present species or else are wholly undeveloped. *R. emarginuliflora* also fails to develop flagelliform branches, but these are replaced to a certain extent by ordinary leafy branches with scattered leaves. These leaves, which are scarcely or not at all modified, secure vegetative reproduction for the species in the same way that the crowded elobulate leaves do in *R. flagelliformis* and *R. Berteroana*. They easily become separated from the axis, usually carrying their lobules with them, and attach themselves to the substratum by means of scattered marginal rhizoids. When this is accomplished each leaf gives rise to one or more leafy shoots, sometimes with the interpolation of a thalloid protonema, sometimes directly from the leaf-cells (figures 7, 8). In the majority of cases the new shoots or their protonemata arise from marginal cells. It often happens that a branch loses many or all of its leaves in this way for a considerable distance and thereby acquires a peculiar appearance (figure 3), very different, however, from what is found in the flagelliform branches of the allied species. It approaches in this respect the following:—

Rectolejeunea phyllobola (Nees & Mont.)*

Lejeunea phyllobola Nees & Mont. in Ramon de la Sagra, Hist. Fis. Pol. y Natur. Cuba **9**: 281. 1845.

On bark of trees. Puerto Rico, without definite locality, *Underwood & Griggs (893)*. Widely distributed in the West Indies; also known from Mexico, Costa Rica and southern Florida.

R. phyllobola bears a strong resemblance to the three preceding species. It differs from all of them, however, in its much larger leaf-cells, which average 21 μ in diameter in the middle of the lobe, in its complete lack of basal ocelli, and in the narrower divisions of its underleaves. The free margin of its lobule is involute to or just beyond the apex, and the apical tooth is distinguished by being short, blunt, and straight. The present species also develops branches with deciduous leaves, but these are scattered as on ordinary branches and no more modified than in *R. emarginuliflora*. Unfortunately the lobules in *R. phyllobola* are often poorly de-

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* For a full description of this species, with synonymy and figures, see EVANS, Mem. Torrey Club **8**: 143. *pl. 20, f. 1–13.* 1902.

veloped, but even under these circumstances the relatively large leaf-cells will usually serve to distinguish the species.

CYSTOLEJEUNEA

The systematic position of *Lejeunea lineata* has long been a matter of uncertainty. Spruce first referred it to the subgenus *Macro-Lejeunea*, basing his opinion on the simple female branch and the perianth without keels. He afterwards followed Stephani and transferred it to *Cheilolejeunea*, apparently on account of the flattened perianth, but remarked at the same time that the species had certain characters in common with *Trachylejeunea*.* Schiffner also followed Stephani at first and considered the plant a *Cheilolejeunea;* afterwards he apparently reverted to the original view of Spruce and listed the species as *Macrolejeunea lineata*. This solution of the problem, however, by no means satisfied him, and he noted that the vegetative structure agreed in many respects with what is found in *Euosmolejeunea*. Still later he replaced the species in *Cheilolejeunea*.†

It will be seen from the above that *Lejeunea lineata* has certain points of agreement with four recognized genera of the *Lejeuneae*, but that the balance of opinion is in favor of placing it in *Cheilolejeunea*. Its peculiar lobule, however, should apparently exclude it not only from this genus, as emended in the present paper, but also from the other three genera to which it has been compared. It becomes necessary, therefore, to propose a new genus for its accommodation.

CYSTOLEJEUNEA gen. nov.

Plants rather robust, firm in texture, not glossy: stems prostrate, loosely adherent to the substratum, sparingly and irregularly branched, the branches widely spreading, not microphyllous: leaves imbricated, the lobe widely spreading, convex and reflexed at the broad apex, entire or nearly so; lobule strongly inflated, ellipsoidal or broadly ovoid, with strongly arched keel, free margin strongly involute throughout, apical tooth scarcely evident, hyaline papilla proximal, reflexed, sinus exceedingly short; leaf-cells convex with large trigones; ocelli none: underleaves distant, subrotund, cuneate at the base, bifid with sharp divisions: ♀ inflorescence borne on a

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* Bull. Soc. Bot. de France 36: clxxxii. 1889.—See also Jour. Linn. Soc. Bot. 30: 331. 1894.

† Conspect. Hepat. Archip. Indici 256. 1898.

simple and very short branch; bracts obliquely spreading, shortly and unequally bifid, the lobe convex and broad at the apex, lobule variable; bracteole longer than the underleaves but less deeply bifid; perianth compressed but with rounded lateral keels, antical and postical surfaces practically ecarinate, apex broad, beak obsolete: ♂ inflorescence occupying a short branch; bracts few, imbricated. (Name from *κύστις*, a bladder, and *Lejeunea*, referring to the strongly inflated lobule.)

When *Cystolejeunea* is compared with *Cheilolejeunea*, as represented by such a robust species as *C. jamaicensis*, the two genera are seen to have much in common. They agree in texture and color, in the shape of the lobe, in the general peculiarities of the leaf-cells, in the absence of ocelli, in the underleaves, in the simple female branch and in the flattened perianth. Aside from its lobules, however, *Cystolejeunea* differs in its convex leaf-lobes and in its beakless perianth. Of course the more delicate species of *Cheilolejeunea* offer still other points of difference.

Macrolejeunea is a genus of somewhat doubtful validity. Its type species is *M. pallescens* (Mitt.) Schiffn.,[*] known only from the Andes of Ecuador. In this plant the female branch is simple, and the perianth is destitute of both beak and keels, characters which it shares with *Cystolejeunea*. It differs, however, in its general habit, in its pointed leaves and in its delicate texture, agreeing in all these respects with the genera *Taxilejeunea* and *Hygrolejeunea*. *Euosmolejeunea* and *Trachylejeunea* both differ from *Cystolejeunea* in their five-keeled perianths.

Cystolejeunea lineata (Lehm. & Lindenb.)

Jungermannia lineata Lehm. & Lindenb. in Lehmann, Pug. Plant. **4**: 53. 1832.

Lejeunea lineata Lehm. & Lindenb. in G. L. & N. Syn. Hep. 371. 1845.

Lejeunea (*Macro-Lejeunea*) *lineata* Spruce, Hep. Amaz. et And. 225. 1884.

Lejeunea (*Cheilolejeunea*) *lineata* Steph. Hedwigia **27**: 287. 1888.

Cheilolejeunea lineata Schiffn. in Engler & Prantl, Nat. Pflanzenfam. **1**^{3}: 124. 1893.

Macrolejeunea lineata Schiffn. Bot. Jahrb. **23**: 588. 1897.

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[*] Engler & Prantl, Nat. Pflanzenfam. **1**^{3}: 124. 1893 (= *Lejeunea pallescens* Mitt. Hook. Jour. Bot. and Kew Gard. Misc. **3**: 360. 1851).

Pale- or bright-green, becoming brownish with age, occasionally forming small depressed mats but usually growing mixed with other hepatics: stems 0.17 mm. in diameter, sparingly branched, some of the branches with smaller leaves than the stem but not microphyllous; rhizoids few: leaves imbricated, the lobe falcate-ovate when explanate, 1 mm. long, 0.85 mm. wide, antical margin strongly curved except at the very base, arching across the axis, postical margin straight or slightly incurved, apex rounded to obtuse, margin entire or indistinctly angular-sinuate; lobule 0.35 mm. long, 0.2 mm. wide, abruptly contracted in the outer part, keel forming an angle of about 90° with the postical margin of the lobe; cells of lobe averaging $18\,\mu$ at the margin, $32 \times 21\,\mu$ in the middle and $37 \times 21\,\mu$ at the base, convex on both surfaces, outer wall strongly thickened especially in the middle of the cell, trigones large, triangular with bulging sides, intermediate thickenings rare, found mostly in basal region of lobe: underleaves distant, broadly orbicular, 0.4 mm. long, 0.5 mm. wide, bifid about one third with broad, erect, acute to apiculate divisions separated by an acute sinus; margin as in the leaves: inflorescence dioicous: ♀ branch usually with a single rudimentary leaf and a single underleaf in addition to the bracts and bracteole; bracts spreading, the lobe convex, falcate-obovate, 0.85 mm. long, 0.5 mm. wide, rounded at the apex, margin as in the leaves, lobule oblong or lanceolate, 0.4 mm. long, 0.08 mm. wide, free portion short, rounded to acute at the apex; bracteole free, oblong, 0.8 mm. long, 0.4 mm. wide, narrowed toward the base, rounded at the apex and very shortly bidentate or retuse; perianth more than half exserted, obovate in outline, 1.4 mm. long, 0.9 mm. wide, narrowed toward the base, truncate or slightly retuse at the apex with rounded outer angles, surface smooth or nearly so: ♂ inflorescence with bracts in from two to four pairs; bracts imbricated, strongly inflated, shortly bifid with a strongly arched keel, both lobes rounded at the apex; bracteoles one or two at the base of the spike, shortly and variously bifid; antheridia single or in pairs: mature sporophyte not seen (PLATE 3).

On trees. Puerto Rico, without definite localities, *Schwanecke*, *Sintenis*. El Yunque, *Evans* (*38 p. p.*, *46 p. p.*, *62*, *99*.) Also known from several of the Lesser Antilles, namely: St. Kitts, *Breutel*, *Britton & Cowell;* Guadeloupe, *L'Herminier;* St. Vincent and Dominica, *Elliott*. Apparently through an error, the type locality of the species was given as "Bourbon," and it has also been recorded from Java. In all probability, however, its range is restricted to the West Indies.

Even in a sterile condition, there is no Puerto Rico species with which *C. lineata* is likely to be confused. Its comparatively large size, its convex lobes with blunt apices, its peculiar lobules, its convex leaf-cells with large trigones, its small underleaves, bifid and with sharp divisions, will all serve to distinguish it. Fruiting specimens are further distinguished by the beakless and flattened perianth borne on a short and simple branch.

PYCNOLEJEUNEA

The characters which have been relied upon in separating *Pycnolejeunea* from *Cheilolejeunea* are the robustness of the plants, the closely imbricated leaves, the elongated lobules, the large underleaves and the five-keeled perianth. All of these characters, with the exception of that drawn from the lobules, are fairly constant and will usually serve to distinguish the genus not only from *Cheilolejeunea*, but also from *Rectolejeunea*. The lobule, however, varies greatly in length and is sometimes scarcely longer than broad. In the structure of the apical tooth and in the position of the hyaline papilla the lobule agrees with that found in *Rectolejeunea*.

The selection of the type species of *Pycnolejeunea* is beset with the same difficulties as in *Cheilolejeunea*. The first species mentioned by Spruce is *L. contigua* Nees;* the first species which he describes is also called *L. contigua*, but the specimens from which this description is drawn are now recognized as the type of *Pycnolejeunea Spruceana* Schiffn.;† the first species which Schiffner lists is *P. macroloba* (Mont.) Schiffn.‡ Under the circumstances the writer suggests that *P. Spruceana* be considered the type, since this is really the first species which Spruce describes.

Pycnolejeunea is confined to tropical and subtropical regions. It attains its highest development in the East Indies and neighboring islands, but has numerous representatives in America. At the present time only one species is definitely known from Puerto Rico. Most if not all of the species grow on bark, sometimes in pure mats, sometimes in admixture with other hepatics.

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* Hep. Amaz. et And. 247. 1884.

† Bot. Jahrb. 23: 583. 1897.

‡ Engler & Prantl, Nat. Pflanzenfam. 1^3: 124. 1893 (=*Lejeunea macroloba* Mont. Ann. Sci. Nat. Bot. II. 19: 260. 1843).

The species belonging to this genus are nearly all robust and vary in color from dull-green to glaucous or whitish-green. They are never glossy and many of them become brownish with age or upon drying. The prostrate stems are more or less closely adherent to the substratum and branch irregularly; some of the branches are similar to the stem, but they are more often short and limited in growth, and in certain species microphyllout branches are to be observed. The leaves are closely imbricated (plate 2, figure 9). The lobes are convex and falcate, although sometimes in a very slight degree; they vary in shape from ovate to subrotund; the apex is broad and rounded, and the margin varies from entire to minutely crenulate. The leaf-cells are more or less convex; their walls are firm, sometimes with distinct trigones (figure 13), sometimes presenting the appearance of being uniformly thickened. Ocelli occur in many species, but not in all; they are sometimes scattered (figures 9, 10), but are usually at the base of the lobe. The lobule varies in outline from broadly ovate to long-rectangular and is built up on the same plan as in *Rectolejeunea,* with the hyaline papilla proximal in position. The underleaves are closely imbricated; they are nearly always orbicular in general outline, but are sometimes broader than long; they are bifid with pointed divisions, and their margins are commonly entire.

The female branch is variable in length, but is usually long. The flowers innovate on one or on both sides, the innovations themselves being often again floriferous. The bracts are about as large as the leaves on robust and sterile axes, but are larger than the leaves which immediately precede them on the female branch. They are unequally bifid and usually distinctly complicate, in many cases showing a narrow and entire wing along the keel (figures 19, 20). The lobe is broad and rounded, and the narrow lobule varies from acute to rounded even on a single specimen. The bracteole is larger than the underleaves and less deeply bifid. The perianth is obovate in outline and is sharply five-keeled, at least in the upper part (figures 9, 21, 22). The apex is broad and usually rounded, the beak being short but distinct. The antheridial spike usually occupies a short branch (figure 23), but is sometimes terminal on a longer branch; the antheridia, so far as observed, occur in pairs.

PYCNOLEJEUNEA SCHWANECKEI (Steph.) Schiffn.

Lejeunea macroloba laxior Hampe & Gottsche, Linnaea **25**: 356. 1852. Not *Lejeunea macroloba* Mont. 1843.

Lejeunea (*Pycnolejeunea*) *Schwaneckei* Steph. Hedwigia **27**: 289. *pl. 13, f. 28.* 1888.

Pycnolejeunea Schwaneckei Schiffn. Bot. Jahrb. **23**: 594. 1897.

Glaucous-green, becoming brownish with age, growing in loose depressed mats, often in company with other hepatics; stems 0.17 mm. in diameter, prostrate and loosely adherent to the substratum, irregularly pinnate, an occasional branch long, unlimited in growth and with normal leaves but most of the branches very short, microphyllous, and concealed by the leaves of the higher axis, all of the branches obliquely to widely spreading: leaves more or less densely imbricated, the lobe convex and often revolute at the apex, broadly falcate-ovate, 0.85–1 mm. long, 0.7–0.85 mm. wide, antical margin straight or slightly incurved near the base, then strongly outwardly curved to the apex, arching partially or wholly across the axis, postical margin revolute and curved, apex broad and rounded, whole margin slightly and indistinctly crenulate from projecting cells; lobule narrowly ovoid-cylindrical, 0.5 mm. long, 0.12 mm. wide (0.17 mm. wide when explanate), inflated throughout, keel straight or nearly so, roughened from projecting cells, free margin straight or nearly so, involute nearly or quite to the apex, sinus lunulate, apical tooth blunt or subacute, not curved, papilla in a scarcely evident depression; cells of lobe convex on both free surfaces, averaging 15 μ at the margin, 22 μ in the middle and 28 μ at the base, walls thickened, especially the antical wall, trigones large, triradiate, sometimes confluent or separated by very narrow pits, intermediate thickenings occasional, circular in outline; ocelli mostly four to nine, scattered but mostly confined to the postical half of lobe and covered over by the preceding leaf, averaging 46 × 35 μ: underleaves imbricated, broadly orbicular, 0.35 mm. long, 0.4 mm. wide, broadly cuneate at the base and sometimes bearing a rudimentary disc in the radicelliferous region, bifid one fifth to one third with erect divisions, obtuse to subacute at the apex, and a narrow sinus; cells and margin as in the leaves: inflorescence dioicous: ♀ inflorescence borne on a leading branch, innovating on one side or more rarely on both sides, the innovations sterile or again floriferous; bracts obliquely spreading, complicate, the lobe falcate-ovate, convex, 1.2 mm. long, 0.85 mm. wide, apex broad, margin as in the leaves, keel narrowly winged, lobule ovate to obovate, rounded to subacute at the apex, 0.75 mm. long, c.35 mm. wide; bracteole connate on one side with bract, broadly ovate to obovate, 0.85 mm. long, 0.6 mm. wide, apex broad, retuse to shortly bidentate, margin as in the leaves; perianth immersed in the involucre or slightly exserted, obovoid, 1 mm. long, 0.6 mm. wide, narrowed toward the base, broad and rounded at the apex and with a very short beak, sharply five-keeled especially toward apex, surface roughened from projecting cells especially along the keels: ♂ inflorescence occupying a short branch or more rarely terminal on a microphyllous branch; bracts mostly in from three to six pairs, closely imbricated, strongly inflated, shortly and subequally bifid with an arched keel, the lobe rounded, the lobule sometimes subacute or apiculate at the apex; bracteoles one or two at the base of the spike, similar to the underleaves but smaller; antheridia in pairs: mature sporophyte not seen (PLATE 2, FIGURES 9–23).

On bark of trees. North slope of the Luquillo Mountains, *Heller* (*4739*). El Yunque, *Evans* (*73*). The type specimens were collected in Puerto Rico by *Schwanecke*. The species has also been found in Jamaica, *Underwood, Maxon, Evans.*

An interesting feature of *P. Schwaneckei* is found in the peculiar microphyllous branches, which are usually abundantly developed on both male and female individuals (figures 9, 11, 12). These branches are nearly always completely concealed by the leaves and are therefore invisible when a stem is viewed from above. Although so short, each branch bears from three to seven pairs of closely imbricated leaves with corresponding underleaves. The leaves are very much smaller than ordinary leaves and measure about 0.2 mm. in length; they are shortly bifid, the lobe being but little larger than the lobule, and the keel is strongly arched. The lobe is suberect and rounded at the apex, and its margin is vaguely angular-dentate. The lobule is inflated and blunt at the apex, being similar in this respect to normal lobules. The small underleaves are essentially like those found on the stem. Apparently these microphyllous branches increase the water-holding power of the plants, partly by means of their protected position, partly by means of the close imbrication of all their parts. They apparently assist also in affixing the plants to the substratum, since rhizoids are abundantly produced by their underleaves.*

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*Similar microphyllous branches occur in *Radula pycnolejeuneoides* Schiffn., from the island of Amboina (Nova Acta Acad. Caes. Leop.-Carol. **60**: 247. *pl. 13, f. 1–7.* 1893). They were originally described as male spikes, but their true nature was soon pointed out by Goebel (Flora **77**: 432. *pl. 8, 9. f. 3, 4.* 1893).

The characters which separate *P. Schwaneckei* from the closely related *P. macroloba* are tabulated by Stephani, and little of importance has since been written on either species. Schwanecke's original material represents a somewhat laxer form than most of the specimens recently collected, although connected with them by intergrading conditions. If well-developed forms of the species are compared with typical *P. macroloba*, it will be found that some of the differential characters relied upon by Stephani are inconstant. The plants, for example, are equally robust in the two species, and the texture of *P. Schwaneckei* is really the denser of the two; there is but little difference in the branching; the leaves in both species are strongly imbricated, and the same is true of the underleaves; the leaf-cells do not show the differences which are ascribed to them, and there is no constant difference in the position of the antheridial spike. The other differential characters which Stephani notes seem to be trustworthy. The inflorescence in *P. Schwaneckei*, as he remarks, seems to be always dioicous, while in *P. macroloba*, the inflorescence is normally autoicous, although unisexual individuals sometimes occur. The keel of the leaves in *P. macroloba* is nearly always distinctly arched, and the postical margin of the lobe, where the free margin of the lobule meets it, is plane or nearly so, although the apex of the lobe tends to be revolute. In *P. Schwaneckei* the keel is straight, and the lobe is revolute along the postical margin as well as at the apex. The underleaves of *P. macroloba*, also, are more deeply bifid, and their divisions are usually more acute.

In addition to these differences, it may be noted that the leaf-cells in *P. macroloba* are a trifle larger than in the other species, averaging 25 μ in the middle of the lobe. The local thickenings in the cell-walls are about the same size, but appear more distinct because separated from one another by broader pits and showing much less tendency to become confluent. The ocelli, also, are fewer, only two to four, and less distinct. According to Schiffner,* the cell-walls in *P. Schwaneckei* are uniformly thickened, an ap-

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* Lebermoose der Forschungreise S. M. S. Gazelle, 32. 1890. The species is here recorded from the island of Amboina, but apparently through error, since Schiffner makes no mention of it in his Conspect. Hepat. Archip. Indici, published in 1898.

pearance due to the frequent confluence of the local thickenings, leading to an obliteration of the pits. The bracts and perianths are very similar in the two species, but the bracteoles afford another difference. In *P. macroloba* these are distinctly bidentate at the apex, the teeth being acute and often connivent; in *P. Schwaneckei* the bracteoles are either undivided or shortly or irregularly bidentate with blunt teeth. In *P. macroloba*, finally, microphyllous branches are rare, and many plants fail to develop them altogether.

For assistance in the preparation of this paper the writer is especially indebted to Professor Lindau, of Berlin, and Herr Stephani, of Leipzig. Through their kindness it has been possible to examine the type specimens of *Lejeunea Berteroana*, *Pycnolejeunea Schwaneckei* and several of their allies. *Lejeunea decidua*, *L. versifolia* and *L. emarginuliflora* were based on specimens distributed in exsiccatae, and these have also been studied by the writer. The type specimens of *L. phyllobola* and *L. lineata* have not been consulted.

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Explanation of plates 1–3

The figures were drawn by the writer and, with a very few exceptions, prepared for publication by Miss Hyatt.

PLATE 1

Cheilolejeunea decidua (Spruce) Evans. 1. Part of prostrate stem, with two branches, postical view, × 32. 2. Cells from middle of lobe, × 250. 3. Cells from antical margin of lobe, × 190. 4. Apex of lobule, × 190. 5. Apex of underleaf-division, × 190. 6. Male inflorescence, postical view, × 40. 7. Part of an ascending branch, from which most of the lobes have fallen away, postical view, × 32. 8. A detached lobe with three leafy shoots growing from it, × 32. 9. A leafy shoot without underleaves, from another detached lobe, × 50. The figures were all drawn from specimens collected in Florida by Small & Carter (*1370 p. p.*, *1408*).

Rectolejeunea flagelliformis Evans. 10. Female branch with perianth and floriferous innovation, postical view, × 32. 11. Part of sterile stem, postical view, × 32. 12. Two leaves, antical view, × 32. 13. Cells from middle of lobe, × 250. 14. Cells from antical margin of lobe, × 190. 15. Apex of lobule, × 190. 16. Base of underleaf, × 190. 17. Apex of underleaf-division, × 190. 18, 19. Bracts, × 32. 20. Bracteole, × 32. 21, 22. Apices of bracteoles, × 32. 23. Apex of flagelliform branch, postical view, × 32. 24. Modified leaf from flagelliform branch, with young leafy shoot growing from it, × 32. 25. Part of modified underleaf, × 190. The figures were all drawn from Cuban specimens collected by Underwood & Earle (*346*, *521*).

PLATE 2

Rectolejeunea emarginuliflora (Gottsche) Evans. 1. Part of a stem with a female inflorescence, postical view, × 45. 2. Part of a sterile stem, postical view, × 35. 3. Part of a stem from which most of the leaves have fallen away, postical view, × 45. 4, 5. Bracts, × 45. 6. Bracteole, × 45. 7. Detached leaf with a protonema and a leafy shoot growing from it, × 45. 8. Detached leaf with several protonemata, × 45. Figs. 4–6 were drawn from the type specimen (Hep. Cubenses); the remaining figures were drawn from the specimens collected by A. A. Heller (*4741 p. p.*).

Pycnolejeunea Schwaneckei (Steph.) Schiffn. 9. Part of a stem with a perianth and a microphyllous branch, postical view, × 25. 10. Part of stem, antical view, × 25. 11. Microphyllous branch, antical view, × 45. 12. The same, postical view, × 45. 13. Cells from middle of lobe, × 265. 14. The same in cross-section, × 200. 15. Cells from antical margin of lobe, × 200. 16. Cells from base of lobe, with an ocellus, × 200. 17. Apex of lobule, × 200. 18. Apex of underleaf-division, × 200. 19. Bract and bracteole, × 25. 20. Bract, × 25. 21. Cross-section of perianth at about the middle, × 35. 22. Cross-section of perianth near the apex, × 35. 23. Male inflorescence, antical view, × 35. The figures were all drawn from specimens collected in Jamaica by the writer (*99*).

PLATE 3

Cystolejeunea lineata (Lehm. & Lindenb.) Evans. 1. Part of sterile stem, postical view, × 35. 2. Part of stem with male inflorescence, postical view, × 35. 3. Explanate leaf, postical view, × 35. 4. Leaf, antical view, × 35. 5. Cells from middle of lobe, × 265. 6. The same in cross-section, × 200. 7. Cells from antical margin of lobe, × 200. 8. Apex of lobule (showing reflexed papilla), × 200. 9, 10. Apices of underleaf-divisions, × 200. 11. Leaf from female branch, × 35. 12. Underleaf from female branch, × 35. 13–15. Bracts, × 35. 16, 17. Bracteoles, × 35. 18. Perianth, × 35. 19. Cross-section of perianth, × 35. The figures were all drawn from specimens collected by the writer (*38 p. p.*, *46 p. p.*).

New species of Uredineae—IV

JOSEPH CHARLES ARTHUR

The following new species are from various parts of the United States, Canada, Mexico and West Indies. They were found in part among new collections sent for determination and in part among herbarium material which has long been known under other names. For the new material I am especially indebted to Messrs. E. W. D. Holway, C. L. Shear, G. P. Clinton, LeRoy Abrams and C. H. Demetrio. In the present descriptions I have used instead of the terms spermogonium, aecidium, uredo and teleutosorus, the new terms pycnium (*πυκνός*), aecium (*αἰκία*), uredinium (uredo) and telium (*τέλος*), which were recently proposed by the writer[*] as more convenient and uniform. Their application is sufficiently self-evident to make further explanation unnecessary.

Uromyces Dolicholi sp. nov.

II. Uredinia amphigenous, scattered, round, 0.2–0.5 mm. across, soon naked, pale cinnamon-brown, pulverulent, ruptured epidermis inconspicuous; urediniospores globose, 18–21 μ in diameter, wall cinnamon-brown, medium thick, 1.5–2 μ, minutely and closely echinulate, pores 4, equatorial.

III. Telia amphigenous, scattered, round, 0.2–0.5 mm. across, soon naked, cinnamon-brown, pulverulent, ruptured epidermis inconspicuous; teliospores oblong, or oblong-lanceolate, 10–15 by 26–32 μ, narrowed toward both ends, wall pale golden-brown, smooth, thin, 1 μ or less, thicker at apex, 3–6 μ, with nearly colorless umbo; pedicels slender, half length of spore, nearly colorless.

On *Dolicholus texanus* (T. & G.) Vail (*Rynchosia texana* T. & G.), San Angelo, Texas, October 19, 1904, *C. L. Shear* (host determined by E. L. Greene).

A strongly marked species. To the unaided eye there is little difference between the uredinia and telia, both being produced in abundance, but under the microscope the teliospores appear much

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[*] ARTHUR, J. C. Terminology of the spore-structures in the Uredinales. Bot. Gaz. 39: 219–222. 1905.

paler than the urediniospores, and both are unlike the usual leguminous species of *Uromyces*.

Puccinia Dolichi sp. nov.

II. Uredinia hypophyllous, irregularly scattered, round, small, 0.25 mm. across, soon naked, chestnut-brown, pulverulent, ruptured epidermis inconspicuous; urediniospores globose, small, 19–23 μ in diameter; wall chestnut-brown, rather thin, 1.5–2 μ, minutely echinulate, pores 3, or rarely 4, equatorial.

III. Telia not seen; teliospores in the uredinia, oblong, very large, 30–40 by 50–70 μ, acute or acuminate at the apex, rounded or obtuse at base, slightly or not constricted at septum; wall semi-opaque, chocolate-brown, thick, 3 μ, thickened and prolonged into a prominent, lighter-colored rostrum at apex, 10–15 μ, surface coarsely verrucose, with very low tubercles, smoother or smooth on the rostrum; pedicel colored next the spore, 6–12 μ thick, once length of spore.

On *Dolichos reticulatus* Hochst., Aguacate (province of Habana), Cuba, March 23, 1903, *E. W. D. Holway.*

Puccinia Fimbristylidis sp. nov.

II. Uredinia chiefly hypophyllous and caulicolous, oblong, 0.5–1 mm. long, soon naked, yellow, pulverulent, ruptured epidermis noticeable; urediniospores broadly elliptical or globoid, 15–20 by 18–23 μ, wall brownish-yellow, medium thick, 1.5 μ, sparsely and evenly echinulate with low points, pores 2, equatorial and opposite.

III. Telia chiefly hypophyllous and caulicolous, subepidermal, covered with the brown epidermis, irregularly oblong, 0.1–0.5 mm. long, or punctiform, compound, each component sorus round, surrounded by abundant, dark-brown, hyphal stroma; teliospores oblong, 16–19 by 34–50 μ, slightly constricted at septum, acute or obtuse at apex, somewhat narrowed at base, wall smooth, golden-brown, medium thick, 1–1.5 μ, thicker at apex, 4–9 μ; pedicel very short, colored.

On *Fimbristylis polymorpha* Boeckl. (type), Cuernavaca, State of Morelos, Mexico, Sept. 27, 1898, *E. W. D. Holway 3227; F. Holwayana* Fernald, Chapala, State of Jalisco, Mexico, Sept. 9, 1899, *Holway 3443; Fimbristylis sp.*, Mayaguez, Porto Rico, April 13, 1904, *G. P. Clinton 48;* the last with uredinia only.

This species differs materially from *Puccinia Eleocharidis* Arth. in the telial characters, although the urediniospores have a close resemblance. In *P. Eleocharidis* the stroma is absent, and the telia are simple, while the teliospores are more rounded above. The urediniospores of both species differ conspicuously from those of *Uredo superior* Arth. in size. All three species occur in Porto Rico.

Puccinia Pattersoniana sp. nov.

II. Uredinia epiphyllous, oblong, soon naked; urediniospores ellipsoid, 21–26 by 28–34μ, wall golden-yellow, thick, 3μ, sparingly and prominently verrucose, pores 3 (?), approximately equatorial.

III. Telia epiphyllous, intercostal, oblong-linear, soon naked, ruptured epidermis noticeable; teliospores oblong, somewhat angular, 16–22 by 30–37μ, slightly or not constricted at septum, rounded or obtuse at both ends; wall golden-brown, uniformly thin throughout, 1μ, appearing smooth when wet, finely and closely striate when dry: pedicel delicate, 5-7μ thick, once to twice length of spore, nearly colorless.

On the rough, or concave side of leaves of *Agropyron spicatum* (Pursh) Rydb., Sandcoulee, Cascade Co., Montana, July, 1888, *F. W. Anderson.*

The urediniospores of this species somewhat resemble those of *Puccinia Agropyri*, but the teliospores are very unlike any known North American rusts on grasses, especially in the uniformly thin walls and surface striation. The specific name is given in recognition of the services rendered to mycology by Mrs. Flora W. Patterson, curator of the cryptogamic herbarium of the United States Department of Agriculture.

Cronartium Comptoniæ sp. nov.

II. Uredinia hypophyllous, scattered or somewhat gregarious, round, very small, about 0.1 mm. across, dehiscent by a central rupture, soon wide open and naked, pulverulent; peridia rather firm, cells polygonal, at the sides with walls uniformly thin, about 1μ, at the top with the inner walls greatly thickened, up to 10μ; urediniospores oval or obovate, 16–21 by 23–31μ, wall colorless, rather thick, 2.5μ, sparsely and finely echinulate.

III. Telia hypophyllous, filiform, 40–100μ thick, 0.5–2 mm. long; teliospores fusiform-oblong, 13–17 by 28–56μ, obtuse at both ends; walls nearly colorless, smooth, thin, 1–1.5μ.

On *Comptonia peregrina* (L.) Coult. (*C. asplenifolia* Gaertn.), Egg Harbor, N. J., Sept. 7, 1874, *J. C. Arthur* (type); Belle Plain, N. J., Oct. 15, 1902, *C. L. Shear* (in Ellis & Everhart, Fungi Columbiani, *no. 1724*); Newton, Mass., without date, *W. G. Farlow* (in Ellis, North American Fungi, *no. 285*); *Myrica Gale* L., Orono, Me., Oct. 12, 1900, *P. L. Ricker* (in Ellis & Everhart, Fungi Columbiani, *no. 1482*).

The much thickened inner walls of the uredinial peridium and the thin-walled teliospores especially distinguish this species. It has been reported on the first named species from North Carolina, New York, and Vermont, in addition to the above data.

Hyalopsora pellaeicola sp. nov.

II. Uredinia amphigenous, scattered, irregularly round or oblong, bullate, 0.3–0.7 mm across, dehiscent by apical rupture, soon naked, pulverulent, golden-yellow, ruptured epidermis noticeable, peridia very delicate and difficult to detect; urediniospores globoid or obovate-globoid, 17-22 by 23-30μ, wall colorless, thin, 1μ, usually appearing twice as thick, minutely verrucose, or even echinulate-verrucose, pores obscure, equatorial.

III. Telia unknown.

On *Pellaea andromedaefolia* (Kaulf.) Fée, San Gabriel Cañon, Los Angeles County, California, March 13, 1903, *LeRoy Abrams 3125* (type); *Cryptogramme Stelleri* (Gmel.) Prantl, (*Pellaea gracilis* Hook.), Red Rock, Michigan, June 28, 1884, *J. Macoun* (host determined by L. M. Underwood), and Decorah, Iowa, August 1882, *E. W. D. Holway.*

The large globoid and very thin-walled urediniospores sharply distinguish this species from those on *Phegopteris* and *Cystopteris.*

CERATELIUM gen. nov.

Pycnia and aecia unknown. Uredinia with peridium, centrally dehiscent, urediniospores borne singly on pedicels, wall nearly colorless, echinulate, pores obscure, contents colored. Telia with spores united into a short column, or globoid mass, arising at first from bed of the uredinia, waxy; teliospores one-celled, wall smooth, nearly or quite colorless.

Ceratelium Canavaliae sp. nov.

II. Uredinia hypophyllous, gregarious on reddish-brown spots, crowded, small, 0.1–0.2 mm. across, bullate, rupturedepidermis inconspicuous, centrally dehiscent; peridia delicate, cells polygonal, inner walls slightly if any thicker than the outer walls; urediniospores broadly ellipsoid or globoid, 18–23 by 26–34μ;

wall medium thick, 1–2μ, pale-yellowish, sparsely and minutely echinulate, pores obscure.

III. Telia hypophyllous, columns scarcely extending beyond the peridia, about as long as broad; teliospores cylindrical or polygonal, small, 6–9 by 13–17μ, wall smooth, thin, 0.5–0.8μ, colorless.

On *Canavalia ensiformis* DC., Mayaguez, Porto Rico, April 16, 1904, *G. P. Clinton 87*.

An especially interesting rust on account of the combination of a melampsoraceous fungus with a leguminous host. The collection shows an abundance of telia. They are less conspicuous than the uredinia, and need to be studied by means of sections. The possession of a peridium in the uredinia at once widely separates the species from any of the usual leguminous rusts. The telia resemble those of *Dietelia*, only are much smaller. The species possesses a uredinial stage, however, which is absent in *Dietelia*. Except in the length of the telial column, there is considerable resemblance to *Cronartium*.

Coleosporium Eupatorii sp. nov.

II. Uredinia chiefly hypophyllous, scattered, round, small, 0.25 mm. across, early naked, pulverulent, yellow fading to white, ruptured epidermis somewhat noticeable; urediniospores short ellipsoid, or globoid, 15–20 by 22–27μ; wall colorless, medium thick, 2–2.5μ, half formed by the rather large, irregular, deciduous tubercles.

III. Telia unknown.

On *Eupatorium macrophyllum* L., El Yunque, Baracoa, Cuba, March 12, 1903, *E. W. D. Holway* (type); *Eupatorium* sp., Volcan Mombacho, Department of Granada, Nicaragua, February 20, 1903, *C. F. Baker 2461*, communicated by E. W. D. Holway.

The species is distinguished from *Coleosporium Steviae* Arth. by larger uredinia and smaller urediniospores. The walls of the spores are thicker, and the tubercles larger and noticeably irregular in form, not round and papilliform as in *C. Steviae* and many other species.

Uredo Dichromenae sp. nov.

II. Uredinia hypophyllous, scattered, oblong, 0.2–0.5 mm. long, covered by the overarching epidermis, and having an apparent peridium of hyphae; urediniospores elliptical, or broadly obovate, 18–23 by 22–35 µ, wall light yellow, medium thick, 1.5–2 µ, sharply and sparsely echinulate, pores obscure.

On *Dichromena ciliata* Vahl, Mayaguez, Porto Rico, April 13, 1904, *G. P. Clinton* (type); *D. radicans* Cham. & Schl., near Troy, Jamaica, May, 1903, *L. M. Underwood* (hosts determined by N. L. Britton).

Both collections are much parasitized, making it difficult to see the structure of the sorus. All sections show what seems like a peridium, enclosing the sorus after the manner of that in *Uredinopsis.* If it is a true hyphal structure, however, the exact construction cannot be made out.

Aecidium Falcatae sp. nov.

O. Pycnia amphigenous, in small groups, punctiform, honey-yellow, wholly immersed, subepidermal, in vertical section globose, 100–125 µ in diameter.

I. Aecia hypophyllous, gregarious in rather large, circular or irregular groups, crowded; peridia short, cylindrical, margin somewhat recurved, finely lacerate; aeciospores globoid, 18–23 by 19–25 µ; wall rather thin, 2 µ, rather coarsely verrucose.

On *Falcata comosa* (L.) Kuntze (*Amphicarpa monoica* Ell.), Decorah, Iowa, June 21, 1881, *E. W. D. Holway* (type); *Apios Apios* (L.) MacM. (*A. tuberosa* Moench), Ames, Iowa, June 17, 1879, *W. A. Thomas*, and Iowa City, Iowa, June, 1886, *Thomas H. Macbride.*

This aecial stage differs slightly from that on various species of *Phaseolus*, *Strophostyles*, and *Vigna*, in having more prominent aecia, with more globoid and rougher aeciospores, and is therefore described as a separate species from *Uromyces appendiculatus* Ung., to which it has usually been referred. As it is not known to be followed by any other stage on the same hosts, it is assumed to be a heteroecious species. Besides occurring in Iowa it is reported from Illinois, Minnesota, Wisconsin, and Nebraska.

Aecidium Triostei sp. nov.

O. Pycnia epiphyllous, in small groups, punctiform, honey-yellow, subepidermal, seen in vertical section globose, 90–130 µ in diameter.

I. Aecia hypophyllous, in circular groups, 5 mm. or more across, not crowded; peridium at first hemispherical, low, margin erect, erose; aeciospores globoid, 18–22 μ in diameter; wall thin, 1 μ thick, pale-yellow, minutely and closely verrucose.

On *Triosteum angustifolium* L., Perryville, Missouri, May, 1884, *C. H. Demetrio.*

No aecial or other form of rust is recorded on this host, or any closely related one. It is probably a heteroecismal species.

Aecidium Cardui sp. nov.

O. Pycnia epiphyllous, in small groups, immersed, inconspicuous, punctiform, subepidermal, globose, 130–180 μ in diameter.

I. Aecia hypophyllous, crowded in circinating groups, 3–5 mm. across, on discolored spots; peridia short, cylindrical, margin erect, erose; aeciospores globoid, small, 15–18 by 16–20 μ; wall nearly colorless, very thin, 0.5–1 μ, very minutely granulose.

On *Carduus Hookerianus* (Nutt.) Heller (*Cirsium Hookerianum* Nutt.), Sandcoulee, Montana, July 28, 1887, *F. W. Anderson 82.*

The common rust on various thistles, which extends across the continent and is especially common westward, is *Puccinia Cirsii* Lasch., and is a species having uredinia and telia, but no aecia. *P. suaveolens* (Pers.) Rostr. is a similar species found only on *Carduus arvensis*, while *P. Cnici* Mart., occurring on *Carduus lanceolatus*, has aecia of a wholly different and peculiar sort. There appears, therefore, to be no recognized species of rust on thistle to which this Aecidium can be referred, and it is consequently described as an independent form. Whether it belongs with an autoecious or heteroecious species can not be stated. The collector only included leaves of the host, and did not supply a specific name. The material has been submitted to Dr. P. A. Rydberg, of the New York Botanical Garden, who gives the above name, but with some degree of uncertainty, due to the very scanty material.

Aecidium Argithamniae sp. nov.

O. Pycnia epiphyllous, few in orbicular groups, not crowded, punctiform, honey-yellow becoming dark-brown, conspicuous, immersed, in section globoid, large, 150–175 μ across.

I. Aecia hypophyllous, on discolored spots in orbicular or annular groups, 2–5 mm. across, not crowded, cylindrical, short, margin erect, erose or lacerate; aeciospores globoid, 15–18 by

18–21 μ; wall nearly colorless, very thin, 1 μ or less, very minutely verrucose, appearing smooth.

On *Argithamnia Schiediana* Müll. Arg. (?), Trinidad, State of Hidalgo, Mexico, May 25, 1904, *C. G. Pringle*, communicated by E. W. D. Holway.

PURDUE UNIVERSITY.

The genus Stenochlaena

LUCIEN MARCUS UNDERWOOD

In no portion of *Synopsis Filicum* does the lack of coördination of the work of other authors manifest itself more strikingly than at page 412 under *Acrostichum sorbifolium,* where the elaborate work of Fée, which had appeared twenty-two years previously, is made to pass for naught, and his seventeen species of *Lomariopsis* are reduced to synonymy. While the elder Hooker was writing the *Species Filicum*, of which the *Synopsis* is a revised and abbreviated digest, Kunze and, later, Mettenius, were describing ferns independently at Leipzig, as was also Presl at Prague, and Fée at Strasburg. The work at each of these centers appears to have gone on in practical independence and without much comparison or coördination. Such species as happened to come to Kew appear to have been reviewed, and the others were often reduced to synonymy with no specimen at hand. Some were never mentioned. The visitation of other centers seems rarely if ever to have been practiced. Presl had no successor to his studies and his still unmounted fern collection exists to-day at Prague, apparently never visited by modern European fern students or monographers. At Berlin, Kuhn was the lineal successor of Mettenius, as Fournier at Paris was the successor of Fée. At Berlin, in addition to the collection of Willdenow, most of the types of Kaulfuss, Kunze, Klotzsch, Mettenius and Kuhn may be seen, and at Paris most of those of Lamarck, Bory, Desvaux, Fée and Fournier are at the museum of the Jardin des Plantes, but neither Hooker nor his successors at Kew consulted them, and to this present year of grace, continental European fern students have never taken the trouble to coördinate them with the Kew collection, but have continued to work on in the same old independent ways.

In attempting to elucidate the American species of *Stenochlaena*, the fact that Hooker had attributed one of our West Indian species to nearly all parts of the tropical world * made it necessary to

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* "West Indies to Peru and South Brazil; Fiji, Samoa, New Caledonia, Philippines, Malaccas, Cochin China, Seychelles, Mascaren Isles, Angola, Guinea Coast." — Syn. Fil. 412.

review the entire genus. During the past summer, while visiting the collections at Vienna, Prague, Berlin, Paris and Kew, the specimens representing this genus were examined comparatively and the following revision is the result of this first synoptical study of a genus based on the materials of all the great fern collections of the world. How different the result appears from that based on the study of the material at a single center may be seen by comparing the present revision with the treatment of the same group in *Synopsis Filicum*, where most of the species of other authors are ruthlessly reduced to synonymy under *Acrostichum sorbifolium*, originally from the West Indies. To the twenty-three Old World species here recognized should be added ten or more which represent the American development of the genus and which will be given a separate treatment. Five species appear in *Synopsis Filicum;* of these three reappear without change; three are here described as new, and the remainder represent species either unknown to the authors of *Synopsis Filicum* or unfortunately reduced to synonymy by them.

The genus *Stenochlaena* forms a rather natural group of non-indusiate ferns whose nearest relatives are to be found in the dimorphous species of *Stegania* R.Br. (*Lomaria* Willd.) as suggested in the name (*Lomariopsis*) given to one section of the genus when monographed by Fée sixty years ago. In fact the species with narrow pinnae in the sporophyls have often been described in the genus *Lomaria*, as those with wider pinnae were supposed to have a corresponding relation to *Acrostichum*. At least four genera have been established from among the species, the name *Stenochlaena* being the oldest for any member of the group. In recent papers Dr. Christ still maintains the genera *Lomariopsis* and *Stenochlaena* as distinct, but this seems less rational than to unite them as sections of one genus. It is true that we have two types of venation represented in the group: the first with the lateral veins springing from the midrib, and the second with accessory veins parallel and adjacent to the midrib with the lateral veins springing from them. Pinnae jointed to the rachis occur in species with both types of venation. The species with the second type have spiny leaves, while those with the first type have a normally cartilaginous margin to the pinnae. With these slight differences, it seems better, therefore, to recognize only a single genus with four fairly marked sections which may be distinguished as follows:

Synopsis of the sections of Stenochlaena

Lateral veins springing from a vein lying parallel to the midrib and occasionally connecting with it; margins of the pinnae spiny.
  Sporophyls simply pinnate. § **Eustenochlaena.**
  Sporophyls normally bipinnate. § **Cafraria** Presl.
Lateral veins springing direct from the midrib; pinnae not spiny.
  Climbing stems spiny, not scaly, naked; leaves trimorphous. § **Teratophyllum** Mett.
  Climbing stems not spiny, usually more or less densely scaly. § **Lomariopsis** Fée.

The species of the first three sections are all confined to the tropics of the Old World. Those of the section *Lomariopsis* are divided between the tropics of the Old and New worlds, approximately in the ratio of three to two.

§ 1. EUSTENOCHLAENA

The genus *Stenochlaena* was founded by John Smith in 1841 and was based on *Acrostichum scandens* * as a type. The species closely allied to this, then, must constitute the section *Eustenochlaena*, notwithstanding the fact that there has been a different use for the term.† There are three species of this section, one of which has a wide range and presents considerable variation from its various stations. The other two species have quite a limited range. They may be easily separated by the following synopsis:

Pinnae of the sporophyls narrow, 3 mm. wide. 3. *S. palustris.*
Pinnae of the sporophyls wider, 5–10 mm. wide.
  Pinnae 3.5–4 cm. wide, rounded-obtuse at the base; pinnae of the sporophyls narrow, 5 mm. wide. 2. *S. Milnei.*
  Pinnae 3 cm. wide, truncate at the base; pinnae of the sporophyls wider, 10 mm. wide. 1. *S. laurifolia.*

1. STENOCHLAENA LAURIFOLIA Presl, Epim. Bot. 164. 1851 (type from Luzon, *Cuming 226*).

Acrostichum laurifolium Hook. Sp. Fil. **5**: 250. 1864.—Syn. Fil. 412.

RANGE: Philippine Islands.

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* SMITH (Jour. Bot. Hook. **3**: 401. 1841) wrongly attributes this species to Linnaeus. His context, however, makes clear the species intended. Later he included members of other sections in the genus (Jour. Bot. Hook. **4**: 149. 1841).

† DIELS, Die natürlichen Pflanzenfamilien 1^4: 251. 1899; where the term *Eustenochlaena* is used to include also species of *Lomariopsis* Fée.

2. **Stenochlaena Milnei** sp. nov.

Creeping stems unknown; leaves pinnate; pinnae 6–7- (or more) jugate, rigid, coriaceous, rounded-obtuse at base, nearly sessile; 20 cm. or more long, 3–3.5 cm. wide, the margins thickly beset with small spines, the apex long-acuminate; veins close, 17–18 spaces to the centimeter, simple or occasionally forked at or near the base; surfaces smooth and shining; sporophyls pinnate; the pinnae about 9-jugate, 25 cm. or more long, 5 mm. wide, tapering at the apex, inclined to be revolute when dry; rachises pallid, smooth, rather stout.

SOLOMON GROUP: *Milne 518* (type), K; *ibid. 590*, K.

NEW GUINEA: *Honkmann*, K (fragment); *Armit*, K (sporophyl only).

ADMIRALTY ISLANDS: *Moseley* (Challenger Exped.), K.

S. Milnei is represented at Kew by fragmentary materials which do not show the stem characters; it is, however, sufficiently differentiated from the variable *S. palustris*, and especially from *S. laurifolia*, under which Hooker cites the type, to justify separation even on present materials. Specimens have been seen only at Kew.

3. STENOCHLAENA PALUSTRIS (Burm.) Beddome, Suppl. Ferns India 26. 1876.

Polpypodium palustre Burm. Fl. Ind. 234. 1768. (Type from Ceylon.)

Onoclea scandens Sw. Syn. Fil. 112, 309. 1806. (Change of Burmann's specific name without warrant.)*

Lomaria scandens Willd. Sp. Pl. **5**: 293. 1810.

Lomaria ? juglandifolia Presl, Rel. Haenk. **1**: 52. 1825. (Type from the Philippines, *Haenke*.) †

Lomaria ? Haenkeana Presl, Rel. Haenk. **1**: 53. 1825. (Type from Sorzogon, Luzon, *Haenke*.)

Stenochlaena scandens J. Sm. Jour. Bot. Hook. **3**: 401. 1841.

Stenochlaena Blumeana Presl, Epim. Bot. 163. 1851. (Type from Tranquebar, *Bottler*.)

Stenochlaena Haenkeana Presl, Epim. Bot. 165. 1851.

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* Swartz, moreover, has his references to Burmann sadly mixed and attributes the species to Linnaeus who apparently never mentioned it. John Smith copied Swartz' error in establishing the genus *Stenochlaena*.

† Like many other plants in this work Presl reported this originally from Mexico but corrected it in his herbarium and in his later writings.

Acrostichum scandens Hook. Sp. Fil. **5**: 249. 1864.—Syn. Fil. 412. 1868.

Lomariopsis palustris Mett. Ann. Mus. Lug.-Bat. **4**: 294. 1869.

ICON.: Rheede, Hort. Malab. **12**: *pl. 35.* 1703; Burmann, Thes. Zeyl. *pl. 46.* 1737; Rumphius, Herb. Amboin. **6**: *pl. 31.* 1750; Schkuhr, Crypt. Gewächse *pl. 106, 107;* Hooker & Bauer, Gen. Fil. *pl. 105 B;* Fée, Mém. Foug. **5**: *pl. 5 A. f. 2;* Beddome, Ferns Southern India *pl. 201.*

RANGE: India from Punjab?, Sikkim and Ceylon, to Malacca, Java, Sumatra, Borneo, the Philippines, to Queensland, Fiji, Samoa, and Tonga Islands.

§ 2. CAFRARIA Presl.

This group was set apart by Presl as a section in 1851.* It agrees with *Eustenochlaena* in venation and in the marginal spines of the pinnae, but differs in the bipinnate sporophyl, a character wholly insufficient to separate it as a genus. Fée founded the genus *Lomariobotrys* on the same group in 1852.

A single species:

4. **Stenochlaena tenuifolia** (Desv.)

Lomaria tenuifolia Desv. Berl. Mag. **5**: 326. 1811. (Type from Madagascar.)

Lomaria Meyeriana Kunze, Linnaea **10**: 509. 1836. (Type from Natal?, "inter Omtendo et Omsamculo," *Drege.*)

Stenochlaena Meyeriana Presl, Epim. Bot. 166. 1851.

Lomariobotrys Meyeriana Fée, Mém. Foug. **5**: 46. *pl. 5A.* 1852.

Lomariobotrys tenuifolia Fée, Mém. Foug. **5**: 46. 1852.

Acrostichum Meyerianum Hook. Garden Ferns *pl. 16.* 1862.—Sp. Fil. **5**: 250. 1864.

Acrostichum tenuifolium Baker, Syn. Fil. 412. 1868.

ICON.: Hooker, *loc. cit.;* Fée, *loc. cit.*

RANGE: Africa from the Cape of Good Hope and Natal to Nossibé, Madagascar, Mauritius, and the Comoro Islands.

There are specimens in the Kew herbarium in which there are some simply pinnate sporophyls as well as the normally bipinnate ones, said to have grown on the same plant.

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* In publishing *Lomariobotrys*, Fée adds the date 1851, citing *Cafraria* Presl, Epim. Bot. 166. This seems to fix the date of the Epim. Bot. as 1851 rather than 1852 (cf. Bull. Torrey Club **32**: 590, *note*). This also enables us to cite 1852 instead of "1850–52" for Fée's fifth Memoir.

§ 3. TERATOPHYLLUM Mett. (in part).

In 1869 Mettenius established the genus *Teratophyllum* based on *T. aculeatum* (*Lomaria aculeata* Bl.) and *T. articulatum* (*Polybotrya articulata* J. Sm.). The latter species forms the type of the genus *Arthrobotrya* J. Sm., and appears to be a valid genus. In this group the rootstock is spiny and naked, the veins are free, the pinnae are articulated to the rachis, and the leaves are trimorphous. In addition to the ordinary foliage leaves which are simply pinnate like those of the other sections of the genus, there are accessory bipinnate or even tripinnate leaves which often lie more closely appressed to the surface over which the plant climbs. A good illustration of this feature may be seen in Karsten, Ann. Bot. Jard. Buitenzorg **12**: *pl. 14*, copied in Velenovsky's Vergleichende Morphologie der Pflanzen 200, *f. 128*. 1905. Such dissected leaves are not unknown in other ferns, occurring even in some of the *Cyatheaceae*.

There are three species known at present, all confined to the East Indian region both continental and insular. They may be distinguished as follows:

Foliage green; pinnae 1.5–2.5 cm. wide, nearly sessile. 5. *S aculeata.*
Foliage pink or violet when dry; pinnae 1 cm. or less wide.
  Pinnae obtuse or truncate at the base, short-stalked; sporophylary pinnae as long as the sterile. 6. *S. gracilis.*
  Pinnae cuneate at the base, long-stalked; sporophylary pinnae twice the length of the sterile. 7. *S. Williamsii.*

Besides the above there are indications of a fourth species, from Perak, with green foliage, the pinnae stalked (1–1.5 cm.), subcoriaceous, and 2.5–3 cm. wide. Specimens exist at Kew.

5. STENOCHLAENA ACULEATA (Blume) Kunze, Bot. Zeitung **6**: 142. 1848.

Lomaria aculeata Blume, Enum. Pl. Jav. 205. 1828. (Type from Java.)

Lomariopsis spinescens Fée, Mém. Foug. **2**: 71. *pl. 33. f. 1.* 1844–5. (Based on the above with an unwarranted change of of specific name.)

Lomariopsis ludens Fée, Mém. Foug. **2**: 70. *p. 30.* 1844–5. (Type from Singapore, *Gaudichaud.*)

Davallia achillaefolia Wall. Cat. n. 248; Hooker, Sp. Fil. **1**: 195. *pl. 56 D.* 1846. (Type from Penang, *Wallich.*)

Teratophyllum aculeatum Mett. Ann. Mus. Bot. Lug.-Bat. **4**: 296. 1869.

Acrostichum aculeatum Racib. Pter. Fl. Buitenzorg 53. 1898.

ICON.: Fée, *loc. cit.;* Hooker, *loc. cit.;* Karsten, Ann. Jard. Bot. Buitenzorg **12**: *pl. 14.* 1893.

RANGE: Perak, Tenasserim, Java, Borneo, and the Philippines. Usually appears in herbaria in a sterile condition. A var. *inermis* Mett., without spines on the rootstock, has also been described (Mett. *loc. cit.* 297).

6. STENOCHLAENA GRACILIS (Blume) Kunze, Bot. Zeitung **6**: 142. 1848.

Lomaria gracilis Blume, Enum. Pl. Jav. 205. 1828.

Acrostichum gracile Racib. Pter. Fl. Buitenzorg 53. 1898.

RANGE: Java.

7. **Stenochlaena Williamsii** sp. nov.

Stems pink, 3–8 mm. thick, widely creeping, densely rooting below, spiny above; foliage leaves scattered, about 6 cm. apart, up to 60 cm. long, the stalks pink with a slight tinge of brown, slightly fibrillose, with a slight ridge and groove along the upper side, pinnate; the pinnae deciduous, stalked (5 mm. or more), lanceolate, 12–15 cm. long, 1.5 cm. wide, cuneate tapering at the base, acuminate at the apex, the margin slightly repand or entire, the surfaces smooth, the midrib prominent, reddish, with occasional fibrils; veins distinct, close (about 15 spaces to 1 cm.), simple or forked; sporophyls pinnate, the pinnae deciduous, long-stalked (8–10 mm.), 25–28 cm. long, 1.5–2 mm. wide, with conspicuous midrib; secondary foliage leaves 1–2 cm. long (or larger in young plants), bipinnatifid, membranous, in growth appressed to the substratum.

PHILIPPINES: Lamao River, Mt. Mariveles, Prov. Bataan, Central Luzon, alt. 120 meters, *Williams 684.* Type in the herbarium of the New York Botanical Garden.

Growing on trees. "Young plants with finely dissected leaves." Unfortunately few of the secondary foliage leaves were secured, so that their exact relation to the others is not clear in the type specimen. The species differs from *S. aculeata* in its narrow pink pinnae, the color appearing in every part of the plant when dry. From *S. gracilis* it differs in its cuneate acute bases of the pinnae and the elongate pinnae of the sporophyls.

§ 4. LOMARIOPSIS Fée

The numerous members of this section, which were so summarily crowded into one species by Hooker, form a natural group in which free veins rising directly from the midribs, scaly climbing rootstocks rarely if ever armed with prickles, and pinnae continuous with the rachis form the most obvious characters. The species are widely distributed and have thereby become notably diverse in the various parts of the earth where they now appear. As a rule the individual species have very clearly marked characters combined with a narrow geographic range. It is therefore somewhat simpler to treat of the great continental regions separately. The American species will form the subject of a separate paper. The accompanying figures of normal lateral pinnae, drawn natural size, will show something of the diversity of leaf-form in the genus in the Old World.

I. THE SPECIES OF AFRICA AND ITS ISLANDS

Willemet (1796) was the first to describe a species of this group from Africa under the name of *Osmunda pollicina*. Later species have been separated by Bory, Fée, Kunze, Mettenius, Kuhn, and Baker, who have each added a single species to the flora, and an eighth is here published as new. The species range from Sierra Leone to Fernando Po on the west coast and across the continent to the islands of Mauritius and Madagascar. Their differential characters will become apparent in the following synopsis:

Pinnae truncate at base.
  Pinnae 5 cm. or less long, those of the lowest third of the leaf gradually decreasing to mere auricles. 11. *S. decrescens.*
  Pinnae 15 cm. long, only the lowest 2–3 pairs slightly smaller. 16. *S. Mannii.*
Pinnae cuneate or rounded-obtuse at the base, never truncate.
  Lateral pinnae under 7 cm. long, rounded-obtuse at the base.
    Pinnae pointed at the apex, 7 by 2 cm.; pinnae of the sporophyls 7.5 cm. long by 5 mm. wide. 20. *S. pollicina.*
    Pinnae rounded at the apex, suboval.
      Pinnae of the sporophyls 10–12 mm. long by 2–3 mm. wide, obtuse at the apices. 9. *S. buxifolia.*
      Pinnae of the sporophyls 3 cm. long by 4–5 mm. wide, pointed at the apices. 15. *S. lomarioides.*
  Lateral pinnae 10–15 cm. or more long, cuneate at the base.

Some of the species confused under *Stenochlaena sorbifolia*. Normal lateral pinnae, natural size. 1. *S. Pervillei*. 2. *S. Mannii*. 3. *S. guineensis*. 4. *S. Brackenridgei*. 5. *S. decrescens*. 6. *S. lomarioides*.

Pinnae broadly elliptic, 3–3.5 cm. wide, abruptly narrowed to an acuminate apex. 12. *S. guineensis.*

Pinnae lanceolate, scarcely over 2 cm. wide, tapering to an acuminate apex.
  Pinnae of the sporophyls short-stalked, 2 mm. or less wide. 19. *S. Pervillei.*
  Pinnae of the sporophyls long-stalked, 4–6 mm. wide. 23. *S. variabilis.*

Species inquirendae

1. Specimens from Namuli, Makua country, East Tropical Africa, collected by *Last* (Herb. Kew.) have only sterile leaves, 9–10-jugate, but these do not agree with those of any known species. More information is necessary before locating a ninth species from Africa.

2. *Polypodium* (?) *binerve* Hook. Sp. Fil. **4**: 176. *pl. 273B.* 1862, is placed by Mr. Baker as "one of the abnormal conditions of *Acrostichum sorbifolium*" (Syn. Fil. 323). It may represent a good species when its sporophyls become known. It has of course no relation to *Polypodium* other than that it is a fern, and none to *Stenochlaena sorbifolia*, but is either a distinct species or less likely a juvenile state of some one already known.

2. THE SPECIES OF THE EAST INDIAN AND AUSTRALIAN REGIONS AND OF THE PACIFIC ISLANDS

Of the eight species belonging to this region, three were described in Fée's original monograph in 1844, two were described by Carruthers in *Flora Vitiensis* and appear entirely to have escaped the notice of the Kew botanists, and one each was added by Presl, Brackenridge, and Mettenius. Most of the species are very clearly marked and not one of them approaches *S. sorbifolia*, with which all of them have been confused. The following synopsis will differentiate the species:

Pinnae narrow, 1.5 cm. or less wide.
  Pinnae serrulate; veins stopping short of the margin; pinnae of the sporophyls 1.5–2 mm. wide. 13. *S. Hügelii.*
  Pinnae entire or barely repand; veins running into a cartilaginous margin; pinnae of the sporophyls 4–5 mm. wide. 14. *S. leptocarpa.*
Pinnae wider, 2–5 cm.
  Pinnae of the sporophyls 2 mm. or less wide. 8. *S. Brackenridgei.*
  Pinnae of the sporophyls wider, 4–8 mm. wide.
    Pinnae of the sporophyls 8–15 cm. long, short-stalked.
      Foliar pinnae 2 cm. wide, tapering at the apex. 17. *S. Novae-Caledoniae.*

Foliar pinnae 3.5–5 cm. wide, abruptly acuminate at the apex.
10. *S. cochinchinensis.*
Pinnae of the sporophyls 20–30 cm. long, long-stalked (2 cm.).
Pinnae of the sporophyls gradually tapering at the apex.
22. *S. Smithii.*
Pinnae of the sporophyls abruptly acuminate at the apex.
Pinnae narrow, about 2 cm. wide. 18. *S. oleandrifolia.*
Pinnae wider, 3–3.5 cm. wide, few-jugate.
21. *S. Seemannii.*

The last two species are quite near to each other in form and general appearance and may represent only two phases of the same species. Since the meager materials represented in herbaria are insufficient, it is better to keep them apart, as they have already been established, awaiting further collection in the South seas. With the strong possibility of distinctness, this is a more rational proceeding than to unite them. This is a far different proposition from separating doubtful things in the event of a possibility of specific distinctness. The geographic range of the two species is practically the same, which further decreases the probability of specific distinctness. As a species or group they are entirely distinct from any other members of the section.

Species excludenda

STENOCHLAENA FEEGEENSIS Brack. Filices U. S. Expl. Exped. 78. *pl. 11. f. 1.* 1854. (Type from the Fiji Islands, *Wilkes Exped.*)

The synonymy and distribution of the species of § *Lomariopsis* of the Old World are given in an alphabetical series :

8. **Stenochlaena Brackenridgei** (Carruth.) [FIGURE 4.]
Lomariopsis Brackenridgei Carruth. Fl. Vit. 373. 1871. (Type from the Fiji Islands.)

RANGE: Known only from its type locality.

9. **Stenochlaena buxifolia** (Kunze).
Acrostichum buxifolium Kunze, Die Farrnkr. **1**: 171. *pl. 72.* 1845. (Type from Madagascar.)

ICON.: Kunze, *loc. cit.*

RANGE: Known only from Madagascar.

Polypodium orbiculatum Poir. Encyc. Méth. Bot. **5**: 525 (type locality, Java) is referred to this species as a synonym by Kuhn, but in the absence of any type specimen and with a widely different type locality it is much safer to leave the matter in abeyance.

10. **Stenochlaena cochinchinensis** (Fée).

Lomariopsis cochinchinensis Fée, Mém. Foug. **2**: 66. *pl. 26.* 1844–5. (Type from Cochin China, *Herb. Mus. Paris.**)

ICON.: Fée, *loc. cit.*

RANGE: Cochin China; known only from the original collection by Gaudichaud.

11. **Stenochlaena decrescens** (Baker) [FIGURE 5.]

Acrostichum decrescens Baker, Syn. Fil. 412. 1868. (Type from the Cameroons, West Tropical Africa, *Mann 1391.*)

RANGE: Known only from its type collection (Kew).

12. **Stenochlaena guineensis** (Kuhn) [FIGURE 3.]

Lomariopsis guineensis Kuhn, Fil. Afr. 53. 1868. (Type from Fernando Po, *Mann 139.*)

Acrostichum guineense Carruth. Cat. Afr. Pl. Welwitsch **2**: 276. 1901.

Foliar pinnae 10 × 3 cm.; sporophyllary pinnae 10 cm. × 4 mm.

RANGE: Fernando Po, St. Thomas, Congo, Angola and Sierra Leone. Sterile fragments from the last named region at Kew have much larger pinnae 17 × 4 cm., but are not otherwise distinct.

13. **Stenochlaena Hügelii** (Presl) Fée in herb. Vindob.

[FIGURE 9.]

Lomariopsis Hügelii Presl, Epim. Bot. 263. 1851. (Type from New Zealand, *Hügel.*)

Lomariopsis sorbifolia var. resectum [*sic*] Christ in Warburg, Monsunia **1**: 56. 1900. (Type from Cairns, North Queensland, *Warburg 19286.*)

This clearly marked species, which naturally has no near resemblance to *S. sorbifolia* of the American tropics, was well characterized by its author in the corrections to the text of *Epimeliae Botanicae*, and for this reason has eluded discovery for a long time. A long manuscript description under a new name by F. Mueller appears in the Kew herbarium with specimens from Rockingham

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* We were unable to find the type in Paris collected by Gaudichaud, but there is a cotype in the herbarium at Berlin.

Bay, Queensland. Warburg's specimens represented at the Berlin herbarium differ mainly in having somewhat shorter pinnae with their upper basal angle more truncate than in Presl's plant. The venation and margins of the pinnae suggest *Plagiogyria*, but there is apparently no indusium. It forms a clearly marked species from a region inhabited by no other species of this section.

14. **Stenochlaena leptocarpa** (Fée).

Lomariopsis leptocarpa Fée, Mém. Foug. **2**: 69. *pl. 29.* 1844–5. (Type from the Philippines, *Cuming 132.*)

Lomaria spectabilis Kunze, Bot. Zeitung **6**: 144. 1848. (Type from Pangarango, Java, *Zollinger 3130.*)

Lomariopsis spectabilis Mett. Fil. Hort. Bot. Lips. 22. 1856.

Acrostichum spectabile Racib. Pter. Fl. Buitenzorg 54. 1898.

ICON: Fée, *loc. cit.*

RANGE: Java and the Philippines.

We have not seen Fée's own specimen of this species, which is now in storage with the Cosson herbarium at the Paris Museum. This number of Cuming in the general collection of the herb. Mus. Paris, does not agree with Fée's excellent figure, but is clearly *S. Smithii.* Original specimens from Mettenius' herbarium agree perfectly with Fée's plate, as does Raciborski's recent excellent description.

15. **Stenochlaena lomarioides** (Bory) [FIGURE 6].

Acrostichum lomarioides Bory, Belang. Voy. Bot. 21. *pl. 2.* 1833. (Type from Ile de France, *Belanger.*)

Lomariopsis Boryana Fée, Mém. Foug. **2**: 68. 1844–5. (Specific name changed from the above without apparent warrant.)

ICON.: Bory, *loc. cit.*

RANGE: Bourbon.

16. **Stenochlaena Mannii** sp. nov. [FIGURE 2.]

Stems stout, climbing, 1.5 cm. or more in diameter, densely covered with dark-brown scales; stipes scattered, stout, 20–30 cm. long, densely covered with similar dark-brown scales; sterile leaves pinnate, about 19-jugate, the pinnae closely placed, up to 17 cm. long by 2 cm. or more wide, the lowest two or three pairs slightly shorter, the upper gradually reduced to 3–5 cm. long, the terminal similar but larger (8 cm. long); pinnae rounded-truncate at the base, gradually tapering to an acute point, margins undu-

Some of the species confused under *Stenochlaena sorbifolia*. Normal lateral pinnae, natural size. 7. *S. Novae-Caledoniae*. 8. *S. pollicina*. 9. *S. Hügelii*. 10. *S. oleandrifolia*.

late, midribs with occasional scales; rachis strongly margined above, more or less scaly throughout; sporophyls pinnate, the pinnae 26-jugate, gradually diminishing above and below, the longest (medial) 11 cm. long by 5–7 mm. wide at the rounded base, tapering gradually to a point; rachis similarly scaly and margined above.

FERNANDO PO: 5,000 ft., 1860, *Mann 354* (type), K (three sheets) *ibid.* 3,000 ft. *446*, K.

CAMEROONS: *Kalbreyer 188*, K (slightly smaller; sterile leaves 28-jugate); *H. H. Johnston 146*, K (still smaller; sterile leaves only, 24-jugate.)

17. **Stenochlaena Novae-Caledoniae** (Mett.) [FIGURE 7.]
Lomariopsis Novae-Caledoniae Mett. Ann. Sci. Nat. IV. **15**: 58. 1861. (Type from Poila, New Caledonia, *Vieillard 1529*.)

RANGE: Known only from its type collection. The species resembles *S. Pervillei* in the form of the pinnae, but differs widely in the sporophyls.

18. STENOCHLAENA OLEANDRIFOLIA Brack. Filices U. S. Expl. Exped. 75. 1854. (Type from the Fiji Islands, *Wilkes*.) [FIGURE 10.]

RANGE: Fiji Islands and New Hebrides.

19. **Stenochlaena Pervillei** (Mett.) [FIGURE 1.]
Lomariopsis Pervillei Mett.; Kuhn, Fil Afr. 53. 1868. (Type from the Seychelles Islands, *Perville 98*.)

RANGE: Known only from the type locality.

20. **Stenochlaena pollicina** (Willemet) [FIGURE 8].
Osmunda pollicina Willemet, Ann. Bot. Usteri **6**^{18}: 61. 1796. (Type locality, Mauritius, Mt. Pollex?.)
Lomaria fraxinea Willd. Sp. Pl. **5**: 294. 1810. (Type locality, Mauritius, and also cites *Osmunda pollicina* as a synonym!)
Lomaria integrifolia Kaulf.; Sprengel, Syst. Veg. **4**: 63. 1827. (Type from Mascarine Islands.)

RANGE: Mauritius, Bourbon, Madagascar, Mascarene Islands.

21. **Stenochlaena Seemannii** (Carruth).
Lomariopsis Seemannii Carruth. Fl. Vit. 373. 1873. (Type from the Fiji Islands, *B. Seemann 712*).

RANGE: Fiji Islands and New Hebrides.

22. **Stenochlaena Smithii** (Fée).

Lomariopsis Smithii Fée, Mém. Foug. **2** : 71. *pl. 33. f. 2 ; pl. 53.* 1844–5. (Type from the Philippines, *Cuming 143.*)

ICON : Fée, *loc. cit.*

RANGE : Philippine Islands.

23. **Stenochlaena variabilis** (Willd.).

Lomaria variabilis Willd. Sp. Pl. **5** : 294. 1810. (Type from Mauritius.)

Osmunda trifrons Bory, Voyage **3** : 163. 1804. (*Nomen nudum.*)

Lomariopsis variabilis Fée, Mém. Foug. **2** : 70. *pl. 31. 32.* 1844–5.

Lomariopsis cuspidata Fée, Mém. Foug. **2** : 68. *pl. 27.* 1844–5. (Type from Mauritius.)

ICON : Fée, *loc. cit.*

RANGE : Known only from Mauritius.

We cannot separate Fée's two species, of which he gives excellent plates ; the type number of his *L. cuspidata* (*Sieber 22*) is also cited under *L. variabilis !*

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Studies in North American Polygonaceae — II

John Kunkel Small

Eriogonum xanthum sp. nov.

Perennial (section *Flava*), dwarf, closely pale-pubescent. Stems (caudices) closely tufted, densely leafy, the lower portions densely clothed with the persistent leaf-bases : leaves numerous, crowded ; blades spatulate, 1–2.5 cm. long, obtuse, somewhat floccose and greenish above, more closely pubescent and gray beneath, rather slender-petioled : scapes 3–5 cm. tall, simple, pubescent, like the upper surface of the leaf-blades : bracts spatulate, quite similar to the leaves, but usually 1–1.5 cm. long : involucres nearly sessile, capitate, turbinate, ultimately ribbed, about 4 mm. long ; lobes triangular, about one fourth as long as the tube : calyxes yellow, becoming 8 mm. long, including the stipe-like base, which is about 1.5 mm. long, silky-pubescent without ; lobes spatulate or the outer ones pandurate-spatulate : filaments copiously villous below the middle : ovary sparingly pubescent at the top ; styles sparingly pubescent at the base : achenes about 5.5 mm. long.

Collected on Mt. Harvard, Colorado, August 17, 1896, by *C. L. Shear, no. 3789* (type), and on Gray's Peak, Colorado, August, 1873, by Mr. Woolson.

Related to both *Eriogonum flavum* and *E. aureum*, but differing from both of them in its longer slender base of the perianth and the glabrous, persistent leaf-bases.

Eriogonum umbelliferum sp. nov.

Perennial, with woody branching rootstocks (section *Umbellata*), bright-green. Stems represented by short caudices : leaves crowded on the caudices ; blades spatulate to elliptic or oval, 1–4 cm. long, or rarely longer, glabrous or nearly so at maturity, except the floccose-ciliate margins, slender-petioled : scapes 6–28 cm. tall, each topped with a 2–6-rayed umbel, which is subtended by a whorl of foliaceous bracts : peduncles mainly 1–2 cm. long and closely pubescent during anthesis, larger and thinly pubescent at maturity : involucres campanulate, sometimes becoming turbinate-campanulate, 2–2.5 mm. long, the lobes fully as long as the tube and strongly reflexed : calyxes yellow or sometimes red-tinged in age, about 8 mm. long at maturity, including the stipe-like base, which is 2–2.5 mm. long; lobes spatulate to oblong-obovate, the inner becoming markedly longer than the outer: filaments copiously villous from above the middle to the base: ovary sparingly pubescent at the top; styles pubescent at least below the middle: achenes about 5 mm. long, the beak fully as long as the body, which is decidedly constricted at the base.

The type was collected west of Ouray, Colorado, September 9, 1901, by *L. M. Underwood, no. 177 b.* The species is apparently common in Colorado and has been collected in two other States, viz.:

WYOMING: Fort Bridger, July, 1873, *Porter.* Elk Mt., July, 1899, *Little & Stanton 171.* Fort Steele, May and June, 1901, *Tweedy 4396.* Copperton, June, 1901, *Tweedy 4395.* UTAH: Wasatch Mts., August, 1879, *Jones 1411* and August, 1900, *Stokes.*

This species differs from its nearest relative, *Eriogonum umbellatum,* chiefly in its longer and more slender-stalked calyx and glabrous or nearly glabrous leaves.

✓ **Eriogonum Tetraneuris** sp. nov.

Perennial (section *Lachnogyna*), silvery-gray and silky-tomentose. Stems (caudices) tufted, very densely leafy, 1–4 cm. long, the older portions thickly clothed with old dilated leaf-bases: leaves crowded; blades elliptic to oblong, 1–3 cm. long, acute or acutish, paler and more densely pubescent beneath than above; petioles as long as the blades or shorter, ciliate and dilated below: scapes 1–1.5 dm. tall, conspicuously more densely pubescent near the top than below, simple or rarely branched, the branch subtended by a leaf-like bract: involucres sessile, capitate, subtended by lanceolate or triangular bracts, campanulate, about 3.5 mm. long, silky; lobes ovate, obtuse, about one third as long as the tube: calyxes lemon-yellow, about 6 mm. broad, silky without; lobes oblong or oblong-cuneate, the inner rather broader than the outer: filaments sparingly villous at the base: ovary densely pubestent; styles glabrous: achenes not seen.

Collected near Pueblo, Colorado, May 15, 1900, by *P. A. Rydberg & F. K. Vreeland, no. 6324.*

Related to *Erigonum lachnogynum* but with capitate inflorescence, and in this resembling *E. villiflorum.* The involucres are slightly longer than those of *E. lachnogynum* and the calyx-lobes are not contracted below the middle. The pubescence of the upper part of the peduncle and that of the involucres is more appressed and silky than the pubescence of *E. lachnogynum.*

✓ **Eriogonum orthocaulon** sp. nov.

Perennial with woody rootstock and caudices which are densely leafy at the ends (section *Heterosepala*). Leaves usually numerous ; blades typically oval, mostly 1–1.5 cm. long, or rarely smaller, densely felty-pubescent, but usually rather more thinly so above than beneath, terminating long curved or somewhat curled petioles : scapes mainly 1–3 dm. long, simple, floccose, each terminating in a head of several involucres, which is subtended by minute or thick-subulated bracts : involucres turbinate, sometimes angled and thus turbinate-obpyramidal, about 7 mm. long, prominently ribbed, floccose, the lobes mostly broader than long and much shorter than the tube : calyxes ochroleucous, becoming 4.5–5 mm. long, the outer sepals suborbicular to ovate-orbicular, the inner linear-cuneate to pandurate, about as long as the outer : filaments slightly pubescent at the base : ovary and styles glabrous : achenes not seen.

The type was collected at Rifle, Garfield county, Colorado, June 23, 1900, by *Geo. E. Osterhout, no. 2125.* Specimens have been collected elsewhere as follows :

IDAHO : Foothills, June, 1892, *Mulford.* Blue Lakes, June 2, 1893, *Palmer 62.* Idaho Falls, July 4, 1901, *Merrill & Wilcox 782.* UTAH : Salt Lake City, May, 1869, *Watson 1016.* ALBERTA : Crow Nest Pass, August, 1897, *Macoun 24480* and *24481.*

This species is related to *Eriogonum ovalifolium* and *E. ochroleucum*, but from both of these it may be distinguished by the large involucres.

✓ **Eriogonum coloradense** sp. nov.

Perennial (section *Capitata*). Depressed stems branched at the base ; branches tufted, 1–4 cm. long, clothed with the persistent leaf-bases : leaves crowded ; blades narrowly spatulate to linear-spatulate, 2–5 cm. long, blunt, slightly revolute, webby-pubescent above or at length glabrous, densely white lanate-tomentose beneath, except the prominent midrib, narrowed into petiole-like bases which are dilated and scarious at the base : peduncles simple, mostly surpassed by some of the leaves, relatively stout, lanuginous, the pubescence becoming floccose : involucres in heads terminating the peduncle, campanulate, about 5 mm. long, thinly woolly without ; lobes suborbicular or nearly reniform, barely one third as long as the tube: calyxes pink or pinkish, fully 4 mm. long at maturity; lobes blunt, the outer broadly ovate or orbicular-ovate, the inner smaller than the outer, oblong, the midrib vanishing below the apex: filaments slightly pubescent near the base: ovary and styles glabrous: achene 3-angled.

Collected on Mt. Harvard, Colorado, 1896, by *Frederic E. Clements, no. 66.*

Related to *Eriogonum pauciflorum*, but stouter and larger in all of its parts. The peduncles are mostly shorter than the leaves, which generally have flat instead of strongly revolute blades. The involucre of this species is narrower and much longer than that of *E. pauciflorum* and has the tube proportionally longer and the lobes proportionally shorter. The calyx too is at least one millimeter longer than that of *E. pauciflorum.*

✓ **Eriogonum nudicaule** (Torr.)

Eriogonum effusum nudicaule Torr. Pacif. R. R. Rep. **4**: 132. 1857.

Related to *Eriogonum lonchophyllum* T. & G., differing in the larger calyx, the campanulate involucre and the revolute leaf-blades.

✓ **Eriogonum scoparium** sp. nov.

Perennial, with woody rootstocks and more or less elongated caudices (section *Corymbosa*). Leaves rather few on each caudex, but sometimes apparently numerous on prolifically branched plants; blades linear to linear-spatulate, 2–5 cm. long, revolute, at least in age, densely lanate beneath, floccose above, relatively short-petioled, the sheathing bases of the petioles very densely woolly: scapes mainly 1–2 dm. tall, glabrous, glaucescent, each topped with a compound open cyme, the bracts very small, the lower ones often subulate-tipped: involucres broadly campanulate, 2.5–3 mm. long, and about as wide at the mouth, the lobes broad, decidedly shorter than the tube: calyxes pink or whitish, becoming 3.5–4 mm. long, the lobes oblong to obovate: filaments pubescent at the base: ovary and styles glabrous: achenes 2.5 mm. long.

The type was collected at Gunnison, Colorado, September 12, 1901, by *Underwood & Selby, no. 376;* other collections from Colorado are as follows: Gunnison, July 7, 1901, *Baker 254.* Denver, September, 1892, *Eastwood.*

This species may be distinguished from *Eriogonum nudicaule* and *E. lonchophyllum* by the long-peduncled involucres in the forks of the inflorescence and from *Eriogonum salicinum* and the following species by its campanulate involucres.

✓ **Eriogonum tristichum** sp. nov.

Perennial with woody rootstocks and somewhat elongated caudices (section *Corymbosa*). Leaves rather few on each caudex; blades narrowly linear, oblanceolate or linear, 2–7 cm. long, usually revolute, floccose above, densely white-woolly beneath; sheathing bases of the petioles very densely white-woolly: scapes mainly 1–3 dm. tall, glabrous, except at the base, glaucescent, each topped with a compound cyme, the bracts very small except sometimes those at the first fork of the inflorescence: involucre turbinate, 2.5–3 mm. long, decidedly longer than thick, the lobes broadly rounded, much shorter than the tube: calyxes pink or whitish, becoming 4 mm. long, the lobes obovate to oblong-obovate: filaments sparingly pubescent at the base: ovary and styles glabrous: achenes about 2.5 mm. long.

The type was collected at Rosa, Colorado, June, 1899, by *C. F. Baker, no. 286;* other specimens have been collected in Colorado as follows: Black Cañon, Gunnison, September 1888, *Parry.* Mesa Verde, September, 1892, *Eastwood.* Arboles, June, 1899, *Baker, 287.* Parlin, August, 1891, *Smith, 53. Eriogonum tristichum* differs from its nearest relative, *E. salicinum*, in its larger and relatively longer involucre and the strongly revolute leaf-blades.

✓ **Eriogonum Fendlerianum** (Benth.)

Eriogonum microthecum Fendlerianum Benth. in DC. Prodr. **14**: 18. 1856.

This species is related to both *Eriogonum corymbosum* and the following species but may be easily distinguished from either by its larger involucre.

✓ **Eriogonum divergens** nom. nov.

Eriogonum corymbosum divaricatum T. & G. Pacif. R. R. Rep. **2**: 129. 1855. Not *E. divaricatum* Hook.

Like the preceding, this species is related to *Eriogonum corymbosum*, from which it may be distinguished by the larger more prominently lobed and scattered involucres, and the stiffly spreading branches of the inflorescence.

✓ **Eriogonum fusiforme** sp. nov.

Annual (section *Pedunculata*), glaucous. Leaves spreading; blades suborbicular, 1–5 cm. in diameter, rounded or bluntly apiculate at the apex, with scattered hairs on both surfaces, or hirsute beneath, hirsute-ciliate; petioles longer than the blades, or shorter, hirsute: scapes solitary or tufted, 2–5 dm. tall, markedly inflated below the several or many inflorescence-branches: peduncles capillary, spreading, many times longer than the involucres, abruptly bent at the base: involucres turbinate, barely 1 mm. long, the lobes ovate, shorter than the tube: calyxes white or mainly so; lobes ovate, becoming 1.5 mm. long, closely pubescent: filaments glabrous: ovary and styles glabrous: achenes about 2 mm. long, the tips exserted.

Type collected at Grand Junction, Colorado, June 20, 1893, by *De Alton Saunders;* the species is also represented by the following specimens:

COLORADO: Palisade, May 29, 1894, *Crandall.* UTAH: St. George, 1877, *Palmer 434.* Bluffs near Green River, June 15, 1901, *Stokes.* ARIZONA: Peach Springs, June 28, 1887, *Tracy & Evans 315.*

This species differs from *Eriogonum inflatum*, its nearest relative, in the much smaller turbinate and few-flowered involucres and the usually numerous large and divaricate accessory inflorescence-branches.

Polygonum buxiforme nom. nov.

Polygonum littorale Small, Mem. Dept. Bot. Columbia Coll. **1** : 102. (excl. synon.) 1895. Not *P. littorale* Link.

Polygonum rubescens sp. nov.

Perennial or sometimes annual, glabrous, bright-green. Stems ultimately branched at the base and above it, the branches ascending or spreading, 1–5 dm. long, striate: leaves scattered; blades thickish, narrowly oblong to elliptic or nearly linear, mainly 1–2.5 cm. long; ocreae silvery, or brown at the base, at length lacerate: flowers usually several in a cluster: calyxes becoming 3 mm. long; lobes with whitish or pinkish margins: achenes triquetrous, 2–2.5 mm. long, dull and distinctly granulate or striate.

Type collected in sandy soil at Parlin, Gunnison County, Colorado, August 16, 1901, by *B. H. Smith, no. 55;* other specimens belonging here are as follows:

COLORADO: Larimer County, June 17, 1895, *Cowen.* IDAHO:

Kootenai County, August 26, 1892, *Sandberg, MacDougal & Heller 966*. NEVADA: Unionville, September 1867, *Watson 1055*.

A species related to *Polygonum ramosissimum*, from which however it differs in the smaller whitish or pinkish margined calyx-lobes and the smaller and rougher achene.

Persicaria omissa (Greene)

Polygonum omissum Greene, Pittonia **5**: 200. 1903.

This species is known from both Kansas and Colorado.

Bistorta bistortoides (Pursh)

Polygonum bistortoides Pursh, Fl. Am. Sept. 271. 1814.

Polygonum Bistorta oblongifolium Meisn in DC. Prodr. **14**: 126. 1856.

This species of *Bistorta* is common in the mountains of Colorado and also in the neighboring states.

NEW YORK BOTANICAL GARDEN.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1905)

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

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

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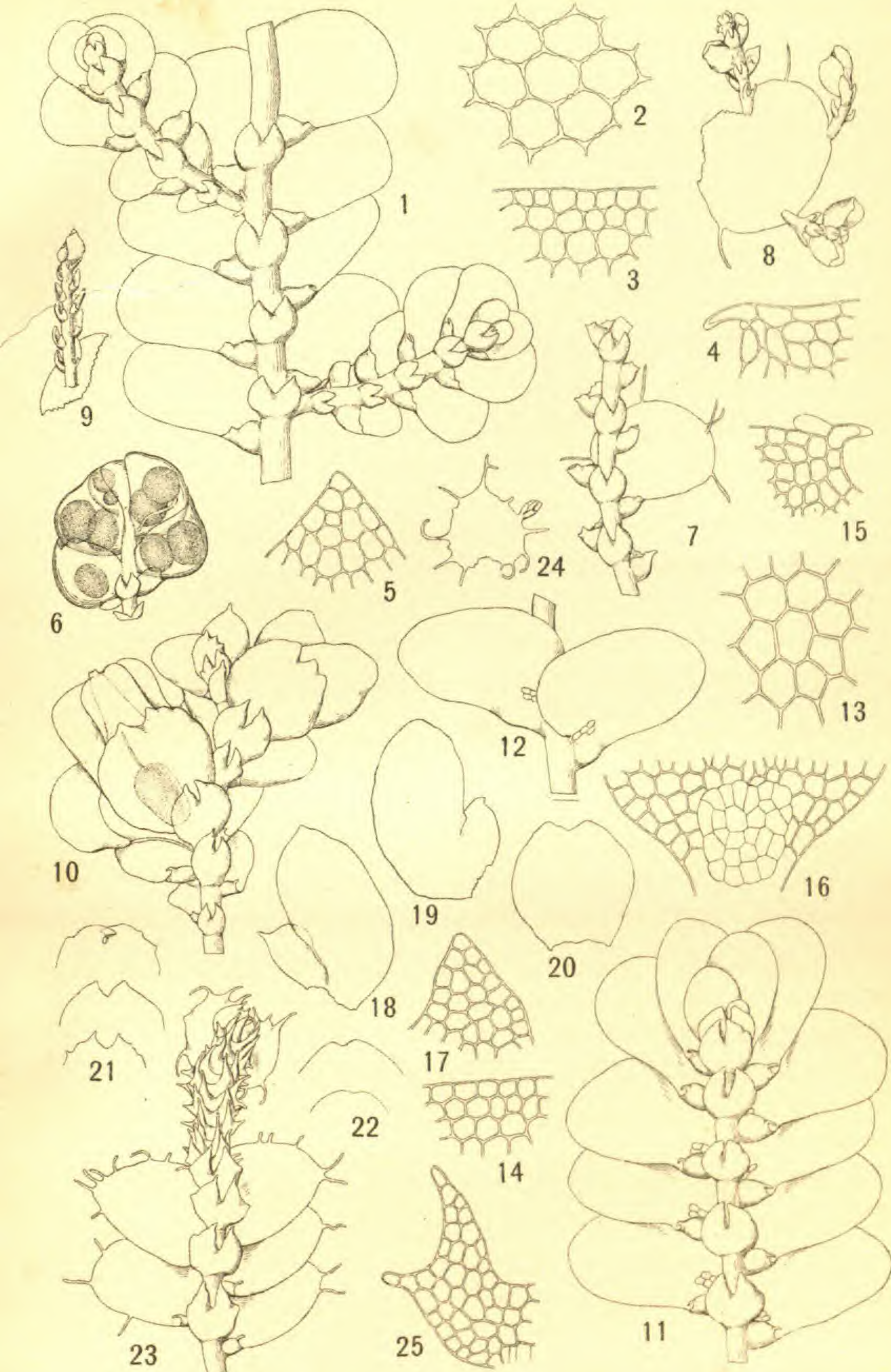

1-9. CHEILOLEJEUNEA DECIDUA (Spruce) Evans

10-25. RECTOLEJEUNEA FLAGELLIFORMIS Evans

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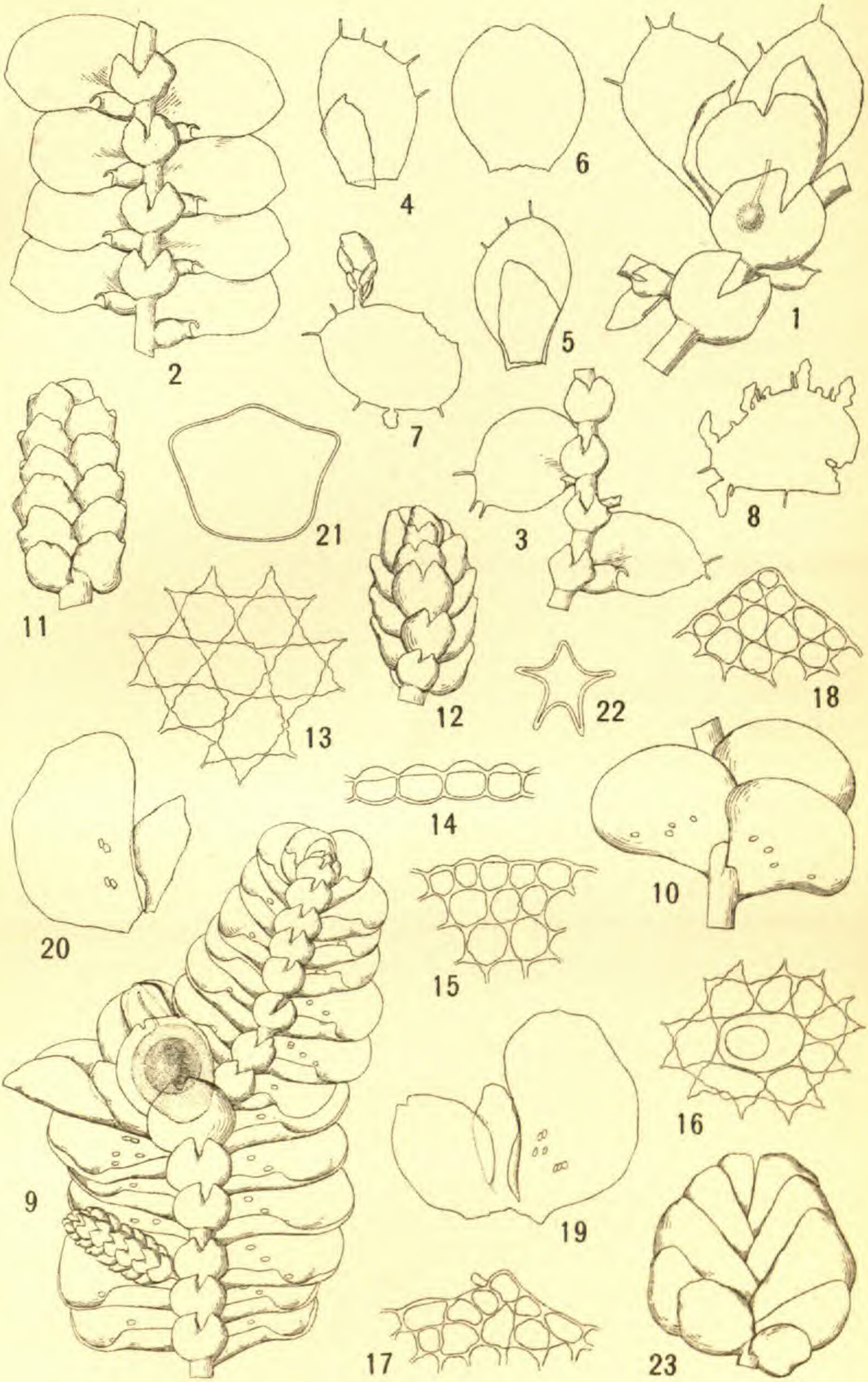

1-8. RECTOLEJEUNEA EMARGINULIFLORA (Gottsche) Evans

9-23. PYCNOLEJEUNEA SCHWANECKEI (Steph.) Schiffn.

CYSTOLEJEUNEA LINEATA (Lehm. & Lindenb.) Evans

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BULLETIN

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FEBRUARY, 1906

Studies in etiolation

AUGUSTINE DAWSON SELBY

(WITH PLATES 4 AND 5)

During the winter of 1902–1903 the writer carried on certain studies of the effects of etiolation upon several species of plants in the laboratories of the New York Botanical Garden. Most of the species studied were latex-bearing sorts. Owing to the press of regular duties, and to ill health, the publication of the results has been long delayed — far too long, indeed. It seems, however, worth while to present them briefly at this time. An announcement of the results obtained with *Persea* was made before the Botanical Society of America at its Washington meeting, January 1, 1903.

Seedlings of the Alligator pear (*Persea gratissima*) were grown in a dark room and propagating houses of the Garden, toward the end of 1902. At the end of ten weeks the normal and etiolated plantlets had developed stems approximately equal in length (about 45 centimeters) which consisted of 17 and 19 internodes respectively (plate 4, figure 7). The variation in the length of the internodes of the normal plantlets was slightly greater than with the etiolated. No acceleration was shown in rate of growth by the etiolated plants, nor was the total amount of growth greater than in the normal. The stem-diameters were nearly the same in both cases. All the leaves of the etiolated stems were bract-like and rudimentary (plate 4, figures 3 and 4); these did not advance beyond a certain stage of 10 mm. in length, with blades 5 x 2 mm., when they withered and dropped off. These rudiments seem generally comparable with the rudimentary organs borne on the basal

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[The BULLETIN for January 1906 (33: 1–66, *pl. 1–3*) was issued 8 F 1906.]

portions of the normal stems. At the end of the period of growth studied, four weeks later, the thick cotyledons of the normal specimens were very much shrunken, discolored and decaying, while those of the etiolated plants were bright, plump, and yet retained reserve material. The contrast in this depletion of stored food was quite clear. An examination of the roots was made at the end of fourteen weeks and the total length of the roots of the etiolated plants was found to be about half that of the normal. The crowded and entangled growth of the roots of the normal plant was in marked contrast to that of the etiolated. A number of buds on the basal portion of the etiolated stems, including those axillary to the cotyledons, started into activity, but those of the normal stem remained dormant.

The cross-section of the middle portion of the normal stem (plate 4, figure 1) showed a fairly well developed woody cylinder about 300 μ thick, with definite cambium and numerous vessels in the wood. The bast-bundles were 48 in number, composed of lignified cells with laminae 3.5–4 μ thick, interspersed at times with unlignified, thin-walled cells; occasionally these latter contained chloroplasts. Usually the secondary bast-bundles were fairly well developed. The remaining cortex consisted throughout of thin-walled cells with a layer of more highly colored cells just without the bast, the whole covered by the unmodified epidermal cells. The cells of the pith frequently contained starch and the perimedullary ring was gorged with starch, as were also the medullary rays. The region of highly colored chloroplasts constituted also a well-marked starch ring at the base of the normal stem.

The cross-section of the etiolated stem (plate 4, figure 2) showed a woody cylinder 150–250 μ thick, consisting of slightly lignified cells, with less conspicuous cambium and with fewer and slightly smaller vessels in the wood. The bast consisted of the same number of bundles but with very slight development of the secondary bundles; the walls were thinner than in the normal and less lignified. The cortex contained fewer chloroplasts than the normal, while the two outer layers of the epidermal system were more or less collapsed and were underlaid by a well-marked hypodermal phellogen. The pith-cells of the etiolated stem were larger than in the normal, while the same gorging of the stems with starch grains was noted in the perimedullary region and in the medullary rays. The earlier formation of phellogen in the etiolated stem may be interpreted as an adaptation to prevent drying out; this phellogen was present near the summit of the etiolated stem. This precocious phellogen formation, in this case with the early collapse of the epidermis, is similar to that observed by MacDougal in *Acer* and *Cornus.**

Etiolated specimens with stems 50 to 60 cm. in length were brought into diffuse illumination near a window and in two months made an additional elongation of about 5 cm. The terminal newly formed portions of such stems bore about 7 normal leaves, with 8 or 10 internodes immediately below still retaining the bract-like organs resulting from etiolation (plate 4, figure 5). The lower portion of the stem, in which precocious development of phellogen had taken place, retained its brown color but was not extended, while the entire upper portion of the stem had become green. Young stems which had made but little growth in darkness made much more rapid growth than that described above for the older stems, and developed an equal crown of normal leaves.

The leaves of the normal plant (plate 4, figure 6) showed a single layer of palisade-cells and no stomata on the upper surface, as before noted by Solereder. † The petioles showed definite cambium, but the vessels gave no lignin reaction. The bract-like hairy leaves of the etiolated plant (plate 4, figures 3 and 4) showed no cambium in petioles, no stomata and no further differentiation of the tissues than an indistinct row of palisade cells, whose length and width were nearly equal.

Rootstocks of *Euphorbia corollata* obtained from Ohio, were also grown in light and darkness under conditions similar to those for *Persea.* No essential difference in the rate of growth, or in the total amount of tissue produced, was observed as between the normal and the etiolated growths of *Euphorbia* (figures *A* and *B*). There was noticeable variation in the thickening of the etiolated stems due to an increase of cortex by activity of the cambium layer.

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* MACDOUGAL, D. T. The influence of light and darkness upon growth and development (Mem. N. Y. Bot. Gard. 2:) 97–100, 188–190. 1903.

† SOLEREDER, H. Systematische Pflanzenanatomie 774. 1900.

The determination of the water and dry matter in the stems of these specimens gave the following results:

DRY SUBSTANCE IN STEMS OF *Euphorbia corollata*

	Normal plant per cent.	Etiolated plant per cent. I	II	Average.
Water	86.90	91.11	89.63	90.37
Dry substance	13.10	8.89	10.37	9.63

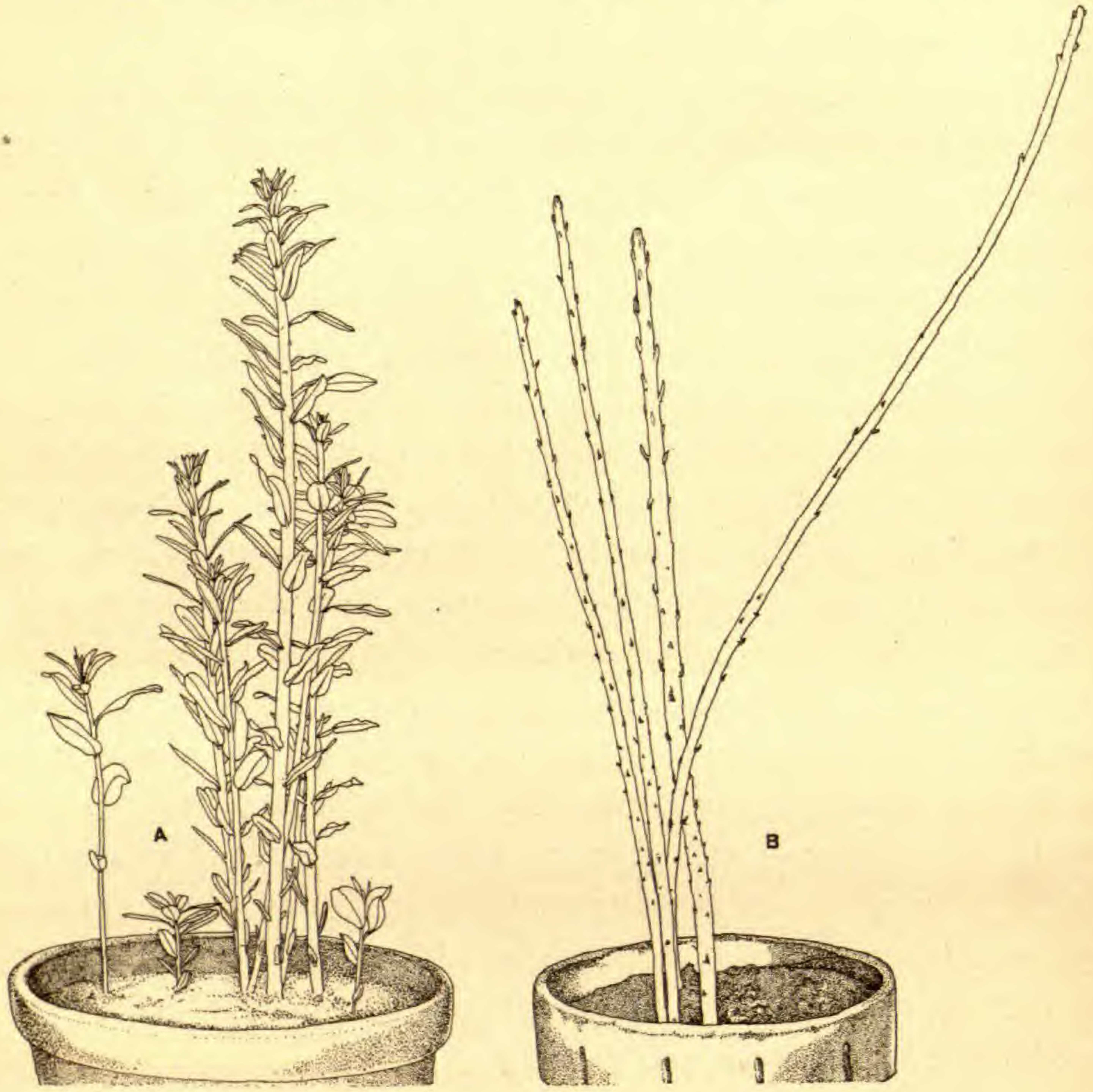

FIGURE A. Normal plant of *Euphorbia corollata*.
FIGURE B. Etiolated plant of *Euphorbia corollata*.

A transverse section of the stems showed (plate 5, figure 1) in the normal a rather feeble development of the strengthening tissue and a cambium of several layers of short cells. The woody parts of the cylinder were irregularly and feebly developed, bringing the groups of vessels into great prominence. The etiolated stem, as before stated, showed (plate 5, figure 2) a tendency to develop cortical parenchyma and the woody portion scarcely less developed than in the normal. These differences will be evident in the illustrations (plate 5, figures 1 and 2). Referring to the analysis it is observed that the increase in the thickness of the etiolated stems has not been accompanied by any considerable increase of solid matter and that the etiolated plant contains about 3½ per cent. more water than the normal. These results are in harmony with those previously obtained by others.

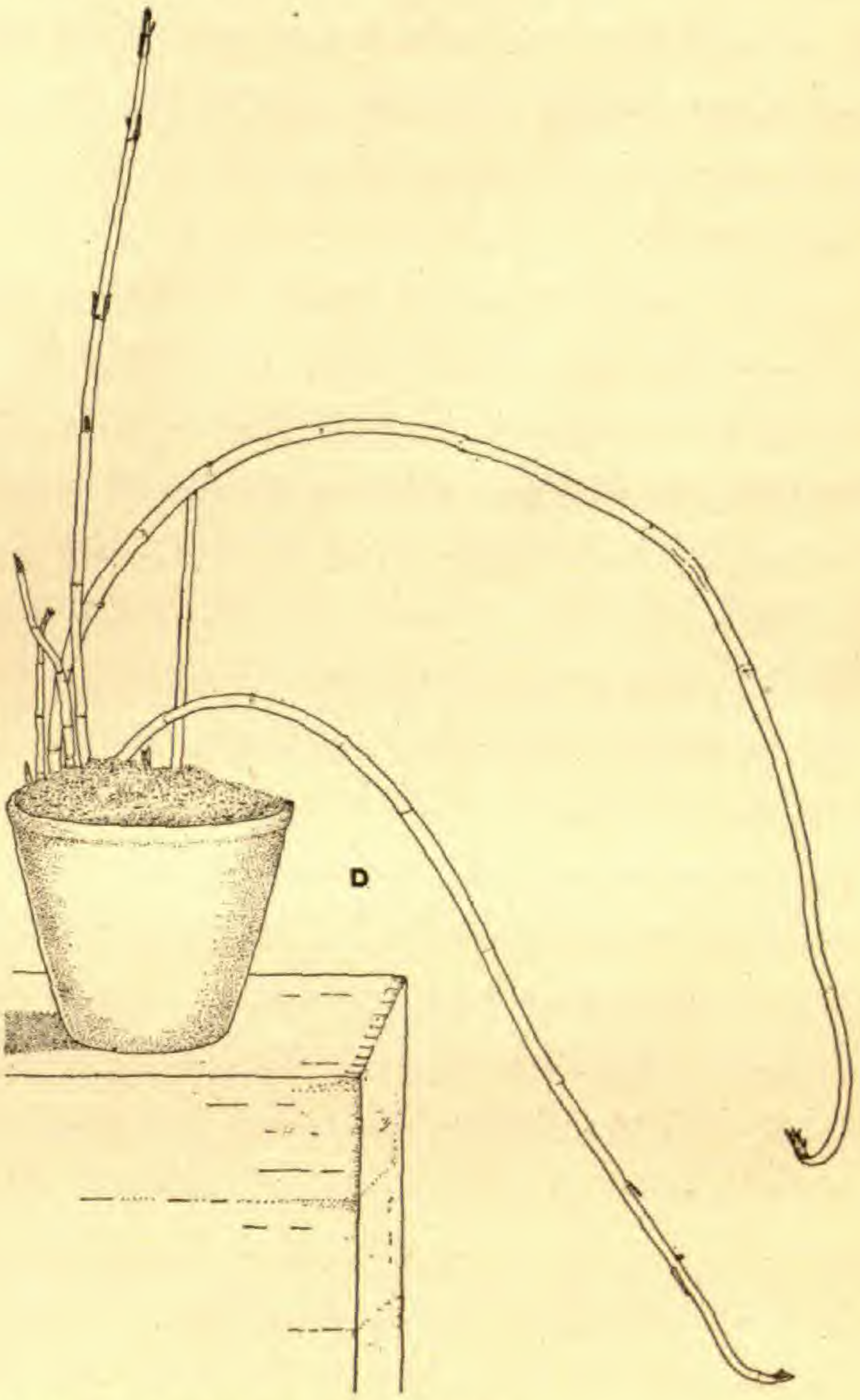

FIGURE C. Normal plant of *Asclepias incarnata*.
FIGURE D. Etiolated plant of *Asclepias incarnata*.

Roots of *Asclepias incarnata* were likewise collected at Wooster, and plants grown from them in the etiolating chamber and the propagating house of the New York Botanical Garden. The etiolated plants of this milkweed started to grow earlier than the normal, and produced longer stems (figures *C* and *D*). These developed as many as 13 or 14 internodes, with a length varying between 5 and 12 cm. The lower axillary buds of the etiolated plants showed a tendency to start into activity during the growth of the main stem. The leaves were dropped from the etiolated stems, so that when the examination was made none were found below the tenth or twelfth internodes from the base; although in a few instances bract-like organs formed on lower internodes were retained for a long time. Normal stems of the same age produced but 7 to 9 internodes with an average length of 3–4 cm. It would appear from these facts that the abnormal length of the etiolated stems of this plant is due both to the exaggerated growth of the internodes and to the actual multiplication of the internodes.

The anatomical features present some interesting comparisons which may be studied by reference to the figures. In the etiolated stems (plate 5, figure 6) the cambium included four or five layers, while the woody cylinder and the bast-cells were less strongly developed than in the normal, as might have been expected. In the middle of the normal stem it was noted that the bast-sheath was more nearly continuous than at the base; a like condition, though less strongly marked, was also observed in the middle of the etiolated stem. In one instance an etiolated stem had become nearly prostrate by its own weight, and the apical portion had responded by an apogeotropic curvature which brought the tip into an erect position. Little difference could be detected in the structure of the central cylinder of these stems with respect to the convex sides, but the bast-fibers, scarcely differentiated on the convex side, were developed as well-marked strands composed of colums of two or three dozen cells in cross-section upon the opposite or concave side. This seems to show that while stretching tension might induce the development and differentiation of this tissue, the absence of stress, or positive compression resulted in the non-differentiation. Similar effects have been noted in special investigations, by various workers, dealing with the effect of compression and tension upon the mechanical tissues. Determinations of water were made in the normal and etiolated stems of this plant with the following results:

DRY SUBSTANCE IN PLANTS OF *Asclepias incarnata*

	Normal plant per cent.	Etiolated plant per cent. I	II	Average.
Water	86.58	91.83	91.57	91.70
Dry substance	13.42	8.17	8.43	8.30

Here we have wider divergence amounting to more than 5 per cent. difference in the dry substance of the normal above that of the etiolated stems.

Rootstocks of *Euphorbia Cyparissias* were brought from Wooster, Ohio, to the New York Botanical Garden, and after these had shown signs of activity were placed in suitable pots and some exposed to light while others were placed in the etiolating chamber, on March 20, 1903. The new stems were one to two cm. in height although none had formed chlorophyl to any noticeable extent. One month later the stem-lengths of the normal and etiolated plants were respectively 8 to 10 cm. for the normal and 6 to 8 cm. for the etiolated. It is evident that this plant does not support the assumption that light exercises an actual retarding effect upon growth.

Roots of *Apocynum cannabinum* were lifted and potted in November, 1902, and at this time duplicate pots were placed in the dark chamber and in the propagating house of the Garden; a large number of duplicates were cared for in the propagating house. The plants showed little tendency to make early growth in either situation. Toward the end of April, 1903, shoots began to appear on the plants in the dark chamber and a corresponding plant was set aside in the propagating house. In June, 1903, measurements were kindly taken by Dr. W. A. Cannon, laboratory assistant at the New York Botanical Garden. The etiolated plants attained a height of about 30 cm., while the normal specimens made no marked growth after having been set aside in April.

Similar results to those of *Apocynum* were obtained with roots of *Asclepias syriaca.* In this case the etiolated specimen attained a height of 30 cm. while the normal plant attained a length of but 5 to 6 cm., development being arrested for some reason.

Interpretation of results

It is evident from the foregoing that the phenomena of etiolation are not in themselves to be regarded as of a useful adaptive character, as put forward by many writers on the subject. In some instances it is conceivable that the undue elongation of stems that ensues might serve the useful purpose of carrying the apical part of the stem with its leaves past an obstruction intercepting the light, but a census of the species which have been subjected to etiolation by MacDougal and others shows that less than half exhibit such elongations.

An important correlation-reaction is shown by the basal buds of etiolated stems. Numbers of such buds usually dormant are awaked in darkness and develop stems.

None of the facts derived from the study of the behavior of etiolated plants may be construed to indicate that light exercises a retarding effect on growth, however. If such a conclusion is to be maintained it must be justified on other grounds beside the results of studies of the action of plants in darkness.

A consideration of the structure of the plants studied in the work described above leads to the conclusion that when grown in darkness the tissues do not attain full development and that the differentiations by which the separate tissues are distinguished appear to be carried out only partially or not at all. The degree of incompleteness depends to some extent upon the organographic relations of the structures taken into consideration. This failure in the perfection of the tissues, which may even include their non-appearance, is very naturally coupled with a prolonged growth of the meristematic cells which by repeated division may thus increase either the thickness or the length of a stem.

Directly and indirectly, light seems to exert a stimulative effect upon the morphogenic processes leading to the differentiation of the tissues. If an etiolated shoot is brought into illumination, the portions in which the embryonic tissue has not gone beyond a certain age carry on development approximating the normal. Older etiolated tissues may form chlorophyl or undergo additional thickening of the walls, but no other differentiations in form are possible.

The formation of prosenchymatous cells in the concave side of a geotropically curving stem of *Asclepias*, in which they were lacking from the opposite convex side, is an excellent example of pure mechanical induction. In normal stems the development must set up, through the tension of the various tissues of the stem, stimuli which would induce the formation of prosenchyma regardless of the action of light. Now in the etiolated stem the bast-strands seem to be induced only by the bending strains exerted on the stems by their tendency to fall over, and the stresses throughout the stem are otherwise equal, being simply those arising from turgidity. When such a stem is laid in a prostrate position and the embryonic cells of the apical portions of the stem produce a curvature in making an adjusting response, the stretching tension set up in the concave side of the stem acts as a stimulus inducing the formation of the mechanical tissue as described.

The writer wishes to express his great obligations to Dr. D. T. MacDougal, Director of the Laboratories of the Garden, for material aid and constant encouragement in the course of this work, and to make further acknowledgment of special assistance in the interpretation of results. The illustrations are chiefly from drawings made by A. Mariolle, of the Garden, to whom his best thanks are due.

OHIO AGRICULTURAL EXPERIMENT STATION.

Explanation of plates 4 and 5

PLATE 4

Persea gratissima

FIG. 1. Portion of cross-section of middle of stem of normal plant.

FIG. 2. Portion of cross-section of middle of stem of etiolated plant.

FIGS. 3, 4. Bract-like hairy leaves of etiolated plant, × 4½.

FIG. 5. Etiolated 10-weeks' seedling (same as figure 7), after two months' illumination, about one-fifth natural size.

FIG. 6. Leaf of normal plant, about one-half natural size.

FIG. 7. Etiolated 10-weeks' seedling, about one-fifth natural size.

PLATE 5

Euphorbia corollata

FIG. 1. Portion of cross-section of stem of normal plant.

FIG. 2. Portion of cross-section of stem of etiolated plant.

FIG. 3. Leaf of normal plant, two thirds natural size.

FIGS. 4, 5. Leaves of etiolated plant, × 1⅓.

Asclepias incarnata

FIG. 6. Portion of cross-section of middle of stem of etiolated plant.

FIG. 7. Portion of cross-section of middle of stem of normal plant.

FIG. 8. Portion of cross-section of concave side of curved stem of etiolated plant.

FIG. 9. Portion of cross-section of convex side of curved stem of etiolated plant.

FIG. 10. Leaf of etiolated plant, × 1⅓.

Studies on color in plants*

HENRY KRAEMER

The subject of color may be viewed in a number of ways. The physicist considers colored substances in their relation to light, and defines color as due to the influence which the substance has upon the vibration of the ether-waves and as dependent upon physical conditions. The chemist is interested in the constitution and composition of the colored substance, while the biologist is concerned with its origin and the role which it plays in metabolism or the life-processes of the plant or animal. The nature of *color in plants and animals* is more or less distinct, and while a number of animal pigments have been isolated, as cochineal and lac-dye, the color effects in animals are due largely, especially in the plumage of birds, to physical structure, *i. e.*, light interference phenomena or the dispersion of light rays. While structural arrangement in plants has also an influence on the color effects, still the colors in plants are usually looked upon as being due to distinct chemical principles without special reference to physical structure.

Upon making a section of some colored tissue of the plant, we find cells containing two or more of the following substances. In the first place there is in the living cell a semi-fluid, viscous, granular or foam-like substance known as *protoplasm*, of which, as regards its chemical composition and function, we know little more than when it was first described by von Mohl in 1846. This lies either close to the walls of the cell, forming a relatively thin layer or lining, which encloses a large vacuole of cell-sap, or it may be distributed in a mesh-work, forming smaller vacuoles. Within the protoplasmic mass we find a differentiated body known as the *nucleus*, and in recent years much of the work done by biologists has been devoted to a study of this body. There are in addition other protoplasmic bodies found in the plant cell, known as *plastids*,

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* Read before the Torrey Botanical Club, with illustrations and demonstrations, December 12, 1905. More complete details of the work will be given in future issues of this BULLETIN.

which are much smaller than the nucleus and are distributed through the protoplasm in relatively large numbers. Of these there are two distinct groups, one containing a green pigment, which gives the green color to leaves, known as the *chloroplastid*, and the other containing a yellow pigment, which gives the yellow color to yellow flowers and fruits, known as a *chromoplastid*. In the vacuoles already referred to occur various coloring principles which are dissolved in the cell-sap and which give the various colors other than yellow to flowers and fruits, as blue in the violet or plum, red in the carnation, rose or apple, etc.

PLASTIDS AND PLASTID COLOR-SUBSTANCES

Regarding the structure of the plastids we know but very little. In all cases they consist of a protoplasm-like substance in which is held either mechanically or in chemical combination the green or yellow coloring principle. The *chloroplastids* in addition contain starch-grains, which are considered to be manufactured by the chloroplastid under the influence of sunlight from water and the carbon dioxide of the air; they may also contain proteid substances and oil. While the protoplasm has been termed by Huxley "the physical basis of life," this little chloroplastid, but the one five-thousandth of an inch in diameter, has been spoken of as the mill which supplies the world with its food, for it is by the process of photosynthesis that the energy of the sun is converted into vital energy, and starch and other products formed, which become not only the source of food for the plant itself, but also the source of the food-supply of the animals which feed upon plants. In other words, horse-power is derived from the energy of the sun which is stored by the chloroplastids in the plant.

In the *chromoplastid*, on the other hand, there are usually present, as first pointed out by Schimper and Meyer, protein substances in the form of crystal-like bodies; starch-grains may also be present. The chromoplastids are very variable in shape and in other ways are markedly different from the chloroplastids. They are more unstable than the chloroplastids, are formed in underground parts of the plant, as in the root of carrot, as well as in parts exposed to the light, as in the flower. Their formation frequently follows that of the chloroplastids, as in the ripening of certain yellow fruits, such as apples, oranges, persimmons, etc.

The *plastid pigments* are distinguished from all other color-substances in the plant by the fact that they are insoluble in water and soluble in ether, chloroform and similar solvents. This seems to be a wise provision, as it probably prevents the diffusion of these principles in the more or less aqueous cell-sap. These plastid pigments are but little affected by the usual chemical reagents under ordinary conditions.

Apart from the difference in color, the yellow pigment is distinguished from the green by the fact that the latter is said to contain nitrogen, and also by their difference in behavior when examined spectroscopically, chlorophyl giving several distinct bands in the yellow and orange portion of the spectrum, which are wanting in the spectrum of the yellow principle.

The leaf-buds of the skunk cabbage are quite large, consisting of numerous leaves. The innermost leaves are of a distinct yellow color. A microscopical examination of these shows that the color is due to a plastid which is very much smaller than the chloroplastids or chromoplastids found in the fully developed leaves and flowers of the plant. This plastid occurs in the palisade cells and contains neither starch nor proteid substances, and the yellow pigment appears to be somewhat similar to that found in chromoplastids, but differs in this, that on reducing with zinc it becomes slightly greenish. This plastid, which I have provisionally termed an *etioplastid* (and the pigment *etiophyl*), appears later, with the development of the leaf, to be transformed into a chloroplastid, whereas just the reverse takes place with chromoplastids, that is, they may be derived from chloroplastids. I may further say with regard to the pigment etiophyl, that on purification and treatment with zinc it appears to be entirely distinct from chlorophyl when viewed both by transmitted and reflected light and when examined by means of the spectroscope. It is also characterized by its greater stability even when exposed to light, and may be partly separated from chlorophyl in an alcoholic solution (85 per cent. alcohol) by means of benzin. An interesting observation which I have made in this connection is that when leaves of skunk cabbage containing both etiophyl and chlorophyl are extracted with alcohol, purified, and reduced with zinc, the resulting solution is a deep green and retains this color.

CELL-SAP COLORS

All the other color-substances found in plants besides the green and yellow principles just mentioned occur in the cell-sap, and may be in the nature of secondary substances derived from the plastid pigments, or they may be produced directly by the activities of the protoplasm. During the course of my work I have been much impressed by the fact that in tissues containing cell-sap color-substances, or as they might be termed *unorganized color-substances*, not infrequently strikingly contrasting colors are observed in contiguous cells; as in the petals of the poppy and petals of certain lilies, where we find some cells of a deep-purple, others of a deep-red and still others of intermediate shades. The same may be said of the germinating kernels of black Mexican corn. This observation has led me to believe that the shades of color in the pigmented cells are largely dependent upon the nature of the substances associated with the fundamental color-substance. The unorganized color-principles are easily extracted with water or dilute alcohol. I have examined the principles from several hundred plants, and find that they are all more or less affected by certain chemicals (many of which occur naturally in the plant), such as citric acid, oxalic acid, salts of calcium, iron, aluminum, etc.

A solution of the mallow flowers of the garden is of a purplish-red color and becomes green with lime water; deep-red with oxalic acid; purplish-red with alum; and deep brownish-red with ferric chloride.

A solution of rose petals (J. S. Fay) is of a more or less light-brown or pale yellowish-red color and becomes pure green with lime water; deep yellowish-red with oxalic acid or citric acid; purple with alum; and deep-blue with ferrous sulphate.

These reactions show that these color-substances are quite sensitive to the influence of chemicals, and many of them correspond to the class of substances known as indicators; in fact a number of plant pigments are used as indicators in volumetric chemical analysis, their use in this connection being dependent upon their sensitiveness to acids and alkalies. The fact that they respond to iron salts, that is, give a blue or green reaction with these salts, would indicate that they are associated with tannin or that they are tannin-like compounds, as has been supposed by some writers. It may therefore be of interest to compare the reactions of tannin with those already given.

A solution of tannin, which is colorless, produces no color with lime water, with acids, or with alum; becomes deep-blue with ferrous sulphate, which is rather characteristic, and reddish-brown with alkalies. It is thus seen that tannin behaves very differently toward these reagents except in the case of iron salts.

An examination of the color-substances of a large number of plants shows that the flower color-substances are distributed in all parts of the plant. For example, the flower color-substance of the rose occurs in the leaves and prickles as well as in the petals, and this substance can be readily separated from the chlorophyl associated with it in the leaves by treating an alcoholic extract of the leaves with benzin.

In an alcoholic extract which has been so treated, the benzin layer at the top contains the separated chlorophyl and the alcoholic layer at the bottom contains the flower color-substance, which becomes more distinct by the addition of reagents.

The color-substance in the root of the radish closely corresponds to that in the flowers, and the color-substance in the grains of black Mexican corn corresponds to that in corn silk.

An extract of black Mexican corn shows reactions with chemicals closely resembling those obtained with various flower color-substances, as of rose.

The solution of black Mexican corn, which is of a reddish-purple color, rapidly changing to purplish-red, becomes green with lime water; red with oxalic acid; purple with alum, which is quite pronounced; and distinct blue with ferrous sulphate.

The cell-sap color-substances are usually found in greatest amount at the tips of the branches, this being well marked in the foliage of the rose, and may be said to be rather characteristic of spring foliage. Not infrequently in the purple beech the young leaves will be of a distinct purplish-red color and almost entirely free from chlorophyl, suggesting a correspondence in position and color to a flower.

The results of my work further seem to show that there is a fundamental cell-sap color-substance which occurs in two modifications in the plant, one becoming yellowish-red and the other purplish-red with acids. These two modifications may occur in the same part of the plant, as in the petals of the poppy, or in widely separated parts, as in radish, where the substance which becomes yellowish-red with acids occurs in the root, and the one which becomes purplish-red occurs in the flower.

Inasmuch as these two modifications behave in addition differently toward other reagents, they might be said to show an analogy to some of the sugars, as well as other substances, of which two modifications occur.

The existence of two modifications of the fundamental cell-sap color-substance is well exemplified in the case of roses, some fifty sorts having been examined. The color-substances extracted from deep-red or crimson roses give a yellowish-red color with mineral acids, a deep-blue or purple with potash-alum, ferric chloride or ammonio-ferric alum. The solutions obtained from pale-red or pink roses give a purplish-red with mineral acids, a pale-purple or pale purplish-brown with potash alum, and olive-green with ferric chloride or ammonio-ferric alum. With some of the hybrid tea roses and some of the yellow roses intermediate tints are obtained by the use of these reagents corresponding to the colors in the parent plants.

Color in autumn leaves

The coloring matters in both spring and autumn leaves closely resemble the cell-sap color-substances of flowers, although it is the spring leaves which give the most satisfactory results. The fact that in the autumn leaves there is little or none of the plastid pigment present would point to the conclusion that the color-substances occurring in these leaves are in the nature of by-products and of no further use to the plant. Of course in the case of autumn leaves we know that these products cannot be further utilized, and for this reason we are justified in regarding them as waste products.

Color in marine algae

The marine algae offer interesting material for the study of vegetable color-substances, and probably will be found to throw some light on the subject of the origin of color in plants. The plastids are numerous, constituting a large proportion of the components of the cell. They are variously colored, being red in the red algae, brown in the brown algae, etc. The color-substances are more or less difficult to extract. The *chlorophyl* can be extracted by the use of absolute or 95 per cent. alcohol, except in the case of some of the more delicate red forms like *Griffithsia*, *Dasya*, *Grinnellia*, *Callithamnion*, *Agardhiella*, etc., where it is necessary to place the material direct from sea-water into a saturated solution of sodium chloride and afterwards treat with alcohol.

While the *red and brown color-substances* are for the most part difficult to extract, still some of them can be extracted quite easily with water or dilute alcohol, and these show an analogy in their behavior toward reagents to the cell-sap color-substances of the higher plants.

It would appear from a microscopical study of the marine algae that all the color-substances arise in the plastids. The difficulty in extracting these substances in most cases leads to the supposition that either owing to the composition of the plastid or of the cell-sap, the color-substances are held by the plastids and not diffused in the cell-sap as in the higher plants, *i. e.*, the cell-sap color is held in the vacuolules of the plastids.

PRESERVATION OF PLANT SPECIMENS

The fact that the red and brown coloring substances of these marine algae were held back or rendered insoluble by the use of a saturated solution of common salt, suggests the use of this solution as a preservative of not only marine algae, but also of fruits, flowers and vegetables for study or exhibition purposes. Specimens have been preserved in this manner, some of them for more than a year. I may add, however, that not all specimens can be preserved with salt solution.

EXPERIMENTS IN CONTROL OF COLOR IN PLANTS

That the color in plants is influenced by a number of factors, including light, temperature and soil, is well known. One of the most common examples showing the influence of light is furnished by certain sorts of apples, those portions of the fruits exposed to the direct sunlight being most highly colored. The influence of temperature on the color of plants is also illustrated by the highly colored red apples of higher latitudes. It is a matter of general observation that the intensity of color is in direct ratio to the amount of sunlight and coolness of temperature, that is, of course, within certain limits. On the other hand, high temperature and diminution of light tend to decrease the intensity of color. The combined effect of sunlight and coolness of temperature is also seen in the foliage of the plants of alpine regions and higher latitudes, as well as in the spring and autumnal foliage of plants in the temperate regions.

The supposition that certain constituents of the soil perceptibly modify the color of plants probably dates from the experiments of Risse, who found that the so-called "zinc-violet," a blue-flowered form of *Viola lutea* (one of the alpine violets of Europe), grows in a soil containing 20 per cent. of zinc oxide, and that the ash of the plant contains as much as 1 per cent. of zinc oxide. The fact that this "zinc-violet" maintains the blue color when transferred to a soil which does not contain zinc, together with the fact that the color varies when grown in a soil containing zinc, led Hoffmann to conclude that the presence of zinc had no influence on the color. On the other hand, it is commonly supposed that the blue color of hydrangea is due to the addition to, or presence in, the soil of certain chemicals, as alum or iron filings. It is also a common practice among rose growers to treat the soil with a solution of copperas or ferrous sulphate (approximately 1 part of salt to 1,000 parts of water) in order to intensify the color of red roses. But curiously, the same treatment appears to decrease the intensity of color in the pale-red roses.

The fact that plant color-substances are modified to a greater or less extent by certain chemicals, as already indicated, led to the idea that it might be possible to influence the color-substances in plants by feeding the plants with chemical substances. The creation of color-principles is quite another problem.

During the past year I have been experimenting with roses, carnations and pansies, using the following chemicals: Acetic acid, citric acid, malic acid, phosphoric and other acids; various iron salts, as the acetate, citrate, chloride, sulphate, etc.; certain aluminum salts, as sulphate, phosphate, and the double salts of aluminum and potassium sulphate and aluminum and ammonium sulphate; ammonia water, potassium hydrate, ammonium nitrate, potassium nitrate, potassium iodide, iodine, potassium cyanide, etc. These chemicals were supplied to the plants through the soil, beginning with a strength of 1 part of chemical to 10,000 parts of water. The strength was gradually increased until that of 1 part of chemical to 1,000 parts of water was reached. It was found that most of these chemicals could be supplied in this strength every five days for some months without injury to the plants. In other words, each plant could be supplied with 75 milligrams of chemical every five days without injury. With the exception of solutions of iodine and potassium iodide, and of potassium cyanide, it was found that a plant in a six-inch pot could be supplied with as much as 300 milligrams of chemical, an equivalent of 150 c.c. of a solution containing 1 part per 500 every five days. It was also found that plants growing in garden soil could be treated with a stronger solution of chemical than those growing in either sand or artificial soil. Plants which would stand treatment with a solution of potassium cyanide, 1 part to 1,000 parts, when growing in garden soil, were killed by a solution of this strength when growing in sand or an artificial soil.

RESULTS OF COLOR-CONTROL EXPERIMENTS

So far as I have been able to see, the treatment with the color-control solutions has not produced any marked effects. Some slight changes have been noted, but these could perhaps be ascribed to other causes as well as to the solutions. For instance, it was noted that in yellow roses supplied with aluminum and potassium sulphate the leaves and stems were slightly reddish and the flowers a deeper yellow than others, while those supplied with potassium hydrate were paler than the type. In the case of the La France rose plants supplied with iron citrate and citric acid the petals were of a uniform pink color.

The inner petals of plants supplied with iron malate and malic acid were pale in color, while the inner petals of plants which were supplied with either formic acid, ammonium nitrate, or iron salicylate and salicylic acid were of a deep-pink color. In the case of maroon roses, the petals tended to a deep purplish-red when treated with potassium cyanide or potassium nitrite; to a dark-red when supplied with phosphoric acid, iron and ammonium sulphate, or sulphuric acid. In fact the color of the maroon roses approached that of the crimson roses when treated with sulphuric acid, and they also tended to singleness.

The scarlet carnation, when supplied with any of the following chemicals, showed a tendency to form white streaks in the petals: iron and ammonium sulphate; aluminum phosphate; iron citrate and citric acid. The maroon carnation, when fed with ferrous sulphate, also showed this same tendency. The petals of a white carnation, when the plant was fed with potassium and aluminum sulphate, showed a tendency to form red streaks.

There was a disposition on the part of the plants treated with potassium cyanide to produce less chlorophyl. In the case of the roses and pansies the leaves were beautifully variegated; in one of the roses growing in sand the edges of the leaves were red, the veins green and the remaining portion yellow. An insufficient supply of iron is generally supposed to produce a paling of leaves, but our observations have not confirmed this. This would tend to show that in certain plants iron is not as necessary as is commonly supposed.

The chief difficulty in experiments of this kind is to achieve and maintain exact control conditions. My work may now be said to be approaching these conditions, and my previous experiments must be regarded as more or less preliminary. It is well known that, when plants grow in a soil containing excessive amounts of copper or zinc, the plants take up these elements, and this demonstrates that the plant will take up certain chemicals under certain conditions, whether they assimilate these or not or whether they are poisoned by them. Until we can establish control conditions whereby we can determine the effects of each substance supplied the plant on different parts of the individual plant, we shall not be able to say just what is the effect of a chemical under varying conditions.

In the interesting experiments of Hoffmann already referred to, on the zinc violet, while he is inclined to consider that individual variation may account for its variability in color, still he says that possibly a difference in climate or physical character of the soil may have influenced the results. While the plant has certain inherent qualities or tendencies which are more or less difficult to influence, and which perhaps can not be modified except within certain limits without injuring the plant, still, by reason of the more or less unspecialized character of the protoplasm, the plant is more or less plastic and susceptible of modification in various ways, and who can say just what the limits are in any one direction? At least we should not allow ourselves to become dogmatic with regard to this problem. As already enumerated, the external factors influencing color in plants are light, temperature, and soil, including certain atmospheric conditions both physical and chemical. When as much work has been done along these lines as in selection and hybridization, we shall probably understand much better than we do now the causes influencing the variation in the colors of plants.

ARTIFICIAL COLORING OF FLOWERS

A few years ago a gentleman traveling in Italy saw a pink iris in one of the florist's establishments which interested him very much and which he desired to purchase. He then learned that the iris had been artifically colored, and that that particular plant was not for sale. He was, however, able to purchase some of the solution for coloring the flowers, but found to his disappointment on arriving home that the solution did not work.

Within the past year or two quite a demand has been created for green carnations on St. Patrick's day. During the course of my experiments it occurred to me that it might be possible to take a plant which was deficient in coloring matter and add to it the extracted coloring matter from some other plant. There is a record that as early as 1709, Magnol colored the flowers of tuberoses by placing the stems in the red juice of poke-berries. Even the botanist Unger (1850) stated that the white flowers of the hyacinth could be colored by adding poke-berry juice to the soil. I have been unable to confirm these observations by the use of any natural coloring substance. For nearly fifty years various artificial coloring substances have been used in the study of the ascent of cell-sap. While considerable attention has been given to the ascent of these substances in the stem, not much attention has been given to their effects on flowers, although here and there in the literature one will find a statement with regard to certain effects of this kind.

In addition to experimenting with vegetable coloring matters, I have experimented with quite a large number of aniline dyes, and have obtained some rather striking results. These dyes are readily soluble in water, and the solutions are made up of a strength of 1 part of dye to 1,000 parts of water. The effects are best seen in white flowers and are produced by allowing the flower-stalks to remain in the solutions from one to two hours, when they are placed in water. With some flowers, as the cultivated anemones, the effects are noticeable in from ten to fifteen minutes. The results show that some flowers will take up the dyes better than others, and also that only a comparatively few of the thousands of aniline dyes can be utilized for the coloring of flowers. These belong chiefly to the classes of azo and rosaniline coloring matters, the acid dyes or those used for dyeing wool producing the best effects. White flowers may be changed to yellow, orange, blue, green, purplish-red or magenta, crimson, purple, salmon-pink or gray by the use of the following dyes:

1. Yellow flowers are produced by the use of the dye known commerically as "Acid Yellow A. T.," which is chemically the sodium salt of disulpho-diphenylazin-dioxytartaric acid.

2. Orange-colored flowers may be produced by the use of the dye "Orange G. G.," which is the sodium salt of benzene-azo-B-napthol-disulphonic acid.

3. Blue flowers may be produced by the use of the dye "Cyanol F. F.," which is the sodium salt of meta-oxy-diethyl-diamido-phenyl-ditolyl-carbinol-disulphonic acid.

4. Green flowers may be produced by the use of equal parts of the dyes "Acid Yellow A. T." and "Cyanol F. F."

5. Purplish-red flowers are produced by the use of the dye "Acid Magenta," which is the sodium salt of the trisulphonic acid of rosaniline.

6. Crimson flowers may be produced by the use of equal parts of the dyes "Acid Yellow A. T." and "Acid Magenta."

7. Purple flowers may be produced by the use of equal parts of "Cyanol F. F." and "Acid Magenta."

8. Salmon-pink flowers may be produced by the use of the dye "Brilliant Croceine M. O. O.," which is the sodium salt of benzene-azo-benzene-azo-B-naphthol-disulphonic acid.

9. Gray flowers may be produced by the use of the dye "Naphthol Black B.," which is the sodium salt of disulpho-B-napthalene-azo-A-napthalene-azo-B-naphthol-disulphonic acid.

I have also tried feeding these solutions to the growing plants, and found that carnations growing in an artificial soil, the basis of which is sand, will take up the solutions and show the effects in the flowers. The dyes are taken up chiefly through the tissues of the veins and are gradually diffused in the adjoining cells. The plants are not injured by the solutions, and if they are properly used neither the texture nor odor of the flowers is affected.

While the artificial coloring of flowers in the manner described is of more or less interest from the scientific point of view, it has also a practical application. In decorative schemes where a particular color is selected this method could be used for producing flowers all of one color, such as blue roses, blue carnations along with violets and other blue flowers. Or in some instances, where the demand for flowers of a certain color is greater than the supply, artificially colored flowers could be produced from white ones.

These dyes may also be used to intensify flowers having a pale color at this season of the year, as pale-yellow carnations, pale-pink roses, pale-yellow snap-dragon, etc. In some cases the natural colors can be modified, as in the production of yellowish-red flowers of snap-dragon from yellow flowers. In the production of novelties, as in the production of green carnations and green roses, the method can be utilized. The color produced by Naphthol Black B. is a delicate gray or grayish-black, and it has been suggested that roses and carnations colored with this dye would furnish appropriate mourning flowers. Another use of these dyes is in the coloring of wild flowers for decorative purposes. For example, wild carrot when colored with a blue dye gives a beautiful effect, being suggestive of a head of forget-me-nots.

The colors of flowers so dyed are permanent, and the dried flowers can in some instances be used for ornamental purposes, as in the case of hydrangeas, which are frequently used in the dried condition. There may be a possible application of these results in the manufacture of artificially colored dried flowers and plants for decorative purposes.

SUMMARY

My observations on the subject of color in plants, may be summarized as follows:

1. There are two classes of color-substances in plants:

(*a*) Organized color-principles which are characterized by being an organic part of the plastid body, and insoluble in water or dilute alcohol, but soluble in xylol and similar solvents.

(*b*) Unorganized color-principles, which are not a fundamental or organic part of the plastids, and occur either in the vacuoles of the cells of higher plants as well as fungi, or in the vacuolules of the plastids of the brown and red sea-weeds. They are further distinguished by being soluble in water and dilute alcohol, and insoluble in xylol and similar solvents.

2. The plastid pigments, or organized color-substances, may be divided into three groups according to their origin.

(*a*) Chlorophyl, which occurs in the chloroplastids in both higher and lower plants, and is especially distinguished by the appearance of its solution when viewed by means of the spectroscope.

(*b*) Chromophyl, which occurs in the chromoplastids, plastid bodies which are peculiar to the higher plants. The chromoplastids together with the accompanying pigment are found in many flowers, in certain roots, and follow the development of the chloroplastids in the ripening of many fruits.

(*c*) Etiophyl, which is found in an etioplastid occurring in the palisade-cells of the innermost leaves of the leaf-bud of *Spathyema foetida*. It is distinguished from chromophyl by becoming slightly greenish when reduced with zinc. The etioplastid is distinguished from the chromoplastid by the fact that its development precedes that of the chloroplastid.

3. In the photosynthesis of the chloroplastid, unorganized color-substances may be produced in comparatively large amount, as in

(*a*) Early spring foliage;

(*b*) The foliage of alpine plants as well as autumnal foliage;

(*c*) The brown and red marine algae;

(*d*) The foliage of certain species or varieties of rose, beech, nasturtium; etc.

4. Unorganized or cell-sap color-substances are distributed

usually in largest amount at the termini of the branches, as in flowers and terminal leaves, or in roots, or in both tops and roots. Their occurrence in those portions of the plant which are young and growing, points to the conclusion that they are not to be disregarded in the study of metabolic processes. Goebel likewise holds to this view. He says that it is "very probable that the feature of color which so often appears when the propagative organs are being brought forth has some connection with definite metabolic processes, although up till now we cannot recognize what these are."

5. The distribution of the so-called flower color-substances in other parts of the plant than the flower also points to the same conclusion, and that the part which they play in attracting insects to flowers is incidental rather than fundamental. (The fact that certain colored flowers as in spruce are pollinated by the wind, would tend to confirm this view.)

6. The occurrence of chromoplastids in a reserve organ, as in the tuberous root of carrot, and the similar occurrence of chromoplastids and of reserve starch in the petals of the buttercup, lead to the inference that the petal of the buttercup, like the root of the carrot, has the function of storing nutrient material. In each case cells containing chromoplastids rich in nitrogenous substances are associated with cells containing reserve materials.

7. The feeding of plants with chemicals or color-control solutions has not so far, in my hands, produced any marked changes in the colors of the flowers, only some slight effects being noted which might be attributed to other causes. Knowing that plants have a certain individuality and certain inherent qualities or tendencies, one could hardly expect other than negative results. On the other hand we know that the plant is a rather plastic organism, and for this reason we are more or less justified in carrying on experiments along the line indicated.

The fact that of thousands of dyes or color-substances only a few are taken up by the plant and carried as high as the flower, would tend to the probability that only certain chemicals or substances would be taken up and thus exert an influence upon the coloring matter in the flower. If such profound changes arise in plants as are provided by the mutation theory, is it too much to suppose that certain definite changes may be produced by means of which we have knowldege or control?

PHILADELPHIA COLLEGE
OF PHARMACY.

The influence of moisture upon the formation of roots by cuttings of ivy

HARRIET RANDOLPH

When pieces of the leafy stem of English ivy (*Hedera Helix* L.) are kept for a time with one end immersed in water or in damp sand, roots generally arise on the part that is submerged. If the stem is then transplanted into soil, the new roots continue to grow and the piece of stem becomes an independent plant. This is the familiar method of raising new individuals from slips.

These new roots may arise close to the cut end of the stem and in any one or in all of the submerged internodes above the cut. They are white and thickly covered with root-hairs. Their structure in cross-section is shown in figure 3. When transplanted, the structure of the part subsequently formed in the soil is very like that of the part that grew in water.

The holdfast-roots, *i. e.*, the outgrowths along the side of the stem by which the ivy clings to the wall, under ordinary circumstances remain unchanged in the water. If kept there for a long time, the outer tissues decay and fall away, leaving the thicker-walled central part.

Experiments to be described below have shown that under varied conditions the ivy may send out roots that differ in some respects from these two kinds.

If the slips in water are kept in a greenhouse or in a room where the air is somewhat more moist than the normal, it sometimes happens that growth is set up in the submerged holdfast-roots. Delicate white outgrowths covered with root-hairs make their appearance either (1) from the tip of the holdfast-root, or (2) from some point along its side, or (3) from the matted felt-like complex formed by the growing together of several holdfast-roots as they attached themselves to a wall. (Figure 1, *hra*, showing near the lower end of the stem absorptive roots arising from the side of the holdfast mat that had adhered to the stone.) These secondary outgrowths from the holdfast-roots may occur in any of the submerged internodes and without any apparent relation to

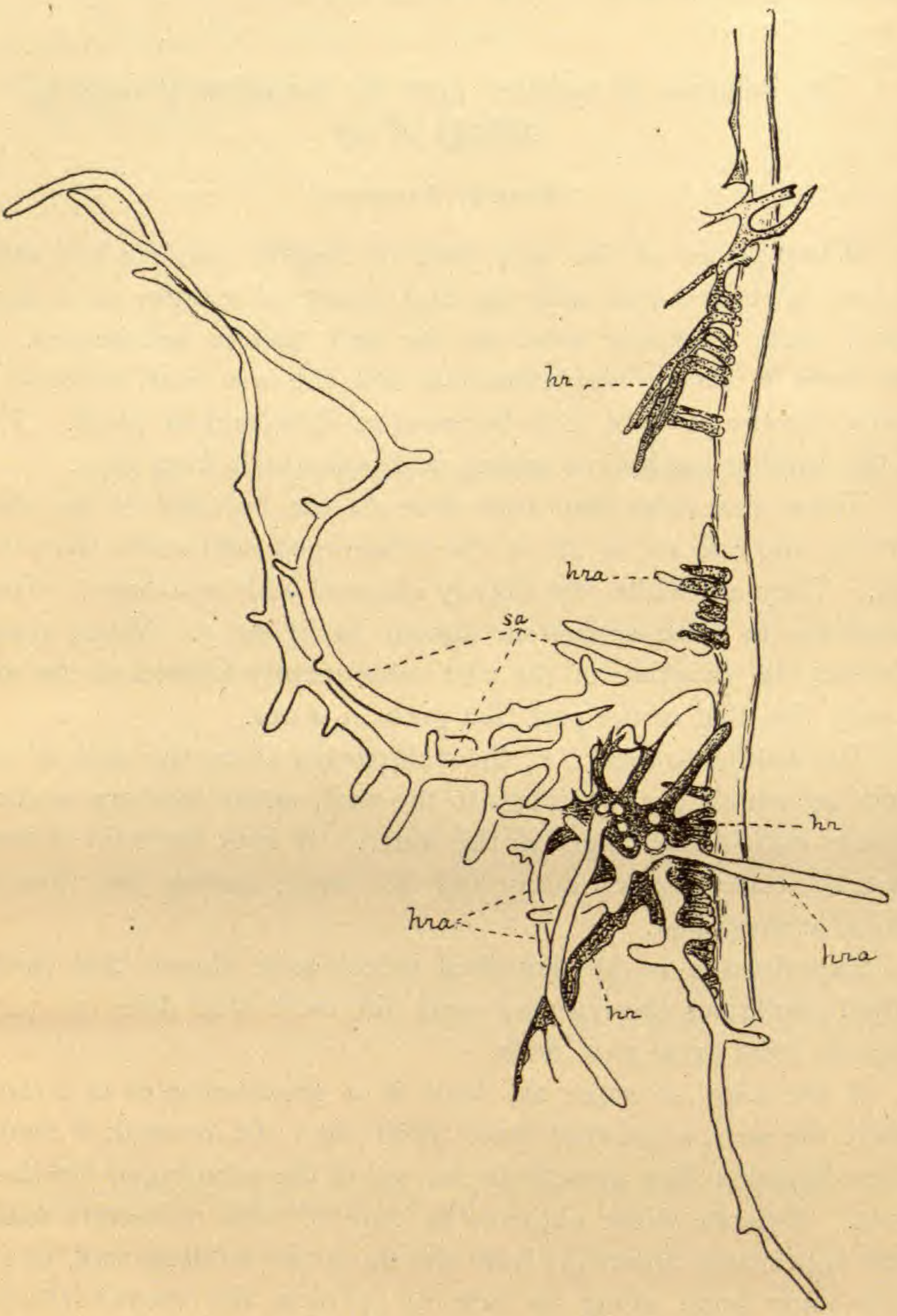

FIGURE 1. Traced from a photograph of ivy stem grown in a greenhouse in air slightly moist, showing the part of the stem that was under water. The lowest group of holdfast-roots (*hr*) had grown together, forming a felt-like mat whose distal surface, which had adhered to a wall, is turned toward the observer. From this distal side of the mat of holdfast-roots absorptive roots (*hra*) have arisen. A group of absorptive roots springing from the stem (*sa*) slightly above has been turned aside in order to leave the view of the holdfast-roots and their outgrowths unobstructed.

the presence or absence of absorptive roots from the stem. The secondary roots increase in length and are not distinguishable in appearance from the ordinary roots that arise from the stem.

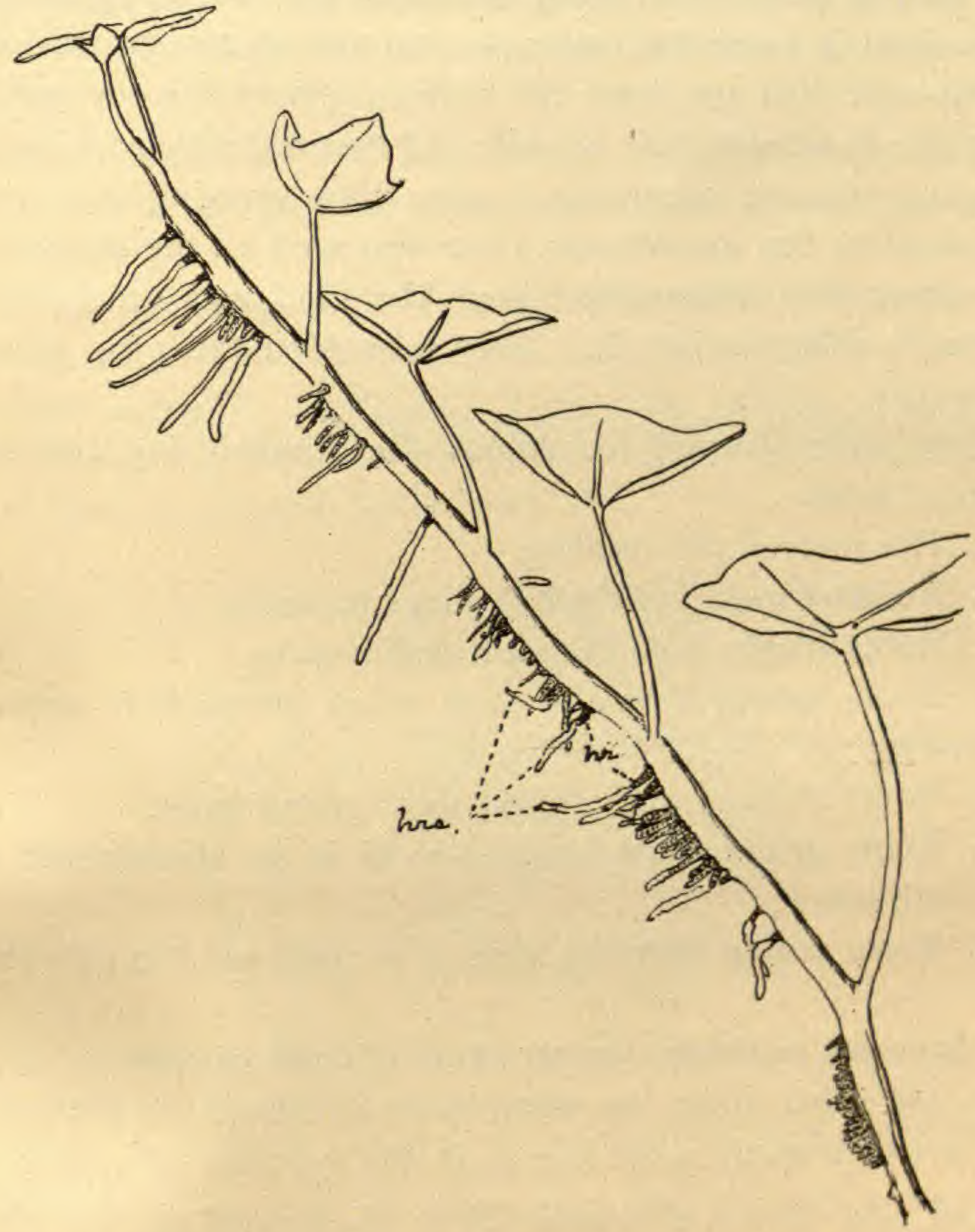

FIGURE 2. Traced from a photograph of young stems growing in water in air saturated with moisture, cut in May when the holdfast-roots had begun to appear. Many of the holdfast-roots (*hr*) have continued to grow, but the part grown in saturated air (*hra*) has a different structure from that of the original holdfast-roots. The holdfast-roots nearest the growing end of the stem had scarcely appeared when the stems were cut.

If the slips in water are kept in an atmosphere saturated with moisture, roots sometimes arise from the part of the stem that is in the air, above the surface of the water in which the stems are standing. They appear to arise indifferently on stems with leaves and on stems from which the leaves had been cut off at the beginning of the experiment. These roots, like those above mentioned that grow from holdfast-roots, have the same appearance as roots that grow from stems under water.

If young stems with green holdfast-roots beginning to grow out are kept in a vessel of water in saturated air, the growth of the holdfast-roots that are above the water continues, but the part that has grown in saturated air is white and covered with root-hairs.

In one instance, occurring in some slips growing in a pot of damp sand in the greenhouse, roots appeared on the sides of the stems about two centimeters above the sand and grew out and downward obliquely into it. They resembled the prop roots of Indian corn.

Thus under varying conditions the English ivy has seven classes of roots:

1. The roots of the seedling.
2. Holdfast-roots by which it clings to walls.
3. Roots arising from the stem under water.
4. Roots arising from the stem in an atmosphere saturated with water.
5. Roots arising from holdfast-roots under water.
6. Roots arising from holdfast-roots in an atmosphere saturated with water.
7. Roots arising from the stem over moist sand in greenhouse air.

I have not examined the structure of roots of class 1.

In the other roots the same kinds of tissues are present, but there are differences in the size or in the number of certain cells that give a characteristic appearance to sections of the different roots.

The structure in general is as follows: The epidermis consists of two (in one case of three) layers, with (or without) root-hairs; the cortical parenchyma is about five cell-rows in thickness; the endodermis surrounds the fibro-vascular bundles; and in the center there is a column of sclerenchymatous cells. Lying within the endodermis, next to it and also next or very near to the outer vessel of each bundle, are ducts lined by secreting cells. When the roots increase in thickness the ducts continue to lie next to the endodermis.

In the common roots that grow out in water from the stem (class 3) the parenchyma has very thin walls, and thus the epidermis and the endodermis are sharply differentiated from it. In these roots, and in the roots that grow out from them after transplantation into earth, the secreting cells are about the size of the cells of the surrounding tissue. The secreting cells contain dense protoplasm and the ducts are empty. The sclerenchyma of the central column is shaped in transverse section like a sharp-pointed star (figure 3).

In the following kinds of roots the ducts have contents * and the central sclerenchyma cells are more numerous and in section resemble a regular pentagon. Hence the phloëm is farther removed from the center of the stem and the endodermal ring is larger than in common water roots, etc.

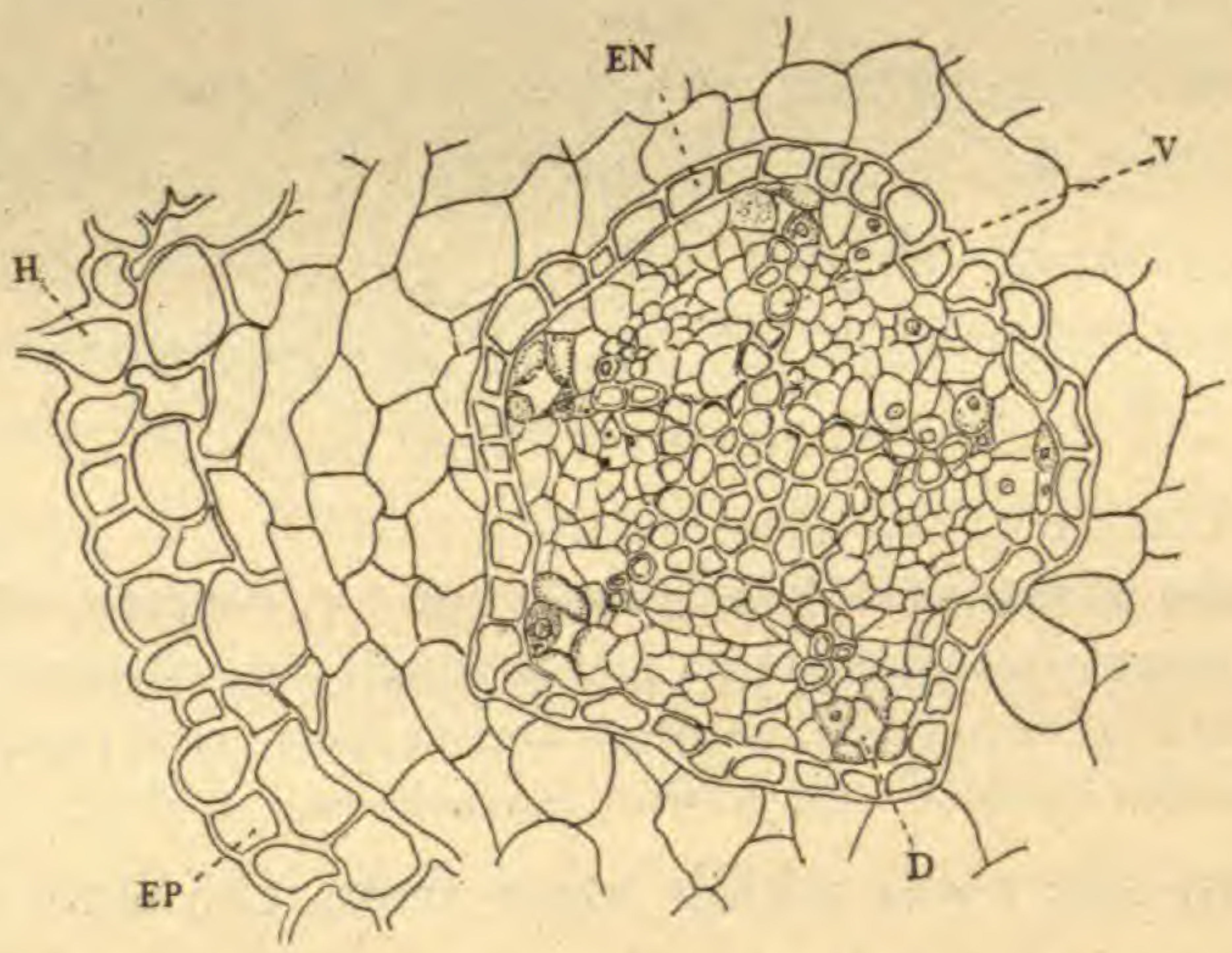

FIGURE 3. Cross-section of absorptive root springing from the submerged part of the stem of ivy in water. *d*, duct; *en*, endodermis; *ep*, epidermis; *h*, hair; *v*, vessels.

In the holdfasts (class 2) the epidermis is from two- to three-layered, and root-hairs are entirely absent or sparse (figure 4).

Adjoining or very near to each set of vessels of the holdfast-roots and on their peripheral side is a duct containing a yellowish substance and bounded in cross-section by four cells. This substance is probably the cement by which the holdfast-roots adhere to foreign surfaces.† Ducts are present in the cortical parenchyma of the stem, with contents apparently similar but with walls consisting of a greater number of cells (figure 5).

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* The roots here described were all preserved in Flemming's solution.

† DARWIN, C. Climbing plants 187, 188.

In roots arising from holdfasts (class 5) the secreting cells are from two to three times the size of the largest cells of that region, and their ducts, like those of the holdfasts contain a yellow substance.

In the roots arising from the stem in air saturated with moisture (class 4) the epidermis is without root-hairs, the secreting cells of the ducts are about four times the size of the largest of the neighboring cells, and the ducts contain a brownish-black substance.

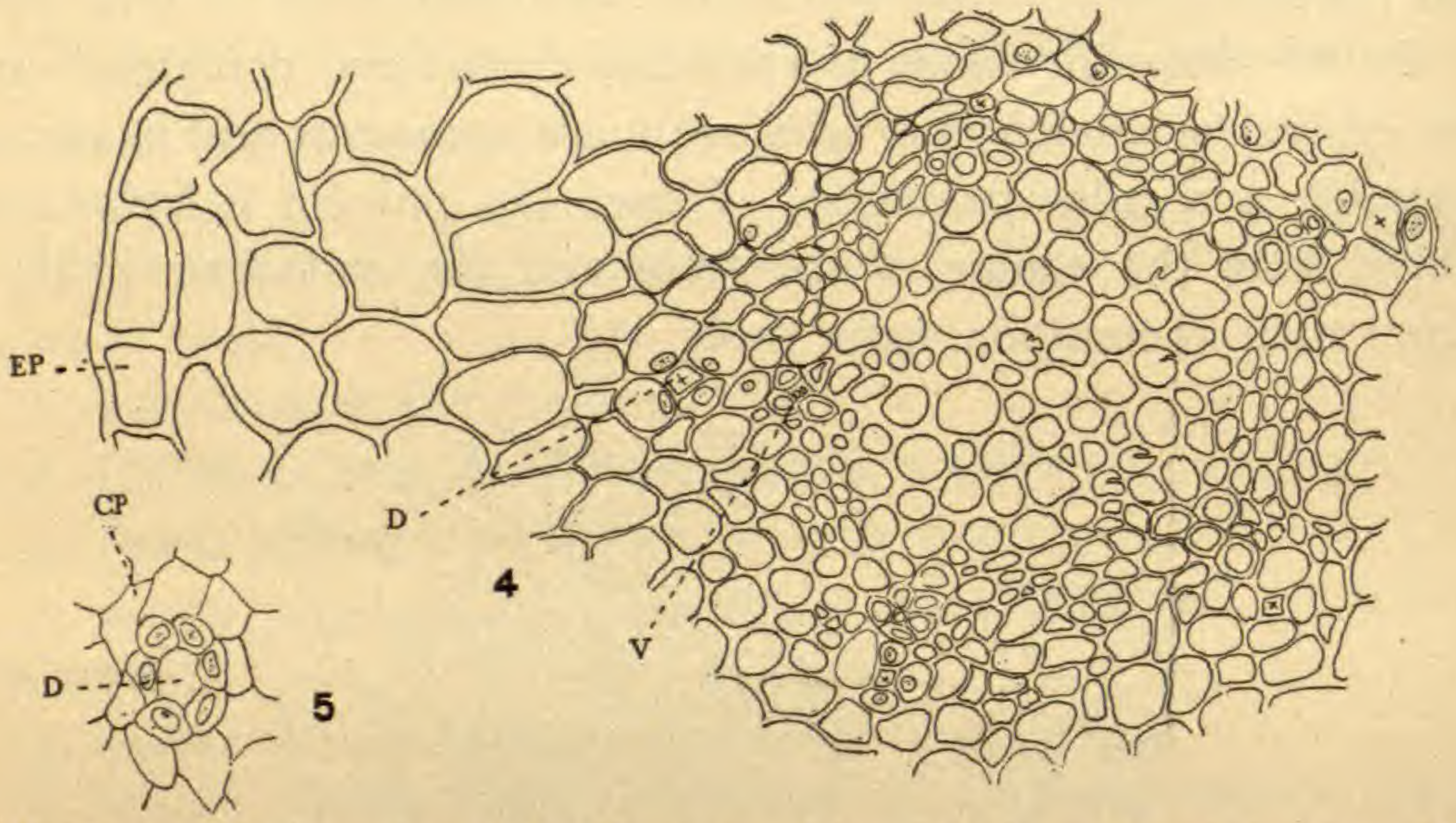

FIGURE 4. Cross-section of holdfast-root of ivy. *d*, the cavity of the duct (also marked ×); in some cases there are six sets of vessels; *ep*, epidermis; *v*, vessels.

FIGURE 5. From the stem of ivy, showing duct in the cortical parenchyma. It lies near the fibro-vascular bundles. *cp*, cortical parenchyma; *d*, duct.

In the corn-like roots which arise from the stem (class 7) the secreting cells are much larger than any of the surrounding cells, and the ducts (like those of the roots arising from the stem in air saturated with moisture) have brownish-black contents. Granules of this substance collected on the inner sides of the cell-walls bordering on the lumen were especially well seen in longitudinal section. These roots contain from six to nine vessels in a bundle, while in all the other kinds of roots the number varies from two to five.

The ivy, *Hedera Helix* L., is the typical example of dimorphism of shoot and leaf.* The possession of absorptive roots growing out into moist air from the holdfast-roots brings the ivy into rela-

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*SCHENCK, H. Beiträge zur Biologie und Anatomie der Lianen **1**: (SCHIMPER, A. F. W. Botanische Mittheilungen aus den Tropen 4:) 93, 94. 1892.

tion with the tropical vines which send down roots to the soil from different points along the climbing stem. These roots (Nährwurzel) convey to the upper parts of the vines a supply of water for which their thin stems are wholly inadequate.* Roots of this kind arising from the stem are believed to have their phylogenetic origin from holdfast-roots (Haftwurzel).† The roots that now grow out from the holdfast-roots of the ivy may represent an early stage of this process. The presence of large numbers of root-hairs is evidence that these secondary roots that spring from the stem have the function of absorption. As in the case of the tropical vines, ‡ there is in the ivy a difference in structure between the absorptive roots and the holdfast-roots.

The presence of secondary absorptive roots in the ivy brings this species into closer relation with other members of its family (*Araliaceae*) in the tropics, and with epiphytes in general. Schenck § states: "In fast allen Familien oder Gattungen mit wurzelkletternden Lianen begegnen uns gleichzeitig auch epiphytische Formen. So enthalten die Araliaceen in den Tropen epiphytische Holzgewächse. . . . Wurzelkletterer und Epiphyten sind verwandte Vegetationsformen, und aus ersteren können sich leicht letztere herausbilden, falls die Verbreitungsmittel der Früchte oder Samen entsprechende sind. . . . In der That giebt es ja auch viele kreichende oder wurzelkletternde Epiphyten, welche in manchen Eigenthümlichkeiten mit den echten Wurzelkletterern übereinstimmen."

BRYN MAWR COLLEGE.

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* SCHENCK, *loc. cit.* 106.

† GOEBEL, K. Organographie der Pflanzen 488. 1900.

‡ GOEBEL, *loc. cit.* 487.

§ *Loc. cit.* 111.

The species of Lycopodium of the American tropics

LUCIEN MARCUS UNDERWOOD AND FRANCIS ERNEST LLOYD

In 1900 we published a preliminary list of the West Indian species of *Lycopodium* in connection with a revision of the species of temperate North America.* During the few years that have since elapsed, our knowledge of the tropical species has been greatly extended, chiefly through the explorations that have been made in various parts of the West Indies under the direction of the New York Botanical Garden. The expeditions to Porto Rico by Underwood and by Wilson, to St. Kitts by Britton and Cowell, to Cuba, by Britton, Shafer, and Wilson, and by Underwood and Earle, to Haiti by Nash, to Jamaica by Underwood and by Maxon of the United States National Museum, and to Dominica by Lloyd have all brought back an extensive array of material. This has been amply supplemented by the Jenman collection purchased by the Garden in 1903, which is specially rich in material from Jamaica, Grenada, Martinique, and Guiana. Other recent South American material has been supplied through the rich collections of H. H. Smith in the Santa Marta region of Colombia, and of R. S. Williams in the Andean region of Bolivia. The latter collection particularly has brought to light a number of very interesting species. American collections are still lacking in good representative material from Brazil, and there are occasional species from other regions about which additional light is still greatly desired. In order to place our present knowledge in an accessible form, we present this second preliminary report on the species of the West Indies and Mexico, and have included occasional species from South America. The West Indian forms are now fairly well limited and localized, yet it is not impossible or even unlikely that still other species will be found in the archipelago when the higher altitudes of the larger islands shall have been explored. The Mexican and especially the Central American species are much more obscure, and must await further exploration. The same is

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* LLOYD, F. E. & UNDERWOOD, L. M. A review of the species of *Lycopodium* of North America. Bull. Torrey Club 27: 147–168. 1900.

even more true of South America, which is likely to yield species yet unknown, as well as much more definite information about many that are now only imperfectly known.

All descriptions of structural characters are based upon material prepared by boiling, and upon glycerin-jelly microscopic preparations, of which in all instances camera-lucida drawings were made to a uniformly applied scale.

The three sections of the genus *Lycopodium* that are represented in the American tropics may be distinguished as follows:

Foliage leaves normally many-ranked, mostly uniform.
  Sporangia in the axils of unaltered leaves. § 1. *Selago*.
  Sporangia aggregated in distinct terminal strobiles whose bracts differ widely from the foliage leaves. § 2. *Lepidotis*.
Foliage leaves 4–5-ranked, dimorphous; stems strongly dorsiventral. § 3. *Diphasium*.

§ 1. SELAGO

The northern types of this group are familiar in the boreal *Lycopodium Selago* and the more common *L. lucidulum* of the Northern States. *L. porophilum* is a more restricted and local plant somewhat intermediate between the other two species. The tropical representatives are more numerous, a very few simulating the northern species in habit, while a much greater number become epiphytic and are pendent from trees. The species * of meridional America may be separated as follows:

Plants with radial symmetry; leaves not twisted.
  Plants terrestrial in habit.
    Leaves short, 1 cm. or less long.
      Plants erect or ascending; leaves rigid.
        Leaves in 16–20 ranks; stems short and rather stout.
          Leaves serrulate, strongly hooked at the ends. 5. *L. densifolium*.
          Leaves straight, with entire margins. 4. *L. Sieberianum*.
        Leaves in 8 ranks, serrulate; stems elongate.
          Leaves reflexed or loosely spreading.
            Leaves verticillate, distant, closely coiling when dry. 3. *L. polycarpum*.
            Leaves scattered, crowded, reflexed-spreading; sporangia 1.2 mm. wide. 1. *L. reflexum*.

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* A number of the species from South America are omitted here, owing largely to lack of sufficient material. The following members of this group are more or less perfectly represented in the herbarium of the New York Botanical Garden in addition to the species tabulated below: *L. compactum* Hook., *L. rufescens* Hook., *L. erythraeum* Spring, *L. tetragonum* Hook., *L. crassum* H.B.K., *L. Hartwegianum* Spring, *L. filiforme* Sw.

Leaves rigid, thick, ascending; sporangia 1.8 mm. wide. 2. *L. rigidum.*
Plants spreading or pendent; leaves lax, somewhat secund. 9. *L. portoricense.*
Leaves longer, 1.5 cm.
Leaves linear, 0.6–0.8 mm. wide. 6. *L. montanum.*
Leaves lanceolate, 1 mm. wide. 7. *L. hippurideum.*
Plants epiphytic, pendent from trees.
Leaves short, 8 mm. or less long.
Plants with slender, many times dichotomous stems.
Plants 60 cm. or more long.
Strobiles compact; sporophyls short, triangular. 10. *L. Pringlei.*
Strobiles lax; sporophyls slender, subulate. 8. *L. setaceum.*
Plants short, under 20 cm. long; leaves very narrow, scattered, widely spreading. 20. *L. Williamsii.*
Plants with thick cord-like stems, closely dichotomous.
Leaves slender, flaccid. 17. *L. funiforme.*
Leaves broader at base, rigid. 16. *L. Picardae.*
Leaves larger, 1–3 cm. long.
Stems red, robust; leaves 2.5 cm. long, sharply reflexed from near the base. 12. *L. pithyoides.*
Stems green.
Leaves and sporophyls 4-ranked. 15. *L. nitens.*
Leaves and sporophyls 6–10-ranked.
Leaves rigid, closely appressed. 14. *L. cuernavacense.*
Leaves lax, spreading.
Leaves narrow, less than 0.5 mm. wide. 19. *L. Wilsonii.*
Leaves wider, 0.5–1 mm. wide; midrib prominent. 18. *L. dichotomum.*
Plants more or less dorsiventral by the twisting of the leaves.
Leaves sharply twisted at the base, usually narrowed below.
Plants short, 25 cm. or less long.
Stems short, dichotomous from near the base; leaves crowded, short and rigid; midribs prominent. 13. *L. Orizabae.*
Stems lax; leaves scattered, widely spreading, broadest at the middle, less than 1 cm. long; sporophyls similar. 23. *L. tenuicaule.*
Plants elongate, 35–80 cm. long; leaves lax, with less conspicuous midribs, long-tapering.
Leaves straight or slightly arcuate, 1.5–3 mm. wide, with inconspicuous midribs. 21. *L. linifolium.*
Leaves strongly arcuate, widely spreading, narrow (1 mm.), with conspicuous midribs; sporophyls short (8 mm.), slender. 22. *L. Jenmani.*
Leaves twisted throughout their entire length, widest at base. 11. *L. taxifolium.*

1. LYCOPODIUM REFLEXUM Lam. Encyc. Meth. Bot. **3**: 653. 1789. (Type from Martinique, *Martin.*)

Lycopodium squarrosum Sw. Nov. Gen. et Sp. Pl. 137. 1788.—Fl. Ind. Occ. **3**: 1571. 1806. (Type from Jamaica, and cites same plates as Lamarck.) Not *L. squarrosum* Forst. 1786.

Lycopodium reflexum Willd. Sp. Pl. **5**: 52. 1810. (Type from "Amer. merid."; apparently described independently by Willdenow, overlooking Lamarck's name.)

Lycopodium bifidum H. & B.; Willd. Sp. Pl. **5**: 53. 1810. (Type from "Amer. merid.")

Lycopodium eversum Poir. Encyc. Meth. Bot. Suppl. **3**: 556. 1813. (Based on *L. reflexum* Willd. not Lam.)

Lycopodium reversum Presl, Rel. Hænk. **1**: 82. 1825. (Type from Guayaquil.)

In the above long synonymy we have a hint of wide distribution and a considerable degree of variability, which was aggravated by the citation in Lamarck's original description of two plates that did not belong to the species, which he described as having reflexed leaves, viz.: Plumier, Fil. *pl. 166, f. A*, and Dillen, Hist. Musc. *pl. 57, f. 4*, which were later separated as a distinct species.

RANGE: Cuba (*Wright 933*), Porto Rico, Jamaica, Haiti (*Nash 557*), Guadeloupe (*Perrin*), Mexico, Guatemala (*J. D. Smith 504, Maxon 3560*), Colombia, Bolivia.

2. LYCOPODIUM RIGIDUM Gmelin, Syst. Nat. ed. 13. **2**: 1289. 1791. (Founded on Dillen, Hist. Musc. *pl. 57, f. 4.*)

This figure of Dillen represents the rigid form of the plant, which has often passed as *L. reflexum*. Dillen's figure according to his own statement is copied from Plumier (Fil. *pl. 166, f. A.*), so that by some *L. rigidum* might be regarded as a synonym of *L. reflexum* Lam.*

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* In the whole matter of the determination of types a certain amount of plain ordinary common sense must be used. In this instance we have in the West Indies two closely allied plants whose imperfect original descriptions both cite the same plates. One plant has notably *reflexed* leaves while the other has *rigid* leaves. It was evidently this character in each case that suggested the names *reflexum* and *rigidum*. Lamarck clearly had the plant whose leaves are lax and consequently become reflexed as they mature. His plant, collected in Martinique by Martin, if in existence will serve as a type of his species. But he added to his description, citations from Plumier and Dillen drawn evidently from the species with rigid erect leaves, which Gmelin later

RANGE: Jamaica (*Wilson, Jenman, Underwood 181*), [Martinique?, *Plumier*]. This plant is apparently less common and less widely distributed than *L. reflexum.*

3. **Lycopodium polycarpum** (Sod.) sp. nov.

Lycopodium reflexum γ polycarpum Sod. Crypt. Vasc. Quitenses 569. 1893. (Type from Ecuador.)

A terrestrial plant with verticillate distant leaves 35–40 cm. high. Stem rather slender, 1.5 mm. or less thick, four times dichotomous, the ultimate divisions elongate; leaves and sporophyls distant, in nearly regular whorls, about 8-ranked, 4–5 mm. long by 0.8 mm. wide, linear-lanceolate, acute, serrulate, recurved, in drying bent back to form a semicircle; sporangia reniform, 1.5 mm. wide, laterally exceeding the sporophyls in width.

ECUADOR: 1899, *Sodiro* (type); *Spruce 4973*.

We have excellent specimens from Father Sodiro which show a relation to *L. reflexum* but are amply distinct as a species. The large sporangia coupled with the distant leaves make the former unusually prominent, a fact that is recorded in the name. The species is apparently most closely related to *L. intermedium* Spring, of which we have not seen the type, but in any case that name is antedated by *L. intermedium* Blume, by a number of years.

4. LYCOPODIUM SIEBERIANUM Spring, Monog. Lycop. **1**: 23, *excl. syn.* 1842. (Type from Martinique, *Sieber 56.*)

Spring apparently confused with specimens of a very distinct species, various figures, some of which had already served as types of other species. On receiving a very distinct plant from St. Kitts we had thought at first to describe it as new on the strength of these citations, but on examination of *Sieber 56* at Berlin the past summer (the plant on which Spring based his name and in part his description) we find that our St. Kitts plant

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separated as *L. rigidum*, basing his description on Dillen's plate which was taken direct from Plumier. In the absence of type specimens there are many who would make the two names synonyms, and rename Gmelin's species. But to one familiar with both plants in the field the names *reflexum* and *rigidum* assume greater importance and significance. The liability of error in interpretation in the purely "literary revision" of plant names without the supplemental knowledge of the plants themselves, receives here a capital illustration, and all such revision is to be deprecated. Plain common sense would suggest the continuance of the two names accepted above as representing the spirit of the founders of the two species concerned.

agrees perfectly, so that it is necessary to retain Spring's name with an emended application. We have therefore drawn up a fresh description from a recently collected plant:

A stout terrestrial plant with 2–3 forks, and leaves crowded in about 20 ranks. Stems 20 cm. or more long; leaves 5 mm. long or more by 0.8 mm. wide at the base, entire, tapering to an acute apex, spreading, slightly ascending, curved dorsiventrally at the base and near the apex; sporangia reniform, exceeding the sporophyl in width by only a small amount.

MARTINIQUE: *Sieber 56* (specimens in herb. Berol.); *Hahn 1263* (specimens in herb. Kew).

ST. KITTS: Mt. Misery, among ferns, *Britton & Cowell 547*. Only a single plant was collected, but its characters are so strikingly different from *L. reflexum* and *L. rigidum*, its nearest allies, that we do not hesitate to take up Spring's name for it as representing a valid species. This plant is no doubt included by Baker in his description of *L. rigidum*, and Hahn's plant above cited was found under the cover of *L. rigidum* at Kew. We have not seen the plants from Peru and Chile, cited by Spring, so can give no details of its distribution further than recorded above. The habitat of the plant seems to be the volcanic craters of the Lesser Antilles. The exact locality of Sieber's plant is not recorded. Hahn's plant came from Mont Pelée and the St. Kitts specimen was found in the similar crater of Mt. Misery. It probably will be found on all the volcanic mountains of this group.

5. **Lycopodium densifolium** (Baker) sp. nov.

Lycopodium reflexum var. *densifolium* Baker, Handbook of Fern Allies 11. 1887.

A terrestrial plant 35 cm. or less tall, 2–4-dichotomous. Stems stout, 4–6 mm. or more in diameter exclusive of the leaves; leaves in about 20 ranks, crowded, 4–5 mm. long by 1 mm. wide at base, tapering from a point one fourth the length from the base to the acute mucronate apex which appears obtuse from above or below owing to the excessive curvature, stiff, spreading at right angles to the stem, strongly curved upward (or nearly hooked) at the apex, thickened dorsiventrally throughout the curve; margins with a few (1–5) short triangular multicellular straight or reflexed teeth near the base, and a few others more widely scattered throughout the length; sporangia broad, mostly confined to the upper portions of the stems.

ECUADOR: 1857–9, *Spruce 5429*. A unique species, with rigid leaves wholly unlike *L. reflexum*, under which name it was distributed. In the Kew Herbarium Mr. Baker has marked this number of Spruce as *L. reflexum* var. *densifolium*, a conclusion no one could have reached from Mr. Baker's brief description of the plant.

6. **Lycopodium montanum** sp. nov.

A terrestrial shade plant, 30–40 cm. high, with decumbent bases and dark-green foliage. Stems 2–3 mm. thick, once or twice forked, the older portions becoming decumbent and ultimately dying away while the newer parts are nearly erect, the whole stems often 70–90 cm. long with dark-green foliage; leaves 1.5 cm. long by 0.7–0.8 mm. wide, linear, acuminate, spreading, at length reflexed, downwardly curved near the tips, the midrib not evident in the dry material but distinct when moist; sporophyls like the leaves, the sporangia much exceeding the sporophyls in width, 1.5 mm. broad and nearly as deep.

JAMAICA: Summit of Blue Mountain Peak in deep shade, *Underwood 2537* (type), *2542*; *Nock* (in herb. Jenman).

Near to this species are the closely allied specimens from Bolivia (*Mandon 1528*) and Ecuador (*Sodiro*), which probably belong to *L. Lechleri* Hieron., a species recently described. *L. hippurideum* Christ is also a closely allied species.

This plant was apparently first collected in Jamaica by Nock in 1880 on the ridge of Blue Mountain Peak. Mr. Jenman confused this elegent terrestrial species with the epiphytic and remotely related *L. dichotomum*, and when the latter species was brought in from Grenada he was inclined to regard it as undescribed, as he had evidently not seen the true *L. dichotomum* from Jamaica, where it appears to be rather rare. The two species have very little in common and this elegant plant is one of the handsomest of the terrestrial species, growing in large patches in the shade of the dense forest that covers the summits of the Blue Mountain range.

7. LYCOPODIUM HIPPURIDEUM Christ, Prim. Fl. Cost. 3^1: 56. 1901. (Type from Costa Rica, *Pittier 10619*.)

COSTA RICA: El Páramo, 3000 m., Massif de Buena Vista, *Pittier 10619*. Known only from its type locality. There is a cotype in the United States National Herbarium.

8. LYCOPODIUM SETACEUM Lam. Encyc. Meth. Bot. **3**: 653. 1789. (Type from the Antilles and Bourbon; but Plumier, Fil. *pl. 166, f. B*, as well as Dillen, Hist. Musc. *pl. 56, f. 3*, is cited.) Not *L. setaceum* Hamilton, 1825.

Lycopodium acerosum Sw. (Fl. Ind. Occ. **3**: 1575. 1806; type from Bourbon) may be the same species, since Swartz cites the same plates as Lamarck and states that Dillen also had it from the West Indies. Swartz in Syn. Fil. (1806) refers both *L. setaceum* and *L. acerosum* to *L. verticillatum* L. fil. (Suppl. 448. 1781; type from Bourbon), but this is described as having "*foliis quadrifariis*," which will not apply to the plant of the American tropics. Since the time of Swartz, the American plant has been referred to *L. verticillatum*, probably incorrectly; at least the name *L. setaceum* is the earliest that it is safe to take up in the absence of any material from Bourbon.*

RANGE: Cuba (*Wright 935*, *Eggers 5173*), Jamaica (*Jenman*), Martinique (*Père Duss*), Haiti (*Nash 664*), Dominica (*Lloyd 342, 697, 808, 810*).

9. **Lycopodium portoricense** sp. nov.

A bushy but slender pale-green terrestrial pendent plant with subsecund leaves. Stems less than 1.5 mm. in diameter, covered to the bases with leaves, several times dichotomous, 30 cm. or more long; leaves and sporophyls alternating in zones, the leaves linear, acuminate, 6–8 mm. long by 0.3–0.4 mm. wide, more or less secund; sporophyls tapering gradually from a base 0.6 mm. wide to the apex, 6 mm. long; sporangia round-reniform, 1.3 mm. wide by 1 mm. deep.

PORTO RICO: Road from Guyama to Cayey, pendent on banks, *Underwood & Griggs 434* (type); Luquillo Mts., *Percy Wilson 141*.

This species is related rather closely to *L. setaceum*, but differs in its longer leaves, which are truly linear and not tapering from the base, in its larger stems, and in its terrestrial habit.

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*Since the time of Swartz it has been quite common to refer West Indian and Central American pteridophytes to species originally described from Bourbon (Réunion) or Mauritius. When we come to examine typical material from those islands we invariably find it very different from the better known American forms referred to the same species. There is every *a priori* reason for supposing the two floras to be very distinct, and every new examination of pteridophyte types shows this supposition to be true.

10. **Lycopodium Pringlei** sp. nov.

Epiphytic, pendulous, of slender open habit; stems 40 cm. or more long, about five times dichotomous, appearing cord-like from the appressed leaves; leaves subulate, 2.5–3 mm. long, 0.6 mm. wide, about 6-ranked; strobiles more or less interrupted, the shoots becoming variable in thickness because of the large crowded sporangia; sporophyls triangular, entire, 1.3 mm. long or less, 0.8 mm. wide at base, exceeding the sporangia only by their short apices, appressed except when distended by the ripened sporangia; sporangia nearly circular, 0.8 mm. wide by 0.6 mm. deep, sometimes slightly protruding beyond the margins of the sporophyls.

MEXICO: Hanging from oaks, Sierra de Clavellinas, 9000 ft., Oaxaca, *Pringle 4994* (type); Orizaba, *Müller 361*. A plant collected at Morelos, *Rose 4416*, is either this or very closely allied.

The plant was distributed by Pringle as *L. verticillatum*, but does not show close relationship to any of the West Indian plants bearing that name or that have been referred to that species. It is a much smaller-stemmed plant than *L. nitens*, and has 6-ranked instead of 4-ranked leaves and sporophyls as in that species.

11. LYCOPODIUM TAXIFOLIUM Sw. Nov. Gen. et Sp. Pl. 138. 1788.— Flor. Ind. Occ. **3**: 1573. 1806. (Type from Jamaica; in the latter work Swartz also says "*etiam in insula St. Helena.*")

While there is very great variation in the length of the leaves, often resulting in the appearance of much more slender stems, we cannot distinguish among the specimens from the West Indies the *Lycopodium passerinoides* H.B.K. (Nov. Gen. **1**: 41. 1815), the type of which was from Peru, and quite likely represents a plant widely different from the West Indian things that in recent years have been referred to it.

RANGE: Cuba, Hispaniola, Porto Rico, Jamaica, Dominica, St. Vincent, Grenada, Mexico, Colombia.

12. LYCOPODIUM PITHYOIDES Schlecht. & Chamisso, Linnaea **5**: 623. 1830. (Type from Jalapa, Mexico, *Schiede & Deppe.*)

MEXICO: Santa Maria, *Schaffner*; Orizaba, *Müller 691*.

GUATEMALA: *Seler 2329*.

CUBA: Santiago, *Hamilton 247*.

This characteristic species, long neglected or overlooked at Kew, is so clearly defined that one wonders at the oversight.

The plant from Cuba, though a fragment, is unmistakable, and shows an unexpected and unusual distribution.

13. **Lycopodium Orizabae** sp. nov.

A short rather stout epiphyte 16 cm. or more tall, with abundant lanceolate leaves. Stems 2–3 mm. thick at the base, more slender above, 3–4 times dichotomous, rising from dense clusters of roots; leaves 1.5–1.8 cm. long by 2–2.3 mm. wide, lanceolate-acuminate, broadest near the base, thence abruptly narrowed at the base, asymmetric, the midrib slender but evident almost to the apex, the margins entire; sporophyls similar to the leaves, but shorter and narrower, 1 cm. long by 1 mm. wide, lanceolate, broadest near the middle, acuminate, twisted at the base, slightly asymmetric; sporangia reniform, 1.8 mm. wide by 1.5 mm. deep.

MEXICO: Orizaba, *Müller 690.* Known only from its type collection.

14. **Lycopodium cuernavacense** sp. nov.

An elongate rigid epiphyte, with stiff appressed leaves. Stems attaining 60 cm. or more long, 3–4-forked, the branches diverging at a very small angle, rather stout, 3–4 mm. thick; leaves crowded, somewhat appressed, rigid, 2 cm. long by 2 mm. wide, subulate-acuminate, broadest at the base, the midrib evident by a furrow when dry, the margins entire; sporophyls similar to the leaves but shorter, about 1 cm. long; sporangia circular, slightly exceeding the sporophyls in width.

MEXICO: Morelos; trees in mountains above Cuernavaca, 8,500 ft., *Pringle 7613.*

This species is related to *L. taxifolium*, for which it was distributed, but differs from that species both in habit and in structural characters.

15. LYCOPODIUM NITENS Schlecht. & Chamisso, Linnaea **5**: 623. 1830. (Type from Jalapa, Mexico, *Schiede & Deppe.*)

Of this species we have seen only an original specimen, a sheet of which is at Kew. Its four-ranked leaves and sporophyls render it a striking plant.

16. LYCOPODIUM PICARDAE Christ, Bot. Jahrb. **24**: 148. 1898. (Type from Haiti, *Picarda 978.*)

We have a portion of the original collection made in 1892 (*Picarda 978*) whose label reads "Haiti prope Keurcoff in caverna, alt. 1,200 m."

17. LYCOPODIUM FUNIFORME Chamisso; Spring, Monog. Lycop. **1**: 50. 1842.

The name was given by Chamisso to a plant in herb. Bory which was marked "California"; to this Spring in publishing the description added "Guadeloupe, *L'Herminier*" which should be regarded as the type locality. The plant is a well known Antillean species and the "California?" was evidently a mistake as the plant is apparently endemic in the West Indies.

RANGE: Cuba (*Wright 943*, *Pollard & Palmer 168*, *Underwood & Earle 658*, *1033*), Porto Rico (*Heller 1084*, *Percy Wilson 102*), Guiana (*Jenman*).

The living plant is well named, as the resemblance to cordage is very striking.

18. LYCOPODIUM DICHOTOMUM Jacq. Hort. Bot. Vind. **3**: 26. *pl. 45*. 1776. (Type from Martinique.)

RANGE: Cuba (*Wright 944*), Hispaniola (*Nash 680*), Jamaica (*Clute 64*), Dominica (*Lloyd 506*, *798*, *809*, *819*), St. Kitts (*Britton & Cowell 304*), Grenada (*Sherring*), Guadeloupe (*Dr. Madiana*), Martinique, St. Vincent (*Smith 735*), Mexico (*Schaffner 3*, *Pringle 3976*), Guiana (*Jenman*).

There is some degree of variation present in this species. We were at first inclined to separate the St. Kitts plant as distinct and with it would go the scrap from Guadeloupe here cited from the Torrey herbarium. As noted above, Mr. Jenman confused the plant which we have described as *L. montanum* with this species, and then in his herbarium referred the Grenada plants really belonging here to a new name, *L. grenadense* Jenm. It is probably more logical to consider all the forms as coming under a single species.

19. **Lycopodium Wilsonii** sp. nov.

A small epiphyte with divergent forking branches and slender leaves. Stems 8–15 cm. long, about 2 mm. thick, with about three forks, the branches divergent; leaves linear, 1.5–1.8 cm. long by 0.6 mm. wide, very gradually tapering from the base to the acuminate apex, symmetrically or slightly curved; sporophyls similar to the leaves, but smaller, 1 cm. long by 0.4 mm. wide; sporangia round-reniform, 1.5 mm. wide by 1.3 mm. deep, exceeding the sporophyls in width.

PORTO RICO: Luquillo Mountains, *Percy Wilson 271* (type), *153*.

This species is perhaps nearest to *L. dichotomum*, varying in the direction of *L. setaceum*, but widely different from either in habit and structure. We dedicate it to its enthusiastic collector, whose visit to Porto Rico was productive of several novelties in the genus *Lycopodium*.

20. **Lycopodium Williamsii** sp. nov.

A small slender much-branched epiphyte 10–15 cm. long. Stems slender, pendulous, less than 1 mm. thick, sparsely covered with foliage below, hidden by the copious sporangia above; leaves scattered, slightly curved, widely spreading or descending, 7–9 mm. long by 0.5 mm. wide, linear, acute, with entire margins; sporophyls shorter, 4–6 mm. long by 0.3 mm. wide, linear; sporangia round-reniform, prominent, relatively large, 1 mm. wide by 0.8 mm. deep.

BOLIVIA: New Brazil, 5,500 ft., *Williams 1393*.

This beautiful moss-like species was collected by Mr. R. S. Williams on the Conway expedition in 1902, and we are pleased to recognize his discriminating field-work which shows itself in most beautifully prepared specimens, a form of work only possible when a trained botanist is sent to the field, and is not hampered by the necessity of collecting "sets of plants" for commercial or exchange purposes.

21. LYCOPODIUM LINIFOLIUM L. Sp. Pl. 1100. 1753. (Type from "Amer. merid." based on Dillen, Hist. Musc. *pl. 57, f. 5*, and Plumier, Fil. *pl. 166, f. C.*)

RANGE: Cuba, Hispaniola (*Nash 195* *), Porto Rico, Jamaica, Grenada, Trinidad, Mexico, Guatemala, Colombia, Venezuela, Guiana, Bolivia.

22. **Lycopodium Jenmani** sp. nov.

A slender pendent much-branched epiphyte with attenuate branches. Stems very slender, 1 mm. thick, much branched, with

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* These specimens collected by Mr. Nash are simply superb developments of this beautiful species, the multitudinous branches of a bushy plant rising from a single stem all represented on the sheet, and strikingly in contrast with the old-fashioned "tips" of branches that constitute too many of the herbarium specimens of a past generation. Such specimens as these really give one some idea of the habit and true character of the living plant.

scattered leaves and contracted sporophyls; leaves arcuate, lanceolate, acuminate, 1–1.3 cm. long by 1–1.2 mm. wide, unsymmetrical, the midrib nearer one margin, widely spreading, distinctly curved, twisted at the base so that the blade lies in the plane of the axis; sporophyls twisted like the leaves, linear, much smaller at the ends of the branches, but ultimately attaining the size of the smaller leaves; sporangia reniform, 1.5 mm. wide by 1 mm. deep, much exceeding the leaves in width and thus appearing very conspicuous in the mass of foliage.

BRITISH GUIANA: Moruca River, *Jenman.*

Mr. Jenman had marked this plant in his herbarium as a distinct variety of *L. linifolium*, but the name assigned being untenable as a specific name in the genus, we are pleased to dedicate it to the memory of this most assiduous of students of the pteridophytes of the British colonies in America, whose collection and critical notes and publications add so much to our exact knowledge of the tropical pteridophyte flora of America.

23. **Lycopodium tenuicaule** sp. nov.

A lax slender epiphyte with delicate scattered leaves. Stems springing from a small cluster of roots, 20–30 cm. long, loosely branched, smooth, 1 mm. thick, the shoots dorsiventral by the twisting of the leaves at their bases; leaves 7–9 mm. long by 1.5 mm. wide, lanceolate, broadest at the middle or just above, acute, slightly unsymmetric, entire, twisted at the base so as to bring the blade to the plane of the axis, widely spreading, scattered, all sporangiate except on the oldest part of the stem; midrib slender, scarcely evident beyond the middle of the leaf: sporangia reniform, 1.3 mm. wide by 1 mm. deep.

DOMINICA: Mt. Diablotin, *Lloyd 878* (type).

PORTO RICO: Luquillo Mountains, *Percy Wilson 139.*

This delicate and graceful species which has appeared from two rather distant and distinct stations is very unlike any other West Indian species, forming a peculiar type with no near congeners.

§ 2. LEPIDOTIS

The tropical American species of this section fall somewhat naturally into four groups which are widely separated from each other in habit. We may separate these groups synoptically as follows:

Species epiphytic, pendent from trees; leaves dorsiventral. **Phlegmaria Group.**
Species of terrestrial habit.
Stems erect, usually naked at the base; habit tree-like. **Cernuum Group.**
Stems creeping.
Stems wide, trailing, with ascending branches. **Clavatum Group.**
Stems short, prostrate, with simple monostachyous branches. **Iuliforme Group.**

PHLEGMARIA GROUP

This group with strongly dorsiventral leaves is largely represented in South America, but one of the species extends into the West Indies. They may be separated as follows:

Leaves broadly oval or obovate.
Leaves small, 3.5 by 2.5 mm.; sporophyls scarcely exceeding the sporangia.
Leaves narrowed (cuneate) at the base. 24. *L. cuneifolium.*
Leaves rounded at the base. 25. *L. callitricaefolium*
Leaves larger, 6–8 by 3–5 mm.; sporophyls extending into a point beyond the sporangia.
Sporophyls long, often attaining 20–40 cm.; leaves mostly regular. 26. *L. aqualupianum.*
Sporophyls short, 1–2 cm.; leaves obtuse or nearly so, irregularly spreading. 27. *L. dichaeoides.*
Leaves lanceolate or lanceolate-ovate.
Leaves 2 mm. or more wide; sporophyls extending beyond the sporangia into a long point. 29. *L. roraimense.*
Leaves under 2 mm. wide; sporophyls shorter than the sporangia. 28. *L. subulatum.*

24. LYCOPODIUM CUNEIFOLIUM Hieron. Bot. Jahrb. **34**: 572. 1905. (Type from Costa Rica, *Hoffmann 50.*)

COSTA RICA: Vulcan de Barba, *Hoffmann 50;* with no locality, 1900, *C. Wercklé.* A plant nearly allied to *L. callitricaefolium* but readily separated by its more distant narrowly obovate leaves.

25. LYCOPODIUM CALLITRICAEFOLIUM Mett. Ann. Sci. Nat. V. **3**: 309. 1865. (Type from Bogota, Colombia, *Triana.*)

RANGE: Ecuador (*Spruce 4792, Sodiro*), Colombia, Costa Rica (*Warscewicz 12.*)

26. LYCOPODIUM AQUALUPIANUM * Spring, Monog. Lycop. **1**: 68. 1842. (Type from Guadeloupe, *L'Herminier*, and Hispaniola, *Neckour.*)

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* This name is probably a misprint for *guadalupianum* to which form Fée changed it in 1866; Urban (1903) writes it "*guadeloupeanum.*" We retain the original orthography as safer.

RANGE: Cuba (*Wright 936*, *Eggers 5165*), Porto Rico (*Sintenis 1546*, *Percy Wilson 155*), [Hispaniola, Guadeloupe], Bolivia (*Rusby 458*). The last named plant is sterile but cannot be separated by its foliage; it is distinct from *Mandon 1529*, which is *L. subulatum*.

27. LYCOPODIUM DICHAEOIDES Maxon, Proc. Biol. Soc. Washington **18**: 231. 1905. (Type from Guatemala, *Cook & Griggs 251*.)

GUATEMALA: Alta Verapaz, near Sepacuité, *Cook & Griggs 251*; between Sepacuité and Secanquim, *Maxon & Hay 3268*. Known only from these two collections now in the United States National Herbarium.

28. LYCOPODIUM SUBULATUM Desv. Encyc. Bot. Suppl. **3**: 544. 1813. (Type from "Amer. merid.")

Represented in typical form in the herbarium of the New York Botanical Garden only by sheets of *Mandon 1529* from Bolivia. There are numerous variations, some of which have been described by Baker. Among these are two sheets from Ecuador collected by Sodiro, which are marked "var. *pastoense*," which differ from each other and must be compared with Baker's type before they can be definitely placed. They probably represent one or more distinct species.

29. **Lycopodium roraimense** sp. nov.

A long slender pendulous epiphyte with sporophyls much longer than the sporangia. Stems over 75 cm. long, 2–3 forked, dorsiventral (except in the sporophyllary region) by the twisting of the leaves, the strobile elongate (30 cm.) and radially symmetrical; leaves lanceolate-ovate, acute, 8–9 mm. long by 2.5 mm. wide, twisted at the base, entire, thin, the midrib slender but distinct; sporophyls triangular, small, 1.5–3.5 mm. long by 1–1.5 mm. wide, extending beyond the sporangia in a point, the margins entire; sporangia conspicuous, nearly circular, exceeding the sporophyls in width.

BRITISH GUIANA: Forest slopes near Roraima (*herb. Jenman*). This plant differs from *L. subulatum*, its nearest ally, in its wider leaves and much longer sporophyls.

CERNUUM GROUP

The species of this group have a close relationship among themselves and are quite isolated from other related species.

Baker,* with characteristic disregard of continental work, reduces all the species involved, to *L. cernuum*, with three varieties, in which citation and synonymy are sadly at variance with accuracy and correctness, and all ideas of geographic distribution are left to reckless abandon.

In 1861 Müller,† with characteristic German positiveness, set aside a Javan plant as the genuine type of *Lycopodium cernuum* L., characterized by having (1) "*Folia caulina squarrosa*" in common with most other species recognized, and (2) "*Amentis centripetali-evolutis*," a character claimed as peculiar to this species, but one difficult to follow in actual material. Further than this he established five new species all from the Old World, besides recognizing *L. marianum* Willd. from the Philippine Islands. The distribution of his five new species was as follows:

Lycopodium Heeschii K. Müll. (*loc. cit.* 164) — Sierra Leone.
Lycopodium secundum K. Müll. (*loc. cit.* 164) — Cape Colony, Natal.
Lycopodium sikkimense K. Müll. (*loc. cit.* 164) — Sikkim (India).
Lycopodium Moritzii K. Müll. (*loc. cit.* 165) — Java.
Lycopodium Hupeanum K. Müll. (*loc. cit.* 165) — Borneo.

In Müller's paper the species of tropical America were not considered, and two earlier descriptions from the Old World were apparently disregarded, *viz*:

Lycopodium vulcanicum Blume, Enum. Pl. Jav. **2**: 266. 1828. (Type from Java.)

Lepidotis convoluta Beauv. Prodr. L'Aetheog. 108. 1805. (Type from "Les deux Indes.") Material in American collections is insufficient to determine the status of Müller's species, but a partial examination of European herbaria convinces us that some of them at least are valid.

Hieronymus has recently ‡ taken up the name *Lycopodium capillaceum* Willd. for the common American species, citing Spring's reference to Willdenow's herbarium note § and stating that Willdenow's plant was from "Nova Andalusia" (Venezuela) instead of "Ins. Marianis" as stated by Spring. After seeing

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* Handbook of Fern Allies 23. 1887.

† MÜLLER, KARL. Zur Kenntniss des *Lycopodium cernuum* L. Bot. Zeitung **19**: 161–165. 1861.

‡ Plantae Lehmannianae etc. Bot. Jahrb. **34**: 573. 1905.

§ Flora **21**^{1}: 165. 1838.

Ceylon material (for we must regard the Ceylon plant as the type of *Lycopodium cernuum*) in various European collections, commencing with that of Linnaeus at London, we are unable yet to point out differences other than minor ones between the plants of Ceylon and those of the West Indies. We are compelled against our tendencies to retain the name *cernuum* for the common species of the American tropics. Hieronymus has also separated two additional South American species, neither of which affect those which had been already separated by us.

The four species from America which we have examined may be separated as follows:

Leaves toothed; axes bristly; strobiles elongate (1.5–4 cm.). 31. *L. curvatum.*
Leaves entire; axes mainly smooth.
  Strobiles short (1 cm. or less), with deeply ciliate-laciniate sporophyls; branches slender. 30. *L. cernuum.*
  Strobiles longer (1.5–2 cm. or more); sporophyls slightly toothed; branches stout.
    Sterile branchlets elongate (5–10 cm.) and pendulous; leaves short and abruptly narrowed. 33. *L. pendulinum.*
    Sterile branchlets short, stout, dichotomously spreading; leaves longer, gradually tapering. 32. *L. tortum.*

30. LYCOPODIUM CERNUUM L. Sp. Pl. 1103. 1753. (Type from "Indiis"; the bulk of the citations commencing with Linnaeus' own Fl. Zeyl. and Dillen indicate that the East India plant is the one which represents the plant as known to Linnaeus and his predecessors. Plumier, Fil. *pl. 165 A* is cited later as an example of an American plant.*)

RANGE: (In America only) Georgia, Florida, Alabama, Mississippi, Cuba, Hispaniola, Porto Rico, Jamaica, S. Thomas, St. Kitts, Guadeloupe, St. Vincent, Dominica, Trinidad, Mexico, Panama, Colombia, Guiana.

31. LYCOPODIUM CURVATUM Sw. Syn. Fil. 178, 402. 1806. (Type from Jamaica.†)

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* As noted above this plant is the one to be renamed in case the American plant is ever distinguished from that of Ceylon.

† In publishing this species Swartz cites in synonymy (*loc. cit.* 178) *Lycopodium arboreum* Gmel. (a name apparently unpublished) and *Lepidotis convoluta* Beauv., a plant imperfectly described in Prodr. L'Aetheog. 108 (1805) from "Les deux Indes." Later (*loc. cit.* 402) Swartz in giving a fuller description cites Jamaica as the definite type locality. We cannot say whether *Lepidotis convoluta* Beauv. is distinct or not, but Swartz's type at least is Jamaican.

JAMAICA: Salt Hill (a mile off the Content road from Gordontown to Cinchona), growing in deep *Sphagnum*, 1903, *Underwood 157*.

The above collection represents, so far as known, the only one made in Jamaica since the time of Swartz. The fine material collected indicates a species abundantly distinct from that common in the vicinity on dry banks.

32. **Lycopodium tortum** Sieber, sp. nov.

A robust much-branched terrestrial plant with long pendent strobiles. Stems erect or ascending, a meter or more high, the secondary branches spreading, triangular in outline, attaining 20 cm. broad by 15 cm. high, repeatedly branched, the terminals inclined irregularly downwards and bearing the sessile strobiles; leaves on the older axes 5 mm. long by 0.5 mm. wide (on younger axes as short as 3 mm.) curved upwards and outward, becoming less curved and more widely spreading on the older axes, the curve commencing at about the middle, and the leaf tapering from above the middle to form an acute apex; margins entire; strobiles 1.5–2 cm. long, 3–4 mm. in diameter, cylindric or slightly angulate at the apex; sporophyls appressed, widely spreading, and but little curved when dry, 2.5 mm. long by 1 mm. wide, the margins irregular, with small scattered uneven teeth.

RANGE: Higher (volcanic) summits of the Lesser Antilles; specimens have been examined as follows:

ST. KITTS: Mt. Misery, *Britton & Cowell 550*.

GUADELOUPE: Mt. Perrin (*herb. Torrey*); 1898 (*herb. Jenman*).

DOMINICA: In old crater near Boiling Lake, Laudat, *Lloyd 315*.

MARTINIQUE: 1897 (*herb. Jenman*); *Sieber, Fl. Mixta 328* (*herb. Kew*).

ST. VINCENT: *H. H. & G. W. Smith 52*.

This species was long ago issued by Sieber under the above name, which in deference to him we have here taken up for the coarse plant of striking habit concerning whose distribution we have now quite definite information. In St. Kitts the species is locally known as "Stag Horn." This plant has been confused with *L. curvatum* Sw., the type locality of which (Jamaica) is quite outside the range of the peculiar species of the volcanic islands.

A second species allied to the last was collected in 1902 by Percy Wilson in the Luquillo Mountains, Porto Rico (*no. 101*), but the specimens are unfortunately in the vegetative condition only; it differs from this species in its much smaller size and in its strongly incurved leaves which are hairy on the lower surface near the base and often toothed. Mature strobiles are a desideratum.

33. LYCOPODIUM PENDULINUM Hook Ic. Pl. **1**: *pl. 90.* 1837.* (Type from Casapi, Peru, *Mathews 1776.*)

RANGE: [Peru]; Cargadira, Bolivia, 8000 ft., *Williams 1386.* Mr. Williams' specimens show a unique plant, widely distinct in habit from any others of the group.

CLAVATUM GROUP

It is a difficult problem to distinguish many of the species of this group, a large proportion of which Baker reduces to the single species *L. clavatum*, whose distribution is curiously given as "Arctic and alpine zones of both hemispheres, also mountains of tropical Asia, Africa and America, Cape, Mascaren [*sic*] Isles and Polynesia." In Jamaica a form occurs from 5000 ft. upwards to the very summit of the Blue Mountains which at present we are not able to separate on structural grounds from our common northern species,† although it differs *toto coelo* in habit. In place of our unobtrusive close-creeping plant, the Jamaican form is rampant in great masses over the paths about the Cinchona plantation, forming a weed, and sprawling over low shrubs in the greatest profusion. Material from the whole world will be needed to elucidate the relations of the species involved in this polymorphic tangle. Besides abundant material from Jamaica we have imperfect collections from Mexico, Guatemala, Colombia, Guiana, Brazil, Ecuador and Bolivia, but insufficient for monographic purposes. For these reasons we prefer to leave the Jamaican plants for the present under

34. LYCOPODIUM CLAVATUM L. Sp. Pl. 1101. 1753. (Type from Europe).

RANGE: Europe and North America from the Arctic zone as far as Pennsylvania; also (provisionally) Jamaica above 5000 ft., and possibly Mexico and Guatemala.

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* *L. Eichleri* Fée, Crypt. Vasc. Bres. *pl. 106. f. 4*, cited by Baker as a synonym, is apparently distinct if Fée's plate is to be relied on, and his plates are usually extremely reliable. Mr. Baker further cites this species incorrectly as *L. pendulum.*

† With a distribution scattered well over the Northeastern States extending as far west as Washington State and Southward to Pennsylvania, this species is far from being either "arctic or alpine" in America, although it does attain both these regions in this country as in Europe.

IULIFORME GROUP

35. **Lycopodium iuliforme** sp. nov.

A low plant with short close-creeping stems and rigid upright monostachyous branches. Creeping stems 6–10 cm. long or more, with numerous roots throughout; leaves in 10 or more ranks, those of the lower surface pale, narrow, and somewhat lax, 2–2.5 mm. long, triangular-subulate from a wider base, those of the lateral surfaces ascending, twisted, 3–5 mm. long, somewhat rigid, ending in a firm acuminate point; erect branches terminal, or becoming apparently lateral from the innovating branches of the prostrate stems, 9–12 cm. high, leafy throughout, the leaves mostly 8-ranked, rather rigid, slightly spreading, 4–5 mm. long, lanceolate-acuminate; strobiles 3–3.5 cm. long, slightly thicker than the stems; sporophyls 8-ranked, lanceolate above from a broad base, the rigid apices wide-spreading; sporangia reniform, 1.5 mm. wide, entirely concealed by the broad base of the sporophyls.

GUIANA: Summit of Roraima, 8,600 ft., *McConnell & Quelch 572*. (Type at the New York Botanical Garden.)

A unique species forming a series of its own, intermediate in a way between the *Inundatum group* and the *Carolinianum group*. It was reported upon by C. H. Wright (Trans. Linn. Soc. II. **6**: 87. 1901) as *L. contiguum* Kl., with which it has only a remote alliance. *L. contiguum* has membranous-tipped leaves and sporophyls, the latter soft, lax, and wide spreading, and with conspicuously erose margins.

§ 3. DIPHASIUM

The members of the section *Diphasium*, which forms a physiological rather than a structural alliance, will group themselves somewhat naturally as follows:

Vertical stems simple; foliage shoots prostrate, creeping, the leaves of the two under rows larger and appearing lateral. **Carolinianum Group.**

Vertical stems much branched.

- Terminal foliage shoots with 4 rows of dimorphous leaves; upper surface with one row of leaves. **Complanatum Group.**
- Terminal foliage shoots with 5 (or 6) rows of leaves, the upper surface with three rows of reduced leaves. **Scariosum Group.**

CAROLINIANUM GROUP

The species of this group were referred by Baker to our familiar *L. carolinianum* of the Southern States, but will readily separate themselves into at least three species as follows:

Sporophyls serrulate; under leaves triangular, nearly as broad at base as long; sporangia round-renate. 36. *L. goyazense.*

Sporophyls entire.

  Sporangia depressed-renate; under leaves ovate, acute. 37. *L. meridionale.*

  Sporangia round-renate; under leaves lanceolate. *L. carolinianum.*

36. **Lycopodium goyazense** sp. nov.

A small creeping plant with stout erect branches bearing large strobiles. Creeping stems 6 cm. or more long, notably dorsiventral, producing occasional short branches; leaves strongly dimorphic, those of the two under rows appearing lateral, triangular, symmetric, 2 mm. wide at the base, not contracted, 2.5 mm. long, acute, entire, thick, somewhat imbricated; those of the three upper rows small, triangular, twice as long as broad or more, stiff, remote from each other and thus exposing the broad upper surface of the stem; erect branches (peduncles) 7–9 cm. long, 1.5 mm. thick, with triangular scale-like leaves which are 4 mm. long by 1.5 mm. wide at base and serrulate; strobiles 3–4 cm. long, stout; sporophyls larger than the lateral leaves, 2.5 mm. wide by 5 mm. long, ovate, acuminate, not contracted above the middle; margins serrulate throughout.

BRAZIL: Goyaz, *Glaziou 22644;* also less perfect specimens from Minas Geraes, *Claussen.*

37. **Lycopodium meridionale** sp. nov.

A small close-creeping, sparingly branched plant with solitary upright strobilary branches. Creeping stems up to 40 cm. or more long, 1–1.5 mm. thick, with occasional short (2–4 cm.) lateral branches; leaves strongly dimorphic, those of the two under rows appearing lateral, 5 mm. long by 2 mm. wide, ovate, acuminate, falcate, the midrib curved asymmetrically and parallel to the proximal leaf-margin; leaves of the upper four rows subulate, spreading, 3.5 mm. long by 1 mm. wide; upright branches (peduncles) 8–26 cm. long, oftener rising from the short prostrate branches, with whorls of subulate spreading scale-like leaves with parallel margins or slightly contracted below the middle, entire or slightly erose near the base; strobiles 2.5–8 cm. long; sporophyls 2 mm. wide by 4 mm. long, triangular, contracted at the middle and subulate above, spreading, the margins entire above, erose below the middle, those of the same level not contiguous.

RANGE: Probably widely distributed through the tropics of meridional America. Specimens have been examined as follows:

PORTO RICO: Dry savannahs, Luquillo Mountains, *Percy Wilson 94* (type) (two sheets); *Sintenis 1544.*

CUBA: *Wright 1819.*

DOMINICA: Laudat, high wet turf, Boiling Lake, *Lloyd 316*.

GUIANA: Wet ground, Essequibo, *Jenman* (two sheets).

BRAZIL: San Carlos and Rio Negro, *Spruce 3039*; Moritiba, *Blanchet 3470*.

(LYCOPODIUM CAROLINIANUM L., ranging from New Jersey to Texas, is not found outside of the Southern States, and is introduced in the above synopsis for comparison only.)

COMPLANATUM GROUP

The only member of this group in the West Indies we described from herbarium material before having seen the plant in the field. Like *L. clavatum* of another group, *L. Fawcettii* forms a weed in the paths of the Cinchona plantation and grows luxuriantly, ascending over bushes and low shrubbery in a sprawling fashion and is thus quite in contrast with its more modest congeners of the Northern States. The status of *L. thyoides* H.B.K. of South America still remains to be determined. Our single West Indian species is

38. LYCOPODIUM FAWCETTII Lloyd & Underw. Bull. Torrey Club **27**: 167. 1900. (Type from Jamaica.)

This species is common in Jamaica from 5000 feet altitude to the extreme summit of the Blue Mountains. It has also been found in Hispaniola (*Wright, Parry & Brummel 37; Picarda 767; Eggers 2270*).

SCARIOSUM GROUP

The members of this group are mostly from tropical or south temperate regions. *Lycopodium scariosum*, with which Baker has confused the American species, is from New Zealand, and there are other Old World species. The American species are mostly South American, only a single species reaching Jamaica in the West Indies. The American species may be separated as follows:

- Lateral leaves of the dorsiventral branches directed upwards, straight, rigid, tapering from the base, not sharply pointed nor crowded. 39. *L. Gayanum.*
- Lateral leaves of the dorsiventral branches curved downwards.
  - Leaves ascending, cuspidate, strongly revolute. 42. *L. Holtoni.*
  - Leaves spreading, slightly curved.
    - Lateral leaves broad near the apex, obtuse. 40. *L. lindsaeaceum.*
    - Lateral leaves broadest at the decurrent base. 41. *L. Jussiaei.*

39. LYCOPODIUM GAYANUM Remy*; Gay, Hist. Chile Bot. **6**: 545. 1853. (Type from Chile, *Gay.*).

A single specimen in the Meissner (Columbia) herbarium from Valdivia, Chile, *no. 208* of "Bridges or Cuming?" represents this species in our collections as described, and shows characters warranting us in maintaining it.

40. LYCOPODIUM LINDSAEACEUM Spring, Flora **21**: 180. 1838. (Type from Peru.)

This species was united by Baker with the New Zealand *L. scariosum*, which naturally has little to do with the new world representatives of the group. The species is represented in the herbarium of the New York Botanical Garden by a single specimen collected by Rusby in Bolivia, and by several more recently brought from the same country by Williams.

41. LYCOPODIUM JUSSIAEI Desv. Encyc. Bot. Suppl. **3**: 543. 1813. (Type from Peru.)

We have specimens of this species collected by Spruce and Sodiro in Ecuador and were inclined for a time to separate Jamaica specimens collected by Purdie and by Jenman and more recently by Underwood and by Maxon. Jamaica material shows a marked differentiation in texture, the leaves being thinner, more distant, acute rather than mucronate, and inequilateral, *i. e.*, with the midrib nearer the anterior leaf-margin. In Jamaica the species is rare, growing at altitudes above 5000 feet. Baker (*loc. cit.*) reduced the species to a variety of *L. scariosum* of the Old World.

42. **Lycopodium Holtoni** sp. nov.

Main stems creeping, sending up lateral shoots 25 cm. or more tall, with foliage shoots ending in bifid peduncles; lateral (upper) leaves of the dorsivental ascending branches crowded and imbricate, ascending, the lateral free margin revolute (so that the leaf appears strongly twisted in the dry condition), the upper surface arched, thick, coriaceous, cuspidate; ascending shoots 3–8 mm. wide, varying in diameter throughout the length; leaves of the under three rows 4–5 mm. long, 1.5 mm. wide at the base, awl-shaped, thin, scarious-margined and often slightly lacerate, the apices scarious or hair-like; strobiles 5–6 cm. long, 5 mm.

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*This species is usually referred to Remy and it is not likely that Gay would name a species after himself, but we have failed to find in this volume any evidence that Remy described this species.

thick, appearing ridged by the somewhat carinate sporophyls; sporophyls ovate, acuminate with a scarious lacerate tip and a narrow (1 mm.) claw, 5 mm. long, by 2.5 mm. wide, the margin slightly erose; sporangia depressed-triangular, 3 mm. broad by 1.75 mm. deep, folded and irregular, sessile.

COLOMBIA: In montibus juxta Bogotam, 7 Oct. 1852, *I. F. Holton 79.*[*]

Unless otherwise noted all the above citations of specimens are from the combined herbaria of Columbia University and the New York Botanical Garden, now forming a single collection.

COLUMBIA UNIVERSITY.

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[*] The extensive collection of Isaac F. Holton was one of the first made in Colombia and has never been studied; a full set of the collections is in the Torrey herbarium; Holton went out from Middlebury College on a twenty months' trip through Colombia. He afterwards published an account of his travels which bears the following title: New Granada: twenty months in the Andes. New York, 1857. A copy has recently been added to the library of the New York Botanical Garden.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1906)

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

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

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

Andrews, E. A. Polarity in the weeping willow. Torreya **6**: 1–5. 25 Ja 1906.

Arthur, J. C. New species of *Uredineae*—IV. Bull. Torrey Club **33**: 27–34. 8 F 1906.

New species in *Uromyces*, *Puccinia* (3), *Cronartium*, *Hyalopsora*, *Cerateliun* gen. nov., *Coleosporium*, *Uredo*, and *Aecidium* (4).

Bates, J. M. *Astragalus lotiflorus nebraskensis.* Torreya **5**: 215, 216. 10 Ja 1906.

Berry, E. W. Fossil plants along the Chesapeake and Delaware canal. Jour. N. Y. Bot. Gard. **7**: 5–7. Ja 1906.

Breazeale, J. F. Effect of certain solids upon the growth of seedlings in water cultures. Bot. Gaz. **41**: 54–63. *f. 1–4.* 26 Ja 1906.

Britton, N. L. The Cuban columneas. Torreya **5**: 215. 10 Ja 1906.

Cannon, W. A. A curious cactus fruit. Torreya **5**: 216, 217. 10 Ja 1906.

Chrysler, M. A. The nodes of grasses. Bot. Gaz. **41**: 1–16. *pl. 1, 2.* 26 Ja 1906.

Cockerell, T. D. A. The evolution of species through climatic conditions. Science II. **23**: 145, 146. 26 Ja 1906. [Illust.]

Cockerell, T. D. A. *Rhus* and its allies. Torreya **6**: 11, 12. 25 Ja 1906.

Criddle, N. The fly agaric (*Amanita muscaria*) and how it affects cattle. Ottawa Nat. **19**: 203, 204. 3 F 1906.

Evans, A. W. *Hepaticae* of Puerto Rico — VI. *Cheilolejeunea*, *Rectolejeunea*, *Cystolejeunea*, and *Pycnolejeunea*. Bull. Torrey Club **33**: 1–25. *pl. 1–3*. 8 F 1905.

Rectolejeunea and *Cystolejeunea* are new genera.

Farmar, L. *Oxalis adenophylla*. Curt. Bot. Mag. IV. **2**: *pl. 8054*. 1 Ja 1906.

Native of Chile.

Farmer, J. B. Sporogenesis in *Pallavicinia*. Bot. Gaz. **41**: 67–69. 26 Ja 1906.

Faull, J. H. A preliminary note on ascus and spore formation in the *Laboulbeniaceae*. Science II. **23**: 152, 153. 26 Ja 1906.

Gleason, H. A. Notes on some southern Illinois plants — III. Torreya **6**: 5–8. 25 Ja 1906.

Greene, E. L. *Madronella*. Leaflets **1**: 168, 169. 23 Ja 1906.

A new name for the genus commonly called *Monardella*.

Greene, E. L. New Asteraceous genera. Leaflets **1**: 173, 174. 23 Ja 1906.

Tumionella and *Hesperodoria* (without diagnoses).

Greene, E. L. A new northern *Antennaria*. Ottawa Nat. **19**: 197. 6 Ja 1906.

A. athabascensis sp. nov.

Greene, E. L. New species of *Isocoma*. Leaflets **1**: 169–173. 23 Ja 1906.

Descriptions of 11 new species.

Greene, E. L. New species of *Pentstemon*. Leaflets **1**: 161–167. 23 Ja 1906.

Descriptions of 21 new species.

Greene, E. L. Segregates from *Sieversia*. Leaflets **1**: 174–176. 23 Ja 1906; 177–179. 30 Ja 1906.

Acomastylis, with 5 species, and *Erythrocoma*, with 14 species, mostly new.

Greene, E. L. Various new species. Leaflets **1**: 180–182. 30 Ja 1906.

Petasites (2), *Euthamia*, and *Poygonatum* (3).

Harper, R. M. A statistical method for comparing the age of different floras. Torreya **5**: 207–210. 10 Ja 1906.

Hillig, F. J. A new case of mutation. Ohio Nat. **6**: 448. 15 Ja 1906.

Commelina nudiflora L.

Hitchcock, A. S. Notes on North American grasses. V. Some Trinius *Panicum* types. Bot. Gaz. **41**: 64–67. 26 Ja 1906.

Hollick, A. Origin of the amber found on Staten Island. Jour. N. Y. Bot. Gard. **7**: 11, 12. Ja 1906.

Kellerman, W. A., York, H. H., & Gleason, H. A. Annual report on the State Herbarium for the years 1903, '04, and '05. Ohio Nat. **6**: 441, 442. 15 Ja 1906.

Kraemer, H. Artificial coloring of flowers. Torreya **5**: 211–213. 10 Ja 1906.

McFarland, J. H. The trees of a great city [New York]. The Outlook **82**: 203–213. F 1906. [Illust.]

McOuat, M. E. The swan song of the leaves. Ottawa Nat. **19**: 197–200. 6 Ja 1906.

Merriman, M. L. Nuclear division in *Zygnema*. Bot. Gaz. **41**: 43–53. *pl. 3, 4.* 26 Ja 1906.

Montgomery, E. G. What is an ear of corn? Pop. Sci. Mo. **68**: 55–62. *f. 1–14.* Ja 1906.

Moore, A. C. Sporogenesis in *Pallavicinia*. Bot. Gaz. **41**: 69, 70. 26 Ja 1906.

Murrill, W. A. Collecting fungi in Maine. Jour. N. Y. Bot. Gard. **6**: 199–202. [Ja 1906.]

Murrill, W. A. A key to the *Agariceae* of temperate North America. Torreya **5**: 213, 214. 10 Ja 1906.

Murrill, W. A. The *Polyporaceae* of North America — XIII. The described species of *Bjerkandera, Trametes,* and *Coriolus*. Bull. Torrey Club **32**: 633–656. 22 Ja 1906.

Nash, G. V. The *coco de mer* or double cocoanut. Jour. N. Y. Bot. Gard. **7**: 7–11. *f. 1.* Ja 1906.

Robinson, B. L. The generic concept in the classification of the flowering plants. Science II. **23**: 81–92. 19 Ja 1906.

Rydberg, P. A. *Astragalus* and its segregates as represented in Colorado. Bull. Torrey Club **32**: 657–668. 22 Ja 1906.
Seventeen genera (7 new) are recognized, with 84 species (3 new).

Rydberg, P. A. *Grayia* or *Eremosemium*. Torreya **6**: 8–10. 25 Ja 1906.

Schaffner, J. H. Additional observations on self-pruning. Ohio Nat. **6**: 450, 451. 15 Ja 1906.

Small, J. K. Studies in North American *Polygonaceae* — II. Bull. Torrey Club **33**: 51–57. 8 F 1906.

New species are described in *Eriogonum* (8) and *Polygonum*.

Sterki, V. Some notes on *Martynia*. Ohio Nat. **6**: 444–447. 15 Ja 1906.

Tillman, O. I. The embryo-sac and embryo of *Cucumis sativus*. Ohio Nat. **6**: 423–430. *f. 1–33*. 15 Ja 1906.

Transeau, E. N. The bogs and bog flora of the Huron River valley. Bot. Gaz. **41**: 17–42. *f. 12–16*. 26 Ja 1906.

Trelease, W. Address before the Central Botanists. Science II. **23**: 97–100. 19 Ja 1906.

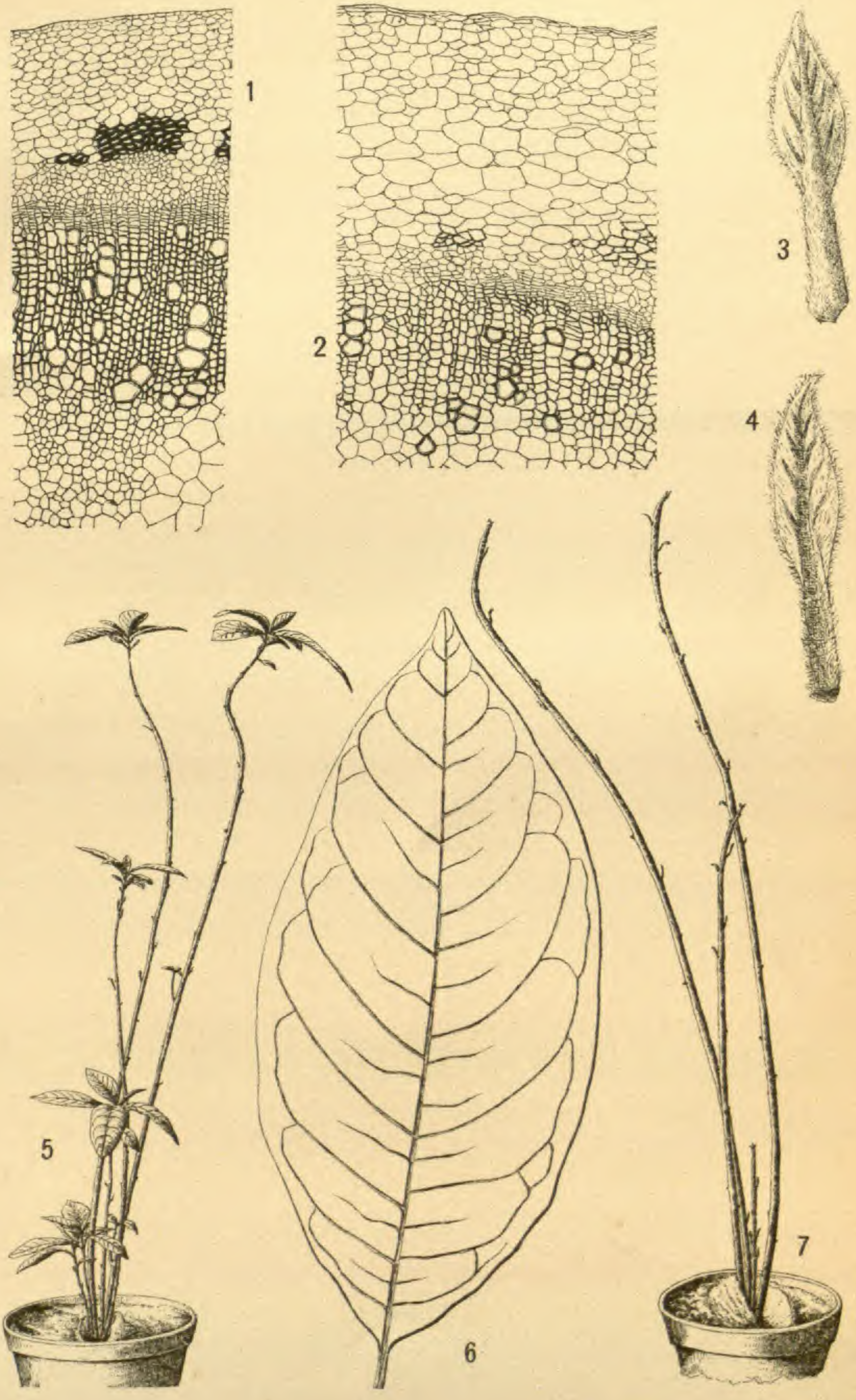
Presidential address at Ann Arbor meeting of the Botanists of the Central States, December 28, 1905.

Underwood, L. M. The genus *Stenochlaena*. Bull. Torrey Club **33**: 35–50. *f. 1–10*. 8 F 1906.

Recognizes 23 old-world species, of which 3 are described as new.

Wright, C. H. *Wittmackia lingulata*. Curt. Bot. Mag. IV. **2**: *pl. 8056*. 1 Ja 1906.

Native of the West Indies.



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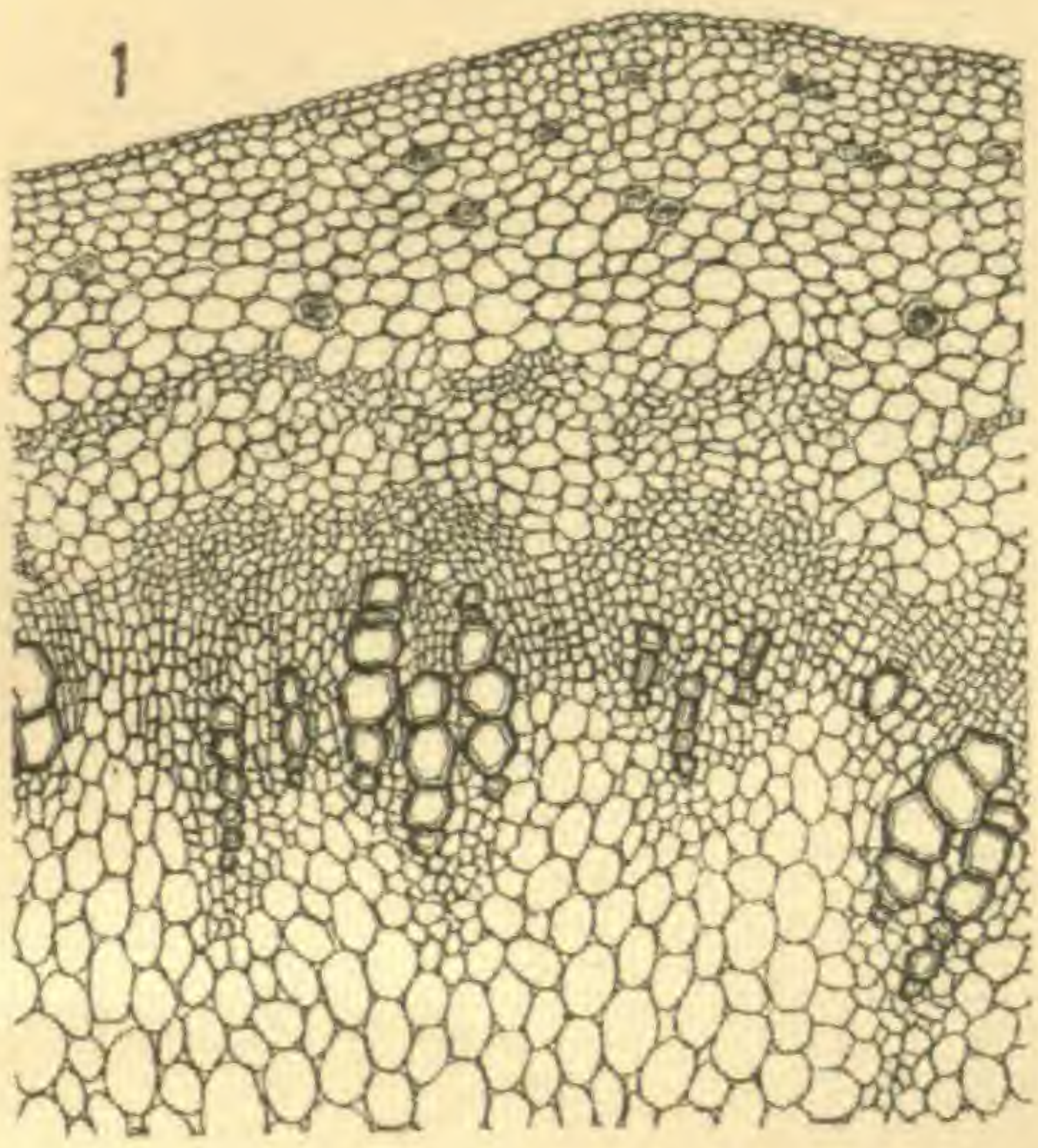

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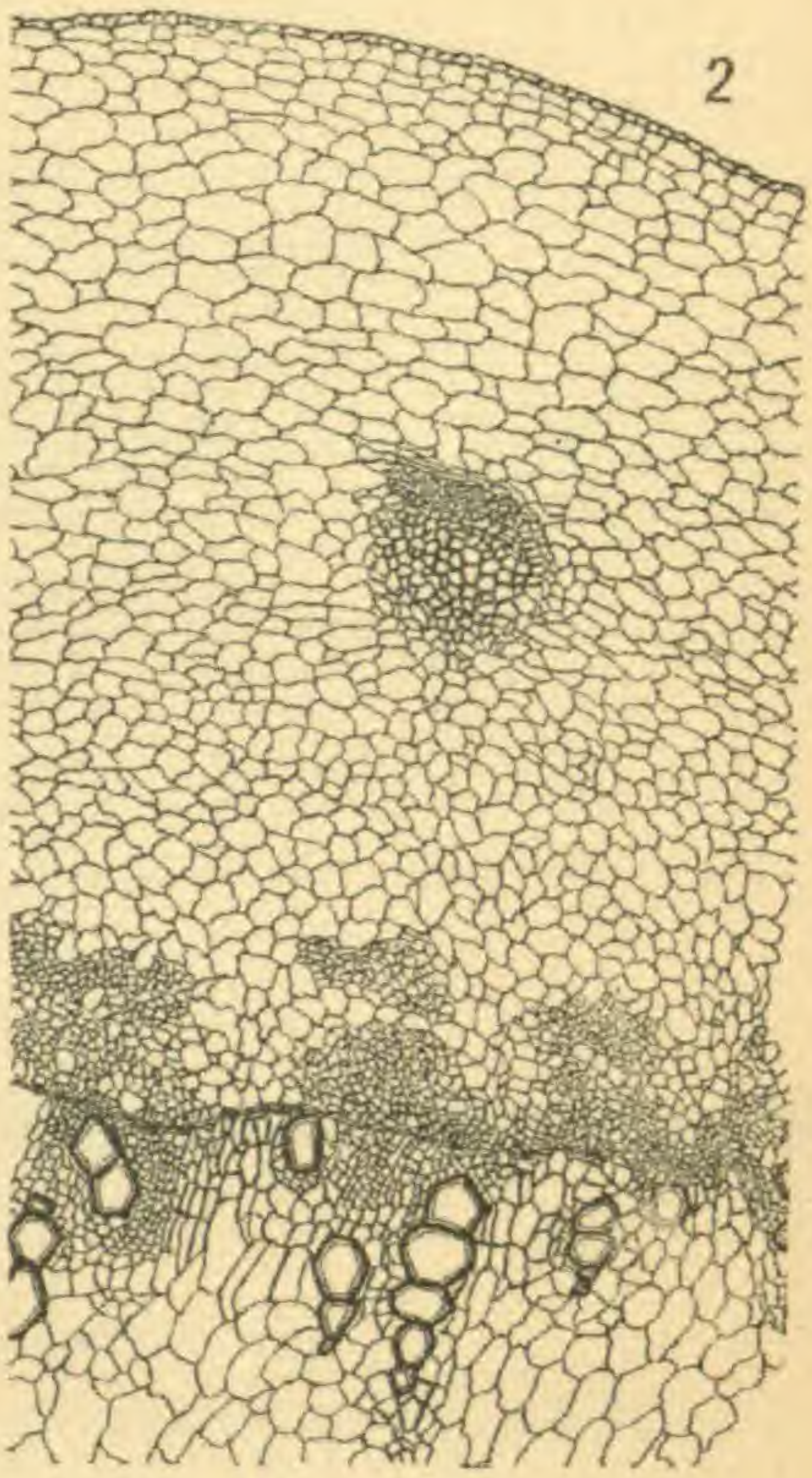

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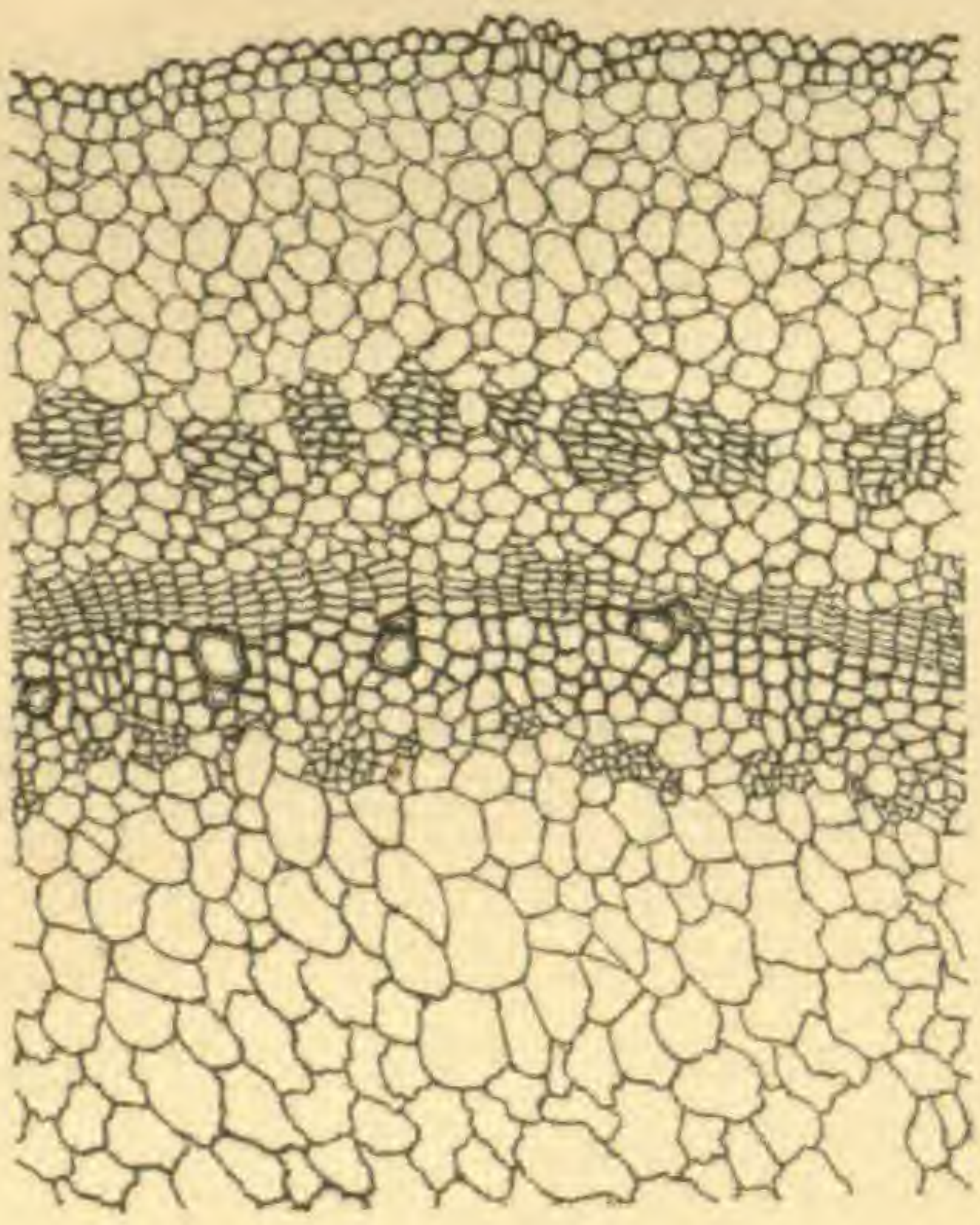

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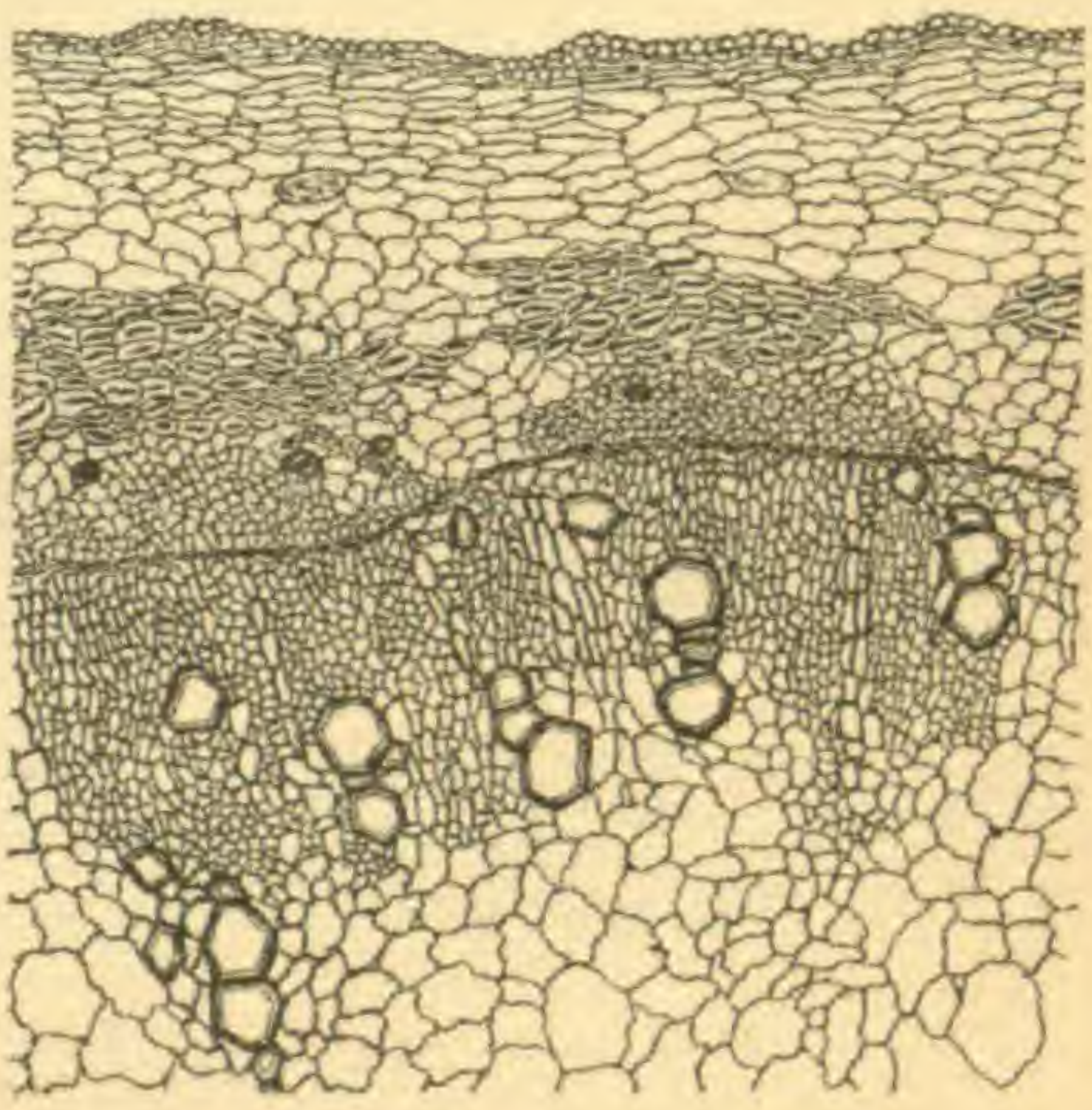

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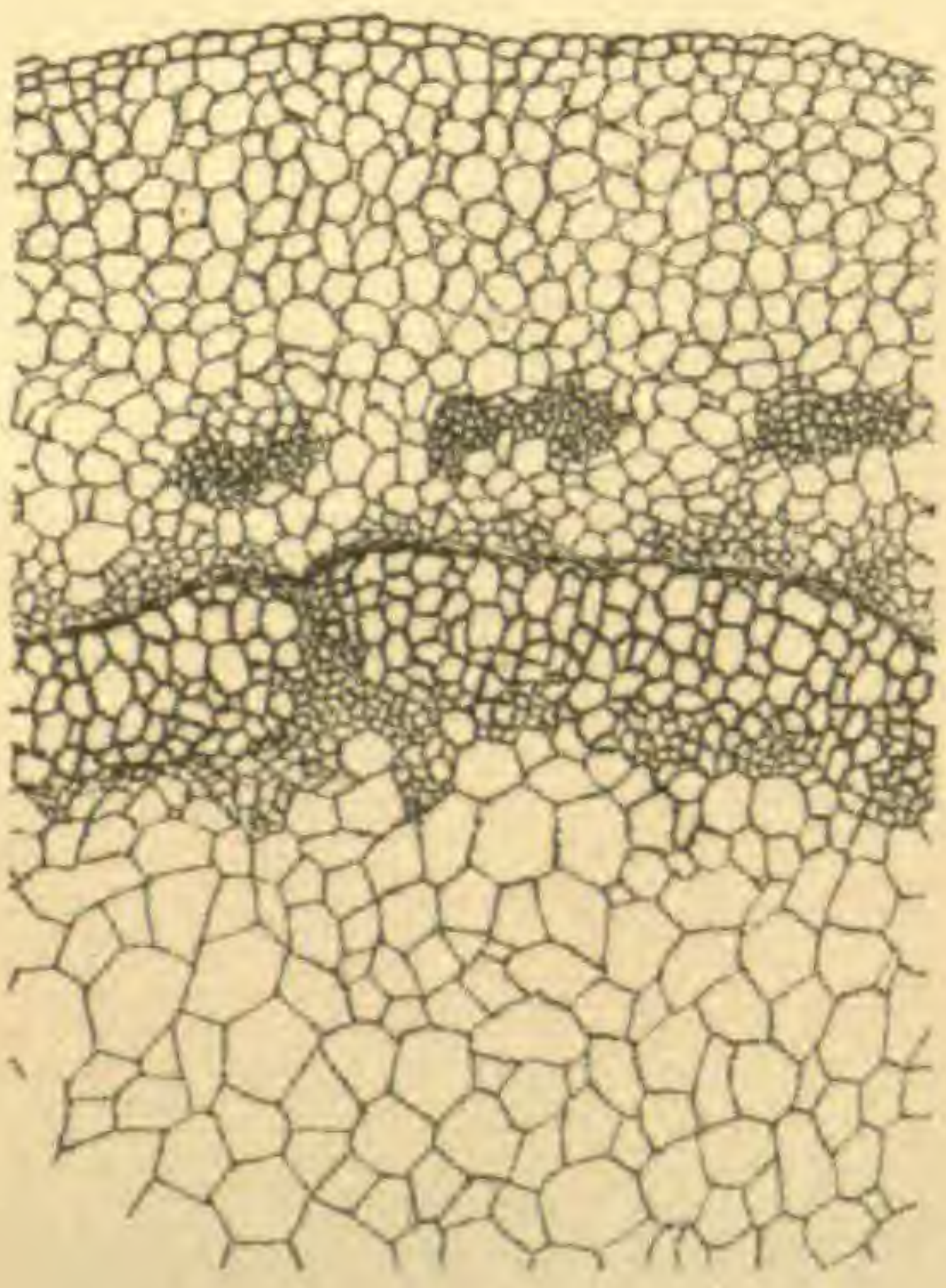

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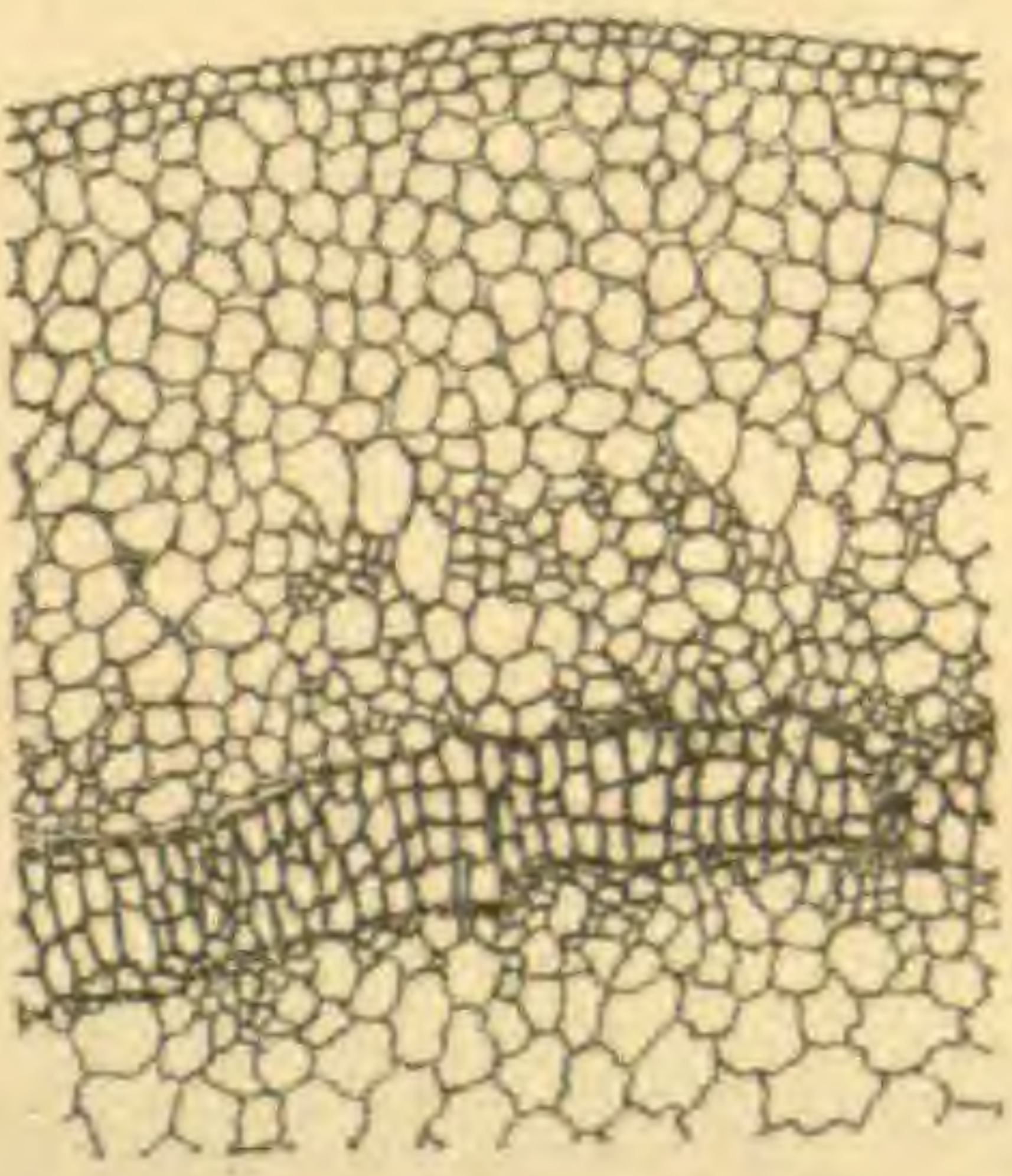

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STUDIES IN ETIOLATION

PUBLICATIONS BY OFFICERS AND STUDENTS OF THE DEPARTMENT OF BOTANY, COLUMBIA UNIVERSITY

1. MEMOIRS OF THE DEPARTMENT :

Vol. 1. A Monograph of the North American Species of the Genus *Polygonum* (1895). By John Kunkel Small, Fellow in Botany, 1893–1895 ; Curator of the Herbarium, 1895–1898.

Quarto, 178 pages, 84 plates. Price $6.00.

Vol. 2. A Monograph of the North American Potentilleae (1898). By Per Axel Rydberg, Fellow in Botany, 1896–7.

Quarto, 224 pages, 112 plates. Price $6.00.

2. CONTRIBUTIONS FROM THE DEPARTMENT :

Vol. 1. Nos. 1–25. 1886–1892. Price $5.00.
Vol. 2. Nos. 26–50. 1892–1894. Price $5.00.
Vol. 3. Nos. 51–75. 1894–1895. Price $5.00.
Vol. 4. Nos. 76–100. 1895–1896. Price $5.00.
Vol. 5. Nos. 101–125. 1896–1897. Price $5.00.
Vol. 6. Nos. 126–150. 1897–1898. Price $5.00.
Vol. 7. Nos. 151–175. 1898–1901. Price $5.00.
Vol. 8. Nos. 176–200. 1901–1902. Price $5.00.
Vol. 9. Nos. 201–. 1903–(current).

List of separate numbers available on application.

3. A Text-book of General Lichenology (1896). By Albert Schneider, Fellow in Botany, 1895–1896.

Octavo, 230 pages, 76 plates. Price $4.25 (cloth) ; $3.80 (paper). Published by Willard N. Clute & Co. Binghamton, N. Y.

The Department invites propositions relative to exchanges of herbarium material for any of the above named publications. Address Professor L. M. Underwood, Columbia University, N. Y. City.

4. An Illustrated Flora of the Northern United States, Canada, and the British Possessions from Newfoundland to the Parallel of the Southern Boundary of Virginia, and from the Atlantic Ocean westward to the 102d Meridian (1896–1898). By Nathaniel Lord Britton, Professor of Botany, 1891–1896 ; Emeritus Professor 1896–, and Hon. Addison Brown.

Three volumes, royal octavo. Vol. 1, 612 pages ; Vol. 2, 642 pages ; Vol. 3, 588 pages ; 4162 figures in the text, illustrating every species described.

Published by Charles Scribner's Sons, New York. Price, in cloth, $9.00 for the three volumes ; with the indexes and keys bound separately, $10.00.

5. Our Native Ferns and their Allies. (Sixth Edition) 1900. By Lucien Marcus Underwood, Professor of Botany, 1896–.

Duodecimo, 158 pages, 35 figures. Published by Henry Holt & Co., New York. Price $1.00.

6 Moulds, Mildews, and Mushrooms. By Lucien Marcus Underwood, Professor of Botany, 1896—.

Duodecimo, 236 pages, 10 plates. Published by Henry Holt & Co. Price $1.50.

7. A Text-book of General Botany (1897). By Carlton Clarence Curtis, Assistant in Botany, 1892–1895 ; Tutor in Botany, 1895–.

Octavo, 360 pages; 87 illustrations. Published by Longmans, Green & Co., New York. Price $3.00.


EIMER
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VOL. 33 MARCH, 1906 NO. 3

BULLETIN

OF THE

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PUBLICATIONS

All subscriptions and other business communications relating to the publications of the Club should be addressed to the Treasurer, Carlton C. Curtis, Columbia University, New York City.

Bulletin. Monthly, established 1870. Price, $3.00 a year; single numbers 30 cents. Of former volumes, only 2, 3, 5, 13, 20, 21, and 24–31 can be supplied separately; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Manuscripts intended for publication in the BULLETIN should be addressed to Dr. John Hendley Barnhart, Editor, New York Botanical Garden, Bronx Park, New York City.

Torreya. Monthly, established 1901. Price, $1.00 a year. Manuscripts inended for publication in TORREYA should be addressed to Dr. Marshall A. Howe, Editor, New York Botanical Garden, Bronx Park, New York City.

Memoirs. Occasional, established 1889. (See last pages of cover.)

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

Vol. 33 No. 3

BULLETIN

OF THE

TORREY BOTANICAL CLUB

MARCH, 1906

The Hepaticae of Bermuda

ALEXANDER WILLIAM EVANS

(WITH PLATE 6)

Very little has been published on the hepatic flora of Bermuda. A short list by Mitten,* which appeared over twenty years ago, and a few scattered references of later date apparently include everything. In Mitten's list only six species are recorded. These were all collected by Mr. H. N. Moseley, one of the botanists of the Challenger Expedition, although one of the species noted had been previously found by Governor Lefroy. They are listed under the following names: *Aneura palmata*, *Cephalozia connivens*, *Dumortiera hirsuta*, *Otiona Aitonia*, *Pleuroschisma prostratum* and *Radula pallens*. Of these species the *Aneura* (or *Riccardia*) *palmata* is marked with an interrogation-point, the determination having been based on poor and sterile material. Since *R. palmata* is a species with a distinctly northern distribution, it would hardly be expected in Bermuda and is therefore omitted from the list which follows. It is possible that the specimens in question ought to have been referred to *R. latifrons* instead. Of the remaining five species two require a word of explanation. *Pleuroschisma prostratum* is of course a synonym of *Odontoschisma prostratum*, and Dr. M. A. Howe kindly reports that the sterile specimens of *Otiona Aitonia* preserved at Kew really represent the common *Reboulia hemisphaerica*. These five species have all been brought from Bermuda by later collectors.

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* Challenger Rep. Botany 1^2: 92, 93. 1884. — The same list, with the exception of *Radula pallens*, was originally published by Mitten in Jour. Linn. Soc. Bot. 15: 61. 1876.

[The BULLETIN for February 1906 (33: 67–128, *pl. 4, 5*) was issued 14 Mr 1906.]

Within the past few years three additional species have been recorded. Two of these, *Cephalozia divaricata* and *Telaranea nematodes*, are mentioned by Howe, who also confirms the presence of *Cephalozia connivens* on the Island.* The third species, *Cololejeunea Jooriana*, is noted by the writer.† Eight hepatics in all, therefore, according to the published records, are satisfactorily known from Bermuda.

The present paper is based on six recent collections and increases the number of known species to twenty-three. These collections are as follows: 1. Four species, found by Professor W. G. Farlow in January 1900; 2. Nineteen species, found by Dr. M. A. Howe in July 1900; 3. Five species, found by Mrs. Helen M. Norcross in 1901; 4. One species, found by Professor W. R. Coe in 1903; 5. One species, found by Miss L. DeF. Haynes in 1903; and 6. Fifteen species, found by Mrs. N. L. Britton in 1905. Although it is probable that other species remain to be discovered, these collections doubtless include most of the conspicuous forms and give a fairly complete representation of the hepatic flora as a whole.

MARCHANTIACEAE

1. REBOULIA HEMISPHAERICA (L.) Raddi. Without definite locality (*Moseley*). On stone walls (*Farlow*). On stones in a cemetery, Hamilton (*Howe*). On shaded walls, Hamilton and Paget Parish (*Howe*). Paynter's Vale (*Mrs. Norcross*). Roadside bank, North Side (*Mrs. Britton*).

2. LUNULARIA CRUCIATA (L.) Dumort. At base of walls, Hamilton (*Howe*).

3. DUMORTIERA HIRSUTA (Sw.) Nees. Without definite locality (*Moseley*). On rocks, Church Cave (*Howe, Mrs. Britton*).

4. MARCHANTIA POLYMORPHA L. Without definite locality (*Miss Haynes*).

METZGERIACEAE

5. RICCARDIA LATIFRONS Lindb. Devonshire Marsh (*Howe, Mrs. Britton*).

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* Bull. Torrey Club **29**: 282, 286. 1902.

† Mem. Torrey Club **8**: 174. 1902.

6. RICCARDIA MULTIFIDA (L.) S. F. Gray. Devonshire Marsh (*Mrs. Britton*).

7. METZGERIA CONJUGATA Lindb. On rocks, Church Cave (*Howe*). Walsingham (*Mrs. Norcross*). The specimens are all sterile, and the determination is therefore somewhat doubtful.

8. PALLAVICINIA LYELLII (Hook.) S. F. Gray. Devonshire Marsh (*Farlow, Howe, Mrs. Britton*). Paget Marsh (*Mrs. Britton*).

JUNGERMANNIACEAE

9. PLAGIOCHILA SMALLII Evans. In a cave, Paynter's Hill (*Howe*). Paynter's Vale (*Mrs. Britton*).

10. CEPHALOZIA CONNIVENS (Dicks.) Lindb. Without definite locality (*Moseley*). Devonshire Marsh (*Howe, Mrs. Britton*).

11. CEPHALOZIA DIVARICATA (Sm.) Dumort. Devonshire Marsh (*Farlow, Howe*).

12. ODONTOSCHISMA PROSTRATUM (Sw.) Trevis. Without definite locality (*Moseley*). Devonshire Marsh (*Howe, Mrs. Britton*).

13. KANTIA TRICHOMANIS (L.) S. F. Gray. On old stump of *Osmunda*, Devonshire Marsh (*Mrs. Britton*).

14. TELARANEA NEMATODES (Gottsche) M. A. Howe. Devonshire Marsh (*Howe*).

15. RADULA PALLENS (Sw.) Nees. Without definite localities (*Lefroy, Moseley*). On rocks, Church Cave (*Howe, Mrs. Britton*). On rocks in a cave, Paynter's Hill (*Howe*). Walsingham and Paynter's Vale (*Mrs. Norcross*).

16. COLOLEJEUNEA JOORIANA (Aust.) Evans. On trees, Paynter's Hill and Devonshire Marsh (*Howe*). A few specimens only.

17. COLOLEJEUNEA MINUTISSIMA (Sm.) Schiffn. On buttonwood, Devonshire Marsh (*Howe*). On *Celtis*, Walsingham Caves (*Mrs. Britton*).

18. LEJEUNEA GLAUCESCENS Gottsche. On stones, Walsingham (*Howe, Mrs. Norcross, Mrs. Britton*). On rocks, Church Cave (*Howe*). Gully, Tuckerstown (*Mrs. Britton*).

19. RECTOLEJEUNEA PHYLLOBOLA (Nees & Mont.) Evans. Devonshire Marsh (*Farlow*). On trees, Church Cave, Walsingham and Paynter's Hill (*Howe*). On sticks and shrubs, near Walsingham Caves (*Howe*). On trees, Walsingham Caves (*Mrs. Norcross, Mrs. Britton*).

20. EUOSMOLEJEUNEA OPACA (Gottsche) Steph. On trees and rocks, Paynter's Hill (*Howe*).

21. CROSSOTOLEJEUNEA BERMUDIANA sp. nov. (see description below). On the ground and on rocks, Flatts (*Coe*). Paynter's Vale (*Mrs. Britton*).

22. JUBULA PENNSYLVANICA (Steph.) Evans. Paynter's Hill (*Howe*). A few sterile fragments only, but apparently referable to this species.

23. FRULLANIA SQUARROSA (R. Bl. & N.) Dumort. On roots of mangrove, Walsingham (*Howe*). Cave, Paynter's Vale (*Mrs. Britton*).

It will be seen from the species listed that over 65 per cent. are *Jungermanniaceae* and that the others are equally divided between the *Marchantiaceae* and the *Metzgeriaceae*. The *Ricciaceae* are as yet unrepresented. Of the *Jungermanniaceae* more than half belong to the *Jubuleae*.

The flora on the whole is most closely related to that found in the eastern part of North America, thirteen species being common to Connecticut and the same number to Florida. At the same time it will be noted that twelve of the species occur in the British Isles and that about as many have been reported from the West Indies. If, however, species are excluded which are almost cosmopolitan, such as *Marchantia polymorpha* and *Reboulia hemisphaerica*, it will be found that the others are nearly all distinctly southern or even tropical in their distribution. The subtropical character of the flora is also illustrated by the relatively large number of the *Jubuleae*.

Crossotolejeunea bermudiana sp. nov.

Yellowish-green, varying to pale-green and becoming brownish with age, growing in depressed tufts: stems 0.08 mm. in diameter, prostrate and loosely adherent to the substratum, sparingly and irregularly branched, the branches widely spreading: leaves distant to loosely imbricated, the lobe widely spreading, more or less convex and sometimes inflexed at the apex, falcate, 0.5 mm. long, 0.4 mm. wide, outer portion broadly orbicular-ovate, abruptly dilated from a narrow basal region, antical margin straight or slightly incurved near the base, then strongly outwardly curved to the apex, arching partially or wholly across axis, postical margin also more or less curved, apex broad, usually abruptly acute or apiculate, whole margin (except close to the antical base) minutely crenulate from projecting cells; lobule ovoid, 0.17 mm. long, 0.1 mm. wide, inflated throughout, keel strongly arched, forming an angle of about 90° with the postical margin of lobe, free margin involute to beyond the apex, sinus straight to lunulate, apical tooth blunt and straight, bearing a hyaline papilla at its proximal base; cells of lobe averaging 17 μ at the margin, $25 \times 19 \mu$ in the middle and $35 \times 23 \mu$ at the base, more or less convex, walls thin, trigones and the rather numerous intermediate thickenings small but usually distinct, cuticle smooth, ocelli none: underleaves distant, orbicular, 0.15 mm. long, bifid about one half with erect, obtuse, acute or apiculate divisions and a narrow, acute or obtuse sinus, margin everywhere crenulate from projecting cells, sometimes obscurely and bluntly unidentate on the sides: inflorescence autoicous: ♀ inflorescence sometimes on a very short branch (with a single rudimentary leaf besides the bracts), sometimes on a leading branch, innovating on one side, rarely on both, the innovations usually sterile; bracts erect-spreading, the lobe ovate to obovate, 0.55 mm. long, 0.3 mm. wide, apex obtuse to acute or apiculate, margin sparingly and irregularly angular-dentate, otherwise crenulate, lobule ligulate, 0.4 mm. long, 0.08 mm. wide, mostly blunt at apex, crenulate; bracteole slightly connate on one side, ovate, 0.5 mm. long, 0.3 mm. wide, bifid about two fifths with erect and acute divisions separated by a narrow sinus, margin as in the bracts; perianth about half exserted, not compressed, oblong-obovoid from a somewhat narrowed base, 0.8 mm. long, 0.35 mm. in diameter, broad and truncate at the apex with a short beak, sharply five-keeled, the keels narrowly and obsoletely bialate in the upper part, the wings crenulate or denticulate from projecting cells, rarely with a few teeth two cells long in the apical region: ♂ inflorescence occupying a short branch; bracts in two or three pairs, closely imbricated, strongly inflated, slightly and subequally bifid with blunt to subacute divisions; bracteole present at base of spike, similar to the underleaves but smaller; antheridia in pairs: mature sporophyte not seen. (PLATE 6.)

The specimens from Flatts may be considered the type.

Except for the five-keeled perianth, this new species has much in common with the genus *Prionolejeunea*. The leaves, the leaf-cells and the underleaves are very similar, and the lobule is constructed on the same plan, bearing a hyaline papilla at the proximal base of the apical tooth; the latter, however, is straight instead of curved, and the papilla is in a distinct depression.

The genus *Crossotolejeunea* is largely if not wholly confined to the American tropics and includes about a dozen species. The type is *C. Boryana* (Mont.) Schiffn., which is of about the same size as *C. bermudiana* and which agrees with it also in its autoicous inflorescence. The leaves of *C. Boryana*, however, are more densely imbricated, the apex of the lobe is acuminate and usually reflexed, the leaf-cells are minutely verruculose, the apical cell of the lobule is more curved and can usually be seen without dissection, the underleaves are larger, with narrow acuminate divisions, sharply unidentate on the sides, the perichaetial bracts and bracteoles are usually more sharply toothed, and the wings of the perianth are spinose or incised-serrate.

C. paucispina (Spruce) Steph.,* a species first described from Brazil but afterwards recorded from Guadeloupe, is even more closely related. Through the kindness of Mr. M. B. Slater, of Malton, Yorkshire, the writer has been enabled to study a portion of the type material of this species from the Spruce herbarium. It agrees with *C. bermudiana* in general appearance and in most of the characters derived from the lobes, lobules and leaf-cells. It is, however, somewhat more robust, the leaves measuring about 0.75 mm. in length and the broadly orbicular underleaves about 0.25 mm. The leaf-cells also are a trifle larger and are very minutely verruculose, although described as smooth by Spruce. The underleaves are more deeply bifid, with acuminate and often connivent divisions, and the perianth is slightly compressed and only four-keeled, the antical face being plane. According to Spruce the keels bear a few deciduous spines in the upper part, but this could not be demonstrated in the material examined by the writer.

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* Hedwigia 35: 76. 1896. (*Lejeunea paucispina* Spruce, Hep. Amaz. et And. 163. 1884).

Explanation of plate 6

Crossotolejeunea bermudiana Evans

FIG. 1. Part of plant showing male inflorescence and female branch with perianth and young sporophyte, postical view, × 40.

FIG. 2. Leading branch with female inflorescence, postical view, × 40.

FIG. 3. Two leaves, antical view, × 40.

FIG. 4. Cells from middle of lobe, × 300.

FIG. 5. Cells from antical margin of lobe, × 225.

FIG. 6. Apex of lobe, × 225.

FIG. 7. Apex of lobule, × 225.

FIGS. 8, 9. Apices of underleaf-divisions, × 225.

FIGS. 10, 11. Bracts and bracteole from the same involucre, × 40.

FIGS. 12–14. Bracts and bracteole from another involucre, × 40.

FIG. 15. Transverse section of perianth, × 40.

FIG. 16. Antical keel of perianth in transverse section, × 225.

The figures were all drawn by the writer from the type specimens, and prepared for publication by Miss Hyatt.

Studies on the Rocky Mountain flora — XVI

Per Axel Rydberg

Salix Watsonii (Bebb) Rydb.

Salix cordata Watsonii Bebb, Bot. Calif. **2**: 86. 1880.
Salix flava Rydb. Bull. Torrey Club **28**: 273. 1901. Not *S. flava* Schoepf. 1796.

Chenopodium oblongifolium (S. Wats.) Rydb.

Chenopodium leptophyllum oblongifolium S. Wats. Proc. Am. Acad. **9**: 95. 1873.

Atriplex subspicata (Nutt.) Rydb.

Chenopodium subspicatum Nutt. Gen. Am. **1**: 199. 1818.
Atriplex patula subspicata S. Wats. Proc. Am. Acad. **9**: 107. 1873.

Rumex praecox Rydb. sp. nov.

Perennial with a thick fleshy rootstock; stem 2–3 dm. high, striate; basal leaves petioled, rather thick; petioles 5–10 cm. long; blades oval or elliptic, 4–10 cm. long, 2–4 cm. wide, rounded at both ends; stem-leaves similar, but smaller, short-petioled and more acute; flowers perfect, in terminal and axillary panicles; perianth-lobes oval, rounded at the apex; the outer 1.5 mm., when fully developed about 3 mm. long, the inner 3–5 mm., without tubercles; fruit developed before the perianth-lobes become much enlarged, shining.

This species is related to *R. occidentalis*, but is characterized by its fleshy tuber-like rootstocks and its precocious fruiting.

Colorado: Grayback mining camps, 1900, *Rydberg & Vreeland 6328* (type); Bob Creek, La Plata Mountains, 1898, *Baker, Earle & Tracy 270*.

Paronychia brevicuspis (A. Nels.) Rydb.

Paronychia sessiliflora brevicuspis A. Nels. Bull. Torrey Club **26**: 237. 1899.

LIMNIA L. (Kongl. Sv. Vet. Ak. Hand. **1746**: 130. 1746); Haw. Syn. Pl. Succ. 11. 1812.

Greene, Howell and Robinson have transferred a number of species from *Claytonia* to *Montia*; but none of them has given any obvious reason. Dr. Greene satisfied himself by transferring the sections ALSINASTRUM, NAIOCRENE and MONTIASTRUM. These evidently come nearest to *Montia* of all the sections of *Claytonia*. Prof. Howell, followed by Dr. Robinson, also transferred the section LIMNIA, and the rhizomatous species of EUCLAYTONIA of Gray. The difference between the two genera *Claytonia* and *Montia* as now limited is practically reduced to the number of ovules; 6 in the former, 3 in the latter. In *Montia* we find now both regular and irregular flowers, free petals and partly united petals, 5 stamens and 3 stamens, opposite stem-leaves and alternate stem-leaves, annuals and perennials, and of the latter several kinds, viz., with horizontal rootstocks, with short stolons bearing offsets, with slender runners bearing cormlets at the ends, or with axillary bulblets. In the olden time, *Montia* was easily distinguished from *Claytonia* by its gamopetalous corolla cleft on one side. It may be that all the sections mentioned above should be removed from *Claytonia*, but they should not be transferred to *Montia*, making this genus more unnatural than *Claytonia* ever was. I think that in a family like *Portulacaceae*, in which the modifications in the flowers are so slight, generic characters should to some degree be sought in the general habit. Instead of transferring the sections to *Montia* it would have been better to restore the Linnaean genus *Limnia* (which was adopted by Haworth), and to include in it all the American species of *Montia*, except *M. fontana*; or else to continue the splitting and propose several new genera. The typical Rocky Mountain species of *Limnia* are the following:

Limnia asarifolia (Bong.) Rydb.
Claytonia asarifolia Bong. Veg. Sitcha 137. 1831.

LIMNIA SIBIRICA (L.) Haw. Syn. Pl. Succ. 11. 1812.
Claytonia sibirica L. Sp. Pl. 204. 1753.

Limnia arenicola (Henderson) Rydb.
Claytonia arenicola Henderson, Bull. Torrey Club **22**: 49. 1895.

LIMNIA PERFOLIATA (Donn) Haw. Syn. Pl. Succ. 11. 1812.

Claytonia perfoliata Donn, Ind. Hort. Cantab. 25. 1796. — Willd. Sp. Pl. **1**: 1186. 1798.

Limnia depressa (A. Gray) Rydb.

Claytonia parviflora depressa A. Gray, Proc. Am. Acad. **22**: 281. 1887.

Limnia parviflora (Dougl.) Rydb.

Claytonia parviflora Dougl.; Hook. Fl. Bor. Am. **1**: 225. 1832.

At least two of the species of *Claytonia* transferred to *Montia* are, however, so unlike the rest that they can not very well be included in *Limnia*, but are better regarded as types of distinct genera.

CRUNOCALLIS Rydb. gen. nov.

Procumbent or decumbent water or mud-plants, rooting at the nodes and producing long runners, which develop small globose cormlets at the apex. Leaves several pairs, opposite. Sepals two, nearly equal. Corolla regular. Petals 5, similar and equal. Stamens 5. Ovary 3-ovuled. Capsule 1–3-seeded. Seeds granular-muriculate.

This genus has the flowers of *Claytonia*, but the general habit of *Montia*; the mode of propagation and the seeds are different from both.

Crunocallis Chamissonis (Ledeb.) Rydb.

Claytonia Chamissoi Ledeb.; Spreng. Syst. **1**: 790. 1825.

NAIOCRENE (T. & G.) Rydb. gen. nov.

Claytonia § *Naiocrene* T. &. G. Fl. N. Am. **1**: 201, in part. 1838.

Sarmentose, spreading or decumbent plants, with alternate fleshy leaves, bearing bulblets in their axils. Sepals very unlike, one broad and 2-lobed at the apex. Corolla regular or nearly so. Stamens 5. Ovary 3-ovuled. Seeds 1-3, shining.

Naiocrene parvifolia (Moç.) Rydb.

Claytonia parvifolia Moç.; DC. Prodr. **3**: 361. 1828.

EROCALLIS Rydb. gen. nov.

Perennials with globular corms. Radical leaf usually solitary, not present at flowering time. Stem low, with 2 or 3 whorled leaf-like bracts. Sepals 2, somewhat unequal. Petals 3–10, oblong. Capsule oblong-conical, circumscissile.

The genus is closely related to *Claytonia*, and the only distinctive character is the circumscissile capsule. Howell included it in *Oreobroma* and Robinson in *Lewisia;* in both genera, especially the latter, it is out of place on account of its habit.

✓**Erocallis triphylla** (S. Wats.) Rydb.

Claytonia triphylla S. Wats. Proc. Am. Acad. **10**: 345. 1875.

✓**Alsinopsis propinqua** (Richardson) Rydb.

Arenaria propinqua Richardson, Franklin Journey 738. 1823.
Arenaria verna hirta S. Wats. Bot. King Exp. 41. 1871. Not *A. hirta* Wormskj.
Arenaria verna (a)equicaulis A. Nels. Bull. Torrey Club **26**: 352. 1899.

✓**Alsinopsis Rossii** (Richardson) Rydb.

Arenaria Rossii Richardson, Franklin Journey 738. 1823.

✓**Alsinopsis quadrivalvis** (R. Br.) Rydb.

Arenaria quadrivalvis R. Br. in Parry 1st Voy. app. cclxxi. 1824.

✓**Alsinopsis obtusiloba** Rydb.

Arenaria obtusa Torr. Ann. Lyc. N. Y. **2**: 170. 1827. Not *A. obtusa* All. 1785.
Arenaria biflora S. Wats. Bibl. Index 94. 1878. Not *A. biflora* L. 1767.
Arenaria sajanensis Robinson, Proc. Am. Acad. **29**: 304. 1894. Not *A. sajanensis* Willd. 1816.

✓**Delphinium reticulatum** (A. Nels.) Rydb.

Delphinium occidentale reticulatum A. Nels. Bull. Torrey Club **27**: 261. 1900.

ODOSTEMON Raf. Am. Monthly Mag. **2**: 265. F 1818.
Mahonia Nutt. Gen. Am. **1**: 211. 1818.

Both *Odostemon* Raf. and *Mahonia* Nutt. were published in the same year, but the former a few months earlier. The Rocky Mountain species are:

Odostemon Aquifolium (Pursh) Rydb.

Berberis Aquifolium Pursh, Fl. Am. Sept. 219. 1814.
Berberis repens Lindl. Bot. Reg. *pl. 1176.* 1828.
Berberis nana Greene, Pittonia 3: 98. 1896.

Odostemon nutkanus (DC.) Rydb.

Mahonia Aquifolium nutkana DC. Syst. 2: 20. 1821.
Berberis Aquifolium Lindl. Bot. Reg. *sub pl. 1176.* 1828.

Odostemon nervosus (Pursh) Rydb.

Berberis nervosa Pursh, Fl. Am. Sept. 219. 1814.

Odostemon Fremontii (Torr.) Rydb.

Berberis Fremontii Torr. Bot. Mex. Bound. 30. 1859.

Lepidium crenatum (Greene) Rydb.

Thelypodium crenatum Greene, Pittonia 4: 20. 1899.

The species was described from flowering specimens, but the ovaries or young fruit were developed enough to indicate the true genus. Dr. Greene was probably led astray by the fact that the specimens were labeled *Thelypodium integrifolium*.

Erysimum asperrimum (Greene) Rydb.

Cheiranthus asperrimus Greene, Pittonia 3: 133. 1896.
Erysimum pumilum Rydb. Mem. N. Y. Bot. Gard. 1: 189. 1900.

In my Flora of Montana I took up Nuttall's *E. pumilum* for this species. This was evidently an error into which I was led by Dr. Greene's discussion in Pittonia, *loc. cit.* *E. pumilum* Nutt. remains as yet unknown, but from the description it must be a close relative of *E. nivale* and *E. radicatum*, if not one of these species.

Erysimum Bakeri (Greene) Rydb.

Cheiranthus aridus Greene, Pittonia 4: 198. 1900. Not *C. aridus* A. Nelson. 1899.
Cheiranthus Bakeri Greene, Pittonia 4: 235. 1901.

Erysimum argillosum (Greene) Rydb.

Cheiranthus argillosus Greene, Pittonia 3: 136. 1896.

✓ **Erysimum amoenum** (Greene) Rydb.

Cheiranthus nivalis amoenus Greene, Pittonia **3**: 137. 1896.

✓ **Lesquerella stenophylla** (A. Gray) Rydb.

Vesicaria stenophylla A. Gray, Bost. Jour. Nat. Hist. **6**: 149. 1850.

This was included in *L. Fendleri* by Dr. Watson, but I think it well distinct.

✓ **Euklisia crassifolia** (Greene) Rydb.

Streptanthus crassifolius Greene, Pittonia **3**: 227. 1897.

Dr. Greene in Leaflets (**1**: 81–85. D 1904) took up *Euklisia* of Nuttall, only changing its spelling, but he overlooked that it had already been proposed as a genus in Dr. Small's Flora of the Southeastern United States. About three years ago I intended to publish it as a genus, making *Streptanthus cordatus* Nutt. the type. Unfortunately my notes were never published and forgotten. Dr. Small, who had seen them, took up the name in his flora, giving me the credit for the same. As he published only one species, *E. hyacinthoides*, this becomes the type. Dr. Greene took up the name for a group, to which neither Dr. Small's type nor my intended type (which I also think was Nuttall's) belong. If *Streptanthus* should be split up into as many genera as Dr. Greene suggests, neither his species of *Euklisia* nor those known to Nuttall would fall within *Euklisia*. My intention was only to divide the genus into two genera, *Streptanthus* and *Euklisia*. So limited the latter genus will contain the Rocky Mountain species here given.

✓ **Euklisia cordata** (Nutt.) Rydb.

Streptanthus cordatus Nutt.; T. & G. Fl. N. Am. **1**: 77. 1838.

✓ **Euklisia longirostris** (S. Wats.) Rydb.

Arabis longirostris S. Wats. Bot. King Exp. 17. 1871.

Streptanthus longirostris S. Wats. Proc. Am. Acad. **25**: 127. 1890.

✓ **Peritoma Sonorae** (A. Gray) Rydb.

Cleome Sonorae A. Gray, Pl. Wright. **2**: 16. 1853.

Potentilla platyloba Rydb.

Potentilla bipinnatifida platyloba Rydb. Mem. Dep. Bot. Columbia Univ. **2**: 100. 1898.

This is as distinct from *P. bipinnatifida* as most species of *Potentilla* are from their relatives.

Potentilla rubripes Rydb.

Potentilla rubricaulis Rydb. Mem. Dep. Bot. Columbia Univ. **2**: 101. 1898. Not *P. rubricaulis* Lehm. 1830.

Lehmann's species, for which I mistook this Rocky Mountain plant, is the same as *P. prostrata* Rottb.

Argentina argentea Rydb.

Argentina anserina concolor Rydb. Mem. Dep. Bot. Columbia Univ. **2**: 160. 1898. Not *Potentilla anserina concolor* Ser. 1825.

The European plant to which this was referred differs in having more deeply and more sharply toothed leaflets, and smaller flowers.

Fragaria ovalis (Lehm.) Rydb.

Potentilla ovalis Lehm. Ind. Sem. Hort. Bot. Hamb. **1849**: 9. 1849.

Fragaria firma Rydb. Mem. Dep. Bot. Columbia Univ. **2**: 184. 1898.

Dr. Wolf, of Dresden, Germany, has called my attention to the fact that *P. ovalis* Lehm. is no *Potentilla* at all. Prof. Lehmann did not cite any type, but his herbarium shows that it was *Fendler 206*, which I included in *Fragaria firma*.

Fallugia acuminata (Wooton) Rydb.

Fallugia paradoxa acuminata Wooton, Bull. Torrey Club **25**: 306. 1898.

Prunus melanocarpa (A. Nelson) Rydb.

Cerasus demissa melanocarpa A. Nels. Bot. Gaz. **34**: 25. 1902.

The common Rocky Mountain tree is well distinct from the original *Cerasus demissa* Nutt. or *Prunus demissa* Walp. The latter, which was from the Columbia Valley, has thin, very pubescent leaves, and is more related to the eastern *P. virginiana*. *P. melanocarpa* is rather nearer the Mexican species known as *P. Copalin*, and it is sometimes very hard to distinguish it from that species.

ANISOLOTUS Bernh. Sem. Hort. Erf. 1837. — Linnaea **12**: Litt. Ber. 75. 1838.

I think that this genus, well characterized by Bernhardi, should be restored. It is well distinct from the Old World *Lotus* and from *Hosackia*. I think that Dr. Greene's merging all our North American species usually known as *Hosackia* into *Lotus* was very unfortunate, for we do not have any native species which could be included in *Lotus*, even if made broad enough to include *Tetragonolobus* and other Old World genera.

The Rocky Mountain species of *Anisolotus* are:

✓**Anisolotus Wrightii** (A. Gray) Rydb.

Hosackia Wrightii A. Gray, Pl. Wright. **2**: 42. 1853.

✓**Anisolotus brachycarpus** (Benth.) Rydb.

Hosackia brachycarpa Benth. Pl. Hartw. 306. 1848.
Lotus huministratus Greene, Pittonia **2**: 139. 1890.

✓**Anisolotus rigidus** (Benth.) Rydb.

Hosackia rigida Benth. Pl. Hartw. 305. 1848.

✓**Aragallus Hallii** (Bunge) Rydb.

Oxytropis Hallii Bunge, Mem. Acad. Sci. St. Petersb. VII. **22**^{1}: 162. 1874.

✓**Vicia dissitifolia** (Nutt.) Rydb.

Lathyrus dissitifolius Nutt.; T. & G. Fl. N. Am. **1**: 277. 1838.

✓**Lathyrus incanus** (Rydb. & Smith) Rydb.

Lathyrus ornatus incanus Rydb. & Smith, Fl. Neb. **21**: 64. 1895.

Chamaesyce flabelliformis (Engelm.) Rydb.

Euphorbia petaloidea flagelliformis Engelm. Bot. Mex. Bound. 185. 1859.
Euphorbia flagelliformis Engelm. Bull. Geol. Surv. Terr. **2**: 243. 1876.

✓ **Chamaesyce rugulosa** (Engelm.) Rydb.

Euphorbia serpyllifolia rugulosa Engelm.; Millsp. Pittonia **2**: 85. 1890.

✓ **Chamaesyce albicaulis** Rydb.

Euphorbia albicaulis Rydb. Mem. N. Y. Bot. Gard. **1**: 266. 1900.

Tithymalus arkansanus coloradensis (Norton) Rydb.

Euphorbia arkansana coloradensis Norton, Rep. Missouri Bot. Gard. **11**: 105. 1900.

✓ **Sida sagittaefolia** (A. Gray) Rydb.

Sida lepidota sagittaefolia A. Gray, Pl. Wright. **1**: 18. 1852.

✓ **Sphaeralcea marginata** York, sp. nov. ✓

Perennial, herbaceous; stem usually branching from the base, with ascending branches, 2–6 dm. tall, densely stellate-canescent; leaf-blades subrotund, rounded-ovate or subcordate, 1.5–4 cm. long, 1.5–3 cm. wide, cordate or truncate at the base, crenate or imperfectly dentate, slightly 3–5-lobed, the middle lobe acute or obtuse, the upper surface with close stellate pubescence, more densely pubescent beneath, petioles less than ½ as long as the blades or sometimes longer; flowers borne in narrow panicles; involucre of 3 small setaceous bracts: calyx-tube densely stellate-pubescent, about 3 mm. long; lobes 5, ovate, acute or acuminate, almost glabrous or sparingly stellate-pubescent on dorsal surface, densely pubescent on the margin, glabrous within, 2–3 mm. long, in fruit 4–5 mm. long; petals pink, obovate, 10–12 mm. long; carpels 10–12 in number, 3–4 mm. long, cuspidate, the lower half reticulated; ovules two; usually only one seed developed in the lower part of each carpel, upper part somewhat aborted; seeds reniform, glabrous.

In general appearance this plant resembles *Sphaeralcea Munroana* (Doug.) Spach; but in the former, the mature carpels separate from the central axis by a small thread attached to the base of each carpel, while in the latter, the carpels do not separate from the central axis by a thread. *Sphaeralcea marginata* also resembles *S. incana* Torr.; but the latter is taller, the leaves are larger, the pubescence on both sides of the leaves is much denser and finer, the paniculate clusters of flowers are longer and more open and the carpels are nearly always two-seeded.

COLORADO: Grand Junction, 1901, *C. F. Baker 93* (type); also 1893, *De Alton Saunders;* McElmo Cañon, 1901, *F. K. Vreeland 860.*

NEW MEXICO: 1901, *F. K. Vreeland 823.*

Cactus similis (Engelm.) Rydb.

Mamillaria similis Engelm. Bost. Jour. Nat. Hist. **5**: 246. 1845.

Mamillaria missouriensis caespitosa S. Wats. Bibl. Index 403. 1878.

Echinocereus aggregatus (Engelm.) Rydb.

Mamillaria aggregata Engelm. in Emory, Notes Recon. 157. 1848.

Echinocereus coccineus Engelm. Wisliz. Rep. 9. 1848. Not *E. coccineus* DC.

Cereus phoeniceus Engelm. Proc. Am. Acad. **3**: 284. 1856.

Echinocereus Roemeri (Muhlenf.) Rydb.

Cereus Roemeri Muhlenf. Allg. Gart. Zeit. **16**: 19. 1848.

Cereus conoideus Engelm. Pac. R. R. Rep. **4**: 35. 1856.

✓ **Epilobium adenocladon** (Haussk.) Rydb.

Epilobium paniculatum adenocladon Haussk. Mon. Gatt. Epil. 247. 1884.

Anogra latifolia Rydb.

Oenothera pallida latifolia Rydb. Contr. U. S. Nat. Herb. **3**: 159. 1895.

✓ **Pachylophus marginatus** (Nutt.) Rydb.

Oenothera marginata Nutt.; Hook. & Arn. Bot. Beechey 342. 1838.

Oenothera idahoensis Mulford, Bot. Gaz. **19**: 117. 1894.

✓ **Sphaerostigma pubens** (S. Wats.) Rydb.

Oenothera strigulosa pubens S. Wats. Proc. Am. Acad. **8**: 594. 1873.

✓ **Sphaerostigma minutiflora** (S. Wats.) Rydb.

Oenothera alyssoides minutiflora S. Wats. Proc. Am. Acad. **8**: 591. 1873.

CORNELLA Rydb. gen. nov.

The type of the genus *Cornus* L. is *C. mas* L. which has no congener in this country, except perhaps *C. sessilis* Torr. of California. Opiz segregated from *Cornus* the genus *Svida*, to which the European *C. sanguinea* and most of our American cornels belong. Rafinesque in his Alsographia Americana made the genus *Cynoxylon* based on *C. florida* L., and also another genus (or subgenus) *Eukrania* in which he placed *C. canadensis* L. and *C. suecica* L. Unfortunately he made *C. mascula* of Europe, which is congeneric with and some claim the same as *C. mas* L., the type, and *C. canadensis* and *C. suecica* have no available generic name, unless they are included with *C. florida* and *C. Nuttallii* in *Cynoxylon*. Outside of the great difference in habit and fruit between the Dwarf Cornels and the Flowering Dogwoods, the former have one character not found in any of the groups usually included in *Cornus*. The sepals of the Dwarf Cornels have a small horn-like, at last deciduous, spine on the back near the apex. This, together with the peculiar habit, makes them deserve generic rank.

Cornella canadensis (L.) Rydb.

Cornus canadensis L. Sp. Pl. 118. 1753.

Cornella suecica (L.) Rydb.

Cornus suecica L. Sp. Pl. 118. 1753.

Cornella unalaschkensis (Ledeb.) Rydb.

Cornus unalaschkensis Ledeb. Fl. Ross. **2**: 378. 1844.

Pseudocymopterus multifidus Rydb.

Pseudocymopterus montanus multifidus Rydb. Bull. Torrey Club **31**: 574. 1904.

Pseudocymopterus purpureus (C. & R.) Rydb.

Pseudocymopterus montanus purpureus C. & R. Rev. N. Am. Umbell. 75. 1888.

Pseudocymopterus tenuifolius (A. Gray) Rydb.

Thaspium montanum tenuifolium A. Gray, Pl. Wright. **2**: 65. 1853.

Ligusticum montanum tenuifolium S. Wats. Bibl. Index 426. 1878.

Vaccinium oreophilum Rydb.

Vaccinium myrtilloides S. Wats. Bot. King Exp. 209. 1871. Not *V. myrtilloides* Michx. 1803.
Vaccinium Myrtillus A. Gray, Syn. Fl. $\mathbf{2}^1$: 24. 1878. Not *V. Myrtillus* L. 1753.

The American plant has depressed globular-ovoid corolla, fully as wide as long, while the original European *V. Myrtillus* has ovoid-urceolate corolla, decidedly longer than broad.

✓**Androsace subulifera** (A. Gray) Rydb.

Androsace septentrionalis subulifera A. Gray, Syn. Fl. $\mathbf{2}^1$: 60. 1878.

✓**Dodecatheon sinuatum** Rydb.

Dodecatheon radicatum sinuatum Rydb. Bull. Torrey Club **31**: 631. 1904.

✓**Erythraea arizonica** (A. Gray) Rydb.

Erythraea calycosa arizonica A. Gray, Syn. Fl. $\mathbf{2}^1$: 113. 1878.

✓**Anthopogon elegans** (A. Nels.) Rydb.

Gentiana elegans A. Nels. Bull. Torrey Club **25**: 276. 1898.

✓**Anthopogon barbellatus** (Engelm.) Rydb.

Gentiana barbellata Engelm. Trans. Acad. St. Louis **2**: 216. 1863.
Gentiana Moseleyi A. Nels. Bot. Gaz. **31**: 396. 1901.

✓**Amarella monantha** (A. Nels.) Rydb.

Gentiana tenella A. Gray, Syn. Fl. $\mathbf{2}^1$: 117, in part. 1878.
Gentiana monantha A. Nels. Bull. Torrey Club **31**: 244. 1904.

✓**Amarella plebeia Holmii** (Wettst.) Rydb.

Gentiana plebeia Holmii Wettst. Oester. Bot. Zeitsch. **50**: 195. 1900.

✓**Dasystephana Romanzovii** (Ledeb.) Rydb.

Gentiana Romanzovii Ledeb.; Bunge, Nouv. Mém. Soc. Nat. Mosc. **1**: 215. 1829.

Gentiana frigida A. Gray, Syn. Fl. **2^1**: 120. 1878. Not *G. frigida* Haenke. 1788.

Dasystephana Parryi (Engelm.) Rydb.

Gentiana Parryi Engelm. Trans. Acad. St. Louis **2**: 218. 1863.

Dasystephana affinis (Griseb.) Rydb.

Gentiana affinis Griseb. Gen. et Sp. Gent. 289. 1839.

Dasystephana Forwoodii (A. Gray) Rydb.

Gentiana Forwoodii A. Gray, Syn. Fl. **2^1**: 406. [Ed. 2.] 1886.

Dasystephana Bigelovii (A. Gray) Rydb.

Gentiana Bigelovii A. Gray, Syn. Fl. **2^1**: 406. [Ed. 2.] 1886.

Dasystephana interrupta (Greene) Rydb.

Gentiana interrupta Greene, Pittonia **4**: 182. 1900.

Frasera scabra (M. E. Jones) Rydb.

Frasera speciosa scabra M. E. Jones, Zoe **4**: 277. 1893.

Frasera stenosepala Rydb.

Frasera speciosa stenosepala Rydb. Bull. Torrey Club **31**: 632. 1904.

Frasera angustifolia Rydb.

Frasera speciosa angustifolia Rydb. Bull. Torrey Club **31**: 632. 1904.

Phlox depressa (E. Nels.) Rydb.

Phlox multiflora depressa E. Nels. Rev. W. N. Am. Phloxes 20. 1899.

Leptodactylon Watsonii (A. Gray) Rydb.

Gilia Watsonii A. Gray, Proc. Am. Acad. **8**: 267. 1870.

Leptodactylon Nuttallii (A. Gray) Rydb.

Gilia Nuttallii A. Gray, Proc. Am. Acad. **8**: 267. 1870.

Phacelia ciliosa Rydb.

Phacelia sericea ciliosa Rydb. Bull. Torrey Club **31**: 636. 1904.

✓ **Oreocarya hispidissima** (Torr.) Rydb.

Eritrichium glomeratum hispidissimum Torr. Bot. Mex. Bound. 140. 1859.

✓ **Oreocarya perennis** (A. Nels.) Rydb.

Oreocarya affinis perennis A. Nels. Erythea **7**: 67. 1899.

✓ **Mertensia platensis** Rydb.

Mertensia polyphylla platensis Rydb. Bull. Torrey Club **31**: 638. 1904.

✓ **Agastache pallidiflora** (Heller) Rydb.

Brittonastrum pallidiflorum Heller, Bull. Torrey Club **26**: 621. 1899.

Brittonastrum Greenei Briquet, Ann. Conserv. & Jard. Genève **6**: 157. 1902.

✓ **Madronella parvifolia** (Greene) Rydb.

Monardella parvifolia Greene, Pl. Baker. **3**: 22. 1901.

✓ **Madronella dentata** Rydb.

Monardella dentata Rydb. Bull. Torrey Club **31**: 641. 1904.

✓ **Mentha Penardi** (Briquet) Rydb.

Mentha arvensis Penardi Briquet, Bull. Herb. Boiss. **3**: 215. 1895.

✓ **Androcera rostrata** (Dunal) Rydb.

Solanum rostratum Dunal, Hist. Sol. 234. 1813.

Androcera lobata Nutt. Gen. Am. **1**: 129. 1818.

Pentstemon unilateralis Rydb. nom. nov.

Pentstemon secundiflorus A. Gray, Syn. Fl. 2^1: 263. 1878. Not *P. secundiflorus* Benth.

In Proc. Am. Acad. **6**: 61, Dr. Gray gives *P. secundiflorus* as a synonym of *P. acuminatus* Benth. This was correct as far as Dr. Gray's conception of the latter is concerned. Dr. Gray included in *P. acuminatus* at least four different plants. Of these, two have very broad rounded clasping and abruptly acuminate upper leaves, viz. : the original *P. acuminatus* Dougl. and my *P. cyathophorus*; and two with lanceolate upper leaves, viz. : *P. Fendleri* A. Gray and the original *P. secundiflorus* Benth. Frémont's plant, the type of the latter, is in the Torrey herbarium. On the sheet is written in Dr. Gray's own handwriting : "This is only *P. acuminatus*, Dougl. ; small. A. G. 1862." Dr. Gray afterwards transferred the name *P. secundiflorus* to an entirely different plant, describing it in the Synoptical Flora. This therefore needs a new name.

Pentstemon angustifolius caudatus (Heller) Rydb.

Pentstemon caudatus Heller, Minn. Bot. Stud. **2** : 34. 1898.

P. caudatus Heller is in my opinion the southern more luxuriant and broad-leaved form of *P. angustifolius*. The two grade absolutely into each other in Colorado.

Pentstemon trichander (A. Gray) Rydb.

Pentstemon barbatus trichander A. Gray, Proc. Am. Acad. **11** : 94. 1876.

This, as well as *P. Torreyi* Benth., I think should be kept distinct from *P. barbatus* (Cav.) Nutt. of Mexico.

MYZORRHIZA Phil. Linnaea **29** : 36. 1857.

The NOTHAPHYLLON subgenus of *Aphyllon* as limited in Gray's Synoptical Flora has been shifted back and forth between the genera *Phelipaea*, *Anoplanthus* and *Aphyllon*, and has lately been restored to *Orobanche*, where its original species were described. The typical species of *Orobanche* have a bilabiate calyx, while the species here discussed have a 5-parted one. As far as I find, the only genus described to which they can be referred is the one given above. The following two species are found in Colorado :

Myzorrhiza ludoviciana (Nutt.) Rydb.

Orobanche ludoviciana Nutt. Gen. Am. **2** : 58. 1818.
Aphyllon ludovicianum A. Gray, Bot. Calif. **1** : 585. 1876.

Myzorrhiza multiflora (Nutt.) Rydb.

Orobanche multiflora Nutt. Jour. Acad. Nat. Sci. Phila. II. **1** : 179. 1848.
Aphyllon multiflorum A. Gray, Bot. Calif. **1** : 585. 1876.

✓ **Galium subbiflorum** (Wieg.) Rydb.

Galium trifidum subbiflorum Wieg. Bull. Torrey Club **24**: 399. 1897.

Distegia involucrata (Richardson) Rydb.

Xylosteum involucratum Richardson, Frankl. Journey 733. 1823.
Lonicera involucratum Banks; Spreng. Syst. **1**: 759. 1825.
Distegia nutans Raf. New Fl. Am. **3**: 21. 1836.

✓ **Chrysothamnus serrulatus** (Torr.) Rydb.

Linosyris serrulata Torr.; Stansbury, Expl. 389. 1852.
Chrysothamnus glaucus A. Nelson, Bull. Torrey Club **25**: 377. 1898.

✓ **Chrysothamnus latifolius** (D. C. Eaton) Rydb.

Linosyris viscidiflora latifolia D. C. Eaton, Bot. King Exp. 157. 1871.
Bigelovia Douglasii latifolia A. Gray, Proc. Am. Acad. **8**: 646. 1873.

✓ **Isocoma Wrightii** (A. Gray) Rydb.

Linosyris Wrightii A. Gray, Pl. Wright. **1**: 95. 1852.
Bigelovia Wrightii A. Gray, Proc. Am. Acad. **8**: 639. 1873.

OREOCHRYSUM Rydb. gen. nov.

Plants with slender horizontal rootstock, leafy, viscid-puberulent above. Involucral bracts oblong, pale, rather obscurely 1-ribbed, chartaceous or the outer foliaceous, in about three moderately unequal ranks. Rays several, short. Disc-corollas narrowly trumpet-shaped, deeply 5-toothed. Style-appendages lanceolate, longer than the stigmatic portion. Achenes angled. Pappus white or slightly tawny, of soft scabrous bristles.

When Dr. Greene made his segregations of the old genus *Aplopappus*, he transferred the type of the genus here proposed to *Solidago*, but it is just as much out of place here as among its old associations, *i. e.*, the present genus *Stenotus*. It is true that in general habit it reminds one of a group of species formerly included in *Solidago*, but now segregated as a genus *Oligoneuron* Small; the character of the involucre and the style-appendages, however, distinguish it from *Oligoneuron* as well as from *Solidago* proper.

Oreochrysum Parryi (A. Gray) Rydb.

Aplopappus Parryi A. Gray, Am. Jour. Sci. II. **33**: 239. 1862.
Solidago Parryi Greene, Erythea **2**: 57. 1894.

Solidago pallida (Porter) Rydb.

Solidago speciosa pallida Porter, Bull. Torrey Club **19**: 130. 1892.

Solidago scabriuscula (Porter) Rydb.

Solidago canadensis scabra T. & G. Fl. N. Am. **2**: 224. 1842. Not *S. scabra* Willd.
Solidago canadensis scabriuscula Porter, Mem. Torrey Club **5**: 318. 1894.

Solidago gilvocanescens Rydb.

Solidago canadensis gilvocanescens Rydb. Contr. U. S. Nat. Herb. **3**: 162. 1895.

Aster polycephalus Rydb.

Aster scoparius DC. Prodr. **5**: 242. 1836. Not *A. scoparius* Nees. 1832.

Leucelene serotina (Greene) Rydb.

Leucelene ericoides serotina Greene, Pittonia **3**: 149. 1896.

Leucelene hirtella (A. Gray) Rydb.

Diplopappus ericaefolius hirtella A. Gray, Mem. Am. Acad. **4**: 69. 1849.

Erigeron Wootonii Rydb.

Erigeron cinereus var. γ A. Gray, Mem. Am. Acad. **4**: 68. 1849.

ESCHENBACHIA Moench, Meth. 573. 1794.

Conyza Less. Syn. Comp. 203, in part. 1832. Not *Conyza* (Tourn.) L. 1753.

The type of the Linnaean genus *Conyza* is *Conyza squarrosa* L. but this as well as most of the original species are now included in *Inula*. Lessing transferred the name *Conyza* to an entirely different group of plants. Dr. Greene united our North American species with some species of *Erigeron* into the genus *Conyzella* Rupr.

(1869), which is antedated by *Leptilon* Raf. (1818). Hence *Conyzella* becomes a synonym. I do not think that *Conyza Coulteri* should be included in *Leptilon*, which it resembles in habit but not in the composition of the heads. It has several relatives in Mexico and Central America as well as in the Old World. The oldest available name for these is, if I am not mistaken, *Eschenbachia* Moench.

Eschenbachia Coulteri (A. Gray) Rydb.

Conyza Coulteri A. Gray, Proc. Am. Acad. **7**: 355. 1868.

BERTHELOTIA DC. Prodr. **5**: 375. 1836.

A sericeous composite shrub of the southwestern United States has been variously referred to *Pluchea* and *Tessaria*, but is rather out of place in either genus. It was originally made a genus by itself, *Polypappus*, by America's keenest botanist, Thomas Nuttall, and I think it should have remained a genus distinct from both *Pluchea* and *Tessaria*. It has evidently a congener, however, in the desert regions of the Orient. This was described by De Candolle as *Berthelotia*.

Berthelotia sericea (Nutt.) Rydb.

Polypappus sericeus Nutt. Jour. Acad. Nat. Sci. Phila. II. **1**: 178. 1848.

Tessaria borealis "DC.;" T. & G. in Emory, Notes Recon. 143. 1848.

Pluchea borealis A. Gray, Proc. Am. Acad. **17**: 212. 1882.

Ximenesia exauriculata (Rob. & Greenm.) Rydb.

Verbesina encelioides exauriculata Rob. & Greenm. Proc. Am. Acad. **34**: 544. 1899.

PLATYSCHKUHRIA (A. Gray) Rydb. gen. nov.

Schkuhria § *Platyschkuhria* A. Gray, Am. Nat. **8**: 213. 1874.

Bahia § *Platyschkuhria* A. Gray, Syn. Fl. **2^1**: 332. 1884.

The genus *Bahia* as limited in Gray's Synoptical Flora is a rather unnatural one. The group most unlike the rest is the one constituting the section *Platyschkuhria*, which I think deserves generic rank. I adopt the sectional name, although its etymology and form are rather bad.

Platyschkuhria integrifolia (A. Gray) Rydb.

Schkuria integrifolia A. Gray, Am. Nat. **8**: 213. 1874.
Bahia nudicaulis A. Gray, Proc. Am. Acad. **19**: 27. 1883.

Platyschkuhria oblongifolia (A. Gray) Rydb.

Bahia oblongifolia A. Gray, Proc. Am. Acad. **19**: 27. 1883.

Tetraneuris glabriuscula Rydb.

Tetraneuris glabra Greene, Pittonia **3**: 268, in part. 1898. Not *Actinella glabra* Nutt. 1841.

What *Actinella glabra* Nutt. was is not exactly known. It is not, however, the plant for which Dr. Greene adopted the name *Tetraneuris glabra*. If it is a *Tetraneuris* at all, it must be a species related to *T. Ivesiana*, *T. argentea* and *T. leptoclada*, as it is described as having stem-leaves. None of these grows near the original locality of *A. glabra*, viz., Shawnee villages on the Missouri (near Kansas City). The only species that are found within 300 miles from this station are *T. herbacea* Greene of Illinois, and *T. fastigiata* Greene and the following from central and western Kansas. None of these answers the description.

Tetraneuris stenophylla Rydb.

Perennial with a branched caudex, the branches of which are partly subterranean, 2–10 cm. long; leaves basal, very narrowly linear-oblanceolate, 2–4 cm. long, 1–2 mm. wide, strongly punctate, glabrous or with a few long hairs near the base; bases dilated and scarious-margined, only slightly long-hairy; scape 5–10 cm. long, striate, punctate and sparingly strigose; involucre about 5 mm. high and 10 mm. wide, hemispheric; bracts elliptic, obtuse; rays light-yellow, about 10 mm. long and 5 mm. wide, 3–4-toothed and 5–7-nerved.

This is closest related to *T. fastigiata* Greene, in which, however, the bases of the leaves are arachnoid-hairy and the involucres densely villous.

KANSAS: Ford County, 1891, *L. D. Ellis* (type).
COLORADO: Banks of Cimarron, 1860, *Newberry*.

CHAMAECHAENACTIS Rydb. gen. nov.

Cespitose scapiferous perennial, branching below the surface of the ground and with a woody root. Leaves all basal and simple, coriaceous, white-strigose below, sparingly hirsute and punctate above. Involucral bracts about twelve, in two series; the inner series longer and with scarious-margined reddish tips. Corolla flesh-colored, with equal lobes. Stamens included. Style-lips broad. Achenes clavate, densely villous. Pappus of eight nearly equal scales, with prominent midrib and erose tips.

Miss Eastwood, the discoverer of the plant, referred it to *Chaenactis*, to which it is not closely related, resembling this genus only in the color of the corolla. The structure of the fruit and pappus would place it nearer *Bahia* and *Tetraneuris*. In general habit it resembles most that exceedingly rare plant described by Nuttall under the name *Bolophyta alpina*, which by Dr. Gray was tranferred to *Parthenium*.

Chamaechaenactis scaposa (Eastw.) Rydb.

Chaenactis scaposa Eastw. Zoe **2**: 231. 1891.

Rydbergia Brandegei (A. Gray) Rydb.

Actinella grandiflora glabrata Porter, in Port. & Coult. Syn. Fl. Colo. 76. 1874.

Actinella Brandegei Porter; A. Gray, Proc. Am. Acad. **13**: 373. 1878.

Rydbergia glabrata Greene, Pittonia **3**: 270. 1898.

Hymenoxys macrantha (A. Nels.) Rydb.

Picradenia macrantha A. Nels. Bot. Gaz. **28**: 130. 1899.

Hymenoxys Richardsonii macrantha Cockerell, Bull. Torrey Club **31**: 475. 1904.

Evidently Professor Cockerell was correct in uniting *Hymenoxys* and *Picradenia* under the older generic name. To his conception of species I am not willing to assent, however. In this respect I would rather agree with Dr. Greene and Prof. Aven Nelson. The changes in nomenclature of the Colorado species are here given.

Hymenoxys pumila (Greene) Rydb.

Picradenia pumila Greene, Pittonia **3**: 271. 1898.

Hymenoxys Richardsonii pumila Cockerell, Bull. Torrey Club **31**: 472. 1904.

✓**Hymenoxys multiflora** (Buckley) Rydb.

Phileozera multiflora Buckley, Proc. Acad. Nat. Sci. Phila. **1861**: 459. 1862.

Picradenia multiflora Greene, Pittonia **3**: 273. 1898.

Hymenoxys chrysanthemoides multiflora Cockerell, Bull. Torrey Club **31**: 507. 1904.

Hymenoxys multiflora Osterhoutii (Cockerell) Rydb.

Picradenia odorata Osterhoutii Cockerell, Bull. Colo. College Mus. 11 D 1903.

Hymenoxys chrysanthemoides Osterhoutii Cockerell, Bull. Torrey Club **31**: 505. 1904.

✓ **Achillea alpicola** Rydb.

Achillea lanulosa alpicola Rydb. Mem. N. Y. Bot. Gard. **1**: 426. 1900.

✓ **Artemisia Scouleriana** (Besser) Rydb.

Artemisia desertorum Scouleriana Besser; Hook. Fl. Bor. Am. **1**: 325. 1833.

✓ **Artemisia pabularis** (A. Nels.) Rydb.

Artemisia rhizomata pabularis A. Nelson, Bull Torrey Club **27**: 34. 1900.

✓ **Artemisia viscidula** (Osterhout) Rydb.

Artemisia cana viscidula Osterhout, Bull. Torrey Club **27**: 507. 1900.

✓ **Carduus filipendulus** (A. Gray) Rydb.

Cirsium virginianum filipendulum A. Gray, Man. ed. 5. 273. 1880.

Cirsium filipendulum Engelm.; A. Gray, *loc. cit.*, as a synonym.

Cnicus altissimus filipendulus A. Gray, Proc. Am. Acad. **19**: 57. 1883.

✓ **Senecio Flintii** Rydb. sp. nov.

Perennial with a cluster of fibrous-fleshy roots; stem about 3 dm. high, striate, sparingly arachnoid-hairy; basal leaves about 8 cm. long; blades orbicular or rounded-oval, abruptly contracted into short petioles, sparingly arachnoid when young, glabrous and rather thick in age; stem-leaves lanceolate, sinuately toothed, auricled and clasping at the base, arachnoid when young; inflorescence small, with 3–6 heads, which are about 1 cm. high; bracts linear, 7–8 mm. long, abruptly acute at the apex, with a triangular black tip; rays light-yellow, broad; achenes striate, glabrous.

Related to *S. exaltatus* and *S. integerrimus*, but differing from the former in the entire basal leaves and small corymb, from the latter in the abruptly acute black-tipped bracts, and from both in the lower stature and the broader basal leaves.

SOUTHWESTERN COLORADO: *W. F. Flint.*

Senecio Harbourii Rydb. sp. nov.

Perennial with a branched caudex; stem 1–2 dm. high, striate, white-floccose, leafy; basal leaves and most stem-leaves petioled, 3–10 cm. long, densely white-floccose; blades oblanceolate or linear-spatulate, entire; uppermost stem-leaves sessile, lanceolate, 1–3 cm. long, more or less auricled at the base; inflorescence corymbiform, with 2–7 heads, which are mostly 10–15 mm. high; bracts narrowly linear, long-attenuate, light yellowish-green and slightly floccose; the calyculate ones minute, subulate; rays bright-yellow, over 1 cm. long and 2 mm. wide; achenes brown, shining, glabrous, angled.

This species is most nearly related to *S. Purshianus* and *S. canus.* From the former it differs in the large heads, longer rays and more leafy stem, and from the latter in the lower habit, narrower and always entire leaves, and the turbinate-campanulate instead of hemispheric heads. It grows in the mountains of Colorado at an altitude of 2700–4000 m., and was first collected by Hall & Harbour.

COLORADO: Mountains south of Ward, Boulder Co., July 18, 1901, *G. E. Osterhout 2424* (type); mountains between Sunshine, and Ward, 1902, *F. Tweedy 4861*; Silver Plume, Aug. 24, 1895, *C. L. Shear 4599*; also at the same date and locality, *P. A. Rydberg.*

Senecio oodes Rydb. sp. nov.

Perennial, with a stout rootstock and caudex; stem 3–4 dm. high, slightly floccose below, branched; basal leaves long-petioled, loosely villous-floccose when young, in age glabrous; petioles

4–9 cm. long; blades thick, oval, 3–6 cm. long, 1.5–4 cm. wide, rounded or obtuse at the apex, abruptly contracted below, coarsely dentate-crenate with triangular-ovate, obtuse teeth; lower stem-leaves similar, the petioles with enlarged toothed or lobed stipule-like bases; the upper short-petioled and narrower; inflorescence corymbiform; heads many, about 1 cm. high; bracts linear, abruptly acute, 5–7 mm. long, slightly villous; rays bright-yellow, 10–12 mm. long, about 2 mm. wide; achenes glabrous, round-angled.

This is perhaps most closely related to *S. cymbalarioides*, but differs in the stouter, more branched and more leafy stem and the large ample stem-leaves. It grows in the higher mountains of Colorado.

COLORADO: Mt. Harvard, 1896, *F. E. Clements 39* (type); Robinson, Aug. 23, 1896, *C. L. Shear 3333*. (U.S. Nat. Herb.)

✓

✓ **Senecio Tracyi** Rydb. = S. [illegible]

Perennial with a short rootstock; stem about 4 dm. high, glabrous; basal leaves glabrous, long-petioled; petioles 3–10 cm. long, slender; blades round-oval or oval, thin, 1.5–5 cm. long, 1–3 cm. wide, entire or merely wavy, rounded at the apex, rounded, truncate or subcordate at the base; stem-leaves lanceolate, acuminate, 2–6 cm. long or the uppermost still smaller, sinuate-crenate, the lower cuneate at the base, the upper auriculate-clasping; inflorescence a small compact cyme; heads 8–11, broadly turbinate, 6–7 mm. high; bracts linear, abruptly acute, glabrous, the calyculate ones subulate, sparingly arachnoid; rays yellow, 6–8 mm. long, about 2 mm. wide.

The species belongs to the *S. aureus* group and is somewhat intermediate between *S. crocatus*, *S. pyrrochrous* and *S. fedifolius*. From the two first it differs in the paler rays and the form of the stem-leaves and from the last in the much larger size and the presence of rays. It grows at an altitude of 3150 m.

COLORADO: Bob Creek, west of Mt. Hesperus, July 1, 1898, *Baker, Earle & Tracy 276*.

✓ **Senecio turbinatus** Rydb. sp. nov. = (?) S. saxosus

Perennial with a cespitose rootstock; stem scapiform, about 1.5 dm. high, more or less floccose; basal leaf-blades cuneate-obovate, thick, 2–3 cm. long, 8–18 mm. wide, loosely floccose when young, dentate above the middle, rounded at the apex, tapering below into petioles about 3 cm. long; inflorescence corymbiform; heads about 4, about 12 mm. high; involucres obconic-turbinate, floccose at the base; bracts linear, gradually acute; rays pale-yellow, 8–9 mm. long, 3 mm. wide.

This species is probably most closely related to *S. pentodontus*, but distinguished by the peculiar involucre, which tapers gradually into the peduncles.

COLORADO: Lake City, 1878, *H. N. Pease.*

Senecio multicapitatus Greenman, sp. nov.

Perennial with a thick woody root; stem 4–10 dm. high, yellowish, glabrous, branched and broom-like, leafy; leaves irregularly pinnately dissected into linear-filiform lobes, 1–1.5 mm. wide, or the upper simple and linear-filiform, somewhat fleshy, glabrous and yellowish-green; heads in a corymbiform inflorescence, numerous, almost cylindric, 7–8 mm. high, about 4 mm. in diameter; bracts 8–10, yellowish, linear, gradually acute, glabrous and shining; calyculate ones small, subulate; rays pale-yellow, 7–8 mm. long and 2 mm. wide; achenes striate, grayish strigose-hispidulous.

This species has been included in *S. Douglasii*, which has long calyculate bracts and is confined to the west coast. *S. multicapitatus* resembles closely *S. Riddellii* in habit, but differs in the narrow heads and few bracts. In *S. Riddellii* the bracts are 12–15 and the involucre campanulate. *S. multicapitatus* grows on plains and in mountain valleys of Colorado, New Mexico, and Arizona.

COLORADO: Huerfano Valley, near Gardner, 1900, *F. R. Vreeland 651;* Mt. Princeton Station, 1901, *Underwood & Selby 465.*

NEW MEXICO: Gray, Lincoln Co., *F. S. Earle & Ester S. Earle;* high plains north of El Capitan Mountains, *F. S. Earle & Ester S. Earle 388.*

ARIZONA: Holbrook, 1896, *Myrtle Zuck.*

PRENANTHELLA Rydb. gen. nov.

Low diffusely branched annuals, with numerous small heads terminating the branches. Lower leaves ample, oblong or spatulate in outline, more or less runcinate; the upper reduced and bract-like. Involucres oblong, 4–5-flowered with as many oblong bracts and 1 or 2 small calyculate ones. Achenes gradually tapering downward from the truncate summit, 4–5-ridged. Pappus of white soft capillary bristles.

The species on which this genus is based was first described as a *Prenanthes* and later transferred to *Lygodesmia*. It is so unlike the other species of *Lygodesmia* in habit, that the habit alone would suggest a distinct genus. But the best character is found in the achenes, which are ribbed and tapering downward from the summit instead of upwards from the base. The fruit agrees better with that of *Nabalus* (*Prenanthes*), but from this genus *Prenanthella* is distinguished by the habit and the structure of the involucre.

Prenanthella exigua (A. Gray) Rydb.

Prenanthes exigua A. Gray, Pl. Wright. **2**: 105. 1853.
Lygodesmia exigua A. Gray, Proc. Am. Acad. **9**: 217. 1874.

New York Botanical Garden.

Contributions to the Mesozoic flora of the Atlantic coastal plain—I

EDWARD WILBER BERRY

(WITH PLATES 7–9)

While the present paper by no means exhausts the floral wealth of the Magothy formation, particularly within the state of Maryland, it is deemed advisable to publish it at this time in order to illustrate the remarkable floral unity of the formation, from which practically no plant-remains have hitherto been described outside the state of New Jersey. Such publication is especially necessary for the reason that while the name Magothy was proposed for these beds some years ago by Darton * it was not recognized by other geologists until republished by W. B. Clark in 1904,† its components having been previously referred to the underlying Raritan formation or to the overlying Matawan formation.

The plants are enumerated in their botanical order and include forms from the following localities: Cliffwood bluff on Raritan bay, New Jersey; the pits of the Cliffwood Brick Company near the head of Whale creek, New Jersey; near Morgan on Cheesequake creek, New Jersey; Kinkora on the Delaware river, below Trenton, New Jersey; the "Deep Cut" of the Chesapeake & Delaware canal just east of the Maryland line in Delaware; and Grove Point on the eastern shore of Chesapeake bay in Cecil county, Maryland. One or two species are included from the outcrop of the same formation on Good Hope Hill just across the Anacostia river at Washington, D. C.

The synonymy is omitted from all of the well-known but much-named species, and forms previously reported are not included in this contribution unless their range is extended.

PTERIDOPHYTA

GLEICHENIA SAUNDERSII Berry, Am. Nat. **37**: 679. *f. 1–3.* 1903.

Described originally from Cliffwood bluff; a single specimen

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* DARTON, Am. Jour. Sci. III. 45: 407–419. 1893.

† CLARK, *Ibid.* IV. 18: 435–440. 1904.

showing a trifle more than two centimeters of a single pinnule occurs in the material from Kinkora, N. J.

GLEICHENIA ZIPPEI Heer, Fl. Foss. Arct. **1**: *79. pl. 43. f. 4.* 1868.

This species, commonly accredited with the wide range from the Neocomian through the Senonian, has been recorded recently from several Cenomanian and Senonian localities in southeastern Europe. In all probability the early and late Cretaceous forms are distinct.

In addition to Cliffwood bluff, N. J., it occurs at Deep Cut, Del.

Osmunda delawarensis sp. nov. PLATE 8, FIGURES 2–4.

Fronds pinnate; pinnae simple, alternate, long, linear-lanceolate, inequilateral at the base; borders undulate, very slightly crenulate; frond substance thick. Pinnae 7.5 cm. long, 5–6 mm. wide near the base, tapering to a long narrow point, closely resembling the sterile pinnae of *Osmunda Presliana* J. Sm. of the east and south Asiatic region, except that the latter has a narrowed base, while this species has a large base more like that in *Osmunda regalis* L.

Whether the larger specimen figured is a pinnule of a bipinnate form like the modern cosmopolitan "royal fern" it is impossible to judge from the material thus far collected.

The *Osmundaceae* are rather common and widespread in the Jurassic, represented by *Todites*, etc. Various species have been referred to *Osmunda* or *Osmundites*, including two or three forms from the lower Potomac described by Fontaine, and showing supposed fructification. Penhallow has described in detail the structure of a stem from the lower Cretaceous of Queen Charlotte Islands under the name of *Osmundites skidegatensis*, which proves beyond question the occurrence of this type of plant at this general horizon.

Without the fertile parts we cannot, of course, be positive in our identification of this form, which is quite abundant at the Deep Cut of the C. & D. canal in western Delaware.

Osmunda at the present time contains six or seven species of swamp-loving ferns, most of them confined to the northern hemisphere, where they are wide-ranging. Three of these forms occur in North America.

SPERMATOPHYTA

CONIFERALES

SEQUOIA HETEROPHYLLA Velen. Gymnosp. Böhm. Kreidef. 22. *pl. 12. f. 2–4, 6–9; pl. 13. f. 12.* 1885.

Described originally from the Cenomanian of Bohemia, this species proves to be very abundant in the mid-cretaceous of the Atlantic coastal plain, with a known range from about the latitude of New York around the southern end of the Appalachian axis to Alabama.

Recorded in abundance from the Magothy formation at the pits of the Cliffwood Brick Co., N. J., Deep Cut, Del., and Grove Point, Md.

SEQUOIA GRACILLIMA (Lesq.) Newb. Fl. Amboy Clays 50. *pl. 9 f. 1–3.* 1896.

The cones of this species, which are so common on the beach at Cliffwood bluff, N. J., have been found during the past summer at Kinkora, N. J., on the Delaware river below Trenton, and at Deep Cut, Del.

SEQUOIA REICHENBACHI (Gein.) Heer, Fl. Foss. Arct. **1**: 83. 1868.

This widespread and probably composite species has been found during the past season in the pits of the Cliffwood Brick Co., N. J., and at Deep Cut, Del.

CUNNINGHAMITES SQUAMOSUS Heer, Kreidefl. v. Quedlinb. 9. *pl. 1. f. 5–7.* 1872.

In addition to the type locality in the Senonian of Saxony, this species has been found to be one of the most abundant forms characterizing the Magothy formation, occurring at Morgan, Cliffwood bluff, and Cliffwood Brick Co., N. J., and Deep Cut, Del.

Several specimens from Morgan and Deep Cut show the spreading sparse-leaved forms, larger specimens of which from the Judith river beds have been described by Knowlton as a new species.

MORICONIA CYCLOTOXON Deb. & Ett. Urwelt. Acrobry. Aachen 59. *pl. 7. f. 23–27.* 1859.

In 1859 Debey and Ettingshausen described this species from the Senonian of Aachen in Rhenish Prussia.[*] They considered it as possibly a fern of unknown affinities (" Plantae incertae sedis, filicibus affines ") but could find nothing in the existing or fossil floras of the globe which matched it in venation, and they remark on its resemblance to such conifers as *Thuja*, *Thujopsis*, and *Libocedrus*.

The Swedish arctic expedition of 1870–1872 collected the same plant at Kudliset on Disco Island, and Professor Heer described it as a new species of *Pecopteris* (*P. kudlisetensis*).[†]

Both the Prussian and Greenland specimens were poorly preserved ; subsequent collections, however, contained better material which was elaborated by Prof. Heer, who recognized the true identity of the specimens, placing them in the *Cupressineae* because of their resemblance to *Libocedrus*.[‡]

He corresponded with Dr. Debey to make sure of his identification, but the latter refused to admit their gymnospermous character, maintaining that certain discoid fungi which were found on some of the specimens were sori which thus established their filicean nature.

The next we hear of this species is in abundant remains from the upper Raritan clays at South Amboy, N. J., which Dr. Newberry during a European trip in 1888 compared with some of Debey's specimens. In his flora of the Amboy Clays numerous fine specimens are figured [§] and it is worth mentioning that the abundant and more representative collections from the lower horizons in the Raritan do not show any trace of this species which is so common at South Amboy.

In 1898 Dr. Hollick records specimens from Block Island and from Staten Island.[||]

The writer has collected this species in considerable abundance, but in a rather fragmentary condition, from the Cretaceous

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[*] DEBEY & ETTINGSHAUSEN, Die Urweltlichen Acrobryen des Kreidegebirges von Aachen etc. Denkschr. Wien. Akad. **17** : 239 (59). *pl. 8. f. 23–27.* 1859 (presented Nov. 12th, 1857).

[†] HEER, Kongl. Svenska Vetenskaps-Akad. Handl. **12** : 97. *pl. 26. f. 18.* 9 O 1873.—Fl. Foss. Arct. 3^2 : 97. *pl. 26. f. 18.* 1874.

[‡] HEER, Fl. Foss. Arct. 6^2 : 49. *pl. 33. f. 1–9.* 1882 ; **7** : 11. *pl. 53. f. 10.* 1883.

[§] NEWBERRY, Mon. U. S. Geol. Surv. **26** : 55. *pl. 10. f. 11–21.* 1896.

[||] HOLLICK, Ann. N. Y. Acad. Sci. **11**: 57, 418. *pl. 3. f. 10 ; pl. 37. f. 8.* 1898.

clays near Cliffwood, N. J.* These specimens are remarkable in being about one hundred per cent. more robust than any of the former that have been figured, and invariably have the main stem covered with the usual leaves, which are wanting on the stem in most of the Greenland specimens.

Recently the writer found several characteristic specimens of this species in the Deep Cut of the Delaware & Chesapeake canal just inside the Delaware state line, thus extending the known range one hundred miles southwest from Cliffwood, N. J. The writer has also collected it recently at Grove Point on Chesapeake Bay some eighteen miles further along the strike from Deep Cut.

So many of the mid-Cretaceous forms that are common in the coastal plain flora extended around its then southern border (Tuscaloosa formation of Alabama) that it would seem as if a careful search would reveal this species as well.

With regard to the botanical affinities of this plant, its gymnospermous nature has been commonly accepted of late years, and I cannot say that I know of any valid arguments against such affinity. It seems strange, in view of the abundant remains at South Amboy and Cliffwood, that no fruits have ever been found associated with the twigs, or in a position to suggest such an association. Another anomaly is the delicate texture of some of the specimens; for instance, from Grove Point, Maryland, I have a good-sized specimen which is of the thinnest consistency, suggesting a lax thallophyte, and yet showing in detail the characteristic markings of this species, which once seen are unmistakable.

FRENELOPSIS GRACILIS Newb. Fl. Amboy Clays 59. *pl. 12. f. 1–3a.* 1896.

This species was described by Newberry from Woodbridge, N. J., and does not show an organism whose botanical relations we can be at all certain about. Some of my Maryland material, originally included under *Widdringtonites Reichii* (Ett.) Heer, is identical with Newberry's species, both probably representing the decorticated twigs of the latter which is so common in these formations.

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* BERRY, Bull. N. Y. Bot. Gard. 3: 65. *pl. 43. f. 4; pl. 48. f. 1.* 1903.—Bull. Torrey Club 31: 70. 1904.

Hollick (Bull. N. Y. Bot. Gard. 3: 411. 1904) has reached the same conclusion, or at least suggested the same origin, for *Frenelopsis Hoheneggeri*, and the evidence seems probable enough in the case of my specimens. The *Frenelopsis* predominates at Deep Cut, Delaware, and the *Widdringtonites* predominates at Grove Point, Maryland. The Portuguese representative is *Frenelopsis leptoclada* Sap.

BRACHYPHYLLUM MACROCARPUM Newb. Fl. Amboy Clays 51 (footnote). 1896. PLATE 9.

Magnificent specimens of this species occur in the pits of the Cliffwood Brick Co., N. J., and at Deep Cut, Del. They are especially common at the latter locality.

Hollick and Jeffrey, from a study of the wood, recently announced the probable affinity of this species with the *Araucariineae*, and the publication of their investigation will be looked forward to with a great deal of interest.

JUNIPERUS HYPNOIDES Heer, Fl. Foss. Arct. 6^2: 47. *pl. 44. f. 3; pl. 46. f. 18.* 1882.

In washing out and picking over the lignite masses from the pits of the Cliffwood Brick Company, at which point the lignite consists of an assortment of leaves, sticks, seeds, and scales, not greatly macerated and but slightly solidified, among an abundant display of the twigs of *Sequoia Reichenbachii* (Gein.) Heer, were found perhaps a dozen fragments of twigs of a very graceful and delicate conifer which I refer to *Juniperus hypnoides* Heer.

I was at first disposed to refer these specimens to *Sequoia gracillima* (Lesq.) Newb., but further consideration has convinced me that they are identical with the twigs which Heer refers to *Juniperus*. Newberry refers somewhat similar remains, from the Raritan formation at Woodbridge, N. J., to *Juniperus macilenta* Heer. The figure which he gives is not very distinct and all that can be made out from it is that it represents a short-leaved graceful conifer. The Cliffwood material is certainly distinct from the type material of *Juniperus macilenta* Heer, which has more open and much less robust leaves than *J. hypnoides*. Also very common in the sandy clays at the Deep Cut of the C. & D. canal, Delaware.

THUJA CRETACEA (Heer) Newb. Fl. Amboy Clays 53. *pl. 10. f. 1, 1a.* 1896.

This species occurs in the Magothy formation at Grove Point, Md., and at Deep Cut, Del., and is excessively common at the latter locality.

WIDDRINGTONITES REICHII (Ett.) Heer, Fl. Foss. Arct. 6^2: 51. *pl. 28. f. 5.* 1882.

A very common species in the Atlantic coastal plain ranging from Greenland and Martha's Vineyard to Alabama. The new localities are Morgan, N. J., Deep Cut, Del., Grove Point and Overlook Inn road on Good Hope Hill in the District of Columbia. All of these localities are in the Magothy formation.

Picea cliffwoodensis sp. nov.

A remarkably well-preserved cone of *Picea* was collected at Cliffwood bluff and scales of apparently the same species occur in the lignite at the pits of the Cliffwood Brick Company. The principal specimen is pyritized and slightly flattened and is 8 cm. long with the apical portion missing, so that the cone in life was 10–12 cm. in length and very similar to the modern European *Picea excelsa* (Lam.) Link. Scales thin, persistent, somewhat kite-shaped, broadest across the middle and obtusely pointed, the two contained seeds rather large. Clearly referable to *Picea* and much more definite in its relations than other spruce-like fossil cones variously described as *Pinus*, *Pinites*, etc.

This species will be fully described and figured in the Report of the State Geologist of New Jersey for 1905.

GRAMINALES

CAREX CLARKII Berry, Am. Nat. **39**: 345. *f. 1.* 1905.

This species of sedge, originally collected by Dr. W. B. Clark on Grove Point, Maryland, has continued to come to light from other localities, and is a characteristic element in the flora of the Magothy formation. The remains are usually fragmentary and to that extent unsatisfactory. To the previously enumerated localities of Morgan and Cliffwood bluff, N. J., Deep Cut, Del. and Grove Point, Md., may be added Kinkora, N. J.

ARECALES

FLABELLARIA MAGOTHIENSIS Berry, Torreya **5**: 32. *f. 1, 2.* 1905.

This species was described from material collected in Delaware and Maryland, so that great interest attaches to the finding of the same form, and in considerable abundance, in the pits of the Cliffwood Brick Company in New Jersey. It thus serves to characterize the Magothy formation. The material is poor, but characteristic. The largest fragments secured are 17 cm. long and 8 cm. wide.

JUGLANDALES

JUGLANS ARCTICA Heer, Fl. Foss Arct. 6^2: *71. pl. 40. f. 2; pl. 41. f. 4c; pl. 42. f. 1–3; pl. 43. f. 3.* 1882.

Heer figures a number of leaves of this species which show considerable range in size, and he includes under this name a nut which is undoubtedly referable to *Juglans*, as well as the remains of aments. His *pl. 40. f. 2* shows a much larger leaf than the rest of his specimens, doubtfully related to *Juglans* in my opinion, and looking more like the leaf of some species of *Magnolia*. With the balance of his figures our leaf agrees very well, as it does with Newberry's leaf from Woodbridge, N. J.,* and Lesquereux's leaves from Kansas.† Hollick's leaf from Long Island ‡ is a basal fragment of a much larger leaf and his Block Island reference is based upon an ament.

In some of the Dakota group leaves the secondaries are somewhat more ascending than in our specimen, but it seems to me that there can be no question as to their identity.

A rather curious point of identity is the fact that the Greenland, New Jersey and Kansas leaves are all inequilateral, additional proof, if that were necessary, that they appertain to *Juglans*. From the pits of the Cliffwood Brick Co., N. J.

MYRICALES

MYRICA LONGA (Heer) Lesq. Fl. Dakota Group 67. *pl. 3. f. 1–6.* 1892.

The Dakota group and Staten Island leaves are smaller than this leaf from Grove Point, Md., while the Arctic leaves vary con-

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* NEWBERRY, Fl. Amboy Clays *pl. 20. f. 2.* 1896.

† LESQUEREUX, Fl. Dak. Group *pl. 19. f. 3; pl. 39. f. 5.* 1892.

‡ HOLLICK, Bull. Torrey Club **21**: *pl. 178. f. 2.* 1894.

siderably in size, some being larger and some smaller than the Maryland leaf, which agrees with them closely, however, in both outline and venation.

SALICALES

SALIX FLEXUOSA Newb. Later Extinct Floras 21. 1868; U. S. Geol. Surv. Mon. **35**: 56. *pl. 2. f. 5; pl. 13. f. 3, 4; pl. 14. f. 1.* 1898.

Salix proteaefolia flexuosa Lesq. Fl. Dak. Group 50. *pl. 64. f. 4, 5.* 1892. — Berry, Bull. N. Y. Bot. Gard. **3**: 67. *pl. 48. f. 12; pl. 52. f. 2.* 1903.

This small, narrow, elongate-leaved willow which Lesquereux regarded as a variety of his species *Salix proteaefolia* is very common in the Cretaceous of the Atlantic coastal plain and is particularly abundant and widespread in the Magothy formation as far as it has been explored in New Jersey, Delaware and Maryland. The forms are here restored to specific rank, as they are obviously distinct from *Salix proteaefolia* when the latter is correctly characterized. As I have discussed these forms at length in the Report of the State Geologist of New Jersey for 1905, they will not be farther considered in this place. Found in the Magothy formation at Cliffwood bluff, Cliffwood Brick Company and Morgan, New Jersey; Deep Cut, Delaware; and Grove Point, Maryland.

SALIX PROTEAEFOLIA Lesq. Am. Jour. Sci. **46**: 94. 1868. — Report on N. J. Clays 29. 1878. — Cret. Fl. 60. *pl. 5. f. 1–4.* 1874. — Cret. and Tert. Fl. 42. *pl. 1. f. 14–16; pl. 16. f. 3.* 1883. — Fl. Dakota Group 49. 1893. — Newb. Fl. Amboy Clays 66. *pl. 18. f. 3, 4.* 1896. PLATE 7, FIGURE 2.

Salix proteaefolia longifolia Lesq. Fl. Dakota Group 50. *pl. 64. f. 9.* 1893.

It is unnecessary to comment upon the forms included under this species, which are shown by the foregoing synonymy.

It occurs in the Magothy formation at the pits of the Cliffwood Brick Co., N. J., Deep Cut, Del., and Grove Point, Md.; PLATE 7, FIGURE 2 being a somewhat misleading representation in so far as the venation is shown of a specimen from the latter locality.

POPULUS (?) APICULATA Newb.; Hollick, Trans. N. Y. Acad. Sci. **12**: 4. *pl. 3. f. 2.* 1892. — Newb. Fl. Amboy Clays 65. *pl. 15. f. 3, 4.* 1896.

While I fully share Newberry's doubt as to this species being a *Populus*, I have no better suggestion to offer. Found in the Magothy formation at Deep Cut, Delaware.

URTICALES

FICUS ALIGERA Lesq. Fl. Dak. Group 84. *pl. 10. f. 3–6.* 1892.

These small oval entire leaves with winged petioles and stout midribs are rather small for this genus. The leaf-substance is thick and the venation is immersed. My collections contain several complete specimens from the pits of the Cliffwood Brick Company which do not differ from Lesquereux's type figures except that they do not show the secondary venation.

FICUS KRAUSIANA Heer, Fl. v. Moletein 15. *pl. 5. f. 3–6.* 1869.

Several characteristic fragments of this species occur in the thin layers of Magothy clay, just beneath the Matawan contact at Grove Point, Md.

FICUS WOOLSONI Newb.; Hollick, Trans. N. Y. Acad. Sci. **12**: 33. *pl. 2. f. 1, 2c.* 1892.

This rather anomalous leaf I take to be an abnormal one of this species, which is so common in the coastal plain Cretaceous. It is an especially common and variable species in the New Jersey Raritan, but has also been collected from Cliffwood bluff.

The leaf before us is ovate with truncate base and pointed apex, triple-veined. A sharp sinus divides one half of the leaf into two nearly equal rounded lobes, which give it the appearance of certain leaves from the Cenomanian of Bohemia which Velenovsky has described * as *Crotonophyllum cretaceum*, the resemblance being especially close to his figures *7* and *11* of that species.

FICUS CRASSIPES Heer, Fl. Foss. Arct. 6^2: 70. *pl. 17. f. 9a; pl. 24. f. 1, 2.* 1882.

Found in the Magothy formation at Deep Cut, Del., and Grove Point, Md.

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* VELENOVSKY, Květena českého cenomanu 20. *pl. 5. f. 4–8, 10, 11.* 1889.

FICUS DAPHNOGENOIDES (Heer) Berry, Bull. Torrey Club **32**: 329. *pl. 21.* 1905. PLATE 1, FIGURE 5.

This species is a common element in the Magothy formation at Deep Cut, Del., and Grove Point, Md., as it is from other localities in the coastal plain.

PROTEALES

PERSOONIA LESQUEREUXII Knowlt. Fl. Dak. Group 89. *pl. 20. f. 10–12.* 1892.

This small rounded leaf, narrowed and somewhat produced basally, occurs in the material from the pits of the Cliffwood Brick Co., N. J. It is entirely characteristic of this species.

RANALES

NELUMBO KEMPII Hollick, Bull. N. Y. Bot. Garden **3**: 412. *pl. 74. f. 1, 2; pl. 75; pl. 76; pl. 77. f. 1.* 1904.

This species of *Nelumbo*, originally considered as related to the palms, is relatively abundant in the Cretaceous of Long Island, but has not been found elsewhere heretofore. The leaves vary greatly in size, so that I have no hesitation in referring the leaves from Morgan, N. J., to this species, although the veins are not so prominent as those of the type material are said to be. My specimens, while somewhat fragmentary, are perfectly characteristic, and denote a leaf about 16 cm. in diameter. There are sixteen rather thin radiating veins, and the remains of the thick petiole is shown pressed close against the under side of the leaf. The specimen figured shows the upper surface of the leaf and there are faint indications of secondary venation. It is quite probable that the primaries would appear considerably more prominent from the under surface were that exposed. The only other fossil *Nelumbo* from the coastal plain is *Nelumbo primaeva* Berry, from the exposure on the beach near Cliffwood, N. J., and this species I am inclined to consider as simply a young leaf of *Nelumbo Kempii.* As Hollick (*loc. cit.*) remarks, *Nelumbo Kempii* is very similar if not identical with *Nelumbium arcticum* Heer from the homotaxial Atane beds of Greenland. My specimen differs from this as well as from Hollick's material, as aforesaid, in its thinner venation. In this character the leaf from Morgan, N. J., is comparable with

Nelumbium Lakesianum and *N. tenuifolium* of Lesquereux from the Denver and Laramie respectively.

I am of the opinion, however, that this difference in venation is almost entirely dependent upon the size of the leaves.

We have in these Long Island and New Jersey specimens the earliest known record of the genus, in species whose leaves are practically indistinguishable from those of the living *Nelumbo lutea*.

MAGNOLIA AURICULATA Newb.; Hollick, Bull. Torrey Club **21**: 61. *pl. 179. f. 6, 7.* 1894.

This species is rather common in the Magothy formation at Grove Point, Md.

MAGNOLIA TENUIFOLIA Lesq. Am. Jour. Sci. **46**: 100. 1868.

PLATE 7, FIGURE 1.

Additional material more complete than that figured occurs in the Magothy formation at Deep Cut, Delaware.

Liriodendron morganensis sp. nov.

Length along the midrib 7 cm., breadth across the lower lobes 9 to 10 cm. Apical sinus deeply and broadly rounded. Lobes stout and bluntly rounded, the lower directed laterally. Midrib and petiole very stout.

Several perfect specimens were collected from the Magothy formation at Morgan, N. J., and they will be fully described and illustrated in the Report of the State Geologist of New Jersey for 1905.

CARPITES LIRIOPHYLLI Lesq. Cret. & Tert. Fl. 77. *pl. 11. f. 5.* 1883.

Unmistakable remains of this species, which was originally described from Morrison, Colorado, occur at Deep Cut, Del. They undoubtedly represent the fruit-remains of some contemporary species of *Liriodendron*.

ROSALES

Platanus Kümmelii sp. nov.

Leaves large, palmately trilobate when mature, triple-veined from the base which is cuneate and entire. Margin sharply and widely serrate. Main sinuses deep and rather narrow for this genus, rounded. Petiole, midrib and lateral primaries stout. Secondaries nearly straight. Tertiary venation characteristically platanoid.

Length about 19 cm. Breadth 21 cm. These leaves are very common in the pits of the Cliffwood Brick Company, occurring both in the clays and in the lignites. With them are found abundant remains of the fruit ("button-balls"). This species will be more fully described and figured in the Report of the State Geologist of New Jersey for 1905.

Colutea obovata sp. nov. PLATE 8, FIGURES 5, 6.

Obovate, almost orbicular in general outline, inequilateral, with rounded lobes and a rather deep and broadly rounded sinus. 2.5 cm. long and about the same breadth, the broadest part being toward the apex, the lower part of the blade being wedge-shaped with curved margins. Midrib curved, rather stout; secondaries four or five on each side, sub-opposite, thin, ascending, camptodrome, leaving the midrib at an angle of about 45°. Tertiary venation very fine, but distinctly shown.

Type specimens consist of one perfect leaf and its somewhat broken counterpart from Grove Point, Maryland.

I was at first disposed to refer this handsome little leaf to *Colutea primordialis* Heer, which is so widely distributed in the American Mid-Cretaceous, but careful comparison renders such reference impossible. While the Grove Point leaf is somewhat of the same proportions as the leaf from the Dakota Group which Lesquereux refers to *C. primordialis*, still it is broader and more retuse and has fewer secondaries. In fact a comparison of Lesquereux's leaves with the type figures renders it doubtful if the Dakota Group leaves are identical with the other leaves that have been referred to this species by Heer, Newberry and Hollick. Comparing our leaf with Heer's type figures we note that the latter are larger, proportionally longer, narrower and with less rounded lobes. The Raritan leaves of Newberry are entirely dissimilar in outline and venation and are very angular looking. Hollick's leaf from the Long Island Cretaceous is rather different from Newberry's leaves, but is still less retuse and spreading than our Maryland leaf. Among the other Cretaceous species of *Colutea*, *C. Langeana* Heer is long and narrow, *C. coronilloides* Heer is narrow and has a pointed apex, *C. protogaea* Heer from Patoot shows two types of form, his *pl. 61. f. 1c* is broadest across the middle of the blade and has a restricted sinus, while his *pl. 62. f. 1c* has a narrow sinus and an angular outline like the leaves which Newberry refers to *C. primordialis*. Probably the most similar to our species among those of the Cretaceous is *Colutea valde-inaequalis* Heer, from Greenland, which in its general proportions is quite similar, but it is a somewhat larger leaf and has the sinus sharp instead of widely rounded.

Comparing our leaf with the various Tertiary species, it may be noted that the only American species (*C. Boweniana* Lesq.) is entirely different. With the forms from the European Tertiary, however, there is more similarity, the nearest being *Colutea macrophylla* Heer (*cf.* Fl. Tert. Helv. **3**: *pl. 132. f. 46*), while the venation of all the Swiss Miocene species (*C. Salteri*, *C. macrophylla*, *C. debilis*, and *C. antiqua*) is very close to that of the American leaf.

HYMENAEA DAKOTANA Lesq. Fl. Dakota Group 145. *pl. 55. f. 2, 3; pl. 56. f. 1, 2; pl. 62. f. 2.* 1892.

Fontaine has referred to this genus a species from the Potomac formation of Virginia, based upon the basal fragments of leaflets. It is perhaps needless to say that very little confidence can be placed in this determination. Undoubted species do occur, however, during the Mid-Cretaceous, Velenovsky having described three forms from the Cenomanian of Bohemia and Lesquereux the above species from the Dakota Group. The latter usually occurs as detached inequilateral leaflets with a rather stout curved midrib. Two of these leaflets occur in the collections from Morgan, N. J. They are somewhat smaller than the other leaves referred to this species, that of Hollick * and some of Lesquereux's being considerably larger. Judging from the figures Hollick's leaf is probably referable to the species *Phaseolites manhassettensis* recently established (Bull. N. Y. Bot. Gard. **3**: 414. *pl. 78. f. 1, 2.* 1904) by him for the reception of certain leaves from Manhasset Neck, Long Island.

Newberry's leaf (Fl. Amboy Clays 90. *pl. 41. f. 14.* 1896) and Lesquereux's *fig. 3* are identical in outline with the Morgan leaf, which appears to have been of a very delicate texture and does not show any venation characters, due undoubtedly to the rather sandy matrix. A single perfect specimen from the pits of

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* HOLLICK, Bull. Torrey Club **21**: *pl. 176. f. 4.* 1894.

the Cliffwood Brick Co. is larger than the Morgan leaf and shows the long ascending camptodrome secondaries.

SAPINDALES

ILEX STRANGULATA Lesq. Ann. Rep. U. S. Geol. and Geog. Surv. Terr. **1874**: 359. *pl. 7. f. 8.* 1876.

While this leaf is not so "strangulate" as the type, it is exactly similar in all other respects. It has the same coriaceous texture, thick petiole and midrib, and the same secondary venation, particularly the marginal vein. From the pits of the Cliffwood Brick Co., N. J.

RHAMNALES

Paliurus populiferus sp. nov.

Leaf orbicular, slightly emarginate at the apex and with a decurrent base. Three-veined from the top of the petiole, which is 0.94 cm. in length. Leaf 2.5 cm. long and 3.25 cm. wide.

Found at the pits of the Cliffwood Brick Co., N. J., and will be figured in the Report of the State Geologist of New Jersey for 1905.

CISSITES CRISPUS Velen. Fl. Böhm. Kreidef. **4**: 12 (73). *pl. 4 (27). f. 6.* 1885 (1887).

Doubtful specimens of this species occur at the pits of the Cliffwood Brick Co., N. J., and in iron carbonate nodules at Deep Cut, Del.

MALVALES

GREWIOPSIS FLABELLATA (Lesq.) Knowlt. Bull. U. S. Geol. Surv. **152**: 114. 1898.

Poorly represented in the material from the Magothy formation at Grove Point, Md.

Sterculia minima sp. nov.

"*Sterculia mucronata* Lesq."; Berry, Bull. N. Y. Bot. Gard. **3**: 90. *pl. 43. f. 3.* 1903.

Small 2- or 3-lobed, subcoriaceous leaves, ranging in length from 4–6 cm. Lobes narrow, pointed, ascending at an angle of somewhat less than 45°, with narrow sinuses extending about half way to the base. Lateral primaries branching from the midrib above its base and secondary venation camptodrome, but not well shown in most specimens.

Because of the well-known variability in fossil *Sterculia* leaves both from this country and abroad, the original two-lobed specimen from Cliffwood bluff was referred to Lesquereux's species cited above, and was considered to be a small bilobed form of the same species, which ordinarily bore rather larger leaves. Subsequent collections, however, at different localities far removed from Cliffwood bluff, show that these small leaves are uniform in size and may be indifferently two or three lobed, so that it seems desirable to consider them distinct from the ordinarily much larger *Sterculia mucronata* Lesq. of the west, from which it may be distinguished by its much smaller size, its less conical lobes, directed upwards instead of laterally, and the fact that in the former the leaves are palmately 3–5-lobed and the primaries are three in number and are palmately arranged from the top of the petiole.

Formation—Magothy.

Localities—Cliffwood bluff (type) and pits of Cliffwood Brick Company, N. J., Deep Cut, Del., and Grove Point, Md.

STERCULIA CLIFFWOODENSIS Berry, Bull. N. Y. Bot. Gard. **3**: 88. *pl. 43. f. 5.* 1903.

Originally described from Cliffwood bluff, N. J. A single broken fragment from Deep Cut, Del., has one lobe preserved for a distance of 10 cm., which must have given the perfect leaf much the appearance of *Sterculia lugubris* Lesq.

THYMELEALES

LAURUS HOLLICKII Berry, Bull. N. Y. Bot. Gard. **3**: 79. *pl. 52. f. 4.* 1903.

This is one of the commonest species in the Magothy formation, to which it is confined, and has been collected at Morgan and Cliffwood bluff, N. J., at Deep Cut, Del., and at Grove Point, Md.

LAURUS PLUTONIA Heer, Fl. Foss. Arct. **6^2**: 75. *pl. 19. f. 1d, 2-4,* et seq. 1882.

This widespread mid-Cretaceous species has been found at the following localities in the Magothy formation: Morgan, Cliffwood bluff and Cliffwood Brick Co., N. J., and Grove Point, Md.

LAUROPHYLLUM ANGUSTIFOLIUM Newb. Fl. Amboy Clays 86. *pl. 17. f. 10, 11.* 1896.

Found in the Magothy formation at Cliffwood bluff, N. J., and at Grove Point, Md.

CINNAMOMUM INTERMEDIUM Newb. Fl. Amboy Clays 89. *pl. 29. f. 1–8, 10.* 1896. PLATE 7. FIGURES 3, 4.

This species ranges from New Jersey to Alabama. It is very common at the pits of the Cliffwood Brick Company in the former state and is also found at Deep Cut, Del., and Grove Point, Md. Velenovský identifies a leaf which is very close to this species from the Cenomanian of Bohemia, where it is widely distributed, as *Aralia daphnophyllum.**

Attention is directed to the similarity which all of these leaves show to the entire forms of the modern *Sassafras.*

CINNAMOMUM HEERII Lesq. Am. Jour. Sci. **27**: 361. 1859. — Trans. Am. Phil. Soc. **13**: 431. *pl. 23. f. 12.* 1869. — Cret. Fl. 84. *pl. 28. f. 11.* 1874. — Cook's Clay Report 28, 29. 1878. — Cret. & Tert. Fl. 54. 1883. — Fl. Dak. Group 105. *pl. 15. f. 1.* 1892. — Newb. Fl. Amboy Clays 28, 29. 1896 (?). — U. S. Geol. Surv. Mon. **35**: 100. *pl. 17. f. 1–3.* 1898. — Knowlton, Ann. Rep. U. S. Geol. Surv. **21^7**: 318. 1901. — ? Kurtz, Revista Mus. La Plata **10**: 52. 1902.

Daphnogene Heerii Lesq. Ann. Rep. U. S. Geol. & Geog. Surv. Terr. **1874**: 343. 1876.

From the number of fragments at the pits of the Cliffwood Brick Co., I judge this species to have been rather common, although much search has failed to reveal complete specimens. One of these shows a leaf of abnormal lateral growth, the midrib being abruptly bent almost at a right angle just above the point of insertion of the lateral primaries. This species differs from the typical form such as is figured in the Flora of the Dakota Group by its slightly more ovate outline and the wide angle which the lateral primaries make with the midrib. It may be distinguished from *Cinnamomum intermedium* Newb., which is common at this locality, by its thicker texture, shorter form, wider and more rounded base, and thicker veins, the latter being comparatively thin in *C. intermedium.* I have included Newberry's reference under this species although I am not absolutely certain that his forms are identical with those of Lesquereux.

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* Fl. böhm Kreidef. 1: 23. *pl. 5. f. 5–8, 10; pl. 6. f. 1–5.* 1882.

The Raritan localities enumerated by Lesquereux in Cook's Clay Report are very doubtful.

Kurtz records (*loc. cit.*) this species from the Cenomanian of Cerro Guido, Argentina, but his paper, unfortunately, is not illustrated. In view of the variety of triple-veined Lauraceous leaves still existing in the warmer parts of South America, his reference of such a leaf to this North American species seems to me to be very doubtful.

MALAPOENNA FALCIFOLIA (Lesq.) Knowlton, U. S. Geol. Surv. Bull. **152**: 142. 1898.

Litsea falcifolia Lesq. Fl. Dak. Group 97. *pl. 11. f. 5.* 1892.

Described originally from the Dakota Group of Kansas, a single specimen has thus far come to light in the collections from the pits of the Cliffwood Brick Co.

UMBELLALES

HEDERA CRETACEA Lesq. Fl. Dak. Group 127. *pl. 18. f. 1.* 1892.

A single specimen which I have correlated with this species occurs in the collections from Deep Cut, Delaware.

MYRTALES

EUCALYPTUS WARDIANA Berry, Bull. Torrey Club **32**: 47. 1905.

Characteristic remains of this species, described from Cliffwood bluff, N. J., have been found in the pits of the Cliffwood Brick Co. in that state and at Deep Cut, Del., and Grove Point, Md.

EUCALYPTUS GEINITZI Heer, Fl. Foss. Arct. **6**^{2}: 93. *pl. 46. f. 12, 13.* 1882.

This species which was found to be common at Cliffwood bluff, N. J., shows remarkably perfect and characteristic specimens from Deep Cut, Delaware.

EUCALYPTUS (?) ATTENUATA Newb. Fl. Amboy Clays 111. *pl. 16. f. 2, 3, 5.* 1896.

Found in the Magothy formation at Cliffwood bluff, N. J., and Grove Point, Md.

ERICALES

ANDROMEDA NOVAE-CAESAREAE Hollick, in Newb. Fl. Amboy Clays 121. *pl. 42. f. 9–12, 28–31.* 1896.

I have four specimens of this well marked small leaf from Grove Point, two of which are perfect. They are identical with Hollick's figures from New Jersey, representing a broadly lanceolate leaf, equally pointed at both ends, with ascending curved secondaries.

ANDROMEDA PARLATORII Heer, Phyll. Crét. Nebr. 18. *pl. 1. 5.* 1866.

This well-known and widespread Cretaceous species was found at Deep Cut, Del., and Grove Point, Md.

EBENALES

DIOSPYROS ROTUNDIFOLIA Lesq. Cret. Fl. 89. *pl. 30. f. 1, 1a.* 1874.

Our leaves agree with Hollick's specimens from Long Island and with the numerous examples from Kansas figured in the Flora of the Dakota group, which are somewhat smaller than the type.

This is a common form in the pits of the Cliffwood Brick Company, N. J., at Deep Cut, Del., and at Grove Point, Md., thus becoming a characteristic species of the Magothy formation.

Sapotacites Knowltoni sp. nov. PLATE 8, FIGURE 1.

Sapotacites sp. ? Lesq. Fl. Dak. Group 114. *pl. 65. f. 3.* 1892.

An oval leaf, 5.5 to 6 cm. long, round-emarginate at the apex, with full rounded margins to the base. Secondaries ascending, camptodrone, their angle of separation rather acute. This is obviously identical with the leaf figured by Lesquereux from the Dakota Group. It is about the same size as *Sapotacites retusus* Heer as it occurs in the Raritan formation, but is considerably less emarginate and is broadest across the middle and not toward the base. The basal margins are convex and not concave and the secondaries are more ascending.

This species, of which several specimens have been collected at Deep Cut, Del., is very close to *Sapotacites obovata* Velen.,* from the Cenomanian of Bohemia, the latter being somewhat larger, and narrower toward the base.

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* Fl. böhm. Kreidef. 3 : 3. *pl. 3. f. 6.* 1884.

SANTALALES

Santalum Novae-Caesareae sp. nov.

Leaf oblong, about 10 cm. long and 2 cm. in greatest width. Blade gradually narrowed to the stout petiole. Tip broadly rounded and midrib stout. Secondaries leaving the midrib at an acute angle, long and ascending, finally becoming camptodrone, showing a tendency to become massed toward the base.

From Morgan and Cliffwood Brick Co., N. J.

Santalum has not hitherto been recognized in the Cretaceous of North America, and while these leaves are rather large for this genus, they appear to be identical with a number of living species of *Santalum*, notably *Santalum cognatum*, *S. ellipticum*, etc.

Material will be more fully described and illustrated in the Report of the State Geologist of New Jersey for 1905.

MARYLAND GEOLOGICAL SURVEY.

Explanation of plates 7-9

PLATE 7

FIG. 1. *Magnolia tenuifolia* Lesq., from Deep Cut, Del.
FIG. 2. *Salix proteaefolia* Lesq., from Grove Point, Md.
FIG. 3. *Cinnamomum intermedium* Newb., from Deep Cut, Del.
FIG. 4. The same, from Grove Point, Md.
FIG. 5. *Ficus daphnogenoides* (Heer) Berry, from Grove Point, Md.

PLATE 8

FIG. 1. *Sapotacites Knowltoni* Berry, from Deep Cut, Del.
FIG. 2, 3, 4. *Osmunda delawarensis* Berry, from Deep Cut, Del.
FIG. 5, 6. *Colutea obovata* Berry, from Grove Point, Md.

PLATE 9

FIG. 1, 2. *Brachyphyllum macrocarpum* Newb., from Deep Cut, Del.
FIG. 3. The same, from the pits of the Cliffwood Brick Co., N. J.

The genus Vernonia in the Bahamas

Henry Allan Gleason

In the recent Bahamian collections made for the New York Botanical Garden is abundant material representing the genus *Vernonia* and including some interesting new forms. Dr. N. L. Britton has referred them to me for study and has also given numerous valuable suggestions concerning their specific characters. The specimens cited are all in the herbarium of the New York Botanical Garden.

In 1864 Grisebach, in the Flora of the British West Indies, described a species of *Vernonia* from the Bahamas as *V. bahamensis.* Since then numerous collections have been made and the species has been mentioned frequently in literature pertaining to the islands. It is, however, an aggregate, and three related but distinct species are represented in recent collections. In addition a second type, represented by a fourth species belonging to a widely different section of the genus, has recently been collected and demands recognition as new. A widely distributed tropical species, *V. cinerea,* is introduced in New Providence Island.

Vernonia bahamensis as characterized by Grisebach has the "heads single, sessile at the top of leafy branches." The two related species resemble it to some extent in this character. The three may together be regarded as members of the section *Lepidaploa,* subsection *Scorpioideae,* in which the scorpioid cymes have been much reduced, even to a single flower as in *V. bahamensis.* Indications of this reduction are seen in *V. longifolia* Pers. with its varieties *Sintenisii* Urban and *Vahliana* Urban of the Windward Islands and Porto Rico. The internodes of the cyme are shortened, and the heads are fewer than in typical scorpioid *Vernoniae,* and the whole inflorescence but little exceeds the upper foliage leaves. This group seems to be of equal rank with *Scorpioideae foliatae,* and *Scorpioideae aphyllae,* and the name *Scorpioideae reductae* will indicate the peculiarities of its inflorescence.

The fourth species, of the section *Lepidaploa*, subsection *Paniculatae*, with corymbose peduncled heads, is entirely different from the others and finds its nearest relatives in the United States.

The five species may be separated as follows:

Herbaceous; heads corymbose, peduncled.	
Leaves ovate, pubescent.	*V. cinerea.*
Leaves linear or oblong-linear, glabrous or nearly so.	*V. insularis.*
Frutescent; heads sessile or nearly so, single or in small cymes.	
Inflorescence of many heads; leaves of an elliptical type, broadest at or near the middle.	*V. arctata.*
Inflorescence of few heads; leaves broadest above the middle.	
Leaves oblanceolate, spatulate, or narrowly obovate.	*V. bahamensis.*
Leaves very broadly obcordate.	*V. obcordata.*

VERNONIA CINEREA (L.) Less. Linnaea **4**: 291. 1829.
Conyza cinerea L. Sp. Pl. 862. 1753.

This well-known introduced species differs from the other Bahamian forms in the ovate or ovate-oblong, petioled, undulate leaves. It belongs to the section *Tephrodes*, characterized by achenes without evident ribs. New Providence, *Earle 60.*

Vernonia insularis sp. nov.

§ *Lepidaploa*, *Paniculatae;* perennial by a horizontal rootstock; stem herbaceous or suffruticose, glabrous or minutely puberulent in the inflorescence, erect, 6–10 dm. high, simple or sparingly branched; leaves numerous, alternate, narrowly oblong-linear, entire, obtuse or sub-acute, mucronate, acute or narrowed at the sessile base, one-nerved or with faint lateral veinlets, green and essentially glabrous on both sides, 6–10 cm. long, 0.8–1.2 cm. wide, the upper somewhat smaller; inflorescence terminal, corymbose, lax; heads 4–25, on peduncles 0.5–4 cm. long; involucre at maturity broadly campanulate or depressed-hemispheric, about 5 mm. high; scales glabrous with membranous margins, the outer lanceolate, sharply acuminate, the inner oblong, abruptly acuminate or mucronate; achenes 2 mm. long, striate, sparsely pubescent; pappus tawny, 6 mm. long, the outer series minute.

Great Bahama, pine lands, Eight Mile Rocks, Feb. 5–13, 1905, *N. L. Britton & C. F. Millspaugh 2392a*, type, in fruit; same place and date, *N. L. Britton & C. F. Millspaugh 2392*, a more mature specimen with the achenes gone; same place, April 16–May 8, 1905, *L. J. K. Brace 3683*, young specimens only 2.5–3 dm. high, with the inflorescence just beginning to appear;

Abaco, pine lands, Marsh Harbor, Dec. 21, 1904, *L. J. K. Brace 1835*, past maturity with the achenes gone.

Abaco and Great Bahama islands, from which *V. insularis* only has been collected, are but a short distance from the east coast of southern Florida, and the nearest relative of the species may be looked for there. In leaf-habit and involucre it is not far from the Floridian *V. Blodgettii* Small, and may be connected phylogenetically with it.

Vernonia arctata sp. nov.

§ *Lepidaploa, Scorpioideae reductae;* a much-branched shrub 3–8 dm. high, stem and branches striate, thinly tomentose or glabrate, branches crowded, leafy; leaves broadly elliptic to obovate-oblong, acute or mucronate, entire, acute or obtuse at the base, pinnately veined, brown-tomentose beneath, glabrate above, 1–1.8 cm. long, 0.6–1.1 cm. broad, divaricately spreading or somewhat reflexed, on tomentose petioles 3–7 mm. long; inflorescence flattened, terminating the branches, consisting of several short leafy irregular scorpioid cymes bearing each 1–5 sessile or short-peduncled heads; involucre campanulate, 4–5 mm. high; scales pauciseriate, lanceolate, irregularly imbricated, acute, tomentose; achenes about 13 in each head, pubescent, 2.5 mm. long; pappus nearly white, 5 mm. long, the outer series conspicuous.

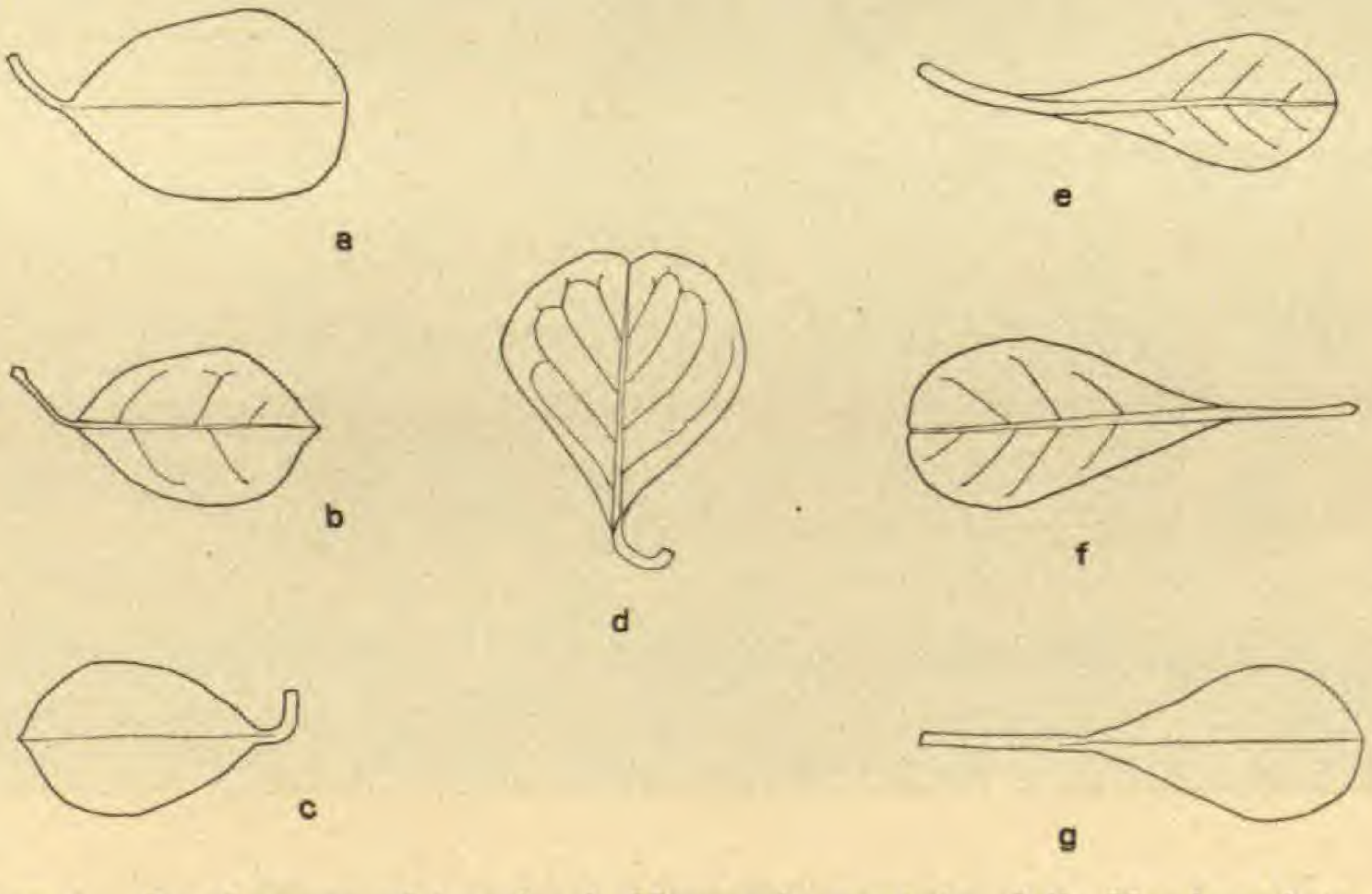

FIGURE 1. Leaf types of (*a*, *b*, *c*) *Vernonia arctata*, (*d*) *V. obcordata*, (*e*, *f*, *g*) *V. bahamensis*. Natural size.

New Providence Island, in dry pine barrens. Most of the recently collected material distributed as *V. bahamensis* belongs here: *A. H. Curtiss 65*, Feb. 5, 1903 (type); *C. F. Millspaugh 2481*, Jan. 24, 1905: *Mrs. E. G. Britton 3275*, Feb. 3, 1905; *N. L. Britton & C. F. Millspaugh 2101*, Jan. 26, 1905; *N. L. Britton 6*, Apr. 7 and 8, 1904; *W. C. Coker 53*, June 20, 1903; *J. I. & A. R. Northrop 101*, Jan. 10, 1890; and two other sheets, in the herbarium of Columbia University, collected by Wm. Cooper.

Several branches usually arise near each other and are straight, virgate, very leafy, and about equal in length. Below the origin of the branches the leaves soon fall off. The inflorescence is sometimes 8 cm. across, and always exceeds the foliage leaves when fully developed. There is some variation among the specimens in the character of the branching but it appears to be due almost entirely to the relative age of the plants as shown by the time of collection.

FIGURE 2. Habit photograph of *Vernonia bahamensis* Griseb.

Vernonia arctata is distinguished from *V. bahamensis* by the shorter and broader leaves, the character of the branching, and the conspicuous inflorescence with numerous heads.

VERNONIA BAHAMENSIS Griseb. Fl. Brit. W. Ind. 352. 1864.

A repeatedly dichotomously branched bushy shrub, reaching a height of 2 m. or more, with the leaves confined mostly to the young branches. Stem flexuous, thinly tomentose; younger branches strongly angled; leaves alternate, numerous, spatulate, oblanceolate, or narrowly obovate, entire, rounded at the tip and varying from mucronate to slightly retuse, narrowed at the base into a margined petiole, pinnately veined, tomentose on both sides, especially beneath, 2–3.5 cm. long, including the petiole, 0.5–1.2 cm. wide; heads few, seldom more than four on each branch, single, sessile among the upper leaves, with 13 flowers or fewer, usually 8; involucre campanulate, 3–4 mm. high; scales ovate-lanceolate, sharply acute, loosely imbricated in few series, tomentose; achenes densely hirsute, 2–2.5 mm. long; pappus nearly white, 4–5 mm. long, the outer series conspicuous.

Fortune Island, *Eggers 3832*, Apr. 2, 1888; Inagua, *Nash & Taylor 1017*, Oct. 14, 1904, and *1344*, Oct. 28, 1904.

Notes accompanying the specimens indicate that it grows in the so-called white lands, has purple flowers, and is locally known as white sage; the photograph, for which I am indebted to Mr. G. V. Nash, shows the general character of the plant.

The last cited specimen has been compared with the original collections in the Kew Herbarium, and pronounced identical by Sir William Dyer, and later also by Dr. N. L. Britton. Fortune Island and Inagua Island are near the southern end of the Bahamian archipelago, and the latter is not far from Haiti. As indicated by the specimens at hand, *V. bahamensis* and *V. arctata* are distinct not only in structure but also in geographical distribution.

Vernonia obcordata sp. nov.

§ *Lepidaploa, Scorpioideae reductae;* a much-branched shrub 6–9 dm. high, with stiff crooked branches, bearing leaves only on the young shoots; young branches strongly angled and tomentose, becoming terete and glabrous with age; leaves numerous, crowded, broadly obcordate, entire, narrowed at the base into a petiole 5 mm. long, pinnately veined, closely gray tomentose on both sides, especially beneath, blade 0.8–1.5 cm. long, 0.7–1.5 cm. wide, the cordation at the apex 2–3 mm. deep; heads few, single, sessile among the upper leaves, 8–13-flowered; involucre campanulate, 4–5 mm. high; scales ovate-lanceolate, acute, irregularly and loosely imbricated, tomentose; achenes as in *V. bahamensis*; pappus yellow.

Little Inagua, *Nash & Taylor 1206*, Oct. 20, 1904.

Vernonia obcordata is distinguished at once from the related species by the obcordate leaves, as broad as long, and by the yellow pappus.

NEW YORK BOTANICAL GARDEN.

American ferns — VI. Species added to the flora of the United States from 1900 to 1905

LUCIEN MARCUS UNDERWOOD

Since the beginning of the serious study of our native ferns, there has probably been no similar period in which so many additions have been made to our flora as in the five years just passed. This has been due to several causes, the most important of which is the opening up to exploration of the really tropical portion of southern Florida, with the consequent addition of a large number of species mostly more or less common in the lowlands of the Bahamas and the Antilles. Some of the additions are due to the closer analysis which has been given in recent years to certain genera, particularly *Selaginella* by Professor Georg Hieronymus, *Isoetes* by Mr. A. A. Eaton, and *Botrychium* by the present writer. The proper delimitation of certain species of central and southern Florida has depended on special conditions. For example, while the writer was collecting in Florida during the winter of 1890–91, two species already known from that state were found growing together in similar situations on limestone rocks. Although these ferns had been referred, the one to a West Indian species and the other to a variety of the same, on collecting these species fifteen years ago the writer felt as fully as he does now (1) that the two had full specific distinctness, and (2) that the places to which they had been assigned by the "authorities" was not the correct one. Two essential conditions, however, were then lacking to justify their separation, and the writer has waited until these conditions might be changed:

1. It was essential for accuracy to make examination of certain types in European herbaria; this has not been practicable until the past summer; and

2. It was necessary to study a large collection of West Indian species of *Asplenium* in order to delimit the boundaries of related species. This has now become possible at home, for while the Kew herbarium and the Berlin collections, including the well

known West Indian herbarium of Krug and Urban, both contain material not found in any other, the collections now accumulated at the New York Botanical Garden exceed either, or both together for that matter, in the richness and completeness of the series of West Indian ferns.

A number of the species in the following list have already been reported by Mr. A. A. Eaton, whose collections in South Florida were partly listed in the Fern Bulletin for April, 1904; others have been reported by Mr. Maxon, by Mr. Gilbert, and by the writer, in various short notes. It is thought desirable to bring these together in a single list which will supplement the last (1900) edition of *Our Native Ferns and their Allies.* It will be noted that the list contains six genera and forty-nine species from the limits of the United States, not included in that work; two of these, however, displace species already reported under other names, so that the net increase is forty-seven species. Besides these a considerable number of varieties have been described; some of these are based on mere sports like the var. *Hortonae* of *Asplenium platyneuron*, and *Pellaea atropurpurea cristata*, while others may represent something more permanent in character. No attempt has been made to list these here. Among the forty-seven species, two are plants introduced from cultivation, which have apparently become locally established. One species of *Equisetum* and four species of *Selaginella* must be placed in the list of "*Species inquirendae*," inasmuch as they are imperfectly known. Removing these two doubtful series from the list there are still forty native species which represent *bona fide* additions to our known flora. The list follows, arranged in systematic order:

OPHIOGLOSSACEAE

BOTRYCHIUM ALABAMENSE Maxon, Proc. Biol. Soc. Washington **19**: 23. 1906. (Type from Mobile, Alabama, *Dukes.*)

BOTRYCHIUM CALIFORNICUM Underw. Torreya **5**: 107. 1905.

This species is the Californian plant hitherto mistaken for *B. silaifolium* Presl. *B. occidentale* Underw. becomes a synonym of the latter species, having been based on a tall-growing form.

BOTRYCHIUM ONONDAGENSE Underw. Bull. Torrey Club **30**: 47. 1903. (Type from Onondaga county, New York, *Underwood.*

RANGE: Central New York, northern Michigan, Montana (?).

BOTRYCHIUM TENUIFOLIUM Underw. Bull. Torrey Club **30**: 52. 1903. (Type from Alexandria, Louisiana, *Hale.*)

RANGE: Southern States from Alabama to Louisiana and Missouri. Closely related to *B. obliquum* Muhl.

SCHIZAEACEAE

ACTINOSTACHYS GERMANI Fée, Mém. Foug. **11**: 123. *pl. 29. f. 3.* 1866. (Type from Guadeloupe, *Deshaies*).

This remarkable discovery of Mr. A. A. Eaton in South Florida adds a fourth member of this family to our flora, and gives to a hitherto rare and local tropical species an unexpected distribution. Like *Schizaea pusilla*, this new species, although larger, is still so inconspicuous that it would be readily passed over by any except the most careful collector of ferns, and quite likely has a much wider range than has hitherto been attributed to it. The genus is closely related to *Schizaea* but has penicillate spikes.

LYGODIUM JAPONICUM (Thunb.) Sw. Jour. Bot. Schrader **1800**^{2}: 106. 1801.

Ophioglossum japonicum Thunb. Fl. Jap. 328. 1784. (Type from Japan, *Thunberg.*)

Escaped from cultivation near Thomasville, Georgia, and at several places near Mobile, Alabama, where it is growing like a wild plant. Mr. W. D. McNeill has sent me a fine series of specimens which were very naturally taken for a native species by their collector.

POLYPODIACEAE

POLYPODIUM HESPERIUM Maxon, Proc. Biol. Soc. Washington **13**: 200. 1900. (Type from Washington, *Gorman 642.*)

A segregate from *P. vulgare* which includes most or all of the forms hitherto referred to that species from the Rocky Mountains westward to the Pacific.

CAMPYLONEURUM LATUM Moore, Ind. Fil. 225. 1861. (Type from the West Indies.)

SOUTH FLORIDA: 14 miles south of Cutler, *A. A. Eaton.*

CAMPYLONEURUM COSTATUM (Kunze) Presl, Tent. Pterid. 190. 1836.

Polypodium costatum Kunze, Linnaea **9**: 38. 1835. (Type from Cuba, *Poeppig.*)

SOUTH FLORIDA: 5 miles north of Everglade, *A. A. Eaton.* Ranges also to Cuba and Jamaica.

CAMPYLONEURUM ANGUSTIFOLIUM (Sw.) Fée, Mém. Foug. **5**: 257. 1852.

Polypodium angustifolium Sw. Nov. Gen. et Sp. 130. 1788. (Type from Jamaica.)

SOUTH FLORIDA: 14 miles south of Cutler, *A. A. Eaton*, by whom it has been reported already. Ranges also to the Bahamas, Cuba, Jamaica, Hispaniola, and Porto Rico.

The four species of *Campyloneurum* now known from our flora may be distinguished as follows:

Leaves narrow, a centimeter or less wide.	*C. angustifolium.*
Leaves broad, 3–8 cm. wide or more.	
Veins obscure; texture opaque.	*C. costatum.*
Veins conspicuous.	
Leaves with a narrow wing, decurrent to near the base.	*C. Phyllitidis.*
Leaves long-stalked; areolae usually divided by a longitudinal vein.	*C. latum.*

ADIANTUM MODESTUM Underw. Bull. Torrey Club **28**: 46. 1901. (Type from Roswell, New Mexico, *Earle.*)

NEW MEXICO: Roswell, *Earle.*

ADIANTUM HISPIDULUM Sw. Jour. Bot. Schrader **1800**^{2}: 82. 1801. (Type from Australia.)

GEORGIA: Growing in a well near Thomasville, *R. M. Harper 1171.* Reported by Mr. Harper as established at this place.

A common species in cultivation and likely to become established in other favorable locations.

HYPOLEPIS REPENS (L.) Presl, Tent. Pterid. 162. 1836.

Lonchitis repens L. Sp. Pl. 1078. 1753. (Type from Martinique, based on Plumier *pl. 12.*)

This tropical fern, which becomes almost a climbing species in the West Indies, has been found in Florida by Mr. C. S. Williamson, as already reported (Torreya **3**: 18. 1903). He says of it: "It was quite abundant in the woods on the borders of Lake Apopka, which at Oakland is quite a distance from the town."

The plant resembles *Dennstaedtia* in habit, but has the indusium of *Cheilanthes.* The specimens sent by Mr. Williamson have a height of only 60 cm.

ASPLENIUM ANDREWSII A. Nelson, Proc. Biol. Soc. Washington **17**: 174. 1904. (Type from Boulder Creek, Colorado; *Andrews.*)

This new discovery from Colorado is a member of the *Adiantum-nigrum* group of *Asplenium* and is closely related to *Asplenium Adiantum-nigrum* of central and southern Europe. Among our species it will stand nearest *A. montanum.*

Asplenium verecundum Chapman in herb. sp. nov.

Rootstock short, erect or inclined, covered with more or less persistent bases of the leaf-stalks; leaves densely cespitose, bitripinnate, 16–40 cm. long, elliptic-lanceolate, 2.5–6 cm. wide, tapering both ways from the middle, borne on stalks 2–10 cm. long, which are smooth and brownish-purple as are also the rachises; pinnae (in larger specimens) bipinnate at base, gradually simpler outwards, or (in smaller specimens) pinnate throughout or with the basal pinnule 2–3-lobed or even divided into 2–3 segments; segments obovate or broadly oblanceolate, obtuse or rarely truncate at the apex and often mucronulate, decurrent on a narrowly winged rachis, bearing a single vein with a short sorus in or near the center; texture delicate, membranous; indusia rather broad, delicately membranous, with entire margins.

RANGE: Florida, northern, central, and southern; specimens have been examined as follows:

Jackson County: *Chapman* (type). Marion County: near Ocala, 1879, *Miss Reynolds; John Donnell Smith;* 1891, *Underwood 1810.* Scott's Spring near Ocala, 1891, *Underwood 1818.* Belleview, 1891, *Underwood 1876.* Hernando County: Istachatta, 1891, *Underwood 2001 b, 2001 c*; *Nash 1396 a.* Dade County: Biscayne Bay, 1887, *Isaac Holden;* 1888, *R. M. Monroe.* Between Cutler and Longview Point, 1903, *Small & Carter 854, 1156.* Miami, 1904, *E. G. Britton 91.*

With the original sheet of Chapman in the Columbia herbarium is a faded photograph marked "*Asplenium anchorita*, Scott's Well, near Ocala, Florida," and also "Rec'd from Miss Murray, Sept. 7, 1855." With this is a letter to Dr. Torrey from Amelia M. Murray, mentioning the collection of the fern at the above-named place. This interesting sink-hole later known as Scott's Spring, where the plant was evidently first collected, was visited in 1891 by the writer, who found the fern still growing there. It will be seen from the localities given that the plant ranges the entire length of the state. The name *anchorita* has been given as a synonym in the first edition of Chapman's Flora (page 593) and the highly appropriate name *verecundum* taken up from Chapman's herbarium was used as a *nomen nudum* in Fournier Mex. Pl. 111, in 1872. The fern is at once the most modest and the most graceful of our species of *Asplenium*.

Asplenium Curtissii sp. nov.

Rootstock short, erect or inclined; leaves 30–50 cm. long, bipinnate to tripinnatifid, lanceolate or lanceolate-ovate, 5–10 cm. wide, broadest a little above the base, the basal pinnae nearly as long as those above, borne on grayish-brown stalks 12–14 cm. long; pinnae lanceolate, in larger plants bipinnatifid, in smaller plants pinnate with 2–4-toothed or lobed closely-set pinnules; segments acute or rarely obtusish, pointed, decurrent on the rachises with a rather broad wing; veins single, or forked in the segments which are toothed, each tooth with a separate excurrent vein; sori prominent; indusia broad.

RANGE: Central Florida; specimens have been examined as follows:

Citrus County: Lake Tsala Apopka, *Curtiss 3728* (type). Marion County: near Ocala, 1879, 1883, *Miss Reynolds.* Indian Spring, 4 miles S. E. of Ocala, 1891, *Underwood 1813.* Belleview, 1891, *Underwood 1875.* Hernando County: Istachatta, 1891, *Underwood 1997, 2001, 2001 a;* 1897, *Curtiss 5683.*

The combined herbaria at the New York Botanical Garden contain seven sheets of *Curtiss 3728*, which represents the first plants collected and distributed. Two of these have a small plant of the previous species included on the same sheet, but the others are straight examples of the present species. We take pleasure in dedicating this very distinct species to Mr. Allen H.

Curtiss, whose botanical explorations in Florida have added so much to our knowledge. The species often grows in company with *Asplenium verecundum* Chapm., and we have collected the two growing together at three distinct localities. All the stations mentioned are within a circle whose radius is only twenty-five miles.

This species is readily distinguished from *Asplenium verecundum* by its shape, the lower pinnae not being reduced as in that species, by its larger size, coarser texture, and numerous other characters. It is scarcely necessary to add that the two plants have long posed under the names *Asplenium myriophyllum* or *A. rhizophyllum* either as species or varieties. *A. myriophyllum* is an entirely distinct species described originally from Jamaica. *A. rhizophyllum* (Thunb.) Kunze came originally from Dominica, and is a plant which roots from a prolonged apex as illustrated by Smith (Pl. Ic. Ined. **2** : *pl. 50*). The name, moreover, is preoccupied by *Asplenium rhizophyllum* L.

ASPLENIUM BISCAYNIANUM (D. C. Eaton) A. A. Eaton, Fern. Bull. **12** : 45. 1904.

Asplenium rhizophyllum var. *biscaynianum* D. C. Eaton, Bull. Torrey Club **14** : 97. *pl. 68.* 1887. (Type from Biscayne Bay, *Holden.*)

SOUTHERN FLORIDA. Collected at Biscayne Bay in 1887 by Isaac Holden, in 1888 by R. M. Monroe, in 1903 by A. A. Eaton, and in 1904 by E. G. Britton. Specimens of all these collections are represented in the herbaria at the New York Botanical Garden. There is a suspicion that this species may prove a hybrid of *Asplenium dentatum* L. and *A. verecundum* Chapm., both of which grow in its immediate vicinity. We agree with Mr. A. A. Eaton in recognizing this as a distinct species, nor should we differ did we know the above suspicion of hybridity to represent the truth of the matter. Species in taxonomy are the units of classification and their origin from others by variation, by hybridity, by mutation, or by any other process should have nothing to do with the simple taxonomic problem, while of the very highest interest in the biological history of the species.

ASPLENIUM MUTICUM Gilbert, Amer. Bot. **4** : 86. 1903. (Type from Bermuda.)

CENTRAL FLORIDA; also found in the Bermudas, whence it was described by Mr. Gilbert.

ASPLENIUM EROSUM L. Syst. Nat. ed. 10. 2: 1324. 1759. (Type from Jamaica, based on Sloane, Voy. Jam. 1: *pl. 33. f. 2.*)

CENTRAL FLORIDA: Cedar hammock, Sumpter County, 1894, *F. L. Lewton.*

This is the plant reported by Mr. Maxon in Torreya 3: 185. 1903, and referred to a form of *A. auritum* Sw., and it represents one of the forms usually referred to that name from various West India islands. We have material similar to the Florida plant at least from Cuba, Jamaica, Hispaniola, and Porto Rico; much of the Jamaica material, however, which has been referred to *A. auritum*, is of quite a distinct type. In establishing *A. erosum*, Linnaeus based his name wholly on Sloane's plate; the plant of the present type, which agrees in every essential with Sloane's plate, must bear the name *A. erosum*, and, for the present, it will be left an open question as to whether all the so-called *A. auritum* Sw. of the West Indies and Mexico shall be merged under this name. It should be noted that Swartz cited the same plate of Sloane in establishing his *Asplenium auritum*, but in this case there is probably a specimen in Swartz's herbarium which will naturally take precedence of a cited plate in determining the type of the species. The name *Asplenium erosum* has unfortunately been used by various writers for species widely different from the one to which the name was originally given. We are fortunate to be able to get back to a real foundation for the application of the name. Sloane's plant is preserved in the British Museum.

CEROPTERIS VISCOSA (D. C. Eaton) Underw. Bull. Torrey Club 29: 631. 1902.

Gymnogramme triangularis var. *viscosa* D. C. Eaton, Ferns of N. Am. 2: 16. *pl. 48. f. 5.* 1880. (Type from Southern California.)

Stenochlaena Kunzeana (Presl) Underw. sp. nov.

Olfersia Kunzeana Presl, Tent. Pterid. 235. 1836 (*nomen nudum*).

Stems wide-climbing, more or less flattened, with occasional brownish scales when young, becoming smooth except for the abundant roots on the under surface; leaves 35–60 cm. or more long, oblanceolate, tapering both ways from above the middle, pinnate, borne on stalks 8–10 cm. long; pinnae 18- (or more) jugate, those of the upper portion lanceolate, 6–12 cm. long, 10–12 mm. wide, cuneate at the base, or long-tapering to a bordered stalk, irregularly and usually coarsely dentate, acute or acuminate at the apex, those of the lower portion of the leaf gradually reduced, the lowest becoming ovate or ovate-triangular, 1–2 cm. long; rachis winged especially when young, stramineous; midrib prominent, lateral veins oblique, simple or rarely forked about 1 mm. apart; sporophyls pinnate, the pinnae 6 cm. or more long, 5 mm. wide, borne on a short (3 mm.) stalk, midvein conspicuous, lateral veins distant, simple or usually forked at the base with the branches widely diverging.

Specimens have been examined as follows:

CUBA: 1822, *Poeppig;** *Wright 973* (type, in herb. D. C. Eaton "scandente arbores *Citri* ad 10 ped. in sylvis").

HISPANIOLA: "San Domingue" without collector or nearer locality, in herb. Mus. Paris; Plaisance, *Nash & Taylor 1492.*

PORTO RICO: *Balbis, Schwanecke.*

FLORIDA: Between Cutler and Longview Camp, 1903, *Small & Carter 856, 1157;* Ross' Hammock, Dade County, *A. A. Eaton 677.* All the Florida plants seen are sterile, but have the unmistakable foliage of this species.

The genus *Stenochlaena* thus added to our flora is related to *Struthiopteris* in its dimorphous simply pinnate leaves, but lacks an indusium; the sporangia soon become confluent on the narrow pinnae of the sporophyls and on this account the genus was merged by Hooker with *Acrostichum*, with which, however, it has no natural alliance. The Florida plants scarcely represent the norm of the species and apparently are straggling plants instead of climbing ones, as in more tropical forests.

DRYOPTERIS AQUILONARIS Maxon, Bull. Torrey Club **27**: 638. 1900. (Type from Cape Nome, Alaska, *Flett.*)

ALASKA: Once collected. A near relative of *Dryopteris fragrans.*

DRYOPTERIS PITTSFORDENSIS Slosson, Rhodora **6**: 75. 1904. (Type from Pittsford, Vermont, *Slosson.*)

Described as a hybrid of *D. spinulosa* and *D. marginalis.*

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*Poeppig's specimens were referred by Kunze (Linnaea **9**: 59. 1835) to *Lomaria longifolia* Kaulf. and it was on the incorrectness of this determination that Presl wrote "*Olfersia Kunzeana* (*Lomaria longifolia* Kunze *nec* Kaulf.)" in 1836 (Tent. Pterid. 235). We have seen Poeppig's plants both at Prague and Vienna.

Other specimens of the same were collected by the writer in 1890 near Cambridge, Massachusetts, as noted in our collections by Dr. Philip Dowell, who collected the same thing on Staten Island, N. Y., in 1904. The species appears to stand on about the same basis as *D. Boottii.* Until the present turma of varieties, now connected with the variable *D. spinulosa,* can be made the subjects of more serious field study than they have yet received in this country, this name may well stand.

Dryopteris stipularis (Willd.) Maxon in herb.

Aspidium stipularis Willd. Sp. Pl. **5**: 239. 1810. (Type from Martinique, citing Plumier, *pl. 23.*)

FLORIDA: Miami, *A. A. Eaton.* Specimens seen in the U. S. National Museum.

DRYOPTERIS AMPLA (H. & B.) Kuntze, Rev. Gen. Pl. **2**: 812. 1891.

Polypodium amplum H. & B. in Willd. Sp. Pl. **5**: 207. 1810. (Type from Caripe, Venezuela.)

FLORIDA: Between Cutler and Longview Camp, 1903, *Small & Carter 834, 835.* Already reported by Mr. A. A. Eaton (*cf.* Fern. Bull. **12**: 46).

This species forms a short caudex like a tree-fern; the peculiar mass of cinnamon-colored matted scales at the base of the leaf-stalks is strikingly characteristic.

MENISCIUM RETICULATUM (L.) Schkuhr, Krypt. Gewächse 5. *pl. 5.* 1804.

Polypodium reticulatum L. Syst. Nat. ed. 10. **2**: 1325. 1759. (Type from Martinique and based on Plumier's figure.)

Dryopteris reticulata Urban, Symb. Ant. **4**: 22. 1903.

FLORIDA: Alapattah near Miami, 1903. *A. A. Eaton 779.* Already reported by Mr. Eaton (*cf.* Fern Bull. **12**: 46).

The genus *Meniscium,* established by Schreber in 1791, is well characterized by its venation and sori, the latter being linear and naked and borne on cross veins connecting the lateral parallel veins which extend from the midribs to the margin forming a series of similar areolae. The validity of the genus was never questioned until Diels, in placing it in its proper tribe, in our judgment went too far by uniting it with *Nephrodium,* from which it has more recently been transferred to *Dryopteris* by Professor Urban.

Tectaria minima sp. nov.

Rootstock creeping, knotty; leaves subcespitose, with slender smooth stramineous stalks 6–18 cm. long; lamina triangular, in larger leaves broadly so, 6–10 cm. long, 3–9 cm. wide, lobed at the base or in larger leaves bearing a pair of separate pinnae which are again slightly lobed below; margin of the terminal portion deeply crenate-incised in young leaves, in age becoming more deeply incised and with pointed rather than rounded divisions; veins everywhere irregularly areolate with numerous free included veinlets; main veins slightly fibrillose; sori arranged in a somewhat irregular row on either side the main lateral veins with occasional ones in the outlying space; indusium usually circular with a slit on one side forming a narrow sinus which is more often obscured by the overlapping folds.

Specimens have been examined as follows:

FLORIDA: Hammocks between Cutler and Longview Camp, 1903, *Small & Carter 855* (type); 10–14 miles south of Cutler, *A. A. Eaton 260.*

BAHAMAS: Conch Sound, Andros, *Northrop 562a;* Near Nassau, New Providence, *A. H. Curtiss 142;* Farringdon Road, New Providence, *E. G. Britton 3198;* Abaco, *Brace 1815.*

CUBA: Yumury, *Rugel 2;* near Ibarra, *Britton & Shafer 344.*

This species has been passed over in herbaria for young forms of *Tectaria heracleifolia* (Willd.), but proves to be a distinct species differing in habit, in size, in texture, in the character of the venation, and in the indusia, which are not strictly peltate as in that larger and more common species. Small leaves resemble those of *T. coriandrifolia*, but differ (1) in being sharp-pointed instead of blunt at the apex, (2) in the longer pointed basal lobes in marked contrast with the short rounded ones of *Tectaria coriandrifolia*, and (3) in the venation. Grisebach has marked the sheet collected by Rugel as "*Aspidium fimbriatum* Willd.," but if we can trust Plumier's *plate 149* this is a species widely different and wholly unknown in our day, and one which is to be looked for in future collections from Hispaniola.

[The plant hitherto known as *Tectaria trifoliata* in Florida and the West Indies cannot henceforth bear that name. The true *Tectaria trifoliata*, based on Plumier's *plate 148*, proves to be a wholly distinct species. This was suspected by some of the earlier writers on ferns, but still others have maintained that the discrepancies noted were due to the inaccuracy or possibly idealization of Plumier's artist. With the now abundant collections at hand from all parts of the West Indies there is no longer a doubt that we have two very excellent species and that Plumier's artist is again justified. Our Florida species (ranging throughout the West Indies) is **Tectaria heracleifolia** (Willd.). (*Aspidium heracleifolium* Willd. Sp. Pl. **5**: 217. 1810; type from Hispaniola, based on Plumier *plate 147*, which is an extreme form of the species.)

This species has uniformly peltate indusia. The true *Tectaria trifoliata* (L.) Cav. has indusia varying on the same plant from reniform with a very broad sinus to circular with a mere emargination on the side, thus breaking down the supposed distinctions between *Tectaria* and *Sagenia* as hitherto maintained. The true *T. trifoliata* ranges from Cuba (where we have collected it on El Yunque) and Porto Rico to Guadeloupe, Martinique, Dominica, St. Vincent, and Grenada. It differs in texture, form of lobes, venation, and indusia, and many of its characters were clearly portrayed in 1703 by Plumier, whose illustrations can now be easily interpreted with ample material of both species at hand.]

Tectaria coriandrifolia (Sw.).

Aspidium coriandrifolium Sw. Jour. Bot. Schrader **1800**^{2}: 36. 1801. (Type from Jamaica, citing Pluk. Alm. *pl. 284. f. 5.*)

FLORIDA: 14 miles south of Cutler, 1903, *A. A. Eaton 563*. The Florida plants are smaller and somewhat less divided than the ordinary Jamaican forms, while the plants from Cuba are quite intermediate between them.

ODONTOSORIA CLAVATA (L.) J. Sm. Hist. Fil. 264. 1875.

Adiantum clavatum L. Sp. Pl. 1056. 1753. (Type from San Domingo, based on Plumier's *pl. 101. f. b.*)

Davallia clavata Sw. Syn. Fil. 123. 1806.

SOUTHERN FLORIDA: 12–20 miles south of Cutler, *A. A. Eaton*. Already reported by Mr. Eaton (*cf.* Fern Bull. **12**: 47).

The discovery of this species in Florida adds the third representative of its tribe (*Davallieae*) to our flora. The narrow truncate and almost cuneate segments make it an easily recognizable species. We have gathered the fern in Cuba, Porto Rico and

Jamaica, and it has been brought in several times from the Bahamas.

HYMENOPHYLLACEAE

DIDYMOGLOSSUM * SPHENOIDES (Kunze) Presl, Hymenoph. 23. 1843.

Trichomanes sphenoides Kunze, Linnaea **9**: 102. 1835; Die Farnkr. **1**: 215. *pl. 88. f. 2.* 1846. (Type from Peru, *Poeppig.*)

FLORIDA: Between Cutler and Longview Camp, 1903, *Small & Carter 1478.* This species was reported by A. A. Eaton under *Trichomanes* (*cf.* Fern Bull. **12**: 47). It is a common lowland species of tropical America.

DIDYMOGLOSSUM * KRAUSII (H. & G.) Presl, Hymenoph. 23. 1843.

Trichomanes Krausii H. & G. Icon. Fil. *pl. 149.* 1831. (Type from Dominica, *Kraus.*)

FLORIDA: Between Cutler and Longview Camp, 1903, *Small & Carter 1479, 1500.* Also reported by Mr. A. A. Eaton under *Trichomanes* (*cf.* Fern. Bull. **12**: 47).

EQUISETACEAE

EQUISETUM FUNSTONI A. A. Eaton, Fern. Bull. **11**: 10. 1903. (Type from San Bernardino, Southern California, *Coville & Funston 13.*)

SOUTHERN CALIFORNIA: Not very well represented in our herbaria, but a number of sheets are found in the collection at Washington.

Species inquirenda

Equisetum Ferrisii Clute, Fern. Bull. **12**: 22. 1904. (Type from Joliet, Illinois, *Clute.*)

Not seen; judging from characters given, a very doubtful species described entirely from sterile material.

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* The genus *Didymoglossum* was established by Desvaux (Ann. Soc. Linn. Paris **6**: 330. 1827), and differs from typical *Trichomanes* in the possession of a distinctly bilabiate involucre which is contracted below the mouth and bordered by the tissues of the leaf. It has been adopted by all the writers who have seriously monographed the filmy ferns since the time of Desvaux.

SELAGINELLACEAE

SELAGINELLA ACANTHONOTA Underw. Torreya **2**: 172. 1902. (Type from North Carolina, *Curtis*.)

NORTH CAROLINA: *Curtis*, *Williamson*.

GEORGIA: Tattnall County, *R. M. Harper 1852;* Dooly County, *R. M. Harper 1957;* Montgomery County, *R. M. Harper 1987*.

SELAGINELLA HANSENI Hieron. Hedwigia **39**: 301. 1900. (Type from Fisher's Cabin, California, *Hansen 878*.)

CALIFORNIA: Collected in Calaveras, Fresno and Butte counties.

Selaginella Parishii sp. nov.

Plants prostrate, close-creeping, and emitting rootlets throughout, much branched, with mostly short stems; stems 6–10 cm. long, mostly with short alternate branches or sometimes with more compound ones; leaves with a dorso-ventral arrangement, brownish below, bright-green above, 5–6-ranked, curved upwards and coiling over the stems when dry, broadly lanceolate, acute, ending in a point but with no terminal bristle, but with 6–20 very short marginal hairs on either side; sporophyls on the ends of short branches, scarcely differing from the leaves, forming short subquadrate strobiles; microspores orange-yellow, 40–50μ in diameter, sphero-tetrahedral, long remaining united in tetrads; macrospores yellow globose, about 350μ in diameter.

CALIFORNIA: Palm Springs, Colorado Desert, March, 1903, *C. F. Saunders* (comm. S. B. Parish); dry rocky mountains in the desert, April, 1882, *Parish 1200*.

MEXICO: Conception del Oro, Zacatecas, Aug., 1904, *Palmer 306* (type).

This species has been known to the writer as distinct for a number of years, and was mentioned in the original breaking up of the group which had passed under the name of *S. rupestris* (*cf.* Bull. Torrey Club **25**: 133. 1898), among the *species inquirendae*. Mr. Parish has more recently sent me specimens with microspores, and from Palmer's recent collections the same plant turns up from Zacatecas with both microspores and macrospores; all the above-named plants are in the herbarium of the New York Botanical Garden.

SELAGINELLA SHERWOODI Underw. Torreya **2**: 172. 1902. (Type from Macon County, North Carolina, *Sherwood*.)

NORTH CAROLINA: Macon County, 1887, *J. Donnell Smith;* 1901–2, *W. L. Sherwood.*

SOUTH CAROLINA: *J. Donnell Smith.*

SELAGINELLA SCHMIDTII Hieron. Hedwigia **39**: 292. 1900. (Type from Sachalin, *Schmidt.*)

UNALASKA: *Chamisso.* Professor Hieronymus also described a var. *Krauseorum, loc. cit.* 293, which was collected in rock fissures on the river Tlehini, Alaska, by the Krause brothers in 1882.

SELAGINELLA UNDERWOODII Hieron. Die Nat. Pflanzenf. **1**^{4}: 714, note. 1901.

Selaginella rupestris Fendleri Underw. Bull. Torrey Club **25**: 127. 1898. (Type from Santa Fé, New Mexico, *Fendler 1024.*)

Selaginella Fendleri Hieron. Hedwigia **39**: 303. 1900. Not *S. Fendleri* Baker.

Colorado, New Mexico, and California; has been sent in by various collectors.

SELAGINELLA WALLACEI Hieron. Hedwigia **39**: 297. 1900. (Type from Oregon, *Wallace.*)

Oregon and Washington; has been sent in by recent collectors.

SELAGINELLA WRIGHTII Hieron. Hedwigia **39**: 301. 1900. (Type from New Mexico, *Wright 828.*)

Known only from its type collection.

Species inquirendae

The following species are known only from their original collections. It is perhaps better to await further collection and study before admitting them to full standing.

Selaginella montanensis Hieron. Hedwigia **39**: 293. 1900. (Type from Crossing, Montana, 1882, *Krause.*)

Selaginella Bourgeauii Hieron. Hedwigia **39**: 295. 1900. (Type from Fort Ellice, Oregon, *Bourgeau.*)

Selaginella Haydeni Hieron. Hedwigia **39**: 296. (Type from Nebraska, *Hayden;* also collected in Washington (then Oregon), *Lyall.*)

Selaginella Bolanderi Hieron. Hedwigia **39**: 300. 1900. (Type from Auburn, California, *Bolander 4511.*)

Selaginella sp.

FLORIDA: Dade County, *Small & Carter, A. A. Eaton.*

Erroneously reported by Mr. B. D. Gilbert as *Selaginella caribensis* Jenman, a species of the higher mountains of Jamaica (*cf.* Fern Bull. **13**: 74. 1905). We await a report on this interesting species from Professor Hieronymus.

Species excludenda

Selaginella Engelmanni Hieron. Hedwigia **39**: 294. 1900 = *S. densa* Rydb. and is therefore not to be included in the list except as a synonym.

ISOETACEAE

ISOETES OCCIDENTALIS Henderson, Bull. Torrey Club **27**: 358. 1900. (Type from Lake Coeur d'Alene, Idaho, *Henderson 5876.*)

Isoetes lacustris paupercula Engelm. Trans. Acad. Sci. St. Louis **4**: 377. 1882.

Isoetes paupercula A. A. Eaton, Proc. U. S. Nat. Mus. **23**: 649. 1901.

Colorado to California, Idaho, and Washington.

In accordance with the now established doctrine that *species* and not varieties are the units of classification, this name set aside under former rules should be restored. The writer wishes to record the fact that he has persistently opposed the principle of giving varietal names a standing in nomenclature since it was proposed at the Madison meeting and there voted. The pernicious effects of this principle have been fully appreciated by all who have tried it on any extensive scale.

ISOETES HETEROSPORA A. A. Eaton, Fernwort Papers 8. 1900. (Type from Jordan Pond, Mt. Desert Island, Maine, *Rand.*)
Known only from its type locality.

ISOETES HIEROGLYPHICA A. A. Eaton, Fernwort Papers 10. 1900. (Type from St. Francis Lake, Maine, *Pringle.*)
MAINE: Reported from several stations.

ISOETES GRAVESII A. A. Eaton, Fernwort Papers 14. 1900. (Type from Connecticut, *Graves, Underwood.*)

CONNECTICUT: Known from one or two ponds in western Connecticut. A fine series was collected by the writer some years ago at Tyler Pond, in Goshen, which is now in the herbarium of the New York Botanical Garden.

Species excludenda

Isoetes Harveyi A. A. Eaton, Fernwort Papers 11. 1900. (Type from Maine, *Harvey*.)

Mr. Eaton now regards this as a variety of *I. Tuckermani*, and we therefore exclude it from the list of species.

COLUMBIA UNIVERSITY.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1901-1903)

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

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

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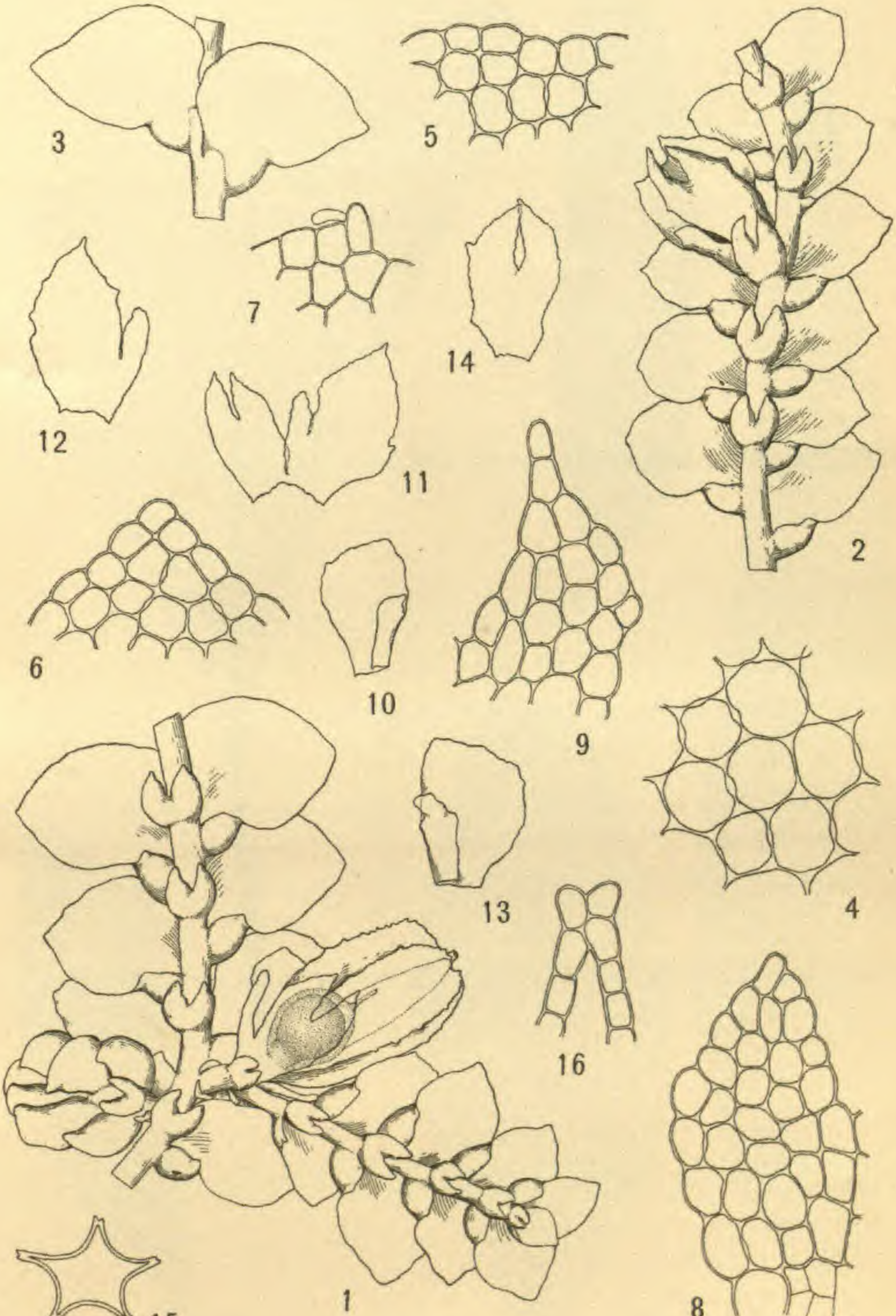
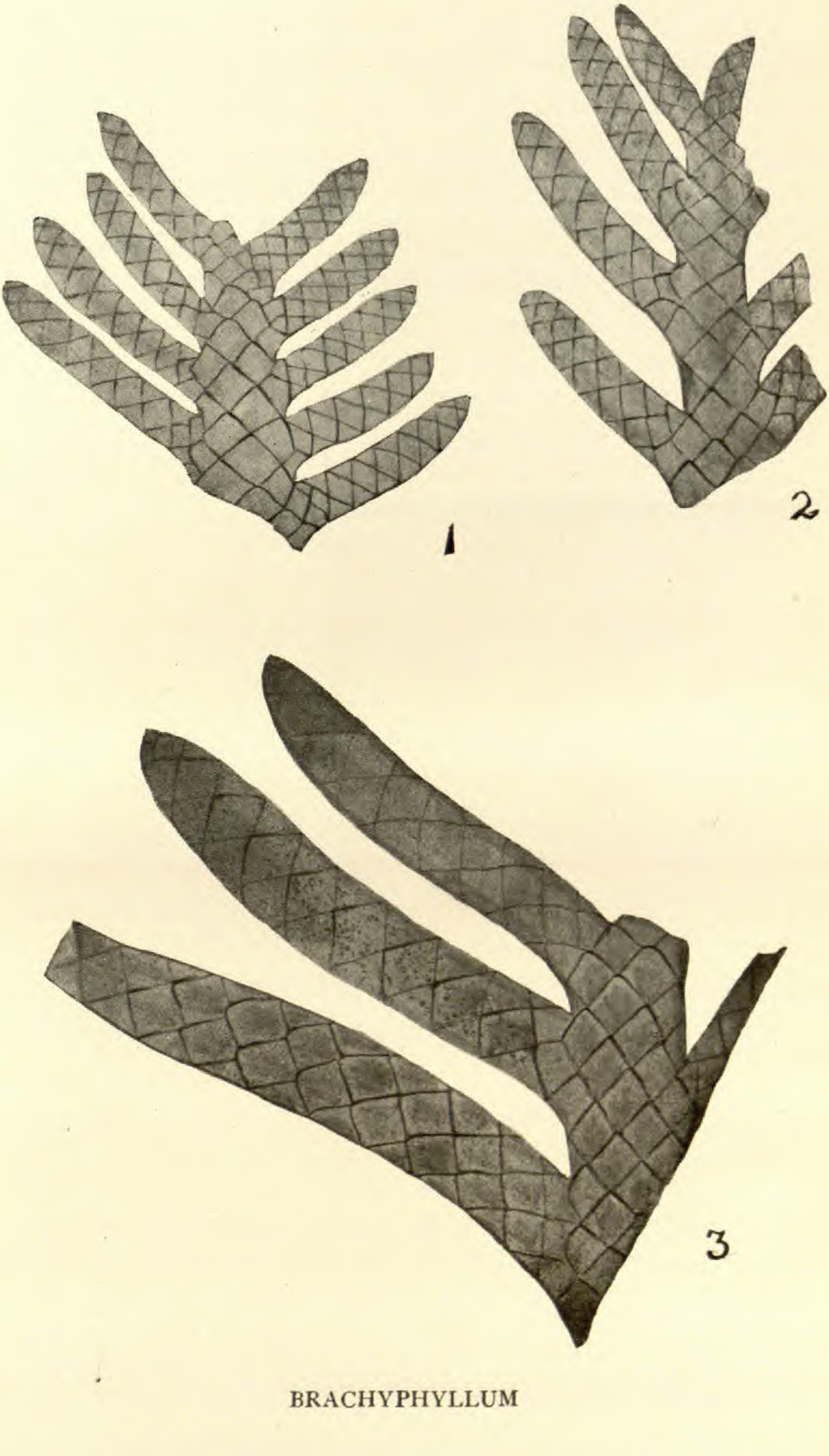


CROSSOTOLEJEUNEA BERMUDIANA Evans

MAGNOLIA, SALIX, CINNAMOMUM, FICUS

SAPOTACITES, OSMUNDA, COLUTEA



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PUBLICATIONS

All subscriptions and other business communications relating to the publications of the Club should be addressed to the Treasurer, Carlton C. Curtis, Columbia University, New York City.

Bulletin. Monthly, established 1870. Price, $3.00 a year; single numbers 30 cents. Of former volumes, only 2, 3, 5, 13, 20, 21, and 24–31 can be supplied separately; certain numbers of other volumes are available, but the entire stock of some numbers has been reserved for the completion of sets. Manuscripts intended for publication in the BULLETIN should be addressed to Dr. John Hendley Barnhart, Editor, New York Botanical Garden, Bronx Park, New York City.

Torreya. Monthly, established 1901. Price, $1.00 a year. Manuscripts intended for publication in TORREYA should be addressed to Dr. Marshall A. Howe, Editor, New York Botanical Garden, Bronx Park, New York City.

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

Vol. 33 No. 4

BULLETIN

OF THE

TORREY BOTANICAL CLUB

APRIL, 1906

New species of fungi

CHARLES HORTON PECK

Lepiota nudipes

Pileus thin, convex, umbonate, minutely brownish-squamulose, becoming obscurely striate on the margin, whitish, the umbo dark-brown and even; lamellae thin, moderately close, free, ventricose, white; stem slender, fibrous, equal or nearly so, pallid above, brownish and fibrillose below; spores white, elliptic, 5–6 μ long, 3–4 μ broad.

Pileus 1.2–2 cm. broad; stem 2.5–4 cm. long, scarcely 1 mm. thick.

Near St. Louis, Missouri. July. N. M. Glatfelter. Externally this species closely resembles *L. arenicola* Peck, but it is easily separated from it by its much smaller spores. Its smaller size, distinct umbo and obsolete or evanescent annulus separate it from *L. cristata* A. & S. The notes of the collector say "veil none, no odor."

Hygrophorus mephiticus

Pileus thin, convex, becoming plane or nearly so, glabrous, hygrophanous, yellowish-brown and striatulate on the margin when moist, ochraceous when dry, sometimes tinged with green, flesh whitish, sometimes tinged with yellow, odor mephitic; lamellae broad, thick, unequal, distant, sinuate, adnexed, sometimes connected by veins, often wavy, grayish-violaceous or grayish-purple; stem equal or tapering at the base, curved or flexuous, brittle, hollow, colored like or a little paler than the pileus, often with a whitish mycelioid tomentum at the base; spores white, elliptic, 8–12 μ long, 6–7 μ broad.

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

[The BULLETIN for March 1906 (33: 128–211, *pl. 6–9*) was issued 7 Ap 1906.]

Among sphagnum in swamps. Stow, Massachusetts. August, 1905. S. Davis. This is a peculiar and well-marked species, easily recognized by its unusual colors, odor and habitat. The odor persists several days after the plants have been collected; its similarity to that of a skunk has suggested its specific name.

Collybia brunnescens

Pileus thin, broadly convex, sometimes slightly umbonate, glabrous, subpruinose, grayish-brown; lamellae thin, close, emarginate, whitish or cream-colored; stem equal or slightly thickened at the base, striate, glabrous, solid or stuffed, white; spores white, elliptic, 8–10 μ long, 5–6 μ broad.

Pileus 2–7 cm. broad; stem 3–5 cm. long, 4–6 mm. thick.

Solitary or cespitose in open places or in thin woods. California. Mrs. C. A. Hunt.

Sometimes the pileus is a little darker on the incurved margin and its surface may be obscurely spotted.

Hygrophorus Davisii

Pileus convex, membranous, fragile, glabrous, very viscid, even on the margin when young, striate when mature, olive-brown variegated with olive-green when young and fresh; lamellae thin, unequal, distant, decurrent, grayish-white; stem slender, equal or slightly tapering upward, flexuous, fragile, hollow, viscid, glabrous, grayish-white, becoming brownish; spores broadly elliptic, white, 6–7 μ long, 4–5 μ broad.

Pileus 1–1.2 cm. broad; stem 2–3 cm. long, 1.5–2 mm. thick.

Damp places under ferns in deciduous woods. Stow, Massachusetts. August, 1905. S. Davis. Gregarious. In the dried specimens the whole plant has assumed a yellowish-buff color with a faint tinge of pink. The pileus is sometimes slightly centrally depressed. The species is dedicated to its discoverer.

Russula nigrescentipes

Pileus convex, nearly plane or centrally depressed, glabrous, striate on the margin, bright-red, flesh white, taste mild; lamellae narrowed and united behind, much broader in front, close, equal, free or nearly so, white; stem equal, glabrous, stuffed or spongy within, tough, elastic, white, becoming blackish by handling or bruising; spores globose or subglobose, white, 6–8 μ in diameter.

Pileus 3–5 cm. broad; stem 3–5 cm. long, 6–8 mm. thick.

In woods. Near St. Louis, Missouri. September. N. M. Glatfelter.

This species is related to *R. uncialis* Peck, from which it may be distinguished by its smaller spores and by its tough stem becoming black where bruised. The stem is sometimes slightly tinged with red at the base. The change of color in the stem is a peculiar feature by which the species may easily be recognized. It is suggestive of the specific name.

Russula subvelutina

Pileus firm, convex or slightly depressed in the center, dry, minutely pubescent or velvety tomentose, even on the margin, dark-red or crimson, sometimes a little darker in the center, cuticle adnate, flesh white, thick, taste sweet; lamellae moderately close, adnate, sometimes forked at the base, white, becoming creamy-yellow, the interspaces venose; stem equal or tapering downward, stuffed or spongy within, not polished, white tinged with red; spores nearly smooth, subglobose, pale-yellow, 7–10 μ broad.

Pileus 5–11 cm. broad; stem 5–10 cm. long, 10–15 mm. thick.

Near St. Louis, Missouri. August. This is one of our most beautiful red russulas. N. M. Glatfelter.

Externally it resembles *R. ochrophylla* Peck, from which it may be separated by its less glabrous pileus and its paler spores and lamellae.

Lentinus obconicus

Pileus obconic, fleshy, sometimes slightly depressed in the center, whitish, with tawny-brown squamules in the center, flesh white; lamellae narrow, close, very decurrent, lacerated and dentate on the edge; stem long, flexuous, solid, whitish at the top, tawny-brown and squamose toward the base; spores oblong, 8–10 μ long, 4–5 μ broad.

Pileus 2.5–6 cm. broad; stem 5–8 cm. long, 6–10 mm. thick.

Cespitose; decaying wood in a lumber yard. Minneapolis, Minnesota. M. S. Whetstone.

The thick flesh and obconic shape of the pileus with the long decurrent lamellae are the prominent distinguishing characters of this species. The flesh of the dried specimens cuts easily. The scales of the pileus are smaller than in *L. lepideus* Fr. It is closely related to *L. cyathiformis* (Schaeff.) Bres.

Lentinus microspermus

Pileus fleshy, thin, convex, somewhat irregular, sometimes lobed on the margin, glabrous, reddish-brown, flesh white, taste sweet, then bitter; lamellae thin, close, emarginate, adnexed, white, becoming creamy-yellow, the edge eroded or denticulate; stems cespitose, equal, glabrous, fleshy-fibrous, hollow, white or whitish, sometimes eccentric; spores minute, globose, white or faintly tinged with yellow, 3–4 μ broad.

Pileus 2.5–5 cm. broad; stem 5–6 cm. long, 6–10 mm. thick.

Decayed wood. Creve Coeur, Missouri. May. N. M. Glatfelter.

Annularia sphaerospora

Pileus fleshy but thin, conic or subcampanulate, becoming expanded, umbonate, silky-fibrillose, yellow, fading to whitish either wholly or in part, umbo brownish; lamellae thin, close, free, whitish or cream-colored when young, flesh-colored when mature; stem equal or slightly tapering upward, solid, fibrous, substriate, whitish, annulate, the white collar sometimes near the middle, sometimes near the base of the stem; spores globose or subglobose, 5–6 μ in diameter.

Pileus 3–6 cm. broad; stem 3–8 cm. long, 4–8 mm. thick.

Decaying wood of elm. Near Detroit, Michigan. August. O. E. Fischer.

The plants are sometimes cespitose. The species may be distinguished from its near relative, *A. Fenzlii* Schulz, by its umbonate fading pileus and its whitish solid stem. *A. Fenzlii* grows on *Tilia*. Twelve species of this genus are described in Sylloge, none of which is credited to this country.

Inocybe desquamans

Pileus convex, umbonate, subglabrous, yellowish-brown becoming brownish-red with age, or in drying, the umbo often darker, the cuticle cracking, forming scales and disappearing except on the umbo, flesh thin, white; lamellae pallid becoming ferruginous-brown; stem firm, solid, fibrous, striate, subbulbous, whitish and mealy above, reddish or brownish and slightly fibrillous below, becoming wholly brownish with age; spores irregular, nodulose, 8–10 μ long, 5–6 μ broad.

Pileus 2.5–4 cm. broad; stem 5–7.5 cm. long, 2–4 mm. thick.

Woods. Near St. Louis, Missouri. July. N. M. Glatfelter.

Inocybe Sterlingii

Pileus fleshy, convex becoming nearly plane, glabrous and slightly viscid in the center when moist, obscurely fibrillose on the incurved subappendiculate margin, brownish in the center, gray or clay-colored elsewhere, taste farinaceous; lamellae thin, close, adnexed, pallid becoming cinnamon; stem equal or slightly thickened at the base, solid, floccose-fibrillose white, bay red within; spores even, elliptic, usually uninucleate, 10–12 μ long, 6–8 μ broad.

Pileus 1.5–2.5 cm. broad; stem 2.5–3.5 cm. long, 2–4 mm. thick. Under spruce trees. Trenton, New Jersey. November. E. B. Sterling.

This species is related to *I. vatricosa* Fr. from which it is separated by the darker color of the pileus, its solid stem, more fully developed veil and farinaceous taste. The veil is fibrillose or webby and adheres partly to the margin of the pileus and partly to the stem on which it forms a slight fibrillose, evanescent annulus. It is solitary or gregarious and is said by its discoverer, for whom it is named, to be edible.

Flammula condensa

Pileus thin, convex or nearly plane, often irregular from its crowded mode of growth, usually umbonate, very viscid, brownish-yellow, the umbo reddish-brown or chestnut-colored, flesh white, often tinged with yellow; lamellae moderately broad, subdistant, adnate or slightly decurrent, sometimes rugosely wrinkled, yellowish becoming brownish-ferruginous; stem equal, hollow, yellowish above, pallid or brownish toward the base; spores elliptic, 8–10 μ long, 4–5 μ broad.

Pileus 2–3 cm. broad; stem 2–4 cm. long, 2–3.5 mm. thick.

Densely cespitose. In clearings in pine woods and on stony hills. Near Washington, D. C. December. F. J. Braendle.

This species forms large flat-topped clusters of many individuals. It is closely related to *F. carbonaria* Fr. and *F. squalida* Peck, but it may easily be separated from both by its more dense mode of growth and its broader and more distant lamellae.

Psathyrella angusticeps

Pileus very thin, submembranous, conic or subcampanulate, subacute, often with a small but prominent umbo, hygrophanous, fragile, minutely flocculose, appendiculate with minute fragments of the whitish veil, sometimes striate on the margin, grayish-brown, whitish or grayish on the margin; lamellae ascending, thin, brittle, moderately close, adnate, pale olive-green becoming darker and finally black; stem very long, slender, fibrous, rather tough, hollow, straight or nearly so, ashy-gray above, chestnut-colored below, sometimes slightly thicker toward the base; spores broadly elliptic, black, abruptly narrowed at the ends, 15–20 µ long, 10–12 µ broad.

Pileus 1–2 cm. broad; stem 5–9 cm. long, about 1 mm. thick.

Gregarious. Grassy ground. Falmouth, Massachusetts. June. S. Davis.

This species is ambiguous, combining the characters of *Panaeolus* and *Psathyrella*. Its spores are similar in size and shape to those of some species of *Panaeolus*, but the tendency of the pileus to become striate on the margin, which is apparently straight and does not extend beyond the lamellae, and the uniform color of the latter, indicate that its proper place is in *Psathyrella*.

Hydnum Blackfordae

Pileus fleshy, convex, glabrous, grayish or greenish-gray, flesh whitish with reddish stains, slowly becoming darker on exposure; aculei subulate, 2–5 mm. long, yellowish-gray becoming brown with age or in drying; stem equal or slightly tapering downward, solid or stuffed, becoming hollow in drying, glabrous, colored like the pileus; spores brown, subglobose, verrucose, 8–10 µ broad.

Pileus 2.5–6 cm. broad; stem 2.5–4 cm. long, 3–4 mm. thick.

Mossy ground in low springy places in damp mixed woods. Ellis, Massachusetts. August, 1904. Mrs. E. B. Blackford.

This species is peculiar in its colors and in its rather long stem. Sometimes there is a slight pinkish tint visible on the pileus. In the dried specimens blackish hues have been assumed, especially by the stems. The species is dedicated to its discoverer. It is apparently very rare.

Craterellus Pogonati

Pileus membranaceous, sessile or stipitate, irregular, 2–4 mm. broad, minutely tomentulose, white; hymenium even, pale creamy-yellow; stem when present lateral or eccentric, slender, tomentulose or sometimes glabrous on one side by reason of the decurrent hymenium, white.

On moss, *Pogonatum alpinum* Roehl. South Windsor, Connecticut, September, 1904. C. C. Hanmer. The specimens are sterile, but the species may be recognized by the described characters. The dimensions here given are those of the dried specimens and may be a little less than those of fresh plants.

Monilia Avenae

Minute, amphigenous; hyphae short, about 8 μ thick, effused on oblong or subelliptic, indefinite, pallid or brownish spots, grayish or grayish-brown; spores catenulate, oblong or elliptic, slightly colored, 25–40 μ long, 12–15 broad.

Living or languishing leaves of some unidentified species of *Avena*. Near Los Gatos, California. February, 1904. A. A. Heller. "The wild oat plants here are often badly infested by this fungus and the young plants on which it appears have their growth checked and they seem never to reach maturity." — A. A. H.

Marsonia Potentillae Helleri var. nov.

Spots small, inconspicuous, angular, pallid; acervuli unequal, irregular, single or sometimes two or three on a spot, black; spores oblong, 20–24 μ long, about 4 μ broad, the upper cell abruptly narrowed into an oblique beak, both cells destitute of guttulae.

Living leaves of *Drymocallis glandulosa* (Lindl.) Rydb. Near Los Gatos, California. May, 1904. A. A. Heller. The paler inconspicuous spots of the leaves, darker-colored acervuli, and more narrow spores without oil globules distinguish this variety from the species.

Haplosporella commixta

Perithecia single or clustered, numerous, thin, globose, erumpent, black; spores broadly elliptic or obovate, colorless when young, becoming dark-brown (by transmitted light) when mature, 24–32 μ long, 16–20 μ broad.

Bark of dead branches of slippery elm, *Ulmus fulva* Michx. Stockton, Kansas. January, 1905. E. Bartholomew.

The specific name is suggested by the commingling of pustules containing a single perithecium with others containing two or more. This feature of the species shows the intimate relation between the genera *Sphaeropsis* and *Haplosporella*, and the species may be considered a connecting link between the two genera.

Sarcoscypha dawsonensis

Receptacle cupular, 1–2 cm. broad, crowded or cespitose, sessile or radicated, often uneven or sulcate at the base, irregular, externally pruinose or tomentulose, pallid, whitish at the base; hymenium red or orange, often rugosely wrinkled; asci cylindric, 200–280 μ long; spores monostichous, elliptic, even, 20 μ long, 10 μ broad, paraphyses slender, filiform, slightly thicker at the top.

Among mosses, *Leptobryum pyriforme* Schimp. West Dawson, Yukon Territory. July, 1905. E. B. Sterling communicated it.

The minute tomentum of the exterior surface of the cups is composed of slender colorless septate filaments. The hymenium of the dried specimens is pruinose.

Poronia macrospora

Stroma 0.75–1.5 cm. broad, irregular, broadly ovate or depressed-globose, stipitate, punctate by the slightly prominent black or blackish ostiola, reddish-brown or blackish-brown, white within; stem irregular, flexuous, slender, simple or with one or two short branches at the top, sometimes enlarged at the apex, crispate tuberculate and perforate at the base, blackish-brown, white within; perithecia immersed in the stroma, black, the ostiola usually surrounded by a pale band; spores very large, elliptic, at first colorless and involved in mucus, then colored, 40–60 μ long, 20–30 μ broad.

Rich sandy ground in a garden. New Haven, Connecticut, December, 1905. P. W. Graff.

This species is remarkable for the large size of the spores, which character has suggested the specific name. The stem is deeply set in the ground and the lower or subterranean part is enlarged, twisted, irregular and uneven or crumpled. The top expands into the stroma which is not disciform in our specimens.

Leptosphaeria Lythri

Perithecia minute, scattered, depressed, partly covered by the scurfy remains of the epidermis, black, usually with a minute papilliform ostiolum; asci oblong or clavate, 100–150 μ long, 20–30 μ broad, the base very short; spores oblong or subfusiform, straight or slightly curved, colorless becoming yellowish-brown with age if viewed with transmitted light, 5–7-septate, the third cell usually larger than the others, 30–40 μ long, 12–16 μ broad.

Dead stems of the wing-angled loosestrife, *Lythrum alatum* Pursh. Stockton, Kansas. October. Common. E. Bartholomew.

Pleospora magnifica

Perithecia minute, at first covered by the thin epidermis, then erumpent or subsuperficial, hemispheric or depressed-globose, black, the ostiolum minute, inconspicuous; asci oblong, cylindric, 200–240 μ long, 48–60 μ broad; spores large, colored, crowded or biseriate, oblong or slightly narrowed toward one end, obtuse, 7–9-septate with about 3 longitudinal septa, 65–75 μ long, 25–35 μ broad.

Dead stems of *Phlox*. Silver Lake, Utah. August, 1905. A. O. Garrett collected it. E. Bartholomew communicated it. Remarkable for the large size of the muriculate spores.

GEOLOGICAL HALL, ALBANY, NEW YORK.

The anomalous anther-structure of Dicorynia, Duparquetia, and Strumpfia

James Arthur Harris

While engaged in the histological portions of a study of the apically dehiscent anther,* I found myself particularly interested by three forms which have not been fully understood by systematists, and since it will probably be a considerable time before my final memoir can appear it has seemed advisable to offer my notes on these genera in a form and place which will render them more accessible to the taxonomist, for whom they are particularly intended, than they would be in a thick paper of morphological and ecological nature. The forms to be considered here are *Dicorynia* and *Duparquetia* of the *Leguminosae*, and *Strumpfia* of the *Rubiaceae*.

We may confine our attention strictly to the morphological features, leaving histological detail for the special treatment.

The first form is *Dicorynia* Benth. † The androecium of this peculiar South American representative of the *Cassieae* has been characterized as follows : Stamens 2, free, unequal ; filaments short and thick ; anthers basifixed, oblong, short and thick, that of the shorter stamen longer, often 8-locellate, dehiscing at the apex.

The form of the anthers in the specimen examined agrees very closely indeed with that figured in Flora Brasiliensis. Both anthers are smooth, brown in color and very hard. A series of sections was secured and mounted in sequence. Figures 1, a and 1, b represent sections from near the base and tip of the smaller anther, the one borne on the longer filament, and show that it has the 4-locellate structure of a typical anther.

In systematic works the larger anther, borne on the shorter filament, has been described as 8-locellate, and the first prepara-

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* See Harris, J. A. Ann. Rep. Missouri Bot. Gard. 16 : 167–257 (1905), and Canadian Entomologist 37 : 353–357, 373–380, 393–398 (1905).

† Benth.; Mart. Fl. Bras. 15^2: 81. *pl. 29.*—Benth. & Hook. Gen. Pl. 1 : 571.—Taubert ; E. & P. Nat. Pfl. 3^3 : 165.

tions examined confirmed this opinion. Later, however, when serially arranged sections were secured, the real condition became apparent and is made quite clear by the outline drawings of selected sections for the series. Figures 1, c, 1, d and 1, e represent typical planes of the anther from the base to near the tip. It will be seen that all show two locules. In the lowermost sections each locule evidences two locelli. The succeeding sections show six, eight, and near the tip even ten locelli.

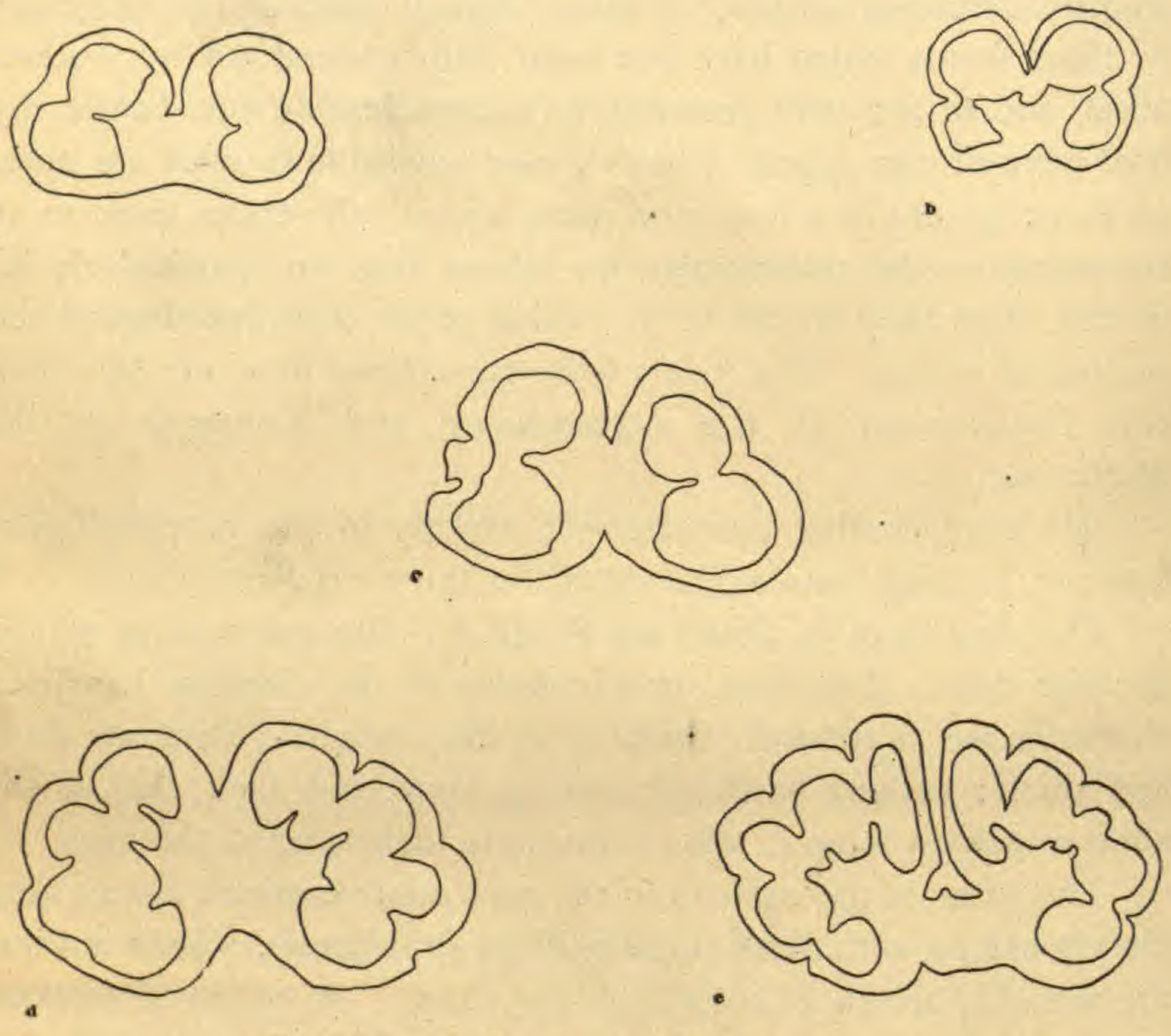

FIGURE 1. Anther-structure of *Dicorynia*.

In structure and geographical distribution *Duparquetia* Baill.* is an anomalous and most interesting monotypic genus found in west tropical Africa.

The androecium has been described as follows: Stamens 5, more rarely 4; filaments short, flattened; anthers basifixed, linear,

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* Baillon, Adansonia **6**: 189. *pl. 4.* — Benth. & Hook. Gen. Pl. **1**: 570. — Benth. Trans. Linn. Soc. **25**: 305. *pl. 39.* — Bois, Jour. de Bot. **17**: 16–22. *f.* 1–18. — Taubert; E. & P. Nat. Pfl. 3^3: 166.

slightly sagittate at the base and bifid at the apex, with the locules acuminate, longitudinally sulcate and dehiscing above by short slits not extending more than half the length of the locules; three upper stamens longitudinally connate, 1 or 2 lateral free, or all more or less firmly coherent at time of flowering, all strongly decurved over the ovary.

I have examined this form and find that dehiscence is as described. The anthers in my specimen were four, on very short, free filaments. In the dry condition they were hard, with the introrse terminal slit widely open but not extending more than a third the length of the conspicuous longitudinal furrow. When moist the walls were leathery in texture. In this condition they may easily be ruptured along the furrow, but the wall is firm enough here to indicate that in nature dehiscence is probably confined exclusively to the short terminal slits.

As will be seen from the literature some confusion has prevailed concerning the androecium of this species. Baillon considered that there are eight apiculate, laterally coherent unilocular anthers. Other writers have correctly regarded the androecium as composed of four or five laterally coherent bilocular anthers, with each locule produced into a terminal apiculum. This interpretation has been corroborated, with the addition of very interesting structural points, by the study of serial sections.

The members of the androecium are slightly coherent, but so far as could be determined there is no organic connection.

The structure of the anther is most intelligible when the sections are followed from the base towards the tip. As will be seen from figures representing the gross structure of the flower, the individual anthers are borne on short, flattened filaments extending as a ventral dark-brown connective towards the tip of the anther. The lowermost sections show only this connective (figure 2, a). A little above this plane the locules will be seen, the walls originating from the ventral surface of the connective (or filament) towards the median line (figure 2, b), the two margins of the connective extending as lateral wings. A little further above, the sections show a normal introrse anther with a prominent connective and two locules. The locellus-walls are broken down but evidently have been very short and the original division into four locelli secured by the strong invagination of the lateral wall which is folded in almost to the connective. Here there is an indication of a beginning of the separation of the two locules (figure 2, c). The split soon extends across the connective, leaving the two halves of the anther free for the greater portion of their length. These conclusions are drawn from the examination of sections, and it is quite probable that the two halves become disconnected lower in the anther in the process of sectioning than they would otherwise. At the same time the sharpness with which they are divided along the median line and the distance to which this separation of the locules extends from the tip indicate a natural longitudinal division.

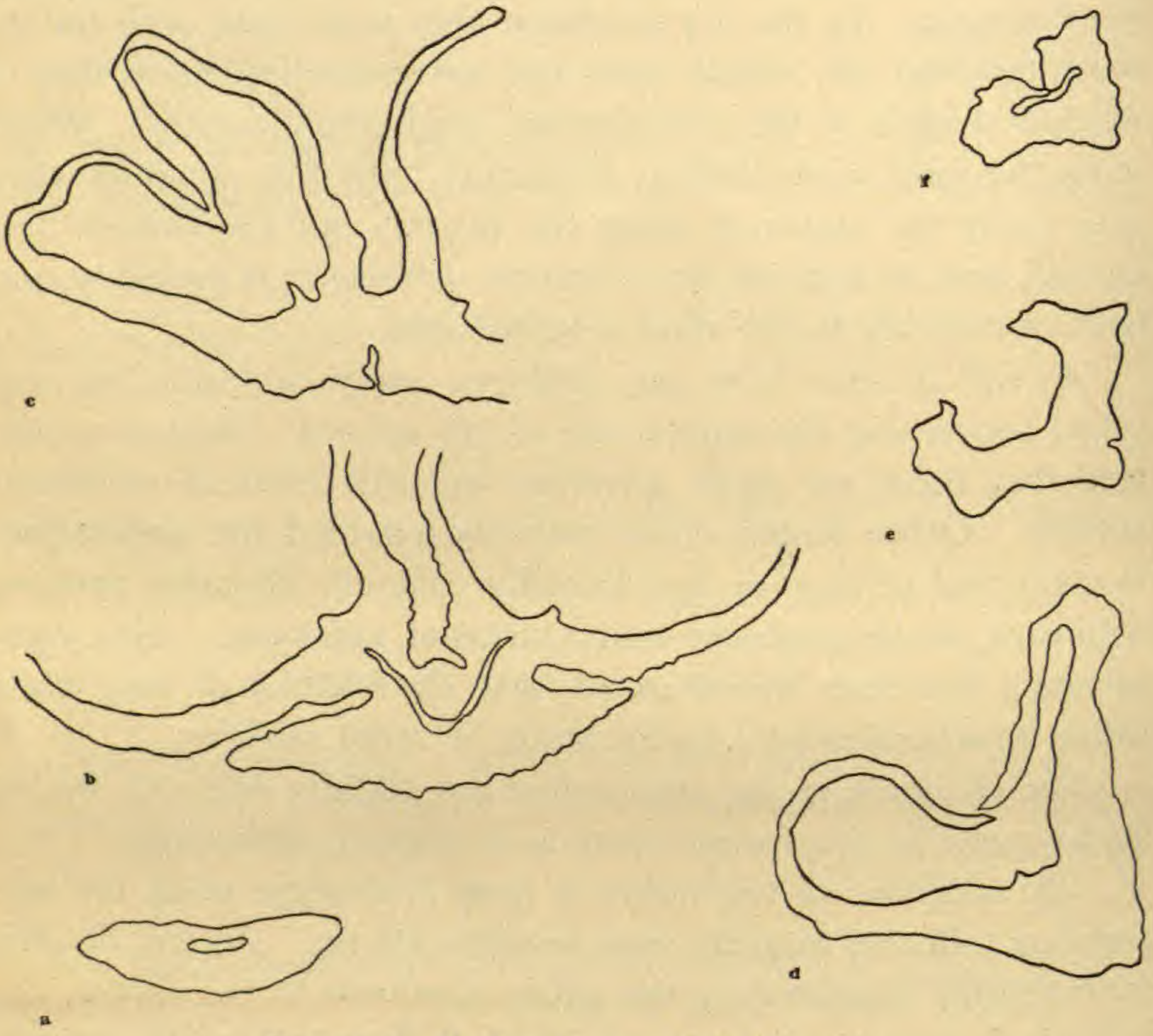

FIGURE 2. Anther-structure of *Duparquetia*.

As has been stated in the description of the gross structure of the flower, each locule opens by an introrse longitudinal split extending for some distance from the tip. The exact form of this is made very clear by the sections. In the lower portion of each locule the wall is invaginated so as to be brought almost in contact with the connective, to which it has evidently been joined by a very short locellus-wall, the vestiges of which may still be seen extending from the connective and from the invaginated margin of the wall (figure 2, c). A little above this plane the furrow is not so deep and sharp but more rounded and the vestiges of the locellus-wall have almost completely disappeared. The wall then breaks along the line of invagination and throughout the remainder of the length the margins gape more widely until the thickened, sterile tip is reached.

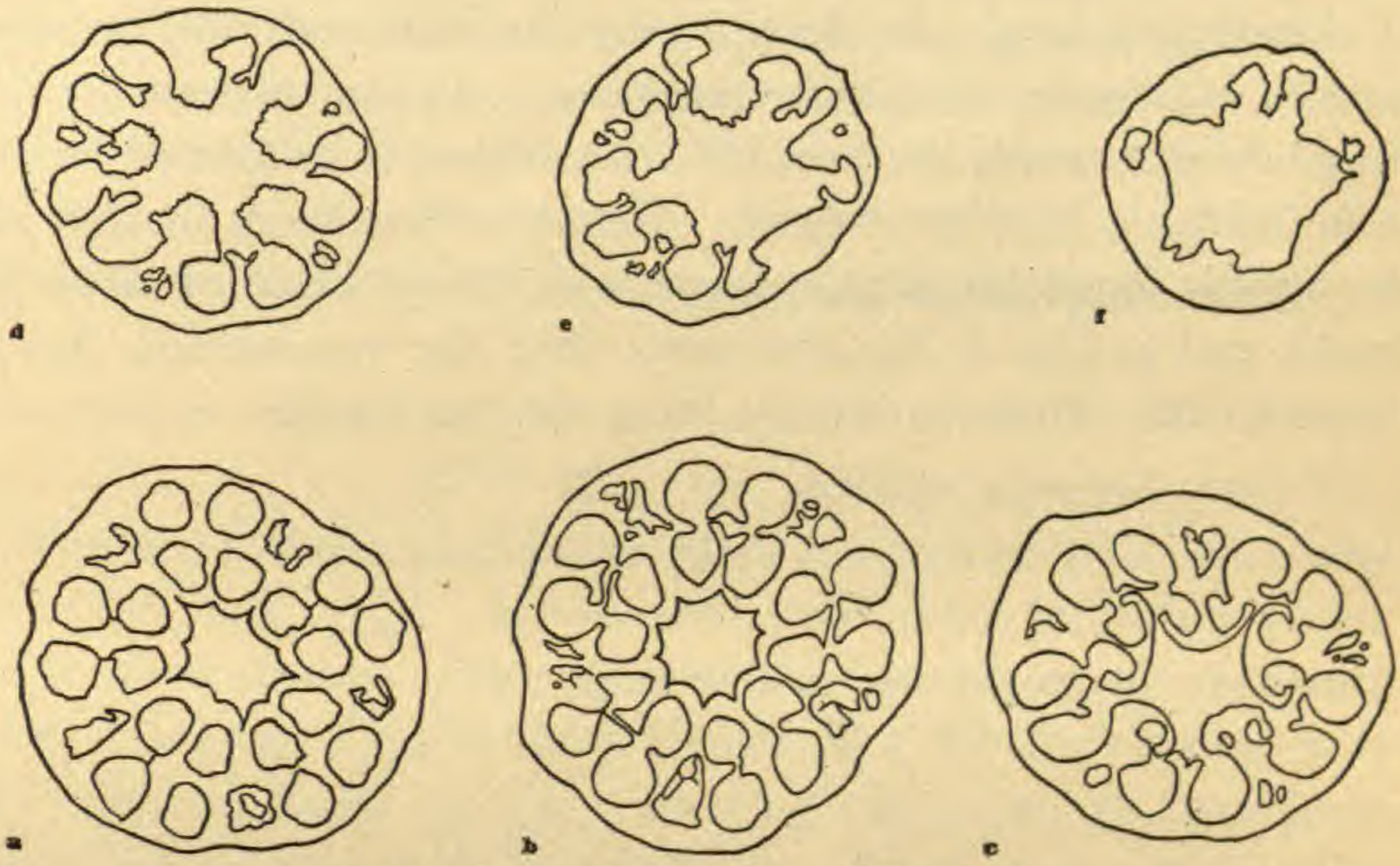

FIGURE 3. Anther-structure of *Strumpfia*.

The third genus, a member of the *Rubiaceae*, is *Strumpfia* Jacq.* This genus is represented by a single species on the rocky coasts of the Antilles.

The androecium has been described as follows: "Anthers subsessile, wholly connate, nearly free from the corolla-base, forming an ovate-oblong column, membranaceous at the top, a little exceeded in length by the corolla segments" (Grisebach). DeCandolle says: "Antheris in tubum ovoideo-oblongum subpenta-

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* Benth. & Hook. Gen. Pl. 2: 117. — DC. Prod. 4: 469. — Griseb. Fl. Brit. W. Ind. 335. — Jacq. Stirp. Am. 218. — Lam. Illustr. *pl. 731*. — Schnizlein, Iconog. *pl. 127b*. — Schumann; E. & P. Nat. Pfl. 4^4: 104.

gonum concretis intus 5-locularibus, loculis nempe 3 externis, 2 internis regulariter dispositis!" but Grisebach writes: "The anomalous structure of the column, described by DeCandolle, must have been a monstrosity; for I find 10 anther-cells, regularly arranged in a single row." The figure given by Schnizlein represents a condition such as DeCandolle describes. Schumann says of the androecium: "Stb. unter sich der ganze Länge nach zu einer dem Grunde der Blkr. angehefteten Röhre verbunden; A. nur in der oberen Hälfte, wie mit Poren geöffnet."

Serial sections represented by figure 3 show the real condition of this synandrium. At the tips only the outer wall may be seen, smooth externally and rough internally. As the sections are followed down towards the base the cone is seen to be formed by the fusion of five 4-locellate anthers. Between these there are towards the outside four intercellular spaces which have been mistaken for locelli, and so lead to the statement that the synandrium has in the outer row fifteen and in the inner row ten locelli.

MISSOURI BOTANICAL GARDEN.

Some new or otherwise noteworthy plants from the coastal plain of Georgia

Roland M. Harper

In five seasons of botanical exploration in the coastal plain of Georgia I have accumulated a few plants of special interest which were not sufficiently studied in time to be mentioned in the separate reports for each season which have already been published.* All but two of those mentioned below are to be included in a flora of the Altamaha Grit region which is now in press, and it seems desirable to discuss them here in advance, so that they will not require a disproportionate amount of space in the flora.

Lycopodium pinnatum (Chapm.) Lloyd & Underw. Bull. Torrey Club **27**: 155. 1900

The name of this pine-barren plant is antedated by *L. pinnatum* Lam. (Encyc. **3**: 654. 1789), said by its author to grow on trees in the West Indies. This species was mentioned by Beauvois (Prodr. Aetheog. 110) in 1805, Swartz (Syn. Fil. 186) in 1806, and Poiret (Encyc. Suppl. **3**: 541) in 1813, but seems to have been overlooked or ignored by later authors. There is no possibility of its being identical with our plant of the pine-barrens, so the latter should be re-named; I therefore propose to call it **Lycopodium prostratum,** in allusion to one of the characters by which it differs conspicuously from its nearest relative, *L. alopecuroides.*

Sporobolus teretifolius sp. nov.

Culms tufted, wiry, 7–8 dm. tall, erect or nearly so: leaves wiry, flexuous, ascending or recurved, about half as long as the culms, less than 1 mm. wide, oval in cross-section, compressed laterally, grooved on the ventral side: † panicles about half the

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* Bull. Torrey Club **28**: 454–484. *pl. 29;* **30**: 282–295, 319–342. *f. 1–3;* **31**: 9–27. *f. 1–4;* **32**: 141–171. *f. 1–5;* **32**: 451–467. *f. 1–5.*

† The following notes on the internal structure of this peculiar leaf may be of interest. The dorsal surface completely surrounds the leaf, and is remarkably smooth, without perceptible furrows or trichomes. The ventral surface is confined to the very

length of the culms, diffusely branched: spikelets yellowish, 3–4 mm. long, solitary on capillary diverging pedicels 5–15 mm. long: scales acute, the outermost one half to two thirds as long as the rest.

A very distinct species, related to *S. Curtissii* (Vasey) Small and *S. floridanus* Chapm. *S. Curtissii* has stiffer and broader leaves of very different structure,* and its spikelets are chestnut-colored, mostly appressed to the nearly straight ascending branches of the subsimple panicle, and longer, with the scales more attenuate and the outermost nearly as long as the rest. The inflorescence of *S. floridanus* is more like that of the new species, except that the spikelets are purplish and more numerous, but the whole plant is much stouter, and the leaves are nearly flat and often 5 mm. broad.†

Sporobolus teretifolius is a frequent and characteristic inhabitant of moist pine-barrens in the Altamaha Grit region,‡ flowering from July to September. I have collected it in Coffee County near Douglas, September 22, 1900 (*no. 677*), and in Colquitt County

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narrow groove, the depth of which at the middle of the leaf is about two fifths of the longest diameter of the leaf. In this groove are a few very short conical hairs. Stomata occur on both surfaces, but are most noticeable in the groove. The leaf figured herewith (taken from an undistributed specimen of my *no. 1642*) contained thirteen vascular (mestome) bundles, of various sizes, as indicated in the figure. The central portion is filled with large-celled colorless parenchyma, without perceptible intercellular spaces. Between the vascular bundles and the epidermis the cells (stereome) are very dense and thick-walled, their cavities being scarcely perceptible. The chlorophyl seems to be confined to the peripheral cells of the bundles.

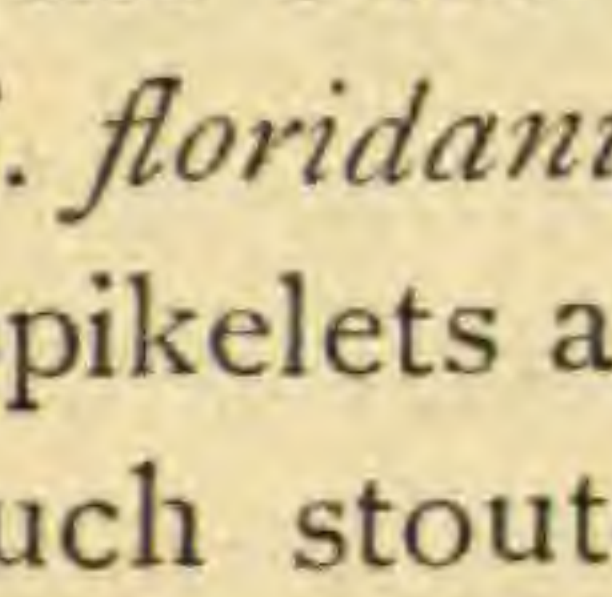

FIGURE 1. Cross-section (somewhat schematic) of leaf of *Sporobolus teretifolius*, enlarged about 20 diameters.

* In *Sporobolus Curtissii* the leaf is about 2 mm. wide when flat, but usually becomes conduplicate when dry. There is a well-marked groove on either side of the midrib, both above and below, and in the ventral grooves can be seen the bulliform cells by means of which the opening and closing of the leaf is accomplished. There are nine mestome bundles, four on each side of the midrib.

† See Bull. Torrey Club **28**: 464, 465. 1901.

The ranges and habitats of these three species will be contrasted in my forthcoming flora. Morphologically the distinction between them and certain species of *Muhlenbergia* (belonging to the section *Trichochloa* of many authors, or genus *Podosemum* of Desvaux) is a rather subtle one. In aspect as well as in habitat and distribution the diffuse-panicled species of *Sporobolus* and *Muhlenbergia* seem more closely related to each other than to the original species of either genus.

‡ See Torreya **5**: 114. 1905.

near Moultrie, September 20, 1902 (*no. 1642*). (In the herbarium of the New York Botanical Garden *no. 677* happens to be the best specimen, but I will designate *no. 1642* as the type because I have distributed more specimens of it, and still have some left.) It is unmistakable when seen in the field, and I have also noted it in similar situations in the counties of Dodge, Irwin, Berrien and Dooly. A specimen in the Columbia University herbarium collected by Prof. S. M. Tracy in the vicinity of Irby P. O. (Cycloneta sta.), in Irwin County, July 28, 1890 (distributed as *Muhlenbergia trichopodes*) is evidently the same thing. No stations for it outside of the Altamaha Grit region are yet known.

SPARTINA BAKERI Merrill, Bull. Bureau Plant Industry U. S. Dept. Agr. 9: 14. 1902

In a recent paper * I described an unidentified *Spartina* (*no. 2187*) collected near Brunswick in May, 1904, and referred it doubtfully to *S. junciformis*. A few days later I came across the original description of *S. Bakeri* (a species which I had overlooked before because it was not represented in the herbaria in New York nor mentioned in Dr. Small's flora), and recognized it at once as belonging to my plant. Prof. A. S. Hitchcock has since kindly compared one of my specimens with the type in the U. S. National Herbarium and pronounces them identical. *Spartina Bakeri* was based on a specimen from Orange County, Florida, and was reported at the same time from several other stations in the eastern and central parts of that state; but my station seems to be the first outside of Florida.

RHYNCHOSPORA LEPTORHYNCHA [Wright?] Sauv. An. Acad. Cienc. Habana 8: 84. 1871

Originally described from Cuba ("*En lagunas de poca profundidad, en los pinales de la Vuelta de Abajo*"), this species, or something very near it, has turned up in pine-barren ponds in Georgia. I have specimens from Sumter (*no. 467*, August 23, 1900) and Pulaski (*no. 1377*, June 26, 1902) counties in the Lower Oligocene region, and have noted it about three miles south of Douglas in the Altamaha Grit region. All my specimens have

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* Bull. Torrey Club 32: 458. 1905.

the stem stiffly curved through an arc of 45°–60° between the uppermost cluster of spikelets and the next one below it, a character which does not appear in the type-specimens (Wright's *no. 3784*). Furthermore, it is very unusual for a species growing in the pine-barren ponds of Georgia to be identical with one in the West Indies; but the structural difference above mentioned can hardly be considered as of specific value by itself.

JUNCUS BIFLORUS Ell. Bot. S. C. & Ga. **1**: 407. 1817

J. marginatus biflorus Chapm. Fl. So. U. S. 495. 1860.

J. marginatus pinetorum Nash, Bull. Torrey Club **22**: 145. 1895; Heller, Cat. N. Am. Pl. 31. 1898; Hitchcock, Trans. Kans. Acad. Sci. **17**: 82. 1901. (Name only.)

J. aristulatus pinetorum Coville; Small, Fl. S. E. U. S. 259. 1903.

The first locality mentioned by Elliott for his *Juncus biflorus* is "10 miles from Savannah, on the road to Augusta." With a view of settling the identity of this species I went to the spot indicated on June 18, 1903, and found it to be right in the village of Monteith, Chatham County. I soon saw a plant answering the description, but as its habitat there had been too much damaged by civilization, I went about a mile away before collecting any of it. My *no. 1842*, from the vicinity of the nearby station of Meinhard, may reasonably be considered typical. It is essentially the same as a plant which is common in the pine-barrens of Georgia and some adjoining states, and differing from its nearest relatives, *J. marginatus* and *J. aristulatus*, by the characters pointed out by Dr. Chapman and Mr. Coville. It is so frequent in Georgia that I will cite only the stations where I have collected it, which are in the following counties: Sumter (*478*, *483*), Screven (*784*, *788*, both from that part of the county which has just been put into the new county of Jenkins), Bulloch (*868*, an excellent specimen), Washington (*1328*), Laurens (*1373*), Charlton (*1495*), Chatham (*1842*), and Bryan (*1846*). Unlike its nearest relatives, it is strictly confined to the coastal plain, and grows usually in moist pine-barrens, but sometimes even in dry pine-barrens or on sand-hills. It is said to range from North Carolina to Florida, and it will doubtless hereafter be found farther west. In Georgia it flowers in May and June.

Juncus scirpoides compositus var. nov.

Rootstocks, stems and leaves essentially similar to those of *J. scirpoides* Lam. (as that species is commonly interpreted). Flowers in short dense spikes, which are aggregated to the number of about half a dozen in each of the numerous subglobose heads about 8 mm. in diameter: sepals acute, 2 mm. long: capsules beaked, about 2.5 mm. long,

The form here proposed as a new variety has been collected by several botanists, but hitherto always included in *J. scirpoides.* It was briefly described by Chapman (Fl. So. U. S. 494) in 1860, and a few years later by Engelmann (Trans. Acad. Sci. St. Louis **2**: 468, 469. 1868), who placed it as a form of his *J. scirpoides macrostemon macrostylus*, but without giving it a name. *J. scirpoides* normally has heads spherical and not perceptibly lobed, sepals 3 mm. and capsule often 5 mm. long. I have never had any difficulty in recognizing the new variety in the field, even from dead specimens nearly a year old; and in the herbarium it is as easily distinguished from *J. scirpoides* as are *J. megacephalus*, *J. brachycarpus*, and perhaps others. In view of its distinctness (which may some time perhaps entitle it to specific rank) there can be no object in letting it remain longer unnamed.

My specimens are from a shallow pond in the sand-hills of the Satilla River near the center of Coffee County, July 25, 1902 (*no. 1445*). I have seen the same thing in the counties of Dodge and Berrien, which are likewise in the Altamaha Grit region, and McIntosh, Wayne and Charlton in the flat pine-barren country, usually around sand-hill ponds and bogs. Its habitat is distinctive, and usually not shared by any other *Juncus.* It seems to flower mostly in July.

I have examined the following specimens besides my own:

SOUTH CAROLINA: "Damp margin of an old millpond, Aiken, with *Juncus dichotomus*, etc.," July 2 and 28, 1868, H. W. Ravenel (Engelm. Herb. Junc. Bor. Am. Norm. *no. 67*).

FLORIDA: Low grounds near Jacksonville, September, A. H. Curtiss (*no. 2981**). Near Jacksonville, July 19, 1893, A. H. Curtiss (*no. 4152*). Moist ground near Jacksonville, Sept. 1, 1894, A. H. Curtiss (*no. 5176*). Sandy swamps, Apalachicola, 1896, Chapman (Biltmore Herb. *no. 4082a*). Low pine land near Eustis, June 9, 1894, G. V. Nash (*no. 917*). Tampa, Britton & Wilson, Aug. 25, 1903 (*nos. 30, 63*). Hammocks, Ft. Lauderdale, Nov. 19 or 25, 1903, Small & Carter (*no. 1139*).

MISSISSIPPI: Cat Island, Aug. 28, 1900, Lloyd & Tracy (*no. 364*).

It would have been appropriate to make the specimen distributed by Engelmann the type, but as it apparently did not come from a natural habitat, I will designate my own instead.

POLYGONELLA GRACILIS var.?

On the sand-hills of Seventeen Mile Creek in Coffee County I collected in September, 1903, some specimens of a curious *Polygonella* (*no. 2010*) with linear acute leaves 5 to 8 cm. long, but otherwise indistinguishable from *P. gracilis* (Nutt.) Meisn., which normally has cuneate-obovate leaves 2 to 4 cm. long. The typical form was not observed in the vicinity, and I have never even seen it in the same county. Whether my plant should be called a new species, variety or form cannot be determined without further study, so I will leave it unnamed for the present.

Nymphaea fluviatilis sp. nov.

Rootstocks horizontal, about 3 cm. in diameter, the leaf-scars rather remote: leaves of two kinds, submersed and floating, both kinds glabrous throughout or essentially so; floating leaves with blades 12–25 cm. long by 10–20 cm. broad, their sinuses narrow or closed and about one third the length of the blades; petioles terete, about 5 mm. in diameter and often 2.5 meters long; submersed leaves about half the dimensions of the floating ones, with petioles not over 3 dm. long, and blades nearly as broad as long, very thin and crisped: peduncles similar to the petioles: flowers about 3 cm. in diameter: fruit green.

Nymphaea fluviatilis seems to be quite common in creeks, small rivers, and the swamps of large rivers, but apparently never in ponds, in the coastal plain. I have seen it in the Savannah River swamp in the southeastern corner of Effingham County, in Rocky Comfort Creek near Louisville, in Buckhead Creek near Millen, in the Ogeechee River near Chalker, Millen, Rocky Ford, Dover, and Meldrim, in the Canoochee at the type-locality (mentioned below), in the Ohoopee near Ohoopee and Reidsville, in the swamps of the Altamaha near Doctortown and Barrington, in the Oconee swamps near Mount Vernon, in the Little Ocmulgee near Lumber City, in Echeconnee Creek near its mouth (on the line between Bibb and Houston counties), in the Ocmulgee River swamps near Abbeville, in the Withlacoochee near Nashville, and in the Flint River swamps in Crawford County near Everett; nineteen stations in all.

My specimens were collected on the morning of June 22, 1903, in sloughs of the Canoochee River near Groveland, in the northwestern corner of Bryan County. The river was rather low at the time,* and many of the floating leaves were left hanging high and dry in the nearby bushes by the receding water, presenting a rather unusual appearance (see FIGURE 2).

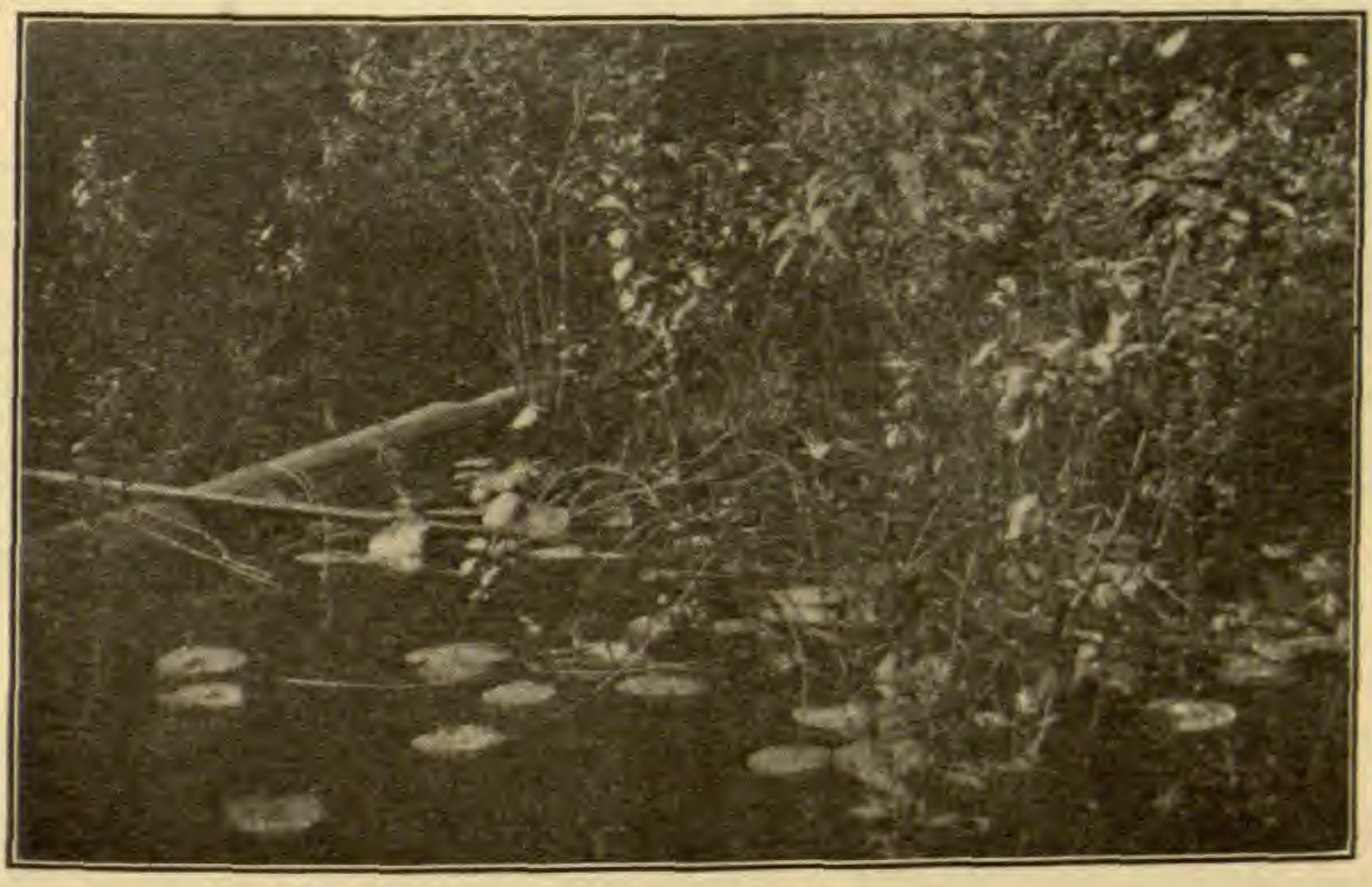

FIGURE 2. *Nymphaea fluviatilis* at the type-locality, photographed at time of collection. Note the very long petioles suspended above the water.

Nymphaea fluviatilis seems nearest related to *N. macrophylla* Small, a species said to range from Florida to Louisiana, from which it differs principally in its much slenderer rootstocks, longer and slenderer petioles, smaller leaf-blades with narrower sinuses, and smaller flowers. Accounts of different collectors differ as to whether the leaves of *N. macrophylla* are floating or emersed, but it is certainly not known to have any submersed leaves. It is almost superfluous to compare *N. fluviatilis* with the other southeastern species; but it differs from *N. advena* in having its princi-

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* See U. S. Geol. Surv. Water Supply & Irrigation paper no. 98, pages 72 and 73, where some hydrographic measurements taken near the same place on the following day are given.

pal leaves floating, never erect, from *N. variegata* * in its terete petioles, from *N. sagittifolia* in the shape of its leaf-blades, and from *N. orbiculata* in habitat, smaller size of all its parts, and absence of silvery pubescence on the submerged portions.

The new species is undoubtedly the commonest representative of the genus in South Georgia, where only two other species are known, namely, *N. orbiculata* in some of the large ponds in the southern tier of counties, and an apparently undescribed species with red-bordered fruit in Long Pond, Lowndes County.† In Middle and Northwest Georgia I have seen only *N. advena*, and that only two or three times.

This genus presents a very interesting problem in geographical distribution. In eastern North America the species with floating leaves seem to be confined to the glaciated region and coastal plain, and the only one known in the Metamorphic and Palaeozoic regions is *N. advena*, with erect leaves.‡ This is of course largely due to the scarcity of permanent ponds in the older regions, but just why there should be no floating-leaved species in the streams of these regions is not clear.

Sarracenia minor × psittacina

In September, 1902, I found in moist pine-barrens near Okapilco Creek, in the center of Colquitt County, several specimens of an unfamiliar *Sarracenia* which appeared exactly intermediate between *S. minor* Walt. and *S. psittacina* Michx., both of which were growing not far away. It was not abundant enough to collect, however, and some attempts to photograph it turned out badly. So in August, 1903, I revisited the spot, only to find the creek swollen by recent rains, the desired specimens all under water, and collecting out of question.

No further light on the subject was received until May 16, 1904, when I was agreeably surprised to find the same thing in Douglas, within a few feet of the specimens of *S. flava* × *minor*

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* See Miller, Proc. Biol. Soc. Wash. 15: 11–13. *f. 1. pl. 2.* 1902.

† See Bull. Torrey Club 31: 15. 1904.

‡ See in this connection Mr. Miller's paper just cited, also Rhodora 7: 69–80. 1905. Mr. Miller noted a marked difference in the ranges of the two plants he was discussing, and attempted to correlate them with temperature zones.

figured in a recent number of the BULLETIN.[*] Here again it was accompanied by the two species suspected of being its parents, as well as by *S. flava.* There were only a few specimens of the new hybrid, but being now convinced that I could find it elsewhere, I did not take any of them, but determined to look for it around Fitzgerald, in Irwin County, where I was going the same evening. On the morning of my departure from Fitzgerald, the 18th, my search was rewarded by finding about a dozen specimens of the hybrid about a mile east of the city, in company with the two parents, as usual. The specimens collected at that time, five in number, are numbered *2211.* On the afternoon of the same day I saw the same thing, with its parents, about five miles southeast of Rochelle, in Wilcox County.

There can be no reasonable doubt as to the hybrid origin of this plant, and I will not attempt to characterize it, for words are almost inadequate for describing such curiously shaped organs as the leaves of *Sarracenia*,[†] particularly those of this hybrid. If the reader can imagine a plant exactly intermediate in appearance between *S. minor* and *S. psittacina* he will have a fair idea of the form in question.

An artificial hybrid between the same two species is called *S. formosa*, and the figure of it in Nicholson's Dictionary of Gardening (3: 365. *f. 419*) resembles my plant very closely.

Unlike *S. flava* × *minor*, the new hybrid seems to be fertile, for I have seen several specimens bearing old capsules. I have no information as to the color of its flowers, however.

AMELANCHIER sp.

On June 6, 1901, I collected in a sandy bog near Graymont, Emanuel County, some fruiting specimens of an *Amelanchier* (*no. 819*) which seems to differ from all described species. It is a shrub with horizontal subterranean stems, sending up slender

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[*] 32: 462. *f. 4.* 1905. At this particular spot, which I have often visited, there are within an area not over 50 feet square about 50 species of moist pine-barren plants, including such things as *Taxodium imbricarium*, *Sporobolus teretifolius*, *Eriocaulon lineare* and *Baldwinia atropurpurea*, which are of particular interest to me for obvious reasons.

[†] It is probably for this reason more than any other that some of the most distinct species of this genus were confused by botanists of the first half of the 19th century.

erect flowering stems 4–6 dm. tall, bearing several short ascending sparingly pubescent branches above the middle. The leaf-blades are oblong, 1.5–4 cm. long and 1–2 cm. broad (the largest on young shoots), subacute at the apex, finely serrate nearly to the truncate or cuneate base, on petioles 6–10 mm. long. The upper surfaces are bright-green and shining, and reticulated with whitish veins, and the lower paler and minutely pubescent. The racemes are terminal, about 5 cm. long, 1 to 3 on each upright stem, few-flowered. Pedicels 6–12 mm. long, bearing 1 or 2 minute glands or tubercles near the middle. Petals unknown. Stamens numerous. Calyx-segments triangular, acute, 2 mm. long in fruit. Fruit globose, 5–7 mm. in diameter, purplish and glaucous.

The plant had very much the aspect of a small form of *Gaylussacia frondosa*, which grew with it. It seems to differ from all other southeastern species in its diminutive stature, shining leaves, and especially in habitat; but I do not care to name it without knowing more of its characters. On March 27, 1904, Mr. A. Cuthbert showed me some flowering specimens of what is probably the same thing in a similar habitat near Augusta, but I did not take any of them. If other botanists will look for this plant in the coastal plain of Georgia and the Carolinas we may soon know more about it.

RHEXIA ALIFANUS Walt. Fl. Car. 130. 1788

I can discover no good reason why this name should not supersede *R. glabella* Michx. Fl. Bor. Am. **1**: 222. 1803. Walter's description is characteristic enough, and the two plants were recognized as identical or nearly so by Michaux himself, also by Poiret, Persoon, Pursh, Elliott, Torrey & Gray and Watson. Even if varietally or specifically distinct, Walter's name would still be entitled to recognition, for it is not known to be a synonym or homonym of any earlier species.

PROSPERPINACA sp.

In moist pine-barrens and branch-swamps in the Altamaha Grit region I have several times encountered a *Proserpinaca* which seems just intermediate between the two well-known species, *P.*

palustris and *P. pectinata*. In stature, diameter of stem, and length of leaves it is like *P. pectinata*, but the leaves, except some of the lowest, are not pinnatifid but merely toothed, a little more deeply than in *P. palustris*, however. It is too near Dr. Small's recently described *P. platycarpa* * from South Florida to be described as a new species, and before it could be described as a new variety one would have to decide which of three species it should be appended to.

I have collected this problematic plant in the counties of Coffee (*no. 1427*) and Irwin (*no. 2210*), and have seen it in two or three other counties. *P. palustris* and *P. pectinata* both occur in the same region, but I have never seen them together, or either of them with the intermediate form; so the latter cannot be regarded as a hybrid.

? AZALEA ARBORESCENS Pursh

On the morning of July 21, 1903, I collected in rich damp woods at two stations in Randolph County a little north of Cuthbert a handsome *Azalea* with bright scarlet corollas (*nos. 1894, 1897*). Two days later I saw the same thing in similar situations near Fort Gaines, and the following week Dr. Eugene A. Smith found it in Barbour County, Alabama, a few miles farther west, and asked me to identify it. The late Rev. C. H. Hyde afterward informed me that he had known the plant in the vicinity of Cuthbert for years, but had never been able to place it correctly. An examination of specimens and literature after my return from the field showed it to be nearest related to *A. arborescens*, an Alleghanian species, from which it differs in its smaller size (being only a shrub), the midrib of the leaves appressed-strigose beneath, scarlet corollas, smaller calyx, and entire absence of glandular pubescence among the flowers. It does not seem advisable to describe it as new, however, until more differences are found. The color of the corollas might lead one to associate it with *A. lutea* L., but that is a vernal species, flowering about three months earlier (in the vicinity of Atlanta, the only region where I have seen it), while the plant under consideration flowers later than any other southeastern species.

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* Bull. N. Y. Bot. Gard. 3: 432. 1905.

Typical *A. arborescens* is not definitely known south of the mountains of Georgia,* and the coastal plain form here discussed seems to be one of a small class of plants inhabiting the "mesophytic" forests of the Eocene region of Southwest Georgia and nearly but not quite identical with Alleghanian species. Other examples of this class are *Magnolia pyramidata* Pursh, *Thaspium barbinode Chapmani* C. & R., and *Rhododendron Cuthbertii* Small, all of which I have found in Randolph County.

BARTONIA LANCEOLATA Small, Fl. S. E. U. S. 932. 1903

This is probably identical with *B. tenella brachiata* Wood (Class-Book 586. 1861). If so this will not be the first time that a supposed new species proposed by one of the present generation of systematists has been found to have been already described as a variety by Wood, who seems to have had an exceptional faculty of recognizing previously unobserved characters in plants, though he was too conservative to describe many new species. The Vienna rules do not require any change of name in a case of this kind, however, so I will not undertake to increase the number of synonyms at present.

In studying our species of *Bartonia*, the papers by Robinson (Bot. Gaz. **26**: 46–48. 1898) and Williams (Rhodora **2**: 55–57. *pl. 15. f. 1–7.* 1900) will be found useful.

AMSONIA CILIATA Walt.

Two forms of this occur quite frequently in South Georgia, one with leaves two or three times as broad as the other. There are other slight differences, but scarcely enough to entitle both forms to specific rank, though they are distinguished easily enough and should receive some recognition in systematic works. As a rule the broader-leaved form grows in dry pine-barrens and the other on sand-hills. Correspondence a few years ago with Mr. E. G. Baker, of the British Museum, elicited the fact that the

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*It is mentioned in Earle's Flora of the Metamorphic Region of Alabama (Bull. Ala. Agric. Exp. Sta. **119**: 96. 1902), but in the absence of specimens it is impossible to ascertain whether the mountain or the coastal plain form is meant. Wood may have known our plant, for his description of *A. arborescens* (Class-Book 490. 1861) fits it very well, and one of the localities cited, Macon, Georgia, is on the edge of the coastal plain and only about 100 miles from Cuthbert.

specimen in Walter's collection was a broad-leaved form (matching very closely Curtiss's *no. 2269* from the vicinity of Aspalaga, Florida, according to Mr. Baker). The narrow-leaved form is in all probability what Rafinesque described as *A. tenuifolia* (New Fl. N. Am. **4**: 58. 1836). Wood's *A. ciliata filifolia* (Class-Book 589. 1861) though inadequately described, is doubtless intended for the same thing. The description of *A. angustifolia* (Ait.) Michx., which has always been considered synonymous with *A. ciliata* Walt., might apply equally well to the narrow-leaved variety also.

A. ciliata is represented in my collections by *no. 1166*, in fruit, from dry pine-barrens in Mitchell County, Aug. 7, 1901, and the narrow-leaved form from the following counties: Dooly (*no. 577*, in fruit), Bulloch (*no. 915*, in fruit), and Laurens (*no. 2138*, in flower). The latter has also been collected along the Flint River near Albany by Dr. Small in May, 1895, and in Leon County, Florida, by Mr. Nash in September of the same year (*no. 2546*). Its total range is as yet unknown.

ANONYMOS CAROLINIENSIS Walt. Fl. Car. 91. 1788

Batschia carolinensis (Walt.) Gmel. Syst. **2**: 315. 1791.
Lithospermum carolinianum Lam. Tab. **1**: 396. 1791.
L. hirtum (Muhl.) Lehm. Asperif. 305. 1818 (and most 19th century authors).
L. carolinense (Walt.) MacMillan, Met. Minn. 438. 1892.
L. Gmelini (Michx.) Hitchcock, Spring Fl. Manh. 30. 1894 (and most subsequent authors).

Mr. Mackenzie * has recently pointed out that Lamarck's *Lithospermum carolinianum* is a synonym of *L. Gmelini*, instead of a conflicting homonym as was thought to be the case a few years ago. But the identity of Lamarck's plant is not of fundamental importance in the present case, since the specific name dates back to Walter, three years earlier, as was noted by MacMillan in 1892, but apparently by no one else who has mentioned this plant since his time. (Several other synonyms for it can be found in MacMillan's work.)

A careful scrutiny of the above synonymy will disclose several problems which do not seem to be provided for in any set of rules

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* Bull. Torrey Club **32**: 501. 1905.

for nomenclature, and the exact designation of this plant will depend somewhat on the rules used. It would be beyond the scope of this paper to discuss these problems fully, but I will briefly indicate some of them for the benefit of those who are more interested in such matters.

In the first place, Walter had quite a number of *Anonymos* genera, as is well known, and in several of them he used the specific name *caroliniensis*. The first *Anonymos* of course invalidates all the rest, but shall the first one be recognized? (It happens to be a good genus, and was named *Tubiflora* by Gmelin and *Elytraria* by Vahl. The only species included in it by Walter bore the specific name in question.) Second, does the first *Anonymos caroliniensis* invalidate all the rest (ours among them)? Third, shall the original spelling of the specific name be maintained? Fourth, if *Anonymos caroliniensis* is a homonym, does that affect the validity of *Batschia caroliniensis* Gmel. and *Lithospermum carolinianum* Lam.? Fifth, which of the two last-mentioned names is older? Sixth, if the third and fourth questions are answered in the negative, shall we call our plant *Lithospermum carolinianum* Lam., *L. carolinianum* (Walt.) Lam., or *L. carolinense* (Walt.) MacM.?

The last problem could be partly circumvented by recognizing Gmelin's genus *Batschia*, which was founded on this species alone, and seems as distinct as many other genera now recognized.

VERBENA CARNEA Med.; Schauer in DC. Prodr. **11**: 545. 1847

?*Phryma caroliniensis* Walt. Fl. Car. 166. 1788; Gmel. Syst. **2**: 921. 1791.

V. caroliniana Willd. Sp. Pl. **1**: 119. 1798; Pursh, Fl. Am. Sept. 417. 1814; Nutt. Gen. **2**: 40. 1818; Ell. Bot. S. C. & Ga. **2**: 99. 1821.

V. caroliniana "L."; Michx. Fl. **2**: 14. 1803; Wood, Class-Book 537. 1861.

"*V. caroliniana* Michx."; Chapm. Fl. So. U. S. 307. 1860; Gray, Syn. Fl. **2**: 336. 1886.

"*V. Carolina* L."; Mohr, Contr. U. S. Nat. Herb. **6**: 693. 1901.

V. carolinensis (Walt.) "Gmel."; Small, Fl. S. E. U. S. 1009. 1903.

(Not *V. Carolina* L. Sp. Pl. ed. 2. 29. 1762, nor *V. caroliniana* Gmel. Syst. **2**: 42. 1791, both of which are based on *V. carolinensis* Dill. Hort. Elth. 407. *pl. 301. f. 388.* 1732.)
Stylodon scabrum Raf. Neog. 2. 1825.

A study of the synonymy of this characteristic southeastern coastal plain plant has revealed a surprising amount of carelessness in citation of names, as has been the case with several other species having a similarly restricted range. The *Verbena Carolina* of Linnaeus was based on a plate and description by Dillenius, which cannot be referred to our plant, and a brief description by Ray, which may belong to the plant in question, as suggested by Gray, though the evidence is insufficient. The first valid name under *Verbena* seems to be *V. carnea*, as above indicated, though Rafinesque 22 years earlier had made this same plant the type of a new genus, *Stylodon*. I am by no means convinced that Rafinesque's genus is not a good one, so I will not cumber synonymy by transferring his specific name to *Verbena*.

Clinopodium georgianum nom. nov.

Thymus carolinianus "(Walt.)" Michx. Fl. Bor. Am. **2**: 9. 1803.
Calamintha caroliniana (Michx.) Nutt. Gen. **2**: 39. 1818; Sweet, Hort. Brit. 315. 1826.
C. caroliniana "Sweet"; Benth. in DC. Prodr. **12**: 229. 1848; Chapm. Fl. So. U. S. 317. 1860; Gray, Syn. Fl. **2**: 360. 1886; Jackson, Ind. Kew. **1**: 375. 1895.
C. caroliniana "Swartz"; Wood, Class-Book 548. 1861.
Melittis caroliniana Spreng. Syst. **2**: 700 (in part). 1825.
Melissa caroliniana (Michx.) Benth. Lab. 388. 1834.
"*Clinopodium carolinianum* Mill."; Jackson, Ind. Kew. **1**: 565 (as syn.). 1895.
C. carolinianum (Michx.) Heller, Cat. N. Am. Pl. 7. 1898; Small, Fl. S. E. U. S. 1043. 1903. (Not of Mill. Gard. Dict. ed. 8. 1768.)
C. carolinianum "(Walt.) Kuntze"; Mohr, Contr. U. S. Nat. Herb. **6**: 700. 1901.
Thymus grandiflorus Sims, Curt. Bot. Mag. **25**: *pl. 997.* 1807.
Calamintha grandiflora (Sims) Pursh, Fl. Am. Sept. 414. 1814; Ell. Bot. S. C. & Ga. **2**: 93. 1821.

(Not *Melissa grandiflora* L., *Calamintha grandiflora* (L.) Moench *Clinopodium grandiflorum* (L.) Kuntze, a European species.)

The bibliographic history of this handsome little southern shrub is even more complicated than in the case of the *Verbena* just mentioned. The plant seems to have been first noticed "*in Carolina et Georgia, secus amnem Savannah, ad urbem Augusta*," by Michaux, who named it *Thymus carolinianus*, supposing it to be the same as Walter's *Thymbra ? caroliniana.* But according to Elliott, Walter's *Thymbra* was identical with the type of his own new genus *Macbridea.** (Walter's description alone would scarcely suffice to identify the plant, but Elliott may have had some other evidence.) Sims, however, figured a plant which is clearly the same as ours, but identified it confidently with Walter's, and changed the specific name so as not to conflict with Michaux's *Thymus carolinianus*, whose identity he doubted.

Pursh and Elliott placed the species in *Calamintha*, using Sims's specific name, regardless of the fact that Moench had used the same combination twenty years earlier for a European plant. Nuttall was the first to combine *Calamintha* with Michaux's specific name, but Bentham, Chapman, Gray and the Kew Index credit this binomial to Sweet, notwithstanding the fact that Sweet plainly refers to Nuttall, and Nuttall's citation and description are perfectly satisfactory.

In 1891 Kuntze transferred all our species of *Calamintha* to *Clinopodium*, and noticing that there was already a *Clinopodium carolinianum* (described by Miller long before Michaux's *Thymus* or even Walter's *Thymbra*), changed the specific name of our plant, as he thought, but erred (presumably) in making it synonymous with Walter's *Thymbra*; so if we accept Elliott's views, Kuntze's *Clinopodium Walterianum* becomes a synonym of *Macbridea.* A few years later Mr. Heller fell into the trap that Kuntze avoided, and took upon himself the credit for the supposed new combination *Clinopodium carolinianum.* Dr. Mohr in

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* MACBRIDEA PULCHRA Ell.; Nutt. Gen. **2**: 36. 1818; Ell. Bot. S. C. & Ga. **2**: 86. 1821; and most subsequent authors.

Thymbra ? caroliniana Walt. Fl. Car. 162. 1788. (*fide* Ell.)

Melittis caroliniana Spreng. Syst. **2**: 700 (in part). 1825.

Macbridea pulchella Benth. Lab. 505. 1834; DC. Prodr. **12**: 435. 1848.

Clinopodium Walterianum Kuntze, Rev. 516. 1891 (excl. syn. Sweet).

1901 seems to have taken for granted that Kuntze was the author of this combination as of many others in the same genus.

Just what plant Miller had in mind is an open question. In the Kew Index his *Clinopodium carolinianum* is made a synonym of "*Calamintha caroliniana* Sweet," but his description does not justify this disposition of it, and it would be a remarkable coincidence if it did. So as long as *Clinopodium* is accepted as the name of this genus both specific names which have been given to our plant are preoccupied, and I have ventured to rename it in honor of the other of the two states where Michaux first saw it, which is centrally located with respect to the known range of the species. For those who would retain *Calamintha* the specific name *caroliniana* is still available, if we disregard Michaux's reference to Walter, or accept Sims's views.

Cytological changes accompanying secretion in the nectar-glands of Vicia Faba

CHARLES RUPERT STOCKARD

(WITH PLATES 10 AND 11)

The cytological changes accompanying secretion have been studied in a number of animal glands with the result that no very obvious degree of uniformity was observed. There are some cases involving the actual destruction of the secretory cells, while in others the integrity of the cell is perfectly preserved. The amount of work on the glandular cells of plants has not been so extensive, yet, among the observations recorded, we find described a considerable diversity in the sequence of events taking place within nucleus and cytoplasm. The nuclei in the case of some glands remain intact but change considerably in their staining reactions, in others the nuclear walls become ruptured and their contents discharged into the body of the cell; the cell-walls themselves in some instances are recorded as being dissolved, and in one case, *Drosera*, the chromatin of the nucleus becomes arranged into a definite number of V-shaped chromosomes during secretion. There are also instances of observers working on similar objects obtaining entirely different results. We are thus forced to recognize the discordant condition existing at present in this field.

Having the above results in view Prof. Francis E. Lloyd kindly suggested to me that I study the cytological changes in the secretory cells of a nectar-gland on the stipules of *Vicia Faba*, the horse bean. It is, therefore, a pleasure to take this opportunity of expressing my indebtedness to Professor Lloyd for his many valuable suggestions and kindly criticism during the progress of this research.

I hoped through the study of these glandular cells to be able to throw some light on the origin of the secretory product and if possible to determine what nuclear and cytological changes accompanied its production and discharge from the gland-cells.

Further, I wished to determine what connection or relation exists between the nuclear and cytoplasmic changes and to find what constituent of the nucleus should it prove to be active in the process is most concerned. The observations described below are designed to attack these questions, though it is recognized that the results rather indicate the need of further careful and exhaustive study than give definite answer to these queries.

METHOD AND MATERIAL

The nectar-glands on the stipules of *Vicia Faba* are beautifully adapted for study; since from the terminal bud to the old mature leaves may be obtained all stages in the development of these glands as well as the entire cycle of secretory action. The living material flourishes in the greenhouse during winter, so that preparations may be made from time to time with little trouble.

Realizing that the methods of fixation and staining in work of this type are open to so much criticism, I have taken all practical precautions against errors from this source. First, observations as far as possible on nuclear positions *et cetera* were made upon free-hand sections of the living glands, and in the second place a large number of fixing and staining solutions were used and the results compared.

The glands were cut from the stipules with a border of non-glandular tissue, thus insuring the presence of all parts of the gland in the preparation, and further facilitating a comparison between gland-cells and ordinary tissue-cells. The material was then, while in the natural condition, quickly placed in the fixing fluids; those employed being Gilson's fluid, picro-acetic, chromo-acetic, picro-corrosive, picro-aceto-sulphuric, alcohol acetic, sublimate acetic, and picro-sulphuric, with the following success. The Gilson's fluid gave most satisfactory preparations, the nucleus and cyptoplasm being in apparently perfect condition. The picro-acetic and chromo-acetic gave fairly good results, and the picro-corrosive used by Reed also proved favorable though inferior to Gilson's fluid. Picro-aceto-sulphuric was rather uncertain, though in some cases fairly good preparations were obtained by its use. Alcohol acetic, sublimate acetic, and picro-sulphuric were all unfavorable. The series for study was then fixed with Gilson's, picro-acetic, and picro-corrosive, all giving good results and supplying valuable means of comparison. The same precaution was resorted to with the stains, and from the number tried those best adapted to this material were selected.

Auerbach's stain (methyl green and acid fuchsin) was extensively used for studying the cell-contents, as it gives a beautiful differentiation of nuclear substances, and differentiates clearly the chromatic granules of the nucleus from the cytoplasmic granules about the nuclear wall. Heidenhain's iron-haematoxylin with congo red as a counter-stain gave far the clearest preparations and is a most valuable stain, although Reed in criticizing Torrey's results, objects on the ground that it does not differentiate between acid and basic elements of the cell. This is an objection in itself open to criticism, as after the use of fixatives we should not depend on any one stain for such differentiation, and probably Auerbach's stain, which Reed failed to use, is best for such purposes. Torrey, himself (page 429), mentions this same objection to an iron-haemotoxylin and states that on this account he resorted to the use of Auerbach's method for comparison.

Eosin-toluidin blue as recommended by Reed was successfully tried. Eosin and polychrome methylin-blue used separately gave good preparations, while mixed as Romanowsky's stain the results were poor. Throughout this study the artificial conditions of stained preparations were always kept in mind and comparisons continually resorted to so that if errors do exist I believe they should be attributed to other causes.

OBSERVATIONS ON THE LIVING GLAND

The glands are situated on the stipules of the leaves and when mature appear as small dark-red spots, one on each stipule rather near its base.* The immature glands found in the terminal buds are tiny white spots on the pale-green stipules, and the gland is several days old before it becomes colored. They are more conspicuous on the lower or outer surface of the stipule, being less distinct and velvety in appearance on the upper side, the side, namely, on which the secretion occurs. The velvety appearance is due to the presence of the hairs described below. The secretion

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* First mentioned by Sprengel, Entd. Geheimniss 357. 1793.

is a limpid watery nectar found usually in the early morning as a droplet on the surface of the gland. This seems to accord with Wilson's observation that these glands may be made to secrete by the stimulus of illumination.

When the gland is examined microscopically it is seen to be perfectly flat, lacking any infolding, and composed of several kinds of cells (FIGURE 1). The inner or lower cells and the epidermal layer seem slightly if at all modified in form, while the epidermal ones are rather more columnar in shape than are those of the general tissue-epidermis. Two kinds of hairs are found on the surface of the glands; one a long slender conical body composed of two cells (FIGURE 2), a small slightly modified basal cell and a long conical apical cell which forms the main body of the hair. This hair is pale-greenish or colorless during life and has a very thick wall. Its function is probably sensitive, though this could not be definitely determined. Haberlandt has suggested that these hairs in another species serve to hold the secretion and prevent its falling off, but I fail to understand, on account of their scarcity on the gland-surface, how they could perform such a function. The other hairs (FIGURE 3) are entirely different in shape, being somewhat club-like, and consisting when mature of five cells. These cells are definitely arranged with a single basal cell usually somewhat smaller than the rest, and four larger cells placed in two pairs one immediately above the other. The four cells might be described as forming the four quarters of an ovate spheroid. These cells contain the secretion-products just as those in other parts of the gland and their color and appearance in life are due to this substance. These will be termed nectar-hairs for the sake of convenience. De Bary states that the glandular properties of these cells have not been observed, but their close similarity to cells of other parts of the glandular area makes it obvious that in younger glands at least these hairs do serve the ordinary secretory functions. The fact that they arise directly from the epidermal gland-cells further suggests their glandular properties.

The color and color-changes in the gland-cells are most interesting. When examining free-hand sections of the living material one finds a brilliant red and a deep blue color arranged in various patterns. At times the epidermal layer with the nectar-hair cells will be red while the lower cell-layers are blue. Again, layers of red and blue cells may alternate for as many as four or five layers or rows. The contents of the hair-cells are actually at times of different colors, the distal pair being red or blue while the proximal pair are, conversely, blue or red. In mature glands many of the outer tips or distal cells of the nectar-hairs contain a colorless liquid. Thus the cell-contents lose their pigmentation before being thrown out. Often the entire gland is found to be of one color, either blue or red.

This shifting color-scheme suggested to me that possibly the color depended upon the conditions of acidity or alkalinity in the different cells. Therefore experiments were tried in which acid and basic solutions were passed over the glands while on the slide and the responses proved that the color did depend upon the cell's chemical reaction. When a weak HCl solution was passed over a gland containing alternate rows of blue and red cells all the blue cells became red, just as litmus would respond to acid. If dilute NaOH was now applied until the liquid on the slide became alkaline the cells all changed to blue. One is able to alternate this color-change back and forth for a number of times, provided the acid solution is not allowed to remain for too long a time, as the cell-substance is soluble in it, finally dissolving out. This suggests Bonnier's statement that an invertin which dissolves the secretion-products is to be found in glands, and Lloyd also suggested that this invertin might occur in certain non-green cells in the pericycle of *Pteridium* nectar-glands. In the glands of *Vicia Faba* the nuclei in most cases also become red on meeting the acid and thus indicate that they contain material similar to the secretion-substance. On adding the base the nuclei became clear and difficult to see having lost their pinkish acid response.

Testing with Fehling's solution for the variety of sugar present in the secretion substance, cane sugar was found.

HISTOLOGY AND DEVELOPMENT

A. *Structure.* — Studying these glands as stained preparations, one sees very little histological difference between the cells of the gland-area and those in adjacent parts of the stipule. The deeper layers of cells in the gland are strikingly similar to cells of the same layer in other portions, except for the fact that they rarely contain chlorophyl-granules and that their nuclei seem a little less irregular in form, tending to be as a rule spherical. Lloyd was probably correct in his supposition that the cells lacking chlorophyl in the foliar nectar-glands of *Pteridium* were functional in the secretory process. The epidermal cells of the gland are more columnar in form than those of the general epidermis, being sometimes more than twice as long as broad. The hairs mentioned above are really the only highly specialized structures to be found in these glands. The basal cell of the conical hair (FIGURE 2, *bc*) is often inferior in size to any other cell present, and its contents at times appears very scanty. The tip, or conical cell, of this hair is highly modified, having an enormously thickened wall which in many cases stained diffusely with the methyl green of Auerbach's stain. In size this cell is more than twice the length of any other present, and somewhat broader at its base than the epidermal cells.

The more numerous hairs which for convenience have been termed nectar-hairs, are constructed as described above. The basal cell in this case (FIGURE 3, *bc*) is likewise somewhat smaller than the neighboring cells, but its walls are not so thick as the upper epidermal wall; otherwise it is not remarkable. The outer walls of the remaining four cells of the hair are thin, and the wall forming the distal dome of the hair is very much thinner than elsewhere. The inner partition-walls which separate the four cells are also thin, though usually appearing thicker than the outer ones. As before stated, the contents of these cells is very much like that of the other cells of the gland, except in cases of old glands, when the general gland-cell material stains lightly with the plasma-stains, while these hairs are filled with substances tending to take the nuclear dies. The nuclei of hair-cells (FIGURE 13) are similar to those of other cells, being vacuolated and changing with age in much the same manner.

I consider that the gland proper consists of the club-shaped hairs and the several layers of cells below these, whereas the conical hairs are accessory, being found in no other part of the stipule.

B. *Development.* — Since the general glandular tissue resembles in structure that of other portions of the stipule, little of especial note is expected in its development. The case, however, of the modified hairs is much more interesting. In very young glands before their contents becomes colored, only the nectar-hair type exists, a few of these being arranged in a central group. As development proceeds new hairs are formed around these as a center until the gland has attained its mature size and color. The nectar-hair is formed in the following manner: the outer wall of an epidermal cell protrudes above the surface to a height about equal to its former depth (FIGURE 4), and its nucleus, which up to this time is still in the resting condition, now divides mitotically (FIGURE 5) into two and thus forms the first cell of the hair. The parent and daughter cell again divide horizontally and so give the hair three cells arranged in a vertical row (FIGURE 6). A vertical division of the two upper, or distal, cells then forms the four-celled arrangement of the mature hair (FIGURE 3). This latter process was not actually observed in my material, but is easily inferred from the stages which do exist.

The conical hairs (FIGURE 2) are found only in glands that have assumed the mature color, and are always far less abundant than the above type. They also arise from an epidermal cell, and in this case the epidermal wall retains its thickness while pushing up to form the heavy cone of the hair. With the development of this type of hair the gland has reached its mature condition.

NUCLEAR AND CYTOPLASMIC CHANGES DURING SECRETION

All observations recorded in these notes were made with Leitz 1/16 oil-immersion objective and number three ocular with the tube-length 170 mm.

(*a*) The youngest glands taken from the terminal buds present the following appearances (FIGURES 7 and 14). The true nucleoli, or plasmosomes, take the acid stains, thus giving with Auerbach's or Congo red a delicate pink color, and they are usually surrounded by large vacuoles. Often two or more plasmosomes are found in the same nucleus (FIGURE 7). They differ slightly in size in the various cells, as do also the vacuoles about them. In some cases the vacuole disappears almost entirely, this being often true of the nuclei in the young nectar-hair cells (FIGURE 13, *A*). The chromatin is granular in structure rarely giving the appearance of a thread-like arrangement. These granules in some nuclei are closely packed, causing them to stain very heavily, while other nuclei in nearby cells contain much less chromatic substance (FIGURE 12). The nuclei of the gland-cells are somewhat larger and more spherical than those found in the adjacent tissues.

The cytoplasm appears finely granular in structure and is often more or less vacuolated. The cytoplasm in the hair-cells does not differ noticeably from that in other cells of the gland. It is usually densest about the nuclei and never contains any nuclear staining, or cyanophil, material.

(*b*) Considering now a gland that is slightly older or more mature than the former, being the next lower on the stem of the terminal bud. Here are also found (FIGURES 4 and 15) vacuoles of various size about the plasmosomes. The chromatin is again granular as a rule, but many nuclei preparing for division are in spireme stage. In some again the granules are densely arranged while in others the chromatic substance is less abundant.

The cytoplasm is granular in appearance, with numerous vacuoles, and is densest about the nuclei. In a few of the central and therefore oldest nectar-hairs the granules of the cytoplasm have become cyanophil and stain heavily. The walls of these hairs have slightly shriveled. All of the nuclei in the nectar-hairs and the epidermal cells are situated near the cell-center, while in lower layers the nuclear position is not so constant.

(*c*) The cells of the next older gland on the stem are still colorless. The nuclei have large vacuoles about the plasmosomes (FIGURES 8, 9, and 11). The chromatin is granular but more diffuse or not so densely arranged as in the two younger, some nuclei being thin and pale. The nuclei of the nectar-hairs are much poorer in chromatin than those in similar parts of the glands above (FIGURE 13, *B*). The plasmosomes are about equal in size in these three stages of the glands.

The cytoplasm is coarsely granular, being again dense around the nuclei, and contains a few basic staining or cyanophil granules. There is no chlorophyl in any of the cells of these three glands, which appear white in life.

(*d*) The youngest gland containing colored material. The nuclei are vacuolated about the plasmosomes (FIGURE 16), but as a rule those of the nectar-hairs do not contain as large vacuoles as are found in other parts. The chromatin is arranged much as in the three former cases: in some nuclei the granules are closely packed, in others loosely.

The cytoplasm now becomes denser and more coarsely granular, staining more heavily than in the three former glands. The nucleus is again, as a rule, surrounded by a dense cytoplasmic arrangement. The granules of the general gland-cells take the plasma-stains, while many in the nectar-hairs stain with the nuclear dies.

(*e*) Newly matured glands, slightly older than the above. The nucleus is still vacuolated about the plasmosomes. The chromatin is granular and arranged much as above described, in some instances being closely packed and in others thinly. Some nuclei in the lower cell-layers take the plasma-stains, seeming to have lost their chromatic character. The nuclear positions tend toward the cell-center (FIGURE 10).

The cytoplasm is now rather densely granular, *the granules of the general gland-cells taking the plasma-stains, while those of the nectar-hairs stain with the nuclear stains, particularly the methyl green of Auerbach's stain.*

(*f*) Old but still secreting glands. The nuclei of these glands are slightly shrunken and lie against the cell-walls (FIGURE 17). The vacuole about the plasmosome is not so large and in some is absent; the granular chromatin is as a rule closely arranged. The nuclei in adjacent tissue-cells are often very small, sometimes apparently absent, and in many cases extremely elongate in form. In fact there is a slight difference in all stages between gland-cell nuclei and general tissue nuclei, the former being as a rule, but not always, larger and tending more toward the spherical form.

The cell-contents is at this time particularly interesting in its structure, and in all cases is granular in appearance. The cells of the epidermal and lower layers stain very palely with plasma-stains, while the nectar-hairs stain deeply with nuclear dies such as methyl green, iron haematoxylin, and others. In some cases the granules of the cell stain so densely as almost to hide the nucleus which responds to the stain in exactly the same manner as do these granules (FIGURE 17). The contents of the basal cell of the conical hairs takes the plasma-stains, thus differing in its staining reaction from the nectar-hair cells.

COMPARISON WITH OTHER OBSERVATIONS

Comparing the above changes with those observed in various gland-cells it is difficult to agree in all points with any one author, but on the other hand a study of the results forces one to recognize that secretion in the cell is a process that may be accomplished in many different ways. To quote the statement made in *An American Text-book of Physiology*, on this subject, by Howell: "In the sebaceous secretion the cells seem to break down completely to form the material of secretion; in the formation of mucus by the goblet-cells of the mucous membrane of the stomach and intestines a portion of the cytoplasm after undergoing a mucoid degeneration is extruded bodily from the cell to form the secretion; in the mammary glands a portion of the substance of the epithelial cells is likewise broken off and disintegrated in the act of secretion, while in other glands the material of the secretion is deposited within the cell in the form of visible granules which during the act of secretion may be observed to disappear, apparently by dissolution, in the stream of water passing through the cell. Facts like these show that some at least of the products of secretion arise from the substance of the gland-cells and may be considered as representing the results of a metabolism within the cell-substance. From this standpoint, therefore, we may explain the variations in the organic constituents of the secretions by referring them to the different kinds of metabolism existing in the different gland-cells." This statement relating to animal secretion might with slight alterations be applied equally well to that of plants.

It is now pertinent to consider some of the later contributions to the cytology of secretion among plants and animals and compare the results indicated with the case at hand. Mathews ('99), working on the pancreas cell of various animals, observed the following facts. He found that these cells contained in their basal portions a ball of thread-like fibers which is termed pancreatic mitosome, or "Nebenkern." During secretion these threads, which extend into the upper portions of the cell, break up into the granules which finally form the secretion-substance. The fibrils were found in a number of cases to terminate in, or over, the peripherally placed chromatic masses of the nucleus. Thus Mathews concluded for this and other reasons that the nucleus was passive in the actual process of *secretion* ("the process of the discharge from cells of their metabolic products"), but was active in the manufacture of the secretion-substance, which process he termed "*hylogenesis.*" I feel sure that in the case of the plant gland-cells which I have studied this statement holds equally well. Since no *Nebenkern* or fibers were found to exist in these cells, no direct morphological relation could be established between the nucleus and the secretion-product, although the staining reactions and the occurrence of the granules lead one to think that the nucleus and particularly its chromatic portion is active in the manufacture of the secretion-products. Mathews further finds that during secretion the nucleus moves from the base to the center of the cell, and during rest it returns to a position at the base; thus the nucleus in secretion is passive, merely changing position, due possibly to currents in the cell, but undergoing no structural changes. He states that he finds no trace of a substance of any kind escaping from the nucleus, nor did I observe any such phenomenon in the nectar-glands under consideration. His final position may be seen in this quotation: "I am, therefore, of Nussbaum's opinion, that the changes in the nuclei of secreting cells are passive, and that the nucleus plays no active part either in secretion or zymogenesis."

Harrington ('99) found in the calciferous glands of the earthworm that the disintegration of cytoplasm is in direct ratio to the amount of lime produced, and, as stated in my observations, as the hair-cells become loaded with the secretion-product the cytoplasm of the general gland-cells becomes much paler and therefore more tenuous. At the height of constructive activity, when the cell is ready for the changes which will result in the formation of lime crystals, Harrington finds that the cytoplasm continues to increase in extent, becomes less dense, and vacuoles appear here and there, the nucleus becomes decidedly vesicular, the nucleolus large and densely staining. This description would apply to the cells figured in most contributions on secretion, and in FIGURE 16, which is a gland at the height of secretion, these structures are to be seen.

Schniewind-Thies ('97) studied the nectar-glands in a large number of plants and found that the nuclei of secretion-surfaces are everywhere distinguished from those of the parenchyma by their greater contents of chromatin. She found in secreting cells that the nucleus sometimes assumed amoeboid shapes and in some entirely disappeared. I find nothing to correspond with these descriptions in my own material, although the slight diversity of form may perhaps be due to amoeboid motion. She further observed that the nucleus in one form lost its response to stains, changing from cyanophil to erythrophil, and as I have recorded above in a few cells of mature glands this staining reaction occurred, but in my material it is rather the exception than a general condition, and was found principally in the deeper layers of the gland, Schniewind-Thies also observed that at the height of secretion the cells are much swollen, which to a less degree is the case in this gland, as is seen by comparing FIGURES 9, 11, and 16 with 17, all drawn at the same magnification.

Huie ('96), studying the changes of the cell-organs of *Drosera*, finds one most noteworthy result; on page 424 she states, "The aggregation of the nuclear chromatin into a definite number of V-shaped segments — eight in *Drosera* — proves that such a change is not a feature of characteristic mitosis, but simply a sign of great activity in the nuclear organs." Similar phenomena have been observed in animal glands, but a constant number of these chromosomes was not found. Huie's observation is striking if the chromosomes do actually exist in a definite number and this number differs from that typical during mitosis. Such would seem to show that chromatin had the power to arrange itself into different sets of chromosomes for physiological and morphological purposes. In my preparations I was unable to find any such chromatic arrangement at any stage of secretion. She also found cytoplasmic changes in staining reactions; during secretion the cyanophil cytoplasm disappeared. The cyanophil chromatin increased during this time and after being thrown out from the nucleus it gave rise to new cyanophil cytoplasm. After long-continued secretion the cyanophil cytoplasm was entirely changed into a scanty erythrophil cytoplasm. This seems to establish a comparable relation between nuclear and cytoplasmic material to that which I have shown in the nectar-glands of *Vicia Faba*. And as Torrey ('02) suggests, a possible explanation of this phenomenon may be that some organic acid is formed during the great metabolic activity of the cell.

Torrey studied the changes accompanying the secretion of diastase in maize and barley. He found as I do that the secretion was intermittent, but held the opinion that the secretion-material was given out as granules from the nucleus through breaks in its wall. The nucleus according to Torrey gradually became loaded with granular material and finally stained a uniform black, the presence of the granules being recognized only by its corrugated edge. The pressure finally bursts the nuclear membrane and the granules stream out in rows, collecting later near the upper, or outer, surface of the cell. This is quite a different process from that recorded by most other writers, and certainly no such nuclear changes occur in the gland which I have studied. Later Reed ('04) has worked on the same material and reached entirely contrary conclusions. In maize he fails to find any indications of granules being given out directly through the nuclear membrane.

Lloyd ('01) investigated the nectar-glands occurring on the leaves of the common brake, *Pteridium*. The position of this gland is similar to that of the one under consideration, and he suggested as the possible function of such organs that the actively secreted sugar may act as a carrier for some other substance in the nature of an excretion. Bonnier had shown that other substances than the secretion-products were thrown off in small quantities from several glands. Lloyd attributed to the cells of the pericycle the power of passing the soluble carbohydrates from the moving sap into the gland, and thus accounted for the greater development of the pericycle. These pericycle cells contain no chlorophyl, and I should rather think that they are actually active in secretion or, in other words, are truly a part of the gland itself; such a view would account equally as well for their greater development in the glandular area.

A felt of dark-colored fungal hyphae was in some cases observed on the surface of the *Pteridium*-glands. I have also found a fungus growth not uncommon on the older glands of *Vicia*. Lloyd offers the apposite suggestion that the nectaral surface is a constant infection-point, the sugary fluid acting as a nutrient medium.

In the case of the nectar-gland under consideration, one is forced to choose the position that *the nucleus takes an important* *part in the manufacture of the secretion-substance, but plays a more or less passive rôle in the essential process of secretion. Further, the cytoplasm also undergoes marked changes during the stages of glandular secretion. It first becomes more vacuolated, and later becomes more coarsely granular, and finally in the nectar-hairs densely granular, at the same time changing its staining reaction from erythrophil to cyanophil. Finally, one must admit that these later changes of the cytoplasm, at least, are largely controlled or influenced by the nucleus and possibly by its chromatic constituent.*

SUMMARY

1. The nectar-glands on the stipules of *Vicia Faba* contain rows, or layers, of cells whose contents have different chemical reactions, as is shown in life by their different colors.

2. This difference in chemical reaction indicates very probably a difference in metabolic activity of the cells, since those of definite rows have a similar reaction. The color-response of these cells to acids and bases is the typical litmus change; acids causing the cell-contents to become red, bases changing it to blue.

3. The cells of young glands differ but slightly from the general tissue-cells.

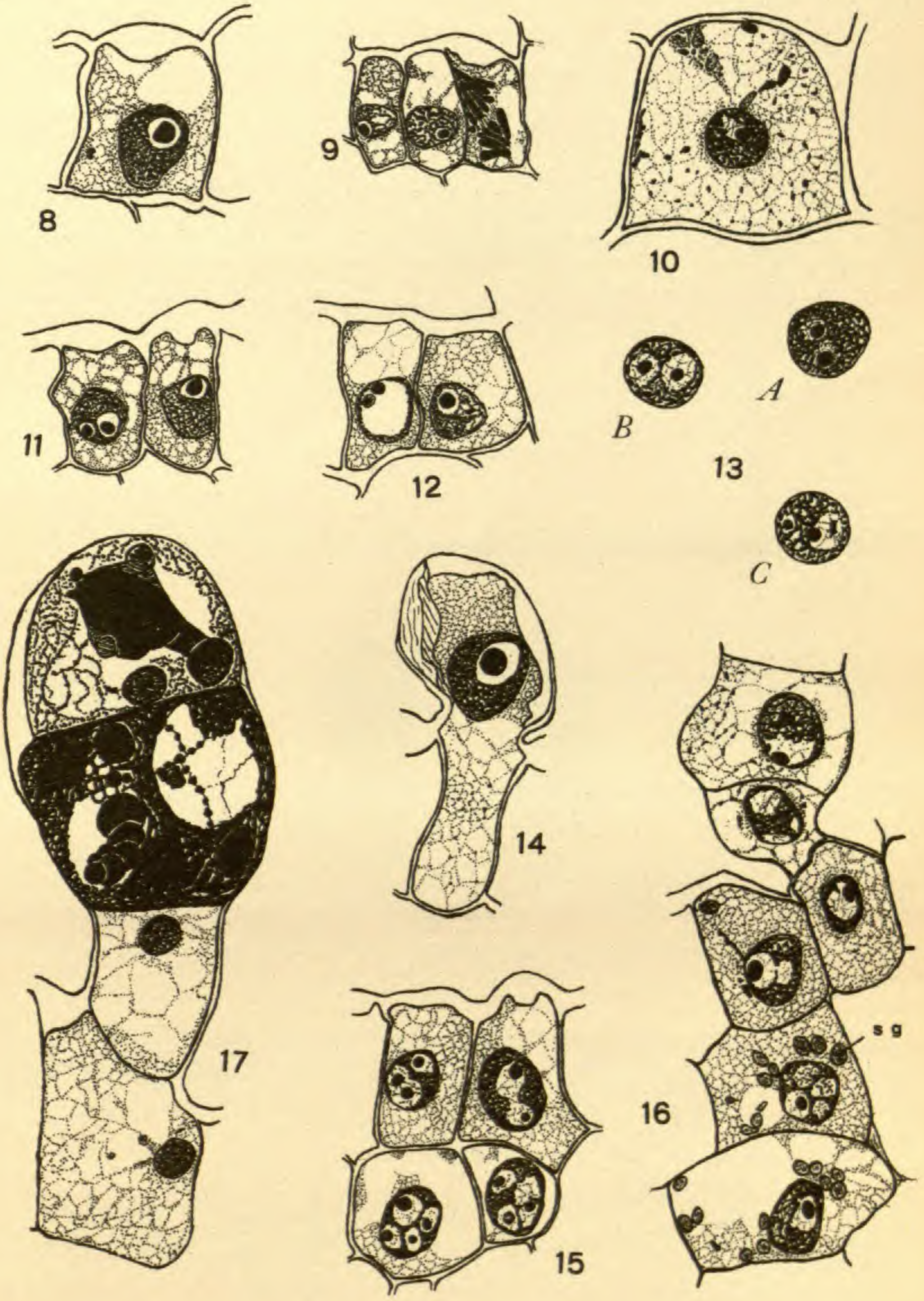
4. The nuclei are granular in structure, often coarsely vacuolated, with one or more plasmosomes surrounded by vacuoles. Their shape tends toward spherical, but in old glands they become shrunken and slightly irregular in form.

5. The position of the nucleus in the secreting cells varies greatly, but is more often near the center of the cell.

6. The nucleus is never observed to give out granular material to the cytoplasm, though evidence is strongly in favor of the supposition that it does transmit substance to the cytoplasm which finally forms, or causes to form, granules and these take during later stages the nuclear stains.

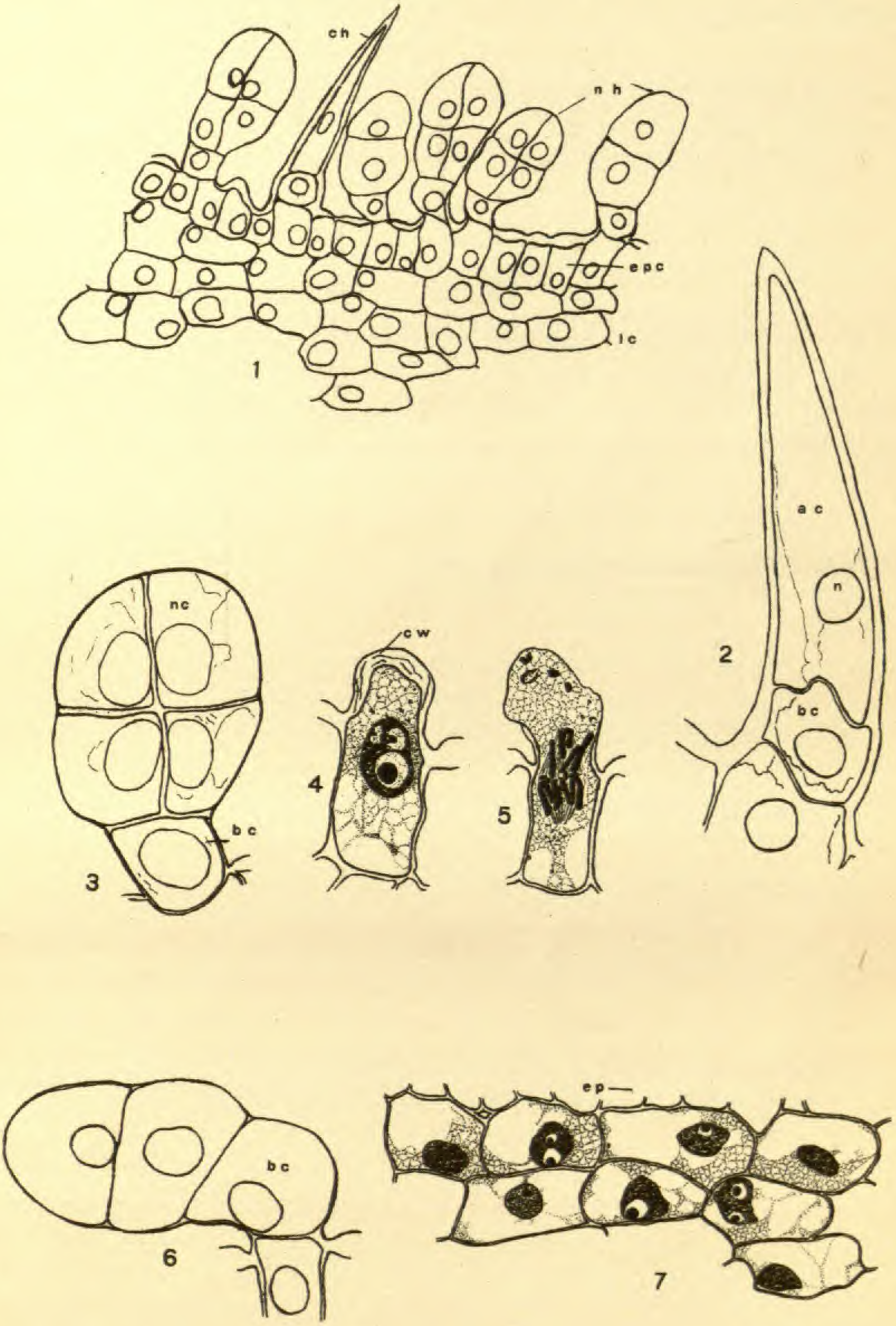
7. In rare cases the nucleus loses its chromatin in older glands and takes the plasma-stains, staining with the acid fuchsin of Auerbach's.

8. The cytoplasm undergoes changes in structure as secretion progresses, at first becoming vacuolar, then slightly granular, still taking the plasma-stains, and then finally becoming densely granular and staining with the nuclear dies.



NECTAR-GLANDS OF VICIA FABA

HELIOTYPE CO., BOSTON.



NECTAR-GLANDS OF VICIA FABA

HELIOTYPE CO., BOSTON.

9. There is evidence to indicate that the cytoplasmic changes are controlled by the nucleus.

10. The nucleus seems to be the center of metabolic activities participating in the formation of the secretion-substance but playing a passive rôle in the actual process of *secretion.*

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Explanation of plates 10 and 11

All figures are from camera sketches. Fig. 1 with Leitz $\frac{1}{8}$ objective and three ocular. Figs. 2, 3, and 6 with $\frac{1}{16}$ objective and 3 ocular. Tube-length 170 mm.

Plate 10

Fig. 1. Outline of the gland-area, showing the relation of its parts. *ch*, conical hair ; *nh*, nectar-hair ; *epc*, epidermal cell-layer ; *lc*, lower cells.

Fig. 2. Conical hair. *bc*, basal cell ; *ac*, apical cell ; *n*, nucleus of apical cell.

Fig. 3. Enlarged nectar-hair. *bc*, basal cell ; *nc*, nectar-cell.

Fig. 4. Epidermal cell preparing to give rise to the hair ; note the up-pushing of epidermal wall and nuclear position. *cw*, cell-wall.

Fig. 5. Similar cell to Fig. 4. in mitosis to give rise to the first cell of the hair.

Fig. 6. Immature nectar-hair, showing the three-cell stage. *bc*; basal cell.

Fig. 7. Nuclear and cytoplasmic structure of the cells in the youngest gland-tissue. *ep*, indicates the position of epidermal cells.

Plate 11

Figs. 8, 9, and 11. Immature gland-cells, before their contents becomes colored.

Fig. 10. Mature epidermal gland-cell, shortly after secretion had begun.

Fig. 12. Cells of youngest gland, showing enormous vacuoles and scarcity of chromatin.

Fig. 13. Three stages of the nectar-hair nuclei. *A*, nucleus of very young hair. *B*, nucleus of hair in next gland down the axial stem. *C*, nucleus of hair in gland just becoming mature.

Fig. 14. Youngest gland-cell preparing to form hair, showing cytoplasmic arrangement and nucleus at this stage.

Fig. 15. Cells of immature gland showing numerous plasmosomes in the nuclei.

Fig. 16. Newly matured gland, first formation of large granules in the cytoplasm.

Fig. 17. Secreting hair of an old gland, showing the marked contrast between the staining of hair-contents and of basal and epidermal cell-substance. The hair stains heavily with nuclear dies, so that the nuclei of its cells cannot be certainly determined.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1905)

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

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

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A study of synapsis and reduction

Ira D. Cardiff

(with plates 12–15)

From the standpoint of heredity the critical stages in an organism are at fertilization and reduction. That in fertilization there is an approximate doubling of the number of chromosomes, half of which were contributed by each gamete, there is no longer any doubt. That this number must be reduced at some time previous to the next union of gametes is equally evident. The method by which reduction is accomplished is not so evident, although the researches of the past few years give promise of an ultimate solution of the problem.

Recent investigations of McClung, Montgomery, Rosenberg, Sutton, Wilson, and others have thrown much light upon the question of the individuality of the chromosomes. The work of these investigators strongly supports the theory that there is a differentiation among the chromosomes. Montgomery ('05) is of the opinion that their individuality is not lost through the growth phase of an organism but that each chromosome of a generation had its predecessor in a preceding generation; that is, there is no *de novo* formation at mitosis. Fick ('05), in a recent discussion in which he goes into the whole cytological question in so far as it bears upon the germ cells, opposes this view as a matter of opinion, but offers no additional data upon the subject. The evidence at present is so very strongly in favor of the theory that the individuality of the chromosomes is retained throughout the history of the organism that it can well be used as a working hypothesis.

[The Bulletin for April 1906 (33: 213–270, *pl. 10, 11*) was issued 10 My 1906.]

From the time that the first explanation of reduction was offered by Van Beneden, when he believed that half the chromosomes degenerated and were thrown off from the nucleus, until the end of the past century, numerous conflicting views, which need not be reviewed here in detail, were held. It suffices to say that the stimulus to investigation as a result of Weismann's speculations in regard to the chromatin in 1887 produced an immense number of valuable results, some of the most important of which may be mentioned.

Henking ('91) first figured a tetrad, or ring, which he interpreted as a chromosome undergoing one transverse and one longitudinal division, thus giving a true reduction division required by Weismann's theory. Later tetrads receiving the same interpretation were found in animals by Haecker ('95*a*), Paulmier ('99), Ruckert ('94), vom Rath ('92), and others. Calkins ('97) figured tetrads in *Pteris* and *Adiantum* and interpreted them as a transverse and a longitudinal division. In the same year Osterhout ('97) figured the same in *Equisetum*. Belajeff ('98) and Atkinson ('99) figured a longitudinal and a transverse division in plant cells. Though different observers found minor variations in the details of tetrad formation, all agreed on the essentials; namely, that there was a longitudinal division of the chromatin thread followed shortly by a transverse division, thereby forming a number of segments equal to one half the number of somatic chromosomes. These segments were looked upon as each composed of two somatic chromosomes united end to end. In the ensuing divisions these segments were divided once longitudinally and once transversely, thus giving a qualitative reduction in accordance with Weismann's hypothesis.

On the other hand, the researches of Carnoy ('86), Boveri ('87), Hertwig ('90), and especially Brauer ('93) on *Ascaris* led them to conclude that both divisions in tedrad formation were longitudinal; that is, the tetrads arose by a double longitudinal division instead of by a longitudinal and a transverse division. The conditions in *Ascaris*, however, are complicated from the fact that the number of chromosomes in the somatic cells is very much larger than in the germ cells; therefore, it may be questioned whether the chromatin body dealt with in the germ cells is a true chromosome in the sense in which that term is used for other organisms. Most of the investigators of this period, however, believed that, as a general thing, tetrads, in the strict sense, are not formed. Miss Sargant ('95) concluded that both divisions were longitudinal in *Lilium*. This was soon concurred in by Strasburger ('95), Farmer and Moore ('95) Dixon ('96), and by a number of other workers. Two years later Strasburger and Mottier ('97) figured a longitudinal and a transverse division in *Lilium* and several other angiosperms. Practically similar results were obtained by Ishikawa ('97) in *Allium*, and by Belajeff ('98) in *Iris*. Schaffner ('97), also working with *Lilium*, figured a transverse division in the first mitosis and a longitudinal in the second. Atkinson ('99) in *Arisaema* represents a tedrad formation which he interprets as a transverse and a longitudinal division, the transverse appearing in the first mitosis. In the same article he represents a transverse division in the second mitosis in *Trillium*. Atkinson attempts to reconcile the discordant views of the different investigators by the interesting explanation that in some plants there is a true reduction, while in others both mitoses are quantitative, and he even believes that "in the same plant qualitative reduction may take place in some cells, while quantitative or numerical reduction only takes place in others." Strasburger and Mottier soon changed their opinion and again believed both divisions to be longitudinal. The latter view was held by Gregoire ('99), McGregor ('99), Guignard ('99), Lloyd ('02), and others. Such, briefly, was the state of the question at the beginning of the present century. About the only conclusion one can draw from a review of the literature of the period is that a large majority of the investigators believed that both divisions are longitudinal and that, therefore, there is no true reduction.

Moore ('95) in his work on elasmobranchs found a unilateral massing of the chromatin at one side of the mother-cell nucleus previous to the formation of the chromosomes of the first mitosis and named this stage synapsis. Moore probably did not at the time appreciate the significance of synapsis nor know that he had so well named this which seems destined to prove the most important stage in the ontogeny of an organism. Little attention was paid to this work, as for some time synapsis was thought to be an artifact. Moore firmly believed, however, that this unilateral massing of the chromatin was natural and said that "whatever the synapsis may eventually turn out to be it is evidently a cellular metamorphosis of profoundly fundamental character." He, as well as many later investigators, found that in many cases the chromosomes emerged from synapsis in the reduced number and frequently longitudinally split.

From the fact that synapsis was by many considered due to faulty fixation little attention was paid to it, and as a result some of the most important periods in the reduction stages have been overlooked. McClung ('02) holds that a unilateral massing of the chromatin — synapsis — is an artifact and says that he has not found it "when the material was well fixed and prepared. It has, moreover, been found possible to produce the appearance at will." He does not tell, however, how it may be produced at will. Schaffner ('06) seems to take somewhat the same stand, that synapsis is due to killing agents, though he finds it "usually present" in his own material just as the spireme is fully formed. While synapsis is still regarded as an artifact by some (Schreiner & Schreiner,'04) it is now very generally regarded as a constant and essential stage in reduction, so much so that one of the recent text-books, Coulter and Chamberlain ('03), considers it a constant morphological character of the mother-cell. That it is a real and not an artificial character I think there can be little doubt. In not one of the dozen or more forms examined in the present work was a unilateral contraction of the chromatin wanting at the proper stage. It was found to occur as often in megaspore as in microspore mother-cell. Though a number of different killing agents were used there was no variation in the effect produced. In such forms examined as *Salomonia*, *Botrychium*, *Dramia*, *Unifolium*, *Pedicularis*, and others where the sporangia are developed acropetally by a whole raceme or spike, all cells are under like conditions and a comparative study is not difficult. In the above-mentioned forms synapsis was always found at a certain stage in the development and persisted for some little time. Davis ('99) made a careful study of the developing sporogenous tissue of *Anthoceros* — a form peculiarly well suited for such a work — to determine whether the unilateral contraction of chromatin is due to killing agents. He tested the effects of a number of different killing agents and found synapsis always to occur at the same period, and at no other, in the development of the mother-cell. Moore ('95) found it in cells which had simply been preserved in glycerine. But most convincing of all is the fact that Miss Sargant ('97) found synapsis in fresh material of *Lilium*.

Most of the recent papers on reduction, recognizing synapsis as a constant character of the mother-cell, have dealt with the question from a somewhat different standpoint, and, naturally, stages in the contraction of the chromatin, which formerly were discarded as artifacts, have been given careful study.

Farmer and Moore ('05), after a study of a number of plants and animals, offer a partial explanation of the synapsis stage which Moore had named ten years previously. According to their accounts a single spireme thread is organized which finally becomes contracted at one side of the nucleus in the vicinity of the nucleolus. This contraction stage persists for some time. Finally, the threads disentangle to some extent and form loops with one end of the loop at the nuclear membrane ("attached rather securely to the nuclear wall") and the other end in the vicinity of the nucleolus where there is still figured a considerable mass of contracted threads. Meanwhile as the threads have disentangled from the knot, first the chromomeres and later the remainder of the thread splits longitudinally. This longitudinal split soon closes up, however, so that in the ensuing stages there is little, if any, evidence of it; a shortening and thickening of the threads follows so that the sides of the loops are pulled into a somewhat parallel position. The number of these loops is found to correspond to the gametophyte (reduced) number of the chromosomes. The original thread is looked upon as composed of sporophytic chromosomes united serially and each of the loops is composed of two of these. There is now a separation of the loops to form V-shaped bivalent chromosomes. The apex of the V represents the part of the loop which was attached to the nuclear wall and is the point of union, end to end, of two sporophytic chromosomes. The arms of the V represent the portions of the thread which splits longitudinally and closes up again after the "first contraction" stage. This split sometimes shows in the late prophases of first mitosis. Farmer and Moore find that the first mitosis is heterotypic and separates the arms of the V by a transverse division through the apex, thus separating whole sporophytic chromosomes. In the second mitosis the division is longitudinal and separates the parts of the thread formed by the longitudinal split of the earlier stages. Thus there is a true reduction. Farmer and Moore believe that in certain organisms the second division may be the heterotypic division, which of course would make no essential difference in the end results.

Essentially similar results to those of Farmer and Moore were found by Schaffner ('97) in *Lilium*, though he does not figure any synapsis (unilateral contraction of the chromatin). In a recent paper Schaffner ('06) in *Lilium* confirms his former results and states that synapsis is an artifact. So far as I am aware he is the only plant cytologist of the present time holding such a view of synapsis.

Mottier ('05) upon a reëxamination of the microspore mother-cell of *Podophyllum* concludes again that the first division is a transverse or reducing division.

Strasburger ('04) gives a peculiar account of synapsis in *Galtonia candicans*. He finds that the sporophytic chromosomes lose their identity during the growth-periods and, in the early mother-cell, the chromatin collects in six centers (*Gamozentren*). Probably both paternal and maternal chromatin enter these centers which finally elongate to form a spireme. The spireme forms into six segments, each of which is composed of two chromosomes united end to end, and since there are six chromosomes in the gametophyte of *Galtonia*, these represent the bivalent chromosomes of the heterotypic mitosis. Thus there is a reduction in the first mitosis essentially in agreement with the results of Farmer and Moore ('05) and Schaffner ('06).

Montgomery ('00 and '01*a*) in work on *Hemiptera*, and on *Peripatus*, a form allied to the myriopods, finds that reduction occurs by an end to end fusion of somatic chromosomes in the late telophase in the last spermatogonial and oögonial division, that is, with the formation of the mother-cell nucleus. He considers this the synapsis stage even though it occurs some time previous to the unilateral massing of the chromatin which he finds constant. Montgomery explains this union of whole chromosomes as a pairing of maternal with paternal chromosomes. These bivalents enter the contraction stage, become longitudinally split, and in the first mitosis are divided transversely, thus separating whole somatic chromosomes, while in the second mitosis the division is longitudinal, an equation division. Montgomery ('03, '05) confirmed these observations in later papers.

Sutton ('02) reports an end to end fusion in *Brachystola*, an orthopteran, in the late telophase in the last spermatogonial mitosis, but finds that the separation of these chromosomes does not take place until the second division following their union; thus the first mitosis is equational, the second reductional.

Dublin ('05*a*) in *Pedicellina*, a bryozoan, describes an end to end fusion at the end of spermatogonial and oögonial divisions and a separation of these, reduction, in the first mitosis. The second mitosis is equational. Haecker ('04) reported results essentially similar to those of Dublin ('05*a*) and Montgomery ('01).

Gregory ('04) in several *Pteridophyta* reports a formation of bivalent V-shaped chromosomes in the reduced number. These segment transversely with the first division and longitudinally in the second division, thus in essential agreement with Schaffner ('97) and Farmer and Moore ('05). Moore in later paper (Moore and Walker, '06) reports results in agreement with his earlier work.

Another group of recent investigators — Allen, Berghs, Gregoire, Miyake, Overton, Rosenberg, Schoenfeld, Schreiner and Schreiner, Miss Stevens, Winiwarter — obtain results somewhat at variance with those previously mentioned. Allen ('04), in a preliminary note on the microspore formation in *Lilium*, finds that after the formation of the mother-cell there is a long growth period in which the chromatin is in a reticulate condition. During the latter part of the growth period the chromatin changes from irregular reticulate masses into threads which become arranged in pairs, the moieties of each pair parallel, as they pass into synapsis. In synapsis the chromatin is massed in a tight knot at one side of the nucleus, often pressed against the nuclear wall with the nucleolus. As these parallel threads enter synapsis they move closer together and finally fuse to form a single thread which shows no evidence of its bivalent character for some time after its formation. Just previous to the union of the two parallel threads their substance is differentiated into linin and chromatin, the latter aggregated into small granules, chromomeres. With the fusion of the threads the chromomeres fuse in pairs. The chromatin is in synapsis for several days. The threads emerge from synapsis and become distributed throughout the nucleus forming twelve loops, not unlike those figured by Farmer and Moore ('05), which segment transversely at or near the point where they are in contact with the nuclear wall to form the reduced number of chromosomes. Previous to this transverse segmentation there is a longitudinal fission of the thread, the chromomeres, which are still apparent, first dividing. Allen believes that this longitudinal fission represents a separation of the paired threads which fused in the presynaptic stages. He finds a second contraction stage when the chromatin threads are drawn away from the nuclear wall. This contraction, however, is not nearly so marked as in the case of synapsis. The first mitosis is longitudinal and probably separates the two threads which fused in synapsis, thus giving a true reduction. The heterotypic chromosomes are not, as a general thing, V-shaped, but rod-shaped as they pass to the poles, though often remaining attached at their equatorial end, thus forming a V-shaped body. The second division is also longitudinal and divides the daughter-chromosomes of the first mitosis.

Winiwarter ('00), suggested a view similar to Allen's as one of three ways in which reduction might be accomplished, and is strongly of the opinion that it is the most plausible explanation of reduction, as it explains the synaptic knot, which he believes to be a constant and important morphological character of the mother-cell.

Almost simultaneously with Allen's work appeared that of Berghs ('04*a*, '04*b*) in *Convallaria* and *Allium*, and of Schreiner and Schreiner ('04). They get essentially the same results as Allen, though Berghs believes there is not a complete fusion of the parallel threads in synapsis. Gregoire ('04), in whose laboratory Berghs worked, vouches for the accuracy of the latter's observations and strongly opposes the idea of an end to end fusion or a reduction by a transverse division. Berghs ('05*b*) in a later work on *Drosera*, *Narthecium*, and *Helleborus* confirms his former results.

Rosenberg ('03, '04*a*, '04*b*) in *Drosera* obtains especially interesting results from a hybrid of *Drosera longifolia* with *D. rotundifolia*. The gametophyte of *D. longifolia* has twenty small chromosomes, while the gametophyte of *D. rotundifolia* has ten large ones. Therefore in the hybrid sporophyte there are thirty, while in the gametophyte there are not fifteen but twenty chromosomes. Rosenberg finds that, in the early prophases of the first mother-cell mitosis of the hybrid, there are twenty chromosomes, ten of which are bivalent, while the other ten are univalent. These ten bivalents are each composed of a larger and a smaller part. Rosenberg believes that the ten large chromosomes from *D. rotundifolia* fused with ten of the smaller ones of *D. longifolia*, thus leaving the other ten small chromosomes univalent. The first mitosis separates by a longitudinal fission whole chromosomes. This is true for others than the hybrid. Thus there is a true reduction in the same sense as in the results of Berghs ('04*a*, '04*b*, '05*a*) and of Allen ('05*a*). The second division is also longitudinal.

Miyake ('05), in a number of monocotyledons, states that the threads are not fully formed previous to synapsis but that masses of chromatin — not chromosomes — fuse and later organize parallel threads which separate with the first mitosis. He finds the second mitosis homotypic.

Overton ('05), in a number of dicotyledons, gets essentially identical results with those of Allen, though he figures masses of chromatin — "protochromosomes" — which he considers the equivalent of the sporophytic chromosomes. These masses pair — but do not fuse — during synapsis and separate longitudinally in the first division. Allen ('05*b*) in a later paper confirms his previous results ('05*a*). Miss Stevens ('05), in *Aphis*, finds that reduction in the spermatocytes is effected by a longitudinal pairing of the chromosomes.

Schreiner and Schreiner ('06) in a recent paper on *Tomopteris*, an annelid, report results essentially similar to those found in the present work. In a number of excellent figures the slender chromatin threads are shown to arrange themselves parallel and, commencing at one pole of the nucleus, conjugate longitudinally. The threads then become shorter and thicker as the first division is approached. After the parallel threads have conjugated the moieties often remain separated for a short distance at their ends and by this means these investigators believe they can follow the history of the thread through the prophases of the heterotypic division. The chromosomes of the prophase assume ring- and cross-forms similar to many of the others recently figured for animals and give appearances that would indicate that the first division is transverse. Schreiner and Schreiner, however, are confident that both divisions are longitudinal, the heterotypic taking place along the line of original fusion of the prereduction chromosomes.

Thus there are, evidently, two schools of the more recent investigators which seem to differ radically in regard to the details of reduction, though they are in agreement on one essential point; namely, that the first division is heterotypic and separates whole somatic chromosomes which had retained their individuality through the growth period of the organism.

The present work was taken up with the hope of throwing some light upon the phenomenon of synapsis and its relation to reduction division. A number of forms have been examined. The results of observations upon four of the forms are presented here. Results from other forms will follow in a succeeding paper. Observations were made upon sporogenous tissue in all stages from early archesporium to spore formation, but chief attention was given to synaptic and presynaptic stages.

The forms chosen represent four groups: namely, pteridophytes, gymnosperms, monocotyledons, and dicotyledons. As the results agree in the essential points, they seem to indicate that the reduction process is the same throughout the plant kingdom.

No pretense is made of citing all the literature on reduction, nor of going into a detailed discussion of the philosophical aspects of the question. Both of these points have been admirably taken up recently by Allen ('05*a*), Davis ('05), Gregoire ('05), and several others.

The material for this work was collected in the vicinity of New York City in the spring of 1905, except in the case of *Botrychium*, which was collected in Indiana and Ohio the year previous. The ordinary methods of microtechnique were used in making the preparations for study. Many preparations were made of each type examined.

ACER PLATANOIDES L.

This plant presented especially good material for study. The chromosomes are few and there is an exceedingly large amount of sporogenous tissue in one small flower cluster. The form has the disadvantage, however, of having exceedingly small sporogenous cells, as will be noted from the drawings. Only microsporangia were examined, though both micro- and megasporogenous tissue were examined in a few cases in *A. Pseudo-Platanus*, which apparently did not differ essentially from *A. platanoides.*

The winter is passed with the sporogenous tissue in the early mother-cell stage. In this stage (figure 1) the cytoplasm is exceedingly dense and granular with a very few small vacuoles, and it takes stain strongly. There is as yet no rounding-off of the cell-wall and no intercellular space in the sporangium. The cells are all characterized by a relatively large nucleolus which appears to contain small vacuoles (figure 1). The chromatin is small in amount and is collected in small granules at the periphery of the nucleus, sometimes, apparently, even pressed against the nuclear membrane. Owing to this position of the chromatin the number of these granules could not be determined. Figure 1 shows only a sectional view of the nucleus. Connecting the chromatin granules are exceedingly fine linin threads which will also occasionally be found running across the nuclear cavity; in the latter case they are usually in contact with the nucleolus. Occasionally at the point of contact of linin thread and nucleolus the latter will be found bulged out forming a small papilla. It was impossible to determine definitely the significance of this, though it suggested at once the formation of the true chromatin thread from the material of the nucleolus. In some preparations this nucleolar papilla looked much like one of the small vacuoles escaping. Later, however, in examining the same phenomenon in *Claytonia virginica* there seemed to be very strong evidence that there is a flowing of material from the nucleolus to the linin-chromatin threads. At this stage it is impossible to determine any definite arrangement of the threads with reference to each other.

As development continues, the threads leave the periphery and traverse the nuclear cavity in all directions (figure 2). The chromatin constantly increases in bulk, chiefly, it appears, by an increase in size of the chromatin granules, and also by spreading along the thread. As chromatin increases along the linin thread it is generally impossible to distinguish definitely between linin and chromatin, and the appearance of this and much of the other material used recalls the theory that linin and chromatin are merely different phases of the same substance. Figure 3 shows a still greater increase in chromatin and at several places an approximation of threads in pairs as at *a* and *b*. An indication of the same pairing can be seen also at *a* in figure 2. By the time the stage shown in figure 4 is reached the cell has increased greatly in size and shows a decided rounding-off of the wall. The nucleus shows, proportionately, a greater increase than the cell. The nucleolus, however, does not partake of this increase in growth, or at least to a very limited extent. The cytoplasm has become more reticulated in structure ; the chromatin has become more evenly distributed over the thread and there is an evident pairing of threads, which, however, is more marked in a slightly later stage (figure 5). In this figure no less than eight distinct pairs of threads or portions of threads can be made out. Most of these pairs seem to be in contact with the nucleolus or very near to it. In stages but little later the pairing of threads is still more evident, as shown in figures 6–12. Figures 7–11 are taken from five adjoining cells. Figures 6–12 show chromomeres actually in contact in many instances, while the portion of the thread between the chromomeres seems to have changed but little from its condition in much earlier cells where it takes the stain very lightly. Chromomeres in many instances show an actual flowing together, as shown in figure 12, which is slightly enlarged. That this is a pairing and not a split seems certain to one examining the preparations. It is not difficult to be sure of the stage in the development of the mother-cell in *Acer*, owing to the gradual change that takes place in the cytoplasm, which shows a reticulated nature as the cell gets older, and owing to the gradual increase in the size of the nucleus until near the synapsis stage, and because, also, of the changes that take place in the cell-wall, etc. A gradual approximation of the threads in pairs can be followed until the chromomeres actually begin to blend in stages shown by figure 13, a stage just previous to the close synaptic knot. This appearance of the threads is undoubtedly what the earlier investigators on reduction called the first longitudinal split. Figure 12 is a portion of a thread from a stage a little earlier than that shown in figure 13. It shows the chromomeres blended while the linin portion of the thread is not in contact. In looking at a preparation like this it is difficult to think of it as a split, especially if one considers the chromatin as the active element of the nucleus. The slender threads are relatively widely separated in the presynaptic stages and as they approach the knot stage they come closer together until in the knot condition they are so closely blended that only occasionally, figures 14 and 15, can two threads be seen. These are evidently the same stages figured by Allen in *Lilium*, Berghs in *Convallaria*, *Allium*, etc.

That the synaptic knot is a region of great activity is indicated by the way in which it resists the extraction of stains (safranin and iron-haematoxylin). That this is due not to the mass effect alone is shown by the fact that a small section cut from one side of the knot behaves in the same way. The contraction of the chromatin threads into the synaptic knot invariably occurs at one side of the nuclear cavity and in close contact with the nucleolus, the latter being almost surrounded by the threads at times. Often loops of thread or threads extend outward some distance from the knot, but these loops are always few in number — much less than the number of chromosomes — and show no such regularity in arrangement and number as those figured by Farmer and Moore ('05). Montgomery ('05) reports that he finds the synaptic knot always on the side of the nucleus bordering upon the greater bulk of cytoplasm in the cell. This does not accord with my observations. In fact the knot seems to be as often, if not more often, on the side of the cell where there is the least cytolasm. It was generally found, however, that in any one sporangium or group of sporangia all the knots occupy the same relative position in the nuclei. I offer as a tentative explanation of this that the chromatin mass is of greater density than the nuclear sap and the position of the nucleolus and knot is due to gravity. From the material with which I worked it was impossible, however, to determine this for a certainty.

As the threads emerge from the synaptic knot they show no differentiation into linin and chromatin, but instead a continuous chromatic character, and are much thicker than when entering the knot. Whether this obscuring of the so-called linin by the chromatin is due to the linin taking on chromatic properties — becoming chromatin — or whether the chromomeres have increased until they have obscured the linin is impossible to say though the former appears to be the more probable. The thread is not even in outline but is thickened at short intervals indicating probably the original chromatin centers or chromomeres. From the position of the nucleolus with reference to the knot it would seem that it must play some part in synapsis, yet it seems to have suffered no change either in size or capacity to take stain as a result of synapsis. However, if the above explanation in regard to the position of the knot is correct, the close proximity of the chromatin and nucleolus may be merely incidental.

As soon as the threads commence to disentangle from the knot, evidence of a longitudinal fission can often be seen (figures 16–20). Whether this splitting is a separation of the threads which paired in the presynaptic stages cannot be determined for a certainty, although it seems very probable, as many close synaptic knots will have portions of threads on their periphery which always show a paired character. Work of Montgomery ('00, '01*a*, '05), Sutton ('02), McClung ('02), Rosenberg ('04*a*) would seem to indicate beyond a doubt that the reducing division occurs along the line of original fusion. Wilson ('05*a*, '05*b*, '06) in his work on *Hemiptera* showed with special clearness that certain univalent chromosomes —the "idiochromosomes" and the "m-chromosomes" — unite in synapsis and the reduction division separates these univalents with their individuality unimpaired. Since this pairing and subsequent separation of the moieties has been so clearly proved for certain chromosomes it may not be unreasonable to expect it to occur between all chromosomes. In other words, in *Acer* there is not a complete fusion of threads in synapsis, but the individual threads probably retain their identity through the synaptic stages.

From synapsis on to the final formation of the heterotypic chromosomes it is easy to follow this longitudinal fission. The threads continue to increase in thickness (figures 19 and 20), but the moieties remain in close contact with each other for some time.

Finally there is a decided shortening (figure 20) of the threads and the paired portions show more of a tendency to separate. It is about this stage that we have the first evidence of a transverse segmentation of the threads into chromosomes. As the chromosomes pass through the prophase of the first, or heterotypic, division they are always bivalent in character and at first the parts of each bivalent are often twisted several times upon each other and they are either in contact with the nuclear membrane or close to it. During the prophase the parts of the bivalents untwist so as to give rings, 8's, Y's, V's, X's, and the various other forms so characteristic of this stage (figures 21–32). It is easy to see how these forms have been so often interpreted as tetrads formed by a longitudinal and a transverse division. There is here, however, not the slightest evidence of a transverse divison of the heterotypic chromosomes; on the other hand, the evidence seems strong that there is simply a separation of univalent parts of a bivalent chromosome which attained its bivalent character in synapsis. From the time they are formed the chromosomes gradually become shorter and thicker until metaphase is reached when they are almost spherical in shape. After synapsis is reached the nucleus ceases to increase in size. The cytoplasm immediately surrounding the nucleus becomes much more dense and shows a decided fibrillar character (figure 15), probably the beginning of the spindle-fibers. As metaphase of the first division of the mother-cell is reached the chromosomes are closely crowded together and the spindle is very small though very clearly defined (figure 35). Repeated counts of the chromosomes both in this and the entire prophases (figures 33 and 34) indicate that the number is probably eleven. Individual differences in the size and shape of the chromosomes were evident in nearly all nuclei. Some were three times the size of others (figures 33 and 34). Certain chromosomes by their shape and size could almost always be identified in the different nuclei. It will require further work to determine what may be the significance of these size differences, but that they are constant there seems little doubt.

From metaphase of the heterotypic division to the final spore formation the stages are passed through very rapidly. There seems no doubt that the second division is homotypic in character.

SALOMONIA BIFLORA (Walt.) Britton

This form affords especially good material for study. The acropetal development of the flowers in the inflorescence, which at the time of reduction is still quite short, enables one to get in each section a series of stages in the development of sporogenous tissue.

In the very early mother-cell the cytoplasm is in a very fine alveolar or granular condition. There are generally present several nucleoli (figure 36). As the cells get older the threads of the reticulum become coarser and take the stain more strongly; the cytoplasm losing its alveolar character, later becoming fibrillar and containing many conspicuous deeply staining granules (figure 44).

The stages are passed through quite rapidly, so that material must be collected at frequent intervals in order to be sure of stages, though the cell seems to pass some time in the stage shown in figure 36. In order to meet this condition, in part, many rhizomes of the plant were taken up early in the spring, brought into a greenhouse and forced. Collections were made from these at all times of day. Material was also fixed in the field at different times.

As soon as the mother-cell commences to increase in size the chromatin commences to increase and is organized into threads which, as in *Acer*, leave the nuclear wall and traverse its cavity. The chromomeres increase in size and seem to spread along the linin thread, which either becomes chromatin or is obscured by it until at the contraction stage of synapsis no trace of linin, as such, is in evidence. With the change in the chromatin from a reticulum to a spireme there begins an arrangement of threads parallel to each other which show as far back as the stages shown in figures 37 and 38. This parallelism becomes more marked — even more than in *Acer* — as the contraction-stage is approached (figures 39–44). Here, too, the collection of the threads near the nucleolus or the movement of the two to the same side of the nucleus is apparent.

As the chromomeres approach each other they seem to become much more active, increasing in size and staining more strongly, than when at a greater distance even in the same nucleus. This is shown in figure 43*a*, where the threads are still widely separated. A careful examination of the material from which figures

39–44 were made convinces me that these parallel threads are in process of conjugation and not in process of fission as undoubtedly most investigators formerly and many at the present time have interpreted their parallel arrangement. Compare, for instance, figures 39 and 40 with figures 43 and 44. There can be no question in regard to the age of the two, judging merely from the extranuclear structures, as the character of the cytoplasm, the rounding-off of the cell-walls, and also the degree of development of the other organs of their respective flowers. Then there is the great difference in size in the nuclei themselves, as shown by the figures, which were made by careful camera drawings. While there is some slight variation in size of the nuclei in the various plants there is a very evident gradual increase in size from the time the mother-cell is formed up to synapsis. In the earlier stages (figures 39 and 40) the chromatin is for the most part near the nuclear wall and it is difficult to represent it all in a drawing, therefore these two figures are sectional views of the nuclei. At these stages the parts of a pair are much farther from each other than in the later stages (figures 43 and 44). In stages shown by figures 43 and 44 the threads have for the most part left the nuclear wall and are becoming massed in the nuclear cavity. They are very close together, in many places actually in close contact so as to appear but one thread, while in other places only the chromomeres are in contact. Where the threads are actually in contact no differentiation of the thread into linin and chromatin is possible; the whole thread appearing to be composed of a continuous mass of chromatin as in the threads in the postsynaptic stages. The bivalent character of the threads disappears entirely in synapsis (figure 45) except at times where a portion of a thread can be seen on the side of a synaptic knot, when this bivalent character can be made out.

Often synaptic knots like the one in figure 46 can be found with portions of threads projecting from the chromatin mass. These invariably show a bivalent character. Figure 46 is probably of a nucleus just coming out of synapsis. Later stages of the thread, disentangling from the knot (figures 47 and 48), show clearly the bivalent character. The univalent parts of these bivalents undoubtedly represent the threads seen in presynaptic stages.

Later there is a transverse segmentation (figure 48*a*) to form the chromosomes of the immediate prophase. Several of these still show their bivalent character though not to such a marked extent as in the case of *Acer* (figure 49).

What may be the significance of the small spherical bodies in the nucleus at this stage (figure 49*a*) was not definitely determined, though it seems probable that they are a disorganized nucleolus, as there appears to be no regularity in their number. The number of the chromosomes is probably seven or eight though not enough counts were made in this case to determine definitely. That there are individual differences as to size, shape, etc., which are constant in the different cells, seems evident. As the chromosomes are arranged in the plate at metaphase they have the short, thick appearance of the usual heterotypic chromosomes (figures 50 and 51). But few of them show a bivalent character and it is impossible to tell whether they are divided along the line of their original conjugation or not.

One point of interest in the metaphase of the heterotypic division is that in a very large number of the cells one of the chromosomes appears to pass undivided to one pole considerably sooner than the others (figures 50 and 51), seeming, generally, to reach the pole about the time that the split is complete in the other chromosomes (figure 51). When first noticed it was thought the position of this chromosome was due to faulty sectioning. Upon closer examination, however, it was seen that this was not the case, but that the behavior of this chromosome is undoubtedly different from that of the others. What the significance of this is I hope to find by later work. The fact undoubtedly suggests a comparison of this chromosome with the "accessory" or heterotropic chromosome found in the spermatogenesis of *Orthoptera*, *Hemiptera*, and other insects, but in view of Wilson's ('05*a*, '05*b*, '06) results regarding the relation of this chromosome to sex production it seems improbable that it should occur in an organism which is essentially hermaphrodite. No chromosomes exactly similar to this were noted in the other forms studied, though in many of them could be found a chromosome that divided earlier than the others. These may possibly correspond to the idiochromosomes of Wilson but there is no direct evidence of this. If the heterotropic chromosome passes undivided to one pole of the nucleus in the first division and divides in the homotypic division, one half of the microspores should contain each one more chromosome than the other half, but I have no direct evidence to show that such is the case. Wilson in his recent investigations upon chromosomes seems to have proved beyond a doubt that these chromosomes of unusual behavior are in some way connected with sex-determination.

He finds in a number of *Hemiptera* that the oögonial cells contain one more chromosome than the spermatogonial cells, the latter having an odd number and the extra chromosome (heterotropic) goes over undivided in the first maturation division. Thus half of the sperms have the same number of chromosomes as the unfertilized eggs, while the other half have one less than this number.

In the spermatogonia of other forms he finds that in one of the bivalent chromosomes the univalent parts are of unequal size. As a result it divides unequally and one half the sperms have one chromosome (idiochromosome) smaller than the other half. In the oögonial division of this group all chromosomes divide equally.

In one form (*Nezara*) Wilson finds that all the heterotypic chromosomes divide equally in both sexes. One pair of chromosomes, however, agrees in behavior with the idiochromosomes of the previous group though they have not yet become differentiated in size. Wilson's work gives the most tangible evidence yet obtained upon the behavior of the individual chromosomes in the germ cells and should the idiochromosomes or their homologues prove to be of general occurrence a most important advance will have been made in this field of cytology.

Even if the heterotropic chromosome of *Salomonia* is of the same significance as in the *Hemiptera* studied by Wilson, its behavior and later history will not be so simple on account of the fact that *Salomonia* is a bisporangiate plant. It may, however, be related to prepotency of microspores.

GINKGO BILOBA L.

While the microsporangia of *Ginkgo* are very abundant and accessible and preparations from them are made with little difficulty, it did not prove as profitable a form for study as some of the others which were used.

The nuclei contain a great abundance of chromatin which in the very early mother-cell is in a coarsely reticulate condition. In this stage, however, can be seen evidence of both chromomeres and linin, often in a thread-like arrangement (figure 52). No regularity in the arrangement of these thread-like masses of chromatin can be discerned except that they appear more abundant near the periphery of the nucleus. There are present several nucleoli which are generally surrounded by a clear area free from chromatin. This condition I have found to obtain in the early mother-cells of a number of other forms. There seems to be no attraction or connection between chromatin and nucleolus as is found so often in later stages. In fact this behavior of the chromatin toward the nucleolus and also the common arrangement of chromatin at the periphery of the nucleolus indicates that, at this stage, there may be a mutually repellant force existing between the chromatin units, or perhaps groups of units. Nor is there anything unreasonable in this idea, if, as is believed by many cytologists, the maternal and paternal chromatin remain separate during the presynaptic period of the first generation.

The relative amount of cytoplasm in the microspore mother-cells is exceedingly small as compared with any other form examined (figure 53).

As the development proceeds the chromatin leaves the nuclear wall and definite spireme threads are formed. Very shortly following this, the threads can be seen arranged in pairs (figure 53), and show a differentiation into linin and chromatin. At this stage the moieties are very seldom in contact. The threads do not appear to be continuous in these early stages though they do later. They change gradually from ragged, irregular, discontinuous threads to those of a more continuous, even outline and are of a deeper staining capacity. In these threads the chromomeres show quite clearly. Owing to the difficulty of showing all of the chromatin of a nucleus at this stage only sections of nuclei are figured (figures 53 and 54). In these later stages there is seldom more than a single nucleolus, which is, however, always much larger than any one of the nucleoli found in the earlier stages.

Whether the one large nucleolus resulted from the union of several smaller ones could not be ascertained, though this seems probable. Around this nucleolus the chromatin threads show a marked tendency to collect. It was also noted, in other forms as well as *Ginkgo*, that the moieties are in contact, or at least closer together, in the vicinity of the nucleolus (figure 54). The contraction of the chromatin continues until a dense knot is formed at one side of the nucleus (figures 55 and 58). In stages just previous to the close knot (figure 55) and in those following, there is very rarely present a nucleolus in *Ginkgo*. This is a marked difference from the nucleolar behavior in other forms and indicates that the nucleolus may be playing a more prominent part in chromatin formation than generally supposed. This unusual behavior of the nucleolus may be correlated in some way with the other unusual cytological conditions in *Ginkgo*.

As the chromatin threads extend from the synaptic knot they nearly always show their paired character, especially if the closely contracted stage is not yet reached, as in figure 55. In these portions of the threads that are still free from the knot the chromomeres are clearly discernible (figure 55), while after they have been drawn closely into the knot the threads appear as a continuous chromatin-mass (figures 56 and 57).

As the threads emerge from synapsis they are much shorter, thicker and more homogeneous throughout than in the presynaptic stages (figure 59).

Their bivalent character can be made out with difficulty until the chromosomes are finally formed in prophase when it is quite evident (figure 60). The twelve chromosomes figured here are from a camera drawing of an unusually good early metaphase view. While this number may not prove correct, it corresponds with a number of other counts.

Owing to the fact that a blepharoplast is formed in the male gametes of *Ginkgo*, it was thought worth while to make a search for centrosomes in the reduction divisions where they would probably be in evidence if they exist at all. No structure of any kind which could be interpreted as a centrosome could be found, the spindles being very short and thick.

BOTRYCHIUM OBLIQUUM Muhl.*

From one standpoint *Botrychium* furnished one of the best forms that was studied. Owing to the peculiar development of the sporangium, an account of which was given in a previous paper (Cardiff, '05), it is possible to be very sure of the stages in development with which one is working. It has the disadvantage, however, of having a large amount of chromatin and many chromosomes.

The early archesporial nuclei contain each several nucleoli. The chromatin in the resting condition does not form a true reticulum, but is in the form of short, broken threads which seem to be composed of small chromomeres and very slender threads of linin. Figure 61 is from an archesporial cell some five or six divisions previous to mother-cell formation. The nuclei throughout the development of the archesporium are similar to this.

With the formation of the mother-cell, these chromatin threads increase in staining capacity. The chromomeres themselves increase in size, especially in the direction of the length of the thread, exactly as observed in many of the other forms studied. At the same time there is an evident pairing of threads or parts of threads (figure 62). When these paired threads can first be seen in the early mother-cell nuclei, they are very seldom in contact at any point. With the growth of the cell the moieties approach each other until in many places, especially in the vicinity of the nucleolus, the chromomeres come in contact (figure 63). The early stages of the mother-cell are passed through quite slowly, but as soon as the chromomeres of each pair commence to come in contact there is a rapid contraction of the threads in the vicinity of the nucleolus. At the same time the individual threads thicken considerably and are apparently continuous (figure 64). Here again the chromatin is so abundant that it is impossible to figure accurately an entire nucleus.

The shortening and thickening of the threads continues (figures 65–67) until they are finally all in synapsis (figure 68). The chromatin seems to remain in synapsis longer than in any of the

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* This material is from the same plants from which previous studies were published. *Cf.* Botanical Gazette 39: 340. The plant there referred to as *Botrychium ternatum* is really the American ally, *B. obliquum* Muhl. The genuine *B. ternatum* is an Asiatic species not known in the United States.

other forms studied, though this may be due simply to the general slow development in *Botrychium*. Differing from the other forms described, the nucleus of *Botrychium* continues to increase in size for some time after synapsis.

As the threads come out of the contracted condition in synapsis they are short and thick and show a bivalent character (figure 69). They disentangle until they are uniformly distributed throughout the nucleus (figure 70), meanwhile continuing to shorten and thicken. Later they can be seen dividing transversely to form the chromosomes (figure 71). These contract until in the later prophase they are almost isodiametric (figures 72 and 73), yet practically all show a bivalent character. In fact, from synapsis to metaphase of the first division, the bivalent character of the threads and chromosomes is always evident. That the univalent parts of these bivalents represent the threads which conjugated in synapsis seems highly probable.

SUMMARY OF RESULTS

Synapsis is not an artifact, but a constant morphological character of the mother-cell.

The synaptic knot is always around or in contact with the nucleolus.

The unilateral position of the synaptic knot and nucleolus is probably due to gravity.

There is a gradual increase in size of the nucleus up to the time of synapsis.

There is an arrangement of chromatin into two or more threads previous to synapsis.

The presynaptic threads arrange themselves in pairs, longitudinally, and move together as synapsis is approached, finally fusing in synapsis.

In the fusing of the threads the chromomeres generally fuse in pairs.

Previous to synapsis the chromomeres are evident and connected by a slender thread of linin. After synapsis the thread is homogeneous throughout; that is, there is a marked difference in appearance of presynaptic and postsynaptic chromatin.

From the fact that in sections of close synaptic knots the threads still show their bivalent character, the identity of the individual threads probably is not lost in synapsis; *i. e.*, there is not a complete intermingling of chromatic substance in the bivalent thread.

The thread splits longitudinally in the first mitosis, probably along the line of previous fusion.

All of the chromosomes, at least in some species, do not behave alike in the reduction divisions.

Considerable difference is found in the size of different chromosomes in the same species.

Synapsis is probably the end-result of fertilization and a stage of great chemotactic activity.

CONCLUSION

From the foregoing results it will be seen that there is considerable uniformity in the behavior of the chromatin in the reduction phases of the forms studied. The results are largely in accord with those of Allen ('05) and Berghs ('04), though they differ to this extent, that there was observed no constant and definite stage that could be called a second contraction period, and there was rarely found any opening out of the moieties of the bivalent spireme after they had once joined. However, in *Acer* (figures 16–33), and several of the other forms which are not included in this paper, there is a slight separation of the moieties after the formation of the heterotypic chromosomes, which is partly due, no doubt, to the twisting of the chromosome as it is being pulled into the metaphase.

From the results obtained it seems highly probable that with the fusion of the gametes in fertilization there is a nuclear but not a chromatin fusion and that the maternal and paternal chromatin retain their identity throughout the sporophytic existence of the plant, finally fusing, in so far as it fuses at all, in synapsis. That is, the sporophyte is a sort of double-celled phase of the organism. Thus Cook and Swingle ('05), in an interesting article, argue that the sporophyte is not an asexual but a highly sexual generation or phase, in that it is produced "during the actual process of conjugation." These writers hold that "it was not the reduction to fewer chromosomes, but the retention of the double number, that constituted the important step in sexual reproduction and made possible the evolution of complex higher organisms." If, as is generally admitted, the chromatin controls the metabolic activities of the cell, it would seem that the above theory is not without considerable foundation. The familiar fact, that an offspring more often possesses certain characters of the one parent to the exclusion of the other, would indicate that it is the chromatin of the latter that is controlling the physiological processes of the organism.

Nor are we without evidence that the maternal and paternal chromatin remains distinct during the sporophyte phase. Blackman ('98), Chamberlain ('99), and Miss Ferguson ('04) have shown, in *Pinus*, that the maternal and paternal chromatin do not fuse with the union of the gametes. Murrill ('00) observed the same behavior of the gametes in *Tsuga*, and similar results have been reported for a number of other gymnosperms and in *Onoclea* by Shaw ('98). Dublin ('05*b*) reported a similar phenomenon in *Pedicellina*, a bryozoan. But it is to the work of Moenkhaus ('04), of Herla ('93), of Haecker ('95*b*), of Ruckert ('95), and of Zoja ('95) we must turn for the best evidence on the independence of the paternal and maternal chromatin. Moenkhaus, in working with hybrid fishes, found that the maternal and paternal chromatin remained distinct until the third division in the embryo. He was able to follow this with especial clearness owing to the fact that the chromosomes of one parent, *Fundulus*, were much larger than those of the other parent, *Menidia*. Haecker and Ruckert in *Cyclops*, and Herla and Zoja in a hybrid *Ascaris* have also found that the chromatin of the two parents retains its identity through several divisions in the embryo. Since it is conclusively proven that the maternal and paternal chromatin retain their identity through several cell-generations, there is no reason why it should not be expected to do so through many generations, in fact, the latter seems highly probable.

If the above is true, the explanation of synapsis is that it is the end-result of fertilization. Thus the two phenomena of fertilization — stimulus to growth and mingling of ancestral characters — are quite widely separated, the former coming at once with the union of the gametes, and the latter with synapsis. The idea — not new — that the offspring is not the offspring of the parents, but of the grandparents, would find support in the results obtained.

In concluding it may be advisable to compare the results obtained with those reported from other recent work. Gregory ('04) reports a presynaptic longitudinal fission; similar results have been reported by others. One is tempted to ask, what can be the significance of this? Why should the chromatin threads split and then fuse again in a close synaptic knot? Whatever the behavior of the chromatin may prove to be, it is undoubtedly a purely physical process, and like many other natural phenomena that have been explained, will turn out to be a much more simple process than was previously expected.

Likewise the results of Farmer and Moore, Schaffner and others present many mechanical difficulties and — without in the least questioning the accuracy of the work done by these investigators — would indicate that we are still very far from a solution of the reduction problem. Thus one is obliged to think of the paternal and maternal chromosomes having arranged themselves alternately in a spireme previous to synapsis, a process presenting some difficulties. Then, if the union of paternal and maternal chromosomes takes place at the outer ends of the loops, that is, in those portions of the thread farthest from the knot, this is the synaptic point, and the knot in which the opposite ends of the loops are collected is not a true synapsis — that is, a fusing together of parental chromatin. In other words, the contraction stage is still unexplained. The same may be said of cases where an end-to-end fusion of chromosomes is reported as occurring in the telophase of the last spermatogonial and oögonial (or archesporial) division. It is quite conceivable that some of the chromosomes of unusual behavior reported in animals by Montgomery and Wilson might conjugate much earlier than the synaptic stage, as they have been shown to do much later, but if there is a general conjugation of the chromosomes with the inception of the mother-cell the contraction stage still remains unexplained. That a tightly coiled and contracted condition of the spireme is a condition conducive to splitting is highly improbable from a physical standpoint.

On the other hand, if the results obtained by Allen, Berghs, and those given in the present work prove to be the general condition the contraction stage is a true synapsis. It is a region, or stage, of great chemotactic activity, which probably accounts for the way it retains dyes. It is the critical stage in the history of an organism. The heterotypic division immediately following it is, then, not a true mitosis, but, as Farmer and Moore have suggested, merely an intercalated phase in the ontogeny of an organism; a phase for the purpose of bringing about the distribution of the parental characters and causing the necessary variation in the progeny of an organism.

The bearing of this union of parental chromatin in the prereductional stages upon the principles of Mendel was first discussed by Wilson ('02), Cannon ('02 and '03), and Sutton ('03). The present work would indicate that the parental chromatins are brought into much closer relationship than was at first supposed by these workers. They are probably brought into such close relationship that there is a more or less blending or complex interchange of characters. DeVries ('03) suggests that in the case of an intimate blending of the chromatins there is possible an interchange of pangens which would, in many cases, approach Mendel's ratios. From the cytological work that has been done in the past six years it is evident that the explanation of Mendel's laws lies in the structure of the germ-cells. While much has been accomplished along this line, and we seem nearer a solution of the problem than ever before, it is equally evident that we are very far from a final explanation of heredity.

From the results of recent investigators it seems possible that there is not a strictly uniform behavior of the chromatin in synapsis, and that there may be considerable variation in the distribution of hereditary characters.

I am indebted to Professor E. B. Wilson and Dr. C. C. Curtis for kind criticism and advice during the progress of the work.

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Explanation of plates 12-15

All figures were made with Spencer 1.5 mm. objective and Leitz ocular, and camera lucida. The original drawings were reduced one half in reproduction. Except where otherwise indicated the magnification of the figures is × 2300.

ACER PLATANOIDES

FIGURE 1. Early mother-cell. Sectional view, only, of nucleus; chromatin at periphery of nucleus.

FIGURE 2. Mother-cell showing increase in chromatin and formation of threads. Parallel threads, *a*.

FIGURE 3. Later stage of mother-cell nucleus; threads parallel at *a* and *b*.

FIGURE 4. Nucleus of mother-cell.

FIGURE 5. Mother-cell; several pairs of parallel threads preparing for synapsis.

FIGURE 6. Presynaptic nucleus a little later than figure 5.

FIGURE 7. Paired chromatin threads from a presynaptic nucleus.

FIGURE 8. Paired presynaptic threads.

FIGURE 9. Paired presynaptic threads.

FIGURE 10. Paired presynaptic threads; moieties in one in close contact, apparently twisted upon each other.

FIGURE 11. Portion of presynaptic nucleus.

FIGURE 12. Pair of threads just previous to synapsis; chromomeres in contact and apparently fusing; linin portion of thread not yet in contact. Slightly greater magnification than other figures.

FIGURE 13. Presynaptic mother-cell; threads contracting at one side of nucleus with nucleolus; moieties much closer together; cytoplasm becoming more dense in neighborhood of nucleus.

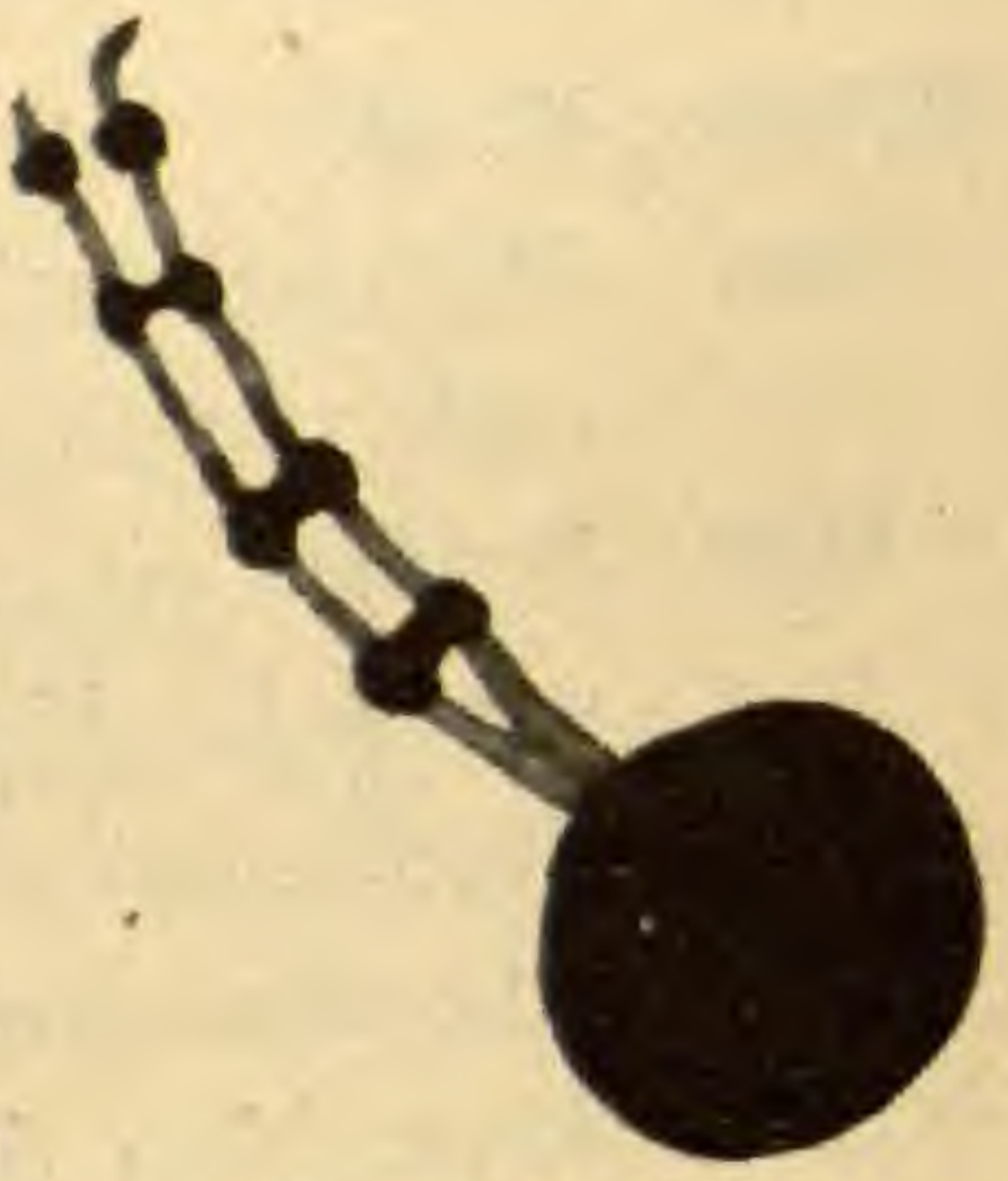

FIGURE 12*

FIGURE 14. Contraction of chromatin threads just previous to close synaptic knot; parallel fusing of threads evident in looser portion of knot.

FIGURE 15. Synapsis; projecting end of thread showing bivalent character.

FIGURE 16. Chromatin threads just leaving synapsis; chromomeres no longer evident, but thread homogeneous throughout.

FIGURE 17. Portion of postsynaptic nucleus showing threads disentangling from synapsis.

FIGURE 18. Postsynaptic nucleus just after threads have left knot; bivalent character of threads.

FIGURE 19. Shortening and thickening of postsynaptic threads.

FIGURE 20. Stage a little later than figure 19, showing beginning of transverse division.

FIGURE 21. Bivalent chromosome just after transverse division.

FIGURES 22 and 23. Stages showing shortening and thickening of chromosomes.

FIGURES 24–32. Bivalent chromosomes of prophase of first division; various stages in shortening and thickening.

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*These text-figures are inserted to illustrate the differentiation into linin and chromatin in the presynaptic threads, a character which the plates failed to show.

FIGURE 33. Prophase of first division; eleven chromosomes most of which show bivalent character.

FIGURE 34. Pole view of early metaphase of first division; different sized chromosomes.

FIGURE 35. Equatorial view of metaphase of first division; only part of chromosomes represented.

SALOMONIA BIFLORA

FIGURE 36. Early mother-cell; chromatin threads just forming.

FIGURE 37. Section of early mother-cell nucleus; formation of threads and arrangement near nuclear wall.

FIGURES 38 and 39. Sections of early presynaptic nuclei; beginning of parallel arrangement of threads.

FIGURE 40. Section of presynaptic nucleus; chromomeres increasing in size and activity; parallel threads.

FIGURES 41 and 42. Presynaptic nucleus, chromomeres beginning to fuse.

FIGURE 43. Nucleus just previous to beginning of contraction of chromatin thread into knot; threads nearly all show paired character; chromomeres smaller when threads are apart as at *a*.


FIGURE 43

FIGURE 44. Mother-cell just previous to synapsis; threads contracting to form knot; cell rounded off; cytoplasm showing many deeply staining granules.

FIGURE 45. Synapsis.

FIGURE 46. Synapsis with portions of threads projecting from side of knot showing bivalent character.

FIGURE 47. Postsynaptic nucleus.

FIGURE 48. Postsynaptic nucleus; beginning of transverse division, *a*.

FIGURE 49. Prophase of first division; seven chromosomes; smaller bodies, *a*, probably a disorganizing nucleolus.

FIGURE 50. Metaphase of first division; heterotropic chromosome at one pole.

GINKGO BILOBA

FIGURE 52. Early mother-cell; beginning of formation of threads; several nucleoli.

FIGURE 53. Section of early mother-cell; beginning of parallel arrangement of chromatin threads; small amount of cytoplasm.

FIGURE 54. Section of presynaptic nucleus; threads thickening; parts of pairs moving closer together.

FIGURE 55. Nucleus just previous to synapsis; projecting threads showing pairing.

FIGURES 56 and 57. Portions of threads cut from periphery of close synaptic knots showing bivalent character.


FIGURE 54

FIGURE 58. Nucleus in synapsis.

FIGURE 59. Portions of nucleus as the thread is disentangling from synaptic knot; bivalent character shown in places.

FIGURE 60. Late prophase of first division; twelve chromosomes; nearly all chromosomes showing bivalent character.

BOTRYCHIUM OBLIQUUM

FIGURE 61. Very early archesporial cell; chromatic material in the form of small granules and slender discontinuous threads.

FIGURE 62. Early mother-cell; chromatin beginning to form continuous threads; pairing of threads apparent in places.

FIGURE 63. Portion of chromatin from presynaptic nucleus; chromomeres still quite distinct; pairing evident.

FIGURE 64. Section of nucleus previous to synapsis; chromomeres losing their identity.

FIGURE 65. Portion of nucleus a little later than figure 64.

FIGURE 66. Threads from knot just previous to synapsis.

FIGURE 67. Entire nucleus just previous to synapsis, moieties in most cases having united.

FIGURE 63

FIGURE 68. Mother-cell in synapsis.

FIGURE 69. Threads disentangling from knot; bivalent character shown in places; threads homogeneous throughout.

FIGURE 70. Loose postsynaptic spireme; beginning of transverse division.

FIGURE 71. Formation, by transverse division, of heterotypic chromosomes; many chromosomes showing bivalent character.

FIGURES 72 and 73. Prophase of first division; thick heterotypic chromosomes; several show undoubted bivalent character.

Fossil plants from Florissant, Colorado

THEODORE DRU ALISON COCKERELL

Typha Lesquereuxi nom. nov.

Typha latissima "Al. Br." Lesq. Cret. and Tert. Fl. 141. *pl. 23. f. 4, 4a.* 1883. Not *T. latissima* Al. Br.

Populus Scudderi sp. nov.

Populus balsamoides (?) var. *latifolia* Lesq. Cret. and Tert. Fl. 158. *pl. 31. f. 4.* 1883.

Populus Lesquereuxi nom. nov.

Populus Heerii Lesquereux, Cret. and Tert. Fl. 157. *pl. 30.* 1883. Not *P. Heerii* Saporta.

Also collected by Henderson & Ramaley, 1905. Dr. M. A. Howe has very kindly sent me a tracing of Saporta's figures of *P. Heerii* of Europe. The one well-formed leaf he shows is broader, and with a more tapering base than in our plant, and does not impress one as being identical. The probability of identity being on general grounds so slight, I think it is best to consider the Florissant plant distinct.

Salix Ramaleyi sp. nov.

Leaf about 11 cm. long, 23 mm. broad in middle; base cuneate, with an angle of about 70°, but tapering gradually to the petiole (not terminating abruptly as in *S. amygdalaefolia* Lesq.); leaf apparently thin and glabrous, the midrib strong for the basal 3 cm., beyond that weak; secondary nerves, at middle of leaf, diverging at an angle of about 45°, and about 8 mm. apart, not joining on lateral margins; reticulations fairly distinct, not especially fine; apex tapering (the extreme apex lost); marginal serrations numerous (4 to 7 in 10 mm., usually about 6), very sharp, about 1.3 mm. long on inner, and 2.3 mm. on outer edge.

By the venation, and the shape of the base, as well as the larger size, this cannot be *S. amygdalaefolia*, nor can I identify it with any other species. At first sight, it struck me as resembling the terminal leaflet of a species of *Sambucus*, but careful comparisons showed that the venation and shape of base were rather those of *Salix* than *Sambucus*. From *Amygdalus gracilis* Lesq. the leaf is known, not only by the venation, but also by the comparatively parallel sides; thus the width in the middle being 23 mm., the widths at intervals of 10 mm. toward the apex are 23 mm., 21 mm., 17 mm., 14 mm., 9 mm.

Florissant; railroad cut east of Florissant station (*Henderson & Ramaley*).

Myrica Hendersoni sp. nov.

Represented by a twig bearing six leaves, which as preserved are light red, the twig being darker red. There is no resemblance to the numerous species of *Myrica* described from Florissant, but, on the contrary, a close resemblance to the living *M. cerifera* and *M. Gale*. At first sight, the leaves seem to be entire, and the plant looks like a *Salix* closely allied to *S. myrtilloides*; on close inspection, however, the apical halves of the larger leaves are seen to be sparingly dentate, irregularly and sharply, not at all in the manner of a *Salix*, but entirely as in *Myrica cerifera*. As compared with *M. cerifera*, the petioles are much shorter (not much

FIG. 1. *Myrica Hendersoni* Cockerell.

over 3 mm.), and the leaves are broader for their length, much less tapering at base. Leaves about 31 mm. long are about 10 mm. wide. The venation appears to be normal; the lateral veins leave the midrib at an angle of perhaps 55°. (FIGURE 1.)

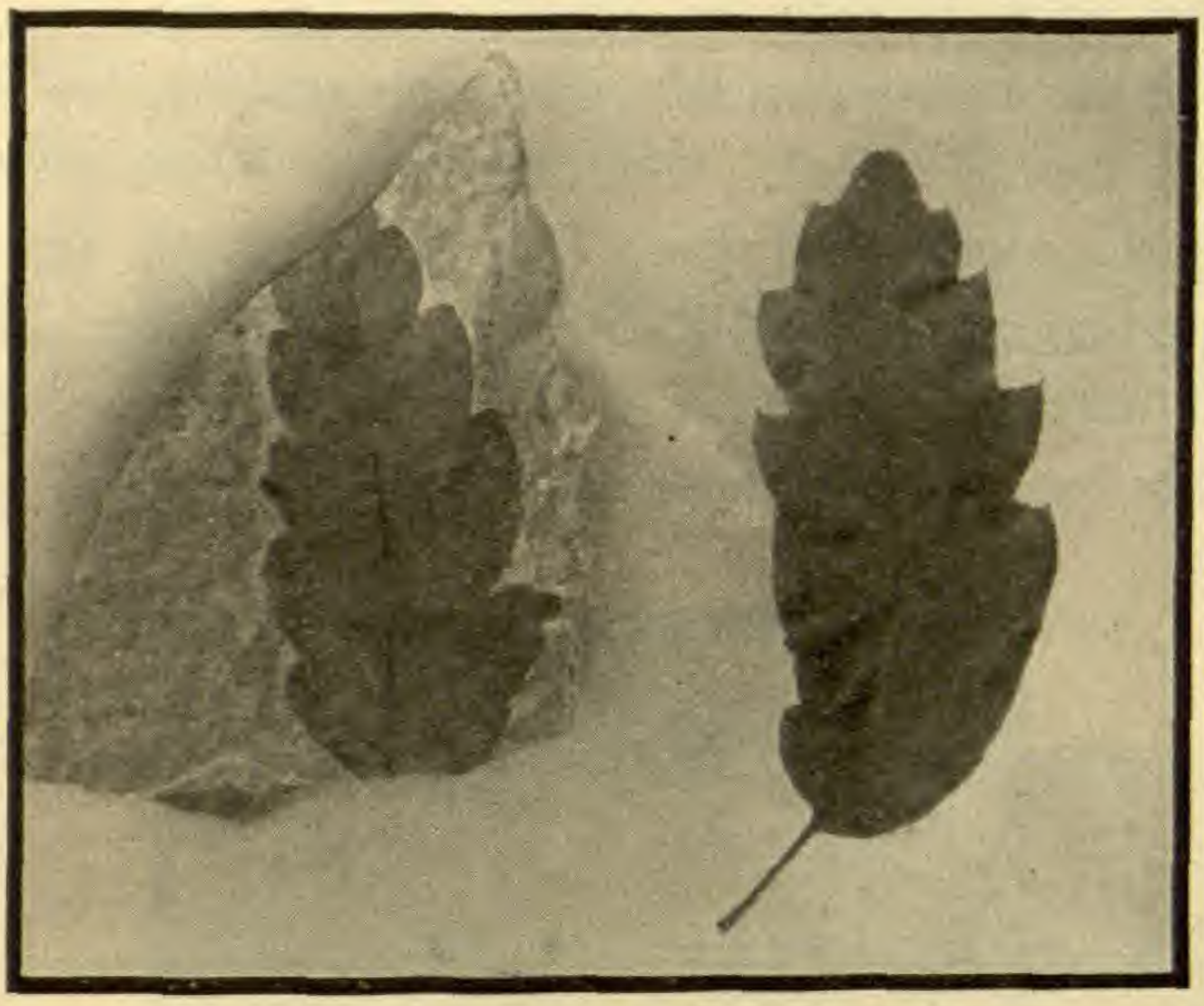

FIG. 2. *Quercus Ramaleyi* Cockerell. FIG. 3. *Quercus Fendleri.*

Southwest of Florissant, 1905 (*Henderson & Ramaley*). There is a singular resemblance to the leaf which Lesquereux calls *Santalum americanum*, but this latter is quite entire, and shows no venation except the midrib.

Quercus Ramaleyi sp. nov.

Leaf about 42 mm. long and 17 mm. wide, apparently firm, with prominent venation; margins divided into low broad lobes, their points directed apicad, and rather blunt, not mucronate, their long outer margins convex. Similar to *Q. Fendleri*, but the lobes somewhat less divergent and not sharp-pointed. In many respects, the leaf recalls that of *Myrica alkalina* Lesq., but it is different in detail, and the venation is that of *Quercus*. (FIGURE 2.)

Florissant, Colorado, at station 3, in railroad cut east of Florissant railway station, 1905 (*Henderson & Ramaley*). With *Ilex*, etc.

Figure 2 shows the fossil species, with a leaf of *Q. Fendleri* (from Las Vegas Hot Springs, N. M.; figure 3) for comparison.

Amelanchier Scudderi sp. nov.

Represented by a leaf, which as preserved is very pale reddish, and is perfect except for the lack of the left apical part, due to the loss of part of the slab. Length about 45 mm., breadth about 38 mm., the apex broadly rounded, and the base very broadly cuneate (forming a very obtuse angle), the shape being much as in the living *A. alnifolia* Nutt. The serrations begin about 27 mm. from the bases measuring along the margin, and are large and entire, shaped as in *A. rotundifolia*, 8 or 9 in number on each side. The lateral nervures are from 6 to 8 mm. apart, mostly simple, but one branches 5.5 mm. from base. (FIGURE 4.)

FIG. 4. *Amelanchier Scudderi* Cockerell.

Florissant, station 3, 1905 (*Henderson & Ramaley*). Named after Mr. S. H. Scudder, who has described the insects of the same beds. It is perhaps as much like a *Malus* as an *Amelanchier*, but from its close resemblance to *A. alnifolia* I refer it to the latter genus. It is quite distinct from *A. typica* Lesq., described from Florissant; there is, however, a good deal of resemblance to the leaf figured by Lesquereux as *Planera Ungeri*, the difference being in the partial branching of the lateral veins, the broader form, more obtuse apex and base, and wider angle of departure of the lateral veins.

Rhamnus Kirchneri nom. nov.

Rhamnus ellipticus Kirch. Trans. Acad. St. Louis **8**: 183. *pl. 15. f. 3.* Not *R. ellipticus* Swartz, 1788.

Ilex Leonis nom. nov.

Ilex quercifolia Lesq. Cret. and Tert. Fl. 186. *pl. 38. f. 2–5.* Not *I. quercifolia* Murb. 1798.

Crataegus Lesquereuxi nom. nov.

Crataegus acerifolia Lesq. Cret. and Tert. Fl. 198. *pl. 36. f. 10.* Not *C. acerifolia* Moench, 1785.

Malvastrum (?) exhumatum sp. nov.

Represented by a leaf, which as preserved is dark reddish, and is perfect except for the loss of nearly all of one of the lateral lobes. Leaf 28 mm. long, trilobed, with the form of the leaf of *M. elatum* (E. G. Baker) A. Nelson, a species not rare in New Mexico. The lobes are cut in the usual irregular manner, and the lobules have the characteristic convex sides and rather blunt points. The large median lobe is about 21 mm. long and 11 mm. broad, with a deep incision nearly 5 mm. long on the left side, and two smaller ones on the right; the left lateral lobe is about 12 mm. long and 5 mm. broad, with a single incision. (FIGURE 5.)

FIG. 5. *Malvastrum* (?) *exhumatum* Cockerell.

Southwest of Florissant, 1905 (*Henderson & Ramaley.*)

Carduus florissantensis sp. nov.

Represented by the apical portion of a leaf, the fragment about 4.5 cm. long, looking exactly like a leaf of *Quercus coccinea*, but having the margin thickened, and the venation like that of *Carduus*, the lateral veins connected by arched veins running parallel (except for the arching) with the midrib. The leaf is pinnatifid into few entire segments, as in the *Quercus* cited, these being sharply pointed; one of them is about 15 mm. long, and

10 mm. broad at base; the least diameter of the leaf, at a distance of some 35 mm. from the apex, is 13 mm.; the lateral veins leave the midrib at an angle perhaps a little less than 45°. The specimen, as preserved, is light reddish. (FIGURE 6.)

FIG. 6. *Carduus florissantensis* Cockerell.

Southwest of Florissant, 1905 (*Henderson & Ramaley*).

I take this opportunity to correct the current name of a Wyoming fossil:

POPULUS AEQUALIS Schimp. Pal. Vég. **2**: 693.

Populus laevigata Lesq. Am. Jour. Sci. II. **45**: 205. Not *P. laevigata* Ait. 1789.

Also of a species of the Dakota group:

Populus dakotana nom. nov.

Populus cordifolia Newb. Later Extinct Floras 18. 1868. Not *P. cordifolia* Burgsdorf, 1787.

Also of a Fort Union species:

Populus Newberryi nom. nov.

Populus acerifolia Newb. Later Extinct Floras 65. 1868. Not *P. acerifolia* Lodd. 1838.

BOULDER, COLORADO.

Studies in the North American Convolvulaceae. I.

Homer Doliver House

The genus *Jacquemontia* Choisy (Mém. Soc. Phys. Genèv. **6**: 476. 1833) is based upon *J. azurea* (Desr.) Choisy (*l. c.*), which seems to be the same as, or at least closely related to, *Jacquemontia sphaerostigma* (Cav.) Rusby (Bull. Torrey Club **26**: 151. 1899). Following the type adopted by Choisy, all the species without the capitately clustered inflorescence and foliaceous bracts should be retained in *Jacquemontia.* Those species having the large foliaceous, hairy or pubescent bracts and densely capitate inflorescence form a natural group worthy of generic recognition.

THYELLA Raf. Fl. Tellur. **4**: 84. 1836

Annual or perennial twining or upright herbs. Leaves alternate; blades entire or lobed. Flowers in dense capitate clusters, interspersed with numerous enlarged and foliaceous bracts, the outer ones usually the largest; bracts and sepals often shaggy or densely pubescent. Sepals narrow, equal. Corolla blue, violet or white, the limb plaited, campanulate, 5-angled or 5-lobed. Stamens 5, not surpassing the corolla. Ovary 2-celled; styles united up to the two ovoid, flattened stigmas. Capsules subglobose, 4-valved. Seeds minutely roughened.

Type species, *T. tamnifolia* (L.) Raf.

Represented by about 12 species, mostly South American, the three following occurring in North America:*

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* The following species of tropical South America should also be referred here:

Thyella acrocephala (Meissn.)

Jacquemontia acrocephala Meissn. in Mart. Fl. Bras. 7: 302. 1869.

Thyella bracteosa (Meissn.)

Jacquemontia bracteosa Meissn. *l. c.* 304.

Thyella Choisyana (Meissn.)

Jacquemontia Choisyana Meissn. *l. c.* 302.
Ipomoea lacioclados Choisy; Meissn. *l. c.* as syn.

THYELLA TAMNIFOLIA (L.) Raf. Fl. Tellur. 4: 84. 1836
Ipomoea tamnifolia L. Sp. Pl. 161. 1753.
Convolvulus tamnifolius Ell. Sk. 1: 258. 1817.
Jacquemontia tamnifolia Griseb. Fl. Br. W. Ind. 474. 1861.

South Carolina to Arkansas, Florida, Louisiana, and throughout tropical America.

Thyella pycnocephala (Benth.)

Jacquemontia pycnocephala Benth. Bot. Voy. Sulphur 137. 1845.

Southern Mexico and Central America.

Thyella lactescens (Seem.)

Jacquemontia lactescens Seem. Bot. Voy. Herald 171. 1854.

Panama.

Jacquemontia simulata sp. nov.

Perennial; stems twining, somewhat woody, smooth, the branches short, tomentose when young; leaf-blades narrowly ovate or oblong-ovate, rounded or subcordate at the base in the larger leaves, acute, 1.5–4 cm. long, densely velvety-pubescent on both surfaces, petioles shorter than the blades, 5–10 mm. long; pedicels sessile, 3–6 mm. long, the flowers not surpassing the leaves; sepals orbicular or obovate, rounded at the apex, 1.5–2 mm. long, subequal, tomentose; corolla 8–10 mm. long, blue, glabrous, the margin slightly 5-angled, and fully 10 mm. broad.

Thyella eriocephala (Moric.)

Ipomoea eriocephala Moric. Pl. Nouv. Am. 43. *pl. 29.* 1838.
Jacquemontia eriocephala Meissn. *l. c.* 303.

Thyella maynensis (Meissn.)

Jacquemontia eriocephala maynensis Meissn. *l. c.* 303.

Thyella montana (Moric.)

Ipomoea montana Moric. Pl. Nouv. Am. 44. *pl. 30.* 1838.
Jacquemontia montana Meissn. in Mart. Fl. Bras. 7: 304. 1869.

Thyella rufa-velutina (Meissn.)

Jacquemontia rufo-velutina Meissn. *l. c.* 305.

Thyella serrata (Choisy)

Ipomoea serrata Choisy, Conv. Rar. 135. 1837.—In DC. Prodr. 9: 364. 1845.
Jacquemontia serrata Meissn. in Mart. Fl. Bras. 7: 304. 1869.

Thyella sphaerocephala (Meissn.)

Jacquemontia sphaerocephala Meissn. *l. c.* 306.

Yucatan: G. F. Gaumer, 1895 (*no. 574*); type in the herbarium of the New York Botanical Garden.

Distributed as *J. abutiloides*, which it resembles only, but most strikingly, in the texture of the leaves. The inflorescence and flowers possess characters which are very different and serve to distinguish it easily from *J. abutiloides.*

Three species of the genus *Cressa* are now recognized in North America, viz. *C. aphylla* Heller, *C. depressa* Goodding, and *C. truxillensis* H.B.K.; and to these must be added a fourth:

Cressa insularis sp. nov.

Perennial by a lignescent base or woody root; stems branching mostly above, spreading, the tips ascending, 10–30 cm. long, leafy, densely pubescent with very fine silvery crinkled hairs; leaf-blades small, sessile, ovate, 2–4 mm. long, broadest below the middle, rounded at the base, apex acute; flowers subsessile or the pedicels 1–2 mm. long; sepals elliptical-oblong, about 3–5 mm. long, convex, obtuse or rounded, the subtending bracts very small, ovate, 1–1.5 mm. long; lobes of the corolla oblong, spreading, obtuse or rounded at the apex, 1–1.5 mm. long, pubescent without; capsules subconical, obtuse, slightly exceeding the calyx.

MEXICO: Socorro Island: F. E. Barkelew (Expedition to the Revillagigedo Islands; Calif. Acad. Sciences), *no. 252;* type sheet, *no. 399033* in the National Herbarium.

Clarion Island: A. W. Anthony, 1897 (*no. 409*).

HAWAIIAN ISLANDS: Near Pearl City, Oahu, A. A. Heller, 1895 (*no. 2410*).

Closely resembling the *C. cretica* of the old world, which is also in its typical form a small-leaved species but has a much smaller calyx and longer more acute lobes to the corolla, and is pubescent with some spreading hairs in addition to being canescent.

The genus *Evolvulus* L. is represented in North America by about twenty-two species, nearly all of them small and inconspicuous annuals or perennials. A brief study of the available herbarium material shows that the Mexican species in particular are in need of a careful revision. The following new species are offered as a preliminary contribution to such a work:

Evolvulus Wilcoxiana sp. nov.

Perennial; branching from a woody, deep-seated root; branches diffuse and spreading, lignescent below, the herbaceous tips sometimes ascending, 5–15 cm. long, softly and densely villous-pubescent with ascending, slightly spreading hairs; leaf-blades sessile, oblong or elliptical in the lower to ovate-lanceolate in the upper, obtuse or subacute at the base, the apex acute, silky-villous beneath with long silvery subappressed hairs, green and glabrous above, conspicuously convex and falcate, 5–15 mm. long; pedicels very short, 1–3 mm. long, the bracts linear-lanceolate, 5–8 mm. long, exceeding the pedicels but not the calyces; sepals broadly lanceolate, acuminate, 4–5 mm. long, silky-villous without; corolla white or pale blue, subrotate, 8–12 mm. broad, the margin with 5 rounded, slightly retuse lobes, the plicae villous without; capsules slightly exceeding the sepals, subglobose, 4-valved, 4-seeded, the seeds dark reddish-brown, smooth.

ARIZONA: Near Fort Huachuca, Timothy E. Wilcox, 1894 (*no. 96*); type sheet, *no. 212769* in the National Herbarium. May, 1892 and 1894 (*no. 8*), by the same collector. Copper Basin, J. W. Toumey, 1892 (*no. 185*); Apache Pass, Chirricahua Mts., J. G. Lemmon, 1881 (*no. 247*).

NEW MEXICO: Grant County, H. H. Rusby, 1881 (*no. 298*); Mangas Springs, O. B. Metcalf, 1903 (*no. 100*).

COAHUILA OR NUEVO LEON: Dr. Edward Palmer, 1880 (*no. 912*).

This species has been referred to *E. discolor* Benth., a species of Mexico, from which this differs by its more dense pubescence of markedly different character, falcate, convex leaf-blades, larger sepals and bracts. The general tufted and spreading habit of this species is also quite different from its Mexican congener.

The abundant and beautiful specimens collected by General Wilcox lead me to attach his name to this characteristic species of southern Arizona.

Evolvulus Wrightii sp. nov.

Perennial; low, branching from a lignescent or somewhat woody base; branches spreading and ascending, densely shaggy-pubescent with long silky hairs, especially above on the stem and on the lower leaf-surfaces; stems 1–2 dm. long; leaf-blades sessile, ovate or narrowly ovate, rounded at the base, the apex acute, 6–10 mm. long, 5–7 mm. broad, less pubescent above than below; pedicels shorter than the leaves, 1-flowered; sepals linear, 4 mm. long; corolla blue, about 7 mm. broad, subrotate, the limb subentire, the throat white.

CUBA: Pinar del Rio, C. Wright, Sept. 1865 (*no. 3105*); type in the herbarium of the New York Botanical Garden.

Differs from the South American species, *E. incanus* Pers., to which it has been referred, by the relatively shorter and broader leaf-blades, the small linear sepals, the much smaller corolla, and the more silky pubescence.

Evolvulus Palmeri sp. nov.

Perennial; silky-pubescent, branching from a woody base; the branches herbaceous, spreading or ascending, 5–15 cm. long; leaf-blades ascending, sessile, very small, narrowly lanceolate, 4–6 mm. long, 1–1.5 mm. broad, the apex acuminate-cuspidate, the base acute, densely pubescent beneath with silvery appressed hairs, less so above; flowers in the axils of the upper reduced leaves, the uppermost becoming bract-like; pedicels short, 2–3 mm. long or less; sepals linear-lanceolate, 3–4 mm. long.

MEXICO: Durango, Dr. Edward Palmer, 1896 (*no. 208*); type in the United States National Herbarium.

The corolla of this distinct species has not been seen, but its other characters are so different from any other Mexican species that it seems best to describe it as new. Of the only two species of doubtful identity to which this might be referred, *E. microphyllus* Mart. & Gal. is excluded by "pedunculis unifloris bibracteolatis, folio 3–4-plo longioribus," and *E. albiflorus* Mart. & Gal. by "pedunculis . . . . folio superantibus; folia subpollicares."

Evolvulus adscendens sp. nov.

Annual; extensively branching from a thickened base; stems ascending, 30–50 cm. tall, pilose above with very fine spreading hairs; leaves sparingly hirsute on both surfaces; petioles 1–2 mm. long; leaf-blades broadly ovate, 1.5–2.5 cm. long, the lower ones rounded at the base, obtuse or rounded at the apex, the upper ones reduced in size, becoming bract-like, elliptical or oblong-ovate, obtuse or acute; the inflorescence paniculate; peduncles as long as the leaves or the upper much exceeding the leaves, filiform, 1- or 2-flowered, 1–2 cm. long, less pubescent than the stems; bracts subulate, 1–2 mm. long, the pedicels 2–3 mm. long; sepals ovate-lanceolate, acuminate, pubescent, 2–2.5 mm. long; corolla blue, 4–5 mm. broad, the margin 5-angled; capsules globose, deflexed when mature, not exceeding the calyx, 4-valved, 4-seeded; seeds dark crimson.

MEXICO: Near Colima, Dr. Edward Palmer, 1897 (*nos. 42* and *43*); type sheet, *no. 315418* in the United States National Herbarium.

SHUTEREIA Choisy, Mém. Soc. Phys. Genèv. **6**: 485. 1833. — Conv. Or. 103. — In DC. Prodr. **9**: 435. 1845. Not *Shuteria* Wight & Arn. 1834

Sanilum Raf. Fl. Tellur. **4**: 70. 1836.

Hewittia Wight, Madr. Jour. **5**: 22. 1837. — Wight & Arn. Linnaea Litt.-Ber. **1838**: 213. 1838. — Benth. & Hook. Gen. **2**: 837. — Kuntze, Rev. Gen. 441. 1891.

Palmia Endl. Gen. 653. 1838.

Type species: *S. bicolor* (Vahl) Choisy, *l. c.* (= *Hewittia sublobata* Kuntze).

Shutereia sublobata (L. f.)

Convolvulus sublobatus L. f. Suppl. 135. 1781.

C. bicolor Vahl, Symb. Bot. **3**: 25. 1794. — Bot. Mag. *pl. 2205.*

Hewittia bicolor Wight & Arn. Madr. Jour. **5**: 22. 1837.

H. sublobata Kuntze, Rev. Gen. 441. 1891.

Calonyction tastense (Brandegee)

Ipomoea tastensis Brandegee, Zoe **5**: 168. 1903.

Type locality: Western slope of Sierra el Taste, Lower California.

CALONYCTION MURICATUM (L.) G. Don, Gen. Syst. **4**: 264. 1838

Convolvulus muricatus L. Mant. 44. 1767.

Ipomoea muricata Jacq. Hort. Schoenb. **3**: 40. 1798. Not *I. muricata* Cav. a

Ipomoea bona-nox purpurascens Ker, Bot. Reg. *pl. 240.* 1818.

Calonyction speciosum muricatum Choisy, in DC. Prodr. **9**: 345. 1845.

Ipomoea spinulosa Brandegee, Zoe **5**: 169. 1903.

The type locality for this species is "Himalayas and Japan," but the tropical American material has long been regarded as identical with that of the old world. The specimens of "*Ipomoea spinulosa* Brandegee" sent to the National Herbarium differ in no important particular from typical specimens of *C. muricatum* from both hemispheres.

CLEMSON COLLEGE, SOUTH CAROLINA.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1906)

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

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

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Adams, C. C. An ecological survey of northern Michigan. 1–133. *f. 1–21.* 1906.

Ames, O. *Habenaria orbiculata* and *H. macrophylla.* Rhodora **8**: 1–5. 7 F 1906. [Illust.]

Ames, O. *Spiranthes ovalis.* Rhodora **8**: 15, 16. 7 F 1906.

Ami, H. M. Notes on an interesting collection of fossil fruits from Vermont, in the museum of the Geological Survey of Canada. Ottawa Nat. **20**: 15–17. 16 Ap 1906.

Andrews, A. L. Preliminary lists of New England plants, — XVIII. *Sphagnaceae.* Rhodora **8**: 62–65. 27 Mr 1906.

Bartlett, H. H. The salt-marsh *Iva* of New England. Rhodora **8**: 25, 26. 26 F 1906.

Berry, E. W. Contributions to the Mesozoic flora of the Atlantic coastal plain. Bull. Torrey Club **33**: 163–182. *pl. 7–9.* 7 Ap 1906.

Includes descriptions of 9 new species in as many genera.

Blanchard, W. H. A new *Rubus* from Connecticut. Rhodora **8**: 17, 18. 7 F 1906.

R. Andrewsianus sp. nov.

Brainerd, E. Hybridism in the genus *Viola,* — II. Rhodora **8**: 6–10. 7 F 1906; — III. Rhodora **8**: 49–61. *pl. 66–70.* 27 Mr 1906.

Brainerd, E. *Nephrodium Filix-mas* in Vermont. Rhodora **8**: 22, 23. 7 F 1906.

Britton, N. L. Notes on West Indian *Cruciferae.* Torreya **6**: 27–32. 19 F 1906.

Britton, N. L. Recent botanical explorations in Porto Rico. Jour. N. Y. Bot. Gard. **7**: 125–139. *f. 4–12.* My 1906.

Cannon, W. A. The effects of high relative humidity on plants. Torreya **6**: 21–25. 19 F 1906.

Cogniaux, A. *Orchidaceae* — X. Flora Bras. **129**: 381–604. *pl. 80–120.* 1 Ap 1906.

Concludes the *Orchidaceae.* There are new species in *Oncidium* (8), *Cheiradenia, Dichaea* (4), and *Campylocentrum* (11); and, in the addenda, 40 new species in 17 genera.

Collins, F. S. Intuition as a substitute for reference. Rhodora **8**: 77–79. 6 Ap 1906.

Darling, N. Plants of Hartland, Vermont. The Vermonter **11**: 44–50. "F" [Ap !] 1906. [Illust.]

Davenport, G. E. A hybrid *Asplenium* new to the flora of Vermont. Rhodora **8**: 12–15. 7 F 1906.

Dempsey, J. H. C. The cultivation of our native orchids. Ottawa Nat. **19**: 228–231. 9 Mr 1906.

Eastwood, A. New species of Californian plants. Bot. Gaz. **41**: 283–293. *f. 1, 2.* 28 Ap 1906.

Descriptions of 13 new species in 10 genera.

Eggleston, W. W. *Crataegus* of Dutchess County, New York. Torreya **6**: 63–67. 25 Ap 1906.

Evans, A. W. The *Hepaticae* of Bermuda. Bull. Torrey Club **33**: 129–135. *pl. 6.* 7 Ap 1906.

A list of 23 species, including *Crossotolejeunea bermudiana* sp. nov.

Evans, A. W. Notes on New England *Hepaticae,* — IV. Rhodora **8**: 34–45. 26 F 1906.

Fairchild, D. G. Our plant immigrants. Nat. Geogr. Mag. **17**: 19–201. Ap 1906. [Illust.]

Fernald, M. L. The genus *Streptopus* in eastern America. Rhodora **8**: 69–71. 6 Ap 1906.

Four species are recognized, two of them described as new.

Fernald, M. L. A handsome willow of the Penobscot Valley. Rhodora **8**: 21, 22. 7 F 1906.

Salix coactilis sp. nov.

Fernald, M. L. A new *Geum* from Vermont and Quebec. Rhodora **8**: 11, 12. 7 F 1906.

Fernald, M. L. Some American representatives of *Arenaria verna*. Rhodora **8**: 31–34. 26 F 1906.

Includes descriptions of a new variety, a new form, and a new species.

Fernald, M. L. The variations of *Carex glareosa*. Rhodora **8**: 45–47. 26 F 1906.

Fernald, M. L. The variations of *Carex paupercula*. Rhodora **8**: 73–77. 6 Ap 1906.

Fernow, B. E. List of trees occurring or likely to occur on the Club preserve. Adirondack League Club Year Book **1905**: 34–40. [1906.]

Fleischer, M. Neue Familien, Gattungen, und Arten der Laubmoose. Hedwigia **45**: 65–87. 16 Ja 1906.

North American species are included in the new genera *Homaliodendron* and *Pinnatella*.

Fulton, H. R. Chemotropism of fungi. Bot. Gaz. **41**: 81–108. 3 Mr 1906.

Ganong, W. F. New normal appliances for use in plant physiology. III. Bot. Gaz. **41**: 209–213. *f. 1, 2.* 31 Mr 1906.

Gleason, H. A. The genus *Vernonia* in the Bahamas. Bull. Torrey Club **33**: 183–188. *f. 1, 2.* 7 Ap 1906.

Five species, of which 3 are described as new.

Griffiths, D. Abnormalities in the fruiting habits of opuntias. Torreya **6**: 57–63. 25 Ap 1906.

Harper, R. M. Further remarks on the coastal plain plants of New England, their history and distribution. Rhodora **8**: 27–30. 26 F 1906.

Harper, R. M. A November day in the upper part of the coastal plain of North Carolina. Torreya **6**: 41–45. 16 Mr 1906.

Harper, R. M. Some new or otherwise noteworthy plants from the coastal plain of Georgia. Bull. Torrey Club **33**: 229–245. *f. 1, 2.* 10 My 1906.

New species are described in *Sporobolus* and *Nymphaea*.

Harris, J. A. The anomalous anther-structure of *Dicorynia*, *Duparquetia*, and *Strumpfia*. Bull. Torrey Club **33**: 223–228. *f. 1–3.* 10 My 1906.

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Hitchcock, A. S. Notes on North American grasses. VI. Synopsis of *Tripsacum.* Bot. Gaz. **41** : 294–298. 28 Ap 1906.

Includes description of *T. latifolium* sp. nov.

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Holm, T. On the structure of roots. Ottawa Nat. **20** : 18–22. *pl. 1.* 16 Ap 1906.

House, H. D. Observations upon *Pogonia* (*Isotria*) *verticillata.* Rhodora **8** : 19, 20. *pl. 65* + *f.* 7 F 1906.

Howe, R. H. & M. A. Common and conspicuous lichens of New England: a fieldbook for beginners. 1 : 1–22. 2 : 23–39. 1906. [Illust.]

Janczewski, E. Species generis *Ribes* L. II. Subgenera *Ribesia* and *Coreosma.* Bull. Acad. Cracovie **1906** : — (1–13). Ja 1906.

Includes descriptions of 3 new North American species.

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SYNAPSIS AND REDUCTION IN ACER

SYNAPSIS AND REDUCTION IN ACER AND SALOMONIA

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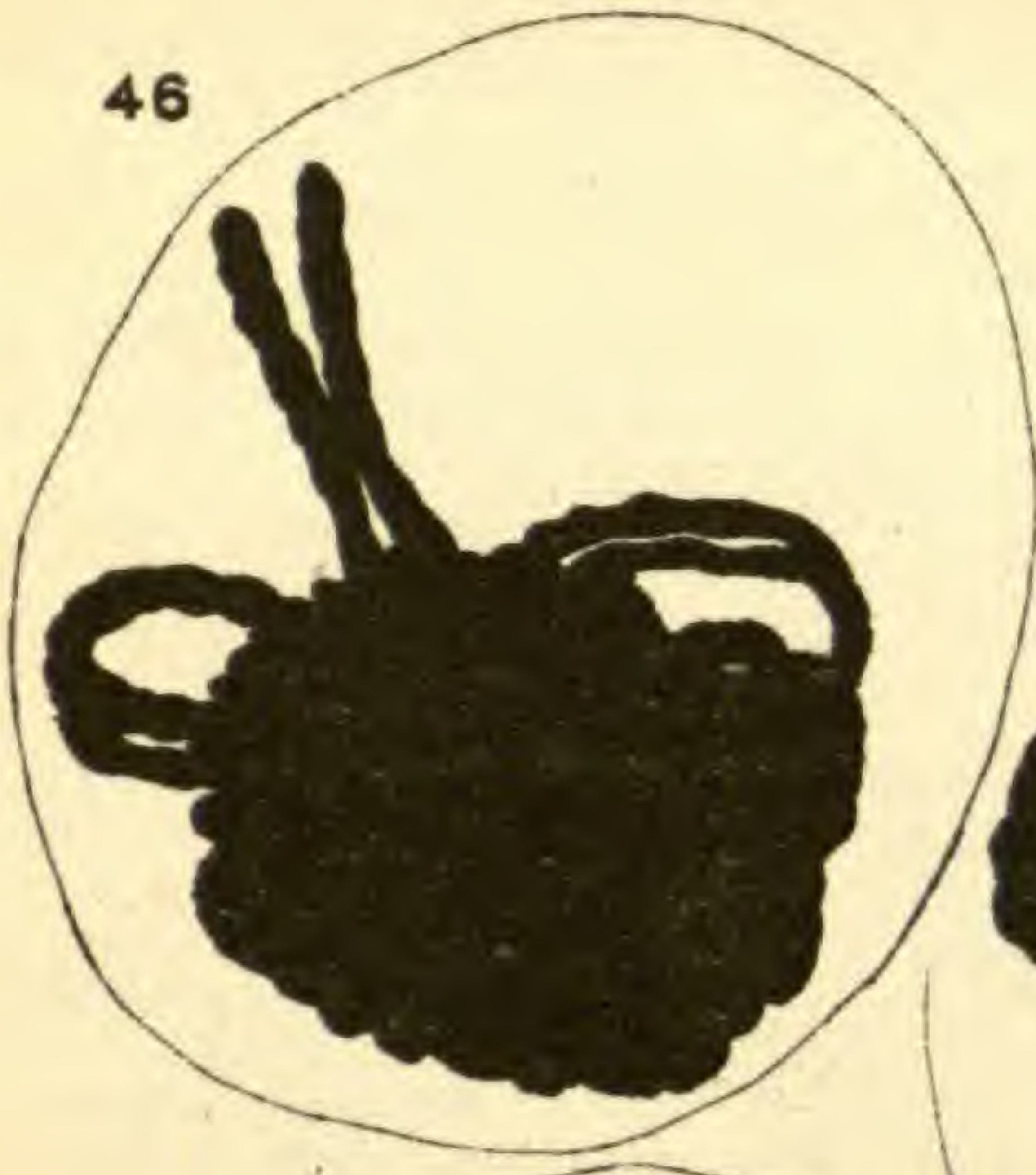

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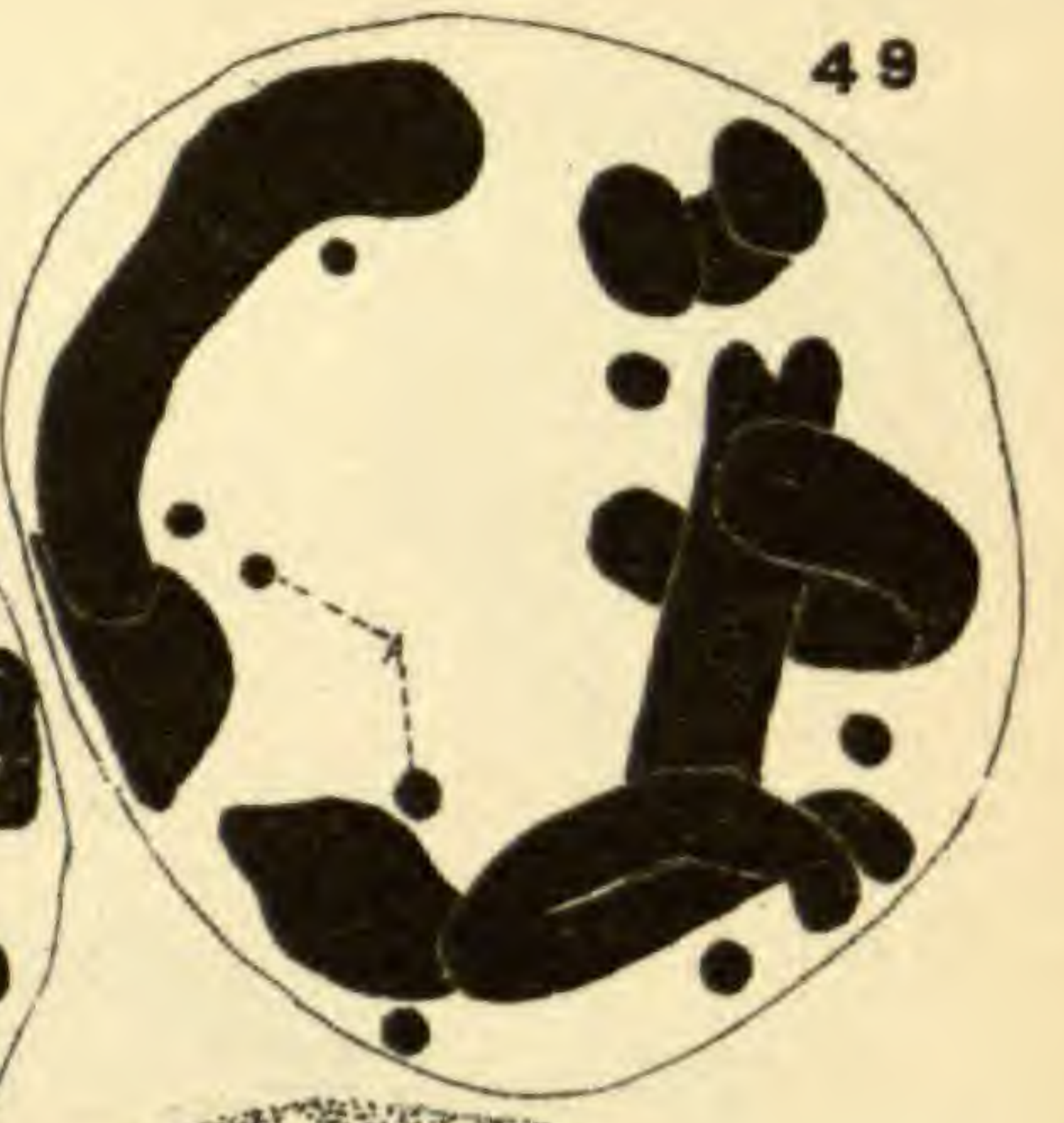

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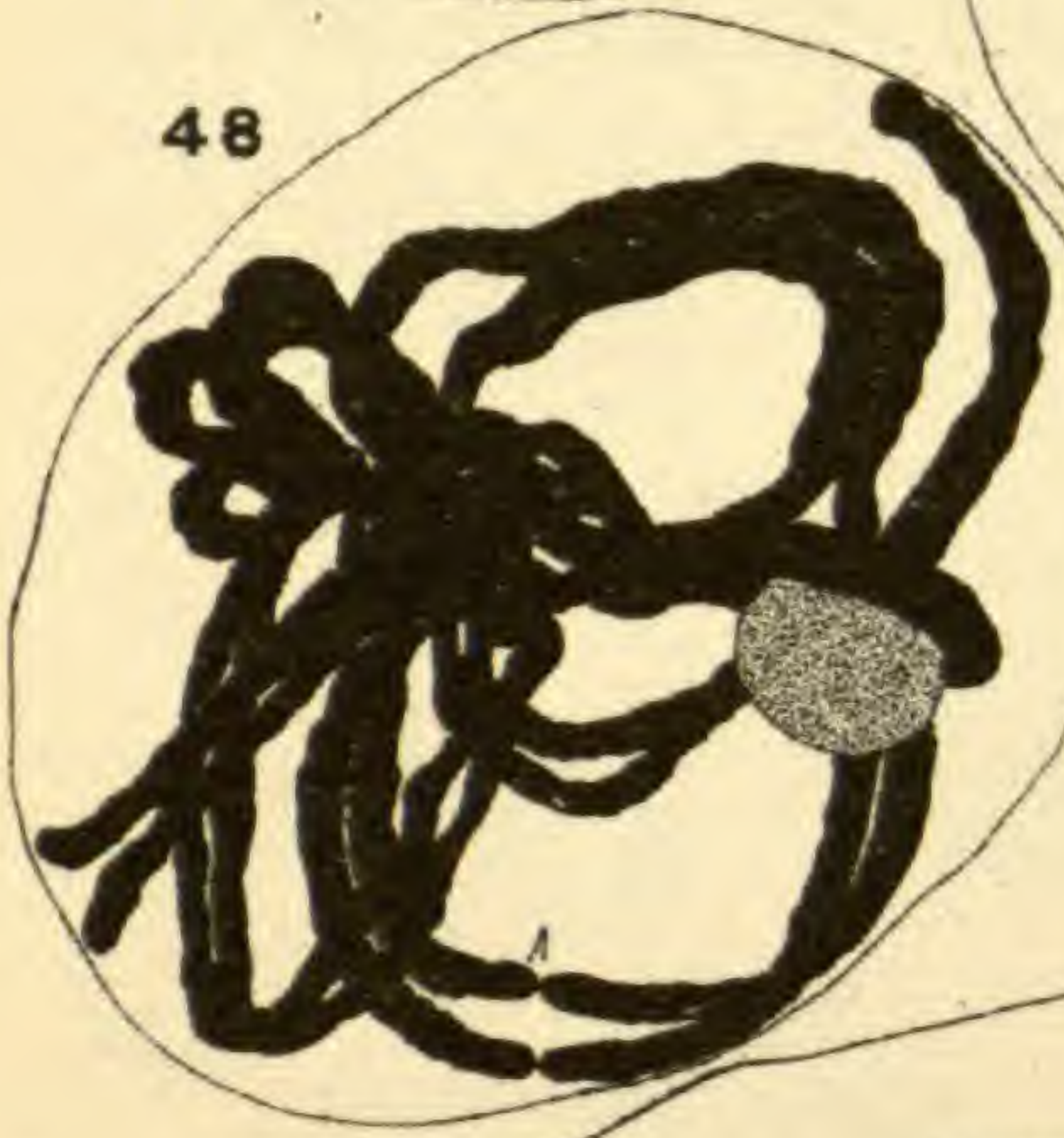

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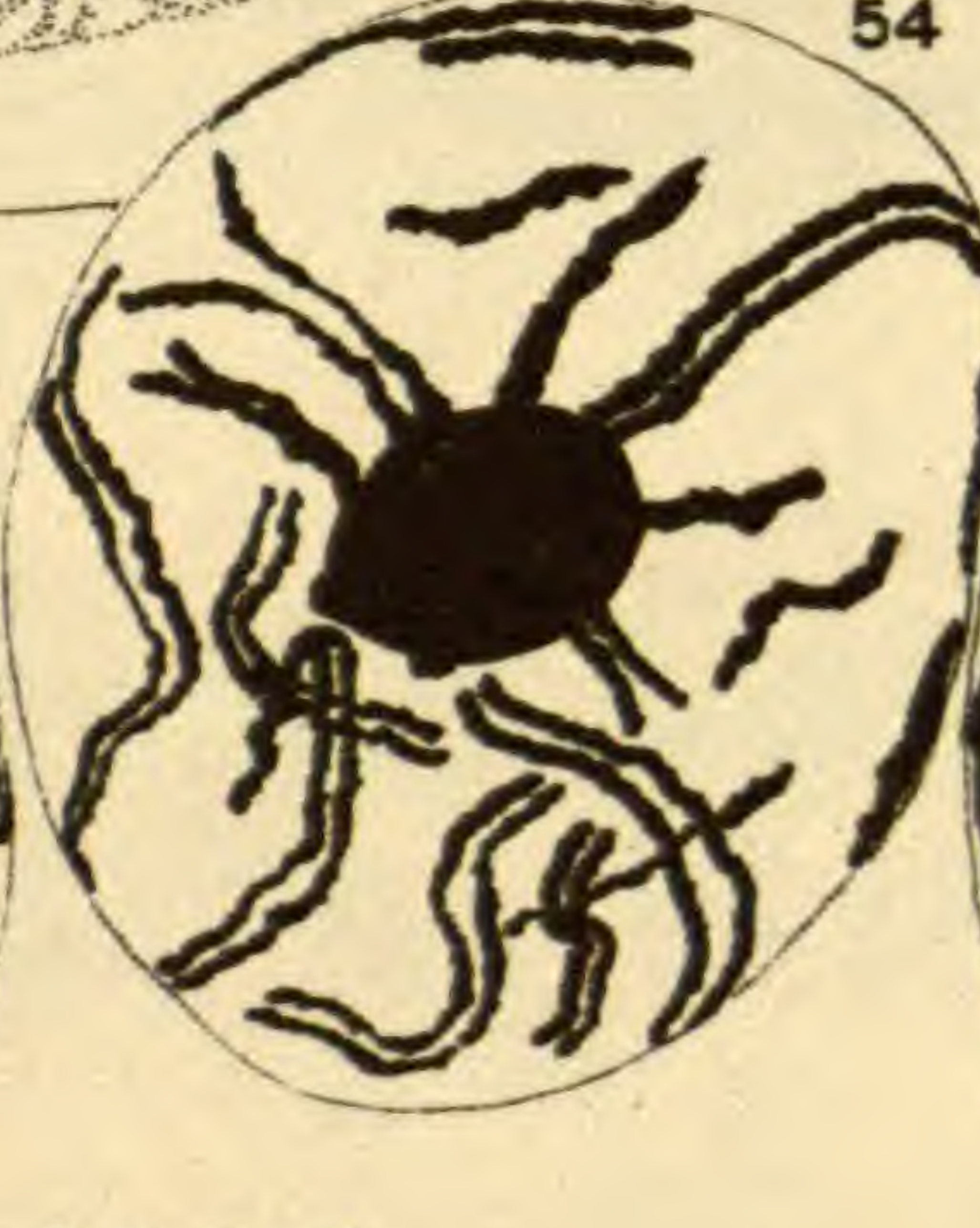

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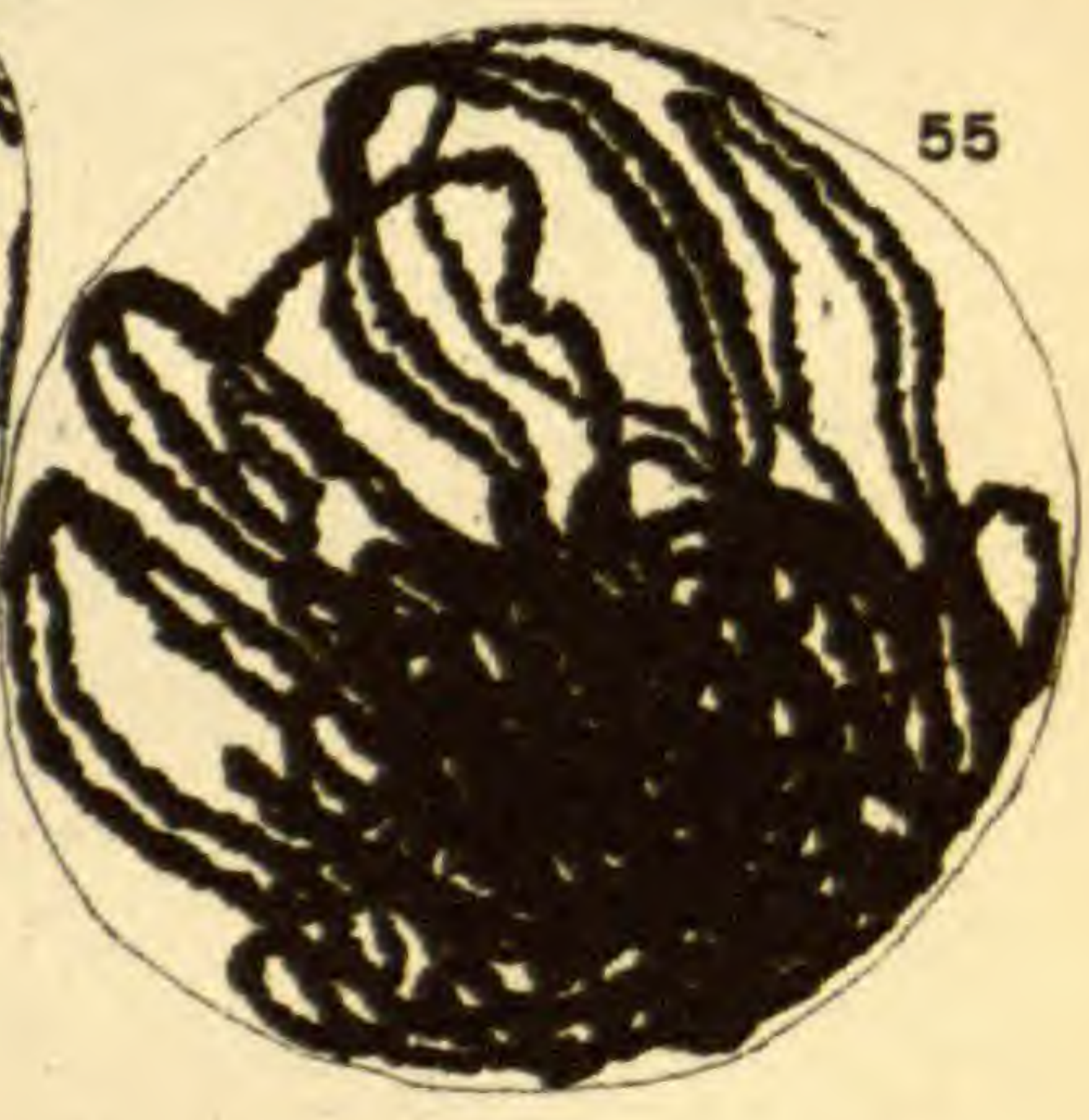

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SYNAPSIS AND REDUCTION IN SALOMONIA AND GINKGO

SYNAPSIS AND REDUCTION IN GINKGO AND BOTRYCHIUM

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Torreya. Monthly, established 1901. Price, $1.00 a year. Manuscripts intended for publication in TORREYA should be addressed to Dr. Marshall A. Howe, Editor, New York Botanical Garden, Bronx Park, New York City.

Memoirs. Occasional, established 1889. (See last pages of cover.)

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

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BULLETIN

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JUNE, 1906

The pollen-tube in some of the Cucurbitaceae *

JOSEPH EDWARD KIRKWOOD

(WITH PLATES 16 AND 17)

In a previous paper on the embryology of the Cucurbitaceae [14] it was the writer's intention to deal with the matters suggested in the present title, but lack of evidence on certain points, and other causes, necessitated their omission at that time. It is hoped here to discover some of the controlling factors in the behavior of the pollen-tube in *Melothria*, *Micrampelis* and *Cyclanthera*, one species of each.

The various phases of the development of the pollen-tube have been studied by numerous writers in widely differing subjects, but until recently little has been done to determine the nature of the influence which directs the pollen-tube in its growth. The conclusions, however, based upon anatomical and experimental evidence, have been by no means unanimous, and much still remains to be done in this field of investigation.

The behavior of the pollen-tube has been seen to vary considerably in different groups. The manner in which it approaches the embryo-sac in different cases has led Pirotta and Longo [27] to recognize three distinct conditions: acrogamy, in which the pollen-tube enters the micropyle, a condition obtaining in the majority of seed plants; basigamy, including those cases in which the tube enters by way of the chalaza, occurring in the Amentiferae; and mesogamy, which thus far has been found in a few cases only and applies to those instances in which the tube enters the nucellus by

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* This work was done on a research scholarship at the New York Botanical Garden, in the summer of 1904. The writer desires to acknowledge with thanks the kindness and coöperation of the officials of that institution.

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some other route, *i. e.*, traversing the tissues of the funicle and integuments. Such conditions have been observed in *Cucurbita* and *Alchemilla.*[23]

In its course from the stigma to the ovule, the pollen-tube may follow a canal through the style where such is available, and intercellular spaces as well, or it may bore through a considerable amount of cellular tissue, which it may or may not affect injuriously. Its course is usually a direct one and the direction of its growth is often influenced mechanically by the structure of the ovary as well as by the distribution of nutritive materials in what has been called conducting-tissue. The influence of the latter as a directing agent has received some attention at the hands of Miyoshi[20],[21] and others whose work we will discuss more fully later, but the results from various sources go to show that in considering the growth of the pollen-tube we are dealing with problems of chemotropic irritability and the action of stimulating substances whose distribution is indicated largely by anatomical features.

While the pollen-tube in angiosperms is ordinarily devoid of branches, a few cases have been observed in which the tube has divided into a number of branches after having reached the ovule. Hofmeister[13], describes the branching of the tubes in *Pothos* and *Hippeastrum*, and in the Amentiferae it has been observed in *Corylus*, *Carpinus*[3], *Juglans*[25], *Hicoria* (*Carya*)[4], *Quercus*[3] and several others. It occurs also in *Cucurbita* as described by Longo[17], and observed by the author. That the branching is associated with the function of absorption has been the accepted view, and the observation of Longo that the branching is in a definite relation to the presence and distribution of starch in adjacent tissues supports this opinion.

Numerous observations have been made on different plants as to the time consumed by the pollen-tube in traversing the distance from the stigma to the embryo-sac. This has been found to vary within wide limits and to be dependent upon no fixed principle except that the immediate approximation of the germ cells is correlated with their degree of maturity. In certain herbaceous plants the time required varies from eighteen hours (*Limnocharis*[12]) to several days (*Crocus*, *Arum*[13]) and even much longer, as in certain orchids, the difference in time being in no relation to the distance traversed. Among woody plants the time between pollination and fertilization has been observed to vary from one month (*Betula*[3]), to several months (*Hamamelis*)[30], and Conrad[7] has shown that it is over a year in *Quercus*. It has been shown that in those cases where a longer time is required the pollen-tube passes through a more or less protracted resting period; in these cases also the branching of tubes is more or less common, as appears in *Pinus* and the other cases above cited.

Another phase of the development at this stage which has not received sufficient attention is the effect of the pollen-tube itself on the formation of the fruit, or the effect in some cases of a mere irritation of the stigma. Gaertner[10] reports that with certain plants he was able to obtain sterile fruits as large as normal ones by applying to the stigmas the spores of *Lycopodium*. Tschermak[32] reports various cases in the enlargement of the ovary by the use of pollen which did not fertilize the seed. Massart[19] secured partial development of fruits in certain Cucurbitaceous forms by applying triturated pollen to the stigmas. In these cases no seeds were fertilized and it appears that the pollen is the seat of an excitant which penetrates the stigma and determines the survival of the ovary. Furthermore Leclerc du Sablon[28] has found that the crossing of melons and cucumbers results in a considerable modification of the quantity and quality of the carbohydrates in the placenta and the pericarp.

The *Cucurbitaceae* have long been under the observation of botanists, and certain features in the development of their fruit have frequently attracted attention. Soon after Amici's discovery of the pollen-tube of *Portulaca oleracea*[1] (1823), Brongniart[5] (1826) described a cellular conducting tissue in *Cucurbita maxima* Duch. and showed the pollen-tube traversing the beak of the nucellus. He observed that the "spermatic granules" were transported by a canal formed of the intercellular spaces of the tissues of the pistil.

Gaertner,[9] in 1827, made observations on a number of plants and reported an acid secretion from the stigma in certain cases at the time of maturity, and also a correlation between the amount of pollen on the stigma and the number of seeds produced, and that the number of seeds was increased by cross-fertilization.

Amici,[2] in 1830, in a letter to Mirbel states that the pollen-tube gradually elongates, descending through the style, and comes into contact with the ovule, each ovule being reached by a separate tube.

Schleiden[29] (1844) traced the pollen-tube through the micropyle and point of the nucellus, even to the embryo-sac, in *Pepo*, *Melo*, *Cucumis*, *Lagenaria* and *Momordica*, and in the case of *Momordica* saw the germinal nuclei emerge from the pollen-tube.

Recently Guéguen,[11] in his studies on the comparative anatomy of the conducting-tissues of style and stigma, examined, among the *Cucurbitaceae*, *Ecballium Elaterium*, *Cucurbita Pepo* and *Bryonia*. He found the stylar canal present in *Ecballium*, but obliterated in *Cucurbita*, but states that where the stigma is tetramerous the conducting-tissue presents an X-like structure as seen in transverse section of the style. This conducting-tissue he observed extended to the ovules, covering the surface of the placenta. He regards the *Cucurbitaceae* as very uniform in the matter of conducting-tissue.

In 1902 Longo[18] announced that the nutrition of the embryo in *Cucurbita* was performed by means of the pollen-tube. At the base of the neck of the nucellus the pollen-tube expands into a large bulla provided with branches which traverse the nucellus and the inner integument and proceed in intimate relation with the internal layers differentiated from the outer integument. Owing to a cutinization in the walls of the epidermal cells of the nucellus, as well as a suberization in the region of the chalaza, the embryo is soon cut off from the usual source of nutritive materials. The pollen-tube, with its branches rich in plasmatic contents and in starch, and with cellulose walls, furnishes the only points where fluids can enter the nucellus. Thus a haustorial function is ascribed to the pollen-tube, which draws upon the inner layers of the outer integument, itself nourished by the vascular bundles.

In the following year Longo[17] published the results of a more extended investigation, including thirteen genera and several more species. In all the cases examined the branching of the pollen-tube was found as a rule only in *Cucurbita*, though in all cases the course of the pollen-tube was always in accord with the distribution of conducting-tissue. The formation of the bulla at the base of the neck of the nucellus is correlated with the presence of starch in the same neck. He found no expansion of the pollen-tube when the nucellus contained no starch; it forms simply a bulla without much branching (*Luffa maxima* Hort.) when the starch is normal, in very small grains; it forms a bulla with numerous branches (*Cucurbita*) when the starch is abundant in large grains, often in the form of amylo-dextrine. He concludes further that the course of the pollen-tube is regulated by particular substances which act in a chemotactic fashion; in this conclusion, agreeing with Lloyd.[16] When these substances are developed in the interior of the tissues it (the tube) has an endotropic course; when on the exterior an ectotropic course.

In an earlier article the writer made reference to the behavior of the pollen-tube in some of the *Cucurbitaceae*, and the phenomena observed in certain cases seemed worthy of further investigation. In most cases studied the pollen-tube presented no unusual conditions, but in a few instances the dilation or branching of the tube in the neck of the nucellus was a conspicuous feature. In *Cucurbita Pepo* the facts recorded by Longo were observed, and in other genera was noted a tendency similar, though less marked. The present study deals particularly with three members of the *Cucurbitaceae*, viz.: *Melothria pendula* L., *Micrampelis lobata* (Michx.) Greene, and *Cyclanthera explodens* Naud.

With a view to determining the length of time required for the pollen-tube to traverse the intervening tissue between the stigma and the embryo-sac, recourse was had to the following methods: Buds of the pistillate flowers about to open were covered with small bags of tissue paper tied about the peduncle. This was done usually between 4 and 6 o'clock P.M., and the flowers were usually found open the next morning. The stigmas were then pollinated and the bag replaced. At different intervals of time after pollination the fruits were collected and fixed in separate lots for study. Some were also examined fresh by means of freehand sections. In such preparations the pollen-tubes were easily recognized.

The effects of pollination were apparent soonest in the case of *Melothria*, in which the corolla-lobes close in over the stigma in a few hours. If pollination is not effected the flowers remain open for several days. In *Micrampelis* and *Cyclanthera* the results were not immediately apparent, only those parts of the stigma upon which the pollen germinated showing any change. Under normal conditions the pistillate flowers of *Melothria* are pollinated early in the morning from staminate flowers which open the same day. The staminate flowers are very ephemeral and fall off usually in a few hours.

The effects of pollination and fertilization in the *Cucurbitaceae* have been carefully studied by Massart,[19] who experimented with *Cucurbita*, *Bryonia*, *Ecballium* and *Thladiantha*. He finds that the excitation which determines the survival and the beginning of the increase in the size of the fruit of *Cucurbita Pepo* is derived from the pollen itself and may be replaced by a traumatism; but that the excitation which provokes the general increase in the fruit proceeds only from fertilized ovules. The placentae, however, do not develop except in the vicinity of the fertilized ovules.

As to the time required for the pollen-tube to reach the embryo-sac, considerable variation was observed, the time varying twenty hours or more, depending on the number and position of the ovules. After twenty-six hours the pollen-tube was observed in the nucellus of *Melothria* and the same condition appeared in *Micrampelis* after nineteen hours from the time of pollination. In *Cyclanthera* no tubes were observed at the ovules until forty-one hours had elapsed. Most of the distance between the stigma and the embryo-sac is traversed by the pollen-tube in three or four hours. During this time the tube has passed through the style and into the ovary. The growth is much slower as the tube nears the micropyle. This feature seems to be correlated with the amount of available reserve food in the tube, which is of course greatest at the beginning of its growth.

In the *Cucurbitaceae* the form and structure of the ovary in different genera varies a good deal, but in most cases the cavity of the ovary is practically filled by the fleshy development of the placentae and the pericarp. A fusion of the ingrowing lobes of the placenta often occurs (*Cucurbita, Citrullus*) and leaves no space between them. In a similar way the stylar canal may also be obliterated. In *Melothria*, *Micrampelis* and *Cyclanthera*, however, such fusion does not take place before fertilization. The structure of the ovary in *Melothria* is similar to that of *Cucurbita*, except that the ovules are arranged in one series instead of several on each flank of the three longitudinally-running placental lobes. Each of the placental lobes is covered with a single layer of cells, abounding in starch and possessed of denser plasmatic contents than those underneath. This layer also lines the narrow stylar canal, and covers the funicles of the ovules.

In *Micrampelis* the structure of the ovary is more complex. Here the normal ovary contains four ovules with their micropyles directed toward the pedicel. These are borne one on each flank of the two inwardly-growing placental lobes. In this case, however, the placental ridges become partially fused and grow downward toward the base of the ovary. In this genus as in *Melothria*, the cells which line the stylar canal and cover the placental lobes are filled with starch and denser protoplasm. Starch is also found in the underlying cells to a greater degree than in *Melothria*, but it is most abundant near the stylar canal and ovarian cavity.

Cyclanthera presents a condition in which there is one placental ridge in the ovary with a row of ovules on each flank. Here too the covering of the placenta and the lining of the stylar canal is similar to that of *Melothria* and *Micrampelis*. Both the epidermal covering of the placenta and that of the ovary-wall lying opposite (FIG. 14) are alike filled with starch, but those on the placenta are larger and more columnar in character. Here to a greater degree than occurs in the other cases the tissue beneath the epidermis is supplied with starch. Quite different from this is the condition found in *Cucurbita Pepo*, in which the conducting-tissue is devoid of starch. In *Cucurbita* the conducting-tissue consists of several layers of cells formed by the periclinal division of the epidermal cells covering the placentae.

The course of the pollen-tube in all cases under consideration is along the conducting-tissue just described. In *Melothria*, *Micrampelis* and *Cyclanthera* the tubes proceed down through the stylar canal and over the surface of the placentae. The tubes proceed upon the surface of the lobes wherever possible and not through them as a rule. In the restricted space of the style, where the canal offers insufficient space to accommodate many tubes, they traverse the surrounding tissues and break them down to a considerable extent. In such conditions, and elsewhere, where the course of the tube lies through the tissues, it appears to travel through the intercellular spaces. The destruction of cells in its path seems to be due mostly to mechanical action and not to digestive enzymes, except in the nucellus of *Cyclanthera*. Fresh ovaries when teased apart showed the pollen-tubes in the stylar canal and passing over various parts of the placental surface. FIGURES 1 and 3–5 represent the course of the tube.

When the surfaces of the placentae are pressed together or against the ovary-wall, the space through which the tubes move is considerably restricted. Under such circumstances they crowd aside the cells of the conducting tissue (FIG. 11). Sometimes a tube may be seen to have passed under the conducting layer (FIG. 15). Where the tubes traverse the ovarian space in *Melothria* they sometimes develop transverse walls or plugs. The manner of their development appears to be the formation of a ring transversely which gradually narrows the aperture until it is completely closed. An excessive development in thickness of this wall sometimes follows, forming plugs as shown in FIGURE 2 *a*, *b*, *c*. Similar plugs have already been observed by Osterwalder[26] in *Aconitum Napellus*, and by others.

The pollen-tube proceeds by an approximately direct course to the micropyle, and passes down through the nucellus to the embryo-sac. In the apex of the nucellus it usually expands to several times its normal diameter in *Cyclanthera* (FIGS. 6, 13), and from this point sends down a straight and narrow tube to the embryo-sac. Sometimes the entire neck of the nucellus is destroyed by the dilation of the tube. This expansion of the pollen-tube in the apex of the nucellus occurs frequently in *Melothria*, though it was never observed to reach the same proportions as in *Cyclanthera*. In *Micrampelis* also such conditions were sometimes observed; here, however, they are not the rule but the exception. In such cases, both in *Melothria* and *Cyclanthera*, the contiguous cells were destroyed.

That such dilations of the pollen-tube are directly correlated with the occurrence of starch in the surrounding tissues is maintained by Longo, as above pointed out; but the behavior of the pollen-tube of *Elodea*, as described by Wylie,[33] indicates that such conditions are not always the cause of the enlargments of the tube, for in this case they occur in the ovarian cavity. This has already been suggested by Lloyd[16] in discussing the pollen-tube in the *Cucurbitaceae* and *Rubiaceae*.

In the plants here under consideration the nucellus is practically devoid of starch, which is abundant in the integuments of *Micrampelis* and *Cyclanthera*, though not so abundant in *Melothria*.

The anatomical character of the conducting-tissue is a feature of some interest. In all cases examined a continuous conducting-tissue reaches from the stigma to the micropyle. In *Micrampelis* the neck of the nucellus pushes through the micropyle, and comes out even with the top of the integuments. Practically the same conditions exist in *Cyclanthera*, but in *Melothria* the apex of the nucellus is usually overtopped by the integuments. In the three genera just mentioned the conducting-tissue consists of a single layer of cells, the epidermis covering the placentae and lining the stylar canal. This layer appears to be the only one serving directly as conducting-tissue. On the stigma the starch is restricted to the subepidermal tissue, none appearing in the more densely plasmatic cells of the epidermis. The glandular character of the epidermal cells is quite apparent both on the stigma and in the interior (FIGS. 9, 11, 14). In the interior the cells in the path of the pollen-tubes show indications of activity, by the dense aggregation of the cytoplasm next the exposed side and surrounding large and conspicuous nuclei.

Considerable effort has been made to determine the directive force controlling the movements of the pollen-tube. We may note in passing that Nawaschin,[24] Zinger[34] and some others have interpreted the endotropic and ectotropic behavior of pollen-tubes as of phylogenetic significance. But evidence at present available seems to point to physiological processes and mechanical relations as the determining factors. In favor of this view we may cite the anatomical evidence contributed by Lloyd[15] in the *Rubiaceae*, Longo[17] on the *Cucurbitaceae*, and the observations of Capus[6] and of Guéguen,[11] and the results of the experimental studies of Miyoshi[20], [21] and others. Molisch[22] has shown that pollen-tubes are positively chemotropic and some negatively aerotropic. Miyoshi sowed pollen-grains on agar in which were imbedded pieces of stigma, ovary, and ovules of different degrees of development. Tne pollen-tubes grew toward the pieces from the vicinity of the stigma and were most strongly attracted by ovules ready for fertilization, growing into the micropyle in each case. He concludes that this stimulant is in the nature of a fluid, and in another article has shown that pollen-tubes grow into the stomata of *Tradescantia* leaves, the intercellular spaces of which have been filled with sugar solution. That the pollen-tube is also directed mechanically in its course is maintained by Miyoshi, and Capus states that the mechanical rôle of the conducting-tissue consists in placing the pollen-tube in relation with the micropyle, and that its economy and simplicity depend on the structure of the ovary.

That the stimulants which direct the pollen-tube are nutritive in character is quite evident. Dalmer[8] states that pollen-tubes are nourished by amyloid substances secreted by stigma, stylar canal, and the interior of the ovary, though he maintains that the entrance of the pollen-tube into the ovule is a purely mechanical phenomenon. Miyoshi points out that sugar as a stimulant can operate only extra-cellularly, and it is plain that where the course of the pollen-tube is intercellular or through the locular space of the ovary that its growth must be at the expense either of the reserve materials within the tube or of substances elaborated by the tissues in its path. The cytological features of the conducting-tissues of the *Cucurbitaceae* here under consideration are similar to those of certain nectaries in the abundance of starch and quantity of cytoplasm, appearance of molecular structures, etc. The evidence here points to the secretion of carbohydrates (probably sugar) as the nutritive material. That the pollen-tubes are partial to the more glandular cells is indicated in *Cyclanthera*. In this case the ovary sometimes shows a considerable locular space at the time of the entrance of the pollen-tubes. The epidermal cells of the placenta are larger and more glandular in appearance than those of the ovary-wall opposite. Though their distance apart is not great, the pollen-tubes always cling to the placenta instead of to the opposite wall, though that likewise is supplied with starch.

One noticeable feature of the relation between pollen-tube and conducting-tissue in *Melothria*, *Micrampelis* and *Cyclanthera* is the fact that while starch is abundant in the conducting-tissue, none appears in the tube. In *Cucurbita Pepo* on the other hand the conditions are reversed, and starch is entirely absent from the ample conducting-tissue, though abundant in the pollen-tube almost to the time of its entrance into the embryo-sac. These facts are regarded as evidence that the directive stimulant, in these cases at least, is of a different character from the substances in the tube. It is, however, recognized that the absence of starch from the cells of the conducting-tissue may not mean an absence of soluble carbohydrates, for no starch is visible in the secreting cells of some nectaries. The application of iodine to sections of the style and ovary of *Cucurbita* easily brings out the pollen-tubes in contrast with the conducting-tissue, the former rich in starch, coloring a dark blue, the latter a deep yellow, indicating an abundance of albuminous material. The pollen-tube branches in the nucellus according to the disposition of starch, as above cited in reference to Longo's work.

If the growth of the pollen-tube or its branches is thus regulated by the occurrence or distribution of nutritive material, we have apparently an explanation for the growth of the tube through the nucellus to the embryo-sac, structures which, in the cases here considered, are normally filled with starch before the approach of the pollen-tube.

At what distance from the ovule the pollen-tube comes under its influence, has not in these cases been determined, but it is evident that the embryo-sac is the source of a stimulant of some sort by which the pollen-tube is directed unerringly toward it. As to the character of this stimulant the evidence is meager, but what there is seems to indicate a sugar.

Miyoshi's results with the pollen of *Digitalis* and numerous other plants show that their tubes are sensitive to the presence of certain soluble carbohydrates, but are indifferent to or repelled by a variety of other substances. Moreover, the fact cited elsewhere by the same author to the effect that the pollen-tubes of distantly related plants were attracted to the same ovule and to different ovules would indicate that the stimulant is some substance quite common in plant tissues.

It is suggested here that a difference in the degree of concentration of such a solution as a sugar may be a sufficient factor in directing the pollen-tube. This is in accord with the observations of Miyoshi and others.

As to the particular organ of the embryo-sac responsible for the discharge of the stimulant, opinions have differed, some ascribing that function to the synergids and others to the egg-cell (Strasburger[31], Lloyd[15]). But to the writer it seems more probable that the source of such a stimulant may be found in the endosperm-nucleus and its cytoplasm. The appearance of this nucleus, indicating the large degree of activity, and its abundant cytoplasm filled with starch would favor such a view. The pollen-tube is presumably ruptured upon entering the embryo-sac by the rapid absorption of water and consequent increased turgor, and its contents discharged into the male generative nuclei come under the influence of the egg-cell and fertilization takes place, and in some cases also the fusion with the endosperm-nucleus.

SUMMARY AND CONCLUSIONS

1. The behavior of the pollen-tube was studied in *Melothria pendula*, *Micrampelis lobata*, and *Cyclanthera explodens*. As observed in these cases the time elapsing between pollination and the arrival of the pollen-tube at the embryo-sac was twenty-six hours in *Melothria*, nineteen hours in *Micrampelis*, and in *Cyclanthera* forty-one.

2. The pollen-tube follows conducting-tissue which for the most part is formed of the epidermis lining the stylar canal and covering the placental lobes. The tube traverses this tissue by passing over its surface wherever possible, and rarely affects the cells injuriously. The conducting-tissue of these plants is abundantly supplied with starch. In *Cucurbita Pepo* starch is wanting in the conducting-tissue but present in abundance in the pollen-tube. In all cases observed where starch abounded in the conducting-tissue it was absent from the pollen-tube. The pollen-tube appears to be directed by nutritive substances secreted by the conducting-tissue. Attention is called to the similarity in anatomical features of the cells of the conducting-tissue to those of certain nectaries, as evidence as to the nature of the secretion.

3. It is thought that the pollen-tube comes under the influence of a stronger stimulant emanating from the ovule. It is suggested that the source of this stimulus may be the endosperm-nucleus.

4. The evidence at hand supports the contention of Miyoshi and others that the behavior of the pollen-tube is a phenomenon

of chemotropism as against its being due to mechanical conditions or of phylogenetic significance.

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Description of plates 16 and 17

PLATE 16

1. Diagrammatic figure representing longitudinal section through gynoecium of *Melothria*. Course of pollen-tube (*P. t.*) intercellular.

2. *a*, *b*, *c*. Pollen-tube showing plugs.

3. Longitudinal section through gynoecium of *Micrampelis*. Conducting-tissue shaded.

4. Ovary of same at right angles to figure 3.

5. Longitudinal section through ovary of *Cyclanthera*, showing path of pollen-tubes.

6. Diagram of micropylar region of ovule of *Cyclanthera*, showing dilation of pollen-tube, *P. t.*

7. Ditto, *Melothria*.

8. Ditto, *Micrampelis*.

PLATE 17

9. Conducting-tissue of *Melothria* on placental folds. Pollen-tube in transverse section. × 440.

10. Conducting-tissue on funicle of ovule of *Melothria*. × 440.

11. Conducting-tissue of *Micrampelis*. Transverse section of pollen-tube. × 440.

12, 13. Transverse section through neck of nucellus, in *Cyclanthera*, before and after passage of pollen-tube, *P. t.* × 440.

14. Conducting-tissue in ovary of *Cyclanthera*. *Pl.*, placenta ; *o. w.*, ovary-wall ; *P. t.*, part of pollen-tube. × 440.

15. Same showing pollen-tube (*P. t.*) passing under some cells of conducting-tissue. × 440.

New England desmids of the sub-family Saccodermae

JOSEPH AUGUSTINE CUSHMAN

The sub-family *Saccodermae* contains many of the least conspicuous of the desmids and also as a rule those which are apt to be overlooked, as is shown by the fact that previous to the writer's work on the New England species there were but fourteen species and varieties known from New England. In the present paper twenty-seven species and varieties are noted, for all of which New England specimens have been seen by the writer. While this doubles the number previously known, it is small when compared with the number known in the British Isles, fifty-seven species and varieties being recorded by W. & G. S. West in their recent monograph. In the genus *Spirotaenia* for instance, there are fourteen species recorded by the Wests from the British Isles, while from New England there are three (one up to the time of the present paper). This difference will probably be somewhat lessened with further collecting, especially in the White Mountain region where conditions are very favorable for certain forms.

In the preparation of the present paper material was examined from all of the New England states and such of the material of previous writers as is available. Material from Vermont and Connecticut has however been disappointing and not in any quantity. All the localities from which actual specimens have been seen by the writer are indicated by an exclamation point. Recent work has shown errors in the previous work and so far as known these are indicated in the brief synonymy given. The generic position is much changed from that in Wolle's Desmids of the United States, and his references are given whenever he has recorded the particular species. The forms new to the New England flora are marked by an asterisk.

In most points the monograph of the Wests has been followed. Free use has been made of their keys where they are given. At the end of the present paper is given a simple key to the New

England genera and species. While this is based upon the New England species actually seen, it nevertheless will largely apply to the northeastern United States.

Tribe GONATOZYGAE

GONATOZYGON DeBary. 1856

1. GONATOZYGON MONOTAENIUM DeBary, in Rabenh. Alg. *539*. 1856. — *G. Ralfsii* DeBary, Conj. 76. *pl. 4. f. 23–25.* 1858. — *G. asperum* Wolle, Desm. U. S. 22. *pl. 1. f. 1.* 1884.

Cells cylindrical, the apices slightly dilated; cell-wall usually with spinose granules.

Length 240–260 μ: breadth 10–22 μ.

Me.: (*W. West*). N. H.: Pudding pond, North Conway, rare! Holderness, scarce (*Wests*). Mass.: Carver's Pond, Bridgewater!

* **Gonatozygon monotaenium minutum** var. nov.

Variety very much smaller than the typical form of the species; other characters like the typical.

Length 59–68 μ: breadth in middle 6 μ: apices 7 μ.

Mass.: Winchester Reservoir, frequent (F. S. Collins Coll., Oct. 9, 1905)!

2. GONATOZYGON BRÉBISSONII DeBary, Conj. 77. *pl. 4. f. 26, 27.* 1858. — *G. asperum* Johnson, Bull. Torrey Club **22**: 291. *pl. 239. f. 8.* 1895.

Cells narrowly cylindric-subfusiform, the poles subcapitate; cell-wall densely granulate.

Length 112–160 μ: breadth 6–8 μ: apices 5.5–7 μ.

Me.: Scarbro' (*W. West*). N. H.: Laconia (*Wests*). Mass.: Reading!

3. GONATOZYGON PILOSUM Wolle, Bull. Torrey Club **9**: 27. *pl. 13. f. 16.* 1882. — Desm. U. S. 32. *pl. 1. f. 2.* 1884.

Cells elongate, cylindrical, usually not dilated at the apices; cell-wall clothed with small, straight, hair-like spines.

Length 390 μ: breadth 12.5 μ.

Mass.: Pondville! Conn.: Lamp Mortar Rock, Fairfield (*Wests*).

4. GONATOZYGON ACULEATUM Hastings, Am. Month. Micr. Jour. **13**: 29. 1892.

Cells cylindrical, the apices not at all or very slightly dilated; cell-wall clothed with long stiff spines.

Length 350 μ: breadth with spines 40 μ: without spines 20 μ.

N. H.: Pennichuck Pond, Nashua (*Hastings*). Meredith, occasional (*Johnson*). Laconia, frequent (*Wests*). Mass.: Plainville!

Tribe SPIROTAENIEAE

SPIROTAENIA Bréb. 1848

5. SPIROTAENIA CONDENSATA Bréb. in Ralfs, Brit. Desm. 179. *pl. 34. f. 1.* 1848. — Wolle, Desm. U. S. 33. *pl. 3. f. 21, 22.* 1884.

Cells cylindrical, the ends rounded, the length 7–10 times the width; a single broad, parietal, revolving chloroplast with eight to ten close revolutions.

Length 108–160 μ: breadth 15–20 μ.

Me.: Orono (*Harvey*). N. H.: Pudding Pond, North Conway! Mass.: South Framingham! Carver's Pond, Bridgewater! Gay Head, Marthas Vineyard! R. I.: Wainskut Pond, North Providence (*Bailey*). Conn.: Mill River, Fairfield (*Wests*).

*6. SPIROTAENIA PARVULA Arch. Proc. Dubl. Nat. Hist. Soc. $\mathbf{3}^2$: 84. *pl. 2. f. 32–43.* 1863.

Cells small, the ends somewhat truncately rounded, 5–6 times as long as wide; a single very narrow chloroplast with slightly more than a single revolution.

Length 23 μ: breadth 4 μ.

Mass.: North Watuppa Lake, Fall River! New to North America.

* *7.* **Spirotaenia obscura crassum** var. nov.

Cells fusiform, attenuated toward the poles, the apices rounded; chloroplast axile, cristate, with several ridges, making about one revolution: variety much smaller and comparatively shorter than the typical form.

Length 24 μ: breadth 10 μ.

Mass: South Framingham (May 1904)!

MESOTAENIUM Näg. 1849

* 8. MESOTAENIUM DEGREYI BREVE West, Jour. Linn. Soc. Bot. **29**: 131. *pl. 20. f. 6.* 1892.

Cells straight or slightly curved, 2½–3 times as long as wide. Length 58–66 μ: breadth 21–22 μ.

Mass.: Sphagnum material, North Watuppa Lake, Fall River (collected by S. N. F. Sanford, July 5, 1905)! New to North America.

9. MESOTAENIUM MACROCOCCUM (Kütz.) Roy & Bisset. *Palmogloea macrococca* Kütz. Phyc. Germ. 153. 1845. — *Mesotaenium macrococcum* Roy & Bisset, Ann. Scott. Nat. Hist. 1894. — *M. Braunii* Wolle, Desm. U. S. 31. *pl. 3. f. 5–9.* 1884.

Cells cylindrical, twice as long as wide, the apices truncately rounded; chloroplast an axile plate.

Length 38 μ: breadth 18 μ.

N. H.: From the Flume (*F. S. Collins*). Mass.: Lake Quinsigamond, Worcester (*Stone*). Gibb's Pond, Nantucket!

MESOTAENIUM MACROCOCCUM MICROCOCCUM (Kütz.) W. & G. S. West. *Palmogloea micrococca* Kütz. Bot. Zeitung **5**: 221. 1847. — *Mesotaenium micrococcum* Wolle, Desm. U. S. 32. *pl. 3. f. 10.* 1884.—*M. macrococcum micrococcum* W. & G. S. West, Bot. Trans. Yorks. Nat. Union **5**: 41. 1901.

Cells cylindrical, usually less than twice as long as wide, the apices rounded, slightly narrowed.

Length 15 μ: breadth 8.5 μ.

Mass.: Lake Quinsigamond, Worcester (*Stone*). Sandwich!

* 10. MESOTAENIUM CHLAMYDOSPORUM DeBary, Conj. 75. *pl. 7D.* 1858.

Cells oblong-cylindrical, 2-2½ times as long as wide, the apices broadly rounded; chloroplast a narrow axile plate.

Length 25 μ: breadth 11 μ.

Mass.: North Lake Watuppa, Fall River! New to the United States.

* MESOTAENIUM CHLAMYDOSPORUM MINOR W. &. G. S. West, Brit. Desm. **1**: 53. 1904.

Smaller than the typical form.

Length 18.5–21 μ: breadth 6.5–8.5 μ.

Mass.: South Framingham!

* 11. **Mesotaenium minimum** sp. nov.

Cells minute, 3 times as long as wide, the apices broadly rounded, imbedded in mucous masses; chloroplast an axile plate.

Length 14 μ: breadth 4.5 μ.

R. I.: Nyatt! (Collected by S. N. F. Sanford, July 2, 1905).

12. MESOTAENIUM ENDLICHERIANUM Näg. Gatt. Einzell. Algen 109. *pl. 6B.* 1849. — Wolle, Desm. U. S. 32. *pl. 3. f. 11.* 1884.

Cells cylindrical, about three times as long as wide, the apices broadly rounded; cells free-swimming; chloroplast an axile plate.

Length 25–31: breadth 8–10 μ.

N. H.: Intervale, frequent! Mass.: Lake Quinsigamond, Worcester (*Stone*). North Lake Watuppa, Fall River! Swansea!

CYLINDROCYSTIS Menegh. 1838

13. CYLINDROCYSTIS BRÉBISSONII Menegh. Accad. Sci. Torino, Mat. e Fis. II. **5**: 89. *pl. 12. f. 13.* 1843.—*Penium Brébissonii* Wolle, Desm. U. S. 36. *pl. 5. f. 7, 8.* 1884.

Cells cylindrical, 2½–3 times as long as wide, the apices rounded; chloroplast stellate with few large radiating processes.

Length 50–62 μ: breadth 17–18 μ.

Me.: Along Penobscot River, near Orono (*Harvey*). Mass.: Amherst (*W. West*). West Bridgewater! Tom Never's Pond, Nantucket!

CYLINDROCYSTIS BRÉBISSONII MINOR W. & G. S. West, Trans. Roy. Irish Acad. **32B**[1]: 20. *pl. 2. f, 7.* 1902.

Cells narrower and shorter than the typical form.

Length 28–32 μ: breadth 12–13 μ.

N. H.: Intervale! Mass.: Westport! Great Miox's Pond, Nantucket!

14. CYLINDROCYSTIS CRASSA DeBary, Conj. 37. 74. *pl. 7. f. C. 1–12.* 1828.—*Penium crassa* Wolle, Desm. U. S. 37. *pl. 5. f. 3.* 1884.

Cells oblong-cylindrical, twice as long as wide; chloroplast as in *C. Brébissonii.*

Length 40 μ: breadth 20 μ.

Me.: Orono (*W. West*). N. H.: Mt. Moosilauke! Mass.: Amherst (*W. West*).

15. CYLINDROCYSTIS AMERICANA MINOR Cushman, Rhodora **7**: 113. 1905.

Cells cylindrical, twice as long as wide, with broadly rounded apices, and a slight median constriction; each cell with a stellate chloroplast, smaller than the typical form.

Length 32–34 μ: breadth 16 μ.

N. H.: Mt. Moosilauke! Mass.: Sandwich!

16. CYLINDROCYSTIS DIPLOSPORA Lund. Nova Acta Reg. Soc. Sci. Upsala III. **8**: 83. *pl. 5. f. 7.* 1871.—*Calocylindrus diplospora* Wolle, Bull. Torrey Club **9**: 15. 1882.—Desm. U. S. 56. *pl. 12. f. 18.* 1884.

Cells subcylindrical, twice as long as wide, slightly broader toward the truncately rounded apices; chloroplasts with numerous radiating processes.

Length 60–61 μ: breadth 31–32 μ: isthmus 27–28 μ.

N. H.: Intervale! Mass.: Mt. Everett (*Wolle*).

* **Cylindrocystis diplospora minor** var. nov.

Cells like the typical but very much smaller.

Length 35–38 μ: breadth 16–18 μ: isthmus 14–15.5 μ.

Mass.: North Lake Watuppa, Fall River!

NETRIUM Näg. 1849

17. NETRIUM DIGITUS (Ehrenb.) Itzigs. & Rothe. *Closterium Digitus* Ehrenb. Phys. Abh. Akad. Wiss. Berlin **1830**: 68. 1832. —*Penium Digitus* Wolle, Desm. U. S. 34. *pl. 53. f. 1.* 1884. —*Netrium Digitus* Itizigs. & Rothe, in Rabenh. Alg. *508.* 1856. —*Penium lamellosum* Wolle, Desm. U. S. 34. *pl. 5. f. 4.* 1884.

Cells elliptical-oblong, gradually attenuated toward the apices which are rounded-truncate, three to four times as long as wide; chloroplasts axile with about six longitudinal plates, deeply notched at the outer margins.

Length 105–430 μ: breadth 34–105 μ: apices 14–45 μ.

Me.: Oldtown and Great Works (*Harvey*). Kittery, frequent! Bridgeton! N. H.: Saco Lake (*Wood*). Mt. Moosilauke, abundant! Pudding Pond, North Conway! Intervale! Mass.: Lake Quinsigamond, Worcester (*Stone*). Amherst (*W. West*). Tewksbury (*Lagerheim*)! Winchester Reservoir! Reading! Wellesley! Pondville! Plainville! Bridgewater! Halifax! Swansea! Fall River!

Sandwich! Marthas Vineyard! Nantucket! R. I.: Nyatt! Portsmouth! Wainskut Pond, North Providence (*Bailey*). Conn.: Bridgeport!

This seems to be the most abundant and widely distributed of the New England desmids, a representative gathering which does not include it being the exception. Its size is extremely variable as shown above.

*18. NETRIUM NAEGELII (Bréb.) W. & G. S. West. *Penium Naegelii* Bréb. in Pritchard, Infusoria 751. 1861. — *Netrium Nägelii* W. & G. S. West, Brit. Desm. **1**: 66. *pl. 7. f. 4, 5.* 1904.

Cells oblong-lanceolate, 4–5 times as long as wide, the apices truncately rounded; chloroplasts as in the preceding species.

Length 100–150 μ: breadth 24–28 μ.

Mass.: Plainville! North Watuppa Lake, Fall River!

This species, although a very cosmopolitan one, has not previously been reported from North America.

19. NETRIUM OBLONGUM (DeBary) Lütkem. *Penium oblongum* DeBary, Conj. 42, 73. *pl. 7G. f. 1. 2.* 1858. — *Netrium oblongum* Lütkem. Beitr. Biol. Pfl. **8**: 407. 1902.

Cells oblong-cylindrical, 3–3½ times as long as wide, the apices rounded; chloroplasts of the usual type, with six longitudinal plates.

Length 96 μ: breadth 29 μ.

N. H.: Intervale! Mass.: Amherst (*W. West*).

Wolle's figure of *Penium oblongum* is not this species, but represents a *Mesotaenium*, possibly *M. DeGreyi* Turn.

NETRIUM OBLONGUM CYLINDRICUM W. & G. S. West, Jour. Bot. **41**: 40. *pl. 446. f. 10.* 1903.

"Cells smaller than in the typical form and exactly cylindrical: apices hemispherical."

Length 60–71 μ: breadth 18–22 μ.

N. H.: Mt. Moosilauke!

NETRIUM OBLONGUM f. MAJOR (Turn.) Cushman, Rhodora **7**: 113. 1905.

Cells much larger than in the typical form of the species.

Length 168 μ: breadth 44 μ.

N. H.: Pudding Pond, North Conway!

20. NETRIUM INTERRUPTUM (Bréb.) Lütkem. *Penium interruptum* Bréb. in Ralfs, Brit. Desm. 151. *pl. 25. f. 4.* 1848. — Wolle, Desm. U. S. 35. *pl. 5. f. 14, 15.* 1884. — *Netrium interruptum* Lütkem. Beitr. Biol. Pfl. 8: 407. 1902.

Cells cylindrical, rapidly attenuate toward the obtusely rounded apices; chloroplasts four, two in each semicell, proximal ones in each semicell cylindrical, distal ones conical, each with eight longitudinal plates, the free margins of which are entire.

Length 172–320 μ: breadth 38–40 μ.

Me.: Oldtown and Great Works (*Harvey*). N. H.: Intervale! Mass.: Lake Quinsigamond, Worcester (*Stone*). Pondville! Bridgewater!

Key to the New England genera and species of Saccodermae

SACCODERMAE: Cell-wall unsegmented, without pores; point of division of cells not fixed, and unknown previous to the actual division.

Cells elongate, cylindrical, unconstricted in the middle, forming loose filaments; cell-wall granular or spinose; chloroplasts axile. (GONATOZYGAE.)	1. GONATOZYGON.
Cells solitary, relatively short and mostly unconstricted. (SPIROTAENIEAE.)	
One chloroplast in each cell.	
Chloroplast spirally twisted.	2. SPIROTAENIA.
Chloroplast plane, axile.	3. MESOTAENIUM.
Two chloroplasts (occasionally four) in each cell.	
Chloroplasts star-shaped, radiating from a central pyrenoid.	4. CYLINDROCYSTIS.
Chloroplasts with longitudinal ridges, the edges of which are usually notched.	5. NETRIUM.

1. GONATOZYGON

Cell-wall densely granulate.	
Cells cylindrical, the apices slightly dilated.	1. *G. monotaenium.*
Cells cylindrical-subfusiform, the apices subcapitate.	2. *G. Brébissonii.*
Cell-wall with small, short, straight, hair-like spines; cells not dilated at the apices.	3. *G. pilosum.*
Cell-wall with long, stiff, fairly stout spines.	4. *G. aculeatum.*

2. SPIROTAENIA

Chloroplast parietal, band-like.	
Cells large, cylindrical; chloroplast broad, making 8–10 close revolutions.	5. *S. condensata.*
Cells minute, fusiform; chloroplast narrow, making about a single revolution.	6. *S. parvula.*
Chloroplast axile, cristate, with several ridges, making about a single revolution.	7. *S. obscura.*

3. MESOTAENIUM

- Cells imbedded in mucilaginous masses.
  - Cells large, often curved, 2½–3 times as long as wide, diameter 20 μ or more. 8. *M. DeGreyi.*
  - Cells small, cylindrical, twice as long as wide, diameter 16–18 μ. 9. *M. macrococcum.*
  - Cells small, cylindrical, 2–2½ times as long as wide, diameter 11–12 μ. 10. *M. chlamydosporum.*
  - Cells minute, cylindrical, 3 times as long as wide, diameter 4–5 μ. 11. *M. minimum.*
- Cells free-swimming, about 3 times as long as wide, the breadth 8–10 μ. 12. *M. Endlicherianum.*

4. CYLINDROCYSTIS

- Cells unconstricted.
  - Cells cylindrical, 2½–3 times as long as wide. 13. *C. Brébissonii.*
  - Cells oblong-cylindrical, 1½–2 times as long as wide. 14. *C. crassa.*
- Cells very slightly constricted.
  - Cells slightly dilated toward the apices, which are truncately rounded. 15. *C. diplospora.*
  - Cells not dilated toward the apices, which are broadly rounded. 16. *C. americana.*

5. NETRIUM

- Cells with 2 chloroplasts, the edges notched.
  - Cells elliptical-oblong, large, 3–4 times as long as wide, diameter usually more than 40 μ. 17. *N. Digitus*
  - Cells oblong-lanceolate, of medium size, 4–5 times as long as wide, diameter usually about 30 μ. 18. *N. Naegelii.*
  - Cells oblong-cylindrical, of medium size, 3–3½ times as long as wide, diameter usually about 30 μ. 19. *N. oblongum.*
- Cells with 4 chloroplasts, the edges entire; ends of cells rapidly attenuated. 20. *N. interruptum.*

BOSTON SOCIETY OF NATURAL HISTORY.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1906)

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

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

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Andrews, F. M. Some monstrosities in *Trillium.* Plant World **9**: 101–103. *f. 17.* My 1906.

Bailey, W. W. Buds. Am. Bot. **10**: 45–48. Mr 1906.

Bailey, W. W. The chocolate plant. Am. Bot. **10**: 87–89. My 1906.

Bailey, W. W. Meadow flowers. Am. Bot. **10**: 106–108. Je 1906.

Bailey, W. W. Our orchids. Am. Bot. **10**: 4–8. [F] 1906.

Bailey, W. W. Our viburnums. Am. Bot. **10**: 62–64. Ap 1906.

Bailey, W. W. The upas tree. (*Antiaris toxicaria.*) Am. Bot. **10**: 24–26. F 1906.

Bailey, W. W. A word for mosses. Am. Bot. **9**: 111–113. [My 1906.]

Baker, C. F. Plant forms existing in nature and their relation to botanical research. Science II. **23**: 804–812. 25 My 1906.

Banker, H. J. A contribution to a revision of the North American *Hydnaceae*. Mem. Torrey Club **12**: 99–194. 13 Je 1906.

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Barnhart, J. H. Chloronyms. Torreya **6**: 85–88. 23 My 1906.

Benton, M. P. A mountain meadow in California. Am. Bot. **10**: 12, 13. [F] 1906.

Berger, A. *Rhipsalis Wercklei* Berger n. sp. Monats. Kakteenk. **16**: 64, 65. 15 Ap 1906.
Native of Costa Rica.

Berry, E. W. Pleistocene plants from Virginia. Torreya **6**: 88–90. 23 My 1906.

Bessey, C. E. An alpine botanical laboratory [near Manitou, Colorado]. Science II. **23**: 853, 854. 1 Je 1906.

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Blakeslee, A. F. Zygospore germinations in the *Mucorineae*. Ann. Myc. **4**: 1–28. *pl. 1*. 5 Ap 1906.

Blanchard, W. H. A new blackberry from Vermont. Am. Bot. **10**: 69, 70. Ap 1906.
Rubus flavinanus sp. nov.

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Rubus floricomus sp. nov.

Blanchard, W. H. A new Vermont blackberry. Am. Bot. **10**: 108–110. Je 1906.
Rubus Groutianus sp. nov.

Blumer, J. C. Two junipers of the southwest. Plant World **9**: 86–91. *f. 16*. Ap 1906.

Bradshaw, M. F. A study of years. Am. Bot. **10**: 84–87. My 1906.

Brand, A. Novae species andinae generis *Symplocos*. Repert. Nov. Sp. **2**: 13, 14. 15 Ja 1906.
Descriptions of 5 new species and a new variety.

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Includes descriptions of new species in *Marsilea*, *Dondia*, *Cassia*, *Maytenus*, *Myroxylon*, *Opuntia*, *Limnanthemum*, *Metastelma* and *Aster*.

Brumhard, P. *Erodii* generis novae varietates atque formae. Repert. Nov. Sp. **2**: 116–119. 1 Ap 1906.
Includes a description of *E. Botrys* f. *montanum* forma nova, from California and Chile.

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Descriptions and illustrations of 84 species, of which 58 are described as new.

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Cannon, W. A. Two miles up and down in an Arizona desert. Plant World **9**: 49–55. *f. 7.* Mr 1906.

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Claassen, E. Key to the species of liverworts recognized in the sixth edition of Gray's Manual of Botany. Ohio Nat. **6**: 530–540. 14 My 1906.

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Clute, W. N. The coral mushroom and its allies. Am. Bot. **10**: 21–24. F 1906. [Illust.]

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Clute, W. N. Our amentaceous plants. Am. Bot. **10**: 61, 62. Ap 1906. [Illust.]

Clute, W. N. Our native arums. Am. Bot. **10**: 41–45. Mr 1906. [Illust.]

Clute, W. N. Our native lilies. Am. Bot. **10**: 81–84. My 1906. [Illust.]

Clute, W. N. *Polypodium piloselloides.* Fern. Bull. **14**: 59. Ap 1906. [Illust.]

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Cockerell, T. D. A. Fossil plants from Florissant, Colorado. Bull. Torrey Club **33**: 307–312. *f. 1–6.* 13 Je 1906.

Includes descriptions of 6 new species in as many genera.

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Descriptions of new species, from Peru, in *Guatteria* (2), *Aberemoa*, and *Oxandra.*

Diels, L. *Basellacea* nova peruviana. Bot. Jahrb. **37**: 400. 24 Ap 1906.

Boussingaultia minor sp. nov.

Diels, L. *Commelinaceae* andinae. Bot. Jahrb. **37**: 381, 382. 24 Ap 1906.

Descriptions of 2 new species in *Tradescantia* from Peru.

Diels, L. *Crassulaceae* andinae. Bot. Jahrb. **37**: 410–412. 24 Ap 1906.

Descriptions of 6 new species in *Cotyledon* from Peru.

Diels, L. *Cunoniaceae* andinae. Bot. Jahrb. **37**: 412–416. 24 Ap 1906.

Descriptions of 10 new species and a variety ("n. sp.") in *Weinmannia.*

Diels, L. *Juglans* in Peruvia amazonica collecta. Bot. Jahrb. **37**: 398. 24 Ap 1906.

J. neotropica sp. nov.

Diels, L. *Oxalidaceae* andinae. Bot. Jahrb. **37**: 423–427. 24 Ap 1906.

Descriptions of 12 new species in *Oxalis* from Peru.

Diels, L. *Portulacaceae* andinae. Bot. Jahrb. **37**: 399, 400. 24 Ap 1906.

Descriptions of 3 new species in *Calandrinia* from Peru.

Diels, L. *Saxifragaceae*: *Escallonia* nova andina. Bot. Jahrb. **37**: 412. 24 Ap 1906.

E. hypsophila sp. nov., native of Peru.

Diels, L. *Scrophulariaceae* andinae (*Calceolariis* exceptis). Bot. Jahrb. **37**: 427–433. 24 Ap 1906.

New species are described in *Alonsoa*, *Linaria*, *Sibthorpia*, *Ourisia*, *Gerardia* (4), *Buechnera*, and *Bartsia* (11).

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Descriptions of 3 new species and several new varieties are included.

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Durand, E. J. Sporangial trichomes. Fern Bull. **14**: 20, 11. [Mr] 1906.

Edwards, A. M. On a deposit of *Bacillaria* from Texas and New Mexico. Nuova Notar. **17**: 61–69. Ap 1906.

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Descriptions of 3 new species and several new varieties, all from California and Nevada.

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Fink, B. Further notes on cladonias. VI. Bryologist **9**: 21–24. 3 Mr 1906. [Illust.]

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Fischer, W. New and rare Ohio plants. Ohio Nat. **6**: 475, 476. 15 F 1906.

Foslie, M. & Howe, M. A. New American coralline algae. Bull. N. Y. Bot. Gard. **4**: 128–136. *pl. 80–93.* 17 Mr 1906.

New species and varieties are described and figured in *Archaeolithothamnion*, *Lithothamnion* (2), *Goniolithon* (3), and *Lithophyllum* (5).

Freeman, E. M. The affinities of the fungus of *Lolium temulentum* L. Ann. Myc. **4**: 32–34. 5 Ap 1906.

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New species are described in *Erythraea*, *Gentiana* (33), *Halenia* (3), *Macrocarpaea* (2), *Chelonanthus* (2), and *Symbolanthus* (3).

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Recognizes 143 species in 17 genera; many described as new.

Goebel, K. Wilhelm Hofmeister. Plant World **8**: 291–298. *portrait*. [Ja 1906.]

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Graebner, P. *Caprifoliaceae* andinae. Bot. Jahrb. **37**: 433–436. 24 Ap 1906.

Includes descriptions of 6 new species in *Viburnum*.

Graebner, P. Die Gattungen der natürlichen Familie der *Valerianaceae*. Bot. Jahrb. **37**: 463–480. 24 Ap 1906.

Graebner, P. *Valerianaceae* andinae. Bot. Jahrb. **27**: 436–451. 24 Ap 1906.

New species are described in *Valeriana* (29 — one from Mexico), *Aretiastrum*, and *Stangea* gen. nov. (5); also the new genus *Belonanthus*.

Greene, E. L. Certain malvaceous types. Leaflets **1**: 205–209. 10 Ap 1906.

Four new genera, *Iliamna*, *Malacothamnus*, *Eremalche*, and *Disella*; a new species in the first of these.

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With descriptions of 18 new species.

Greene, E. L. The genus *Bossekia*. Leaflets **1**: 210, 211. 10 Ap 1906.

A Neckerian name, here substituted for *Rubacer* Rydb.

Greene, E. L. The genus *Nuttallia*. Leaflets **1**: 209, 210. 10 Ap 1906.

Nuttallia Raf. 1818.

Greene, E. L. The genus *Tridophyllum*. Leaflets **1**: 188, 189. 24 F 1906.

Tridophyllum Necker.

Greene, E. L. *Icianthus* and *Sprengeria.* Leaflets **1**: 197–199. 24 F 1906.

Two new genera (with 3 new species) of *Cruciferae.*

Greene, E. L. Mutations in *Viola.* Leaflets **1**: 182–184. 30 Ja 1906; 185–187. 24 F 1906.

Greene, E. L. New or noteworthy species. Leaflets **1**: 199, 200. 24 F 1906.

Includes new species in *Dalea, Bidens,* and *Aster.*

Greene, E. L. New plants from New Mexico. Leaflets **1**: 211, 212. 10 Ap 1906; 213, 214. 5 Je 1906.

New species in *Ranunculus, Erigeron, Senecio* (3), *Townsendia, Hedeoma,* and *Uropappus.*

Greene, E. L. New species of *Mimulus.* Leaflets **1**: 189, 190. 24 F 1906.

Descriptions of 4 new species.

Greene, E. L. New species of *Viola.* Leaflets **1**: 214–216. 5 Je 1906; 217–219. 16 Je 1906.

Descriptions of 5 new species.

Greene, E. L. *Parthenocissus* a synonym. Leaflets **1**: 219, 220. 16 Je 1906.

Takes up *Psedera* Necker.

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Native of Argentina.

Gürke, M. *Echinocactus Lecontei* Engelm. Monats. Kakteenk. **16**: 12, 13. 15 Ja 1906.

Gürke, M. *Echinocactus longihamatus* Gal. var. *sinuatus* (Dietr.) Web. Monats. Kakteenk. **16**: 56, 57. 15 Ap 1906. [Illust.]

Gürke, M. *Echinocactus Mostii* Gürke n. sp. Monats. Kakteenk. **16**: 11, 12. 15 Ja 1906.

Native of Argentina.

Gürke, M. *Echinocactus Fiebrigii* Gürke. Monats. Kakteenk. **16**: 25–29. 15 F 1906. [Illust.]

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Includes new South American species in *Agrostis* and *Festuca*.

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Harper, R. M. A December ramble in Tuscaloosa County, Alabama. Plant World **9**: 102, 104–107. My 1906.

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Includes descriptions of new American species in *Lippia* (4), *Duranta* (2), and *Lantana* (7).

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Queckettia australis sp. nov.

Kränzlin, F. *Orchidaceae* andinae imprimis peruvianae Weberbauerianae. III. Bot. Jahrb. **37**: 382–398. 24 Ap 1906.

Including new species in *Liparis*, *Orchidotypus* gen. nov., *Masdevallia*, *Epidendrum*, *Dichaea*, *Pachyphyllum*, *Camaridium*, *Trichoceros*, *Gongora*, *Centropetalum*, *Zygopetalum* (from Paraguay), *Oncidium*, *Odontoglossum* (3), *Pterichis*, *Spiranthes*, *Stenoptera*, *Prescottia*, *Cranichis*, *Sobralia*, *Vanilla*, and *Chloraea* (3).

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Descriptions of new species in *Cusparia* and *Fagara*.

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A list of 219 species of fungi occurring on 55 species of *Juncaceae*.

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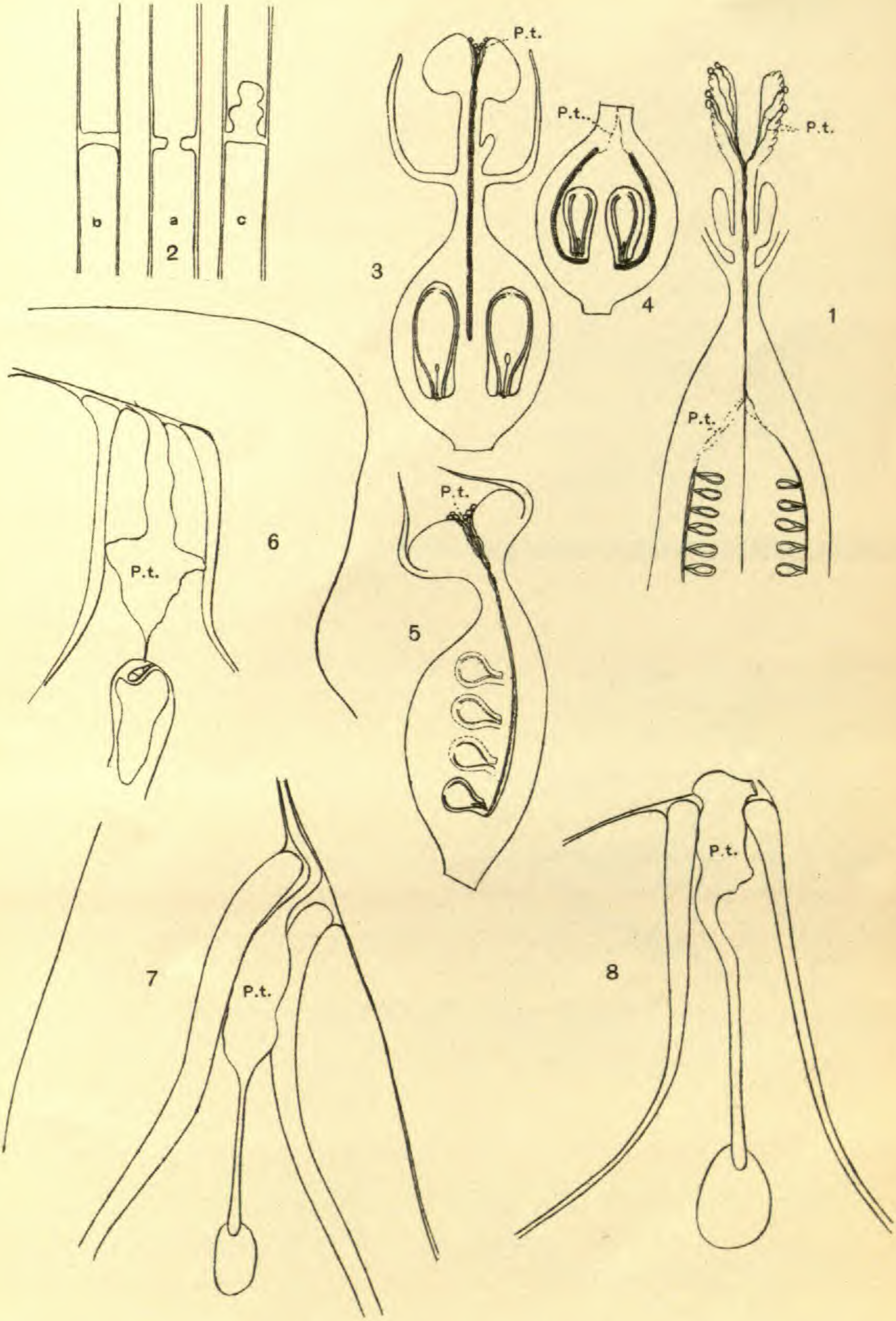
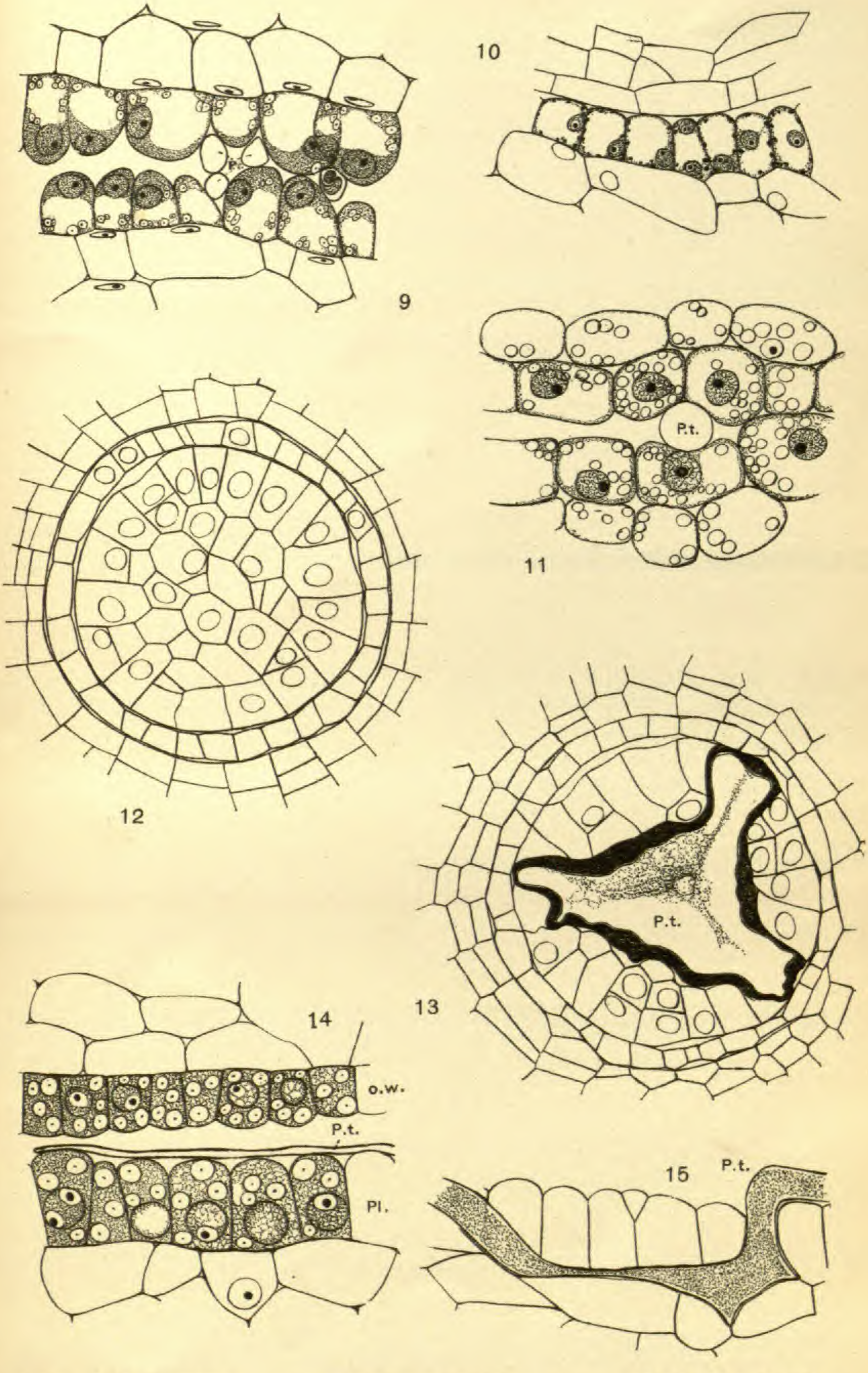


1,2,7. MELOTHRIA. 3,4,8. MICRAMPELIS. 5,6. CYCLANTHERA



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Torreya. Monthly, established 1901. Price, $1.00 a year. Manuscripts intended for publication in TORREYA should be addressed to Dr. Marshall A. Howe, Editor, New York Botanical Garden, Bronx Park, New York City.

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

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BULLETIN

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TORREY BOTANICAL CLUB

JULY, 1906

Absorption of atmospheric moisture by desert shrubs

VOLNEY MORGAN SPALDING

A large body of more or less conflicting literature has accumulated on the subject of the absorption of water directly from the atmosphere by leaves and other aerial parts of plants. The lack of agreement on this subject, and the fact that desert plants, if any, might be expected to take advantage of this means of adding to their meager water supply, led to an investigation of this subject by the writer, the results of which have appeared in the Botanical Gazette.* Briefly stated, they go to show that certain desert shrubs absorb to a limited extent water that is presented to their leaves and other aerial parts, while others under similar conditions are quite incapable of doing so.

At the time the experiments referred to were in progress no attempt was made to determine whether any of these plants are capable of absorbing water vapor directly from the atmosphere. It was thought that the low relative humidity of the region in which the Desert Botanical Laboratory is situated rendered such a process improbable, or, if it occurred, that it could hardly reach significant proportions. On returning to the laboratory, however, in the fall of 1905, it was learned that the ocotillo, *Fouquieria splendens*, a shrub which exhibits extreme sensitiveness to variations in water supply, and ordinarily casts its leaves in time of drouth, had been in full leaf during the entire summer, notwithstanding the exceptionally slight rainfall, the effects of which were

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* SPALDING, V. M. Biological relations of desert shrubs. II. Absorption of water by leaves. Bot. Gaz. 41 : 262–282. 1906.

[The BULLETIN for June 1906 (33: 327–365, *pl. 16, 17*) was issued 20 Jl 1906.]

plainly manifest in the dried-up and discolored vegetation around.* Various other species, notably *Parkinsonia microphylla*, *Lycium Berlandieri*, and some others, were also in full leaf, in striking contrast with their condition the year before; and this state of things, coupled with the extraordinary relative humidity, which for months had averaged approximately 60 per cent., as recorded by the hygrograph, suggested as a possible explanation of the long retention of their foliage the capacity of these plants to absorb water vapor directly from the atmosphere.† The prompt reaction of the ocotillo to increase of water supply, whether through root or stem, had already been strikingly shown by the fact that this species may form as many as five distinct leaf-coverings between February and August, "the exciting cause in each instance being an increase in the water supply" (through the root),‡ and also that leaf-formation may be induced in four or five days by artificial irrigation of the stem.§ It seemed worth while, therefore, to institute a special set of experiments in order to determine whether this shrub, and some others with which it is associated, are capable of directly absorbing and utilizing the water vapor of the atmosphere.

The method employed is essentially the same as that adopted in earlier experiments on leaf-absorption. Leaves and other aerial parts were accurately weighed and then kept for varying periods in a nearly saturated atmosphere, after which they were weighed and differences of weight noted.

The accumulation of more or less dew on one side of the receptacle employed in the experiments was taken to indicate a very nearly saturated atmosphere where the plant was placed. No deposition of dew on the surface of the plant was ever noticed, but if in any instance this occurred, the conclusion drawn from the results obtained is thereby strengthened.

Beginning with the ocotillo, two lots of leaves were taken, the

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* While the aggregate rainfall for 1905 was 23.18 inches, that for the six months, May to October, inclusive, was only 4.40 inches.

† CANNON, W. A. The effects of high relative humidity on plants. Torreya 6: 21–25. 1906.

‡ CANNON, W. A. On the transpiration of *Fouquieria splendens*. Bull. Torrey Club 32: 397–414. 1905.

§ LLOYD, F. E. The artificial induction of leaf-formation in the ocotillo. Torreya 5: 175–179. 1905.

first wholly green, though showing some loss of turgidity, while the other lot, from another plant, were turning pale, but had not become yellow. There was reason to believe that all were capable of photosynthesis, but that all had reached a condition in which more water could well be utilized. Inspection of the accompanying table (I), however, shows that both lots of leaves failed to gain in weight during two hours exposure to a nearly saturated atmosphere, and even lost slightly when kept in it over night. Moreover, following exposure to sunshine in the open air for some three hours, during which the two lots lost 0.6 and 0.8 per cent. of their weight respectively, they still failed to show any increase of weight after being kept nearly five hours in a practically saturated atmosphere. It is important, however, to note that in every case, during their stay in moist air, transpiration was reduced to such a degree as to amount essentially to complete suppression.

TABLE I. FOUQUIERIA SPLENDENS. OCTOBER 27–28, 1905.

No.	Time.	Weight.	Loss or Gain.		Conditions.
1	10.30 A.M.	9.257G			Weighed soon after gathering. Recorded relative humidity = 25 per cent.
2	10.35 "	10.677			Weighed soon after gathering. Recorded relative humidity = 25 per cent.
1	2.10 P.M.	9.236	0.021	Loss.	After exposure to currents of air in laboratory.
2	2.15 "	10.654	0.023	"	After exposure to currents of air in laboratory.
1	4.10 "	9.234	0.002	"	After exposure to nearly saturated atmosphere.
2	4.15 "	10.652	0.002	"	After exposure to nearly saturated atmosphere.
1	4.40 "	9.231	0.003	"	After exposure to open air of laboratory.
2	4.45 "	10.648	0.004	"	After exposure to open air of laboratory.
	October 28				
1	6.43 A.M.	9.225	0.006	"	After exposure to nearly saturated atmosphere.
2	6.50 "	10.637	0.011	"	After exposure to nearly saturated atmosphere.
1	10.42 "	9.167	0.058	"	After exposure to sunlight in open air.
2	10.33 "	10.558	0.079	"	After exposure to sunlight in open air.
1	3.33 P.M.	9.164	0.003	"	After exposure to nearly saturated atmosphere.
2	3.37 "	10.554	0.004	"	After exposure to nearly saturated atmosphere.

This experiment, agreeing with others not reported, indicates no capacity on the part of the leaves of *Fouquieria* to absorb water vapor, even after they have lost turgescence, or have turned pale and are almost ready to fall, but it does point to the prompt influence of a moist atmosphere, in checking, or even suppressing, transpiration, as the probably significant factor determining the long retention of its leaves the present year. At this writing, December 12, many individuals of the ocotillo have not been completely defoliated since last March.

In a second experiment with the same species, leafless shoots a

TABLE II. FOUQUIERIA SPLENDENS. NOVEMBER 13–15, 1905.

No.	Time.	Weight.	Loss or Gain.		Conditions.
1	11.58 A.M.	3.858G			Weighed soon after cutting. Recorded relative humidity = 61 per cent.
2	12.05 P.M.	7.738			Weighed soon after cutting.
1	1.20 "	3.856	0.002	Loss.	After exposure to open air of laboratory.
2	1.24 "	7.735	0.003	"	After exposure to open air of laboratory.
1	3.29 "	3.868	0.012	Gain.	After exposure to nearly saturated atmosphere.
2	3.33 "	7.756	0.021	"	After exposure to nearly saturated atmosphere.
	Nov. 14.				
1	9.58 A.M.	3.886	0.018	"	After exposure to nearly saturated atmosphere.
2	10.04 "	7.785	0.029	"	After exposure to nearly saturated atmosphere.
1	12.54 P.M.	3.863	0.023	Loss.	After exposure to open air of laboratory. Recorded relative humidity = 45 per cent.
2	12.57 "	7.750	0.035	"	After exposure to open air of laboratory.
1	2.40 "	3.873	0.010	Gain.	After exposure to nearly saturated atmosphere.
2	2.45 "	7.768	0.018	"	After exposure to nearly saturated atmosphere.
	Nov. 15.				
1	9.55 A.M.	3.836	0.037	Loss.	After exposure to open air of laboratory.
2	10.00 "	7.712	0.056	"	After exposure to open air of laboratory.
1	12.34 P.M.	3.848	0.012	Gain.	After exposure to nearly saturated atmosphere.
2	12.40 "	7.734	0.022	"	After exposure to nearly saturated atmosphere.

few centimeters in length, with their terminal buds, were employed. Table II shows that these shoots gained appreciably in weight in a nearly saturated atmosphere, but rapidly lost more than they had gained when left in an atmosphere the relative humidity of which was registered at 45 and upwards. The experiment was varied by covering the buds of another shoot with vaseline and leaving those of a control shoot untouched. As shown by Table III, the former shoot gained in weight nearly two thirds as much as the control, thus indicating that although the buds share in the process they are not the chief absorbing structure.

TABLE III. FOUQUIERIA SPLENDENS. NOVEMBER 14–15, 1905.

No.	Time.	Weight.	Loss or Gain.		Conditions.
3	10.48 A.M.	5.643G			Weighed soon after cutting.
4	10.54	6.406			Weighed soon after cutting.
3	2.05 P.M.	5.655	0.012	Gain.	After exposure to nearly saturated atmosphere.
4	2.10 "	6.425	0.019	"	After exposure to nearly saturated atmosphere.
3	2.30	5.650	0.005	Loss.	After exposure to air of laboratory. Recorded relative humidity = 44 per cent.
4	2.33	6.417	0.008	"	After exposure to air of laboratory. Recorded relative humidity = 44 per cent.
	Nov. 15.				
3	10.09 A.M.	5.618	0.032	Loss.	After exposure to air of laboratory.
4	10.14	6.365	0.052	"	After exposure to air of laboratory.
3	12.46 P.M.	5.629	0.011	Gain.	After exposure to nearly saturated atmosphere.
4	12.50	6.380	0.015	"	After exposure to nearly saturated atmosphere.

But, notwithstanding the fact, thus fully established, that the shoots of *Fouquieria* absorb considerable quantities of water vapor from a saturated atmosphere, it seems entirely unlikely that in nature the leaves receive from the branches any appreciable amount of water as a result. One morning with the recording hygrometer registering the humidity at 72, the branches lost rapidly a large percentage of what they had gained over night in a nearly saturated atmosphere, and this was the usual, rather than exceptional, state of affairs; so that the rapidity with which the branches return to the air the water they have absorbed, even when the humidity is high, seems to preclude the assumption that any, or at least any considerable amount, is passed on by them to the leaves.

It appears, then, in the case of *Fouquieria*, that (1) the leaves do not, even under favorable conditions, absorb water vapor from the atmosphere ; (2) the branches are capable of such absorption, as are also the buds, though the latter are not more specially concerned in the process than the former ; (3) both shoots and leaves give off water rapidly, not only in a dry atmosphere but also in one of rather high relative humidity ; (4) as is well known, this process is checked or practically suspended in an atmosphere nearly or quite saturated with water vapor.

Herein, apparently, lies the explanation of the fact that in spite of the very scanty rainfall of the summer, the ocotillo has remained in leaf during so large a part of the present year. It is not due to absorption of water vapor from the atmosphere, although the relative humidity, during the period of observation, has reached the extraordinary average of approximately 60 per cent., but it is due to the fact that water, which with lower humidity would be given off, has been retained by the plant. While, too, leaf-formation may be induced, as shown by Lloyd, by artificial irrigation of the stems, but not, as far as the present study indicates, by absorption of water vapor from the atmosphere, there results, nevertheless, from a long period of high relative humidity what is apparently of greater advantage to the plant, namely, the retention, for months in succession, of leaves already formed and in condition for productive work. Had the plants been defoliated, as they must have been if lack of rain had been accompanied, as usual, by low relative humidity, even the maximum number of new leaf-coverings, reported by Cannon, if they could have been produced, would probably fall far below the single continuous leaf-covering in productive energy, though this is a matter the settlement of which would involve another and very different line of experimentation.

Experiments similar to those already described were next carried out with *Celtis pallida*, which was remarkably fresh and green, notwithstanding the slight rainfall of the preceding summer. The leaves were found to lose weight rapidly in a dry atmosphere — upwards of 24 per cent. in three hours — and to gain extremely slowly in an atmosphere nearly saturated with water vapor — only eight-tenths to nine-tenths of one per cent. in five hours. Later, after abundant rain, fresh ends of branches, with leaves, lost 31 per cent. of their original weight when left in a desiccator over night, and subsequently gained in two hours barely enough to show that transpiration had been checked and absorption set up. After further drying, and consequent departure from natural conditions, the rate of gain became greater, but the experiments fail to furnish any satisfactory evidence of the absorption of water vapor from the atmosphere by the living parts of this plant before pathological changes have set in.

Experiments of the same kind with the creosote bush, *Covillea tridentata*, were carried on both before and after heavy November rains. The earlier experiments, in which branchlets and leaves that appeared pretty dry, but still normally active, were employed, exhibited a gain of nearly 1 per cent. in two and one half hours, and their surface showed a distinct increase in the stickiness which is due to the mixture of mucilaginous and waxy substances with which they are coated. Later experiments with leaves and shoots much washed by recent rains showed rapid loss of weight in a dry atmosphere, amounting in some cases to ten per cent., while after remaining in a nearly saturated atmosphere over night the gain was only from one-tenth to less than two-tenths of what they had lost.

These and other experiments with *Covillea* indicate on its part a very limited capacity for absorption of water vapor from the atmosphere. None the less such absorption does take place, and it seems highly probable that it is advantageous to the plant. Even if absorption is so slight as merely to balance, or materially reduce transpiration for a time, this may, at a critical period, prolong the life and activity of leaves that would otherwise succumb; and furthermore the spread of the waxy-mucilaginous covering over the leaves, which is manifestly favored by a high percentage of atmospheric moisture, must also materially aid in checking excessive transpiration. A period of high relative humidity, occurring as it did the past summer, coincidently with a prolonged period of light rainfall, would operate in both of these ways to prevent the premature loss of parts actively engaged in photosynthesis. It is apparently impossible, at present, to express these complicated relations quantitatively, but this by no means detracts from their importance in the economy of a plant, which owes its dominant position over wide areas not to a single advantageous structure but to a complex of successful adaptations.

Experiments of the same general character were conducted on *Prosopis*, *Parkinsonia*, *Franseria*, *Atriplex*, *Encelia*, and a number of other perennials which represent the characteristic vegetation of the region. To give these in detail would serve no useful purpose, and the results may be briefly stated as follows: The mesquite (*Prosopis*) absorbs water vapor through its leaves, but at a slow rate. *Parkinsonia microphylla* showed no capacity for absorption of water vapor except as the specimens employed retained their minute scale-leaves, and then only to a very limited extent. *Franseria deltoidea*, *Abutilon incanum* and *Encelia farinosa* all failed to show any gain whatever in a nearly saturated atmosphere until the experiments had been in progress from two to four days. Later some absorption took place, but up to the time when the leaves were plainly passing into a pathological condition the amount absorbed was wholly inadequate to compensate for what had previously been lost or even to restore turgescence.

From the hygroscopic action exhibited by the fronds of *Notholaena* sp., which in dry weather are rolled up, but are unfolded after rain, it was thought that they would probably exhibit some manifest capacity for absorption of atmospheric vapor, and this anticipation was realized, although, as the records show, it would take at least 14 days for the fronds under observation to absorb from a saturated atmosphere what they had lost in twenty hours, and keeping the curled-up fronds for days in a very moist atmosphere was not sufficient to induce their unfolding. Immersing in water was soon followed by their expansion, and partial unfolding was also induced by placing the subterranean parts in water. It appears, then, that with the coming of rain the fronds of *Notholaena* absorb water directly and that this is also accomplished, though with less prompt and complete unfolding, by the subterranean parts. As the plant continues to absorb water from the soil the fronds remain expanded until the water supply diminishes to a point where they begin to curl up. At this point a high percentage of atmospheric moisture would retard the process, thus keeping them unfolded longer than if the relative humidity were less, and maintaining them in an advantageous position for photosynthesis.

A review of the data gathered establishes the fact that of the twelve species of desert perennials subjected to experiment all exhibit some slight capacity for direct absorption of water vapor from the atmosphere, but in general the amount absorbed is inconsiderable in comparison with that given off in corresponding periods in dry air. As yet there is no evidence that these almost infinitesimal quantities of water are utilized in the body of the plant. The promptness with which the water thus absorbed is returned to the atmosphere suggests rather a superficial process, purely physical in its nature, and of no immediate physiological significance. In any case the present experiments, taken in connection with earlier ones already referred to, show that the net result to the plants found to be capable of absorbing either liquid water or water vapor is plainly much less in the latter than in the former case. Nevertheless, as shown most clearly in the experiments with *Fouquieria* and *Covillea*, a high degree of saturation of the atmosphere, by directly or indirectly preventing excessive transpiration, may be far more advantageous to the plant than a succession of light rains which are insufficient to moisten the soil; the advantage, in this case, being manifested in most striking fashion to the eye in the living green with which these otherwise sombre-hued shrubs of the desert are clothed.

Possibly the most important conclusion to be drawn from this study and a preceding one on leaf-absorption is the patent fact that the roots of desert plants constitute their only reliably active agent in providing a normal water supply. This conclusion, indeed, was to be expected; but it is none the less important to establish, in the face of evidence that might be interpreted otherwise, the capital fact that upon the roots of these desert plants rests practically the entire burden of securing and transmitting the water upon which they depend, and, however far some of them have departed from the habits of present-day mesophytes, they remain in this particular fundamentally unchanged.

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The mechanism of seed-dispersal in Polygonum virginianum *

HOWARD SPRAGUE REED AND ISADORE SMOOT

The achenes of *Polygonum virginianum* Linnaeus have a particularly efficient mode of dispersal. The long two-parted styles are persistent and become lignified during the process of development. If, after maturity, these projecting styles are struck by any object with sufficient impact, the achenes are thrown off with force enough to carry them a distance of three or four meters.

During windy weather the tall, slender racemes are blown against each other and against the strong stems of plants like *Phytolacca* and *Sambucus*, with which this species of *Polygonum* is associated. The impact thus produced is sufficient to throw off the mature achēnes without the agency of animals. Nevertheless, animals are very efficient means of dissemination, for, if they do touch the trigger-like styles, the achenes are thrown with some force against the body of the animal, where they cling, the sharp, reflexed points of the style (see fig. 1) becoming fixed in the hair, or fleece, and they may thus be carried some distance.

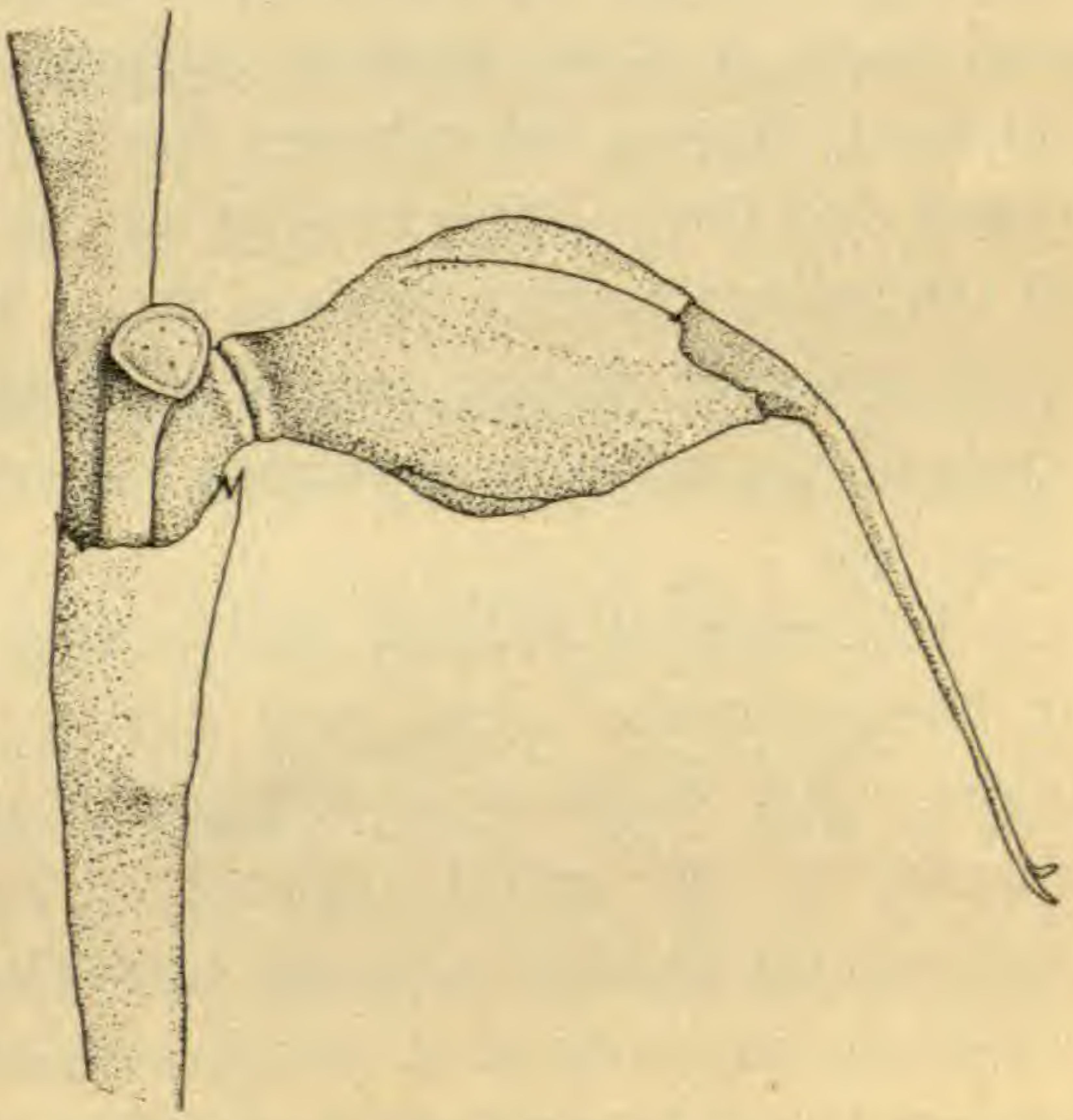

FIG. 1. A mature achene of *Polygonum virginianum*.

All botanical text-books give examples of fruits and seeds which are forcibly ejected when ripe. In most cases the force is due to some property of the ripened wall of the gynoecium. The ejection of the achenes of *Polygonum virginianum* is unique in that the requisite force is derived from a tension in the pedicel.

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* Contribution No. 9 from the Botanical Laboratory of the University of Missouri.

Hildebrand ('73) mentions this plant as one whose achenes are transported by animals, but appears not to have noticed their forcible expulsion. He mentions only the hooked styles which fasten the achenes to the hair, or fleece, of animals.

Kerner ('95) described it as a "catapult fruit." He perceived the separation-layer in the pedicel, but gave no satisfactory explanation of the manner in which ejection was accomplished. His account (2 : 842) might lead one to think that the tension was produced by the cells of the cortical parenchyma. We have not found it to be so.

The devices of the plant for dispersing its fruits have been noted by Beal ('98), but no explanation was given.

This paper relates the results of a histological study of the tissues in question. Since the achenes fly off with a force entirely disproportionate to that which strikes them, it may be assumed that there is some tension existing in the pedicels which, when released, throws the achenes from the plant. It has been supposed that the existing tension was given by changes in the tissues of the pedicel as they became dry. The attempt was made to discover whether changes might be found in the structure or arrangement of these tissues sufficient to account for the phenomenon of dispersal.

The material studied was collected near Columbia, Missouri, in the autumn of 1904, and during the summer and autumn of 1905. All stages were obtained, from the first formation of the raceme to the mature achene. The killing fluids used were mercuric-bichloride in 95 per cent. alcohol, Mann's picro-corrosive fluid, chrom-acetic acid, and Worcester's killing fluid. The older material was embedded in celloidin and the younger in paraffin. The stains used were fuchsin-iodine-green, iron-alum-haematoxylin and safranin, and Delafield's haematoxylin.

P. virginianum constitutes the only member of the subgenus *Tovara*, according to Small ('95). The plants are herbaceous annuals, somewhat woody at the base. When the species of this genus are arranged according to their histological structure, *P. virginianum* appears to stand about midway in the series. The epidermis, like that of nearly all the other species, consists of a single row of cells. The hypodermal tissues are not so well developed as in those species, like *P. alpinum*, which grow in dry situations, but is better develeped than in species like *P. scandens*, which grow in wet localities. In comparison with the other species, the stereome cylinder of *P. virginianum* is compact and well developed. The elements are small and very thick-walled, therefore they may be regarded as contributing much of the rigidity necessary to support these tall, slender stems.

The phloem bundles, although small, do not disintegrate as they do in some other species. The xylem forms a comparatively wide zone and contributes a great deal of mechanical strength to the stem. It consists of five different elements, namely, woody fibers, tracheids, spiral vessels, annular vessels, and wood parenchyma which gradually merges into the pith.

The pith consists of large cells, hexagonal in longitudinal section. Unlike the same kind of cells in other species, they are usually broader than they are high.

In a general way, the form and structure of the tissues in the pedicel are similar to those in the stem. The most constant difference between them is that some of the individual elements of the pedicels are more elongated than the corresponding elements in the stems. About 0.75 mm. below the base of the achene, the tissues of the mature pedicel are interrupted by a crescent-shaped "separation-layer." It is by virtue of this layer that the fracture is readily effected when the achenes are thrown off. Its characters will be more fully discussed later. The cells of the epidermis, which at first are parallelopipeds, like those of the cauline epidermis, become stretched from four to six times their original length as the pedicel develops.

The zones of stereome and woody tissue are reduced in width and number of elements. The zone of stereome tissue is usually thicker on the concave side of the pedicel than on the convex side (fig. 3). In all probability this may be regarded as a regulatory thickening such as Newcombe ('95) described for mechanical tissues in general.

The fibro-vascular tissue never forms a zone of any considerable thickness. There is no evidence that the phloem bundles ever disintegrate, but are continuous throughout the pedicel, although they decrease in size beyond the separation-layer. Opposite each phloem bundle there is a group of from five to seven annular and spiral vessels. Between these groups of vessels the space is filled up with wood parenchyma in such a way as to form a continuous cylinder. The woody tissue never reaches any considerable development, hence this cylinder is thin-walled even at maturity.

Just above the separation layer the fibro-vascular bundles branch dichotomously. The outer branches continue their course into the persistent calyx, the inner branches meet and fuse directly below the achene. (Figs. 2 and 3.)

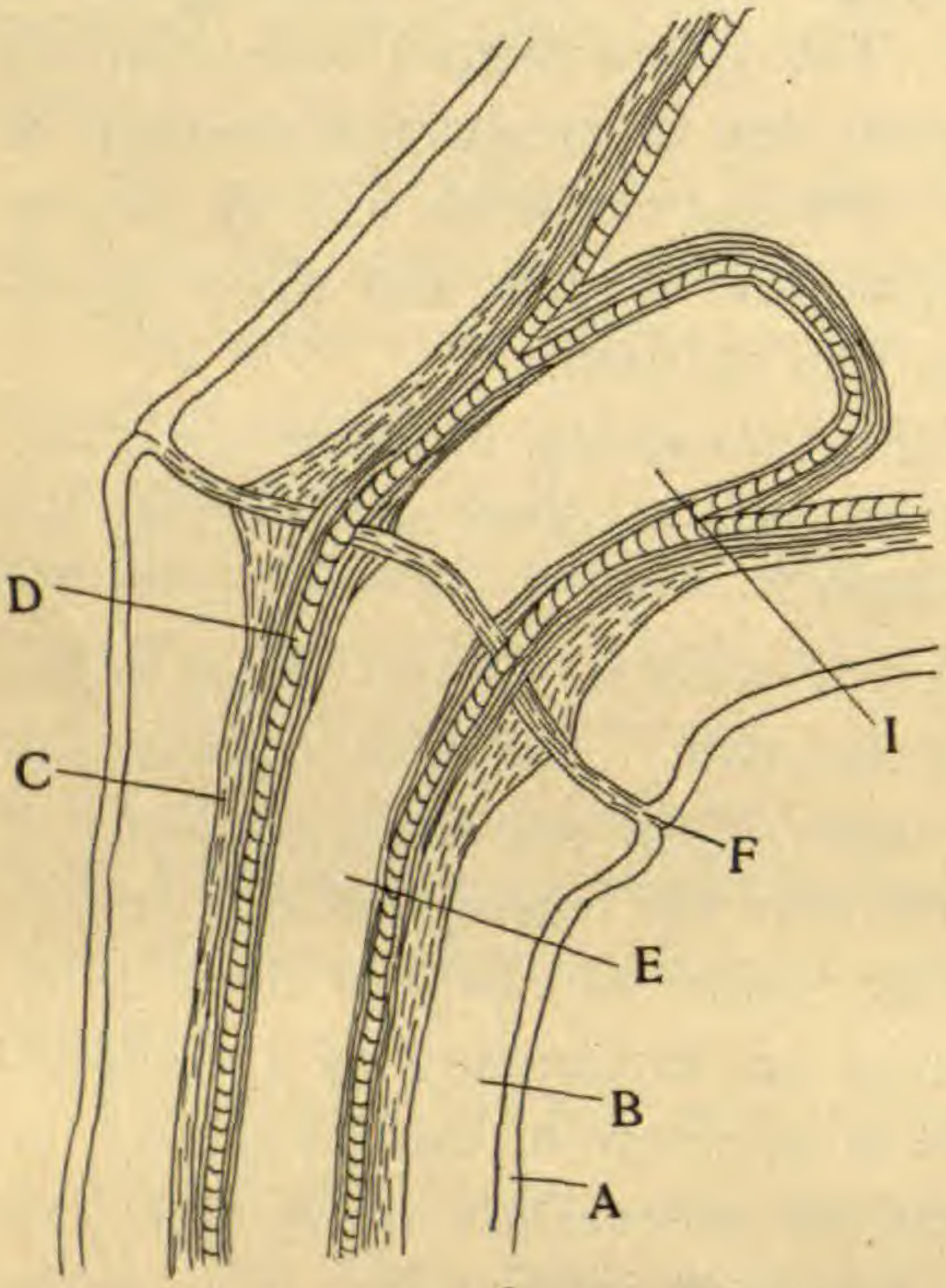

FIG. 2. Diagram of a median longitudinal section of a young pedicel shortly after the differentiation of the separation-layer. *A*, epidermis; *B*, cortex; *C*, sclerenchyma; *D*, fibro-vascular bundles; *E*, pith; *F*, separation-layer; *I*, cushion of thin-walled pith-cells.

A longitudinal section of the pedicel shows that the cells of the pith differ in size and shape from the corresponding cells in the stem. The latter were described as being hexagonal in longitudinal section and distinctly broader than they were high. The pith cells in the pedicels, on the other hand, are rectangular in longitudinal section and have a length from two to six times as great as their width (fig. 5). The longest cells are formed near the base of the pedicel; the shortest ones near the separation-layer. Subsequent changes in the form and structure of the pith cells will be described later.

The achene is attached to the distal end of the pedicel by a broad base, which does not become weakened as the fruit matures. This accounts for the fact that when the achene is cast off the fracture occurs, not at its base, but at the specially developed separation-layer mentioned above.

The wall of the achene consists of two layers. The outer and thicker layer is composed of compact sclerenchyma elements, which have been described by Sirrine ('94), and the inner layer is composed of long, woody fibers, which are in close contact with the sclerenchyma wall. At the apex of the achene the fibers of the inner wall are continued outward and downward, forming the tissue of the persistent style. The whole structure of the achene gives to it sufficient mechanical strength to resist fracture at all points except the specially constructed separation-layer.

Certain indications of a separation-layer in the pedicel are evident from a very early stage. The youngest flower-stalks examined seemed to indicate that the pollen-mother-cells had recently accomplished the second division. In such sections one may discern a zone of short cells extending across the pedicel a short distance beneath the base of the macrosporangium. The cells of this zone are thin-walled and parenchymatous like the other cells of the young pedicel. At the same time, or very shortly afterward, the pedicel is slightly constricted in the region of this zone.

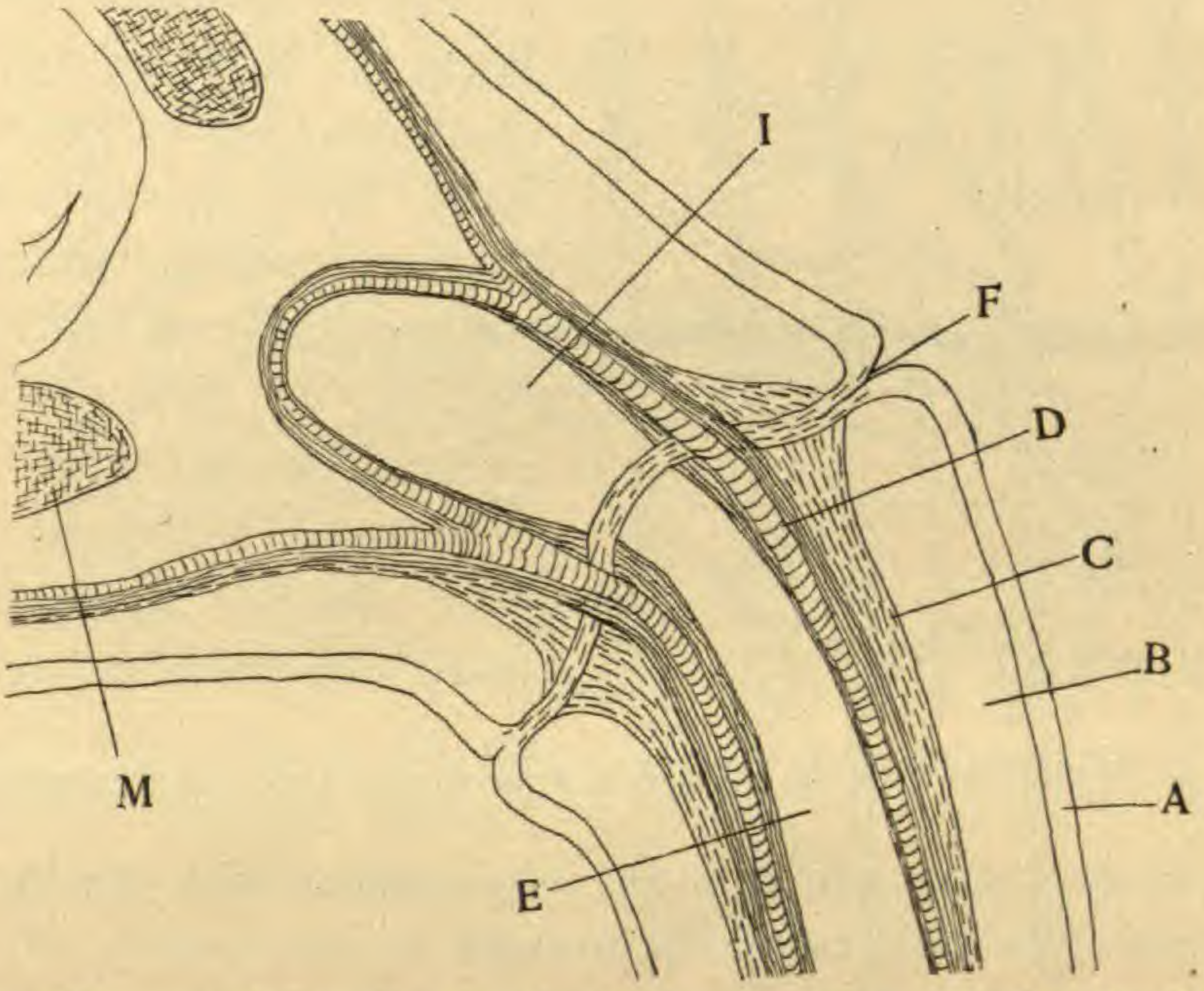

FIG. 3. Diagram of a median longitudinal section of a pedicel at the time of maturity. *A*, epidermis; *B*, cortex; *C*, sclerenchyma; *D*, fibro-vascular bundles; *E*, pith; *F*, separation-layer; *I*, cushion of thin-walled pith-cells; *M*, sclerenchyma-layer of achene-wall.

As the flower approaches the time of blossoming the cells of the pedicel undergo differentiation into the tissues described above.

At the time when the gynoecium is pollinated, it has been raised by intercalary growth nearly 0.5 mm. above the place where the zone of short cells arose. Simultaneously, a well-defined separation-layer may be distinguished in the midst of this zone. It consists of two rows of very short cells (fig. 4), which come in contact with the epidermis of the pedicel at the constriction which appeared somewhat earlier. This layer has the general form of a very low, flat-topped dome (fig. 2). All the tissues of the pedicel, except the fibro-vascular bundles, are intersected by this double row of cells. As the superficial notch deepens, the margins of these layers are brought into contact with the epidermal layers, and their cells become cutinized.

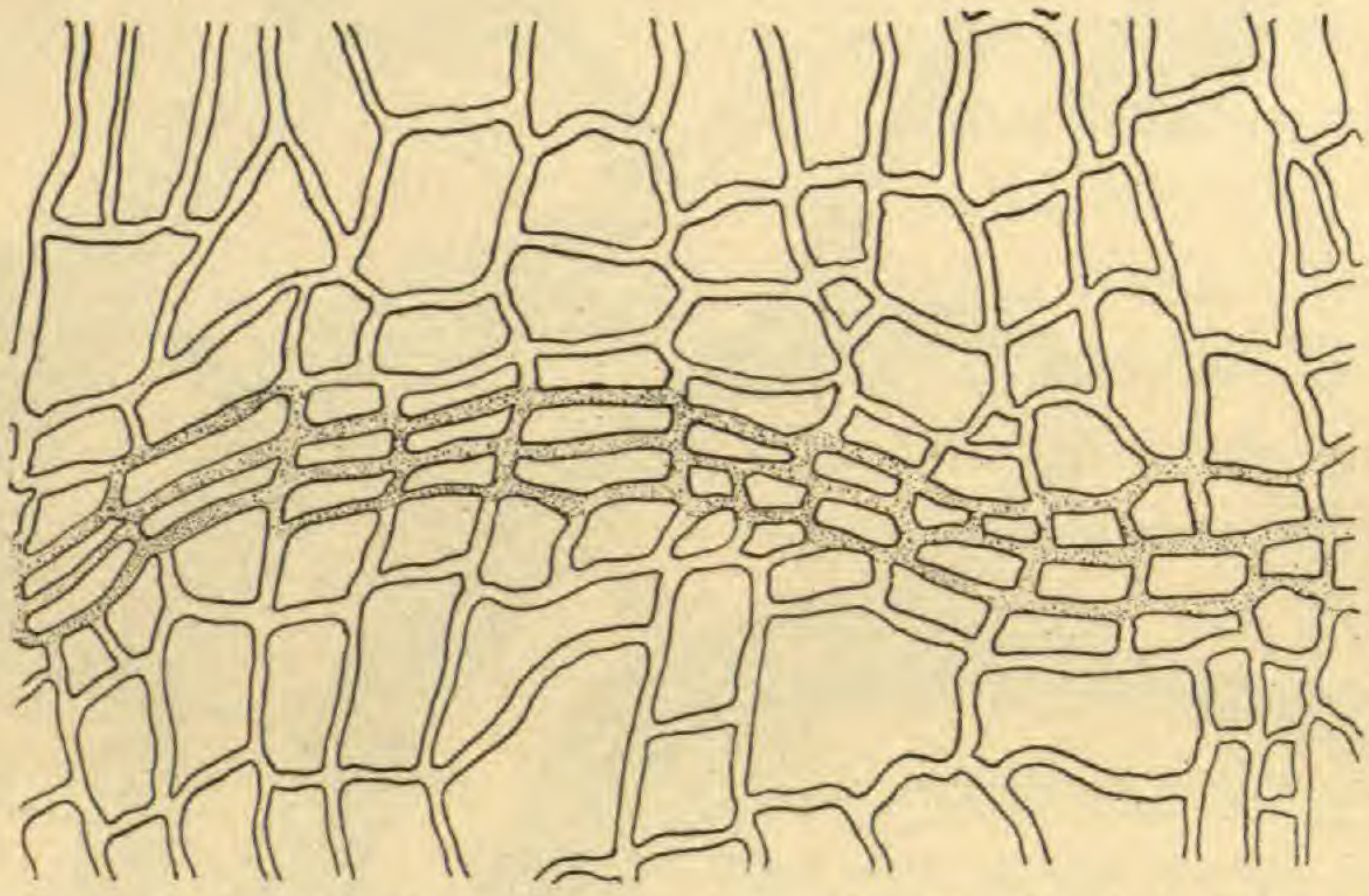

FIG. 4. Section showing the separation-layer shortly after it is differentiated.

Following the differentiation of the separation-layer, there is instituted a series of changes in the tissues of the pedicel. The pith-cells for some distance on the proximal side of the layer begin to elongate, and at the same time their walls become considerably thickened. The cell-elongation and wall-thickening appear to start about the same time; ultimately the greatest wall-thickness is reached in the immediate vicinity of the separation-layer. The result is that the separation-layer is pushed upward in the middle, giving it the form of a higher and more sharply pointed dome than formerly (fig. 3). Some notion of the amount of elongation may be formed by noting the increase of curvature in the separation-layer as the time of maturity approaches (figs. 2 and 3). Figure 6, T, represents the thickness of walls of pith-cells in the immediate vicinity of the separation-layer, as compared with the same kind of cells half way down the pedicel, shown in figure 5. On the distal side of the separation-layer, the walls of the pith-cells remain thin and unchanged (fig. 7), except for a few rows in the immediate vicinity of the layer. The slender, pointed cells of this tissue are interpreted to mean that they have grown under pressure, which caused them to glide between neighboring cells, as opportunity offered. The pressure involved was produced by the elongation of the thick-walled cells. By referring to figure 5 it will be seen that the rigid, thick-walled cells of the pith do not glide between each other. The mechanical tissues develop regularly and form the cylinder described above.

The fibro-vascular system may be compared to a thin-walled, inelastic cylinder (fig. 3, D), inside of which the elongating pith-cells (fig. 3, E) act like a piston moving against the soft, spongy, pith-cells (fig. 3, I) in the closed end of the rigid cylinder. The cushion of thin-walled cells is thus analogous to a compressed spring (one end of which presses against the achene and the other against the separation-layer). So long as the structure is undisturbed, the fibro-vascular cylinder restrains the elongating force of the pith column, but when the rigid style is struck by sufficient force, the strained walls of the cylinder break at the separation-layer and the compressed cushion of cells, suddenly expanding like a released spring, throws the achene off with considerable force. The invariable breaking of the fibrovascular bundles at the separation-layer is not hard to explain. An examination of a

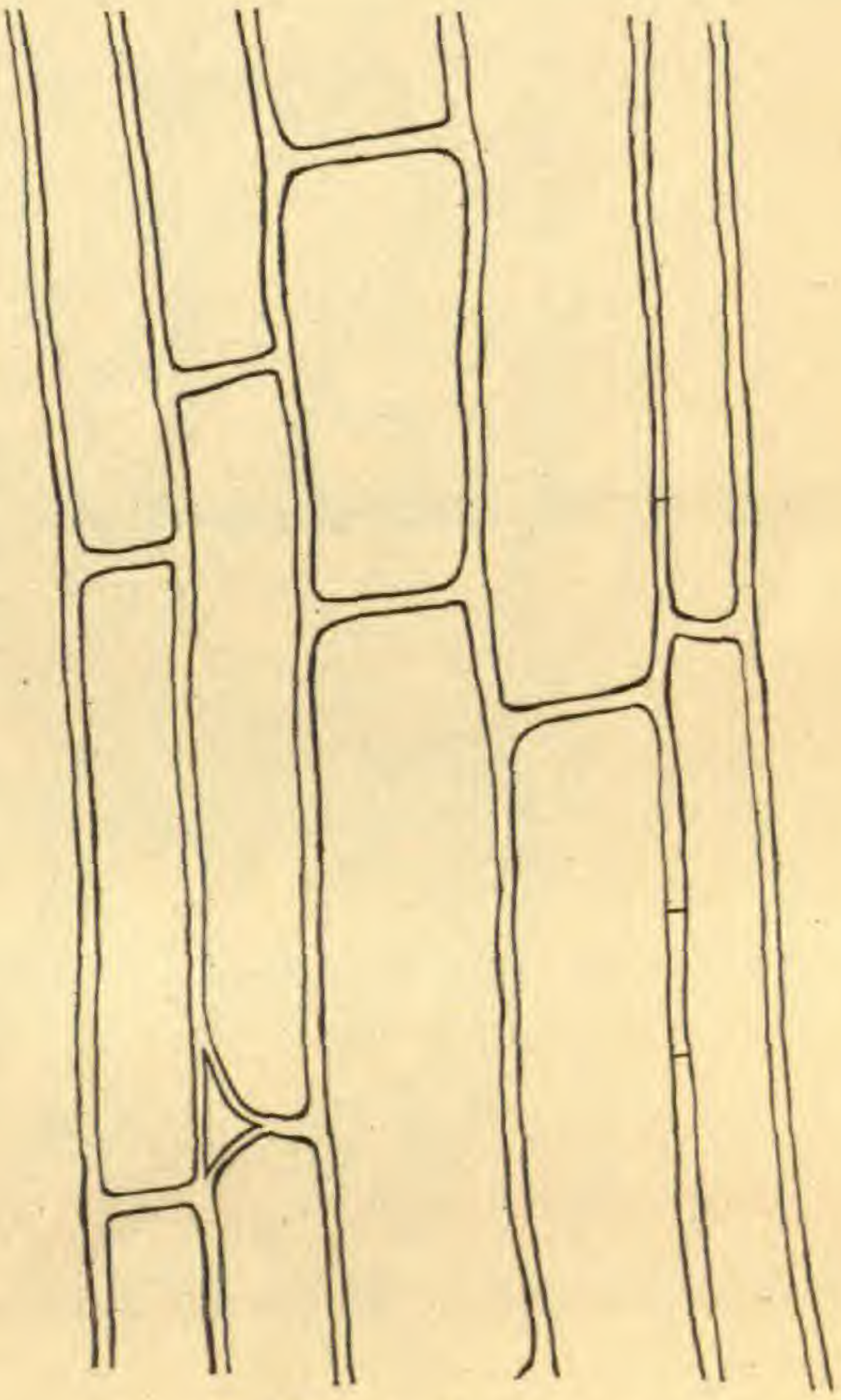
FIG. 5. Longitudinal section of pith taken about midway between the base and apex of the pedicel.

longitudinal section (fig. 3) shows that the reinforcing sclerenchyma-tissue is intersected by the separation-layer, thus materially weakening the mechanical tissue at that point.

Many longitudinal sections show a splitting of the marginal portion of the separation-layer as the fruits approach maturity. This was interpreted to mean that the cells of the cortex had lost part of their water content, and consequently had shrunken. When the cortical layer is thus cleft, the subsequent ejection of the achene is entirely dependent on the pith and mechanical tissue. The careful examination of several hundred sections failed to give any evidence which would confirm Kerner's statement that the cells of the cortical parenchyma become lignified. On the contrary, we found that the cortex plays no part whatever in producing the tension which ejects the fruit.

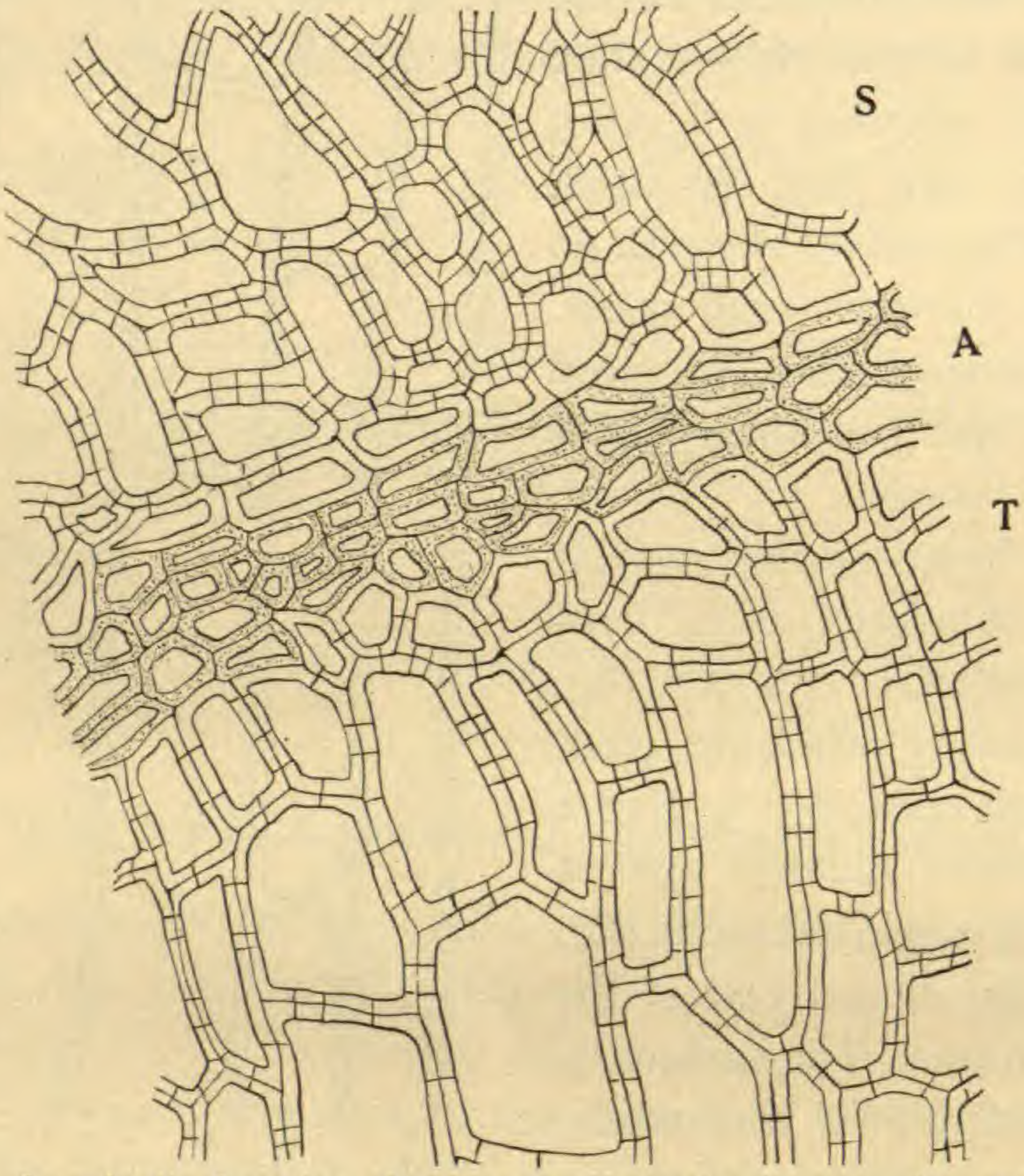

FIG. 6. Longitudinal section of pith at the separation-layer. *A*, separation-layer; *S*, pith-cells on distal side of separation-layer; *T*, pith-cells on proximal side of separation-layer.

In order to learn whether any of the tissues of the pedicel were hygroscopic, they were subjected to moisture, with subsequent drying. Several mature racemes were placed in a moist chamber with a saturated atmosphere and allowed to remain there for four days, during which time the achenes remained attached. The racemes were then removed and placed in an oven, heated to 75 degrees C. After seven hours they were again examined, but the effect of the drying had not been sufficient to detach any of the achenes.

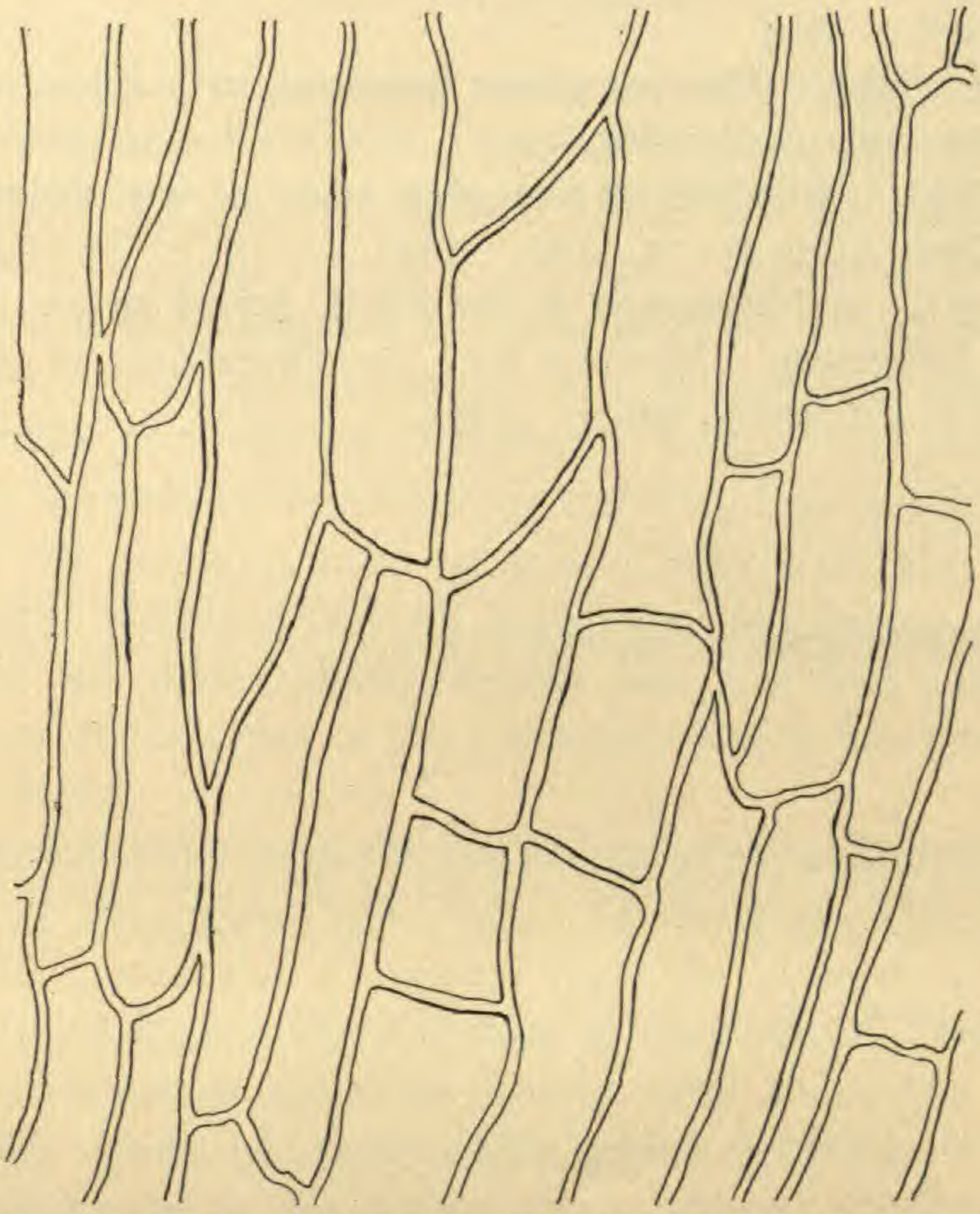

FIG. 7. Longitudinal section of thin-walled pith-cells which form the cushion (*cf.* figures 2 and 3, *I*).

The phenomenon of dispersal awaits an impact strong enough to break the fibrovascular cylinder and release the compressed cushion of cells. It is principally dependent on three things — a specially developed "separation-layer"; the existence of a longitudinal tension between the pith-column and the investing fibrovascular cylinder; and a blow on the achene analogous to the pull on the trigger which discharges a gun.

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The pedunculate species of Trillium

HENRY ALLAN GLEASON

About forty specific names and a correspondingly large number of varietal ones have been proposed for the pedunculate species of *Trillium* during the century and a half that has elapsed since the publication of the *Species Plantarum*. Linnaeus himself left the genus in some confusion by including two species under the name *T. cernuum*. Others added to it by imperfect descriptions and incorrect citations, and Rafinesque complicated matters still further by the publication of a large number of species the identity of which will probably never be satisfactorily established. Gray, Watson, and Harbison have all contributed in bringing order into the genus, and more recently Rendle has published such careful descriptions of the types of the Linnaean species that they are no longer in doubt.

The species fall into three very natural groups separated by the character of the stigmas and ovary. In the first of these, which may be designated the *T. erectum* type, the ovary is deeply and sharply six-lobed, and the members of each pair of lobes, corresponding with one of the three carpels, unite above into a short thick sessile recurved stigma,which tapers gradually to the tip. In the second, the *T. grandiflorum* type, the ovary is less deeply angled or even merely three-lobed ; it is truncate, rounded, or somewhat narrowed at the end ; and the stigmas are slender and of virtually uniform diameter throughout. *T. rivale* S. Watson is included in this group because of Watson's statement that it is related to *T. nivale*. The material available for examination was too fragmentary to determine accurately the character of the stigma. In the last, or *T. Catesbaei* type, the stigmas are likewise slender and of uniform diameter, but they are united below into a definite style. These distinctions are not only constant, but they are very striking, and characters of no greater importance have been used in other families for the segregation of genera.

Within the three groups thus separated by the structure of the stigmas, the species are distinguished most certainly by the length of the filaments and anthers, supplemented by the color of the petals and ovary, and the length and position of the peduncle. The absolute length of the stamens may be lessened considerably by drying, but in that case the shrinkage is uniform, so that the proportionate lengths of filaments and anthers remain unchanged. The other specific characters, while quite typical of many species, are either subject to considerable variation in nature or are easily altered by pressing. The color of the ovary, for certain forms at least, is quite constant. A very few species, such as *T. undulatum* and *T. nivale*, may be distinguished by the shape of the leaves, but in general the leaves and stems of all the species are very similar.

No attempt has been made to provide exhaustive descriptions of the species. In some cases the characters used in the key include all of the typical features; in other cases a few additional descriptive notes have been added in the text.

Key to the species

- Stigmas sessile, short, stout, tapering from the base to the apex, recurved at the tip, their length about half that of the 6-angled or 6-winged ovary.
  - North American species; petals white, pink, or dark purple.
    - Ovary white or with a tinge of pink; petals white or rarely pink; peduncle nodding or horizontal.
      - Filaments one half as long as the anthers, or shorter. 1. *T. declinatum.*
      - Filaments two thirds as long as the anthers, or longer. 2. *T. cernuum.*
    - Ovary dark-purple or nearly black; petals white to dark-purple; peduncle erect or declined, or rarely nodding.
      - Filaments 8–12 mm. long, approximately equaling the anthers. 3. *T. Vaseyi.*
      - Filaments 2–6 mm. long, shorter than the anthers or very rarely subequal to them.
        - Stamens 15 mm. long or more, much exceeding the stigmas. 4. *T. simile.*
        - Stamens 13 mm. long or less, equaling or shorter than the stigmas.
          - Anthers purple, 8–10 mm. long, 2–3 times as long as the filaments. 5. *T. Rugelii.*
          - Anthers yellow, 5–9 mm. long, 1.2–2 times as long as the filaments. 6. *T. erectum.*
  - Species of eastern Asia and Japan; petals white or none.

Petals none or abortive. 7. *T. Smallii.*

Petals present.

Anthers about equaling the filaments, 4–6.5 mm. long. 8. *T. Tschonoskii.*

Anthers 2–3 times as long as the filaments, about 10 mm. long. 9. *T. camschatcense.*

Stigmas sessile, usually more than half as long as the ovary, slender and of uniform diameter throughout, erect or spreading, or somewhat recurved.

Ovary 3-lobed.

Petals very narrow, less than half as wide as the sepals. 10. *T. Govanianum.*

Petals much broader than the sepals.

Ovary tapering at the tip; peduncle exceeding the leaves. 11. *T. rivale.*

Ovary truncate or rounded; peduncle shorter than the leaves.

Leaves oblong, ~~acute~~ obtuse. 12. *T. nivale.*

Leaves ovate, acuminate. 13. *T. undulatum.*

Ovary 6-angled.

Filaments one-half to two-thirds as long as the anthers. 14. *T. Scouleri.*

Filaments equaling the anthers, or barely shorter than them.

Stamens 15 mm. long or more; stigmas straight or nearly so. 15. *T. grandiflorum.*

Stamens 13 mm. long or less; stigmas more or less recurved. 16. *T. ovatum.*

Stigmas united below into a short straight style.

Leaves narrowly elliptic; peduncle erect; stamens straight. 17. *T. pusillum.*

Leaves broadly elliptic; peduncle nodding; stamens curved.

Filaments equaling the anthers. 18. *T. Catesbaei.*

Filaments much shorter than the anthers. 19. *T. affine.*

✓1. **Trillium declinatum** (A. Gray) sp. nov.

Trillium erectum declinatum A. Gray, Man. ed. 5. 523. 1878.

Stem stout, smooth, erect, 2–3.5 dm. high; leaves broadly rhomboid, 8–12 cm. long and wide, narrowed at base, abruptly short-acuminate; peduncles horizontal or declined, 4–6 cm. long; petals ovate-oblong, white, 2–3.5 cm. long; filaments 2–5 mm. long, 30–50 per cent. as long as the anthers, which are 5–12 mm. long; ovary white or with a tinge of pink, deeply 6-winged; stigmas sessile, stout, thick at the base, tapering gradually to the recurved tip.

Type locality: Ohio.

Distribution: Ohio and southern Michigan to Missouri and southern Minnesota.

Trillium declinatum has heretofore been associated with *T. erectum*, but its affinities, as shown by distribution and structure, are much more with *T. cernuum*. *T. declinatum* also has a pleasant odor, wholly unlike the heavy, disagreeable odor of *T. erectum*.

2. TRILLIUM CERNUUM L. Sp. Pl. 339. 1753

Not *Trillium cernuum* Walt. Fl. Car. 126. 1788, nor Michx. Fl. Bor. Am. 1: 216. 1803.

Peduncle deflexed, 1–4 cm. long; filaments 3–6 mm. long, 67–120 per cent. as long as the anthers, which are 3–6.5 mm. long.

Type locality: Carolina.

Distribution: Nova Scotia to Manitoba; south to Minnesota, Michigan and Pennsylvania, and in the mountains to North Carolina and Georgia. This range lies entirely to the north and east of that of the preceding species, and the only herbarium evidence that they overlap at any place is from collections of both species made in the vicinity of St. Paul, Minnesota.

The most evident distinction between the two in fresh material is the position and length of the peduncle, nodding and short in *T. cernuum*, long and horizontal in *T. declinatum*. The length cannot be taken as an absolute criterion, since in exceptional cases it may fall within the normal limits of the other species, and the position may be changed by pressing. In dried material a safe character is the relative length of the filaments and anthers. Careful measurements of a large series of specimens show that in this the two species do not overlap, and the distinction is so obvious that measurements are virtually never necessary.

Linnaeus' description, as is now well known, referred to two species, this and *T. Catesbaei*. The type specimen, preserved in the Linnaean herbarium, is of the form usually regarded as *T. cernuum*, as has been recently shown by Rendle.

3. TRILLIUM VASEYI Harbison, Biltmore Bot. Studies **1**: 24. 1901

Peduncle declined or horizontal, 5–8 cm. long; petals dark-red, ovate, 3.5–6 cm. long, 2.5–4 cm. wide; stamens much surpassing the stigmas; filaments and anthers about equal, each 8–12 mm. long.

Type locality: The southern Alleghanies.

Distribution: The lower Appalachian region, from Tennessee to Georgia and South Carolina.

The flowers are larger and the filaments longer in this than in any other red-flowered North American species.

✓4. **Trillium simile** sp. nov.

Stem stout, erect, smooth, 3–4.5 dm. high; leaves very broadly rhomboid, abruptly narrowed at base, short-acuminate at apex, 10–18 cm. long and broad; peduncle 3–7 cm. long, declined or cernuous; petals white, broadly ovate, obtuse or subacute, 3–4 cm. long, 2–3 cm. wide; stamens much surpassing the stigmas; filaments 5–6 mm. long, about half as long as the yellow anthers, which are 10–12 mm. long; ovary dark-purple, deeply 6-lobed, the stigmas short, stout, sessile, tapering from the base to the recurved tip.

Type collected in moist woodlands near Tryon, North Carolina; *Biltmore Herbarium 14933A*, in the herbarium of the New York Botanical Garden. Other specimens of this species have been collected on Tryon Mountain, North Carolina, and in Fannin County, Georgia, by A. M. Huger, and at Biltmore, North Carolina.

In general habit it resembles closely *T. Rugelii*, but is distinguished by the much longer stamens, the yellow anthers and the proportionately longer filaments.

5. TRILLIUM RUGELII Rendle, Jour. Bot. **39**: 331. 1901

Peduncle about 2 cm. long, nodding: petals broadly ovate, white; filaments 3–3.5 mm. long; anthers purple, 8–10 mm. long.

Type locality: Broad River, North Carolina.

Distribution: The mountains of western North Carolina and northern Georgia. The Georgia record is based on a fruiting plant, *Harper 1891*, from Randolph county.

6. TRILLIUM ERECTUM L. Sp. Pl. 340. 1753

Trillium pendulum Willd. Gesell. Naturf. Berlin Neue Schr. **3**: 421. 1801.

Trillium rhomboideum Michx. Fl. Bor. Am. **1**: 215. 1803.

Trillium rhomboideum album Michx. Fl. Bor. Am. **1**: 215. 1803.

Trillium foetidum Salisb. Parad. Lond. *pl. 35.* 1806.
Trillium obovatum Pursh, Fl. Am. Sept. 245. 1814.
Trillium erectum atropurpureum Pursh, Fl. Am. Sept. 245. 1814.
Trillium erectum album Pursh, Fl. Am. Sept. 245. 1814.
Trillium purpureum Kin; Ell. Sk. **1**: 430. 1817.
Trillium erectum viridiflorum Hook. Bot. Mag. *pl. 3250.* 1833.
Trillium erectum flavum Torr. Fl. New York **2**: 296. 1843.
Trillium album Small, Fl. S. U. S. 278. 1903.

Peduncle 2–8 cm. long, erect or nearly so; petals ovate to narrowly oblong, dark-purple, white or greenish-white; anthers 5–9 mm. long, once and a fourth to twice as long as the filaments.

Type locality: Virginia.

Distribution: New Hampshire to Ontario, south to Pennsylvania, and in the mountains to Virginia, West Virginia and North Carolina; nearly all of its range lies in the Atlantic watershed.

The species is very variable in the color, size, and shape of the petals, but the different forms so intergrade that specific separation is impossible. Of the forms described by Rendle, number 2 apparently refers to the plant described in this paper as *T. declinatum.* A plate of Willdenow's illustrating his *T. pendulum* leaves no doubt of its identity with the white-flowered form of *T. erectum,* but later usage of the name may possibly refer in part to *T. cernuum.* Terms have been somewhat confused so that no distinction is made between a nodding or pendulous peduncle, hanging below the leaves, and a nodding flower upon an erect peduncle. There is some doubt also concerning the species described as *T. obovatum* by Pursh. It had white, obovate petals, and in this resembles *T. grandiflorum,* but various authors have since regarded it as synonymous with *T. erectum,* and it will be so treated here. Under either interpretation it has no bearing on the nomenclature of any species.

7. TRILLIUM SMALLII Maxim. Mel. Biol. **11**: 862. 1883

Petals none or abortive: anthers short, dilated, blunt, about 3–4 mm. long.

Type locality and distribution: Japan.

Rendle would consider this but a form of *T. Tschonoskii,* with reduced or abortive petals. This peculiarity, however, seems to be constant, and in addition the anthers are totally different from those of *T. Tschonoskii.*

8. TRILLIUM TSCHONOSKII Maxim. Mel. Biol. **11**: 863. 1883

Trillium erectum album A. Gray, in Perry, Narr. Exped. China and Japan **2**: 320. 1856. Not *T. erectum album* Pursh.
Trillium erectum japonicum A. Gray, Mem. Am. Acad. **6**: 413. 1859.

Peduncle usually only 1–4 cm. long; petals white; flower much smaller than in *T. erectum.*

Type locality: Japan.

Distribution: Japan and China.

9. TRILLIUM CAMSCHATCENSE Ker, Bot. Mag. *sub pl. 855.* 1805.

Trillium obovatum Pursh, Fl. Am. Sept. 245, in part. 1814.
Trillium camtschaticum Pallas; Pursh, Fl. Am. Sept. 246, as a synonym. 1814.

Type locality: Kamtschatka.

Distribution: China, Japan, and eastern Siberia.

10. TRILLIUM GOVANIANUM Wall. Cat. no. 812. 1828. — Royle, Illustr. Bot. Himal. 384. *pl. 93. f. 1.* 1839

Trillidium Govanianum Kunth, Enum. Pl. **5**: 120. 1850.

Type locality and distribution: The Himalaya Mountains.

11. TRILLIUM RIVALE S. Watson, Proc. Am. Acad. **20**: 378. 1885

Type locality: California.

Distribution: California and Oregon.

The slender stem and peduncle do not exceed 2 dm. in height; the leaves are 3–5 cm. long and evidently petioled. The material available for examination is in poor condition, and the species is associated with *T. nivale* and *T. undulatum* from Watson's statement alone. The stigma is said to be short, and the ovary narrowed at the tip; in both of these characters it is quite unlike *T. nivale.*

12. TRILLIUM NIVALE Riddell, Syn. Fl. West. St. 93. 1835

Type locality: Central Ohio.

Distribution: Western Pennsylvania to southeastern Minnesota, a range nearly coinciding with that of *T. declinatum.*

13. TRILLIUM UNDULATUM Willd. Gesell. Naturf. Berlin Neue Schr. **3**: 422. 1801

Trillium erythrocarpum Michx. Fl. Bor. Am. **1**: 216. 1803.
Trillium pictum Pursh, Fl. Am. Sept. 244. 1814.

Type locality: Pennsylvania.

Distribution: Nova Scotia to Ontario and Wisconsin, and south in the mountains to South Carolina and Georgia.

14. **Trillium Scouleri** Rydberg, sp. nov.

Trillium grandiflorum Hook. Fl. Bor. Am. **2**: 180, in part. 1839. Not *T. grandiflorum* Salisb.
Trillium obovatum Hook. *loc. cit.* in part. Not *T. obovatum* Pursh.

Stem stout, erect, 2–4 dm. high; leaves broadly rhomboid, 6–12 cm. long and wide, acute or short-acuminate, rounded or truncate at base, closely sessile; peduncle erect or nearly so, 3–5 cm. long; petals ovate-oblong, white, subacute, 3–5 cm. long, 1–2 cm. wide; stamens 13–24 mm. long, equaling or exceeding the stigmas; filaments 5–9 mm. long, about one-half to two-thirds as long as the anthers; stigmas slender, recurved at the tip, erect, or usually divergent, about equaling the ovary.

Type locality: British Columbia.

Distribution: British Columbia to Montana and California.

15. TRILLIUM GRANDIFLORUM (Michx.) Salisb. Parad. Lond. *pl. 1.* 1805

Trillium rhomboideum grandiflorum Michx. Fl. Bor. Am. **1**: 216. 1803.
Trillium erythrocarpum Ker, Bot. Mag. *pl. 855.* 1805. Not *T. erythrocarpum* Michx.

Type locality: The mountains of North Carolina.

Distribution: From Quebec and New England west to Minnesota, and south along the mountains to Florida.

16. TRILLIUM OVATUM Pursh, Fl. Am. Sept. 245. 1814

Trillium californicum Kellogg, Proc. Calif. Acad. **2**: 50. 1863.
Trillium crassifolium Piper, Erythea **7**: 104. 1899.

Type locality: The Columbia River.

Distribution: British Columbia to Montana, Colorado, and California.

The three preceding species constitute a very well-marked natural group closely resembling each other in habit and flower-structure. In the western species the stigmas are usually somewhat spreading, while in *T. grandiflorum* they are normally erect and connivent. The latter is separated also by its geographical distribution. Aside from these the only reliable characters are found in the length of the filaments and anthers. Measurements of a series of herbarium specimens give the following results:

Species.	Filaments.			Anthers.		
	Maximum.	Mean.	Minimum.	Maximum.	Mean.	Minimum.
T. Scouleri	9	6.4	5	15	10.8	8
T. grandiflorum	11	9.1	6	13	10.4	8
T. ovatum	5	4.4	4	7	6.4	5

T. crassifolium Piper is founded on a small form of *T. ovatum* with thickish, shining, broadly ovate, closely sessile leaves. It has no definite morphological character to separate it from Pursh's species.

17. TRILLIUM PUSILLUM Michx. Fl. Bor. Am. **1**: 215. 1803

Trillium pumilum Pursh, Fl. Am. Sept. 245. 1814.
Trillium texanum Buckl. Proc. Acad. Philad. **1860**: 443. 1861.

Type locality: South Carolina.

Distribution: Pine barrens of the southern Atlantic States. The species is little known and very poorly represented in American herbaria.

18. TRILLIUM CATESBAEI Ell. Sk. **1**: 429. 1817

Trillium cernuum L. Sp. Pl. 339, in part. 1753.
Trillium nervosum Ell. Sk. **1**: 429. 1817.
Trillium stylosum Nutt. Gen. 1: 239. 1818.

Type locality: South Carolina.

Distribution: North Carolina and Tennessee to Georgia and Alabama.

19. TRILLIUM AFFINE Rendle, Jour. Bot. **39**: 334. 1901

Type locality and distribution: Georgia.

No specimens have been seen which could be referred to this species, but Rendle's careful description makes it certain that it is quite distinct from *T. Catesbaei.*

SPECIES DUBIAE

The following species were all described by Rafinesque, with usually very imperfect characterizations. Accurate identification of them from the descriptions alone is impossible, although his statements as to the color of the petals make it probable that most of them refer to *T. erectum* or to *T. cernuum.*

Trillium acuminatum, Med. Repos. N. Y. II. **5**: 361. 1808.
Trillium brevipetalum, Med. Fl. **2**: 100. 1830.
Trillium divaricatum, loc. cit. 102.
Trillium flavum, loc. cit. 100.
Trillium hamosum, loc. cit. 101.
Trillium latifolium, loc. cit. 101.
Trillium lirioides, loc. cit. 100.
Trillium nutans, loc. cit. 99.
Trillium obcordatum, loc. cit. 101.
Trillium spatulatum, loc. cit. 101.

COLUMBIA UNIVERSITY.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1906)

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

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

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Bacon, A. E. A new station for *Rhodora*. Vermont Bot. Club Bull. **1**: 15. Ap 1906.

Bates, J. M. Rust notes for 1905. Jour. Myc. **12**: 45–47. 31 My 1906.

Bergen, J. Y. Some littoral spermatophytes of the Naples region. Bot. Gaz. **41**: 327–333. 31 My 1906.

Bessey, E. A. *Dilophospora Alopecuri*. Jour. Myc. **12**: 57, 58. 31 My 1906. [Illust.]

Blanchard, W. H. Two new species of *Rubus* from Vermont and New Hampshire. Rhodora **8**: 95–98. 12 My 1906.

R. elegantulus and *R. pergratus* spp. nov.

Bowman, H. H. M. The Chinese sumach, or tree of heaven, *Ailanthus glandulosa*. Plant World **9**: 136–138. Je 1906.

Brainerd, E. How stems and stolons disappear in *Viola*. Vermont Bot. Club Bull. **1**: 11. Ap 1906.

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Brown, N. E. *Anthurium Forgeti* N. E. Brown (n. sp.). Gard. Chron. III. **39**: 161, 162. 17 Mr 1906.

Native of Colombia.

Bubák, F. Einige neue Pilze aus Nord America. Jour. Myc. **12**: 52–56. 31 My 1906.

Descriptions of 11 new species in 9 genera, including *Pseudostegia* gen. nov.

Clute, W. N. The moonwort, *Botrychium Lunaria*. Fern Bull. **14**: 80, 81. Jl 1906. [Illust.]

Cook, M. T. The disintegrating influences of tropical plants. Plant World **9**: 129–131. *f. 19*. Je 1906.

Cook, O. F. The vital fabric of descent. Proc. Wash. Acad. Sci. **7**: 301–323. 19 Mr 1906.

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Twelve species are recognized, of which 11 are described as new and 3 are reported from arctic America.

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Elmer, A. D. E. New and noteworthy western plants. III. Bot. Gaz. **41**: 309–326. 31 My 1906.

Includes descriptions of 19 new species in as many genera, all from California.

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Includes descriptions of 12 new species and varieties, in 9 genera.

Fernald, M. L. Some anomalous plants of *Tiarella* and *Mitella*. Rhodora **8**: 90–92. 12 My 1906.

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Includes new species in *Vernonia*, *Stevia*, *Eupatorium*, *Verbesina*, *Liabum*, *Senecio*, and *Lophopappus*; all illustrated.

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A descriptive monograph; new species are described in *Usnea*, *Parmelia* and *Gyrophora*.

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Includes a description of *R. macrostachyum* sp. nov. (of the subgenus *Parilla*), from Peru.

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Peckolt, T. Volksbenennungen der brasilianischen Pflanzen und Produkte derselben in brasilianischer (portugiesischer) und von der Tupisprache adoptirten Namen. Pharm. Rev. **24**: 17–24. Ja 1906; 33–38. F 1906; 65–68. Mr 1906; 161–165. Je 1906.

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BULLETIN

OF THE

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

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BULLETIN

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AUGUST, 1906

North American species of Peridermium*

JOSEPH CHARLES ARTHUR AND FRANK DUNN KERN

No descriptive account of the species of *Peridermium* found in North America has ever been published. The species have been listed by Farlow and Seymour in their Index issued fifteen years ago, † and again within the year. ‡ The pine-inhabiting forms were the subject of a paper before this association in 1896 by Underwood and Earle, § in which the forms of the eastern United States were described under three species, and three other species, not described, were said to occur in western North America. No other general survey of this part of the North American flora is at present available in any form.

There has been, and still is, great uncertainty regarding the number of valid species. The study and comparison of these species is rendered very difficult owing to the absence of detailed descriptions and figures, the original descriptions especially containing few diagnostic characters. There are also inherent difficulties due to the slight morphological differences between some of the species, and, furthermore, a full understanding of the subject cannot be expected until the microscopic examination is liberally supplemented by cultures. Although there has been no mono-

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* Read before the Botanical Section of the American Association for the Advancement of Science, New Orleans meeting, January 1, 1906.

† FARLOW, W. G., & SEYMOUR, A. B. A provisional host index of the fungi of the United States. Part 3. 1891.

‡ FARLOW, W. G. Bibliographical index of North American fungi. Vol. 1, part 1. 1905.

§ UNDERWOOD, L. M., & EARLE, F. S. Notes on the pine-inhabiting species of *Peridermium*. Bull. Torrey Club 23 : 400–405. 1896.

[The BULLETIN for July 1906 (33 : 367–402) was issued 1 Au 1906.]

graphic study of the North American species up to the present time, yet there has been a steadily increasing accumulation of knowledge regarding them, well indicated in Farlow and Seymour's indexes, referred to above, in 1896 seven species being recognized, and in 1905 fifteen species.

The present paper describes twenty-seven species of *Peridermium*, ranging from Mexico to Alaska, and from the Atlantic to the Pacific coasts, and also three species not yet found in America, but which doubtless occur, as the telial forms are abundant. Some important characters are used in the diagnoses not hitherto employed for American forms, such as those derived from the presence and form of pycnia, the structure, especially the cross-section view of the peridium, and the thickness of the wall of the spores. The characters of the peridial cells and of the pycnia have been obtained by making thin vertical sections of the leaf. A piece of the leaf is allowed to soak for a few minutes in boiling hot water, then placed between pith, and sectioned with a sharp razor and steady hand.

Many recent, as well as earlier, mycologists have treated the species of *Peridermium* under *Aecidium*. But that method, it seems to us, more obscures than illuminates the subject. Both names as ordinarily used belong to form-genera. The species are all aecia (aecidia) of species belonging to telial genera, but our knowledge is yet insufficient to properly assign them. The species in the great majoriy of cases which have been described under the form-genus *Aecidium* are the aecia of pucciniaceous species, while the species described under *Peridermium* with scarcely an exception are the aecia of melampsoraceous species, using these terms in the Dietelian sense. The species of *Peridermium* with rare or possibly no exceptions can be distinguished from other aecial species by both host and structural characters, and there seems no good reason for submerging them under the more general form-genus *Aecidium*.

The genus *Peridermium* as here understood embraces all aecial forms possessing peridia, inhabiting the *Pinaceae* and *Gnetaceae*. By this definition those aecia on gymnospermous hosts having no peridia, usually classed under *Caeoma*, are excluded, for example, *Caeoma Laricis* belonging to the poplar and willow rust, *C.*

Abietis-canadensis Farl. on hemlock, and *C. conigenum* Pat., on pine.

Only three of the twenty-seven species have been definitely associated with telial forms. One of these, the *Peridermium Pini* of American authors, was found by Kellerman* to grow on *Campanula* producing *Coleosporium Campanulae* (Pers.) Lév.; another, *Per. Cerebrum* Peck, has been grown by Shear and the writers on oak, producing a *Cronartium;* while the third, *Per. elatinum*, shows such close morphological identity with the form in Europe proven to belong to *Melampsorella Cerastii* (Pers.) Schröt., that taken in connection with geographical distribution it seems safe to assume that the American form has the same relationship as the European. Other American forms have been somewhat confidently assigned to certain telial species, but in all cases careful study brings out so many uncertainties and apparent discrepancies that it seems less likely to lead to confusion if for the present such forms are described independently. That cultures are absolutely demanded before the *Peridermium* tangle can be straightened may be shown by the present uncertainty regarding the aecium of *Calyptospora*. There seems to be no reason to doubt the identity of the American and European rust commonly referred to the monotypic genus *Calyp-*

PROBABLE CONNECTION OF NORTH AMERICAN SPECIES OF PERIDERMIUM WITH KNOWN TELIAL GENERA

Host of Peridermium	Pycnia	Aecia	No. Forms Recognized	No. Actually Connected	No. Forms Required	Telial Genus
Pinus, leaves	subep.	tongue-like	7	1	25	*Coleosporium*
Pinus, bark	subcort.	hemispherical †	8	1	5	*Cronartium*
Abies *Tsuga* *Ephedra*	subcut.	cylindrical	4	0	11	*Pucciniastrum* *Calyptospora*
Abies *Larix* ‡	subcut.	tongue-like	2	1	2	*Melampsorella* *Melampsoridium*
Picea *Pseudotsuga*	subep.	tongue-like	6	0	8	"*Chrysomyxa*"
Totals.			27	3	51	

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* Jour. Myc. 11: 32. 1905.

† An exception in case of *Per. filimentosum*, which is cylindrical.

‡ No *Peridermium* yet found in North America on *Larix*, but it is assumed to occur.

tospora, so abundant and conspicuous on *Vaccinium*, in this country extending from the Atlantic to the Pacific coasts. Twenty years ago, in 1885–6, Julius Kühn * sowed the spores of this rust upon European spruces in the experimental garden of the University of Halle, and at the same time upon the American species, *Abies balsamea* Mill., *A. nobilis* Lindl., *A. Fraseri* Pursh, *A. concolor* L. & G., and *A. magnifica* Murr., in all cases raising the *Per. columnare*, which Kühn had previously shown belonged to the species; and yet to this day no American collection of *Peridermium* can with certainty be assigned to the species. There is assuredly an attractive field for culture work here, and one which derives importance both from the economic and scientific sides.

Although it is not possible to distribute the American species of *Peridermium* with their respective telial forms, yet some approach toward this end can be made by distributing them among telial genera. So far as we know, no attempt of this kind has heretofore been made, but we believe that our studies warrant us in assigning with some degree of probability the form-species of *Peridermium*, which we are able to distinguish morphologically, to seven prominent telial genera, or to six, if *Calyptospora* be considered a synonym of *Pucciniastrum*, as some would have it. The genus *Melampsoridium* is included in this connection, although no *Peridermium* has yet been found in North America that can be assigned to it. The name "*Chrysomyxa*" is used in the customary sense, but as we believe, not in its true application, this being indicated by the quotation marks, the better generic name being *Melampsoropsis*. The accompanying table exhibits the distribution and the underlying characters.

We have found the most important character for assorting the species into groups to be the position of the pycnia, whether subcuticular or subepidermal. After this comes the shape of the aecia, whether cylindrical, or flattened laterally and tongue-like, the forms on *Pinus* being kept distinct from those on other *Coniferae*. There still remain the bark-inhabiting forms, all on *Pinus* so far as known, which have peridia differing from those of all other aecia in being tissue-like and more than one cell thick. These characters may be arranged in the form of a key, as follows:

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* Hedwigia **26**: 28. 1887.

Key to the assignment of species of Peridermium

Pycnia subcuticular.	
Aecia cylindrical.	*Pucciniastrum*, *Calyptospora*.
Aecia tongue-shaped.	*Melampsorella*, *Melampsoridium*.
Pycnia subepidermal.	
Aecial peridia one cell thick.	
On *Pinus*.	*Coleosporium*.
On other Coniferae.	"*Chrysomyxa*."
Pycnia subcorticular.	
Aecial peridia more than one cell thick.	*Cronartium*.

Our guide for selecting the proper telial genus has been the kind of aecia found to belong to certain species of those genera in the culture work accomplished mainly by European botanists, although the characters given as dominant are of our own selection.

After this explanation of the method of deriving the data of the table, we may turn to its statistics to see why in some cases more telial species are known than corresponding aecial forms, and why in two cases the reverse should be true. It must be borne in mind that the whole tabular presentation rests upon a large basis of assumption, in which there is plenty of opportunity for error after every precaution is taken. The rust flora of North America is, moreover, very imperfectly known, and especially the part under discussion. Turning to the table we find that in the first line twenty-five species of *Coleosporium* are recognized and only seven corresponding species of *Peridermium*, which is easily enough accounted for by the fact that the aecia of this genus are remarkably similar. Fischer * in his recent flora of Switzerland describes with much fullness ten species of *Coleosporium*, but gives almost no characters to separate the aecia, saying that these "can not be determined with certainty without infection experiments." It is quite likely that when cultures are made, the seven species as now understood will be segregated into two or three times that number, and in the meantime others may be found. In the second line of the table the situation is quite different; more aecia are known than telial forms. Here the aecia are conspicuous, and the telia comparatively inconspicuous. Probably more species of *Cronartium* are yet to be discovered, or else closely related genera not yet recognized. In the fourth line of the table the two re-

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* FISCHER, ED. Die Uredineen der Schweiz. Beitr. Krypt. Schweiz **2**: 439–455. 1904.

cognized forms of aecia appear to belong to *Melampsorella*, although only one species of that genus has yet been found within our limits, which may be due to their being inconspicuous. In the remaining lines of the table the discrepancy between aecia and telia is only what would naturally occur by this method of tabulation, and one which may confidently be expected to be removed when more collections are made and studied.

To ascertain the particular species represented by the numbers in this table reference may be made to the following pages for those of *Peridermium.* The species of *Coleosporium* are embraced in a paper presented before the Botanical Society of America one year ago by one of the present writers, but not yet published. The species of this latter genus and of the other telial genera will soon be described in the current *North American Flora*, including a few species that are new.

Thanks are due, and are hereby most heartily accorded, to the curators of many important herbaria for the privilege of examining and studying the collections of *Peridermium*, and to many individual botanists, who have assisted with specimens and various information. The following herbaria proved especially helpful: New York Botanical Garden, New York State Museum, Missouri Botanical Garden, Cryptogamic Herbarium of Harvard University, Cryptogamic Herbarium United States Department of Agriculture, Holway Collection in University of Minnesota, Cornell University, Iowa State College, Mississippi Valley Laboratory at St. Louis. We are particularly indebted to Messrs. W. G. Farlow, W. A. Kellerman, H. Klebahn, P. L. Ricker, P. H. Rolfs, H. von Schrenk, C. L. Shear, C. H. Peck, S. M. Tracy, L. M. Underwood and H. H. Whetzel. The ready coöperation by all botanists to whom our special problems were presented, has enabled us to give a fairly complete account of present available knowledge regarding American forms of *Peridermium.*

Analytical key

- Pycnia subcorticular.
  - Peridium one cell thick.
    - Peridia very low and fragile.
      - Spores thin-walled, without smooth spot. 1. *P. delicatulum.*
    - Peridia medium high (0.5–0.8 mm.).
      - Spores thin-walled, without smooth spot. 2. *P. montanum.*

Spores thick-walled, with smooth spot.	3. *P. acicolum.*
Peridia high and firm (0.7–1.8 mm.).	
Spores thick-walled, without smooth spot.	
Peridial cells very large.	
Walls equally thick.	
Spores coarsely verrucose.	4. *P. carneum.*
Peridial cells medium large; walls medium.	
Walls equally thick.	
Spores moderately verrucose.	5. *P. intermedium.*
Spores coarsely verrucose.	6. *P. Rostrupi.*
Outer wall thinner than inner.	
Spores coarsely verrucose.	7. *P. gracile.*
Peridium more than one cell thick.	
Peridia cylindrical, with internal filaments.	
Branch not or slightly swollen.	8. *P. filamentosum.*
Peridia hemispherical, imperfectly filamentose.	
Branch not or slightly swollen.	
Spores moderately verrucose.	9. *P. stalactiforme.*
Spores coarsely verrucose.	10. *P. pyriforme.*
Peridia hemispherical or tortuous, without filaments.	
Branch gradually swollen into a gall.	
Spores finely verrucose.	11. *P. Harknessii.*
Spores coarsely verrucose.	12. *P. fusiforme.*
Branch abruptly swollen into a gall.	
Gall globoid, lobed and irregular.	
Peridial cells angularly globoid.	13. *P. mexicanum.*
Gall globoid, its outline regular.	
Peridial cells globoid.	14. *P. Cerebrum.*
Peridial cells lanceolate.	15. *P. globosum.*
Pycnia subepidermal.	
Pycnia conspicuous, on leaves.	
Mycelium perennial.	
Aeciospores small.	
Peridial cells scarcely imbricated.	16. *P. boreale.*
Peridial cells considerably imbricated.	17. *P. coloradense.*
Mycelium annual.	
Aeciospores medium.	18. *P. consimile.*
Aeciospores large.	19. *P. decolorans.*
Pycnia inconspicuous, on leaves.	
Mycelium annual.	
Aeciospores with smooth line.	
Wall thick.	20. *P. abietinum.*
Aeciospores without smooth line.	
Wall thick.	21. *P. pseudo-balsameum.*
Wall thin.	22. *P. Holwayi.*
Pycnia subcuticular.	
Pycnia flat, on cones.	23. *P. conorum-Piceae.*
Pycnia slightly convex, on leaves.	
Peridia cylindrical.	24. *P. columnare.*
Peridia flattened laterally.	25. *P. ornamentale.*

- Pycnia hemispherical, on leaves.
  - Mycelium perennial; aeciospores small.
    - Peridia cylindrical. 26. *P. Peckii.*
    - Peridia flattened laterally. 27. *P. elatinum.*
  - Mycelium annual.
    - Peridia cylindrical. 28. *P. balsameum.*
    - Peridia flattened laterally. 29. *P. Laricis.*
- Pycnia conoidal, on stems.
  - Mycelium perennial. 30. *P. Ephedrae.*

Host key

Pinus:

- Foliicolous.
  - Peridia very low and fragile.
    - Spores thin-walled. {*species undet.*} 1. *P. delicatulum.*
  - Peridia medium high (0.5–0.8 mm.).
    - Spores thin-walled. {*P. Murrayana* *P. scopulorum*} 2. *P. montanum.*
    - Spores thick-walled. {*P. rigida*} 3. *P. acicolum.*
  - Peridia high and firm (0.7–1.8 mm.).
    - Spores thick-walled, moderately verrucose.
      - Peridial cells medium, walls equally thick. {*P. echinata*} 5. *P. intermedium.*
    - Spores thick-walled, coarsely verrucose.
      - Peridial cells very large, walls thick. {*P. Taeda* *P. palustris* *P. Elliottii*} 4. *P. carneum.*
      - Peridial cells medium, walls equally thick. {*P. rigida*} 6. *P. Rostrupi.*
      - Peridial cells medium, outer wall thinner. {*P. filifolia*} 7. *P. gracile.*
- Caulicolous.
  - Branch slightly or not swollen.
    - Peridia cylindrical. {*P. ponderosa*} 8. *P. filamentosum.*
    - Peridia hemispherical.
      - Spores moderately verrucose. {*P. Murrayana* *P. Jeffreyi*} 9. *P. stalactiforme.*
      - Spores coarsely verrucose. {*P. rigida* *P. sylvestris* *P. virginiana*} 10. *P. pyriforme.*
  - Branch gradually swollen into a gall.
    - Peridia hemispherical or tortuous.
      - Spores finely verrucose. {*P. insignis* *P. Murrayana* *P. ponderosa* *P. contorta*} 11. *P. Harknessii.*

Spores coarsely verrucose.	*P. Taeda* *P. palustris*	12. *P. fusiforme.*
Branch abruptly swollen into a gall.		
Gall globoid, lobed and irregular.	*P. patula* *P. oocarpa*	13. *P. mexicanum.*
Gall globoid, outline regular.	*P. rigida* *P. virginiana* *P. echinata* *P. Taeda* *P. divaricata* *P. ponderosa*	14. *P. Cerebrum.*
Strobus:		
Caulicolous.		
Branch abruptly swollen into a gall.		
Gall globoid, outline regular.	*S. Strobus*	15. *P. globosum.*
Picea:		
Foliicolous.		
Mycelium perennial, forming witches' brooms.		
Leaves somewhat adherent.	*P. Parryana* *P. Engelmanni*	16. *P. boreale.*
Leaves fugacious.	*P. Mariana* *P. Engelmanni*	17. *P. coloradense.*
Mycelium annual, not forming witches' brooms.		
Pycnia conspicuous.		
Aeciospores small.	*P. Mariana* *P. rubra*	18. *P. consimile.*
Aeciospores large.	*P. Mariana* *P. rubra* *P. Engelmanni* *P. sitchensis* *P. canadensis*	19. *P. decolorans.*
Pycnia inconspicuous.		
Aeciospores small.	*P. excelsa*	20. *P. abietinum.*
Squamicolous.		
Mycelium annual.	*P. Mariana* *P. excelsa* *P. Engelmanni* *P. rubra* *P. canadensis*	23. *P. conorum-Piceae.*
Pseudotsuga:		
Foliicolous.		
Pycnia subepidermal, inconspicuous.		
Mycelium annual.	*P. mucronata*	22. *P. Holwayi.*
Abies:		
Foliicolous.		
Mycelium annual, not forming witches' brooms.		

Pycnia subepidermal.		
Pycnia inconspicuous.	{*A. grandis*}	21. *P. pseudo-balsameum.*
Pycnia subcuticular.		
Pycnia slightly convex.		
Peridia cylindrical.	{*A. pectinata*}	24. *P. columnare.*
Peridia flattened laterally.	{*A. lasiocarpa*}	25. *P. ornamentale.*
Pycnia hemispherical.		
Peridia cylindrical.	*A. balsamea* *A. grandis*	28. *P. balsameum.*
Mycelium perennial, forming witches' brooms.		
Pycnia subcuticular, hemispherical.	*A. balsamea* *A. lasiocarpa* *A. religiosa*	27. *P. elatinum.*
Tsuga:		
Foliicolous.		
Pycnia subcuticular, inconspicuous.		
Mycelium perennial, forming witches' brooms.	{*T. canadensis*}	26. *P. Peckii.*
Larix:		
Foliicolous.		
Pycnia subcuticular, inconspicuous.		
Mycelium annual.	{*L. decidua*}	29. *P. Laricis.*
Ephedra:		
Caulicolous.		
Pycnia subcuticular, conspicuous.		
Mycelium perennial.	*E. Torreyana* *E. californica* *E. nevadensis* *E. trifurca* *E. pedunculata*	30. *P. Ephedrae.*

1. **Peridermium delicatulum** sp. nov.

O. Pycnia amphigenous, numerous, scattered, conspicuous, brownish, dehiscent by a longitudinal slit, subcorticular, large, 0.3–0.4 mm. broad by 0.5–1 mm. long, low-conoidal, 80–100 μ high.

I. Aecia amphigenous, from a limited mycelium, numerous, scattered on discolored spots occupying part of a leaf, erumpent from longitudinal slits, 1–5 mm. long; peridium colorless, delicate, scarcely protruding above the ruptured epidermis, cells isodiametric, slightly or not overlapping, 20–25 μ long, walls transversely striate, inner finely verrucose, 4–5 μ thick, outer walls slightly thinner; aeciospores ovoid or cuboidal, 19–21 by 21–28 μ, contents bright-orange when fresh, wall colorless, finely verrucose, 2.5–3 μ thick.

On leaves of *Pinus* sp., St. Augustine, Florida, March 27, 1903, *E. W. D. Holway*. Only one collection has been made. It occurred in abundance, but only reached to about four feet above the ground. The host appeared to be the common long-leaved pine (*P. Taeda*); but the microscopic structure of the leaves does not agree well with that of authentic collections of this species. No cones were found. The exact determination of the host must, therefore, remain in doubt for the present. The peridium of this species is so fragile and short that the fungus has the general appearance of a caeoma, and in the field might easily be mistaken for one.

2. **Peridermium montanum** sp. nov.

O. Pycnia chiefly hypophyllous, rather numerous, scattered, noticeable, subcorticular, dehiscent by a longitudinal slit, large, 0.3–0.5 mm. broad by 0.5–1 mm. long, low-conoidal, 55–65 μ high.

I. Aecia from a limited mycelium, chiefly epiphyllous, rather numerous on yellowish spots occupying part or rarely all of the leaf, erumpent from a narrow slit, flattened laterally, 1–1.5 mm. long by 0.5–0.8 mm. high, rupturing irregularly; peridium colorless, delicate, cells separating readily, 55–65 μ long, overlapping, outer and inner walls about same thickness, 3–5 μ, outer minutely verrucose, inner moderately verrucose; aeciospores oblong to linear-oblong, 16–24 by 32–45 μ, wall colorless, rather thin, 2–3 μ, closely and rather coarsely verrucose.

On leaves of *Pinus scopulorum* (Engelm.) Lemm., Rimini, Montana, June 24, 1889, *F. D. Kelsey* (type, specimen in herbarium of N. Y. Bot. Garden).

On leaves of *Pinus Murrayana* Oreg. Com., Chiquash Mountains, Skamania County, Washington, August 12, 1886, *W. N. Suksdorf 302*; Rocky Mountains (Canada ?), July 3, 1885, *J. M. Macoun*; Chiquash Mountains, Skamania County, Washington, July 22, 1901, *W. N. Suksdorf 645*, communicated by E. W. D. Holway; Bozeman, Montana, June 26, 1900, *J. W. Blankinship*, communicated by E. W. D. Holway.

3. PERIDERMIUM ACICOLUM Underw. & Earle, Bull. Torrey Club 23: 400. 1896

O. Pycnia amphigenous, numerous, scattered, noticeable, subcorticular, dehiscent by a longitudinal slit, 0.3–0.5 mm. broad by 0.5–0.8 mm. long, low-conoidal, 80–100 μ high.

I. Aecia from a limited mycelium, numerous, scattered, on discolored spots occupying part of a leaf, erumpent from longitudinal slits, flattened laterally, 0.5–1 mm. long by 0.5–0.7 mm. high, rupturing irregularly; peridium colorless, moderately firm, cells overlapping, 35–45 μ long, not much narrower, walls transversely striate, inner coarsely verrucose, thick, 5–6 μ, outer less rough and somewhat thinner; aeciospores ellipsoid, 20–24 by 28–40 μ, wall colorless, closely and coarsely verrucose with deciduous tubercles, which are directed away from a smooth spot extending up one side, thick, 2–3 μ on the smooth spot, increasing to 5–6 μ on the opposite side, including the tubercles.

On leaves of *Pinus rigida* Mill., Egg Harbor, New Jersey, June, 1877, *I. C. Martindale* (specimen in Herb. N. Y. Botanical Garden); Plainville, Connecticut, no date, *J. N. Bishop* (specimen in N. Y. State Herb. at Albany); Sherburne, Massachusetts, June 8, 1888, *Cummings & Seymour* (in Seymour & Earle, Econ. Fungi, *no. 223*); May's Landing, New Jersey, July 4, 1888, *Pennypacker* (in Ellis & Everh. N. Am. Fungi, *no. 2222*); Belleplain, New Jersey, May 25, 1903, *C. L. Shear 1457;* Riverhead, Long Island, New York, June 8, 1904, *F. A. Sirrine* (specimen in N. Y. State Herb. at Albany).

This species appears to be unique in having the tubercles on the aeciospores noticeably bent away from the smooth toward the opposite side, so that the longest tubercles directly opposite to the smooth side are the only ones that are truly radial. The species is known from only a small area along the Atlantic coast from near Boston, Mass., to the southern end of New Jersey.

4. PERIDERMIUM CARNEUM (Bosc) Seym. & Earle, Econ. Fungi *550.* 1899

Tubercularia carnea Bosc, Ges. Nat. Freunde Berlin Mag. **5**: 88. 1811.

Peridermium oblongisporium Ravenelii Thüm. Mitth. Forstl. Vers. Oest. **2**: 316 (20). 1880.

Peridermium Ravenelii Kleb. Ber. Deutsch. Bot. Ges. 8^2: 69. 1890.

Aecidium Ravenelii Dietel, in Engler & Prantl, Pflanzenfam. $\mathbf{1}^1$ **: 78. 1897.

Aecidium carneum Farl. Bibl. Index **1**: 25. 1905.

O. Pycnia amphigenous, numerous, scattered, noticeable, subcorticular, dehiscent by a longitudinal slit, large, 0.4–0.7 mm. broad by 1–1.5 mm. long, low-conoidal, 60–80 μ high.

I. Aecia amphigenous, from a limited mycelium, numerous, scattered, on discolored spots occupying part of a leaf, erumpent from longitudinal slits, flattened laterally, large, 1–6 mm. long by 0.8–1.5 mm. high, rupturing along the apical line; peridium flesh-colored, especially at apex, when fresh, becoming colorless, rather firm, cells isodiametric, somewhat overlapping, 38–48 μ long, walls transversely striate, inner coarsely verrucose, very thick, 7–13 μ, outer less rough and slightly thinner; aeciospores ellipsoid, 16–24 by 26–38 μ, wall colorless, closely and uniformly verrucose with large, deciduous tubercles, 5–7 μ, or 2–3 μ without tubercles.

On leaves of *Pinus palustris* Mill. (*P. australis* Michx.), Gainesville, Florida, February 12 and February 24, 1906, *P. H. Rolfs.*

On leaves of *Pinus Taeda* L., Darien, Georgia, no date, *H. W. Ravenel* (in Ellis, N. A. F. *no. 1026a*); Crescent City, Florida, no date, *George Martin* (in Ellis, N. A. F. *no. 1026b* as on "*Pinus australis*"); Green Cove Springs, Florida, February 23, 1883, *Geo. Martin* (as on "*P. australis*"); Kissimmee, Florida, March, 1885, *E. A. Rau* (in Rabenhorst-Winter, F. Europ., *no. 3315b*, as on "*P. australis*"); Toccoa, Georgia, April 19, 20 and 21, 1891, *L. M. Underwood;* South Jacksonville, Florida, April, 1891, *L. M. Underwood* (as on "*P. palustris*"); Auburn, Alabama, spring of 1891, *Geo. F. Atkinson* (as on "*P. serotina*"); Lake City, Florida, February 28, 1892, *P. H. Rolfs* (as on "*P. palustris*"); Grassmere, Florida, March, 1893, *W. C. Sturgis* (in Seymour & Earle, Econ. Fungi *no. 550*, as on "*P. palustris*"); Auburn, Alabama, April 18, 1896, *Underwood & Earle;* Gainesville, Florida, February 12 and 24, 1906, *P. H. Rolfs.*

On leaves of *Pinus Elliottii* Engelm., Ocean Springs, Mississippi, March 31, 1895, *F. S. Earle* (as on "*P. australis*"); Biloxi, Mississippi, March 19, 1898, *S. M. Tracy 5190* (as on "*P. heterophylla*"); Live Oak, Florida, April 31, 1900, *S. M. Tracy 7153* (as on "*P. australis*"); Cairo, Georgia, March 26, 1904, *P. J. O'Gara.*

Beside the above collections one in the herbarium of the New York Botanical Garden on *Pinus Taeda*, collected at Ft. Payne, Alabama, in 1896, by L. M. Underwood, may belong here, although both spores and peridial cells are smaller and thinner-walled than usual.

The species is very common along the coast of the southeastern states from South Carolina to Mississippi. It is an especially large and conspicuous form, usually passing under the name *Peridermium orientale*. The type as stated by Bosc, was collected in South Carolina on *Pinus palustris*. Although it is probably no longer in existence, his description is so explicit and full, that together with the illustration, *l.c. pl. 6, fig. 13*, no doubt can exist of the application of the name.

5. **Peridermium intermedium** sp. nov.

O. Pycnia amphigenous, scattered, noticeable, dehiscent by a longitudinal slit, subcorticular, 0.3–0.4 mm. broad by 0.5–0.75 mm. long, low-conoidal, 65–80 μ high.

I. Aecia amphigenous, from a limited mycelium, scattered, on discolored spots occupying part of a leaf, erumpent from longitudinal slits, flattened laterally, tongue-shaped, of medium size, 1.5–3 mm. long by 0.8–1.5 mm. high, rupturing along the apical line; peridium colorless, rather firm, cells 35–50 μ long, somewhat longer than broad, overlapping, walls transversely striate, inner coarsely verrucose, rather thick, 6–9 μ, outer less rough and of about equal thickness; aeciospores ellipsoid, 16–20 by 23–29 μ, wall colorless, evenly and moderately verrucose, 2.5–3.5 μ thick.

On leaves of *Pinus echinata* Mill. (*P. mitis* Michx.), Perryville, Missouri, May, 1883, *C. H. Demetrio* (in Rabenhorst-Winter, Fungi Europ. *no. 3315a*); Cadet, Washington County, Missouri, May, 1890, *J. G. Barlow 1573* (specimen in herbarium of U. S. Dept. of Agric.); Garrett Park, Maryland, May 29, 1891, *B. T. Galloway;* Eureka Springs, Arkansas, May 23, 1906, *H. von Schrenk*.

This species is intermediate in most of its gross and microscopic characters between *Per. carneum* and *Per. Rostrupi*, and as might be anticipated the determination of collections is likely to be uncertain in some cases. The first collection listed above is taken as the type.

6. PERIDERMIUM ROSTRUPI Ed. Fischer, Bull. Soc. Bot. France **41**: clxxi. 1894.

O. Pycnia amphigenous, scattered, numerous, dehiscent by a longitudinal slit, noticeable, 0.2–0.4 mm. broad by 1–2 mm. long, low-conoidal, subcorticular, 90–110 μ high.

I. Aecia amphigenous, from a limited mycelium, scattered on discolored spots occupying part of a leaf, erumpent from longitudinal slits, flattened laterally, tongue-shaped, 1–3 mm. long by

0.7–1.5 mm. high, rupturing irregularly; peridium yellow fading to white, fragile, cells 35–45 μ long, somewhat longer than broad, overlapping, walls transversely striate, inner moderately verrucose, about 4–6 μ thick, outer less rough and of about equal thickness; aeciospores broadly ellipsoid or globoid, 17–22 by 22–31 μ, wall colorless, densely verrucose with prominent elongate papillae, 2–3.5 μ thick.

On leaves of *Pinus rigida* Mill., Sugar Grove, Ohio, May 17, 1902, May, 1902 (in Kellerman, Ohio Fungi, *no. 104*), May, 1903, and May 30, 1904, *W. A. Kellerman;* Egg Harbor, New Jersey, June, 1877, *I. C. Martindale* (specimen in herbarium of N. Y. Botanical Garden); Ironton, Ohio, May 27, 1892, *Wm. C. Werner* (specimen in herbarium of U. S. Department of Agriculture).

This rust, as here represented, is the aecial form of *Coleosporium Campanulae* (Pers.) Lév. The demonstration was carried out by Professor Kellerman,* who, in June, 1904, successfully sowed spores from the Sugar Grove station on *Campanula americana*. This is the only culture of *Peridermium* on pine leaves that has yet been successfully made in America. The other two collections that are listed agree closely in microscopic characters with the Sugar Grove collection, and are listed here with much confidence. Still another collection on *Pinus rigida*, collected at Lunenburg, Massachusetts, by F. L. Sargent, on July 1, 1889, possesses considerably larger spores, but is otherwise quite similar. While it may belong with this species, it is more likely to belong to one of several species of *Coleosporium*, whose aecial forms have not yet been identified. Much cultural work has been done in Europe on this and related species, for which the reader is referred to Klebahn's *Die wirtswechselnden Rostpilze*, and Fischer's *Die Uredineen der Schweiz*.

7. **Peridermium gracile** sp. nov.

O. Pycnia amphigenous, numerous, scattered, dehiscent by a longitudinal slit, 190–350 μ broad by 0.5–0.75 mm. long, low-conoidal, subcorticular, 60–75 μ high.

I. Aecia amphigenous, from a limited mycelium, numerous, scattered on discolored spots occupying part of a leaf, erumpent from longitudinal narrow slits 0.3–0.5 mm. wide, flattened laterally,

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* Jour. Myc. 11: 32. 1905.

0.5–1.5 mm. long, by 1–1.8 mm. high, rupturing irregularly; peridium colorless, moderately firm, cells somewhat overlapping, 30–40 μ long, walls transversely striate, inner moderately verrucose, thick, 6–9 μ, outer less rough and thinner, 4–6 μ; aeciospores ellipsoid, 18–24 by 23–39 μ, wall colorless, closely and evenly verrucose with large deciduous tubercles, 3.5 μ thick.

On leaves of *Pinus filifolia* Lindl., mountains above Oaxaca, Mexico, May 28, 1894, *C. G. Pringle* (type); Topalpa, state of Jalisco, Mexico, June 10, 1892, collector unknown (specimens in herbarium of N. Y. Bot. Garden).

8. PERIDERMIUM FILAMENTOSUM Peck, Bot. Gaz. 7: 56. 1882

Aecidium filamentosum Farl. Bibl. Index **1**: 44. 1905.

O. Pycnia unknown.

I. Aecia caulicolous, not producing noticeable swellings, scattered, cylindrical, 4–7 mm. high by 1–2 mm. wide, pale-yellow or white; peridium rupturing laterally in longitudinal lines, rather firm, scarcely more than 1 cell thick at the sides, becoming thicker above where it extends downward into numerous concolorous, filament-like processes, 70–100 μ in diameter, passing through the spore-mass from apex to base of the aecium, peridial cells linear-oblong, 15–23 by 55–80 μ, pointed at one or both ends, placed longitudinally, walls 4–6 μ thick, inner rather coarsely verrucose, outer somewhat smoother; aeciospores oblong, obovate-oblong or rarely ellipsoid, 13–21 by 27–31 μ, wall colorless, uniformly thick, 2.5–3.5 μ, moderately verrucose, with a smooth area at base often extending up one side.

On *Pinus ponderosa* Dougl., Santa Rita Mountains, Arizona, July 13, 1881, *C. G. Pringle.* This remarkable and interesting species of *Peridermium* has been collected but once, although an interval of a quarter of a century has passed, and the fungus is a conspicuous one. Mr. C. H. Peck in his account in the Botanical Gazette, gave an excellent characterization, and very properly laid stress on the presence of longitudinal filaments, and on the slitting of the peridium. The filaments are easily seen, even without a hand-lens, and extend from the dome of the aecium to its floor, and are sufficiently numerous to keep the spores from easily falling away, even after the rather fragile peridium has partially disappeared. The apex or dome of the peridium, as in other forms on the branches of pine, is more than one cell thick, but the long cylindrical sides are for the most part composed of a single layer of cells, and these have their longer axis extending longitudinally, as in foliicolous forms, instead of transversely as in other caulicolous forms. This structure permits of the longitudinal rupture of the peridium, which is especially notable.

9. **Peridermium stalactiforme** sp. nov.

O. Pycnia unknown.

I. Aecia caulicolous, not producing noticeable swellings, scattered, round or irregular, 0.5–1.5 by 1–2 mm., distinct or sometimes confluent, pale-yellow fading to white, low, not much exserted above the bark ; peridium hemispherical or tortuous, rupturing irregularly along the sides, about 2 cells thick, often extending numerous concolorous processes from apex and from floor of the aecium a short distance into the spore-mass, peridial cells roundish or occasionally elongate and somewhat pointed, walls thick, striate, lumen small ; aeciospores ellipsoid, 16–21 by 27–35 μ, wall colorless, 2.5–3.5 μ thick, moderately verrucose, with a smooth area extending from base up one side, slightly thicker on smooth side.

On branches of *Pinus Murrayana* Oreg. Com., Chiquash Mountains, Skamania County, Washington, July 22, 1901, *W. N. Suksdorf 645* (type), communicated by E. W. D. Holway.

On branches of *Pinus Jeffreyi* Oreg. Com., Little Valley, Washoe County, Nevada, 2000–2155 m., July 24, 1902, *C. F. Baker 1351*.

This species does not produce noticeable enlargement of the branch, in this respect being similar to *Per. filamentosum*, but the peridium is of the usual character of the caulicolous species. In the short attenuate projections from the floor and dome of the aecium, one is reminded of the connecting filaments of *Per. filamentosum*, with which they are homologous.

10. PERIDERMIUM PYRIFORME Peck, Bull. Torrey Club 6: 13. 1875

Aecidium pyriforme Farl. Bibl. Index **1**: 78. 1905.

O. Pycnia unknown.

I. Aecia caulicolous, producing no or only slight swellings, scattered, rounded or irregular, 1–1.5 by 1–2 mm. across, rarely larger by becoming confluent, pale-yellow or white, about 1–1.5 mm. high ; peridium bladdery, subhemispherical, rupturing irregularly along the sides, about 2 cells thick, outer surface infolded and verrucose, inner more coarsely verrucose, numerous, delicate, concolorous processes often projecting from apex and from floor of aecium a short distance into the spore-mass, peridial cells roundish or pyriform, walls thick, striate, lumen small; aeciospores ellipsoid or rarely obovate, 16–23 by 25–31 μ, wall colorless, uniformly thick, 3–4.5 μ, rather coarsely verrucose, with a rather inconspicuous smooth area at base often extending up one side.

On small branches of *Pinus rigida* Mill., Newfield, New Jersey, May, 1890, *J. B. Ellis* (specimen in herbarium of N. Y. Bot. Garden).

On small branches of *Pinus virginiana* Mill. (*P. inops* Ait.), Newfield, New Jersey, May, 1882, *J. B. Ellis* (in Ellis, N. A. F. *no. 1021*).

On small branches of *Pinus sylvestris* L., fruticetum of Missouri Botanical Garden, St. Louis, Missouri, May, 1887, *L. H. Pammel* (specimen in herbarium of Missouri Bot. Garden).

The authors have examined the type specimen in the herbarium of the N. Y. State Museum at Albany, N. Y. It is a very small fragment, and gave little material for study. So far as we can judge, however, it is identical with the specimen at New York City, the first one cited above, and the host appears to be the same, that is *P. rigida*. The specimen is in the original wrapper, and is labeled "on pine limbs in the spring, Newfield, New Jersey, J. B. Ellis, no. 2040." In the original publication some doubt was expressed regarding the type locality, but there is strong circumstantial evidence that the inscription on the type specimen records the actual facts. In the original description emphasis is laid on the form of the spores, which are said to be "obovate, pyriform, or oblong-pyriform, accuminate below, .0015–.0025 inch long." It is further stated that "the acumination is generally acutely pointed, and sometimes so elongated as to make the spore appear clavate; it is one of the most distinctive features of the species." This description of the spores in both form and size, corresponds to that of the smaller peridial cells, which were doubtless mistaken for spores. A drawing for a spore on the original packet shows a small lumen, which is true for peridial cells, but not for spores; the measurement given is also twice too large for spores.

11. PERIDERMIUM HARKNESSII Moore, Bull. Calif. Acad. Sci. **1**: 37. 1884

O. Pycnia unknown.

I. Aecia caulicolous, appearing on ellipsoid, oblong or sometimes nearly globoid swellings, scattered or often in groups and confluent, yellow at first fading to white, bladdery, large; peridium rupturing irregularly, soon falling away entirely, about two cells thick, outer surface smooth, inner irregularly verrucose, cells roundish or irregularly compressed, walls very thick, radially striate, lumen small; aeciospores ellipsoid or obovate, 15–21 by 23–31 μ, wall colorless, uniformly thick, 2.5–3.5 μ, finely verrucose, with smooth area at base often extending up one side.

On branches of *Pinus insignis* Dougl., Menlo Park, California, May 6, 1893, *W. C. Blasdale* (specimen in herbarium of E. W. D. Holway).

On branches of *Pinus Murrayana* Oreg. Com., Yosemite Valley, California, May 29, 1895, *W. C. Blasdale* (specimen in herbarium of E. W. D. Holway); Dragoon, Washington, no date, *H. von Schrenk* (specimen at Miss. Valley Lab., St. Louis); Bozeman, Montana, September, 1903, collector unknown (two specimens at Miss. Valley Lab., St. Louis, each about 60 cm. long and 8–10 cm. thick).

On branches of *Pinus ponderosa* Dougl., Colfax, California, no date, *H. W. Harkness* (specimen in herbarium of N. Y. Bot. Garden); Dragoon, Washington, no date, *H. von Schrenk* (specimen at Miss. Valley Lab., St. Louis); Long Pine, Nebraska, May 13, 1889, *J. M. Bates 370* (specimen in herbarium N. Y. Bot. Garden).

On branches of *Pinus contorta* Dougl., New Metlakahtla, Alaska, June 4, 1899, *Wm. Trelease 667* (specimen in herbarium of Missouri Bot. Garden, St. Louis).

This species appears to be very abundant in the Rocky Mt. region, often doing much damage, especially to seedling trees. The galls are usually large, often one to two feet in diameter. The large size is doubtless one reason why the species is so poorly represented in herbaria.

12. **Peridermium fusiforme** sp. nov.

O. Pycnia unknown.

I. Aecia caulicolous, forming fusiform swellings, 2–6 cm. in diameter by 5–25 cm. long, on comparatively small branches, numerous, scattered, individual sori elongate and sometimes tortuous, 1–2 by 3–9 mm., distinct or rarely confluent, pale-yellow, bladdery, low, scarcely exserted above the bark; peridia circumscissile, soon falling away, about two cells thick, outer surface infolded and verrucose, inner more coarsely verrucose, cells roundish or irregular, walls very thick, radially striate, lumen small; aeciospores obovate or ellipsoid, 15–24 by 24–33 μ, wall colorless, 3–5 μ thick, uniform, coarsely verrucose, usually with smooth area at base, often extending up one side, tubercles about 1 μ long, tardily deciduous.

On branches of *Pinus Taeda* L., Auburn, Alabama, April, 1896, *L. M. Underwood* (type); Auburn, Alabama, no date, *F. S. Earle* (specimen at Miss. Valley Lab., St. Louis); Lake City, Florida, March, 1895, *P. H. Rolfs;* Gainesville, Florida, February, 12, 1906, *P. H. Rolfs.*

On branches of *Pinus palustris* Mill., Cleveland, Texas, no date, *Perley Spaulding* (specimen in herbarium Missouri Bot. Garden, St. Louis); Lake City, Florida, June, 1906, *P. H. Rolfs.*

On branches of *Pinus* sp., Georgia, no date, *H. W. Ravenel* (specimen in herbarium N. Y. Bot. Garden); Cairo, Georgia, March 26, 1904, *P. J. O'Gara* (specimen in herbarium U. S. Dept. Agric.).

The spindle-shaped gall is very characteristic of this species, which rarely shows an abrupt change from the healthy tissue to the hypertrophied area, as in other species.

13. **Peridermium mexicanum** sp. nov.

O. Pycnia unknown.

I. Aecia caulicolous, forming irregular, globoid, gall-like excrescences, 3–7 cm. across, often on small branches, arranged in tortuous lines or cerebroid, pale-yellow fading to white, bladdery, not much exserted above the bark; peridia colorless, circumscissile, soon falling away in flakes or sheets, about 2 cells thick, outer surface somewhat irregularly roughened, inner surface more noticeably roughened, cells roundish or irregularly compressed, walls thick, with radial striations, which may on exposed surfaces separate the wall into tubercle-like processes, lumen moderately small; aeciospores ellipsoid or obovate, 13–22 by 23–33 μ, wall colorless, 2.3 μ thick, very coarsely verrucose, sometimes with a smooth area showing at base and extending up one side, slightly thicker, 3–4 μ, tubercles somewhat deciduous.

On branches of *Pinus patula* Schiede & Deppe, Hovey Station, state of Hidalgo, Mexico, April, 1904, *C. G. Pringle* (type), communicated by E. W. D. Holway.

On branches of *Pinus oocarpa* Schiede, hills near Guadalajara, state of Jalisco, Mexico, June 22, 1893, *C. G. Pringle.*

The type specimen consists of a lobulated, irregularly globose gall, about 4 cm. in diameter, nearly surrounding a slender branch only 8 mm. thick, and attached by a very narrow band of connecting-tissue. The record on the packet says: "forming balls 2–3 inches in diam. on small branches; very common."

14. PERIDERMIUM CEREBRUM Peck, Bull. Buffalo Soc. **1**: 68. 1873

Aecidium deformans Mayr, Waldungen Nordam. 119. 1890.

Aecidium giganteum Mayr, Waldungen Nordam. 120. 1890. (Bot. Centr. **58**: 149. 1894.)

Peridermium giganteum Tubeuf, Pflanzenkr. 429. 1895.

Peridermium deformans Tubeuf, Pflanzenkr. 429. 1895.

Aecidium Cerebrum Dietel, in Engler & Prantl, Pflanzenfam. **1**^{1**} 79. 1897.

O. Pycnia unknown.

I. Aecia caulicolous, forming globoid swellings, 5–25 cm. across, arranged in tortuous lines or cerebroid, at first orange-yellow, bladdery, large; peridia colorless, circumscissile, soon falling away in flakes or sheets, about 2 cells thick, outer surface smooth, inner verrucose, cells roundish, or irregularly compressed, walls very thick, radially striate, lumen small; aeciopores obovate, 17–23 by 25–32 μ, wall colorless, uniformly thick, 2.5–3.5 μ, coarsely verrucose, with a smooth spot at base usually extending up one side, tubercles somewhat deciduous.

On branches of *Pinus rigida* Mill., Center, New York, May, year?, *J. A. Lintner* (type specimen in herbarium N. Y. State Museum, Albany, N. Y.); Belleplain, New Jersey, March 25, 1903, *C. L. Shear 1456;* Newfield, New Jersey, May, 1882, *J. B. Ellis* (in Ellis, N. A. F. *no. 1022*).

On branches of *Pinus virginiana* Mill., Washington, D. C., May 11, 1903, and April 24, 1905, *C. L. Shear;* Glen Sligo, Maryland, May 5, 1905, *P. L. Ricker.*

On branches of *Pinus divaricata* (Ait.) Sudw. (*P. Banksiana*

Lamb.), Omer, Arenac County, Michigan, August, 1900, *C. F. Wheeler* (specimen in herbarium U. S. Dept. Agric.).

On branches of *Pinus echinata* Mill. (*P. mitis* Michx.), Eureka Springs, Arkansas, May 29, 1906, *H. von Schrenk;* Alabama, other data wanting (specimen in herbarium of New York Bot. Garden).

On branches of *Pinus Taeda* L., Columbus, Mississippi, April 5, 1896, *S. M. Tracy* (specimen in herbarium of New York Bot. Garden).

On branches of *Pinus ponderosa* Dougl., Colfax, California, no date, *H. W. Harkness* (specimen in herbarium of New York Bot. Garden.

A widespread and characteristic species, more common southward, now known to be the aecial stage of *Cronartium* on the several species of *Quercus*, as demonstrated by Dr. C. L. Shear,* and verified by the writers just as the manuscript goes to press.

The type collection consists of a globoid gall about 2 cm. in diameter, accompanied by a water-color sketch, showing a small lateral branch bearing a sheath with two leaves, now lost from the specimen. This is the only collection reported from the state of New York. The village of Center is now called Karner, and the pine forest is cleared away.

15. **Peridermium globosum** sp. nov.

O. Pycnia unknown.

I. Aecia caulicolous, on globoid swellings, 2–3 cm. across, individual sori scarcely discernible but confluent over almost the entire area giving the whole a crinkled appearance, pale-yellow fading to white ; peridia circumscissile, falling away in very large flakes or sheets of uneven thickness, varying from 1 to 2 cells, outer surface verrucose, inner more coarsely verrucose, cells lanceolate, often very slender, placed radially, walls thick, with radial striations, somewhat tuberculate, lumen moderately small ; aeciospores ellipsoid, 16–22 by 26–31 μ, wall colorless, rather coarsely verrucose with smooth area extending from base up one side, 2–3 μ thick, about 1 μ thicker on smooth side.

On *Strobus Strobus* (L.) Small (*Pinus Strobus* L.), Lone Rock, Wisconsin, May 21, 1890, *E. S. Goff.* Only one specimen seen,

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*Jour. Myc. **12**: 89. 1906.

which consists of a regularly globose swelling 3 cm. in diameter, on a branch 1 cm. thick at a point where three smaller branches arise. Its gross appearance is similar to *Per. Cerebrum*, but it is readily distinguished from this and all other known forms on branches, and especially from *Per. Strobi* Kleb., the aecial stage of *Cronartium ribicola*, by the remarkably elongate and attenuate peridial cells, placed radially.

16. **Peridermium boreale** sp. nov.

O. Pycnia amphigenous, numerous, scattered, conspicuous, punctiform, honey-yellow becoming blackish-brown, subepidermal, flask-shaped or globoid, protruding, 95–140 μ broad.

I. Aecia from perennial mycelium, dwarfing the shoot and causing the leaves to adhere somewhat when dried, if not too mature, hypophyllous, in two irregular rows, flattened laterally, erumpent from slits 0.5–2.5 mm. long, often confluent, 0.5–1.2 mm. high, dehiscent along the sides, upper part often falling away intact, leaving an erose margin; peridium colorless, or pinkish at apex, cells very slightly or not overlapping, walls rather thin, outer smooth, 1.5–2.5 μ, inner verrucose, 3–4 μ; aeciospores broadly ellipsoid or globoid, 16–22 by 23–32 μ, wall colorless, rather thick, 2–4 μ, densely and rather finely verrucose; contents orange-red fading to nearly colorless.

On *Picea Parryana* (André) Parry (*P. pungens* Engelm.), southern Colorado, July, 1897, *E. Bethel* (in Ellis & Everh. Fungi Columbiani *no. 1479*), type; Gypsum Creek Cañon, Colorado, August, 1894, *C. S. Crandall* (in Ellis & Everh. Fungi Columb. *no. 876*, as on "*P. Engelmanni*"); North Elk Cañon, Rio Blanco County, Colorado, August 20, 1902, *W. C. Sturgis;* Harvey Peak, South Dakota, July 28, 1904, *C. F. Wheeler*, communicated by E. W. D. Holway.

On *Picea Engelmanni* (Parry) Engelm., Argentine Pass, Colorado, July 17, 1886 (specimen in herbarium of Missouri Bot. Garden, St. Louis); Camp Creek, Routt County, Colorado, July, 1903, *L. N. Goodding 1450* (as on "*P. pungens*"); Edith Pass, Banff, Canada, July 27, 1901, *E. W. D. Holway;* Vermilion River Valley, British Columbia, Canada, Aug. 16, 1905, *E. W. D. Holway;* Kittitas County, Washington, July-September, 1904, *J. S. Cotton*, communicated by P. L. Ricker.

Although the boundaries of this species are not well defined, yet it appears fairly distinct in most specimens examined. It sometimes forms witches' brooms, as in *Per. coloradense*, and in other characters closely resembles that species. It differs in the leaves usually remaining attached to the branch after drying, in the more prominent pycnia, and in small differences in spores and peridial cells.

17. **Peridermium coloradense** (Dietel) nom. nov.

Aecidium coloradense Dietel, in Engler & Prantl, Pflanzenfam. 1^{1**}: 78. 1897.

O. Pycnia amphigenous, numerous, scattered, conspicuous, honey-yellow becoming blackish-brown, punctiform, subepidermal, globoid or flask-shaped, slightly protruding, 110–150 μ broad.

I. Aecia from perennial mycelium, usually forming witches' brooms often of great size, hypophyllous, forming two irregular lines, flattened laterally, 0.8–1 mm. high, erumpent from a lenticular opening, 1–2 mm. long, dehiscent along the sides, the upper part often falling away in pieces leaving a lacerate margin; peridium colorless, or pinkish at apex, cells slightly overlapping, walls rather thin, outer smooth, thin, inner thicker, verrucose; aeciospores broadly ellipsoid or globoid, 16–25 by 26–35 μ, wall colorless, medium and rather unevenly thick, 2–3 μ, densely and rather coarsely verrucose; contents orange-red fading to nearly colorless.

On *Picea Engelmanni* (Parry) Engelm., Colorado, August, 1877, *T. S. Brandegee* (specimens in Crypt. Herb. Harvard University); Rocky Mountains, Canada (?), March 8, 1885, *J. Macoun* (specimen in herbarium N. Y. Bot. Garden); Music Pass, Sangre de Cristo Range, Colorado, July, 1888, *Rev. C. H. Demetrio* (in Ellis & Everh. N. A. F. *no. 2223*); Devil's Lake, Athabaska, Canada, March 7, 1891, *J. Macoun 372;* Lower Basin of the Gallatin River, Montana, July 8, 1898, *J. W. Blankinship;* Black's Fork, Wyoming, July 16, 1901, *Pammel, Johnson, Lummis, & Buchanan 664;* Smith's Fork, Wyoming, August 2, 1901, *L. H. Pammel 638;* Boulder, Colorado, July 1904, *E. Bethel;* Mariposa Dell, Colorado, August 10, 1905, *F. E. & E. S. Clements* (in Crypt. Format. Colorado, *no. 152*); Georgetown, Colorado, no date, *Wm. Trelease.*

On *Picea Mariana* (Mill.) B.S.P. (*Abies nigra* Desf.), Cacouna, Quebec, Canada, August 10, 1891, *D. P. Penhallow* (in Seym.

& Earle, Econ. Fungi, *no. 221*); Isle au Haut, Maine, August 16, 1899, and August 17, 1900, *J. C. Arthur;* North East Harbor, Maine, no date, *H. de Raasloff.*

A very abundant species, especially in the western mountains. It can be distinguished from *Per. decolorans*, with which it is often confused, not only by its common habit of forming witches' brooms, but by its much longer aecium and smaller aeciospores.

18. **Peridermium consimile** sp. nov.

O. Pycnia amphigenous, numerous, scattered, conspicuous, punctiform, honey-yellow becoming blackish-brown, subepidermal, globoid or flask-shaped, almost wholly immersed, 110–150 μ broad.

I. Aecia from a limited mycelium, not changing form of leaf, chiefly hypophyllous, in two irregular rows on yellowish spots occupying part or all of a leaf, flattened laterally, 0.5–1.5 mm. long, 0.5–0.8 mm. high, dehiscent at apex; peridium colorless, rather delicate, margin becoming lacerate, cells slightly overlapping, inner thickened, verrucose, transversely striate, outer thinner, smooth; aeciospores broadly ellipsoid or globoid, 16–23 by 24–35 μ, wall colorless, rather unevenly thick, 1.5–2.5 μ, moderately and densely verrucose.

On *Picea Mariana* (Mill.) B. S. P. (*Abies nigra* Desf.), Junius, New York, July, 1905, *E. J. Durand* (type); Lily Swamp, Oswego County, New York, August 4, 1891, *W. R. Dudley;* Burlington, Vermont, July 30, 1896, *A. J. Grout* (specimen in herbarium N. Y. Bot. Garden); London, Ontario, Canada, no date, *J. Dearness* (specimen in Crypt. Herb. Harvard University); Vermilion Lake, Minnesota, July 20, 1886, *E. W. D. Holway.*

On *Picea rubra* (Lamb.) Link (*Picea rubens* Sarg.), Adirondack Mountains, Aug. 1873, *Chas. H. Peck* (specimen in herbarium of N. Y. State Museum, Albany, N. Y.).

This form has been confused with *Per. decolorans* on the one hand, and *Per. coloradense* on the other. From the former it differs in size of spores and thickening of peridial cells, while agreeing in having an annual mycelium; and from the latter it differs in never forming witches' brooms and in dehiscence of peridia, while agreeing rather closely in size of aecia and spores. It is usually found in swamps.

19. PERIDERMIUM DECOLORANS Peck, Rep. N. Y. State Mus. **27**: 104. 1875

Peridermium abietinum decolorans Thuem. Mitth. Forstl. Vers. Oest. **2**: 321 (25). 1880.

Aecidium decolorans Farl. Bibl. Index **1**: 38. 1905.

O. Pycnia amphigenous, numerous, forming a row on each leaf-face, prominent, punctiform, honey-yellow becoming reddish-brown, subepidermal, flask-shaped, 105–145 µ broad.

I. Aecia from a limited mycelium, not changing form of leaf, hypophyllous, in two rows on yellowish spots occupying a part or all of a leaf, much compressed, erumpent from slits 0.5–3 mm. long, low, 0.5 mm. or less high, dehiscent at apex and readily falling away; peridium colorless, delicate, margin finely lacerate, cells abutted, sometimes slightly overlapping, outer wall and portions in contact strongly thickened, moderately verrucose, appearing transversely striate in section, inner wall smooth and thin; aeciospores broadly ellipsoid or globoid, 22–40 by 27–55 µ, wall colorless, thick, 3–6 µ, densely and finely verrucose, intercalary cells noticeable, about 5 by 7 µ; contents orange-red, fading to nearly colorless.

On *Picea Mariana* (Mill.) B. S. P. (*Abies nigra* Desf.), Mt. Colvin, Adirondack Mountains, New York, August 1873, *Chas. H. Peck* (type specimen in Herb. N. Y. State Museum, Albany, N. Y.); King's Ravine, Mt. Adams, New Hampshire, August, 1882, *W. G. Farlow* (in Ellis, N. A. F. *no. 1024*); Mt. Washington, New Hampshire, September, 1884, *W. G. Farlow* (in Rab.-Wint. Fungi Eur. *no. 3607*); Holly Bay, Newfoundland, August 6, 1894, *Robinson & Schrenk;* North East Harbor, Maine, August, 1902, *Miss T. McV. Hinton* (specimen in herbarium U. S. Dept. Agric.); Mt. Adams, New Hampshire, no date, *W. G. Farlow;* South West Point, Anticosti Island, Quebec, no date (*Macoun?*) (specimen in Crypt. Herb. Harvard University).

On *Picea rubra* (Lamb.) Link (*P. rubens* Sarg.), Nipple Top, Adirondack Mountains, New York, August, 1873, *Chas. H. Peck;* Sand Lake, New York, August (year ?), *Chas. H. Peck;* Adirondack Mountains, New York, August, 1873, *Chas. H. Peck* (one or more specimens in N. Y. State Museum, Albany, N. Y.); Prince Edward Island, Sept. 8, 1888 (*Macoun?*) *433;* Mt. Washington, New Hampshire, August 16, 1895, *E. J. Harper 267.*

On *Picea Engelmanni* (Parry) Engelm., Lake Louise, Canada, Aug. 27, 1904, *E. W. D. Holway;* Laggan, Alberta, Canada, 6,500 feet altitude, September 20, 1905, *E. W. D. Holway.*

On *Picea sitchensis* (Bong.) Carr., Seldovia, Alaska, August 12, 1904, *C. V. Piper*, communicated by P. L. Ricker.

On *Picea canadensis* (Mill.) B. S. P., Kenai, Alaska, August 18–20, 1904, *C. V. Piper*, communicated by P. L. Ricker.

A common species northward, of an essentially alpine character. It occurs on the summits of the Adirondack and White Mountains, islands of the Atlantic coast from Mt. Desert to Newfoundland, and along the mountains of the Pacific coast from Banff, British Columbia, into Alaska. The species is especially marked by its very large spores, being much larger than of any other American *Peridermium.*

In 1882 and 1883 Dr. W. G. Farlow explored the subalpine summits of the White Mountains with the especial object in view of ascertaining the distribution of the species of *Peridermium*, and "their proximity to certain teleutosporic forms on *Ericaceae.*" He discussed the results of his observations at considerable length in a paper before the Appalachian Club,* in which he concluded that *Per. colorans* was sufficiently like *Per. abietinum* of Europe to be considered synonymous, especially when taken with the known distribution of the rust on *Ledum*, which had recently been shown by De Bary to be the telial form. This conclusion was accepted by German botanists, as well as American, and a collection made on Mt. Washington, New Hampshire, was issued in Rabenhorst's Fungi Europaei under the name "*Chrysomyxa Ledi* (A. & S.)."

In the score of years since these observations were made much knowledge of the distribution of rusts has accumulated, and it is now apparent that there are two species of rusts on *Ledum*, and that it is *Uredo ledicola* Peck, with which the distribution of *Per. decolorans* corresponds, and not with the one common to Europe and America, generally called *Chrysomyxa Ledi.* Moreover, the spores of *Per. decolorans* are very much larger than those of *Per. abietinum*, a difference corresponding with the difference in size of the uredospores of the two forms on *Ledum.* We believe, in fact, that judging both from structural characters and geographical distribution, *Per. decolorans* is the aecial form of what in most herbaria is called *Uredo ledicola.*

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* Appalachia **3**: 239–243. 1884. See also Proc. Am. Acad. **20**: 320. 1885.

20. PERIDERMIUM ABIETINUM (A. & S.) Thuem. Mitth. Forstl. Vers. Oest. **2**: 320. 1880

Aecidium abietinum Alb. & Schw. Consp. Fung. Nisk. 120. 1805.

O. Pycnia amphigenous, numerous, inconspicuous, forming imperfect rows on either leaf-surface, subepidermal, honey-yellow becoming reddish-brown, globose, 100–150 μ broad, 100–130 μ high.

I. Aecia from a limited mycelium, hypophyllous in two rows on yellow spots occupying part or all of a leaf, erumpent from slits 0.3–1.5 mm. long, low, 0.5 mm. or less high, dehiscent at apex; peridium colorless, delicate, lacerate, cells abutted, outer wall and portions in contact much thickened, 5–7 μ, transversely striate, inner wall thin and smooth; aeciospores ellipsoid, 15–22 by 20–35 μ, wall colorless, 2–3 μ thick, strongly and densely verrucose with the exception of a smooth longitudinal stripe.

On *Picea excelsa* (Lam.) Link, in Europe, but not yet found in America. The peridial cells of this species, like those of *Per. decolorans*, are abutted, and not overlapped as in related forms. The cells of the peridium, as well as the spores, are smaller than in *Per. decolorans*, and the spores also have a smooth line, not found in *Per. decolorans* or other American forms. It is the aecial form of *Chrysomyxa Ledi* (A. & S.) DeB. The telial form has been collected in the White Mountains, New Hampshire, northern Wisconsin, and the Yellowstone Park, and consequently the aecial form should eventually be found in America.

21. **Peridermium pseudo-balsameum** (D. & H.) nom. nov.

Aecidium pseudo-balsameum D. & H. Erythea **7**: 98. 1899.

O. Pycnia hypophyllous, rather numerous, inconspicuous, scattered, honey-yellow becoming blackish-brown, subepidermal, globose, large, 160–175 μ broad.

I. Aecia from a limited mycelium, hypophyllous, sparsely arranged in two rows, on yellow spots occupying a part or all of a leaf, deep-seated, cylindrical, 0.4–0.6 mm. in diam. by 0.75–1 mm. high, dehiscent at apex becoming deeply lacerate; peridium colorless, rather delicate, cells overlapping, walls not striate, inner very coarsely verrucose, 5–7 μ thick including tubercles, outer thinner, 3–4 μ; aeciospores broadly ellipsoid, 18–22 by 23–28 μ, wall colorless, medium thick, 2.5–3.5 μ, closely and rather finely verrucose.

On *Abies grandis* Lindl., Eureka, California, June 4, 1896, *W. C. Blasdale & M. A. Howe.* Known only from the type locality, although not an inconspicuous species.

22. PERIDERMIUM HOLWAYI Sydow, Ann. Myc. **1**: 19. 1903

O. Pycnia chiefly hypophyllous, rather numerous, scattered, inconspicuous, scarcely arising above the surface of the epidermis, honey-yellow becoming brown, subepidermal, usually destructive to the epidermal cells above, large, 145–160 μ in diameter.

I. Aecia from a limited mycelium, amphigenous, scattered on yellow areas occupying part or all of a leaf, slightly tongue-like or flattened-cylindrical, 0.2–0.4 mm. across by 0.3–0.6 mm. long, low, 0.4–0.8 mm. high; peridium colorless, delicate, dehiscence irregular, margin becoming lacerate, cells overlapping, walls not striate, outer thin, inner considerably thickened, and strongly tuberculate; aeciospores broadly ellipsoid, 15–18 by 18–24 μ, wall colorless, thin, about 1 μ, evenly and finely verrucose.

On *Pseudotsuga mucronata* (Raf.) Sudw. (*Pseudotsuga Douglasii* Carr., *Abies Douglasii* Lindl.), Glacier, British Columbia, August 11, 1901, *E. W. D. Holway.* Known only from the type locality.

23. **Peridermium conorum-Piceae** (Reess) nom. nov.

Aecidium conorum-Piceae Reess, Abh. Nat. Ges. Halle **11**: (54). 1869.

Peridermium conorum Thuem. Mitth. Forstl. Vers. Oest. **2**: 313 (17). 1880.

Peridermium Engelmanni Thuem. Mitth. Forstl. Vers. Oest. **2**: 314 (18). 1880.

Aecidium Engelmanni Dietel, in Engler & Prantl, Pflanzenfam. **1**^{1}**: 79. 1897.

O. Pycnia episquamous, numerous, subepidermal, flat, forming continuous layers, 600–900 μ broad, 50–100 μ high, inconspicuous, not noticeably elevating the surface.

I. Aecia chiefly episquamous, subepidermal, forming bullate swellings, irregularly round, large, crowded and often confluent, finally rupturing the epidermis, very pulverulent; peridium irregularly convex, soon dropping away, cells broadly ellipsoid or globoid, loosely united, coarsely tuberculate, resembling the spores; aeciospores broadly elliptical or obovoid, large, variable in size, 20–27 by 25–40 μ, wall colorless, thick, 4–5 μ, half formed by the large deciduous tubercles, which are rather crowded, broad, 3–4 μ, and depressed.

On cones of *Picea Mariana* (Mill.) B. S. P. (*Abies nigra* Desf.), Lake Sunapee, New Hampshire, July 30, 1891, and foot of Mt. Lafayette, New Hampshire, July, 1895, *W. G. Farlow* (both specimens in Crypt. Herb. of Harvard Univ.).

On cones of *Picea rubra* (Lamb.) Link (*P. rubens* Sarg.), Fulton Chain, Herkimer County, New York, and North Elba, Essex County, New York, no date, *Chas. H. Peck* (both specimens in the herbarium of N. Y. State Museum, Albany).

On cones of *Picea canadensis* (Mill.) B. S. P. (*Picea alba* Link), Kittery Point, Maine, August 13, 1891, *Roland Thaxter* (in Seym. & Earle, Econ. Fungi *no. 220*).

On cones of *Picea Engelmanni* (Parry) Engelm., Colorado, no date, *T. S. Brandegee 477* (specimen in herbarium of N. Y. Bot. Garden).

On cones of *Picea excelsa* L., Newton, Massachusetts, August, 1874, *W. G. Farlow* (specimen in Crypt. Herb. of Harvard Univ.).

The species is probably rather common and widely distributed, but owing to its occurrence high up on trees it is not often or easily collected. It has been suggested by Rostrup that this is the aecial form of *Chrysomyxa Pyrolae* (DC.) Rostr., but this has not yet been fully confirmed. The geographical distribution of the form on *Pyrola* in North America would favor this assumption.

24. PERIDERMIUM COLUMNARE (A. & S.) Kunze & Schmidt, Deutschl. Schwämme *10.* 1815

Aecidium columnare Alb. & Schw. Consp. Fung. Nisk. 121. 1805.

O. Pycnia rarely if ever formed.

I. Aecia from a limited mycelium, hypophyllous, numerous, usually forming rows on either side of the midrib, cylindrical, 0.1–0.15 mm. across, 0.4–0.7 mm. high; peridium colorless, delicate, rupturing at apex, becoming irregularly lacerate, cells slightly overlapping, inner wall finely verrucose, not noticeably striate, 2.5–3.5 μ thick, outer wall of equal thickness, smooth; aeciospores globoid or broadly ellipsoid, 13–17 by 16–24 μ, wall colorless, rather thin, 1–1.5 μ, finely and closely verrucose.

On *Abies pectinata* DC. (*A. alba* Mill.) in Europe, but not yet found in America. It has been proven by incontestable cultures to be the aecial stage of *Calyptospora Goeppertiana* Kühn. The *Calyptospora* forms cylindrical swellings on stems of *Vaccinium*, and is frequently collected in the New England states and along the Pacific coast, which makes it reasonably certain that the aecial form will be found eventually within the same regions.

A peculiarity of this *Peridermium* is the absence of pycnia. So far none have been found in authentic specimens, which makes one think that they may never occur. Very low, inconspicuous pycnia are to be found in a closely related species, which often passes under the same name (see Sydow, Ured. *896* and Vestergren, Micr. rar. sel. *754*), a form also undetected in America.

25. PERIDERMIUM ORNAMENTALE Arth. Bull. Torrey Club 28: 665. 1901

Aecidium ornamentale Farl. (non Kalchbr. 1875) Bibl. Index **1**: 71. 1905.

O. Pycnia amphigenous, numerous, flat, often confluent, inconspicuous, subcuticular, in section broad and low, slightly convex or even a little conical, 130–210 μ broad, 25–35 μ high.

I. Aecia from a limited mycelium, hypophyllous in two rows on yellowish spots occupying part or all of the leaf, large, 1–2 mm. high, somewhat flattened laterally; peridium bladdery, colorless, rupturing irregularly, cells overlapping, rather large, outer wall smooth, rather thin, 2 μ, inner wall thicker, 3–5 μ, moderately verrucose; aeciospores with cylindrical intercalary cells, 3–4 by 5–8 μ, spores broadly ellipsoid, 13–18 by 20–29 μ, wall colorless, thin, 1–1.5 μ, closely and finely verrucose; contents orange-red, fading to pale-yellow.

On *Abies lasiocarpa* (Hook.) Nutt., mountains of Skamania County, Washington, August 11, 1886, *W. N. Suksdorf 296*; Mt. Paddo, Washington, 6000 ft. alt., September 4, 1900, *W. N. Suksdorf 588* (type collection); Laggan, Alberta, Canada, 6500 ft. alt., September 20, 1905, *E. W. D. Holway*.

26. PERIDERMIUM PECKII Thuem. Mitth. Forstl. Vers. Oest. 2: 320 (24). 1880

Aecidium Peckii Dietel, in Engler & Prantl, Pflanzenfam. **1**^{1**}: 78. 1897.

O. Pycnia hypophyllous, numerous, scattered, inconspicuous, subcuticular, extending considerably into the walls of the epidermal cells, in section broad and low, slightly convex or even a little conoidal, small, 65–125 μ broad, 20–26 μ high.

I. Aecia from a limited mycelium, hypophyllous in two rows on yellow spots occupying part or usually all of the leaf, deep-seated, small, 0.2–0.3 mm. in diam., 0.5–1 mm. high, cylindrical; peridium colorless, dehiscence at apex, cells overlapping, only loosely joined, readily falling apart, rather slender, inner wall moderately verrucose, 4–5 µ thick, outer wall smooth and thinner; aeciospores broadly ellipsoid, 15–18 by 18–27 µ, wall colorless, thin, about 1 µ, finely and evenly verrucose.

On *Tsuga canadensis* (L.) Carr. (*Abies canadensis* Michx.), Buffalo, New York, no date, *G. W. Clinton* (specimen in herbarium of U. S. Dept. Agric.), Shelburne, New Hampshire, September, 1882, *W. G. Farlow* (in Ellis, N. A. F. *no. 1023*); Utica, New York, December 9, 1886 and February, 1887, *Daniel Batchelor;* Wellesley, Massachusetts, June, 1889, *Grace E. Cooley* (in Seym. & Earle, Econ. Fungi *no. 225 a*); Manchester, Massachusetts, July, 1890, *W. C. Sturgis* (in Seym. & Earle, Econ. Fungi *no. 225b*); Blacksburg, Virginia, July 14, 1897, *W. A. Murrill* (specimen in herbarium of the N. Y. Bot. Garden); near Tibb's Run reservoir, West Virginia, June 15, 1904, *John L. Sheldon.*

27. PERIDERMIUM ELATINUM (A. & S.) Kunze & Schmidt, Deutschl. Schwämme *141.* 1817

Aecidium elatinum Alb. & Schw. Consp. Fung. Nisk. 121. 1805.

O. Pycnia epiphyllous, few, scattered, punctiform, inconspicuous, subcuticular, not extending much into walls of epidermis, in section depressed-hemispherical, small, 100–130 µ broad, 40–50 µ high.

I. Aecia from a perennial mycelium, dwarfing the young shoots and forming witches' brooms, hypophyllous, forming two irregular lines, deep-seated, wholly dropping out of the substratum at maturity, roundish or irregularly oblong, large, 0.5–1 mm. across, bladdery, soon open by falling away of the upper part; peridium colorless, dehiscence irregular, cells with thin inner and outer walls; aeciospores broadly ellipsoid or nearly globoid, 14–18 by 16–28 µ, wall colorless, thin, 1–1.5 µ, closely and rather finely verrucose.

On *Abies balsamea* (L.) Mill., Ripton, Vermont, no date, *E. Brainerd* (in Ellis, N. A. F. *no. 1437*); Andover, Massachusetts, no date, *Joseph Blake*, communicated by P. L. Ricker; Riverhead, Bay of Islands, Newfoundland, September 12, 1885, *A. C. Waghorne;* La Pointe, Wisconsin, 1896, *L. S. Cheney* (specimen in herbarium N. Y. State Museum, Albany); Sailor's Encampment, Michigan, August 5, 1899, *E. T. Harper 316*, communicated by E. W. D. Holway; Isle Royal, Michigan, September 4, 1901, *Stuntz & Allen* (in Ellis & Everh. Fungi Columb. *no. 1620*); Isle au Haut, Maine, August 20, 1900, *J. C. Arthur*.

On *Abies lasiocarpa* (Hook.) Nutt. (*A. subalpina* Engelm.), Yellowstone Park, Wyoming, August, 1884, *Frank Tweedy;* Black Mountain, Manti, Utah, 8000 ft. alt., August 6, 1895, *Marcus E. Jones;* Battle Lake, Wyoming, August 18, 1897, *Aven Nelson 4244;* Mystic Lake, Bozeman, Montana, 7000 ft. alt., August 1, 1898, *J. W. Blankinship*, communicated by E. W. D. Holway; Brush Creek, Utah, 9000 ft. alt., July 27, 1900, *Pammel & Stanton 642;* Aquarius Plateau, Utah, August 5, 1905, *Rydberg & Carlton 7462*.

On *Abies religiosa* Lindl., Orizaba, Mexico, 1901, *J. N. Rose 5753* (specimen in herbarium of U S. Dept. Agric.).

A wide-spread and conspicuous species. It appears to be identical in both gross appearance and microscopic structure with the European form of the same name, which through the numerous cultures by Klebahn and Fischer has been proven to be the aecial stage of *Melampsorella Cerastii* (Pers.) Schröt. The uredinial and telial forms of this species on *Alsine*, *Stellaria* and *Cerastium* are very inconspicuous, but have been collected a few times in the United States.

28. PERIDERMIUM BALSAMEUM Peck, Rep. N. Y. State Mus. **27**: 104. 1875

Aecidium balsameum Dietel, in Engler & Prantl, Pflanzenfam. 1^{1**}: 78. 1897.

O. Pycnia hypophyllous, few, scattered, punctiform, inconspicuous, honey-yellow, small, subcuticular, extending into the lateral walls of epidermis, in section hemispherical, 100–130 µ broad, 35–50 µ high.

I. Aecia from a limited mycelium not changing form of leaf, hypophyllous in two irregular rows on yellowish spots occupying a part or all of a leaf, white even before spores are discharged, deep-seated, cylindrical, or somewhat flattened laterally, rather small, 0.2–0.5 mm. across, opening at apex; peridium colorless, margin erect, erose or somewhat lacerate, cells overlapping, with medium thick walls, 2–4 µ, the outer smooth, inner somewhat thicker and rather coarsely verrucose; aeciospores broadly ellipsoid or globoid, 18–22 by 20–30 μ, wall thin, 1–1.5 μ, densely and rather coarsely verrucose; contents colorless.

On *Abies balsamea* (L.) Mill., Kings Ravine, Mt. Adams, New Hampshire, August, 1882, *W. G. Farlow* (in Ellis, N. A. F. *no. 1025*, and de Thuemen, Mycoth. Universalis, *no. 2258*); Vermilion Lake, Minnesota, July 24, 1886, *E. W. D. Holway 208;* Mt. Moosilauke, New Hampshire, August 26, 1884, *Miss Clara E. Cummings;* Ellis River, New Hampshire, August, 1889, *L. M. Underwood;* Catskill Mountains, Greene County, New York, August, 1894, *J. F. James* (specimen in herbarium of U. S. Dept. Agric.); Newfoundland, 1894, *Robinson & Schrenk;* Summit of Mt. Washington, New Hampshire, August 16, 1895, *E. T. Harper 268;* Neebish Island, Michigan, August 25, 1899, *E. T. Harper 333;* Adirondack Mountains, New York, no date, *Chas. H. Peck;* Delaware County, Iowa, 1890, collector unknown, communicated by Prof. T. H. Macbride.

On *Abies grandis* Lindl., southern slope of Mt. Paddo, Washington, October 31, 1903, *W. N. Suksdorf 965.*

This species is especially characterized by white spores, which also occur in *Aecidium pseudo-columnare* Kühn. The probable identity of the two forms was pointed out by Farlow,* and our studies confirm this opinion. The only difference we could detect was that the peridial cells were a little more coarsely verrucose in the American specimens. But our European material for the study was scanty, and even this seeming difference may not be constant. Should the two be found to be identical, Kühn's name should be added to the above as a synonym, as it was published about ten years later than the one by Peck.

29. **Peridermium Laricis** (Kleb.) nom. nov.

Aecidium Laricis Kleb. Zeits. Pflanzenkr. **9**: 18. 1899.

O. Pycnia amphigenous, rather numerous, scattered, inconspicuous, subcuticular, pale-yellow, flattened-conical, 50–65 μ in diameter by 20–30 μ high; pycniospores oval, 1.5–2 μ long, abundant.

I. Aecia from a limited mycelium, hypophyllous, solitary or in rows on one or both sides of the midrib, flattened laterally, or

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* Proc. Am. Acad. **20**: 322. 1885.

subcylindrical, 0.1–0.15 mm. wide, 0.3–1 mm. long, by 0.3–0.5 mm. high; peridium light reddish-orange fading to white, rupturing along the apical line, peridial cells rhomboidal in longitudinal section, 25–30 µ long, somewhat overlapping, inner wall finely verrucose, transversely striate, 2–3 µ thick, outer of equal thickness, smooth; aeciospores globoid or broadly ellipsoid, 12–18 by 16–25 µ, wall colorless, rather thin, 1–1.5 µ, closely and evenly verrucose, except a small area on one side which is smooth and slightly thinner.

On *Larix decidua* Mill. in Europe, not yet detected in America. It has been shown by Klebahn and others to be the aecial stage of *Melampsoridium betulinum* (Tul.) Kleb. The uredinial and telial stages occur on *Betula;* they have been collected in many localities in this country, both east and west, and the *Peridermium*, which is quite inconspicuous, will doubtless be found also.

30. PERIDERMIUM EPHEDRAE Cooke, Indian Forester **3**: 95. 1877

Peridermium Pini minor B. & C. Grevillea **3**: 59. 1874.

Coleosporium Senecionis minus De Toni; Sacc. Syll. Fung. **7**: 752. 1888.

Aecidium Ephedrae Dietel, in Engler & Prantl, Pflanzenfam. **1**^{1**}: 79. 1897.

O. Pycnia caulicolous, numerous, conspicuous, subcuticular, scattered irregularly over large areas, honey-yellow becoming golden-brown, conical, or often with broad flat top, 75–130 µ broad, 50–70 µ high.

I. Aecia from a perennial mycelium, caulicolous, numerous, scattered over the slightly hypertrophied shoots, cylindrical, slender, 0.3–0.4 mm. in diameter, 1.5–2.5 mm. high, dehiscent at apex; peridium colorless, firm, cells slightly or not overlapping, walls rather thin, outer smooth, inner somewhat thicker and finely verrucose; aeciospores broadly ellipsoid or globoid, 16–20 by 19–26 µ; wall colorless, thin, 1–1.5 µ, closely and finely verrucose.

On *Ephedra nevadensis* S. Wats. (*E. antisyphilitica* S. Wats.), Arizona, no date, *H. H. Rusby*.

On *Ephedra pedunculata* Engelm. (as on "*E. antisyphilitica*"), Texas, no date, *Chas. Wright* (in Ravenel, F. Car. Exsicc. **3**: *95*, part of type collection); Bradshaw Mountains, Arizona, June 20, 1892, *J. W. Toumey* (as on "*E. oxycarpa*"); San Luis Potosi, Mexico, 1878, *E. Palmer 1027* (specimen in herbarium of the N. Y. Bot. Garden); Mexico, March, 1885, *C. G. Pringle* (specimen in herbarium of Iowa State College).

On *Ephedra trifurca* Torr., mesa near Las Cruces, New Mexico, July 5, 1897, 4000 ft. alt., *E. O. Wooton 542;* plain between Las Cruces and Organ Mountains, New Mexico, August 22, 1897, *J. D. Tinsley* (specimen in herbarium of N. Y. Bot. Garden).

On *Ephedra californica* S. Wats., San Diego, California, March 16, 1882, *Marcus E. Jones 3077;* Lower California, Mexico, January, 1883, *L. F. Ward* (specimen in herbarium of N. Y. Bot. Garden); Cabezo, Colorado Desert, Riverside County, California, April 11, 1896, *S. B. Parish,* communicated by E. W. D. Holway.

On *Ephedra Torreyana* S. Wats., Angeles Bay, Lower California, Mexico, September, 1887, *E. Palmer.*

A common and conspicuous species along the southwestern border of the United States and southward into Mexico. In Thuemen's monograph of the genus *Peridermium*, page 323, the species is credited to South Carolina (Ravenel), which is clearly an error in citing the type collection.

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Notes on Carex—I

Kenneth Kent Mackenzie

The following notes are chiefly the result of an endeavor to name a large amount of material which has accumulated in the New York Botanical Garden, and which collectors as a rule have not attempted to name.

Carex saximontana sp. nov.

A tufted, very leafy species, allied to *Carex durifolia* Bailey. Leaves strongly glaucous, much exceeding the culms, 15–30 cm. long, 3–5 mm. wide, rough on the margins and on the midnerve below; culms leafless or nearly so, from very short to 15 cm. long, triangular, slightly roughened and winged on the lower portions, strongly winged above; pistillate flowers 2–5, on a zigzag, triangular, winged rachis, each subtended by a bract, the lower two or three of which are enlarged, leaf-like, saccate, and exceed the inflorescence, being from 7 to 35 mm. long and 2–6 mm. wide; the upper scale-like, ovate-lanceolate, acuminate, hyaline, shorter than the perigynia; staminate spike sessile, 3 mm. long, exceeded by the upper perigynium; perigynium glabrous, the body oblong-orbicular tapering to a stipitate base 0.5 mm. long, and rather abruptly contracted into a short, hyaline, slightly toothed beak less than or barely 1 mm. long, the whole perigynium about 4 mm. long, the body being about 2 mm. wide and 2.5 mm. long, two of the nerves prominent, the others very inconspicuous; achene oblong-orbicular, completely filling the perigynium, 3-lined, but otherwise not triangular.

Readily distinguished from *Carex durifolia* Bailey (*Carex Backii* Boott), to which it has been referred, by the glaucous leaves; by the perigynia, which in *C. durifolia* exceed 5 mm. in length, are oblong-lanceolate and gradually taper into the greenish, hardly-toothed, stout beak; and by the upper scales or bracts, which in *C. durifolia* resemble the lower, are green and much exceed the perigynia. The "*Carex Backii* Boott" of the Rocky Mountains.

Type in Herb. N. Y. Bot. Garden, collected by Carl F. Baker in the foothills of north Colorado, near Ft. Collins, altitude 5,500 feet, May 24, 1896.

To this species also belong the following, collected in Wyoming:

Sheridan county, Big Horn Mountains, *Tweedy 2251*, July 2, 1899; head-waters of Clear Creek, Big Horn Mountains, *Tweedy 3334*, July 20–Aug. 15, 1900.

Carex concinnoides sp. nov.

Plants strongly stoloniferous, the culms arising singly, slender, smooth, 25 cm. or less high. Leaves crowded at the base of the culm, the sheaths reddish-brown, strongly striate and more or less filamentose, the blades flat, glabrous, more or less glaucous, shorter than the culm, 20 cm. or less long, 2–4 mm. wide; culm bearing 2–4 bladeless long-acuminate sheaths at base, which are usually tinged with purplish-red; pistillate spikes one or two, approximate at the summit of the culm, erect, sessile or short-peduncled, 5–10-flowered, 5–10 mm. long and 4–5 mm. wide; the bract much shorter than the spike, usually tinged with reddish-purple and hyaline on the margins above; scales ovate-lanceolate, narrower and shorter than the perigynia, acute, reddish-purple with hyaline margins; perigynium 2.5–3 mm. long, 1.5 mm. wide, the body oblong-elliptical, tapering to a short stipitate base and rather abruptly contracted into a short entire beak 0.5 mm. long, strongly loosely pubescent; staminate spike short, sessile or nearly so, 8–15 mm. long, 2–3 mm. wide, the scales broadly ovate, purplish-brown with a hyaline margin; achenes closely enveloped by the perigynia, 2 mm. long.

This species may be distinguished from *Carex Richardsonii* R. Br. and *Carex concinna* R. Br., to which it is related, by the following key:

Staminate spike 3–6 mm. long; scales obtuse, one-half the length of the perigynia. *C. concinna.*

Staminate spike 8–22 mm. long; scales acute to acuminate, from little shorter than to exceeding the perigynia.

- Perigynia loosely pubescent, wider and longer than the scales; staminate spike nearly sessile; pistillate spikes few-flowered. *C. concinnoides.*
- Perigynia appressed-pubescent, narrower and shorter than the scales; staminate spike noticeably peduncled; pistillate spikes many-flowered. *C. Richardsonii.*

The type-specimen of this pretty little species was collected by R. S. Williams at Columbia Falls, Montana, on June 7 and July 28, 1893, and is in the New York Botanical Garden Herbarium.

The following specimens also belong here:

IDAHO: Moscow Mt., Latah County, *Abrams 636*, May, 1906.

BRITISH COLUMBIA: Selkirk Mountains, near 51° 30″, *Shaw 77a*, July 1, 1904; Deer Park, Columbia River, *Macoun 56*, June 6, 1890.

ALBERTA: Banff, *Macoun 7464*, June 26, 1891 (very young).

✓ **Carex mediterranea** sp. nov.

A strongly tufted species, the culms 35 cm. or less high, usually about 25 cm., and about twice exceeding in length the leaves, triangular, smooth below, rough on the angles above. Leaves flat, long-acuminate, 2.5–4 mm. wide, typically about 10 cm. long, smoothish above, roughened below, especially towards the apex; spikes densely aggregated in a solitary terminal head 10–17 mm. long and about 10 mm. wide, the spikes bearing a few inconspicuous staminate flowers above and ten to many pistillate flowers below, the bracts awl-shaped, long-cuspidate, much shorter than the head; perigynium ascending or spreading, 3.5 mm. long, 2.25 mm. wide, the body ovate, flattened, margined, round-tapering at base, tapering above to the serrulate, bidentate beak, which occupies about ⅓ of the perigynium, nerveless on the inner surface, nerved on the outer; scales ovate, cuspidate, brownish-hyaline with a green midrib, from slightly shorter to slightly longer than the perigynia and usually a little narrower; achene lenticular, nearly orbicular, 1.5 mm. long, very short-stipitate; stigmas 2.

The above species, which is not uncommon from the District of Columbia westward to Kansas, has a strong outward resemblance to *Carex cephalophora* Muhl. and has usually been referred to that species, which is also common in the same range. The reference of specimens of this plant, however, to *Carex Muhlenbergii* Schkr., and even to *Carex gravida* Bailey, shows that it has given much trouble to students and collectors. As a matter of fact its nearest relative is *Carex Muhlenbergii* Schkr., and this last-named species is, of course, exceedingly close to *Carex gravida* Bailey. In short, the plant may be described as having the aspect, leaves and head of *Carex cephalophora*, while it has the perigynia and scales of *Carex Muhlenbergii*. The following key will serve to distinguish some of the closely related species of this group:

Heads short, rarely interrupted, 8–20 mm. long.
  Scales much exceeded by the perigynia.
    Perigynia ovate-lanceolate or narrower; leaves 2.5–4 mm. wide. *C. cephalophora.*

Perigynia ovate-orbicular; leaves 1–2 mm. wide. *C. Leavenworthii.*
Scales about the length of the perigynia.
Perigynia 3.5 mm. or less long; culms twice the length of the leaves. *C. mediterranea.*
Perigynia exceeding 3.5 mm. in length; culms little exceeding the upper leaves. *C. gravida.*
Heads long, usually interrupted, 15–35 mm. long. *C. Muhlenbergii.*

The type-specimen was collected by E. S. Steele at Washington, D. C., May 23, 1898, distributed as *Carex gravida*, and is in my private herbarium. Other specimens referable to this species are:

TENNESSEE: Knoxville, *Ruth 10925*, July, 1897, and *107*, June, 1898.

MISSOURI: Jackson County, *Mackenzie*, June 4, 1899 and June 10, 1900, and June 13, 1900; St. Louis, *Glatfelter*, 1894 and 1895.

KANSAS: Cherokee County, *Hitchcock 1019*, May 7, 1897.

Carex agglomerata sp. nov.

A strongly tufted plant, the culms 6 dm. or less high, usually considerably exceeding the leaves, triangular, smooth below, slightly rough on the angles immediately below the head. Leaves regularly and evenly distributed on the lower part of the culm and not chiefly tufted near the base, flat, 3–4 mm. wide, 10–20 cm. long, smooth towards the base, roughened towards the apex and on the margins; spikes densely aggregated in a solitary terminal head, 10 mm. wide, 25–35 mm. long, the lower usually slightly separated, the spikes bearing the few inconspicuous staminate flowers above, and the ten to many pistillate flowers below, the bracts awl-shaped, elongate, those of the lower spikes, at least, usually conspicuous, but much shorter than the heads; perigynium ascending or spreading, about 3.25 mm. long and 2 mm. wide, the body ovate, flattened, margined, round-tapering at base, tapering into the serrulate, bidentate beak, which occupies one half the length of the perigynium, nerveless on the inner face, nerved on the outer; scales ovate, hyaline with a green midrib, acuminate to cuspidate, the body about the length of the body of the perigynia, but somewhat narrower; achene lenticular, oblong-orbicular, 2 mm. long, very short-stipitate; stigmas 2.

Heretofore referred to the more northern *Carex cephaloidea* Dewey, but always with doubt; this species may be distinguished from that species, as well as from the polymorphous *Carex Muhlenbergii* Schkr. and *Carex gravida* Bailey, as follows:

Bracts not elongate; scales one half length of body of perigynia; culm-angles strongly serrulate. *C. cephaloidea.*

Some of the bracts elongate; scales equaling body of perigynia or longer; culm-angles roughened beneath head only.

  Scales equaling body of perigynia; beak as long as body of perigynia. *C. agglomerata.*

  Scales equaling or exceeding perigynia; beak shorter than body of perigynia. *C. Muhlenbergii.*

Carex agglomerata is the plant referred to *Carex cephaloidea* at page 52 of the Manual of the Flora of Jackson County, Missouri. The type-specimen was collected by B. F. Bush at Courtney, Jackson County, Missouri, *no. 1718*, on May 25, 1902, at which place it is rather common in the woods along the Missouri River bluffs, where it was also collected by myself on May 23, 1896. The same species has been collected by E. S. Steele near Washington, D. C., June 5, 1901. It doubtless occurs in the intermediate territory, but the almost total absence of collectors in that region easily accounts for its non-appearance in collections.

Two new southwestern species of Pentstemon[*]

LE ROY ABRAMS

Pentstemon jacintensis sp. nov.

A low woody plant, 3–5 dm. high, with minutely puberulent branches : leaves oval to ovate, 6–12 mm. long, remotely denticulate, very sparsely and minutely puberulent, appearing glabrous to the eye : flowers in loose spiciform racemes, subsessile, solitary or rarely in pairs ; sepals lanceolate, 6 mm. long, glandular-pubescent; corolla sparsely villous without, "dull-yellow veined with purple", 15 mm. long ; corolla-tube about 9 mm. long ; filaments pubescent at base, the sterile one glabrous above.

In the supplement to the Synoptical Flora, Dr. Gray referred this species to *P. Rothrockii.* Later Mr. Hall, in his Botanical Survey of San Jacinto Mountain, also referred these plants to that species, but with the note that "the corolla is not glabrous, as described, but conspicuously though sparsely pubescent externally and is of a dull yellow color veined with purple — never 'reddish'."[†] *P. Rothrockii* has minutely and rather densely hispidulous leaves and branches, ovate-lanceolate sepals, 3–4 mm. long, and glabrous corolla, 9 mm. long.

This species seems to be confined to the San Jacinto Mountains of Southern California, where, according to Mr. Hall, it is "quite frequent in the open forests from Tahquitz Valley to Fullers Ridge, occupying the upper part of the Transition Zone." The following specimens are in the U. S. National Herbarium :

San Jacinto Mountain, *S. B. & W. F. Parish 473*, July, 1880.

San Jacinto Mountain, altitude 9,000 feet, *H. M. Hall 704*, July 21, 1897 (U. S. National Herbarium, *no. 314515*, type).

San Jacinto Mountains, Tahquitz Valley at 8,200 feet altitude, *H. M. Hall 2588*, July, 1901.

Pentstemon Plummerae sp. nov.

Shrub with shredded grayish bark and pubescent twigs : leaves oblanceolate to spatulate, 6–10 mm. long, tapering at base to

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[*] Published by permission of the Secretary of the Smithsonian Institution.

[†] Univ. Calif. Publ. Bot. 1 : 120. 1902.

petioles half as long, entire, rather sparsely short-pubescent: inflorescence paniculate, leafy; peduncles 5–10 mm. long, 1-flowered; sepals narrowly ovate-lanceolate, 6 mm. long, pubescent; corolla probably yellow, ventricose, 15–18 mm. long; tube scarcely equaling the limb; upper lip fornicate, slightly lobed, the lower pendulous-recurved; sterile filament densely bearded on one side.

This species has been confused with *P. antirrhinoides* Benth., but that is glabrous or merely puberulent, with round-ovate sepals, and is confined to the chaparral region of the coast slope of southern California, extending from the vicinity of San Bernardino to the international boundary line and probably into adjacent Lower California.

The following specimens of *P. Plummerae* are in the U. S. National Herbarium, all of which are from northern Arizona:

No locality, *Palmer 334*, 1876.

Yucca, *M. E. Jones 3941*, May 21, 1884.

Mineral Park, *Mr. & Mrs. J. G. Lemmon*, June, 1884 (U. S. National Herbarium, *no. 40236*, type).

Mescal Mountains, *M. E. Jones*, May 24, 1890.

UNITED STATES NATIONAL MUSEUM.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1905)

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

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

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CONTENTS

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BULLETIN

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TORREY BOTANICAL CLUB

SEPTEMBER, 1906

Pteridophytes observed during three excursions into southern Florida *

ALVAH AUGUSTUS EATON

In November and December, 1903, I discovered in southern Florida several ferns new to the United States, of which a brief notice was published in the Fern Bulletin for April, 1904. As several species, at that time undetermined, were omitted from my account, and furthermore two subsequent trips have added other species new to the flora, it now seems best to bring all these little-known plants together, with somewhat careful descriptions which will make them the more readily distinguishable by fern students ; † and, moreover, to enumerate all the fernworts discovered in the course of my travels in Florida, with the hope that the notes so presented will add materially to knowledge of geographical distribution, as well as aid future botanical explorers. It is hoped, also, that the great ecological interest of the region will be so well suggested as to lead ecologists into southern Florida. Such lists as the present one, if carefully prepared, should be of much assistance when exact ecological surveys come to be made. Acknowledgments are due to Mr. B. D. Gilbert, Mr. William R. Maxon and Dr. L. M. Underwood for assistance in the determination of specimens.

ITINERARY

It becomes necessary to present a brief account of my itinerary. I arrived at Miami on November 6, 1903, where I met Dr. J. K. Small and Mr. J. J. Carter. Making Miami our base, we imme-

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* Contributions from The Ames Botanical Laboratory, No. 4.

† The species added to the flora of the United States are indicated by an asterisk.

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diately began explorations of the surrounding territory, visiting the everglades and making excursions to localities southward; namely, Camp Longview (about 45 miles distant), the vicinity of Black Point (20 miles), and hammocks in the "Homestead" region (30 to 40 miles). We also explored most of the hammocks between Miami and Cutler, and made a trip up the canal from Miami to Fort Lauderdale and Boynton. On the 22d of November I left the other members of the party and went to Planter, on Key Largo, from there exploring the southern half of the key and the adjacent Plantation Key, and making a trip across Florida Bay to Madeira hammocks on the mainland. I returned to Miami December 3, and in company with Mr. John Soar and Prof. Chas. T. Simpson made a visit to Royal Palm, or Paradise Key, at the eastern end of Long Key, or Pine Island, lying in the everglade about 50 miles south of Miami. We explored some new hammocks in the Homestead region, to which I subsequently returned in company with Mr. Soar, when we revisited all the hammocks of the vicinity. On December 31 I was at Fort Lauderdale, and on January 1 at Jupiter, from thence going to Thomasville, Georgia, on the way home.

I returned to Miami, May 14, 1904. The copious rains prevented extensive exploration, but I revisited the hammocks about Miami and went to Black Point. On May 30 I left Miami for Oviedo, spending the thirty-first at that place. June 1 I was at Sanford and June 2 at Kissimmee. From thence I went to Tampa and took steamer for Braidentown, Manatee, and Oneco. Returning to Tampa I took passage by rail to Fort Myers, then by mail boat to Marco, and thence by skiff to Fahkahatchie Cypress and Everglade, whence I returned home.

In February, 1905, I revisited the hammocks about Miami. In March I went *via* Punta Gorda to Everglade. I made a trip to Deep Lake, about 15 miles through the cypress from Everglade. Then I engaged a gasoline launch with a man to run it and skirted along the whole coast to Flamingo, thus nearly completing a circuit of the peninsula. Returning in the launch I visited the headwaters of Whitewater Bay and touched at various places in the Ten Thousand Islands. I made another trip to the cypress, about 10 miles inland from Everglade. I stopped for a day each at Fort Myers and Fort Ogden and then returned to North Easton.

PHYSICAL AND BOTANICAL FEATURES OF THE REGION

Miami is very near the northern limit of the coral formation which lies along the southeast coast of Florida from the vicinity of Miami about 50 miles southward. Northward from Fort Lauderdale the surface is overlaid by fine white silicious sand, with its characteristic vegetation. Between this place and Miami lies the borderland, where the southern calcareous rocks, of coraline origin, dip down gradually under the sand, and where, therefore, the latter lies here and there in patches and in pockets of the lime substratum.

Below Miami, we pass into a new world of plants. The limestone is usually bare of soil, save for a very small amount of humus lodged in the interstices, is irregularly eroded and leached away in the most fantastic shapes, and is for the most part exceedingly rough and full of hollows and sharp cutting points. This coastal lime formation is from 2 to 6 miles wide and is covered with a growth of *Pinus Elliottiana* to the practical exclusion of other trees. Ferns are very scarce on the higher elevations, but on the borders of the so-called "prairies"—incursions of the everglade—and hammocks, where there is more dampness, there is usually an abundance of *Ancimia adiantifolia* and *Pteris longifolia.* Along the sea front there is likely to be a mangrove swamp, inhabited by two species of *Acrostichum.* The Everglade proper is an open shallow lake in summer, the water receding and leaving large areas of damp marsh in winter. I found no fernwort in the open everglade.

All angiospermous woods are called hammocks by the Floridians; and hammocks may be classed as of two kinds, those of the everglades and river-borders and those of the pine woods. The first are simply low, occasionally inundated islands in the everglades or in the swamps bordering the rivers. The undergrowth is a tangle of small trees and shrubbery. I found no new epiphytic ferns here, but these hammocks are the home of several terrestrial species, some of them new. The pine-land hammocks are simply isolated pieces of angiospermous woods in the pine forest. They are numerous and botanically are the most interesting regions. The largest, Breckell hammock, near Miami, is some three miles long and half a mile wide.

Often there is no apparent reason for the existence of these angiospermous areas in the midst of the pine forest; but in general the requisite condition is probably a porosity of the underlying rock, since the surface is usually more uneven as one approaches, and the hammocks are well supplied with sink-holes from 3 or 4 to 12 feet deep and of all diameters from a few inches up to many feet. The margins of these cavities are usually covered for some feet down with a fern flora characteristic of limestone regions and the trees and humus-covered rocks also bear a rich fern flora. A striking peculiarity of the region is that one hammock may bear an abundance of one species which may be absent from a neighboring hammock of apparently the same constitution. The surrounding pine-lands are almost free from sinks; but such sinks as do occur, and especially if holding water or if very damp, are often the site of *Odontosoria clavata*. Both the ferns and the other interesting herbaceous plants of the Homestead hammocks, as well as of those near Miami, will soon be only a memory, for the hammocks are already in process of destruction.

Of the hammocks mentioned in the list, Snapper is about 10 miles south of Miami. By far the most interesting are the hammocks in the Homestead region, near the new station of Gossman's on the extension of the Florida East Coast Railway; viz., Colwell's, Costello's, Ross's, Timb's and Bauer's, as they are called from the owners or nearest inhabitants. The southern portion of Key Largo is very low and much of it is subject to inundation by salt water. The rock is bare of humus and ferns are rare. The only species I saw at Planter and Newport were *Polypodium polypodioides* and *Campyloneurum Phyllitidis*. *Phymatodes exiguum* has also been found near the northern end of the island, but I did not visit that part. Conditions at Madeira are similar, but a marly sediment is substituted for coral. The region has been abandoned by all inhabitants because of frequent inundation by salt water. No new ferns were found there.

The conditions on the west coast of Florida are entirely different. The Ten Thousand Islands are mostly mangrove-covered and tide-swept, most of the few habitations being on immense shell-heaps left by the aborigines. Even at Flamingo the shores are low, and impregnated with salt, and few ferns are found there. The same is true of Whitewater Bay. Back from the coast a few miles there stretches an immense belt of cypress forest, interspersed with open "prairie," all more or less covered with water during a part of the year. There is a coral outcrop about ten miles from Everglade on which a few pines are found, and a hammock similar to those on the east coast at Deep Lake, now mostly cleared and set with orange trees. The "cypress" proper bears few species of epiphytes and no terrestrials, but in the numerous "heads" (low places containing water all the year) there is a deciduous growth of pop-ash (*Fraxinus carolinianus*) and there are also hammock-like growths of oak and bay, on which some ferns thrive. Except for a small region in the Fahkahatchie cypress I saw no place which appeared especially congenial to ferns.

OPHIOGLOSSACEAE

OPHIOGLOSSUM PALMATUM L.

Very rare. Found only once on the east coast, in decaying leaf-bases and fern roots at the top of a cabbage palmetto at Snapper hammock, putting forth fruit in the middle of November. A few specimens were found at Deep Lake, 15 miles northeast of Everglade, and the species was found to be quite common on Alligator Bay, at head of Turner's river, about 20 miles south of Everglade. At the latter place the palmettos were in a narrow border of trees between the bay and the everglade, a strip too swampy to burn, to which fact — since the glade was yet smoking from a recent fire — I owed my specimens. The plants were growing in the interstices between the old leaf-bases at varying heights, but always in the loose fiber. This is very tinder-like and when ignited burns to the utter destruction of its epiphytic flora. The inhabitants set fire to whatever will burn, and the time seems not far distant when this *Ophioglossum* will be exterminated.

OPHIOGLOSSUM PUSILLUM Nutt.

A single very small plant of this species was found in a low sandy arm of the prairie in the pine woods at Little River.

Several patches were seen about the base of an Indian mound at Fort Lauderdale. The mound had been made on a level, damp, sandy place, a short distance from the river, and the plants were growing at the border of the saw palmetto growth. The roots are quite long and proliferous, sometimes with 2 or 3 young plants, and the colonies appear to have been formed by this method. One of my specimens shows the sterile leaf with three sori on each margin. This is the only instance of the kind I have observed in the genus, though partial reversion of the spike is not very rare.

HYMENOPHYLLACEAE

TRICHOMANES KRAUSII Hook. & Grev.*

Rootstocks matted, extensively creeping, slender, densely covered with short bristly root-hairs; stipes scattered, 3–10 mm. long, bristly radiculose below, often narrowly winged by the decurrent frond above; fronds broadly oblong to linear-oblong, 1.5–2 cm. long, 5–12 mm. wide, thinly membranaceous, pinnatifid nearly to the rachis, with a broad, usually angular, often closed sinus; pinnae linear and toothed to oblanceolate and pinnatisect, the segments rounded, each sinus bearing a single, black stellate-bristled tubercle; sori 3–13, partially immersed, the borders winged, the lobes rounded, free, spreading; column included or short-exserted; veins pinnate, one to each lobe, and occasionally a few short, spurious ones, especially as faint, broken, intramarginal nerves.

On roots, logs and bases of trees, often completely covering them, in humid hammocks. Border of the everglades at Camp Longview; Costello's hammock.

TRICHOMANES SPHENOIDES Kunze

Rootstocks matted, slender, bristly radiculose; stipes none to 2 cm. long, bristly radiculose below, often winged above; fronds 0.5–1.5 cm. long, 2–10 mm. broad, those of outlying new rootstocks cordate-orbicular and sessile, those of dense tufts passing through fan-shaped to oblanceolate, and linear-oblanceolate, irregularly lobed, incised, or parted, the margins with stellate reflexed hairs when young; indusia 1–11, included or mostly free, sometimes stipitate; veins dichotomous throughout or pinnate above.

In lime-sinks and rarely on tree-trunks in hammocks in pine woods, Costello's, Ross's, Colwell's and Bauer's; also in a hammock near the road, near Camp Longview.

Extremely variable as to shape and cutting of the fronds. Those on strong, new rootstocks are sessile, cordate, and nearly orbicular, always sterile, the edges brown with reflexed stellate bristles. Farther back from the end they become petioled, entire or more or less incised; in the dense tufts they are of various shapes, almost linear and entire when crowded and in deep shade, irregularly incised when well developed, so that no particular condition can be taken as typical. The receptacles are usually inserted at the base and winged somewhat at the sides, but they are sometimes almost completely included and at others are wholly exserted and on distinct pedicels. The round fronds are essentially those of *T. punctatum* of Hooker and Greville's Icones Filicum, *plate 236* ; while many are exactly comparable with the illustration of *T. reptans* of the same work.

SCHIZAEACEAE

ANEIMIA ADIANTIFOLIA (L.) SW.

Common in the limestone rubble of the pine woods, mostly a little back from the hammocks, where the surface is uneven, but occasionally in the shrubbery at the borders of the hammocks. In well-drained but not dry places, the stipes frequently reach a length of 4 dm. or more, the sterile segment a length of 2 dm. and an equal width, the total height of the frond 6.5 dm.

Rarely there are three spikes, one removed from the others and smaller, occupying the position of one of the basal pinnae: in other cases the apex of the sterile segment becomes elongated and fertile. Miami appears to be near the northern limit of this species, as the limestone extends only a short distance above, but it is abundant in suitable places throughout the pine belt to the southward. It is usually in company with *Pteris longifolia.*

SCHIZAEA GERMANI (Fée) Prantl

§ *Actinostachys:* Characterized by digitate pinnae and often four rows of capsules on a pinna.

Plants from bristly tubers sunk in rotten wood, sessile or elevated 1–3 cm; on a slender, smooth, castaneous rootstock; fronds 1–3 from a small castaneous-scaly, embedded bud; the stipe buried in humus and castaneous for the first 2–7 cm., then light-green, triangular, and stiffly erect, 5–15 cm. tall, 1 mm. in diameter, surmounted by the capsular fructification; the latter composed of 2–4 pairs of erect, closely appressed linear pinnae; pinnae 8–15 mm. long, 1 mm. wide, green on the back, with two rows of capsules covering their inner faces, these interspersed with long, slender fibrils.

In decaying wood, sometimes in stumps 9–12 dm. from the ground, the bulbs buried sometimes to the depth of 10–12 cm. No sterile fronds were observed. The fruit looks very much like a very young ovary of *Pogonia ophioglossoides*, though smaller, and I did not guess the nature of the plant till I found an uncoiling frond. It was very scarce, found only in a small area in the tangled growth along Miami river across the Alapattah, on my second and third trips.

The genus *Actinostachys* is founded in part on the four rows of capsules on the pinnae, but as my specimens have only two the character would seem not to be common to all the digitate species. It would thus appear that this character is of little generic value, and in my opinion the digitate nature of the fronds alone is insufficient to erect a genus on, especially as they are not truly digitate, all of them having a short rachis, thus differing only in degree from *Euschizaea;* therefore I retain this species in *Schizaea.*

OSMUNDACEAE

OSMUNDA CINNAMOMEA L.

Apparently absent from the lower coast of the east side, though common about Fort Myers and found as far south as Harney's, or Shark river on the west coast, where I got fertile fronds a meter tall. Its common time of fruiting appears to be early November, as it was in full fruit in the middle of the state at that date, and bore no indication of fruit in March, save in the case of one plant.

OSMUNDA REGALIS L.

Quite common in the cypress swamps and damp hammocks bordering the everglades. The plants here form tussocks that may be 3 to 5 dm. high and sometimes only a decimeter through, covered with the densely brown-felted roots that are sent down from the growing crown and spread in all directions in the soft, black soil.

The southern plant shows a few fairly constant differences from the northern. The petioles of the pinnae are woolly with long, slender, tortuous and matted scales; the secondary rachises and mid-nerves of the pinnae are clothed with a similar though usually shorter tomentum; the pinnae are narrower, usually linear-lanceolate, 4 to 5 times as long as broad, the veins very prominent, and edges sharply serrate and indurated as though bounded by a marginal vein. It is also different in aspect, the fronds being more open and rather straggling. Specimens from Florida are very similar to those from the West Indies, Mexico and Brazil, and quite likely represent *O. palustris* Schrader.

POLYPODIACEAE

ACROSTICHUM AUREUM L.

On the east side this species was found only in the mangrove swamp bordering the bay at Larkins. A low narrow beach has been thrown up, so there is not a regular ebb and flow of the tide, but the salt water enters during storms and the soil must be quite salt. The plant grew in pools among the mangrove trees, mostly in little openings, where there was a strong diffused light; more rarely in the sun. The whole floor of the swamp was flooded and traversable only by stepping from root to root of the mangroves, mostly 3 or 4 feet from the ground. Although less common than *A. excelsum* and confined to brackish swamps, *A. aureum* has been supposed to be the only species of the genus in Florida. It is a smaller plant than the other species, being mostly less than 2 meters high; the stipes bear a few horny, black processes that might be considered rudimentary pinnae; the pinnae are farther apart, the fruiting ones being confined to the top, usually only a quarter or a third of each being fruited. The under surfaces of the sterile fronds are naked save for a few minute dark scales, mostly near the midrib; the basal areolations are elongated and parallel with the midrib, the others oblique to it. It is a less handsome plant than *A. excelsum.* The pinnae and rachis are very brittle, the former being thinner than in *A. excelsum.* It is the commoner species among the mangroves of the Ten Thousand Islands, always under the influence of salt water.

ACROSTICHUM EXCELSUM Maxon, Proc. Biol. Soc. Wash. 18: 224. 1905

(*A. lomarioides* Jenman)

This is the largest fern growing in the United States. The species has been confused with *A. aureum*, from which it is most readily distinguished by its larger size, its close-set pinnae and the fact that all the pinnae of the fertile fronds bear sporangia. The stipes lack the spinous processes of *A. aureum*, and the under side of the sterile pinnae in all my specimens but one is covered with very short bristles. The basal areolations are not enlarged and are not parallel to the midrib; the primary veins spread at a greater angle, and are often parallel, and the connecting veinlets are often at right angles to them, the resulting areolations being more or less rectangular. The rootstocks are not infrequently 5–9 dm. long, 7–10 cm. in diameter, horizontal with an ascending tip, or assurgent, bearing numerous thick cord-like roots. The fronds may be 30–33 dm. long and 7.5 dm. broad, the stipes 2.5 cm. or more in diameter. Usually, especially in sunlight, the pinnae are abruptly ascending with the upper side facing the rachis. This habit is also seen in *A. aureum* and is not universal in either species. It is not confined to brackish shores, but grows well in the swamp hammocks bordering streams, less frequently in those of the everglades and the cypress. Although often growing where the water is fresh, it becomes scarce a short distance from the influence of salt water, and doubtless disappears entirely a few miles away from the sea. Not infrequently the pinnae bear one to several simple or forked lobes at the bases, on one or both sides, each lobe with a midrib that in the largest examples is branched from the main vein, but in the smaller ones melts away into the ordinary nerves before reaching it. Although several fronds of this structure may often be found on a single plant, the occurrence is simply accidental and the form may be known as *forma* **lobatum.**

STENOCHLAENA J. Smith

Fronds dimorphous, the fertile pinnae contracted, soriferous all over the back as in *Acrostichum*, the thin membranaceous margin often revolute.

STENOCHLAENA KUNZEANA (Presl) Underw. Bull. Torrey Club 33: 196. 1906

This is a very pretty fern. The rootstocks are scandent, arising in and about the sink-holes and climbing neighboring trees. They are flattened dorsiventrally, rooting from the under surface, and at the growing end are rather sparingly clothed with thin ovate-lanceolate, acuminate, purplish scales. The stipes are arranged alternately along the sides of the rootstock and are from 5 cm. to 1.5 dm. in length. Their bases diverge at a very small angle and continue for some distance in the same plane, then curve backward till the frond stands nearly at right angles to this plane. They are flat and deeply grooved on the upper surface, while the edges bear a sharp ridge which becomes a narrow wing above. The fronds are from 1 to 4 dm. long and 3 to 9 cm. wide in Florida specimens, of a coriaceous texture and dark glossy green color, each pinna resembling a small holly leaf. They are more narrowly oblanceolate, abruptly contracted above and gradually so below. The rachis is grooved on the upper surface and broadly winged. The pinnae are articulated to the rachis, and are lanceolate from a cuneate base, the lowermost much reduced and roundish, the margins deeply serrate with divaricate teeth. The fertile pinnae are linear and densely fruited. I found this fern in four hammocks about Gossman's; *viz.*, Costello's, Ross's, Timb's and Bauer's. In all it was sterile save for one frond. It attained its best development in Ross's hammock, where rootstocks 12 dm. long were observed; but they are much longer in the tropics. It was found fruited in a hammock near Cocoanut Grove, in 1905, by O. Rodham.

POLYPODIUM PECTINATUM L.

First observed by Mr. Soar in Timb's hammock, Gossman's. It was growing on the ground, prostrate logs and bases of trees, and was quite scarce. Not observed elsewhere on the east coast. Found sparingly on magnolia trees at Oviedo, and abundantly over a small area in a hammock in Fahkahatchie cypress, on logs, stumps and cypress knees, but not found in two other trips to the cypress, nor at Whitewater Bay.

POLYPODIUM PLUMULA H. & B.

On magnolia trees with the last, at Oviedo; not observed elsewhere.

POLYPODIUM POLYPODIOIDES (L.) Hitch.

Principally on hardwood trees; very common throughout my itinerary except on the keys, where but few plants were observed.

PHYMATODES EXIGUUM (Hew.) Underw. Torreya 3: 18. 1903

On my second trip to Bauer's hammock, Mr. Soar called my attention to a small fern with sterile, obliquely ovate to lanceolate, obtuse or rounded fronds, 1–2 cm. long, growing over the limestone and on roots and twigs. I immediately concluded it was *Phymatodes exiguum* and began a search of the surrounding trees for it. It proved to be abundant in a spot perhaps 40 meters across, mostly on small trees. The rootstocks were found to have their origin in the sterile phase on the ground, to grow up the trunks of the trees and shrubs to a height of twenty feet or more and spread out on the branches of the shorter ones. They are mostly simple, are clothed with dark-brown scales, and are closely appressed to the tree, holding on by the numerous, short, alternate roots. The fronds are alternate and confined to 3–4 dm. of the upper portion; are approximate and comparatively short and broad, mostly rounded, when sterile; and narrowly lanceolate, 6–15 cm. long (including stipe) and 5–12 mm. wide, when fertile, acute or acuminate at tip, obliquely acuminate at base. As most of the fronds are several feet up the small trees, often on branches where they appear like the proper leaves of its support, this fern is easily overlooked and may be expected in abundance as soon as collectors become familiar with it. The first locality on the mainland. Found by Curtiss on the north end of Key Largo, where it has since been collected several times.

VITTARIA LINEATA Sw.

Very common on palmettos throughout; sometimes on other trees. In favorable localities in shaded hammocks, the grass-like fronds are sometimes in large clusters that must contain thousands, and are up to 10 or 11 dm. in length.

PHLEBODIUM AUREUM (L.) J. Smith

Very common on palmettos, mostly in the decaying leaf-bases near the crown, occasionally found on logs or other trees than the palmetto, rarely on the ground. Apparently rare on the keys. At Madeira hammock there is a glaucous form.

CAMPYLONEURUM ANGUSTIFOLIUM (Sw.) Fée*

Plants epiphytic; rootstocks 1–3 cm. long, 0.5 cm. wide, marked at the naked proximal end by close-set, cup-shaped leaf-traces crossing diagonally in 3's, clothed at the living end with narrowly lanceolate-acuminate, seal-brown scales; fronds 6–12, about half being of the current year's growth, the rest of the preceding year's, the two cycles usually separated 0.5–1 cm.; stipes clustered, short, 3–5 cm. long, slightly grooved above, winged laterally, passing gradually into the fronds; fronds narrowly linear-lanceolate, usually somewhat falcate, long-acuminate, 2–4.5 dm. long, 0.5–1 cm. wide, leathery, the veining obscure; primary veins often zig-zag, the first branch arising from near the base on the upper side, soriferous just below the apex. The vein that encloses the upper edge of the basal areole often bears a branch above the middle, this occasionally soriferous, the sori thus being in a regular or somewhat broken line on each side of the midrib, about half-way to the margin.

On trees, mostly live-oaks that bend considerably from the perpendicular, growing on the upper side; also on branches among tillandsias; the fronds at first at right angles to the rootstock, then recurving toward the base of the tree. Considerable numbers seen in Timb's hammock; not observed elsewhere in South Florida. First discovered by Mr. Soar. Also seen on magnolias at Oviedo with *Polypodium Plumula* and *P. pectinatum*; first discovered by Mr. T. L. Mead (not J. E. Layne, as reported in Fern Bull. for April, 1904). Not seen by me on the west coast, but reported by Mr. Oakes Ames to be common in the "bay heads" near Naples.

CAMPYLONEURUM COSTATUM (Kunze) Presl*

Rootstocks much as in *C. Phyllitidis*, clothed at growing end with narrow, flexuous, triangular-acuminate dark-brown scales; stipes in two rows, 4–14 cm. long, smooth, green or castaneous beneath, rounded on the back, green and flat above, with a narrow sharp groove in the center, the edges bordered by a narrow, indurated, decurrent wing, not visible above, but set off from main stipe below by a narrow groove; rachis narrow and costate below, broad and flat above; fronds smooth, coriaceous, shining, linear-oblong to oblong-oblanceolate, 2–3 dm. long, 3.5–5.5 cm. wide, often widest near the apex, then abruptly contracted into an acuminate point 2 cm. long, gradually attenuate at base, the margins entire or nearly so, with very narrow hyaline border; veins obscure, the free veinlets which arise from the united apices of the cross-veins often continuous as a sub-nerve, dividing the space between the main nerves into two quadrate areoles, each of which bears one, sometimes two sori on the enclosed free veins.

Differs from *C. Phyllitidis* in its petioled fronds, and from *C. latum* principally by the scales of the rootstock, the flat stipes, the outline and coriaceous texture of the fronds. Abundant on trees, logs and cypress knees in a hardwood hammock in Fahkahatchie cypress, June 11, 1904 (*no. 1135*). Apparently local, as it was not seen in two trips of several days each into the cypress in March, 1905.

CAMPYLONEURUM LATUM Moore *

Rootstocks 2–7 cm. long, 5–7 mm. thick, green at the growing end, clothed with asymmetrically peltate, imbricated, irregularly lobed, light seal-brown scales; stipes 4–6, clustered, flat on back, deeply centrally grooved above, slightly laterally grooved when dry, the sides folding in in drying and covering the upper surface, giving a triangular section; leaf-scars 5 mm. long, in a single row; fronds oblong-lanceolate, broadest in the middle, with sinuate, undulate or entire edges, 2–6 dm. long, 4–9 cm. broad, obtuse or acuminate at apex, gradually or rather abruptly contracted at base, smooth, dark-green above, lighter below, usually with a small scar or gland on the upper side of the main nerves near the base, the epidermis silvery-punctate about the stomata; midrib flat above, the back flattened below, the sides strongly concave, the edges sharp, bearing a few orbicular to oblong, basally peltate or deeply cordate scales along the sides; primary veins 5–7 mm. apart, the secondary irregularly anastomosing into 2–3 areoles, each of which may bear 1–3 free veinlets, or the central none; sori mostly in two rows between the main nerves.

Differs from *C. Phyllitidis* in the shape of the scales, the long stipes and the shape and color of the fronds. Found about the sides of a large lime-sink and on the bases of trees overhanging it in Bauer's hammock, Gossman's. First observed by Mr. Soar. Very scarce.

CAMPYLONEURUM PHYLLITIDIS (L.) Presl

Abundant in nearly all hammocks visited, and various in position, oftenest on decaying vegetable matter on the ground, or on prostrate logs. In particularly favorable places plants grow to a large size and are often on trees, sometimes at a height of ten meters or more. Rare on the Keys, only one or two seen on Key Largo, none on Long Island (Plantation Key); and but few at Madeira hammock, Flamingo, and Whitewater Bay. The largest frond collected is rather more than a meter long and 7 cm. wide.

MENISCIUM Schreb.

Simple or pinnate ferns with naked sori borne on the arched cross-veins which form regular areoles between the parallel primary veins. Differs from the subgenus *Goniopteris* of *Dryopteris* principally in its elongate sori.

MENISCIUM RETICULATUM (L.) Sw.*

Rootstocks short, stout, ascending; stipes stout, 2–15 dm. long, 4-ridged above, sparingly clothed at first with small, thin, irregular brown scales, soon naked; fronds 2–14 dm. long, 1.5–9 dm. broad, oblong-lanceolate, as broad at base as at middle; rachis 4-ridged and hairy above, smooth beneath; pinnæ 1–4.5 dm. long, 2–7.5 cm. broad, shortly petiolate or sessile, oblong to lanceolate, the sterile broadest at middle, the fertile with sides parallel to middle, thence narrowed to the long-acuminate point, the edges irregularly repand-toothed or subentire, rounded or mostly asymmetrically cuneate at base, the lower side somewhat rounded, or in upper pinnae decurrent on rachis, the upper edge straight; rachises of pinnae smooth below, hairy and centrally grooved above; primary veins parallel, secondary forming regular arched areoles, the top of the arch bearing a short incrassated veinlet that reaches to the middle of the superior areole; areoles 8–20 between midrib and margin; petioles of lower pinnae usually, and of others quite often, giving rise to bulbils which develop into plants, the buds and stipes covered with brown scales.

On cypress knees, border of the everglade at pumping station at Alapattah. This was first found in Florida by the late J. E. Layne in the spring of 1903, who likewise found it in a cypress swamp and sent a few pinnae only to Mr. J. H. Ferriss. Mr. Layne's plants came from Fahkahatchie near Everglade, Lee County, and his guide informed me that it grew on cypress knees.

This magnificent fern is a close competitor of *Acrostichum excelsum* in size. There are perhaps 40 large plants and many seedlings of it growing on cypress knees in the tangled hammock north of the old Miami pumping station. My first plants were only 1.5–2 dm. high, but were sufficient to convince me that here was an unreported fern and to spur me to an extended search, which was rewarded by plants with fronds 28.5 dm. long by 9 dm. broad.

The rootstocks are thick, covered with bases of old fronds, several inches long, clinging to the older, often decaying and humus-filled, cypress knees by numerous roots. They were usually above the flood line, and wound over the small knees, about a foot from the forest floor. In no instance did I see one rooted in soil.

The fronds are rather firm, but not coriaceous. The bulbils are formed at the apex of an appressed basal nerve, on either or both sides of the petiolule of a pinna. As the nerve thickens to correspond with the size of the plantlet the latter can not become detached and can only take root by the bending of the parent frond toward the earth. The plantlets thus grow in situ, sending out roots and fronds, the latter sometimes a foot long, well developed and fructiferous. The stipes and veins are smooth and stramineous save for a narrow chestnut axillary band at base of each pinna.

The sterile pinnae are somewhat narrowed at base and broadly and obliquely cuneate, or more rarely narrowed and somewhat rounded to the short petiole. The fertile are usually more sharply cuneate, the lower margin starting at the point of insertion and somewhat rounded to the angle, the upper margin starting 2–4 mm. from the axil and running straight or somewhat incurving to the angle, making the base oblique. The pinnae of the sterile fronds are often broadest near the middle, but the fertile usually attain their greatest width 12–16 mm. from the base and hold it to or beyond the middle, whence they are very gradually long-attenuate.

The primary veinlets spread nearly horizontally at first, gradually sweeping upward to the margin. They are very regularly placed and parallel, and very distinct on both surfaces because of their stramineous color. They are flat on the upper and somewhat prominent on the lower surface. The cross-veinlets are also regularly placed and parallel. The lowermost starts at or near the axil of the vein, runs obliquely upward to a little above the middle of the space, then turns abruptly down to the base of the vein above, describing a broad inverted V. Other veinlets follow in regular succession at a distance of about a millimeter. At the outer angle of the V there is a free clavate vein reaching nearly to the inner angle of the next above. The sori are naked, and are formed along both sides of the V-shaped veins, beginning at the angle in less fruited specimens. Usually the sori are confluent in the later stages, covering the whole back of the pinna, even to the apex, with cinnamon-brown spore-cases, divided into parallel bands by the stramineous veins.

The species appears to be quite variable, and is found throughout the West Indies and Mexico to Brazil, and finds a counterpart in *M. cuspidatum* Bl., of the Sunda islands.

ADIANTUM TENERUM SW.

This beautiful fern was abundant in the hammocks of the pine woods, growing mostly in and around lime-sinks, in rich leaf-mould. Most of the plants were in full vigor, although a few had lost their pinnae. In Timb's hammock a clearing had been made, the trees being simply felled and allowed to decay. Here the ground was completely covered in places with tangles of this fern, the sinks being lined with the young plants. At this place I found a clump of plants, all sterile, that strongly resembled *A. Farleyense*, the pinnae being large, sometimes 3 cm. long and broad, cuneate at the base, very deeply cleft, the lobes mostly rounded. The species was found only in limestone hammocks and is apparently absent from the lower counties of the west coast.

PTERIS AQUILINA PSEUDOCAUDATA Clute

Apparently absent from the rocky woods of South Florida, but abundant about Oviedo and Sanford in central Florida and about Fort Myers on the west coast. Confined to dry sandy regions, so far as observed.

PTERIS CAUDATA L.

Quite common in the pine woods and on borders of hammocks, small when in dry situations but attaining a great size when in fairly moist humus. At Orange Glade there was an abandoned Indian camp that was a complete tangle of this fern, some specimens being 36 dm. high, with a spread of 18 dm.

PTERIS LONGIFOLIA L.

Common in the rough limestone a little back from hammocks and in small lime-sinks and pot-holes in pine woods, usually in company with *Aneimia adiantifolia.* Sometimes 11.5 dm. high and 12 cm. wide when growing in deep shaded cavities. Not observed save in the limestone region.

BLECHNUM SERRULATUM Rich.

Abundant throughout, in fresh-water swamps, in the rich mucky hammocks bordering the streams and everglades, and in the cypress of the west coast. In sunlight the fronds are erect, the pinnae ascending or erect, and the plants are rather small, being only 4–6 dm. tall; but in rich moist hammocks they often exceed 18 dm. in height and 3 dm. in width, clambering among the shrubbery. At a little distance the species has the appearance of a large *Polystichum acrostichoides.* In sandy swamps the rootstocks creep just beneath the surface and are about 5 mm. in diameter, covered with narrowly lanceolate, almost bristly, scales. In the heavy cypress of the west coast, where subject to inundation for much of the year, the rootstocks become erect, sometimes 5 dm. long, 1–1.5 cm. in diameter, irregular, finely rugose-roughened, and bear a crown of fronds, often a few roots also, at the top. At Flamingo the soil is too salty for it, but I found one plant, with the rootstocks several feet long, winding about in the decayed leaf-bases of a cabbage palmetto at the height of ten feet from the ground. The rootstocks were about as thick as in the normal form and similarly clothed, but the fronds were much thinner and doubly serrate.

WOODWARDIA AREOLATA (L.) Moore

Not found in the lower counties of the east coast. It grew in the ditches and thickets on the border of the Caloosahatchee at Fort Myers, the southernmost point at which it was seen. There was no evidence of fruit in either March or June.

WOODWARDIA VIRGINICA (L.) J. E. Smith

Sandy cypress-swamps at Fort Lauderdale and in the thickets near the river at Fort Myers. The southernmost points at which it was observed. Sparingly fruited in December and March.

Asplenium biscaynianum (D. C. Eaton) A. A. Eaton

Asplenium rhizophyllum var. *biscaynianum* D. C. Eaton, Bull. Torrey Club **14**: 97. 1885.

Rootstocks short, erect, clothed at tip with linear-lanceolate, brown, white-fenestrate scales; fronds 10–50, erect; stipes 4–15 cm. long, 1/4–2/5 the entire length, dull-castaneous with a few fenestrate and many scattered small membranous scales when young, smooth when old, angled on front at base, the angles becoming green wings above; rachis castaneous beneath, green above, winged; lamina 1–2.5 dm. long, 1.5–3 cm. wide, linear-oblanceolate, broadest above the middle, bipinnate; pinnae 12–20 pairs, obliquely ascending, 1–2 cm. long, 0.5–1 cm. wide, the lower remote, the upper approximate, dark-green, rather firmly herbaceous, with 5–7 pinnules; the lowest superior pinnule is cuneate-obovate, with a midnerve that gives off 2–6 branches, each of which ends in a short, obtuse or acute lobe; the second and third and often the fourth and fifth pinnules are 2–4-nerved with as many lobes, the next one or two linear-falcate, the terminal one similar to the basal but more deeply lobed; sori large, often exceeding half the length of the pinnule, 2–4 to each of the larger, one to each segment of the terminal and one to each of the narrow intermediate ones; on the latter they are submarginal, facing the midrib, and are often incurved, giving the pinnule a falcate appearance; indusia firm.

This fern was found abundantly at the bluffs near the Punchbowl in Breckell hammock, in company with *A. dentatum* and *A. verecundum*, between which it appears to be an almost exact intermediate in cutting, having the erect caudices, long stipes, firmer texture and large sori of the former and the larger size and brown stipes of the latter. At the time of collecting I was struck with the aspect and habit of this plant, and wondered if it could be a hybrid. I was somewhat surprised on referring to Holden's note in the Bulletin of the Torrey Club (*l. c.* 97) to find that I had happened on the type station of the fern, and that he had also surmised that it might be of hybrid origin, a view in which D. C. Eaton appears to coincide. The cocoanut tree he mentions is now quite large and often resorted to for fruit. Evidently Mr. Holden did not explore the bluffs far enough to get the best specimens, as he mentions but one recess where they grew. The bluff faces the east but is protected from the sun by a fine growth of mangroves, the moisture of the soggy earth beneath them keeping up a considerable humidity. The bluff arises to a height of 6–10 feet and its shelving walls and recesses, as well as detached boulders at the base and the rocks of the neighboring woods above are carpeted with *A. dentatum*, *A. verecundum* and this species, which though common is the least so of the three. An extended search for half a mile along the bluff failed to show any individuals of *A. biscaynianum* removed from the other species.

Though having most of its characters in common with one or both of its associates, the aspect of *A. biscaynianum* was peculiar to itself, the fronds being erect, the stipes long, pinnae remote and ascending, bipinnate, the pinnules often with 2–5 sori, while in *A. verecundum* the stipes are short (1/5 or less of the total length of fronds), the fronds spreading, tripinnate, the pinnae longer, spreading nearly or quite at right angles, the segments rounded on the inner face, the sori small, one to each segment, remote from the margin. From *A. dentatum* it is most readily distinguished by the large size and the cutting. The uppermost pinnae of the frond are often very similar to those of *A. dentatum*, but are not oblique nor auricled, and the main nerve is in the middle.

ASPLENIUM DENTATUM L.

This species does not appear to thrive so well in the small lime-sinks as does *A. verecundum*, very few plants, and these not thrifty, being found in them. It is at its best on nearly perpendicular walls of limestone, where sufficiently shaded. It is usually abundant where found at all. Breckell hammock, bluffs north of the Punch-bowl and on rough coral-rock in the woods; roadside, hammock near Cutler, on sides of large sinks and on boulders; Costello's hammock, in small sinks.

ASPLENIUM SERRATUM L.

This fine fern was first shown to me by Dr. Small in Snapper hammock, about ten miles below Miami. Subsequently I found it at Costello's and Ross's hammocks in the Homestead region, and at Breckell hammock near Miami. At Costello's there were but few plants, but at the other places they were abundant, growing on the ground, prostrate logs, and even on the bases of the trees. The caudices are short, erect, felted by the many roots, the fronds ascending or somewhat drooping at the tips. Their color is dark, glossy green. It grows in rather low places in the hammock, but not where swampy, and is subject to thorough drying out in the winter. It was abundant in Fahkahatchie cypress, Lee County, in a hammock of live-oak, growing on tree trunks, decaying logs and cypress knees down to the high-water mark. At the last locality there were a few plants with the margin of the frond above the middle irregularly incised, sometimes half way to the midrib. This may be characterized as *forma* **incisum.**

ASPLENIUM VERECUNDUM Chapm.

This was the most delicately beautiful of all the ferns found on the trip. It was first seen at Costello's hammock, but was subsequently found in several other hammocks in the vicinity, and on the face of the bluff and in adjoining woods near the Punch-bowl in Breckell hammock. It usually grows on the sides of the limesinks, but often in irregularities of the rock, in the more humid places, as for instance near the large sinks. Near the sea at the Punch-bowl it grew on detached boulders or the bare rock.

The well-like sinks, often six to ten feet deep, round as if shaped by man, form a peculiarly fitting home for this fern, and often the sides are lined with it to a depth of several feet. The large, older fronds appear to be dark-green, while the young ones, being thin and delicate, catch and reflect the light as do some cave mosses, appearing as a delicate silvery mesh over the dark background. In texture and cutting they are strikingly like some filmy ferns. The water at the bottom of the well keeps the air humid, a condition apparently necessary for the fern. The stipes are very short, mostly less than 6 cm. even on the largest plants, and the fronds grow in such a way as to conceal them, then spread radially. My largest fronds are 3.5 cm. wide and 27 cm. long, exclusive of the stipe. There are sometimes 70 in a cluster. This is the species that heretofore has been known as *A. myriophyllum*, which appears to be distinct. I have not been able, however, to distinguish it from *A. monteverdense* Hook. of Cuba.

DRYOPTERIS AMPLA (H. & B.) O. Kuntze *

Rootstocks erect, often 4–5 dm. high and 5–7 cm. thick, covered with fine, loose, ferruginous, woolly scales; stripes in a crown at the end of the rootstock, erect, 4–8 dm. long, densely clothed below with woolly, ferruginous scales 3–4 cm. long and more sparingly above with short hairy scales; fronds triangular, 3–7 dm. long, by nearly as broad at base, quadripinnatifid at the base, tripinnatifid above; rachises and principal veins clothed with light-brown hairy scales, and a shorter, fine puberulence; texture thin and herbaceous; lower pair of pinnae much the largest, petioled, anadromous with one to three, but usually two, secondary pinnae on the upper side before there are any on the lower; the first lower secondary pinnae much the largest, but the others of the lower side gradually reduced till they equal the upper ones near the tip of the pinnae; upper pinnae catadromous; secondary pinnae lance-triangular to linear-lanceolate, acute; segments linear-oblong, rounded, entire or crenate, the lower ones incised; sori small with fugacious indusia, in a single row on each side of the nerves of the ultimate segments.

In Costello's and Ross's hammocks, and another small hammock in pine woods a mile northeast of Colwell's. A very striking large fern with a texture much like *D. noveboracense*, quite easily taken for a *Phegopteris* because of the very fugacious indusium. It is found throughout the West Indies and southward to Ecuador.

DRYOPTERIS FLORIDANA (Hook.) O. Kuntze

Apparently absent or rare in the southern counties of the state. I saw it in Florida only in the rich hammock at Oviedo, where I made a stop of one day. In company with Mrs. A. P. Taylor, I had previously found it at Thomasville, Georgia, which proves to be its most northerly extension. It is a noble and beautiful fern, recalling *D. cristata Clintoniana* in aspect.

DRYOPTERIS PATENS (Sw.) O. Kuntze

Very common throughout on the east coast, less so on the west coast. Apparently prefers limestone in damp situations. When growing in exposed places the pinnae often contract, at first vertically, then spread and describe a half-circle at the tip, being of precisely the appearance of *D. simulata* under similar circumstances. At Colwell's hammock I got a specimen with the rachis, pinnae and indusia covered with glandular capitate hairs instead of the usual long white pubescence. This may be known as variety **glandulosa.**

DRYOPTERIS REPTANS (Gmel.) C. Chr.

(*Phegopteris reptans* D. C. Eaton)

This interesting plant was abundant about the lime-sinks in the hammocks of the Homestead region, and was extremely variable. The normally fruiting plants resemble undersized *D. parasitica* (*Nephrodium molle*), the aspect being similar and the venation identical. Other plants have few or no fruiting fronds, the sterile ones filiform, pendent, 3–6 dm. long, frequently rooting and giving rise to new plants. The sporangia are deciduous from the persistent pedicels. The sori of my specimens possess small indusia which are bristly-fringed on the edges. As the species is closely related to *D. parasitica,* being put in a separate genus solely on account of the absence of indusium, it seems best to treat it as a *Dryopteris.*

DRYOPTERIS SETIGERA (Bl.) O. Kuntze *

Rootstock stout, creeping or assurgent, clothed with copious long-subulate, ciliate, dark-brown scales; fronds 8–10, the stipes when fully developed 1–1.5 cm. in diameter and 6 dm. long, light-green with whitish cast as if pruinose, densely clothed at base with scales like those of the rootstock, with an under tomentum of short, white, bristly hairs, these sometimes on the scales also, naked above; laminae 7–9 dm. long, membranaceous, triangular-ovate, acuminate, quadripinnatifid, the second pair of pinnae longest; primary and scondary rachises smooth below, grooved in each side above, the portion between the grooves, as well as the costae of the ultimate pinnae, more or less densely clothed with fine white bristle-like hairs; primary pinnae oblong-lanceolate, the largest 3–4 dm. long, 1–1.5 dm. wide, more or less winged beyond the middle by the decurrent bases of the secondary pinnae; secondary pinnae triangular-lanceolate, acuminate, contiguous, the rachises narrowly winged; ultimate pinnae linear-oblong, obtuse or rounded at apex, nearly smooth above, more or less setigerous beneath, cut half-way to the costa by about seven pairs of rounded, toothed segments; veins of lower segments forking once or twice, those of the upper ones simple, thickened and prominent on the upper surface at the apex; sori 1–3 on the lowermost segments, one on the upper, approximate near the main rachis of the pinna; indusia fugacious.

A very fine large species, widely distributed in India and Malaysia, now apparently well established in a piece of swampy woods at Oviedo, having escaped from the greenhouse of Mr. T. L. Mead. The fronds are often more than 15 dm. in height, the stipes succulent and whitish as if covered with a bloom. The basal scales are sometimes 1 cm. long by about 1 mm. wide, bristly-ciliate on the margins and not infrequently setigerous on the surfaces. In falling they leave brown, inverted V-shaped scars. Mr. Mead procured the original plants from Reasoner Bros. of Oneco, as *Cibotium Barometz*. It is a very prolific species, and spores of some plants I procured from the same source germinated freely in other flower-pots in a living-room, and came to maturity. It would thus appear amply able to take care of itself in the rich swamps of middle Florida.

Dryopteris stipularis (Willd.) Maxon *

Rootstock erect, 7.5 cm. high, about 3 cm. thick; stipes 3–5.5 dm. long, 3–4 mm. thick, terete, light-green, scaly and finely pulverulent at base, smooth above; scales very dense at base, the lower 1 cm. long, 5 mm. wide, the upper smaller, falcate, acuminate, very thin and hyaline, soon withering and deciduous; rachis, nerves and indusia more or less strigose-pubescent; fronds 4–6.5 dm. long, 2–3.5 dm. wide, gracefully arched, broadly lanceolate, pinnate; pinnae approximate, opposite or nearly so, linear-acuminate, the lower pair approaching and deflexed; the upper basal segments of the lower 3–4 pairs enlarged, 1–2.5 cm. long, 0.5–1 cm. broad, with 5–10 pairs of segments, often fruited, having the aspect of miniature pinnae, deflexed under the frond at right angles to point of insertion. Aspect very similar to that of some forms of *D. patens* but readily distinguishable through the stout erect rootstock, the large chaffy scales and stipular appendages of the lower pinnae.

One plant only, collected February 1905, in a hole in the limestone six inches across and about 2 ft. deep, in a clearing in Ross's hammock. It is now thriving in a greenhouse at North Easton. It had but 4 fronds when found. It was in a tangle of *D. patens*, and was noticed because of its brighter green color and more graceful carriage.

DRYOPTERIS THELYPTERIS (L.) Gray

Common in low mucky swamps where the water is fresh, on both coasts. On the side of the prairie between the pine woods and mangroves at Black Point I collected plants 11.5 dm. long. Florida specimens have a slightly different aspect from those of the north, the pinnae being proportionately shorter and the basal pair of pinnules 1/3 longer than the next pair, and serrate or undulate.

DRYOPTERIS UNITA GLABRA (Mett.) Underw.

In the low hammocks of the everglades where inundated most of the year; also in the tangled shrubbery along the Miami. My largest frond is over 21 dm. long and 4.5 dm. wide. It has the appearance of a large, glossy *D. Thelypteris.* The rootstocks sometimes grow out over the surface of the ground for a distance of a meter or more. They are slightly scaly, dichotomously forking, slightly flattened dorsi-ventrally, green at tip but soon glossy black. I did not observe this species on the west coast.

Tectaria Amesiana sp. nov.

Rootstocks short, creeping, the dead portion covered with terete stipe-bases, otherwise naked, the living portion clothed with lance-acuminate, brown scales; stipes 5–10, clustered, 1–3 dm. long, slender, flat above, slightly rounded below, light-castaneous, sparsely beset with deciduous lance-acuminate, brown scales, very finely puberulent-scaly at base and on upper surface; fronds 10–16 cm. long, 3–6 cm. wide, with 1 or 2 pairs of pinnae and a large terminal one; rachis and principal veins puberulent, especially above; lower pinnae distant, petioled, more or less cordate, obliquely triangular-ovate, with about three coarse rounded lobes on each side, those of lower side largest, the segments and terminal portion sinuate or undulate; second pair of pinnae (when present) oblong-lanceolate, obtuse, adnate to rachis, coarsely round-lobed or sinuate-undulate, most deeply on lower edges; terminal portion equaling one half the frond or more, lanceolate, acuminate, with 3–4 blunt sinuate lobes on each side, passing to mere undulations near tip; veins forming regular large paracostal areoles and 2 or 3 large meshes beyond, mostly united at the edge of the frond, often, especially in sterile fronds, with included, simple or forked free veins; sori mostly at a fork on the middle of the paracostal nerve; indusia firm, ample, nephroid, usually firmly pressed over the sorus and with a free edge beyond.

In three lime-sinks in Bauer's hammock, difficult of access as it grew on the perpendicular walls out of reach. This fern was first collected as an extreme form of *T. minima*, which in carriage, general cutting and vestiture it resembles. A careful comparison, however, shows it to be intermediate between that and *T. coriandrifolia*, with which it was associated in two places, and it may possibly be a hybrid between those species. The rootstocks of the three are almost identical. The aspect is nearer that of *T. minima*, which it also resembles in the flattened stipe, the fine puberulent scales of the stipe and veins, in the texture, the cordate basal pinnae, the lower side of which is somewhat auriculate, and in the more or less irregularly placed sori. It also lacks the proliferous bulbils of *T. coriandrifolia*. The areolation is more like that of the latter species, though free veinlets are not rare, especially in sterile fronds. The sori are also nephroid, a condition which is also found occasionally in *T. minima*. Dedicated to Mrs. Oakes Ames.

TECTARIA CORIANDRIFOLIA (Sw.) Underw.*

Rootstocks short, creeping, covered at the growing end with lanceolate, filiform-acuminate, brown scales; stipes 6–15, clustered, nearly terete, spreading, 2–6 cm. long, with a few brown scales at base, clothed, as well as the rachis, with hair-like, contorted, gray or brown scales; lamina pubescent, especially on the nerves, oblong-lanceolate, slightly narrowed below, 6–10 cm. long, 2.5–3 cm. broad, proliferous at the axils, thin, darkening in drying, with 1–3 pairs of remote pinnae and a terminal lanceolate pinnatilobed one; lower pinnae shortly petioled, obliquely ovate with 2–4 rounded lobes, the lower basal ones much the largest; second pair of pinnae blunt-lobed below, sinuate or entire above; terminal pinna 8–10 lobed, the segments rounded, entire or more or less toothed; veins forming large paracostal areoles along the rachis and midnerves and one or two between them and the margin, the ends mostly free; sori few, in a row on each side of the midnerve, borne in a fork of a paracostal nerve at about the middle; indusium reniform, withering-persistent.

In lime-sinks, Bauer's hammock, Gossman's. This hammock is nearly half a mile long and one quarter mile wide, in some places with abundant sinks. This fern was found in but three of these, rooting in the rough rocks of the sides from two to six feet down, spreading extensively by the proliferations of the fronds.

TECTARIA HERACLEIFOLIA (Willd.) Underw.

Rootstocks stout, erect, 1–3 dm. tall and 3 cm. in diameter, sometimes aggregated into erect clumps 5 dm. tall and 1 dm. in diameter, overlaid with wiry roots, clothed with long lanceolate-acuminate dark-brown scales, the bases of which persist; stipes 2–6 dm. long, stout, castaneous, shining, nearly flat above, grooved on sides, with a few lanceolate-acuminate deciduous scales at base, and more or less puberulent with very fine scattered or matted scales; fronds ternate, ample, 1.5–5 dm. long, 1–4 dm. wide, chartaceous, glossy above, dull beneath, surface smooth, all the principal veins finely puberulent, especially above; lower pair of pinnae mostly distinct, often petioled, mostly auricled at base, upwardly falcate, acuminate, with a large upwardly falcate, acuminate, coarsely crenate or lobed basal pinnule and several other blunt, shallow lobes passing to undulations above, or in larger specimens often more cut; second pair of lobes often distinct, upwardly falcate, more or less lobed or incised; terminal portion triangular-ovate, more or less incised or coarsely lobed below, entire or undulate above, acuminate; young fronds ovate-lanceolate, acuminate, cordate, the sinus closed, with one or two rounded shallow lobes at base; paracostal areoles with free veins or often small areoles, the rest of areoles irregular, mostly with free, simple or irregularly branched included veinlets; sori large, round, irregularly placed but mostly in two rows between the veins, on an angle or fork of the first branch of the veins that form the paracostal areoles.

Growing in small lime-sinks in hammocks of the Homestead region. A large glossy beautiful fern, very different in aspect from the next. Apparently absent in some hammocks where that is abundant. This fern has been known as *Aspidium trifoliatum*, from which it is distinct.

TECTARIA MINIMA Underw. Bull. Torrey Club 33: 199. 1906*

This plant is very distinct from *T.* (*Aspidium*) *trifoliata*, with which it has been confused. The rootstocks are small (about 5 mm. in diameter and 2–6 cm. long) and prostrate, clothed at the growing end with narrow, lance-acuminate dark scales, the bases of which persist for several years. Contrary to the usual habit of ferns with horizontal rhizomes, the fronds arise from all parts of its surface, those beneath growing out laterally, then erect. The stipes are usually from one to two, rarely three decimeters long. They are slender and nearly naked, green or somewhat castaneous, especially near the base. They are slightly grooved on the edges, and puberulent on the upper surface near the top. The laminae are lance-ovate to triangular-ovate, acute or acuminate, about 6–15 cm. long and nearly as broad. They are herbaceous and dull, entirely lacking the beautiful gloss of the last species, and the upper surface is somewhat hairy-puberulent, most pronounced on the veins. When simple they have much the appearance of a maple leaf. Usually the basal lobes are distinct, with two or three lobes on the lower margin and the upper margin undulate. The apical lobe of the frond bears several usually obtuse lobes on each side, these passing to undulations towards the acuminate tip. The venation is similar to the last, but the paracostal areoles are usually without free veinlets. The indusia usually appear to be peltate because of the overlapping of the "full" basal lobes.

Sides of lime-sinks and neighboring lime rocks in all the hammocks of the Homestead region. Found also in Cuba and the Bahamas. At Ross's hammock I found a form with pentagonal fronds 2–2.7 dm. long, and 2 dm. wide, the lower pair of pinnae petioled and deeply lobed, the second pair cut to the rachis, the chief segments coarsely lobed. This appears to be an extreme form of the present species. This species differs from the last in the horizontal, small rootstocks, smaller size, outline of the fronds, the dull surface, the divergent rather than falcate lobes, the reniform indusia, the lack of veinlets in the paracostal areolations and the scarcity of free veinlets in the others.

ODONTOSORIA J. Smith

General habit of *Davallia* and sometimes considered as a section of that genus (§ *Stenoloma* Fée; *Cuneatae* Hook.).

Fronds mostly decompound, the ultimate segments narrow, cuneate, glabrous, with the sori sunk in a transverse pocket at the apex, much like the genus *Lindsaya.*

ODONTOSORIA CLAVATA (Sw.) J. Smith *

Rootstocks short, creeping, densely clothed with jointed filiform, glossy, dark-brown hair-like scales; stipes contiguous, stramineous, naked except for a few scales at the base, 3–25 cm. long, obtusely triangular; fronds 1–3 dm. long, 5–18 cm. wide, ovate to lanceolate, dichotomously tri-quadripinnate, the ultimate segments often cleft or divided; rachis stramineous, deeply grooved above; pinnae long-stalked; ultimate rachises green, centrally grooved; segments linear to cuneate, entire on sides, finely toothed at apex, about 1 cm. long and 1–2 mm. wide, with 1 or 2 usually dichotomously forked veins with thickened and confluent ends; sori sunk in the ends of the segments, confluent on a transverse vein that connects the tips of the primary veins.

On the edges of small lime-sinks which usually contain water, in pine woods; first observed by Mr. Simpson near Camp Jackson. Found later by Mr. Soar and myself in sinks between Costello's and Ross's hammocks, and later by me in an old well at Buena Vista. It is a very pretty fern, lining the sides of the sinks, thriving best where shaded from the direct sunlight. It is found only in those sinks that are in the comparatively strong light of the pine woods. Its yellowish-green, finely cut, close-set fronds hanging gracefully over the rugged rocks form a very pleasing sight. It is found in most of the West Indies, including the Bahamas, and it is not surprising that it should be found in the lime-rock regions of South Florida.

NEPHROLEPIS BISERRATA Schott

Abundant in swampy hammocks back of Miami and in similar situations southward, often on palmettos. In Costello's hammock is an opening overrun by this fern, through which it is impossible for one to force his way, except by bending the plants down and walking over them; the tangle being so dense that it will support the weight of a man. In favorable localities the fronds attain a length of 3 to 3.6 meters.

NEPHROLEPIS EXALTATA Schott

Mostly on palmettos but often on the ground in drier situations than the last, much smaller in size. Very common in hammocks.

SALVINIACEAE

AZOLLA CAROLINIANA Willd.

Collected only once, in a ditch at Sanford, and seen once from a car window in east central Florida. Apparently absent from the lower counties.

LYCOPODIACEAE

LYCOPODIUM CAROLINIANUM L.

In damp sand bordering a swamp at Fort Lauderdale, in company with *L. adpressum*; resting in December. In a sandy swamp at Sanford, with immature spikes June 1. In the autumn the tips of the stems elongate and penetrate the earth to the depth of 1 cm. or more, then thicken into scaly rootstocks 1 to 2 cm. long, from the end of which a shoot arises in spring to continue the growth.

LYCOPODIUM CERNUUM L.

Only one specimen seen from a car window on the damp borders of a stream at Nocatee.

LYCOPODIUM ADPRESSUM (Chapm.) Underw.

First found at Fort Lauderdale in November, in a ditch by the railroad. I subsequently found a little at Orange Glade near Miami, and another place along the river above Fort Lauderdale. It was plentiful in a swampy field at Fort Myers, where it bore abundant flabellate or decompound sterile peduncles in June. Apparently confined to the borders of swamps in sandy regions. I saw no *L. alopecuroides* in South Florida.

PSILOTUM NUDUM (L.) Griseb.

Not uncommon in decaying vegetable matter, often at the bases of palmetto trees. It grows most luxuriantly in decayed places in prostrate logs or living trees, sometimes at an altitude of 5 meters. Some specimens obtained at Costello's hammock are 4.5 dm. high and 3 dm. broad.

SELAGINELLA RHODOSPORA Baker*

§ *Apodae.* Tufts small; plant annual, pinnate, 1–3 cm. long; branches short, 2 mm. broad; under leaves spaced or slightly imbricated, 1.75–2 mm. long by 0.75 mm. broad, obliquely oblong, the upper edge more rounded, apiculate, finely papillose over the upper surface, each margin with 14–18 minute bristle-like teeth; upper leaves lanceolate, long acuminate, appressed to the stem, 1 mm. long, 0.25 mm. broad, with about 7 setae on each side; spikes 2–5 mm. long; sporophyls 1.6 mm. by 0.57 mm., ovate-lanceolate, abruptly long-acuminate and ending in a rough awnlike point, the edges slightly hyaline and with 15–18 bristles, the under ones broader, divaricate and fructiferous, the upper darker green and sterile, keeled and bristled on the back towards the apex; gynospores reddish-orange, 22 μ in diameter, coarsely tubercled; androspores not seen.

A very delicate little species growing among the algae on the borders of pot-holes on the edges of the prairies, where inundated most of the year. Black Point bridge and beside a prairie below Homestead, in November and December. Evidently only collected once before, in eastern Cuba, by Wright. This has been erroneously referred by Gilbert * to *S. caribensis* Jenman.

SELAGINELLA ARENICOLA Underw.

Common in the sandy pine woods about Alapattah, but apparently absent from the rocky woods from Miami southward.

ISOETACEAE

ISOETES FLACCIDA Shuttlew.

Rich soil, border of everglade at Orange Glade, border of the north fork of the Miami at the rapids, and in the brook at Snapper

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* Fern Bull. 13: 74.

hammock, in November, scarce. In a muddy, shaded alligator hole in the pine woods at Gossman's; abundant in February. Plentiful in low places near a swamp at Fort Ogden, in March.

AMES BOTANICAL LABORATORY,
NORTH EASTON, MASSACHUSETTS.

The behavior of the pollen-tube in Houstonia coerulea

CHESTER ARTHUR MATHEWSON

The present study was undertaken at the instance of Professor F. E. Lloyd during the past winter, and prosecuted in the laboratory of Teachers College with his assistance and under his direction. My work, the material for which was collected in the neighborhood of Mt. Holyoke, Mass., in the summer of 1904, has thus far been confined to one species, *Houstonia coerulea.*

METHODS

Both young and old flowers were collected and fixed in Flemming's fluid, chromo-acetic solution, and alcohol-acetic solution. With the tissue that had been fixed in the first two I used the Flemming triple stain. The tissue fixed in alcohol-acetic solution was stained with iron-alum haematoxylin and Bismarck brown. The latter method has thus far yielded the best results. All the sections were cut 10 μ thick.

RESULTS OBTAINED FROM ALLIED FORMS

In connection with his work on the embryology of the *Rubiaceae,* Lloyd has studied the pollen-tube in two genera — *Richardsonia* and *Diodia.* Briefly stated, his results show that in *Richardsonia pilosa* and in *Diodia teres* the course of the pollen-tube is chiefly intercellular, while in *D. virginiana* the pollen-tube grows freely in the cavity of the ovary. Since the behavior of the tube is so different in two closely related species of the same genus, and likewise in two closely related genera of the same family, Lloyd agrees with Murbeck that the phenomenon is a matter of physiological meaning only, and disagrees with Treub and Nawaschin in their contention that the intercellular mode of growth is of importance from a phylogenetic point of view. It will be remembered in this connection that Longo, as a result of his studies in the Cucurbitaceae, has come to conclusions similar to those of Lloyd. I may add that my own results seem to add further evidence in support of this view.

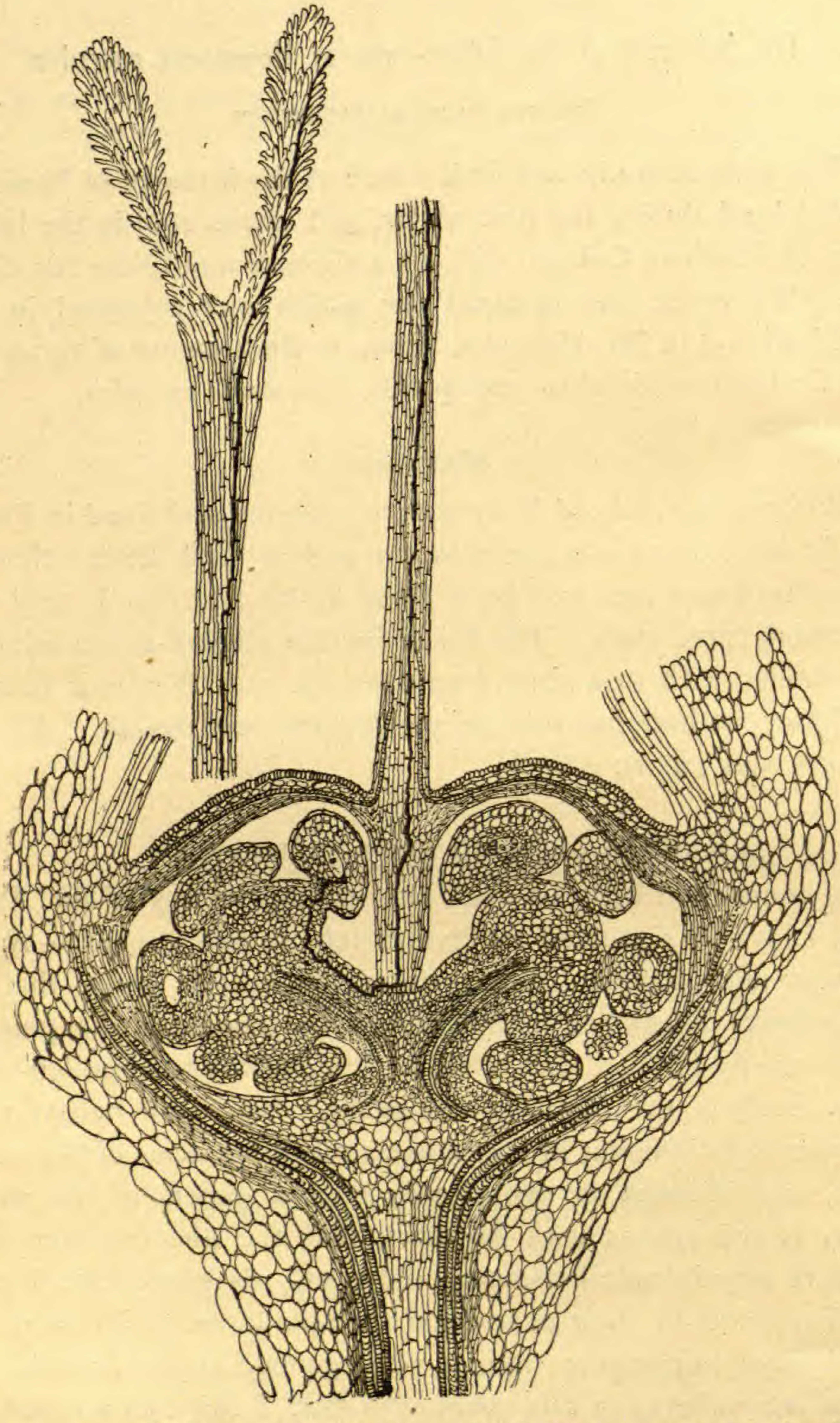

FIG. I. Longitudinal section of the pistil of *Houstonea coerulea*, showing the course of the pollen-tube from the stigma to an embryo-sac, at its egg pole.

HISTOLOGY

In *Houstonia coerulea* there is a bilocular inferior ovary 1.9 mm. wide in its longer axis, and about 1.3 mm. deep (figure 1). The locules, as in the case of *Diodia* and *Richardsonia*, are separated by a partition of two portions. The lower portion arises, as Lloyd has shown, from the floor of the ovary. The original single ridge gives rise to two club-shaped placentae, one in each locule. Each placenta soon begins to show a number of protuberances — the primordia of the ovules. The style is single, with two stigmas, and arises by the concrescence of two ridge-like fundaments which develop laterally and opposite to each other on the inside of the hollow torus. During this concrescence a transverse ridge is formed on the inside of the ovary roof which by growing downward until it meets the ridge arising from the floor, ultimately divides the originally single ovarian chamber into two locules. The main point concerning the ovule is that there is no integument whatever at any stage, and as a result the micropyle is entirely wanting. The ovules, usually at least 15 in each locule, are very small, averaging about 70 μ long by 60 μ deep. They are when mature somewhat bowl-shaped with the concave side toward the placenta. The funicle is very short. The ovule conforms, broadly speaking, to the campylotropous type. The embryo-sac lies buried about midway in the ovule with its slightly curved longer axis at right angles with the funicle, coincident with the longer axis of the ovule.

BEHAVIOR OF THE POLLEN-TUBE

The two stigmas are furnished with numerous club-shaped papillae (figure 1), which are found over their entire surfaces. These papillae are formed by the outward bending of superficial cells. The pollen-grains average 15 to 17 μ in diameter, and are about twice the diameter of the papillae. They have numerous germ-pores.

As a rule the tube emerges from the pollen-grain on the side toward the papilla, but there are many exceptions to this. In some cases the pollen-tubes have been observed to emerge through a germ-spot diametrically opposite to the point of contact with the stigma, growing down upon the surface of the grain and so reaching the hair. In a similar case the tube grew out toward the adjacent papilla and pursued its way thereon instead of on the one with which the grain was in contact. Strasburger figures cases in *Agrostemma* and *Malva* in which the tube enters the papillary cell and pursues its way within, but I have found no evidence that this occurs in the form I have studied. Growth on the papilla is entirely superficial. The tube very often makes one, or even two full turns around a papilla before it reaches the base, a condition precisely like that described by Strasburger in the case of one of the grasses, *Alopecurus pratensis*.

Arrived at the base of the papilla the tube begins its intercellular course. The papillae merge at their bases with long, narrow relatively thin-walled cells, the first kind of conductive tissue which it meets in its course. There are no intercellular spaces whatever in the tissues traversed by the tube. The width of the pollen-tube varies from 2 to 4 μ. It seems quite probable that the method by which the tube first penetrates between the cells of the epidermis of the stigma is the method by which it is able to force its way throughout its entire course. It is well known that the pollen-tube is capable of secreting a cellulose-dissolving enzyme, and it seems that we should be safe in saying that by breaking down the middle lamella between the cells with which it comes in contact the slender tube of this species makes room for its growth. The tube is doubtless nourished, in part at least, by the absorption of the cellulose which has been converted into available food by its enzymes. The width of the tube is not constant, usually being somewhat greater in its younger portion than farther back, where it becomes collapsed. The vascular elements of the style are in two small bundles which are always farther from the middle of the style than the pollen-tubes. Little or no distortion or other bad effect results from the contact of the pollen-tube with the cells along its course. If the tube meets a cell lying directly across its path it simply passes around it.

At the level of the roof of the ovary the pollen-tube encounters a tissue, the cells of which are more irregular and the walls thicker (figure 1). Some of the cells are quite short. The tube goes on down through this stylar portion of the ovarian partition as readily as through the part above. Anatomically there appears no reason why it should not make its way into the cavity of the ovary directly after reaching this tissue, but it appears that it never does so.

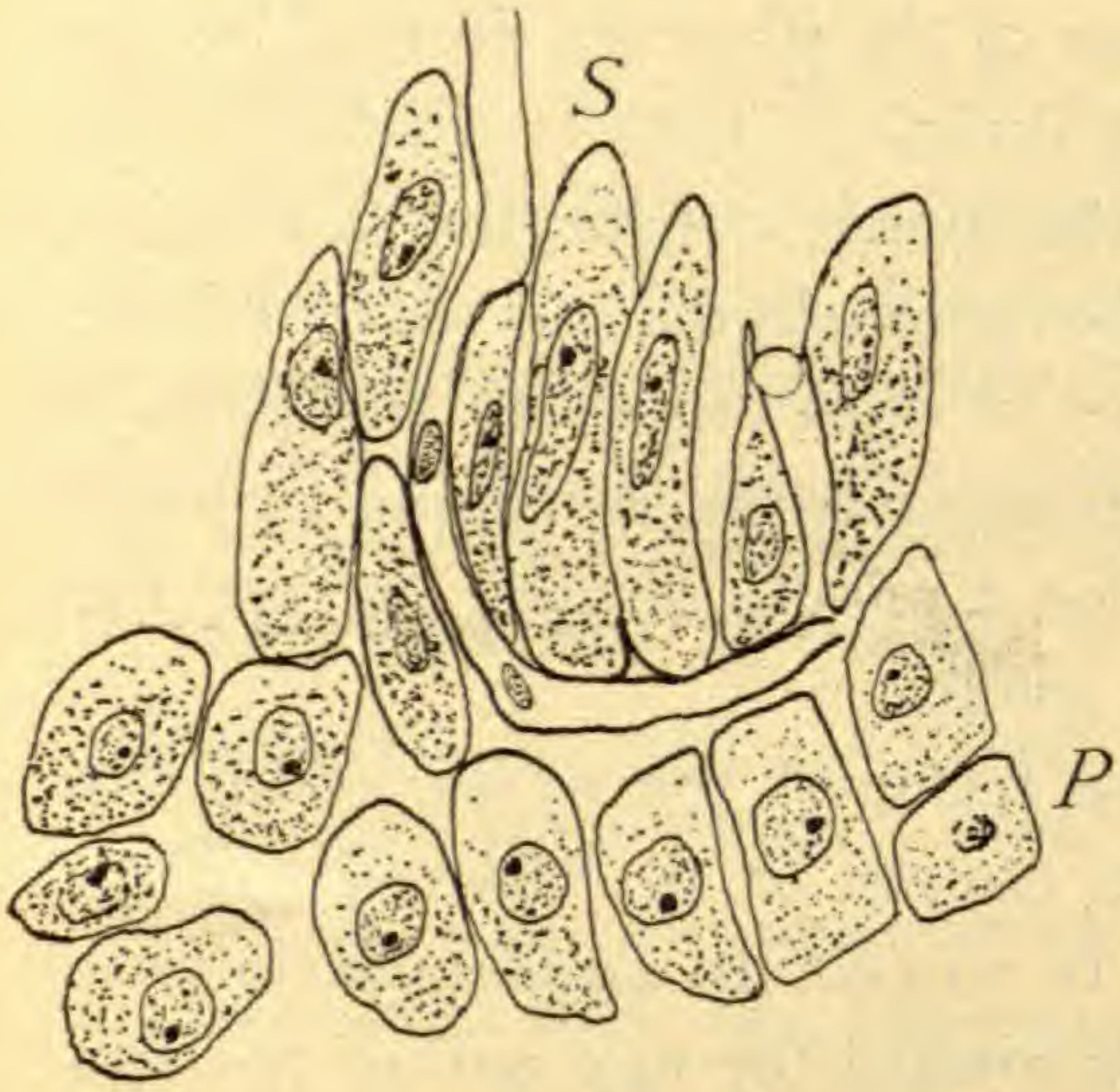

FIG. 2. Contact of stylar tissue (S) with the basal element of the ovary-partition (P), showing the turn made by the pollen-tube on reaching the latter.

At the place where the stylar elements blend with the basal elements of the partition the tube encounters a third kind of tissue which is in sharp contrast with those heretofore traversed. Its course appears to be interrupted by relatively shorter, columnar cells with thicker walls beneath which are parenchymatous cells. On reaching this tissue the tube invariably makes a sharp turn to the right or left (figure 2), and thus enters the stalk of one of the two placentae. It often happens that this turn takes the tube directly toward the surface of the placenta, and in such a case the tube makes a further turn which carries it beneath the epidermis (figure 3). In no case does it approach nearer than within one cell-layer of the surface. Large cellulose plugs (figure 3), twice the diameter of the pollen-tube itself, are often seen in this region. They also occur quite often in the style.

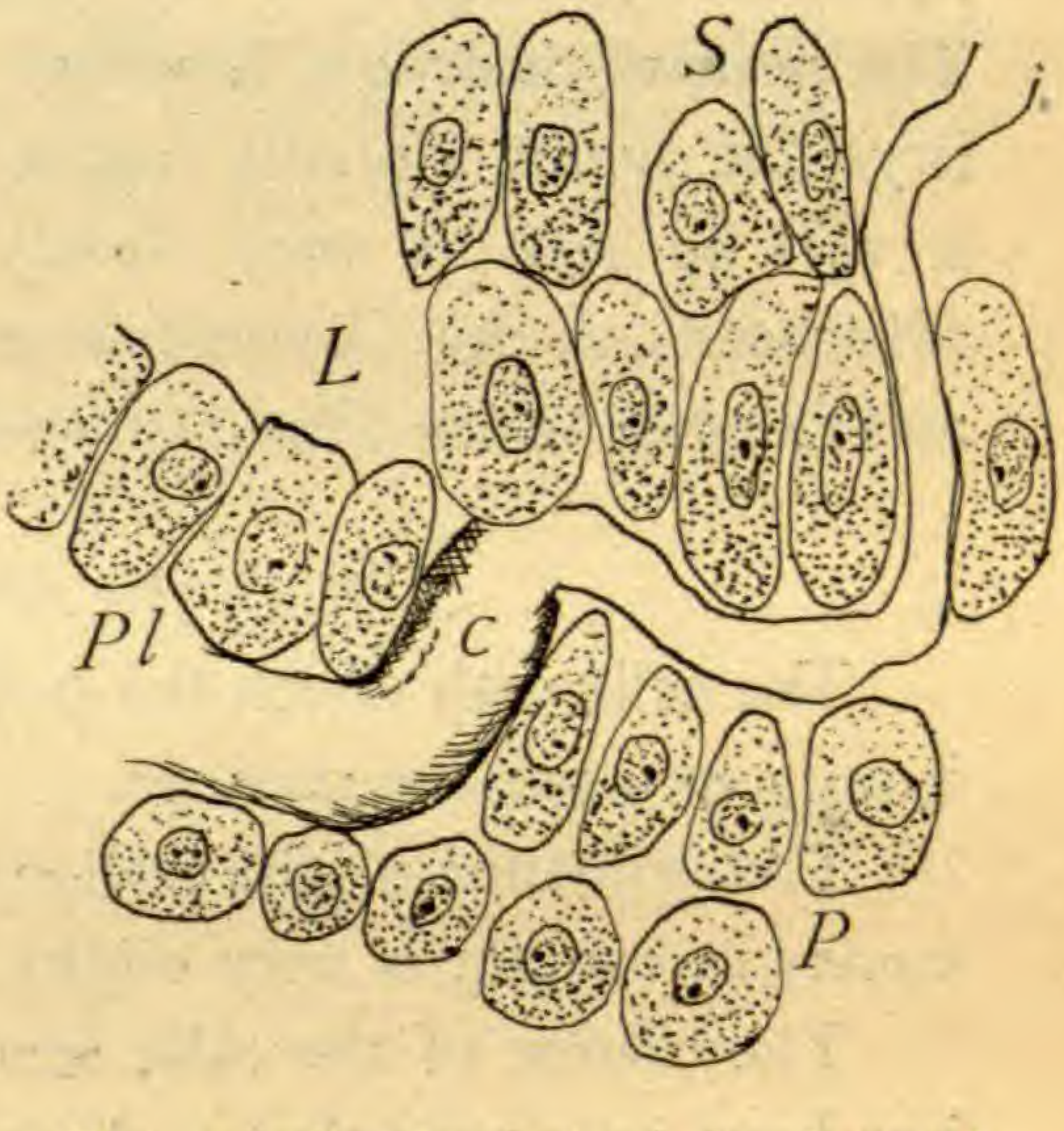

FIG. 3. Basal portion of placental stalk (Pl) and adjacent tissue (P) of the basal partition, with a part of the stylar tissue (S) abutting on the latter. C, cellulose plug in the pollen-tube, which at this point turns in order to penetrate the placental stalk. L, locule.

The pollen-tube continues its course through the placenta either immediately below the epidermis or from one to several cell-rows below it. This tissue is composed of approximately isodiametric cells and the path of the tube in it may be straight or subject to sudden variations. As the tube approaches the ovule it usually grows toward the interior of the placenta, so that by the time it reaches the region of the funicle, it may be six cell-rows below the surface. The cells of the funicle constituting a scission layer, are much smaller than the parenchymatous cells of the placenta and have their long axes at right angles to the path of the tube. The tube usually makes many turns in passing through this tissue. It may even grow for a minute distance across the sinus between the funicle and the ovule.

The tube has now reached the tissue of the ovule, composed of small thin-walled cells, and its course, as in *Alchemilla* (Murbeck), in the region of the egg is subject to sudden deviations. The general direction, however, is toward the egg end of the embryo-sac, which it finally reaches. The course of the pollen-tube, it will be seen, is very closely analogous to that in *Alchemilla* (Murbeck), in the *Cannabinaceae* (Zinger), in *Cynomorium* (Pirotta and Longo), and in *Ulmus* (in some instances studied by Nawaschin).

SUMMARY AND CONCLUSIONS

The cells with which the pollen-tube comes in contact influence it only in a passive manner.

The influence of the pollen-tube upon the cells with which it comes in contact is very slight.

The course of the tube seems to support the hypothesis that has been advanced that a chemotactic stimulus originating in the egg-apparatus, or the egg itself, is the chief directive influence.

The endotropic phenomenon here set forth adds another link in the chain of evidence that the intercellular mode of growth is purely a physiological phenomenon, and not a character inherited from more primitive forms.

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Studies in the North American Convolvulaceae, II. The genus Operculina

HOMER DOLIVER HOUSE

The original description of the genus *Operculina* S. Manso was based upon the operculum-like structure, quatrefoil in shape, which tops the capsule in the type species — *O. macrocarpa* Urban. An examination of a large number of specimens of this and related species shows that the presence of an operculum is not in this case a generic distinction, for often of two species closely and evidently related by all other characters, one will have a well developed operculum and the other none or sometimes in a few specimens, only vestiges of one. While the type has irregular dehiscence some other species with an operculum have a valvular dehiscence to the capsules.

The common features, however, that do occur throughout a considerable group of species that seem by a preponderance of characters to center congenerically about the type of *Operculina* are as follows: the pear-shaped calyx, rounded at the base and narrowed above; the large imbricated sepals more or less chartaceous or parchment-like in fruit; the broadly campanulate-funnelform tube of the corolla, and the strongly contorted anthers which are often protruding from the tube of the corolla. The capsules are usually large and thin-walled, often the upper hemisphere of the capsule thicker than the lower.

This extension of the genus seems to be the only satisfactory way to place properly those species variously assigned to *Merremia*, *Batatas*, and *Ipomoea*, with spirally-twisted anthers and other characters in common with species now placed in *Operculina*.

OPERCULINA S. Manso, Enum. Subst. Bras. 16. 1836

Twining plants with woody or herbaceous, perennial stems, entire or divided leaves. Stems or peduncles often more or less winged. Calyx large, pear-shaped, constricted above, the closely imbricated sepals scarious or chartaceous and often colored, usually enlarged in fruit. Corolla campanulate, campanulate-funnelform, or sub-salverform. Stamens included or protruding, the anthers spirally twisted. Disk hypogynus or obsolete. Ovary 2-celled, 4-ovuled. Capsules large, often extremely so, 2-celled and usually 4-seeded, or partially 4-celled, usually differentiated into an upper thicker and a lower thinner portion, or the thin-walled capsule covered by an operculum-like, quatrefoil cap which is deciduous at maturity. More rarely, the capsule of uniform texture and valved; the dehiscence transverse or irregular. Seeds large, black or brown and usually smooth.

Type species: *Operculina Convolvulus* S. Manso, *l. c.* (*Convolvulus macrocarpus* L., *O. macrocarpa* Urban). About 20 species of tropical distribution.

Turpithum Raf. Fl. Tellur. 4: 71. 1836.
Spiranthera Boj. Hort. Maurit. 226. 1837. Not *Spiranthera* A. St. Hil. 1823.
Piptostegia Reichenb. Nom. 113. 1841. — Hoffmannsegg, in Mart. Syst. Mat. Med. Veg. Bras. 78. 1843.
Ipomoea § *Operculina* Griseb. Fl. Br. W. Ind. 467. 1861.

Key to the North American species

- Leaves entire.
  - Stems conspicuously winged.
    - Stems glabrous; corolla yellow, 4–5 cm. long. — 1. *O. alata.*
    - Stems pubescent or pilose.
      - Corolla white; peduncles exceeding the subtending petioles. — 2. *O. triquetra.*
      - Corolla violet; peduncles shorter than the subtending petioles. — 3. *O. leptoptera.*
  - Stems not winged; peduncles usually winged.
    - Corolla white or cream-colored; leaf-blades deeply cordate, 10–30 cm. long. — 4. *O. ventricosa.*
    - Corolla not white; leaf-blades shallowly-cordate, rarely more than 10 cm. long.
      - Corolla yellowish; peduncles obscurely or not at all winged, 1–2-flowered. — 5. *O. rhodocalyx.*
      - Corolla scarlet or salmon-colored; peduncles conspicuously winged.
        - Corolla scarlet; peduncles 1–3-flowered. — 6. *O. rubicunda.*
        - Corolla salmon-colored; peduncles flexuose, 2–7-flowered. — 7. *O. alatipes.*
- Leaves lobed or divided.
  - Stems winged; corolla white. — 8. *O. macrocarpa.*

Stems not winged.
Corolla yellow; sepals 3 cm. long or longer; capsule 3–4 cm. in diameter. 9. *O. tuberosa.*
Corolla white or whitish; sepals smaller; capsules 1–2 cm. in diameter.
Leaves pinnately lobed or, if palmately lobed, not cut to the petiole.
Leaves palmately lobed, the segments much toothed or cut; petioles and stem hispid. 10. *O. dissecta.*
Leaves pinnately lobed; plant glabrous.
Lobes lanceolate or broader, with undulate margins. 11. *O. Roseana.*
Lobes linear, margins entire. 12. *O. angustiloba.*
Leaves palmately lobed to the petiole.
Plant glabrous.
Leaflets lanceolate, acuminate. 13. *O. Palmeri.*
Leaflets elliptical-oblong, obtuse. 14. *O. platyphylla.*
Sepals and stems hispid. 15. *O. aegyptia.*

1. OPERCULINA ALATA (Ham.) Urban, Symb. Ant. **3**: 343. 1902.

Convolvulus alatus Ham. Prodr. Fl. Ind. Occ. 24. 1824.

Ipomoea Hamiltoni G. Don, Gen. Syst. **4**: 268. 1838.

Ipomoea pterodes Choisy, in DC. Prodr. **9**: 361. 1845.—Griseb. Fl. Br. W. Ind. 467. 1861.

Ipomoea altissima Mart.; Choisy, *l. c.* 359.

Operculina pterodes and *O. altissima* Meissn. in Mart. Fl. Bras. **7**: 313. 1869.

Ipomoea alulata Miquel, Linnaea **18**: 599. 1844.

Operculina populifolia Hallier f. Bot. Jahrb. **16**: 550. 1893. (Ex spec. Wright *no. 3083.*)

Type locality: Near Scarborough, Tobago.

Distribution: Cuba and the Lesser Antilles, northern coast of South America and adjacent islands.

Illustrations: Mart. Fl. Bras. **7**: *pl. 75.*

2. OPERCULINA TRIQUETRA (Vahl) Hallier f. Bot. Jahrb. **18**: 120. 1894

Convolvulus triquetra Vahl, Symb. **3**: 30. 1794.—Schlecht. Linnaea **6**: 738. 1831.

Ipomoea triquetra Roem. & Schultz, Syst. **4**: 231. 1819.—Choisy, in DC. Prodr. **9**: 360. 1845, excl. syn. Ham. & G. Don.

Type locality: St. Croix.

Distribution: Lesser Antilles (St. Croix, St. Thomas, Santa Cruz and Tobago), Venezuela, Guiana, and Brazil.

3. OPERCULINA LEPTOPTERA Urban, Symb. Ant. **3**: 342. 1902

Type locality: Hateurs des Trois Islets, *Père Duss 426* (type).

4. OPERCULINA VENTRICOSA (Bert.) Peter, in Engl. & Prantl, Nat. Pfl. 4^{3a}: 32. 1891

Convolvulus ventricosus Bert. in Colla, Hort. Ripul. 37. 1824. Not *C. ventricosus* S. Manso, 1836.

Ipomoea ventricosa G. Don, Gen. Syst. **4**: 274. 1838.—Choisy, in DC. Prodr. **9**: 360. 1845.

Type locality: St. Bartholomew.

Distribution: Lesser Antilles; Martinique, Antigua; French and Swedish Islands; Guadeloupe, St. Bartholomew, etc.

Illustrations: Jacq. Vind. **3**: *pl. 69.*

5. **Operculina rhodocalyx** (A. Gray)

Ipomoea rhodocalyx A. Gray, Proc. Am. Acad. **22**: 439. 1887.

Type locality: "At base of hills, Tequila, Jalisco [Mexico], Palmer No. 421, 1886" (type).

6. **Operculina rubicunda** nom. nov.

Ipomoea alata J. N. Rose, Contr. Nat. Herb. **1**: 108. 1891. Not *I. alata* R. Br. 1810; nor *I. alata* G. Don, 1838. Not *Operculina alata* (Ham.) Urban.

Similar in habit to *O. alatipes* and *O. rhodocalyx*. Leaf-blades thin, triangular-ovate, 3–8 cm. long, shallowly cordate, entire, acuminate; petioles shorter than the blades: peduncles exceeding the subtending petioles, broadly 2-winged below the middle, 1–3-flowered; pedicels 1.5–2 cm. long, clavately thickened and angled, somewhat deciduous in fruit: sepals membranaceous, acute, 2.5 cm. long, the outer ones more or less tinged with brick-red: corolla subsalverform, scarlet, the tube about 5 cm. long and 1 cm. in diameter, the limb 2.5–3 cm. broad, the spirally twisted anthers equaling the tube or barely protruding: capsules globose, 1.5 cm. in diameter, 2-celled, 4-seeded; seeds black, glabrous, 6 by 8 mm.

SONORA: Alamos, *Dr. E. Palmer 706*, Sept. 16–20, 1890, type, n the National Herbarium.

Ymala, *Dr. E. Palmer 1709*, Sept. 25–Oct. 8, 1891.

MICHOACAN: Real de Guadalupe, *E. Langlassé 352*, Sept. 12, 1898.

Differs from *O. rhodocalyx* by its less cordate, thinner and more triangular leaf-blades, winged peduncles and scarlet corollas; from *O. alatipes*, by its more slender habit, fewer-flowered infloresence, and smaller scarlet corollas.

7. **Operculina alatipes** (Hook.)

Ipomoea pterodes Seem. Bot. Voy. Herald 171. 1854. Not *I. pterodes* Choisy, 1845; nor *I. pterodes* Griseb. 1861.

Ipomoea alatipes Hook. Bot. Mag. *pl. 5330.* 1862.

The stout peduncles curved, broadly 2-winged below the middle, 2–7-flowered and strongly flexuous between the pedicels, the pedicels secund and upright, thickened: calyx 2.5 cm. long: corolla subsalverform, 6–7 cm. long, salmon-colored, the limb 4.5–5 cm. broad, with five obscure, rounded lobes.

Distribution: Southern Mexico to Columbia.

8. OPERCULINA MACROCARPA (L.) Urban, Symb. Ant. 3: 343 1902

Convolvulus macrocarpus L. Syst. ed. 10. 923. 1759. — Sp. Pl. ed. 2. 222. 1762.

Convolvulus operculatus Gomes, Mem. Acad. Lisb. 3: App. 27. 1812.

Ipomoea operculata Mart. in Spix & Mart. Reise Bras. 2: 547. 1828. — Choisy, in DC. Prodr. 9: 361. 1845.

Operculina Convolvulus S. Manso, Enum. Subst. Bras. 12. 1836. — Meissn. in Mart. Fl. Bras. 7: 211. 1869.

Type locality: America.

Distribution: Antilles and tropical South America.

Illustrations: Plum. Am. *pl. 91. f. 1.* Gomes, *l. c. pl. 3.* Mart. Fl. Bras. 7: *pl. 74.*

9. OPERCULINA TUBEROSA (L.) Meissn. in Mart. Fl. Bras. 7: 212. 1869.

Ipomoea tuberosa L. Sp. Pl. 160. 1753; ed. 2. 227. 1762; excl. syn. Plukn. — Choisy, in DC. Prodr. 9: 362. 1845, excl. syn.

Convolvulus gossypiifolius Spreng. Syst. **1**: 592. 1825.—Schlecht. Linnaea **6**: 742. 1831.

Convolvulus tuberosus Spreng. *l.c.* Not *C. tuberosus* Vell.

Ipomoea kentrocaulos C. B. Clarke, in Hook. Fl. Brit. Ind. **4**: 213. 1874; excl. syn. Steud.

Ipomoea nuda Peter, in Engl. & Prantl, Nat. Pfl. 4^{3a}: 31. 1891.

Type locality: Jamaica.

Distribution: Cuba, Jamaica, St. Domingo and other West Indian islands, Central America, tropical South America and the old world.

Illustrations: Sloane, Jam. **1**: *pl. 96. f. 2.* Bot. Reg. *pl. 768* (white flowers probably an error).

10. **Operculina dissecta** (Jacq.)*

Convolvulus dissectus Jacq. Obs. **2**: 4. 1767.—L. Mant. 204. 1771.

Ipomoea sinuata Ortega, Hort. Matr. Dec. 84. 1798.

Ipomoea dissecta Pursh, Fl. Am. Sept. 145. 1814. Not *I. dissecta* Willd. 1794, nor *I. dissecta* R. Br. 1810.

Ipomoea subpedata Desf. Cat. Hort. Par. ed. 3. 397. 1829.

Ipomoea nigricans Gardn. Lond. Jour. Bot. **1**: 180. 1842.

Merremia dissecta Hallier f. Bot. Jahrb. **18**: 114. 1894.

Type locality: America.

Distribution: Florida and Texas; Mexico, West Indies and tropical South America.

Illustrations: Jacq. Obs. **2**: *pl. 28;* Hort. Vindob. *pl. 159.*

11. **Operculina Roseana** sp. nov.

Low, extensively twining among bushes, 1–3 m. long, glabrous: leaf-blades ovate in outline, 4–7 cm. long, pinnately parted into 5

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* The *Ipomoea dissecta* Willd. and R. Br. of the old world has often been confused with the American plant both on account of the homonymous name and their strong relationship. It cannot be consistently kept in a different genus but belongs to *Spiranthera* of Bojer, which is not separable from *Operculina* by any constant character.

Operculina coptica (L.)

Convolvulus copticus L. Mant. 559. 1771.

Ipomoea dissecta Willd. Phyt. 5. *pl. 2. f. 3.* 1794.—Sp. Pl. **1**: 880. 1798.—R. Br. Prodr. 487. 1810.

Ipomoea coptica Roth, Nov. Pl. Sp. 110. 1821.—Choisy, in DC. Prodr. **9**: 384. 1845.

Tropical Africa, Asia, East Indies, and Australasia.

lanceolate lobes, the lobes contracted below the middle, the margins undulate or subsinuately toothed, the middle lobe longest, broadest below the middle and tapering to an acute or acuminate apex, two of the lateral lobes arising from near the base of the middle lobe, the other two entirely basal and often again somewhat 1–2-lobed on the outer margin; petioles shorter than the blades: peduncles 3–6 cm. long, 1-flowered; pedicels about 2 cm. long, thickened above, especially in fruit, sharply angled but not winged: sepals equal, 1–1.5 cm. long, oval or oblong, rounded at the apex, margins scarious: corolla campanulate-funnelform, yellowish-white, about 3 cm. long, the limb as broad, silky-hirsute on the plicae without with blackish hairs, densely so in bud, the strongly contorted anthers protruding or inserted: capsules globose, 1.5 cm. in diameter, topped by a quatrefoil, deciduous operculum, with rounded lobes, thick and coriaceous in texture, the walls of the capsules thin and submembranaceous, semitranslucent.

SONORA: Agiabampo, *Dr. Edward Palmer 781*, 1894, type, in the National Herbarium, sheets *no. 208789* and *208790*.

MORELOS: Puenta de Ixtla, *Rose & Hay 5320*, July 4, 1901.

CHIAPAS: San Vicente, *Goldman 871*, April 20, 1904.

The three specimens seen indicate a most remarkable range, and the species will undoubtedly be found in many intervening localities. The specimens from Morelos and Chiapas have the lobes of the leaf-blades relatively shorter and broader than the type specimens from Sonora. The leaf-outline is strikingly odd and not closely simulated by any other known species of *Operculina*, except the next which may prove to be but an extremely narrow-lobed variety of *O. Roseana*.

Operculina Roseana was described without name, in Contr. U. S. Nat. Herb. **1**: 344. 1895, by Dr. J. N. Rose, for whom it is now named.

12. **Operculina angustiloba** sp. nov.

Similar to *O. Roseana*, but more slender; leaf-blades more elongate in outline, primarily 3-lobed, the middle lobe with 2 lateral lobes at or near its base, the lobes linear, entire, somewhat emarginate, the middle lobe 3–5 cm. long, 1.5–2 cm. wide, the lateral lobe 0.5–3 cm. long and usually narrower than the middle lobe with small lateral segments near the middle in addition to those at the base: peduncles 6–8 cm. long, bracts linear-lanceolate, 5–6 mm. long; pedicels thickened above, 2.5–4 cm. long: sepals 10–13 mm. long, greenish, tinged with purple above: corolla-limb somewhat broader than *O. Roseana*, 4–5 cm. broad, the margin subentire, the plicae hirsute without with black hairs.

SAN LUIS POTOSI: San Dieguito, *Dr. Edward Palmer 112*, June 13–16, 1904; type in the National Herbarium.

13. **Operculina Palmeri** (S. Wats.)

Ipomoea Palmeri S. Wats. Proc. Am. Acad. **24**: 63. 1889.

Type locality: Guaymas, Sonora [Mexico], *Dr. Edward Palmer 75*, 1887 (type).

Distribution: Stream beds and ravines, Sonora, Mexico.

14. **Operculina platyphylla** (Fernald)

Ipomoea Palmeri platyphylla Fernald, Proc. Am. Acad. **33**: 90. 1897.

Resembling *O. Palmeri*, but the stems smoother, leaflets broader, more obtuse at the ends; peduncles often many-flowered; corolla longer than in *O. Palmeri*.

Type locality: Acapulco, Guerrero [Mexico], *Dr. Edward Palmer 415*, 1894–95 (type).

15. **Operculina aegyptia** (L.)

Ipomoea aegyptia L. Sp. Pl. 162. 1753.
Convolvulus pentaphyllus L. Sp. Pl. ed. 2. 233. 1762.
Ipomoea pentaphylla Jacq. Coll. **2**: 297. 1788.
Ipomoea pilosa Cav. Ic. **4**: 11. 1797. Not *I. pilosa* Sweet.
Convolvulus nemorosus Willd. in R. & S. Syst. **4**: 303. 1819.
Spiranthera pentaphylla Bojer, Hort. Maurit. 226. 1837.
Batatas pentaphyllus Choisy, Conv. Or. 54. 1834.—In DC. Prodr. **9**: 339. 1845.

Type locality: Tropical America.

Distribution: West Indies; central and southern Mexico to Brazil and Peru. Tropics of the old world.

Illustrations: Herm. Lugdb. *pl. 185*.—Jacq. Coll. **2**: *pl. 319*.—Wight, Ill. Ind. Bot. *pl. 7*.—Cav. Ic. **4**: *pl. 323*.—Wight, Ic. *pl. 834*.

The commonly accepted name for this species, *Ipomoea pentaphylla* (L.) Jacq., is plainly antedated by the Linnaean name *I. aegyptia*. Linnaeus did here what he frequently did in the case of other species, *i. e.*, he changed the name of the species in the second edition of the Species Plantarum from that of the first edition. The two Linnaean names are shown to be synonymous by the same pre-Linnaean citations given under both.

In addition to the fifteen species of North America the following two species are found on the western coast of tropical South America and may occur in Central America:

Operculina ampliata (Choisy)

Ipomoea ampliata Choisy, in DC. Prodr. **9**: 361. 1845.
Type locality: "Campeche, ins. oceani Pacifici."

Operculina codonantha (Benth.)

Ipomoea codonantha Benth. Pl. Hartw. 120. 1843.
Type locality: "In sylvis prope Guayaquil."

SPECIES INQUIRENDAE

Operculina Pavoni Hallier f. Bot. Jahrb. **16**: 550. 1893. "Nova Hispania; Pavon, in herb. Boiss."

INDEX TO AMERICAN BOTANICAL LITERATURE
(1906)

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

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

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Abrams, L. R. Two new southwestern species of *Pentstemon*. Bull. Torrey Club **33**: 445, 446. 30 Au 1906.

Arthur, J. C. Eine auf die Struktur und Entwicklungsgeschichte begründete Klassifikation der Uredineen. Result. Sci. Congr. Internat. Bot. Wien 331–348. 1906.

Includes diagnoses of 16 new genera.

Arthur, J. C. & Kern, F. D. North American species of *Peridermium*. Bull. Torrey Club **33**: 403–438. 30 Au 1906.

Thirty species are recognized, of which 10 are described as new.

Bay, J. C. Contributions to the theory and history of botanical bibliography. Bibl. Soc. Am. Proc. **1**: 75–83. Ap 1906.

Berry, E. W. Living and fossil species of *Comptonia*. Am. Nat. **40**: 485–520. *pl. 1–4.* 11 Jl 1906.

Blanchard, W. H. Two new and somewhat anomalous blackberries. Torreya **6**: 117–120. 20 Je 1906.

Rubus permixtus sp. nov. and *R. frondisentis* sp. nov.

Blanchard, W. H. Two new dewberries of the *Hispidus* group. Torreya **6**: 147–149. 25 Jl 1906.

Rubus jacens sp. nov. and *R. cubitans* sp. nov.

Britton, E. G. Notes on nomenclature VI. Bryologist **9**: 37–40. 3 My 1906. [Illust.]

Britton, N. L. *Galactia Odonia* Griseb. Torreya **6**: 149. 25 Jl 1906.

Buchenau, F. *Juncaceae.* Das Pflanzenreich 4^{36}: 1–284. *f. 1–121.* 15 My 1906.

Campbell, D. H. Germination of the spores of *Ophioglossum.* Ann. Bot. **20**: 321. Jl 1906.

Campbell, D. H. Multiple chromatophores in *Anthoceros.* Ann. Bot. **20**: 321. Jl 1906.

Cockerell, T. D. A. The fossil fauna and flora of the Florissant (Colorado) shales. Univ. Colo. Stud. **3**: 157–176. *f. 1–7.* Je 1906.

Collins, F. S. New species, etc., issued in the Phycotheca Boreali-americana. Rhodora **8**: 104–113. 28 Je 1906.

Collins, F. S. Notes on algae,—VII. Rhodora **8**: 122–126. 28 Jl 1906.

Collins, J. F. Mounting mosses—some hints. Bryologist **9**: 60–63. 2 Jl 1906.

Collins, J. F. Preliminary lists of New England plants,—XIX. Rhodora **8**: 131–135. 28 Jl 1906.

Buxbaumiaceae, Georgiaceae, Polytrichaceae.

Cook, M. T. Tropical epiphytes. Plant World **9**: 192–194. *f. 28.* [S] 1906.

Cushman, J. A. New England desmids of the sub-family *Saccodermae.* Bull. Torrey Club **33**: 343–351. 20 Jl 1906.

With new species and varieties in *Gonatozygon, Spirotaenia, Mesotaenium,* and *Cylindrocystis.*

Dalla Torre, K. W. von & Harms, H. Genera *Siphonogamarum* ad systema Englerianum conscripta. 8: 561–640. 1906.

Davenport, E. B. The apetalous form of *Arenaria groenlandica* on Mt. Mansfield. Rhodora **8**: 114. 28 Je 1906.

Douglas, G. E. The rate of growth of *Panaeolus retirugis.* Torreya **6**: 157–165. *f. 1–4.* 25 Au 1906.

Eastwood, A. The earthquake and the California Academy of Sciences. Torreya **6**: 120–123. 20 Je 1906.

Farr, E. M. Some new plants from the Canadian Rockies and Selkirks. Ottawa Nat. **20**: 105–111. 15 Au 1906.

New species are described in *Pachystima* (3), *Arnica, Hieracium, Dryas,* and *Ranunculus.*

Fernald, M. L. The identity of *Eriophorum Chamissonis* and *E. russeolum.* Ottawa Nat. **20**: 62–65. 4 Je 1906.

Fernald, M. L. A new variety of *Carex interior.* Rhodora **8**: 114, 115. 28 Je 1906.

Fernald, M. L. *Paronychia argyrocoma* and its New England representative. Rhodora **8**: 101–104. 28 Je 1906.

Fernald, M. L. Some new or little known *Cyperaceae* of eastern North America. Rhodora **8**: 126–130. 28 Jl 1906.

Includes descriptions of new species in *Cyperus* (2) and *Eleocharis*.

Fink, B. Further notes on cladonias. VII. *Cladonia subcariosa*, *Cladonia mitrula*, and *Cladonia leptophylla*. Bryologist **9**: 57–60. *pl. 4.* 2 Jl 1906.

Fink, B. The gynaecocentric theory and the sexes in plants. Plant World **9**: 179–185. [S] 1906.

Foslie, M. Den botaniske samling. K. Norske Vid. Selsk. Aarsb. **1905**: — (1–8). 1906.

Includes descriptions of new species in *Phymatolithon* and *Lithophyllum* (3), from the Pacific coast of North America.

Frye, T. C. *Nereocystis luetkeana.* Bot. Gaz. **42**: 143–146. *f. 1.* 30 Au 1906.

Ganong, W. F. The nascent forest of the Miscou beach plain. Bot. Gaz. **42**: 81–106. *f. 1–14.* 30 Au 1906.

Gilbert, B. D. Two anomalies and a curious sight. Bryologist **9**: 72. 2 Jl 1906.

Gleason, H. A. The pedunculate species of *Trillium*. Bull. Torrey Club **33**: 387–396. 1 Au 1906.

Two species are described as new.

Greene, E. L. Doctor Torrey and *Downingia*. Torreya **6**: 145–147. 25 Jl 1906.

Greene, E. L. Four streptanthoid genera. Leaflets **1**: 224–228. 8 S 1906.

Disaccanthus, *Cartiera*, *Guillenia*, and *Agianthus*, all proposed as new.

Greene, E. L. The genus *Batanthes*. Leaflets **1**: 224. 8 S 1906.

Greene, E. L. The genus *Leiostemon*. Leaflets **1**: 223. 8 S 1906.

Greene, E. L. The genus *Ptelea* in the western and southwestern United States and Mexico. Contr. U. S. Nat. Herb. **10**: i–v. 49–78. i. 16 Jl 1906.

Recognizes 59 species, of which 55 are described as new.

Greene, E. L. A new genus of *Rutaceae*. Leaflets **1**: 222, 223. 8 S 1906.

Taravalia, a segregate from *Ptelea*.

Greene, E. L. New western plants. Leaflets **1**: 221, 222. 8 S 1906.

Descriptions of new species in *Senecio* (3) and *Erigeron*.

Greene, E. L. Revision of the genus *Wislizenia.* Proc. Biol. Soc. Wash. **19**: 127–132. 6 S 1906.

Ten species are recognized, of which 7 are described as new.

Greene, E. L. Some Canadian antennarias.—III. Ottawa Nat. **20**: 71, 72. 5 Jl 1906.

Includes descriptions of 2 new species in *Antennaria.*

Greenman, J. M. Two new species from northwestern America. Bot. Gaz. **42**: 146, 147. 30 Au 1906.

Castilleja purpurascens sp. nov. and *Senecio Farriae* sp. nov.

Grout, A. J. Bryological notes. Bryologist **9**: 42–46. *pl. 3.* 3 My 1906.

Includes a description of *Burnettia fabrofolia* sp. nov.

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Hackel, E. Ueber Kleistogamie bei den Gräsern. Oesterr. Bot. Zeits. **56**: 81–88. Mr 1906; 143–154. Ap 1906; 180–186. Je 1906.

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Heller, A. A. Western species, new and old—V. Muhlenbergia **1**: 132–138. 24 Ap 1906;—VI. Muhlenbergia **1**: 144–147. 30 Jl 1906.

Includes descriptions of new species in *Ribes*, *Trifolium* (2), *Navarretia* and *Anaphalis.*

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Holm, T. *Eriophorum russeolum* Fr. versus *E. Chamissonis* C. A. Mey. Ottawa Nat. **20**: 62. 4 Je 1906.

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C. sericatus sp. nov., from Georgia.

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D. occidentalis, from Southern California and Lower California.

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Including a description of *Viola redunca* sp. nov.

House, H. D. The violets and violet hybrids of the District of Columbia and vicinity. Rhodora **8**: 117–122. *pl. 71, 72.* 28 Jl 1906.

Howe, R. H. *Ramalina rigida* in Massachusetts. Bryologist **9**: 54. 3 My 1906.

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Jeffrey, E. C. & Chrysler, M. A. On Cretaceous *Pityoxyla*. Bot. Gaz. **42**: 1–15. *pl. 1, 2.* 28 Jl 1906.

Jennings, O. E. Additions and corrections to the list of the vascular flora of Allegheny County, Pa. Ann. Carnegie Mus. **3**: 473–479. Jl 1906.

Jennings, O. E. A new species of *Ibidium* (*Gyrostachys*). Ann. Carnegie Mus. **3**: 482–486. *pl. 20.* Jl 1906.

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K. Sumstinei, from Pennsylvania.

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Lawrence, W. H. Apple scab in eastern Washington. Wash. Agr. Exp. Sta. Bull. 75: 1–14. 1906.

Lloyd, F. E. Palo verde: the evergreen tree of the desert. Plant World **9**: 165–171. *f. 22–25.* [Au] 1906.

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Descriptions of 4 new species.

Mackenzie, K. K. *Ranunculus sicaeformis* Mackenzie & Bush, sp. nov. Torreya **6**: 123. 20 Je 1906.

Maxon, W. R. Report on a collecting trip in Costa Rica. Jour. N. Y. Bot. Gard. **7**: 187–193. *f. 23, 24.* Au 1906.

Merkel, H. W. A deadly fungus on the American chestnut. Ann. Rep. N. Y. Zool. Soc. **10**: 97–103. Ja 1906. [Illust.]

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Moore, C. L. The *Myxomycetes* of Pictou County [Nova Scotia]. Bull. Pictou Acad. Sci. Assoc. **1**: 11–16. Je 1906.

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Nelson, A. Contributions from the Rocky Mountain Herbarium VII. Bot. Gaz. **42**: 48–54. 28 Jl 1906.

Includes descriptions of 14 new species in 11 genera.

Osterhout, G. E. Colorado notes: descriptions of new species. Muhlenbergia **1**: 139–143. 30 Jl 1906.

Eight new species in as many genera.

Osterhout, W. J. V. On the importance of physiologically balanced solutions for plants. I. Marine plants. Bot. Gaz. **42**: 127–134. 30 Au 1906.

Peirce, G. J. *Anthoceros* and its *Nostoc* colonies. Bot. Gaz. **42**: 55–59. 28 Jl 1906.

Piper, C. V. North American species of *Festuca.* Contr. U. S. Nat. Herb. **10**: i–ix. 1–49. *pl. 1–15.* 30 Mr 1906.

Includes descriptions of 5 new species.

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Native of Chile.

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BULLETIN

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OCTOBER, 1906

New species of Uredineae — V

Joseph Charles Arthur

The following new species are presented as the result in part of critical study of general herbarium material and in part of recent collections kindly sent by the collectors or otherwise communicated. For the new material I am indebted to Messrs. E. W. D. Holway, P. H. Rolfs, C. F. Baker and Ernst A. Bessey, and extend hearty thanks for the same. The species come from various parts of western Canada, western and southern United States, Mexico and the West Indies. The assortment of species is more than usually interesting, as it embraces some belonging to little-known genera, and some that clarify knowledge of common forms.

In the preceding number of this series occur two errors needing correction. *Puccinia Dolichi* (Bull. Torrey Club **33**: 28) is an unwarranted name. Only the uredinia of the description belong to the species, the teliospores being yet unknown; but as the rust is on a leguminous host, they are more likely when found to belong to *Uromyces* than to *Puccinia*. The teliospores of the description, as pointed out recently by the collector, were stray spores from some Mexican euphorbiaceous plant transferred to the Cuban specimens by means of the drying papers. Until the teliospores are discovered it might be well to call the Cuban rust on *Dolichos*, **Uredo Dolichi.**

The second error is orthographical, and requires the substitution of *o* in place of *a* in the new generic name (*loc. cit.* page 30),

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[The Bulletin for September 1906 (33: 455–512) was issued 5 O 1906.]

which should read *Cerotelium.* The derivation is from *κηρός*, wax, and *telium* (from *τέλος*).

There are also errors in the recent paper on "North American species of *Peridermium*," by Arthur and Kern, published in the August number of this journal, which might be pointed out here. The host of *Peridermium Holwayi* (*loc. cit.* page 431) proves to be *Abies lasiocarpa* (Hook.) Nutt. This was ascertained by Professor Holway, who visited the type locality in August of this year in company with Mr. F. K. Butters, who knows the trees of the region well, and found that there can be no question regarding the error in the original determination. *Abies lasiocarpa* and *Pseudotsuga mucronata* have a similarity of appearance which makes it quite easy to mistake one for the other. It was found, however, that while the *Abies* is abundant in the type locality, the *Pseudotsuga* is entirely absent, although it does occur on slopes of the same mountains at a lower altitude. As no *Peridermium* has yet been correctly reported on *Pseudotsuga*, the lines referring to this host on page 411 should be cancelled, and the species with its corrected host transferred to the top of the next page to follow *P. pseudo-balsameum.* In the first column of the table, on page 405, *Abies* should be substituted for *Pseudotsuga.* Besides this, there is an erroneous citation of a host under *Peridermium Cerebrum*. On page 424 the three lines referring to *Pinus ponderosa* should be stricken out.

Uromyces Eleocharidis sp. nov.

II. Uredinia amphigenous, scattered, oblong, 0.3–1.5 mm. long, tardily dehiscent by one or more longitudinal slits, dark cinnamon-brown; urediniospores oblong to broadly oval, 15–19 by 19–29 μ, wall golden-yellow, medium thin, 1–1.5 μ, sparsely and finely echinulate; pores usually 3, approximately equatorial or superequatorial.

III. Telia amphigenous, thickly scattered, oblong, 0.5–2 mm. or more long, tardily dehiscent by longitudinal slits, chocolate-brown; teliospores angularly obovate, truncate or rounded above, narrowed below, 16–22 by 27–45 μ, wall light chestnut-brown, medium thin, 1–1.5 μ, thicker above, 7–10 μ, smooth; pedicel tinted, about one to one and a half times length of spore.

On *Eleocharis palustris* (L.) R. & S., Aberdeen, South Dakota, September, 1897, *David Griffiths* (West American Fungi *no. 60a,* type); Armstrong, Iowa, July 17, and August, 1886, *R. I. Cratty;* Rooks County, Kansas, December 7, 1894, *E. Bartholomew;* Racine, Wisconsin, October 27, 1901, *J. J. Davis;* Spirit Lake, Iowa, April 7, 1902, *J. C. Arthur;* Stockton, Kansas, March 7, 1906, *E. Bartholomew.* This rust has been known for some time, and has been listed under *Uromyces Junci.* It differs from that species, however, in a number of inconspicuous but positive characters. Comparing it with *U. Junci*, the dehiscence of the sori is brought about by longitudinal slitting of the overlying epidermis, and not by falling away of the epidermis, while the urediniospores are more inclined to oblong, with thinner walls, and a wholly unlike arrangement of the germ-pores. The teliospores are much alike in both species. When *Eleocharis* and *Juncus* stems are deprived of their upper and lower portions, as in most cryptogamic collections, they are quite similar in appearance, and not infrequently misnamed. They can be distinguished, however, by a cross-section of the stem, which in *Juncus* will show a rather uniform central pith, and in *Eleocharis* a number of large lacunae.

Uromyces insularis sp. nov.

II. Uredinia amphigenous, scattered, small, round, 0.1–0.4 mm. across, soon naked, dark cinnamon-brown, ruptured epidermis noticeable; urediniospores globoid, 19–23 by 23–25 μ, wall golden-brown, 1–1.5 μ thick, sparsely echinulate with conical points about 3 μ apart; pores 3, equatorial.

III. Telia amphigenous, scattered or oval, 0.2–0.8 mm. across, soon naked, light cinnamon-brown, ruptured epidermis noticeable; teliospores broadly lanceolate, rounded or obtuse at both ends, 15–18 by 29–39 μ, wall golden-yellow, thin, about 1 μ, apex usually bearing a hyaline umbo, 3–7 μ thick; pedicel hyaline, short, deciduous.

On *Clitoria cajanifolia* (Presl) Benth., near Dorado, Porto Rico, May 19, 1887, *I. Urban.* This species was found on sheet *no. 80339* of the phanerogamic herbarium of the Field Columbian Museum. Thanks are due the officers of the Museum for their kindness in permitting the writer to examine the collection for rusts. The species is very unlike *Uromyces Clitoriae* Arth., from Mexico, which has ellipsoid teliospores with thick, verrucose walls.

Puccinia inflata sp. nov.

O. Pycnia hypophyllous, crowded in orbicular groups, punctiform, prominent, pale yellowish or brownish, subepidermal, irregularly globoid, 100–120 µ; sterigmata large.

II. Uredinia chiefly hypophyllous, scattered or gregarious, roundish, small, 0.1–0.3 mm. across, soon naked, somewhat pulverulent, cinnamon-brown, ruptured epidermis inconspicuous; urediniospores broadly obovate or ellipsoid, 21–25 by 26–33 µ, wall cinnamon-brown, medium thick, 1.5–2 µ, sparsely and sharply echinulate; pores 3 or 4, usually scattered, rarely equatorial.

III. Telia amphigenous, scattered or gregarious, roundish, small, 0.1–0.5 mm. across, soon naked, somewhat pulverulent, chocolate-brown, ruptured epidermis slightly evident; teliospores ellipsoid, 23–26 by 29–34 µ, rounded at both ends, slightly or not constricted at septum, wall chocolate-brown, uniformly thick, 4–5 µ, conspicuously reticulate, areolae 2–3 µ across; pedicel often attached more or less obliquely, colorless, once and a half to twice length of spore, with globose enlargement near the spore, which swells in water to 20–25 µ across.

On *Stigmatophyllon periplocifolium* (Desf.) Juss., Baracoa, Cuba, March 13, 1903, *E. W. D. Holway* (type); near Cayamas, Santa Clara Province, Cuba, October 13, 1904, *C. F. Baker 3538*. There is much similarity between this species and *Puccinia Echinopteridis* Holw. from Mexico. It has, however, smaller sori throughout, with more ellipsoid and smaller teliospores borne on longer and more slender pedicels. The surface-markings appear to be the same in the two species.

Puccinia Tridacis sp. nov.

O. Pycnia wanting.

III. Telia hypophyllous, numerous, small, 0.2–0.5 mm. across, scattered, or often gregarious and confluent in circinating groups 2–5 mm. across, early naked, ruptured epidermis inconspicuous, pulverulent, chestnut-brown; teliospores oblong or narrowly oblong, rounded or obtuse at apex, obtuse or narrowed at base, 13–17 by 40–58 µ, wall golden-brown, smooth, about 1 µ, thicker at apex, 6–10 µ, pedicel colorless, short, about one half length of spore.

On *Tridax procumbens* L., Punta Brava, Cuba, November 15, 1904, *Baker & O'Donovan 4039*. A leptopucciniaceous rust of the macroscopic appearance of *Puccinia Xanthii*.

Melampsora albertensis sp. nov.

II. Uredinia hypophyllous, numerous, scattered, round, 0.2–0.4 mm. across, early naked, pulverulent, pale-yellow, ruptured epidermis noticeable; paraphyses numerous, intermixed with the spores, clavate, 9–15 by 67–90 μ, wall colorless, 3–5 μ thick, smooth, stipe solid; urediniospores flattened laterally, when seen from the broad side broadly-elliptical, 16–19 by 23–27 μ, when seen from the narrow side oblong, 13–15 by 23–27 μ, wall colorless, 1.5–2 μ, much thickened on the flattened sides, 2.5–3.5 μ, evenly and sparsely verrucose-echinulate, without smooth spots.

III. Telia hypophyllous, numerous, small, irregular, often confluent, usually crowded in more or less extensive groups about the uredinia, subepidermal, waxy, orange-brown; teliospores prismatic, 10–13 by 29–39 μ, wall golden-brown, smooth, thin, about 1 μ, thicker above, 2–3 μ, with an evident apical germpore.

On *Populus tremuloides* Michx., Moraine Lake, Laggan, Alberta, Canada, September, 1906, *E. W. D. Holway*. An interesting species, being the second one on *Populus* recorded for America. It differs from the common species in the smaller urediniospores which have no smooth spot, and in having the teliospores slightly thickened above. The gross appearance of the fungus is also somewhat different.

Uredo biocellata sp. nov.

II. Uredinia amphigenous, scattered, round, large, 0.75–1.5 mm. across, subepidermal, without paraphyses or peridium, early naked, pulverulent, light chocolate-brown, ruptured epidermis noticeable; urediniospores broadly ellipsoid or obovate-globoid, 23–27 by 27–32 μ, wall light chestnut-brown, 1.5–2 μ thick, coarsely echinulate, depressed over the 2 opposite pores, but with the cuticle greatly inflated, nearly colorless, smooth, forming bullate areas 18–25 μ in diameter.

On *Pluchea purpurascens* (L.) DC., Florida Keys, 1898, *C. L. Pollard 143*. The inflated sides of the spores give them a conspicuously odd and distinctive appearance.

Uredo Holwayi sp. nov.

O. Pycnia hypophyllous, numerous, scattered, inconspicuous, subcuticular, pale-yellow, becoming brownish, frustum-like or sometimes columnar, 80–112 μ in diameter by 40–70 μ high.

II. Uredinia from a limited mycelium, hypophyllous, in two rows, on yellow spots occupying part or all of a leaf, subepidermal, roundish or oval, 0.1–0.3 mm. across, brownish-yellow, dehiscent by a small central orifice, ruptured epidermis not noticeable; peridium hemispherical, consisting of appressed hyphae, free at the orifice where they are 10–14 μ in diameter, with walls 3–4 μ thick; urediniospores borne singly on pedicels, broadly ellipsoid or obovate, 15–19 by 21–26 μ, wall nearly colorless, medium thick, 1.5–2.5 μ, strongly echinulate below with sharp points 1.5–2.5 μ apart, smooth above; pores obscure; contents orange-yellow when fresh.

On leaves of *Tsuga Mertensiana* (Bong.) Carr., Glacier, British Columbia, August 13, 1906, *E. W. D. Holway*. A unique rust for which no genus seems rightly constituted. It is physiologically an aecium, and possesses a peridium, but cannot be called *Aecidium* because the spores are borne singly on pedicels instead of being catenulate. In gross appearance it resembles an over-mature *Peridermium Peckii*, which has lost its protruding peridial cells. Its peridium, however, is not made up of distinct cells, as in *Peridermium*, but of compacted filaments, the ostiolar ends of which resemble paraphyses. The spores show considerable similarity to those of *Kuehneola*, and the pycnia also, but are still more like the pycnia of *Gymnoconia*. From these resemblances, the subcuticular pycnia, and other structural features, we may conclude that this is a heteroecious form, having Melampsora-like teliospores on some rosaceous host, or a host belonging to some small family. It may be furthermore assumed, in accordance with the general relationship pointed out by Tranzschel, that the telia will resemble those of the so-called *Chrysomyxa Abietis* on *Tsuga canadensis*, found in Massachusetts, and that the new genus will be closely related to *Pucciniastrum*.

Uredo Chaetochloae sp. nov.

II. Uredinia amphigenous, numerous, oblong to linear-oblong, about 0.1 mm. wide, 0.5–2 mm. or more long, soon dehiscent by a longitudinal rupture, dark cinnamon-brown, ruptured epidermis conspicuous; urediniospores broadly ellipsoid, 21–29 by 29–42 µ, wall chestnut-brown, 1.5–2 µ thick, sparsely and strongly echinulate with sharp conical points about 3 µ apart; pores 3, equatorial.

On *Chaetochloa macrosperma* Scribn. & Mer., Miami, Florida, March 25, 1903, *E. W. D. Holway* (type); May 15, 1906, *Ernst A. Bessey 41.* The sori of both collections are black, due to a fungous parasite. No teliospores could be found. The uredinia resemble those of *Puccinia atra* D. & H., but the spores are larger with echinulate instead of verrucose surface.

Caeoma strobilina sp. nov.

O. Pycnia conicolous, preceding and among the aecia, arising beneath the cortical layers, flattened, in more or less continuous layers, 130–160 µ high.

I. Aecia conicolous, subcorticular, usually covering the entire surface, causing hypertrophy, the scales becoming solidly united and turning prematurely reddish-brown; peridium wanting; aeciospores narrowly ellipsoid or broadly lanceolate, rarely globoid or obovoid, often attenuate below, 12–19 by 29–50 µ, wall colorless, about 1.5 µ thick, rather coarsely verrucose, with a smooth spot at base.

On cones of *Pinus palustris* Mill., East Palatka, Florida, May 30, 1906, *P. H. Rolfs* (type); *Pinus Taeda* L., Dunedin, Florida, June 20, 1901, *S. M. Tracy 7324;* Lake City, Florida, May 30 and July 10, 1906, *P. H. Rolfs.* This species, which appears not to be abundant, has probably been overlooked from its habit of growth on the cones of high trees, where it is generally inaccessible. The specimens, on which this description is based, were sent by Professor Rolfs in fresh condition. To him and to Mr. H. S. Fawcett, who ascended the trees for the type material, thanks are due for their enthusiastic search for specimens. Professor Rolfs reports seeing diseased cones, presumably of this species, in South Carolina between Charleston and Florence, as he journeyed on the Atlantic Coast Line Railway. When the cones are dead and dry, they usually fall to the ground, but then are so wormeaten and abnormal in appearance as to give little suggestion of bearing a rust. Such was the specimen sent by Professor Tracy, which was found on the ground. The fungus usually penetrates the whole cone, causing it to become much enlarged and of a brick-red color, being in strong contrast to the normal deep green of the immature cone. The scales of the cone become cemented together, and show no tendency to separate when mature and dry. After a time the sori open by breaking away the superposed tissues, and the whole surface is covered with the orange-yellow spores. As the cones become old and dry the powdery surface fades to white. There is no peridium, and consequently the species is not placed in the genus *Peridermium.* The species differs from *Caeoma conigenum* Pat., found in Mexico by P. Maury, in having spores with much thinner and less verrucose walls. There is much probability that these two species of *Caeoma* are the aecial forms of species of *Bubakia*, the rust on *Croton.* This is assumed from the fact that all known coniferous species of *Caeoma* belong to the *Uredinatae*, so far as their life histories have been ascertained. They have been previously collected only on leaves of *Abies* and *Larix* as aecia of species of the true genus *Uredo* (*Melampsora* of most authors). Two other American genera under this subfamily are known, *Physopella* and *Bubakia*, and of these the latter, judging by geographical distribution of its species, is the most likely to be associated with these species of *Caeoma* on *Pinus*, for the rust is so unlike those on *Abies* and *Larix* that it is not likely to belong to the same telial genus.

Aecidium Herrerianum sp. nov.

O. Pycnia hypophyllous, in small groups, 1 mm. or more across, surrounded by aecia, inconspicuous, subepidermal, almost wholly immersed, honey-yellow becoming dark-brown, flask-shaped, 80–110 μ broad by 80–100 μ high; ostiolar filaments 40–55 μ long.

I. Aecia hypophyllous, gregarious, crowded, cylindrical, long; peridium pale-yellow, margin erect, lacerate, peridial cells rhomboidal, 32–48 μ long, considerably overlapping, outer wall much thickened, 10–15 μ, transversely striate, inner wall thinner, 4–5 μ, moderately verrucose; aeciospores globoid, often angular, large, 23–26 by 27–33 μ, wall pale cinnamon-brown, thick, 3–4 μ, moderately verrucose.

On *Senecio salignus* DC., Hacienda of San Joaquin, District of Tulancingo, State of Hidalgo, Mexico, May, 1906, *A. L. Herrera* of the Comision de Parasitologia Agricola; communicated by E.

W. D. Holway. A very conspicuous aecium on account of its long peridium, and the large, dark-colored spores.

Aecidium Sorbi sp. nov.

O. Pycnia epiphyllous, numerous, gregarious, in small groups on discolored areas, noticeable, subepidermal, honey-yellow becoming brownish, conoidal, 110–130 μ in diameter, 70–80 μ high; ostiolar filaments 30–45 μ long.

I. Aecia hypophyllous, numerous, gregarious, in small groups of 4 to 7, arising from slight swellings on discolored spots, or often more numerous on larger swellings on the veins or rachis, cupulate, 0.2–0.4 mm. high by 0.2–0.3 mm. across; peridium colorless, margin nearly erect, erose, peridial cells rhomboidal, 30–45 μ long, slightly overlapping, lumen small, outer wall much thickened, 10–13 μ, transversely striate, smooth, inner wall thinner, 3–5 μ, somewhat striate, moderately verrucose; aeciospores broadly ellipsoid, usually somewhat angular, 23–27 by 27–39 μ, wall colorless, thick, 3–4 μ, minutely verrucose.

On *Sorbus occidentalis* (Wats.) Greene, Hodag Lake, Vancouver Island, British Columbia, Canada, August 8, 1905, *F. K. Butters;* communicated by E. W. D. Holway. A very distinct species of *Aecidium*, and especially interesting as it is the second one so far known on a pomaceous host.

Aecidium pulverulentum sp. nov.

O. Pycnia epiphyllous, numerous, gregarious, in rather small indeterminate groups, not crowded, conspicuous, punctiform, subcuticular, becoming blackish-brown, hemispherical, 80–140 μ in diameter, 40–50 μ high; without ostiolar filaments; pycniospores numerous above a flat hymenium.

I. Aecia hypophyllous, numerous in indefinite groups, not much crowded, cylindrical, deep-seated, small, about 0.1 mm. in diameter, pulverulent; peridium colorless, evanescent, peridial cells rather thin, 30–45 μ long, overlapping, easily separating, outer wall smooth, inner wall rather coarsely verrucose; aeciospores angularly globoid or ellipsoid, or elongate-polyhedral, sometimes broader above, 23–29 by 24–32 μ, wall light cinnamon-brown fading to almost colorless, thick, 3–5 μ, much thicker above, 7–13 μ, noticeably and strongly verrucose.

On *Randia sp.*, Cuernavaca, State of Morelos, Mexico, October 30, 1903, *E. W. D. Holway 5275* (type); Chapala, State of

Jalisco, Mexico, October 5, 1903, *Holway 5115*. The two collections are apparently on different species of *Randia*. This is a peculiar form of rust. From the subcuticular pycnia, the unusually small aecia, and the strongly verrucose spores it is evident that it does not belong under the *Dicaeomatae*, *i. e.*, to any of the usual forms of *Puccinia* or *Uromyces*; but its true affinities are not apparent.

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Notes on the distribution of some Alabama plants

ROLAND M. HARPER

From November, 1905, to July, 1906, I was doing botanical field work for the Geological Survey of Alabama, and in the course of my travels over the state, which took me into nearly every county, I found many plants in unexpected places. Some of those discussed below have not been reported from Alabama before, but few are mentioned for that reason alone. The mere fact of extending the known range of a species a short distance across some political boundary or parallel of latitude, in a region where botanists are as scarce as they are in Alabama, is not ordinarily of sufficient importance to justify publishing it, but if at the same time some new light is thrown on the laws of distribution, then the case may be different. Several of the following species are here reported for the first time from natural regions which they were not previously known to occupy, which will necessitate more or less readjustment of existing theories of their distribution. Some notes of this kind from the northern part of the state, mentioning two species new to Alabama, were published in Torreya for June, 1906.

ANCHISTEA VIRGINICA (L.) Presl (*Woodwardia* J. E. Smith)

Hitherto this has been known only in the glaciated region and coastal plain of the Eastern United States,* but last spring I found it in damp woods in the Coosa valley near Center, in Cherokee County, and in the metamorphic (eastern) part of Chilton County, a few miles from the same river. Although the finer details of geological history in the southeastern states are still very imperfectly known, there are several reasons for believing that much of the country adjacent to the Coosa River throughout its length was submerged beneath the sea during the Tertiary period, or later, and the vegetation of this area must therefore be much newer than that of most of the Metamorphic and Palaeozoic terranes.

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* See Rhodora 7: 71. 1905.

PINUS SEROTINA Michx.

In Georgia this pine can be found almost anywhere in the coastal plain except in the lime-sink region, but the only previous record of its occurrence in Alabama which I have come across is on page 192 of Mohr's Plant Life, where it is cited as the host of a fungus collected in Lee County by Professor Atkinson. (And even this is an error, according to Arthur and Kern.)* Last winter I found this tree in Chilton County near Thorsby, in Autauga between Prattville and Booth (these two localities being in the region of the Tuscaloosa formation, corresponding approximately with the fall-line sand-hills of Georgia and the Carolinas), in the southeastern corner of Dale, and at several places in Houston, Geneva and Covington (the last three counties being in the pine-barren region, along the southern border of the state). There can be little doubt that it will eventually turn up in many other places in the southeastern quarter of the State. Just what keeps it from extending farther west I am unable to say.

In the last chapter of the revised edition of Mohr's Timber Pines of the Southern United States (1897) is an excellent summary of the known distribution of this species up to that time, by Dr. F. Roth.

TSUGA CANADENSIS (L.) Carr.

Geographical names are sometimes of considerable assistance in discovering little known geological, botanical or historical facts. The name "spruce pine" is applied by the natives to several different coniferous trees in the South, but in the mountains it usually means either *Tsuga canadensis* or *Pinus virginiana*. On March 30 last I happened to be passing through the village of Spruce Pine, in Franklin County, and not seeing any of the latter species in the vicinity, and being out of the known range of *Tsuga*, I inquired as to the origin of the name, and was told that it was derived from a tree similarly named, more rarely called hemlock, which grew wild near by, some of it being within a mile to the westward. Having about an hour to spare before train-time, I hastened in the direction indicated, following down a branch †

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* Bull. Torrey Club 33: 415. August, 1906.

† See Ann. N. Y. Acad. Sci. 17: 24 (footnote). 1906.

which headed near the station, and after going a little over a mile found a group of four trees on the steep bank of the branch. On my return to the station with the desired specimens I was told further that the species extends down the same stream about twenty miles (which would bring it almost to the Mississippi line), and that some of the specimens are three or four feet in diameter.

Tsuga canadensis is known from only two other counties in Alabama, namely, Winston, where it was found by Judge Peters and Dr. Mohr,* and Jackson, where Mr. Harbison reported it a few years ago. † All of the Alabama stations are on the sandstone rocks of the Coal Measures, and not far from 1,000 feet above sea-level.

TAXODIUM DISTICHUM (L.) Rich.

It was quite a surprise to find this tree growing on granite rocks along and in the shoals of the Tallapoosa River for a mile or two above the fall-line at Tallassee, amid typical Piedmont region scenery, with not a trace of any coastal plain deposits in sight; for it is almost confined to the coastal plain, and to calcareous formations. I measured one specimen 33 inches in diameter above the enlarged base. With it were several other species of somewhat similar distribution, but I did not have time to ascertain how far up the river any of them extended. To explain their occurrence there will require a knowledge of some details of geological history which are as yet unwritten; but the plants themselves may be expected to furnish important clues when the laws of their distribution are better understood.

SCIRPUS CARINATUS (H. & A.) Gray

Dr. Mohr knew of no definite Alabama station for this species, but last spring I found it to be a common weed along damp roadsides, etc., in or near Tuscaloosa, Auburn, Tuskegee, Prattville, Elmore, Clanton and Maplesville. It flowers in April, and is probably more difficult to recognize at other seasons of the year. It is evidently introduced, and its natural range is yet to be determined.

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* See his remarks on this species on pages 34 and 72 of his Plant Life of Alabama.

† Biltmore Bot. Stud. 1: 154. 1902.

SCIRPUS GEORGIANUS Harper, Bull. Torrey Club 27: 331. *pl. 22.* 1900

Quite abundant in a marshy place near Wellington, Calhoun County (in the Palaeozoic region), May 17, in flower. Previously known only from two or three places in Middle Georgia.* During the same month I saw from trains in Tuscaloosa and one or two other counties what is probably the same species, though some of it may have been *S. atrovirens* Muhl., which is likewise unrecorded from Alabama.

RYNCHOSPORA SEMIPLUMOSA Gray

As this species was originally described from Louisiana and is common in the pine-barrens of Georgia, it was to be expected in Alabama. In June I found it in moist pine-barrens within a few miles of Geneva and Andalusia.

CAREX PICTA Steud.

This has always had the reputation of being rare, but probably chiefly because it flowers in March, when not many botanists are stirring in the regions where it grows. Last spring I found it in six counties, namely, Lauderdale, Colbert, Marshall, Blount, Walker and Fayette. Dr. Mohr knew it only from Winston. Its usual habitat is on shaded bluffs of the Coal Measures and other non-calcareous Carboniferous strata.

RHAPIDOPHYLLUM HYSTRIX (Pursh) Wendl. & Drude

This has been known to Alabama botanists from only one station, in the vicinity of Auburn. On a visit to Evergreen, in Conecuh County, last December, I found that it forms an important asset of the shippers of Christmas decorations at that place,† so I instituted a search for it in the vicinity, and found it at two places a few miles apart. On a remote and almost inaccessible island in a creek swamp, which the evergreen hunters must have so far overlooked, were many fine specimens. In June I saw a few leaves being carried in a

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* See Bull. Torrey Club **28**: 466. 1901. — Later. Mr. Fernald (in Rhodora **8**: 163–164. 1906) has just announced a much wider distribution for it.

† See Country Life in America **7**: 171–176. Dec., 1904. The palms in the picture in the lower left-hand corner of the first page are *Rhapidophyllum*.

buggy which I met a few miles from Greenville, in the next county above, but I did not learn where they were gathered. It is rather unfortunate that this species should be in demand for decorative purposes, for it is the rarest palm in the Eastern United States outside of subtropical Florida, and it is liable to be exterminated from some places before the laws of its distribution can be fully worked out.

Dryopteris floridana, which likewise has been reported in Alabama only from the vicinity of Auburn, is also shipped from Evergreen for the same purpose, but I did not succeed in finding any of it growing.

ERIOCAULON LINEARE Small

On May 15th a few specimens were noted in a boggy place in the Coosa valley about two miles from Center, in Cherokee County, together with *Anchistea virginica* and several other species rarely seen outside of the coastal plain. It was previously known only from the pine-barrens of Georgia.*

LUZULA SALTUENSIS Fernald

(*Juncoides pilosum* of other recent American authors)

This has much the same habitat as *Carex picta*, and flowers at the same time. I noted it last spring in Lauderdale, Colbert, Fayette, Tuscaloosa, Cleburne and Chilton Counties, all in the upper half of the state, in the Palaeozoic and Metamorphic regions. It is not mentioned in Mohr's Plant Life or in Earle's Flora of the Metamorphic Region of Alabama.†

TILLANDSIA USNEOIDES L.

Professor Earle ‡ reported this as having been all killed in the Metamorphic region of Alabama by the freeze of February, 1899; but I was gratified to find last April that his estimate of the damage was somewhat exaggerated. There is a good deal of this plant growing on trees among the granite cliffs along the Tal-

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* See Bull. Torrey Club 32: 461–463. 1905.

† For notes on its occurrence in Georgia see Bull. Torrey Club 27: 324, 325. 1900; 32: 154, 452. 1905.

‡ Bull. Ala. Agric. Exp. Sta. 119: 63. 1902.

lapoosa River near Tallassee (the same locality mentioned above in connection with *Taxodium distichum*). Many of the specimens observed there and in the neighboring Cretaceous region are dead, however, and it is probable that those now living came from seeds which managed to survive the freeze.

The occurrence of this species there at all was somewhat of a surprise, for it is almost confined to the coastal plain, barely entering the Metamorphic region for a couple of miles at its extreme southern edge in Georgia and Alabama, about latitude 32° 30′. Just why the inland edge of the range of an epiphyte should so nearly coincide with a geological boundary is an unsolved problem. It is significant in this connection that it shows a decided preference for trees growing in calcareous soil (as was noted by Dr. Hilgard in Mississippi in 1860 and by Dr. Smith in Alabama in 1894); but the reason for this is equally obscure.

UVULARIA FLORIDANA Chapm.

Collected in the bottoms of Catoma Creek about five miles southwest of Montgomery, April 23, 1906. This species is not mentioned by Dr. Mohr, but there is a specimen in the Torrey Herbarium collected by Buckley in May, 1841, in Alabama, locality not specified, but presumably in Wilcox County, like most of Buckley's other Alabama plants.*

MYRICA CAROLINENSIS Mill.

In habitat and distribution this is very similar to *Anchistea virginica*, already mentioned.† In Alabama I have noted it in eight coastal plain counties, also in sandy bogs in Marshall (on Sand Mountain), Cherokee (Coosa valley), Clay, Chilton and Tuscaloosa counties, in the older parts of the state. The specimens at these places, however, are very small, being scarcely more than knee-high.

The explanation suggested for the occurrence of *Anchistea* outside of the coastal plain will not apply so well to this case, for the Marshall and Clay County stations at least have in all probability

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* See Mohr, Contr. U. S. Nat. Herb. 6: 16. 1901.

† See also Rhodora 7: 74. 1905.

been dry land since a time antedating the appearance of all species of dicotyledons now living.

It now seems as if practically all the bog plants common to the glaciated region and coastal plain can be found in at least a few places in the older regions between, and perhaps they were all once more widely distributed there, and are being gradually crowded out into the newer regions by the climax vegetation.*

QUERCUS LAURIFOLIA Michx.

Until this year this too was known only from the coastal plain, but during the spring I found it quite abundant along the Coosa River in Chilton and Coosa counties, in the Metamorphic region, also along streams at several places in the Coal Measures, particularly in Bibb County around Blocton, in the upper (northeastern) part of Tuscaloosa County, and in Walker County near Cordova, Cedrom † and South Lowell. It is doubtless slowly retreating from the highlands, like several other species mentioned in this paper. To determine where it reached its maximum inland extension, and at what geological period, would be a most interesting problem, but I can suggest no way of solving it at present. The fact that at all the localities above mentioned, except those near Cordova and Cedrom, *Pinus palustris* is common on the neighboring hills, is perhaps worth remembering.

In the coastal plain *Quercus laurifolia* is common in most of the counties, but rather avoids the Cretaceous prairies and other calcareous regions where climax vegetation prevails. Dr. Mohr's remarks about this species and *Q. Phellos* on page 473 of his Plant Life show that he had the two species partly confused, for the latter is one of the commonest trees in the prairie region, where *Q. laurifolia* is almost unknown. The two trees are indeed difficult to distinguish in summer, but in winter and early spring (at which seasons most of my observations on Alabama trees were made) they are very distinct.

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* Some interesting suggestions along this line are found in Mr. Kearney's paper in Science for Nov. 30, 1900, though he seeks the cause of the phenomena in changes of climate, which must have played a relatively unimportant part, and moreover are largely hypothetical.

† A small station on the Frisco System, between Townley and Pocahontas.

PARONYCHIA RIPARIA Chapm.

SIPHONYCHIA PAUCIFLORA Small

These two species, new to the state, I found on sandy banks of rivers near Geneva the latter part of June.

MAGNOLIA GLAUCA L.

This tree has long been known to occur in the Metamorphic and Palaeozoic regions of Georgia and Alabama,* but it may be worth mentioning that I have recently found it still farther from the coast than it is usually seen. It grows on Sand Mountain in Marshall County near Albertville (some of the specimens there reaching a diameter of nine inches and a height of about fifty feet), on Lookout Mountain (a foot in diameter) as well as in the Coosa valley in Cherokee County, and in Blount County near Oneonta. The Sand and Lookout Mountain localities are between 900 and 1100 feet above sea-level. (Dr. Gattinger reports it from Madison County, Tennessee, which is still farther inland, but in the coastal plain.)

In the western part of the state, in the Tuscaloosa region of the coastal plain, this species is very common in the southern part of Marion County, up to latitude 34°, and the largest specimen I have ever seen, three feet in diameter, is in the western part of Fayette County, a little outside of the range given on Dr. Mohr's map.

The geological history of *Magnolia glauca* is probably similar to that of *Myrica carolinensis*, with which it often associates.

ILLICIUM FLORIDANUM Ellis

The range usually given for this species, "Florida to Louisiana," might lead uninformed persons to believe that it is found only near the coast. But in Alabama it has a pretty wide distribution, and is not even confined to the coastal plain. It seems to be most common in the region of the Tuscaloosa formation, in Marion, Lamar, Pickens, Tuscaloosa, Bibb, Chilton, Autauga, Elmore and Macon counties. In Chilton County it is also com-

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* The northern boundary of its range in Alabama as known to Dr. Mohr is mapped on the frontispiece of his Plant Life.

mon along streams in the metamorphic region near the Coosa River ; and it has recently been reported from Coosa County, on the other side of the river, by F. W. Reed.*

Like several other southern evergreens now nearly confined to the coastal plain, this in all probability formerly grew in the mountains farther north, where there is no longer any trace of it. The fact that it has near relatives in eastern Asia is doubtless of some significance in this connection. Its habitat is difficult to describe, and not exactly like that of any other species known to me. It grows normally neither in swamps nor in hammocks, but just on the border line between them. A peculiarity of its range is that no one seems to have ever seen it in Georgia, though in Macon and Dale counties it is not very far from there, and Professor Earle reports it from Lee County, which is still nearer. Bartram's observations on this species (summarized in Mohr's Plant Life, pp. 14, 15) are worth reading.

HEPATICA ACUTILOBA DC.

Seen in March, in flower, on shaded Subcarboniferous bluffs in Marshall, Madison and Colbert counties. Near Riverton, in the last-named county, it grows within a mile or so of the Mississippi line, and it could doubtless be found on the Palaeozoic hills of that state also, though it does not seem to have been hitherto reported west of Georgia and south of Tennessee. Having found it near Riverton I naturally expected to find it also in the vicinity of Florence, a little farther up the Tennessee river ; but strange to say, the *Hepatica* there seems to be all *triloba* (as I was told before I looked for it by Professor M. C. Wilson, a local botanist).

Judging from a remark in Gattinger's Tennessee Flora, and observations which have been made by other botanists, the exact relationship between these two supposed species of *Hepatica* deserves looking into, and might well be made the subject of statistical and experimental studies.

JEFFERSONIA DIPHYLLA (L.) Pers.

In rich woods on the limestone at the northern base of Sand Mountain, near the Tennessee River, a few miles east of Guntersville

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* U. S. Forest Service Bull. **68** : 11, 47. 1906.

ville, Marshall County, March 22, 1906, in flower. Not previously reported south of Tennessee.

ARABIS GEORGIANA Harper, Torreya 3: 88. 1903

Previously known only from the banks of the Oostanaula and Chattahoochee rivers in Georgia.* On December 9th last I was walking along the Coosa River (a continuation of the Oostanaula), in the upper edge of the coastal plain in Elmore County, a few miles below Wetumpka, and thinking that this species should grow there if anywhere in Alabama, I looked for it at the first promising spot — and found it, of course in the same condition in which I had last seen it in Georgia. On April 24 I revisited the locality and was fortunate in finding my plant in full bloom — the first time it had ever been seen in that condition in the wild state, by the way. Its habitat and associates there are very much the same as at the two Georgia stations.

PARNASSIA ASARIFOLIA Vent.

A few years ago I supposed that this species reached its southern limit in Clarke County, Georgia. † But Dr. Mohr ‡ has since reported it from Clay County, Alabama, and last spring I saw it in wet woods in the counties of Cleburne, Randolph and Chambers, which are likewise in the Metamorphic region.

NEVIUSIA ALABAMENSIS Gray

As is well known, this is one of the rarest of North American shrubs. It was known only from the vicinity of Tuscaloosa § until Mr. T. G. Harbison found it at the northwestern base of Sand Mountain in Jackson County a few years ago.|| On March 23 I saw it on limestone rocks on the lower slopes of the mountains east of New Market, Madison County, about five miles from the Tennessee line, on the same formation (Subcarboniferous) as that on which Mr. Harbison found it.

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* See Torreya 4: 24. 1904.

† Bull. Torrey Club 27: 324, 335. 1900.

‡ Contr. U. S. Nat. Herb. 6: 535. 1901.

§ See Plant World 3: 136. 1900; 9: 105. 1906.

|| Biltmore Bot. Stud. 1: 155. 1902.

BAPTISIA BRACTEATA Muhl.

Seen in April and May on several dry rocky ridges in Cleburne, Calhoun and Talladega Counties, near the rather ill-defined boundary between Metamorphic and Palaeozoic. Associated in every case with *Pinus palustris* and other species of somewhat similar distributiion. Previously known only from eastern Middle Georgia.

POLYGALA NANA (Michx.) DC.

Since reporting this from DeKalb County* I have seen it in many other places in the upper parts of the state, particularly in Marshall, Etowah, Blount, Walker, Talladega and Chilton Counties. It occurs usually in dry woods, associated with *Pinus palustris* (except on Sand and Lookout Mountains, where this pine is not found), and grows scatteringly, rarely more than half a dozen specimens being visible at once. In Georgia, where it seems to be confined to the pine-barrens, I have not seen this species within fifty miles of the fall-line. Whether or not its irregular distribution follows approximately the same laws as that of *Myrica carolinensis* and other species mentioned above is an open question.

STAPHYLEA TRIFOLIA L.

Probably the only coastal plain stations on record for this species are in Quitman and Decatur counties, Georgia, along the Chattahoochee River.† But on April 23 I found many specimens along Catoma Creek in Montgomery County, some of them about three inches in diameter and twenty feet tall, which seems to be the maximum height recorded for this species, though not the maximum diameter.‡

CIRCAEA LUTETIANA L.

In rich woods along Chickasawbogue Creek on the road from Linden to Demopolis, Marengo County (Cretaceous region of the coastal plain), June 28. This station is of interest as being the first recorded in the coastal plain (at least in the South), as well as the southernmost by a good many miles.

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* Torreya **6**: 113, 115. 1906.

† See Bull. Torrey Club **32**: 162, 163. 1905.

‡ See Torreya **5**: 164. 1905.

? RHODODENDRON CUTHBERTII Small

At several places in the eastern (Metamorphic) part of Chilton County, on banks of streams, is a *Rhododendron* which a few years ago would have been pronounced without hesitation *R. punctatum* Andr.; but without flowers I have no way of distinguishing it from *R. Cuthbertii* Small,[*] a recently described species. Neither is mentioned in Mohr's Plant Life, but *R. punctatum* is reported from Tallapoosa County by Professor Earle[†] and from Eufaula by Dr. Chapman.[‡] Professor Earle's plant is doubtless the same as mine and as one which grows among the Pine Mountains of western Middle Georgia, and Dr. Chapman's the same as one in the Eocene region of Southwest Georgia,[§] but whether the two are identical or not cannot be determined at present.

PIERIS PHILLYREIFOLIA (Hook.) DC.

Dr. Mohr knew this only as a diminutive shrub in the pine-barrens of Mobile County; but last December I saw it in cypress ponds near Gordon and Cowarts, in Houston County, and around the lake near Florala, in Covington County, climbing the trees in the same unique manner that I noticed in Georgia a few years ago.[||]

ADELIA ACUMINATA Michx.

In view of the fact that this species, like many others of alluvial habitat, extends up the Mississippi valley embayment of the coastal plain to southern Illinois,[¶] it is not surprising that it should occur along the Tennessee river near Florence, though that is a little out of the coastal plain. (The same remarks will apply to *Taxodium distichum*, *Planera aquatica* and *Brunnichia cirrhosa* as well.) When I saw it there, on the 29th of March, it was just beginning to flower. The specimens were quite numerous and mostly above

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[*] Torreya **2**: 9. 1902.

[†] Bull. Ala. Agric. Exp. Sta. **119**: 97. 1902.

[‡] Fl. So. U. S. ed. 3. 288. 1897.

[§] See Bull. Torrey Club **33**: 240. 1906.

[||] Torreya **3**: 21, 22. 1903.

[¶] S. M. Coulter, Rep. Mo. Bot. Gard. **15**: 53, 54. *pl. 10.* 1904; H. A. Gleason, Torreya **6**: 8. 1906.

the average size, some being about 25 feet tall, with trunks 6 inches in diameter.

OSMANTHUS AMERICANUS (L.) B. & H.

In Alabama as well as in Georgia this evergreen shrub or small tree is by no means confined to the immediate vicinity of the coast, as was thought to be the case up to a few years ago.* It occurs at a number of places in the Eocene region, and extends inland to Chilton, Autauga and Elmore Counties, growing along streams in the metamorphic portion of the first-named, like *Illicium floridanum.* (It has also been found in Lee County.)† Like *Illicium* again, it has a number of Asiatic relatives, and may have had a similar history.

TRACHELOSPERMUM DIFFORME (Walt.) Gray

Still another coastal plain plant found occasionally in the upper districts. Dr. Mohr has already reported it from Morgan and Walker counties, and on May 13 I found it at two or three places along the Calvert Prong of the Locust Fork of the Warrior River in Blount County, on upper Carboniferous strata (Coal Measures). This too has Asiatic relatives, like the preceding.

In Georgia I have found this species almost always along streams which have passed through calcareous regions,‡ and this new Alabama station for it is no exception to the rule. For although the Calvert Prong runs lengthwise of Sand Mountain, occupying the synclinal trough of the plateau, like several other streams,§ it has some tributaries entering above the point in question which rise in the limestone valley on the southeast and flow into the mountain.‖ This peculiar type of drainage I have not met with anywhere else than in Blount County.

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* See Bull. Torrey Club 30: 338. 1903.

† What is perhaps the first specimen of this species collected in the Metamorphic region was distributed by Professor and Mrs. Earle (*no. 56*), and is labeled "Occasional, usually along streams, often on rocky banks. Auburn, Lee Co., April 11, 1900."

‡ See Ann. N. Y. Acad. Sci. 17: 69, 70, 175. 1906.

§ See Torreya 6: 112, 114. 1906.

‖ This is very well shown by the map of Blount County in the report of the field operations of the U. S. Bureau of Soils for 1905, taken in connection with the topographic maps of the same region, published by the U. S. Geological Survey.

CHRYSOPSIS OLIGANTHA Chapm.

In rather dry pine-barrens, Geneva and Covington counties. Nearly past flowering in the latter part of June, when I collected it, differing notably in this respect from the somewhat similar *C. graminifolia*, which flowers from August to November in Georgia.

ANTENNARIA SOLITARIA Rydb.

Like *Carex picta* and *Luzula saltuensis*, this is frequent on shaded non-calcareous bluffs in the upper half of the state. I have noted it in Lauderdale, Colbert, Franklin, Limestone, Marshall, Cherokee, Cleburne and Chilton counties. It is not mentioned by Chapman, Mohr, Harbison or Earle, which is strange, for it is a very distinct species, and can be easily recognized any day in the year.*

MESADENIA SULCATA (Fernald) Small

In and near branch-swamps in the pine-barrens, Geneva and Escambia counties. Previously known only from Southwest Georgia and West Florida,† and possibly also from South Carolina.‡

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* For notes on its occurrence in Georgia see Bull. Torrey Club **28**: 482. 1901; **30**: 294. 1903; **32**: 169. 1905.

† See Bull. Torrey Club **30**: 342. 1903; **31**: 27. 1904.

‡ See Torreya **5**: 183. 1905.

Notes on Calochortus

CHARLES VANCOUVER PIPER

In the Proceedings of the Academy of Natural Sciences of Philadelphia, for 1868, Professor Alphonso Wood described *Calochortus elegans nanus* based on specimens collected on "High Hills, Yreka. Also on Mt. Hood." In Dr. Sereno Watson's treatment of the genus (Proc. Am. Acad. vol. **15**), Professor Wood's subspecies is recognized and *C. Lyallii* Baker, Jour. Linn. Soc. **14**: 305, is cited as a synonym. The Mt. Hood plant has since been collected several times, and in Howell's Flora of Northwest America is well described under the name *C. Lyallii* Baker. Wood's name, *C. elegans nanus*, is common on herbarium specimens, but without exception all such specimens seen are merely small plants of true *C. elegans* Pursh, and have nothing to do with the original specimens of Wood.

To clear up the confusion an endeavor was made to find Wood's type specimens, but according to Dr. H. H. Rusby these are not now to be found in Wood's herbarium. Specimens of both collections are, however, in the Gray Herbarium labeled respectively "Mts. W. of Yreka, June, 1866" and "Mount Hood, August 20, 1866."

A study of these specimens reveals two entirely distinct species, both of which are distinct from *C. Lyallii* or any other described species. The following descriptions and notes will make clear the confusion which has existed.

Calochortus nanus (Wood)

Calochortus elegans nanus Wood, Proc. Acad. Phila. **1868**: 168. 1868.

Bulbs ovate, deep-seated, 2–3 cm. long: stems erect, 10–15 cm. long, exceeded by the solitary leaf, 1–5-flowered: leaf linear or linear-lanceolate, acute, 10–25 cm. long, 2–7 mm. wide, not paler beneath: bracts lanceolate: sepals oblong-ovate, acute or acuminate, blue-tinged, 10–15 mm. long, thinnish, slightly arched at base, without spot at base: petals rhombic-ovate, faintly tinged with blue, evenly hairy all over the inner face and ciliate, 15–18 mm. long; scale about one third as broad as the petal at its place of insertion, nearly semicircular, but little incised: stamens one third as long as petals, the acuminate anthers as long as the flattened filaments: style short: capsules nodding, orbicular when mature, 1.5 cm. long.

This species is nearer true *C. elegans* Pursh than any other Californian species. It is most easily distinguished by the character of the scale, which in *C. elegans* is half as wide as the petal or more, and deeply laciniate into many narrow segments.

The original specimens of Wood are very slender, but later collections show that the species becomes at least as large as *C. elegans*. The species seems to be rare and is not accounted for apparently in any recent treatment of the genus. Only the following specimens have been seen:

"Mts. W. of Yreka," *A. Wood 967*, June, 1866.

Castle Crags, in pine woods, *Piper 6398*, May 30, 1904.

Sissons, in dry woods, *Applegate 725*, May 28, 1895.

Siskyou Mountains at the summit, *Howell*, June 16, 1884.

The last locality may be in Oregon; the others are in California.

CALOCHORTUS SUBALPINUS Piper, Contr. U. S. Nat. Herb. 11: 195. 1906

Bulbs ovate, 2–3 cm. long, the outer coats dark: stems flexuous, erect, 15–20 cm. high, usually exceeded by the solitary leaf, 1–3-flowered: leaf linear-lanceolate, acuminate, 3–8 mm. wide, paler beneath: bracts lanceolate, long-acuminate, 2–3 cm. long: sepals lance-ovate, acuminate, somewhat scarious on the margins, 1.5–2.5 cm. long, 6–9-nerved, the base strongly arched, forming a shallow pit inside, this marked by a purple spot: petals cream-colored, purplish at base, obovate or rhombic-orbicular, 2–3 cm. long, slightly erose at margin, sparsely villous over the upper face above the striate, minutely puberulent gland, excepting a narrow portion near the apex; scale narrow, entire, extending in a gentle curve nearly across the petal and covered with long retrorse hairs: filaments broadly wing-margined, equaling the long-beaked anthers: capsules nodding, narrowly elliptical, rather acutish at each end, 2–3 cm. long, beaked by a style 1–2 cm. long.

A subalpine species, closely allied to *C. Purdyi* Eastwood, which differs in having thinner sepals lacking the pit at base;

more villous petals without the naked apical area; less villous scales which are very strongly arched; a much thinner, perfectly smooth gland; and merely acuminate, not beaked anthers.

Specimens of this species have been examined as follows:

WASHINGTON: Mount St. Helens, *Coville 765*, July 18, 1898; Mount Adams, *Henderson 52*, 1883; Klickitat river, *Flett 1124*; High mountains, Skamania County, *Suksdorf*, August 11, 1886; White Salmon, *Suksdorf*, 1879; Falcon Valley, *Suksdorf*, July 1, August, 1881; Falcon Valley, *Suksdorf*, 700 m. alt., 1879.

OREGON: Mount Hood, *A. Wood*, August 20, 1866; *Mrs. P. G. Barrett*, snow line, September, 1882; *Gorman*, September 23, 1896; *C. H. Merriam*, alt. 2000–2300 m., 1896; *Howell*, 1881; *M. A. Barber 230*, alt. 2500 m., August 26, 1899. Three Sisters, *Gorman 121*, July 21, 1903, alt. 2000 m.

This species has been mistaken for *C. apiculatus* Baker, but that has no scale on the petal. Specimens of this species sent to the British Museum have been compared with the type of *C. elegans Lobbii* Baker, Jour. Linn. Soc. **14**: 305, by Mr. C. H. Wright, who reports that the two are identical. This species is however very different from *C. Lobbii* Purdy, Proc. Calif. Acad. III. **2**: 122, which Purdy states was identified by Baker himself as his *C. elegans Lobbii*. A regrettable confusion has thus arisen in the synonymy through the use of the name *Lobbii* for two very distinct species.

CALOCHORTUS LYALLII Baker, Jour. Linn. Soc. **14**: 305. 1875

(Type collected by Lyall in "Columbia brittanica ad apicem montis alt. 5800 pedes inter fluv. Columbia et Yakima." This locality is the Wenache Mountains, Washington.)

Calochortus ciliatus Rob. & Seaton, Bot. Gaz. **18**: 238. 1893.

(Type in the Gray Herbarium, collected by Brandegee in the "Wenatchie Region.")

This species occurs in the Wenache and adjacent Cascade Mountains in Washington. It has been collected as follows:

Wenache Region, *Brandegee 1107*, 1883; Naches River, *Henderson 2485;* Wenache Mountains, *Whited 40* and *1139*, *Cotton 1266, 1313, 1657; Vasey 82*, 1892; Mount Stuart, *Sandberg &*

Leiberg 575; Peshastin, *Sandberg & Leiberg*, July, 1893; "North Branch of the Columbia," *Wilkes Expedition 1068.*

Specimens collected by Cotton have kindly been compared for me with the type of *C. Lyallii* by Mr. E. G. Baker, who states that they differ only in the relative length of the anthers to filaments. This character, however, varies with age. The species is very distinct from *C. elegans* and its immediate allies in having erect pods. It may readily be recognized by its narrow, acuminate, jagged-margined petals which excepting the scale are glabrous or only sparsely pilose, and by its abruptly subacute anthers. Thus far the species has been found only in Chelan, Kittitas and Yakima Counties, Washington.

CALOCHORTUS ELEGANS Pursh, Fl. Am. Sept. 240. 1814.

This is the type species of the genus and was collected by Lewis "on the headwaters of the Kooskoosky, Idaho." The exact locality was at Lewis and Clark's spring camp of 1806, opposite the present site of Kamiah, Idaho. The species is common in pine woods in the Bitter-Root Mountains of Idaho and the Blue Mountains of Washington and Oregon up to 2000 meters altitude. It does not seem to reach the Cascade Mountains at any point. It varies considerably as do other species in the breadth of the solitary leaf and in the size of the flowers. The smaller and larger forms were long ago named by Hooker, in the Flora Boreali-americana, *C. elegans major* and *C. elegans minor*, but these seem unworthy of botanical recognition.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1906)

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

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

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

NOVEMBER, 1906

North American species of Calceolaria

PHILIP DOWELL

(WITH PLATES 18–22)

The first records we find of plants belonging to this genus of Violaceae are those of Pehr Löfling, a Swedish naturalist, who was employed by the Spanish government to study the natural history of Spain. Among the specimens collected by him in South America were three species of violaceous plants which he described under the generic name *Calceolaria* (Iter Hisp. 183. 1758). His descriptions were full, but he did not designate the species by binomials. Linnaeus published these three species with binomials in 1763, but he assigned them to *Viola*. In 1766 Dr. A. B. Kölpin published a German edition of Löfling's Iter, and at the head of each of the three species of *Calceolaria* the corresponding binomial given by Linnaeus is inserted. According to Kölpin these insertions were made by Linnaeus, who also had edited the 1758 edition of the Iter after Löfling's death. Thus *Calceolaria* dates from 1766 and is to be credited to Löfling. Jacquin's *Hybanthus* (Enum. Pl. Carib. 2. 1760) is a different genus and does not include any of our species. Sprengel (Jour. Bot. Schrad. **4**: 192. 1800) proposed the name *Solea* for Ortega's *Viola verticillata*, which he described and figured. The name that seems to have been more in use than either of the preceding is *Ionidium* (Vent. Jard. Malm. *pl. 27*. 1804), the type of which is *I. polygalaefolium*, the same species as Sprengel's *Solea verticillata*.

Out of some 45 species described, about 20 species of *Calceolaria* have been reported as found in North America, including

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the West Indies; a few occur in the Old World, and the rest are South American. The North American species are found chiefly in Mexico, only a few having been reported from Central America and the West Indies, and only one from the United States. The species included in this paper are only such as are represented by specimens in the Gray Herbarium of Harvard University, in the herbaria of the United States National Museum, Columbia University and the New York Botanical Garden, and in the private herbarium of Mr. T. S. Brandegee.

CALCEOLARIA Löfl. (Iter Hisp. 183; hyponym. 1758)
Reise 244. 1766. Type, *Viola Calceolaria* L.
SOLEA Spreng. Jour. Bot. Schrad. **4**: 192. 1800
IONIDIUM Vent. Jard. Malm. *pl. 27.* 1804

Herbs, or rarely small shrubs, with simple alternate or opposite leaves and axillary or racemose flowers. Peduncles or pedicels one-flowered, solitary in the axils of the leaves or bracts, mostly bibracteate near the middle, articulate above the middle. Sepals unequal, not appendaged at the base. Lower petal largest, saccate or gibbous at the base; the two lateral petals longer than the upper pair. Stamens alternate with the petals, each of the lower with a gland or spur at the base, membranaceous at the top by the prolongation of the filament above the anther; anthers connivent. Capsule few-ovuled, otherwise similar to that of *Viola*. Seeds ovoid-globose with hard seed-coats; "embryo straight, central in the fleshy perisperm; cotyledons ovate."

Analytical key

Lower petal less than twice the length of the sepals.	
Flowers axillary.	
Leaves narrow, linear to oblong, usually entire.	1. *C. verticillata.*
Leaves wider, usually ovate.	
Petiole short or none.	2. *C. glutinosa.*
Petiole 1 cm. long or longer.	3. *C. tenuifolia.*
Flowers racemose.	4. *C. fruticulosa.*
Lower petal twice as long as the sepals or longer.	
Stipules minute, 5 mm. or shorter.	
Plant procumbent, small.	5. *C. procumbens.*
Plant erect or ascending.	
Leaves alternate or clustered.	
Flowers long-peduncled.	6. *C. longipes.*
Flowers short-peduncled.	7. *C. glabra.*
Lower leaves usually opposite.	
Leaves about twice as long as broad or shorter.	
Leaves crenulate-serrate, glabrate.	8. *C. brevis.*

- Leaves crenate-serrate, pubescent. 9. *C. verbenacea.*
- Leaves more than twice as long as broad.
  - Leaves mostly linear, the lowest sometimes wider.
    - Leaves obovate to oblong-linear, 2–3 cm. long. 10. *C. stricta.*
    - Leaves lance-linear to linear, 4–8 cm. long. 11. *C. angustifolia.*
  - Leaves mostly lanceolate.
    - Leaves gradually tapering at the base. 12. *C. riparia.*
    - Leaves truncate or abruptly tapering at the base. 13. *C. nigricans.*
- Stipules larger, foliaceous.
  - Leaves ovate to orbicular, mostly obtuse.
    - Leaves mostly opposite. 14. *C. humilis.*
    - Leaves mostly alternate. 15. *C. Rosei.*
  - Leaves lanceolate to linear. 16. *C.* sp.

1. CALCEOLARIA VERTICILLATA (Ort.) Kuntze

Viola verticillata Ort. Dec. **4**: 50. 1797.
Solea verticillata Spreng. Jour. Bot. Schrad. **4**: 192. *pl. 6.* 1800.
Ionidium polygalaefolium Vent. Jard. Malm. *pl. 27.* 1804.
Viola polygalaefolia Poir. Enc. Meth. **8**: 647. 1808.
Ionidium lineare Torr. Ann. Lyc. N. Y. **2**: 168. 1828.
Ionidium stipulaceum Nutt.; Torr. & Gray, Fl. N. Am. **1**: 144. 1838.
Calceolaria verticillata Kuntze, Rev. Gen. Pl. 41. 1891.

This species is reported as "intertropical both in the New and the Old World." It has been found as far north as Colorado and is common in the southwestern states and in Mexico. It shows considerable variation in the length and shape of its leaves, which are short and obovate in some specimens and long and linear in others, with numerous intermediate forms.

2. CALCEOLARIA GLUTINOSA (Vent.) Kuntze

Ionidium glutinosum Vent. Jard. Malm. *pl. 27.* 1804.
Viola glutinosa Poir. Enc. Meth. **8**: 647. 1808.
Solea glutinosa Spreng. Syst. **1**: 803. 1825.
Calceolaria glutinosa Kuntze, Rev. Gen. Pl. 41. 1891.

The specimens collected on ballast near Communipaw Ferry, N. J., by *Jos. Schrenk,* July 20, 1880, and by *Addison Brown,* September, 1880, are like the South American specimens. There are specimens from Communipaw Ferry in the Gray Herbarium, the U. S. National Herbarium, and in the Columbia Herbarium in the N. Y. Botanical Garden.

3. **Calceolaria tenuifolia** sp. nov. (PLATE 18)

Stem herbaceous, erect, branching, somewhat striate, loosely puberulent, 3 dm. high or taller; branches erect or ascending, weak, similar to the stem; leaves opposite below, alternate above, the blade ovate-lanceolate, gradually tapering to a blunt apex, abruptly decurrent on the petiole at the somewhat oblique and rounded base, thin and lax, nearly glabrous, light-green, paler beneath, with low distant teeth, subciliate, 3–7 cm. long, 1.5–2 cm. wide; petiole very slender, channeled, puberulent, 1 cm. long; stipules linear, ciliolate, 2–3 mm. long; flowers 2–3 mm. long, axillary, nodding, on filiform finely puberulent peduncles, which are less than 1 cm. long; bracts on the peduncles slightly below the middle; sepals oblong, obtusish, nearly glabrous, finely ciliolate; lower petal 3 mm. long, about one third longer than the sepals, spatulate, notched, winged near the base, glabrous.

The specimens were not in the fruiting stage, so the characters of the fruit were not observed.

LOWER CALIFORNIA: San José del Cabo, *T. S. Brandegee, no. 18*, type. Specimens in the Gray Herbarium and in Brandegee's herbarium, collected September 6, 1890.

4. CALCEOLARIA FRUTICULOSA (Benth.) Kuntze

Ionidium fruticulosum Benth. Bot. Voy. Sulph. 7. *pl. 2.* 1844.

Ionidium fruticulosum dentatum A. Gray, Proc. Am. Acad. **5**: 154. 1861.

Calceolaria fruticulosa Kuntze, Rev. Gen. Pl. 41. 1891.

The type locality is Cape San Lucas, Lower California, from which locality there are specimens in all the herbaria mentioned in this paper.

It should be noted here that some of the specimens show two sets of leaves that are quite different in general shape and aspect. The older leaves may be described as thin, membranous, with veins prominent beneath; alternate, ovate-lanceolate to linear-lanceolate, gradually tapering to the apex, more abruptly tapering at the base and decurrent on the petiole, dentate with prominent unequal rather distant teeth, 3–6 cm. long, 1–2 cm. wide, with petiole 0.5–1 cm. long. The younger or later leaves are mostly linear, entire or subentire, with shorter petiole. Bentham's description and figure were evidently made from specimens that had lost the older or larger leaves. Gray's variety *dentatum* is based on specimens having the larger leaves present.

Calceolaria fruticulosa flavescens var. nov.

Herbaceous, erect, branching, glabrous; leaves ovate to ovate-lanceolate, more uniform than in the type of the species; petioles longer; inflorescence more decidedly racemose. The lighter-colored stem suggests the name.

SONORA, MEXICO: Guaymas, *Dr. E. Palmer, no. 253* (October, 1887), type; and *no. 258* (October, 1897); *T. S. Brandegee,* November 7, 1893.

5. CALCEOLARIA PROCUMBENS (Griseb.) Kuntze

Ionidium procumbens Griseb. Cat. Pl. Cub. 11. 1866.

Calceolaria procumbens Kuntze, Rev. Gen. Pl. 41. 1891.

C. Wright no. 1898, collected in western Cuba, 1860–4, is the plant referred to by Grisebach in his description. Specimens are in the Gray Herbarium, the U. S. National Herbarium, and the Columbia Herbarium in the N. Y. Botanical Garden.

6. **Calceolaria longipes** sp. nov. (PLATE 19)

Stem erect, branched above, woody at the base, terete, ridged or striate, pubescent, about 2 dm. high; leaves alternate, crowded above, ovate to oblong-elliptical, abruptly narrowed at the rounded oblique base, appressed-pubescent especially on the upper surface, ciliolate, serrate with gland-tipped teeth, thin, dull-green, paler beneath, the veins prominent on the under side; 2–7 cm. long, 1–3.5 cm. wide; petioles pubescent, channeled, somewhat flattened, 1–2 cm. long; stipules linear, slender and minute, ciliolate; flowers erect or nodding, axillary, on puberulent filiform peduncles, which are 2–3.5 cm. long; lip 3-nerved, rhombic-ovate, obtuse, pubescent outside, glabrous inside, much involute in dried specimen, 3 times as long as its claw, 9–10 mm. long, 8–10 mm. wide; claw slender, channeled, puberulent; lateral petals veiny, 5-nerved, slightly exceeding the sepals; upper pair of petals oblong, about two-thirds the length of the sepals; sepals lanceolate, acuminate, 3–5-nerved, ciliolate, puberulent on the veins, nearly equal, 3–4 mm. long; capsule rather small, ovate, obtusely 3-angled, hairy, capped with the persistent style, which is nearly as long as the capsule; seeds minutely pitted, one in each of the three cells, straw-colored.

CHIAPAS, MEXICO: *E. W. Nelson no. 2961*, type. Specimens in the U. S. National Herbarium, collected August 18, 1895, between San Richardo and Ocozucuantla, alt. 800–1000 m.

7. **Calceolaria glabra** sp. nov. (PLATE 20)

Stem erect, flexuous, angular, puberulent to glabrous; leaves alternate, obovate to elliptical, acuminate, gradually tapering at the base and decurrent on the petiole to the stem, crenulate-serrate, glabrous, or finely puberulent and pale on the under side, 7–14 cm. long, 3–4 cm. wide including the winged petiole, which is 2–3 cm. long, the lower leaves smaller; stipules linear-lanceolate, somewhat puberulent, 1–3 mm. long; flowers axillary on puberulent peduncles which are 0.5–1 cm. long; sepals thin, ciliolate, linear-lanceolate 3-nerved, 4 mm. long; lip orbicular, veiny, about as long as its puberulent claw, which widens toward the base; lateral petals falcate, 3-nerved or faintly 4-nerved, 5 mm. long; upper petals oblong, 1-nerved; connectiles of all the stamens puberulent on the outside; capsule large, smooth and veiny, with prominent beak, 8–10 mm. high.

VERA CRUZ, MEXICO: *Charles L. Smith no. 1840*, type. Specimen in the U. S. National Herbarium, collected in 1894 at Banderilla near Jalapa, alt. 1200–1400 m.

8. **Calceolaria brevis** sp. nov. (PLATE 21)

Branching from a woody base; branches ascending, pubescent in two lines; leaves mostly alternate, short-petioled, obovate to ovate, tapering at both ends, crenate-serrate, hispidulose, paler on the under side, 2–5 cm. long, 1–2 cm. wide; stipules minute, lanceolate-subulate, ciliolate; flowers nodding, axillary, on slender puberulent peduncles which are 10–12 mm. long, the bracts opposite at or near the articulation; sepals lanceolate, acuminate, ciliate, puberulent, obscurely 3-nerved, about equal, 3 mm. long; lip 3-nerved, veiny, broadly rhomboid-orbicular, abruptly contracted at the base, 3–4 mm. in diameter; claw somewhat channeled, puberulent, broadest near the base, winged, longer than the lip and exceeding the lateral petals, which are falcate and 4-nerved; upper petals oblong-obovate, 3-nerved, veiny, glabrous; connectile of the lower stamens puberulent on the outside; capsule subglobose, glabrous, with a short thickened beak, each cell with about two orbicular seeds.

GUATEMALA: *Heyde & Lux* in John Donnell Smith's distribution *no. 3943*, September, 1892, and *no. 4435*, May, 1893, type. Specimens in the Gray Herbarium, the U. S. National Herbarium, and the Columbia Herbarium in the N. Y. Botanical Garden, collected at Volcan Jumaytepeque, Depart. Santa Rosa, alt. 1,850 m.

In the Gray Herbarium is one sheet labeled *E. T. Heyde no. 449.* 1892. This is the same as *no. 3943* in J. D. Smith's distribution, and these specimens were probably all collected at the same place. Those collected in May, 1893, show the growth of a different season, with more simple stem and larger leaves. The leaves on the more numerous branches of the September growth are smaller than those of the main stem, and since only few of the stem-leaves are retained in this stage, the general appearance of the plants in the two stages is quite different.

9. CALCEOLARIA VERBENACEA (H. B. K.) Kuntze

Ionidium verbenaceum H. B. K. Nov. Gen. & Sp. **5**: 379. *pl. 497.* 1821.
Solea verbenacea Spreng. Syst. **1**: 803. 1825.
Calceolaria verbenacea Kuntze, Rev. Gen. Pl. 41. 1891.

E. Palmer no. 55, July, 1880, collected at Coahuila, Mexico, is here considered as belonging to this species. Specimens are in the Gray Herbarium, U. S. National Herbarium, and the Columbia Herbarium. This determination is based on comparison of the specimens with the published description and plate in H. B. K. Nov. Gen. & Sp. and not on comparison with authentic specimens, and I am not entirely satisfied that our plants are the same as those described as *I. verbenaceum.*

10. CALCEOLARIA STRICTA (Vent.) Kuntze

Ionidium strictum Vent. Jard. Malm. *pl. 27.* 1804.
Viola stricta Poir. Enc. Meth. **8**: 648. 1808.
Solea stricta Spreng. Syst. **1**: 803. 1825.
Calceolaria stricta Kuntze, Rev. Gen. Pl. 41. 1891.

Found in Mexico according to Grisebach, otherwise in the West Indies. San Domingo is given as the type locality, from which there is a specimen in the U. S. National Herbarium collected by *Wright, Parry & Brummell*, January-March, 1871. In the Columbia and the Gray herbaria are specimens collected by *C. Wright* in Eastern Cuba, *no. 20*, 1856–7.

11. **Calceolaria angustifolia** (H. B. K.)

Ionidium angustifolium H. B. K. Nov. Gen. & Sp. **5**: 377. 1821.
Solea longifolia Spreng. Syst. **1**: 803. 1825.

MEXICO: San Luis Potosi, *C. G. Pringle no. 5011*, August 21, 1891. Also Prov. Huasteca, near Tantoyuca, *L. C. Ervendberg no. 210*, September, 1858. These specimens are in the Gray Herbarium.

The determination is based entirely on description. Sprengel considers his *Solea longifolia* a variety of *S. stricta.*

12. CALCEOLARIA RIPARIA (H. B. K.) Kuntze

Ionidium riparium H. B. K. Nov. Gen. & Sp. **5**: 378. 1821.
Ionidium parietariaefolium DC. Prod. **1**: 308. 1824.
Solea riparia Spreng. Syst. **1**: 803. 1891.
Calceolaria riparia Kuntze, Rev. Gen. Pl. 41. 1891.

Whether the large number of specimens that have been considered as belonging here are varying forms of the same species or not is a question that could best be answered by field work. I hesitate to put down *I. parietariaefolium* as a synonym of *I. riparium*, but DeCandolle's description of *I. parietariaefolium* is too meager to make sure of his plants. His variety *Houstoni*, however, is recognizable in some of the herbarium material. We include here under *C. riparia* such specimens as *Wright no. 859* from Sonora, Mexico, collected in 1851; *E. Palmer no. 1826* from Tepic, Mexico, 1892; and *T. S. Brandegee's* specimen from El Taste, Lower California, November, 1902. These specimens differ considerably, however, from such as *E. Palmer nos. 25* and *93* from Chihuahua, Mexico, 1885, and *C. G. Pringle no. 6391* from Morelos, Mexico, July, 1896.

Calceolaria riparia Houstoni (DC.)

Ionidium parietariaefolium Houstoni DC. Prod. **1**: 308. 1824.

This is characterized chiefly by its more prominently sharp-toothed leaves. Here we include such specimens as *M. Bourgeau no. 2661* from Orizaba, Mexico, 1865–6, and *Rose & Hay no. 6158* from Vera Cruz, Mexico, August 16, 1901.

13. **Calceolaria nigricans** sp. nov.

Stem woody, puberulent, terete; leaves alternate, the blade ovate-oblong, mostly acute and pointed, truncate and somewhat oblique at the base, glabrate, serrulate with low rounded teeth furnished with white callous points, firm, 3–7 cm. long, 1.5–2.5 cm. wide; petioles slender, terete, puberulent, 4–12 mm. long; stipules minute, subulate, about 1 mm. long; flowers solitary, axillary, nodding; peduncles filiform, finely puberulent, 1–3 cm. long; sepals lanceolate, 4–5 mm. long; lip of the lower petal rhombic-ovate, 6 mm. long, longer than the claw; capsule 6 mm. long, with a short beak.

HONDURAS: *C. Thieme* in J. D. Smith's distribution *no. 5127*, type. Specimen collected in May, 1889, at San Pedro Sula, Santa Barbara, alt. 250 m.

14. CALCEOLARIA HUMILIS Rose & Dowell; Rose, Contr. U. S. Nat. Herb. **10**: 125. *pl. 42.* 1906

Perennial; stem herbaceous, branching from the woody base, 1–2 dm. high; branches decumbent or ascending, pubescent in two lines; leaves opposite, short-petioled, the blades 1–3 cm. long, 1–2 cm. wide, orbicular to ovate, acute or obtuse, glabrous, crenate-serrate, decurrent on the ciliolate petiole, which is about 2 mm. long; stipules subulate to lanceolate and foliaceous, 4–8 mm. long, glabrous; flowers violaceous, nodding, on slender axillary puberulent peduncles, which are 6–8 mm. long, the bracts opposite near the articulation; sepals lanceolate, acuminate, 3-nerved, glabrous, 4 mm. long; lip orbicular, slightly longer than the claw, 4–5 mm. long; the claw broadly winged, 5-nerved; lower stamens puberulent on the lower part of the connectile above the gland-like appendages; capsule ovoid-globose, with a blunt beak, glabrous.

VALLEY OF MEXICO: *C. G. Pringle no. 9653*, type. Specimen in the U. S. National Museum, collected July 30, 1901, on lava fields near Tizapan, alt. 2300 m.

15. **Calceolaria Rosei** sp. nov. (PLATE 22)

Stem erect, simple or branched, angular and grooved, pubescent with spreading hairs; leaves alternate, short-petioled, obovate to ovate, mostly obtuse, abruptly narrowed at the base and decurrent on the petiole, crenate, hirsute, rather firm, paler on the under side, 2–4 cm. long, 1–2 cm. wide; stipules lanceolate, ciliate, puberulent, variable in size, some foliaceous; flowers axillary, nodding, on slender puberulent peduncles, the minute bracts variable in position; sepals lanceolate, acuminate, ciliate, pubescent, 3-nerved, about equal; lip 3-nerved, glabrous, rhombic-orbicular to broadly ovate, abruptly contracted on the narrow claw; claw channeled, puberulent, about equaling the lip; petals glabrous, veiny, the lateral falcate, 4-nerved, the upper oblong, 3-nerved; connectiles of lower stamens puberulent.

MEXICO: *Rose & Hough no. 4851*, type. Specimen in the U. S. National Herbarium, collected July 11, 1899, at Guanajuato.

16. CALCEOLARIA sp.*

Specimens of the plant referred to were collected by *T. S. Brandegee*, March 2, 1889, on Santa Margarita Island, Lower California, and are preserved in the Gray Herbarium and in his own private herbarium. The specimen in Mr. Brandegee's herbarium is mounted on the same sheet with two others, all labeled *Ionidium lineare*, and is designated by the figure 2.

It does show a general resemblance to broad-leaved forms of *Calceolaria verticillata* (*Ionidium lineare*), but it is quite distinct from this on account of its larger flowers with the lower petal twice the length of the sepals. On account of its large foliaceous stipules it is placed in the last group and not with *C. stricta* nor with *C. angustifolia.*

Explanation of plates 18-22

PLATE 18. *Calceolaria tenuifolia*

a, whole plant, × $\frac{2}{5}$; *b*, opened flower, × 4.

PLATE 19. *Calceolaria longipes*, × $\frac{2}{3}$

a, petals; *b*, sepals; *c*, lateral view of flower; *d*, dorsal view of flower; *e*, young capsule; *a*, *b*, *c*, *d*, *e*, all × 2.

PLATE 20. *Calceolaria glabra*, × $\frac{2}{3}$

a, petals, × 3; *b*, sepals, × 3; *c*, stamen, × $6\frac{2}{3}$; *d*, mature capsule, × 2.

PLATE 21. *Calceolaria brevis*, × $\frac{3}{4}$

a, petals; *b*, sepals; *c*, stamens; *d*, lateral view of flower; *a*, *b*, *d*, × 2, *c* × 5.

PLATE 22. *Calceolaria Rosei*, natural size

a, upper petals; *b*, lateral petal; *c*, lower petal; *d*, one of the upper sepals; *e*, one of the lower sepals; *f*, upper stamen, dorsal view; *g*, lower pair of stamens, dorsal view; *h*, side view of one of the lower stamens showing the appendage at the base; *i*, flower; *a*, *b*, *c*, *d*, *e* × 3; *f*, *g*, *h* × 4; *i* × 2.

Plates 19–21 were drawn by Prof. Homer D. House, of Clemson College, South Carolina.

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* No description is given, and thus no name, because material is not accessible at present. When specimens were accessible the description was deferred in the hope of getting access to more and better material.

The identity of Mucor Mucedo

GUY WEST WILSON

The modern genus *Mucor* dates from the first edition of Linnaeus's Species Plantarum * in which eleven species are named. Of these only *M. Mucedo* is retained in the genus by modern mycologists while the others are distributed among various genera of Lichenes, Myxomycetes and Hyphomycetes. According to the Genera Plantarum † of 1754 the genus is coextensive with "Mucor *Mich.* 95. Mucilago *Mich.* 96. Lycogala *Mich.* 95." It is interesting to note that none of Micheli's species of *Mucilago* or of *Lycogala* appear among the Linnaean species, of which *Mucor Mucedo* alone is common to both authors. This species is, therefore, the type of the genus. For this reason it is important to know to what Linnaeus applied the name and whether it is used in the same sense to-day. An examination of Linnaeus's citations and of their collateral references is amply sufficient to determine the first point while recent mycological literature holds a wealth of information upon the second.

The citations in the Species Plantarum ‡ are as follows :

"6. Mucor stipitatus, capsula globosa. *Mucedo.*
Mucor filamentis granulatis fugacibus putrescentibus
innatis. *Fl. lapp.* 534. *Fl. suec.* 1119. *Roy. lugdb.* 520.
Mucor vulgaris, capitulo lucido per maturitatem nigro,
pediculo griseo. *Mich. gen.* 215. *t.* 95. *f.* 1.
Mucedo capitulo diaphano deinde viridi & postremo
nigro. *Malp. vegetat. t.* 25. *f.* 108. *p.* 2.
Habitat in variis putridis : pane, plantis, &c."

The first series of references ultimately reduce themselves to the second. The genus *Mucor* was originally founded by Micheli § with four species. A translation of his characterization is as

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* Pages 1185 and 1186. 1753.

† Page 493.

‡ Page 1185.

§ Nova Plant. Gen. 215. *pl. 95.* 1739.

follows: "*Mucor* is a genus of globular plants which are usually stipate but sometimes sessile, all bursting irregularly and containing a cavity in which are numerous small rounded seeds which are affixed to a placenta." With a single exception these characters are all drawn from *Mucor vulgaris* which is further described as having a white head (capitulum) which turns black at maturity and is supported by a grey stripe. The elaboration of the genus is followed by a reference to certain experiments conducted by Micheli, during the autumn and winter of 1718–19, for the purpose of determining the validity of species among the fungi. One of these experiments * deals entirely with *Mucor vulgaris* and is described in detail. On the 5th of November a piece of pumpkin was sown with the spores (semina) of the black mould and placed in the sun. By the 10th of the month the infected portion of the substratum appeared white and was covered with long slender threads resembling white wool. Two days later these were about an inch high and by the 12th were assuming a grayish tint. A few of the filaments also bore white heads which were matured by the 15th. Spores from this culture were sown the next day upon the same substratum and by the middle of January following six generations of *Mucor* had been cultivated from a pedigreed strain.

The account of these experiments contains the key to the identity of Micheli's *Mucor vulgaris* and the Linnaean *M. Mucedo*. They may be duplicated by infecting a piece of pumpkin or sweet potato with the spores of the mould which passes current as *Rhizopus nigricans* Ehrenb. That the identity of these species is beyond question is evident from Micheli's own writings. This conclusion is further strengthened by his reference to Malpighi † who describes the stoloniferous habit of this mould and figures the collapsed columellae.

With this identity in mind it is interesting to trace the "historical usage" of *Mucor Mucedo*. Between 1753 and 1790 this mould was reported from all the principal countries of central and

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* Observatio II. *l. c.* 137.

† Anat. Plant. 2: 64, 65. *pl. 28. f. 108.* Reproduced in Malp. Opera Omnia 1: 142, 143. *f. 108.*

western Europe, and frequently described and figured.[*] The descriptions all agree in a most satisfactory manner, the figures are all referable to the same species, the habitat agrees with that given by Linnaeus and Micheli, the synonymy is in the main correct. No new name was proposed either for this or for a closely related species until Bulliard[†] published his *Mucor sphaerocephalus*, which he himself admits is but a second rechristening of *M. vulgaris*. The first real step toward complicating the synonymy of the species was taken by Tode[‡] when he redescribed it as *Ascophora Mucedo*. Some years later Ehrenberg redescribed the stoloniferous habit of the species, renamed it *Mucor stolonifer*[§] and later made it the type of the new genus *Rhizopus*.[||] A few years later Link[¶] recognized as valid species a number of forms of *Mucor Mucedo* which differed from each other in substratum and in characters for which the substratum and the stage of development would account.

The confusion became so great that Fresenius[**] attempted to bring order out of the chaos. After examining the figures of *Mucor Mucedo* L., *Ascophora Mucedo* Tode and *Rhizopus nigricans* Ehrenb. from the time of Malpighi down, and contrasting the descriptions of these species he decided that there were no characters upon which to separate the genera and that therefore "we had best return to the old genus *Mucor*, and with Link recognize a *Mucor stolonifer* (*Rhizopus nigricans* Ehrenb.) and *Mucor Mucedo*, of which last *Mucor ascophorus* Link and *Ascophorus Mucedo* Tode are merely synonyms." So far the results of this work appear to unravel the nomenclatural tangle of the species in question. Permanent results would have rewarded his labor had he not fallen into a still graver error than that which he strove to counteract,

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[*] Monti, Bononiensi Acad. Comment. 3: 141–159. *pl. 1.* Bologna. 1755. — Hudson, Flora Anglica 504. 1762. — Scopoli, Flora Carniolica 67. 1760. — Wulff, Flora Borussica 1. 1765. — Haller, Hist. Stirp. Helv. 3: 113. 1768. — Oeder, Flora Danica *pl. 467. f. 4.* 1769. — Bolton, Fung. Halifax 3: 132. *pl. 132. f. 1.* 1789. — Lightfoot, Flora Scotica 1072. 1789. — Bulliard, Herb. France *pl. 480. f. 2.* 1789.

[†] *L. c.*, and Champ. France 112. 1791.

[‡] Fungi Meckl. Sel. 1: 13. *pl. 3. f. 22.*

[§] Sylvae Myc. Berol. 13, 25. 1818.

[||] Nova Acta Acad. Leop. 10^1: 198. *pl. 11. f. 1–6.* 1820.

[¶] Willd. Sp. Pl. 6^1: 85ff. 1824.

[**] Beitr. Myk. 4–13. 1850.

and described and figured in detail, under the name of *Mucor Mucedo* L.,* the plant which is now known by that name; this, however, had never appeared in botanical literature until 1791 when Tode described it as *Hydrophora stercorea.*† The *Mucor Mucedo* of Linnaeus and the older mycologists is a black mould which grows profusely upon bread, fruits and other vegetable substances, while the *Mucor Mucedo* of Fresenius and his followers (de Bary, Zimmermann, Brefeld and the vast majority of modern mycologists) is a gray mould which inhabits dung of various animals and appears upon vegetables substances as rarely as does the first species upon dung.

The chief synonymy of the two species of moulds which have at various times passed under the name *Mucor Mucedo* L. is as follows:

1. MUCOR MUCEDO L. Sp. Pl. 1185. 1753.
   Mucor vulgaris Mich. Nova Plant. Gen. 215. *pl. 95. f. 1.* 1729.
   Mucor sphaerocephalus Bull. Herb. France *pl. 480. f. 2.* 1789. Not *M. sphaerocephalus* L. 1753, nor *M. sphaerocephalus* Batsch 1783.
   Ascophora Mucedo Tode, Fungi Meckl. Sel. **1**: 13. *pl. 3. f. 22.* 1790.
   Mucor ascophorus Link, in Willd. Sp. Pl. **6**^{1}: 85. 1824.
   Mucor stolonifer Ehrenb. Sylvae Myc. Berol. 13, 25. 1818.
   Rhizopus nigricans Ehrenb. Nova Acta Acad. Leop. **10**^{1}: 198. *pl. 11. f. 1–6.* 1820.
2. MUCOR STERCOREUS (Tode) Link, in Willd. Sp. Pl. **6**^{1}: 90. 1824.
   Hydrophora stercorea Tode, Fungi Meckl. Sel. **2**: 6. 1791.
   Mucor caninus Pers. Obs. Myc. **1**: 96. *pl. 6. f. 3, 4.* 1796.
   Mucor Mucedo Fres. Beitr. Myk. 7. *pl. 1. f. 1–12.* 1850. Not *M. Mucedo* L. 1753.

NEW YORK BOTANICAL GARDEN.

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* *L. c.* 7. *pl. 1. f. 1–12.* 1850.

† Fungi Meckl. Sel. **2**: 6.

Southwestern localities visited by Charles Wright

ELMER OTTIS WOOTON

Systematic botanists who have tried to work with the plants collected by Charles Wright in the southwestern portion of the United States, know something of the difficulties arising, (1) from the changes of geographical names which have taken place in that region, and (2) from the fact that very few of the sheets show anything but a single printed label, when one looks for locality data.

Each specimen has a number which is referred to in connection with all those species listed in Plantae Wrightianae. Localities are unknown for practically all the other specimens collected. Each plant was collected under its own separate number by Mr. Wright and his field notes containing these numbers are still in existence; but, unfortunately, the plants were not distributed under the collection numbers. Since the labels do not show localities (and sometimes only the year of collection) it is very difficult it not well-nigh impossible to tell where some of the specimens came from in any but the most general way.

The labels for the 1849 collection say "Collected on a journey from San Antonio, Texas, to El Paso, New Mexico," etc., giving the year and the collector's name. At that time New Mexico was a somewhat indefinite area extending from well down in what is now the state of Chihuahua, Mexico, to and including some of southern Colorado, and including some of western Texas, all of Arizona, and a little of Nevada. The El Paso there referred to is not the present Texan city, but is the ancestor, as it were, of the present-day Ciudad de Juarez, just across the Rio Grande from El Paso, and then known as El Paso del Norte.

In making a study of the flora of New Mexico, it has been my fate to meet many of these labels and to wonder (and work for hours without result) as to whence in all that vast expanse a particular plant had come.

Through Dr. Britton I learned of the existence of Wright's field notes and numbers, and by the kindness of Dr. Robinson I was permitted to copy them. They did not give me all the information I wanted (because the distribution numbers were not the same as the collection numbers) but they did set my mind at rest upon a few major points. These points are as follows:

1. Practically all of the plants of the 1849 collection were gathered in what is now the state of Texas. Wright *may* have entered what is now New Mexico on the return journey between October 12 and October 20, but this is quite doubtful, since the party apparently went down the river to San Elezario * and then turned eastward.

2. The plants obtained on the 1851 trip were mostly collected in New Mexico (about Santa Rita),† though all the time from September 2 to October 4 was spent on a trip through southeastern Arizona and northeastern Sonora.

3. Nearly all the plants collected in 1852 were obtained in Texas. He made a ten days trip to Lakes Gusman and Santa Maria in northern Chihuahua, and another of four or five days to Fort Filmore and the Organ Mountains, in southern New Mexico.

A new difficulty arises here, since the specimens of the 1851 and 1852 collections were sent out under the same printed label and it is not possible to tell which specimens were collected each year.

Some of the sheets of Wright's plants in Herb. Gray have Wright's collection numbers penciled on them by Dr. Gray, and I have had the ambition for years to run through that herbarium and correlate these with the distribution numbers as thoroughly as possible, but have never had the time nor the opportunity. I have been able to make such a correlation in regard to a few species, thanks to the kindness of Dr. Robinson.

It has occurred to me that a list of the places visited and the dates on which he was there might be of service to others as it has been to myself, and such a list is here appended in the hope of its being welcome to some workers. This list was compiled from the notes using Wright's phraseology (and spellings) in the main. Where possible I have combined dates applying to a single locality.

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* Map of Mex. Bound. Survey says "San Elceario." Rand and McNally map of Texas, and other recent maps, say "San Elizario."

† Santa Rita del Cobre, the "Cobre" or "Copper Mines" of Wright's notes.

List of localities visited in 1849

Galveston Island,	Ap 28.
Travis County, west of Houston,	My 5.
Prairies near the Brazos,	My 6.
Brazos bottom,	My 7.
Prairies west of Brazos,	My 8.
Near Mill Creek,	My 9.
Cummings Creek,	My 10.
Rutersville,	My 12.
On the Colorado and along it,	My 15, 18, 19, 23, 24, 25.
Austin,	My 23, 24, 25.
San Marcos,	My 27, 28.
On the Blanco,	My 28.
Guadalupe and New Braunfels,	My 29.
San Antonio,	My 30, 31.
Banks of Medina,	Je 1.
Banks of Hondo,	Je 4.
On the Seco,	Je 5.
On the Sabinal and Frio,	Je 6.
Along the Frio,	Je 7.
On the Leona,	Je 8, 9, 12, 13, 14, 15, 16, 18.
Near the Nueces and westward,	Je 19, 20.
Near Turkey Creek,	Je 21, 23, 25, 26, 27, 28.
Live Oak Creek and to Las Moras,	Je 29.
Live Oak Creek and Elm Creek,	Je 30.
Las Moras,	Jl 2.
Piedra Pinta,	Jl 3.
Zacate Creek,	Jl 4, 5, 6.
San Felipe, along and at the head,	Jl 7, 9.
San Felipe, spring and near the creek,	Jl 11, 13, 17, 19, 20, 21.
Between San Felipe and the Devil's River and on the latter,	Jl 22, 23, 24, 25, 26, 28, 30, 31, Au 1, 2.
Approaching the Pecos,	Au 11, 12.
Valley of the Pecos,	Au 13, 14.
Plains and hills beyond the Pecos,	Au 15, 16.
Valley 20 miles beyond the Pecos,	Au 17.
30, 40, 60 miles beyond the Pecos,	Au 18, 20,
80 miles beyond the Pecos,	Au 21.
Bed of Limpio and along it,	Au 22, 23, 24.
Pass of Limpio,	Au 24, 25, 26.
Mountains beyond the Limpio,	Au 26, 27, 28.
Mountains toward the Rio Grande,	Au 29, 30.
Mountains 30 to 40 miles from the Rio Grande and on to 10 miles from the Rio Grande,	S 1, 2, 3.
Valley of Rio Grande 60 to 70 miles below El Paso,	S 4, 5.
Valley of Rio Grande 40 to 60 miles below El Paso,	S 6.
Valley of Rio Grande 25 to 30 miles below El Paso,	S 7.
Valley of Rio Grande 8 to 10 miles below El Paso,	S 8.

Valley of Rio Grande 5 miles below El Paso,	S 9, 11.
El Paso, on mountains and in the river bed,	S 12, 16, 17.
From El Paso to San Elezario,	S 18.
San Elezario,	S 22, 24, 25, 26.
About El Paso, Isleta, and San Elezario,	O 1, 4, 5, 7, 8, 11.
Prairies 6 to 30 miles east of El Paso,	O 12.
Mountains 30 to 40 miles east of El Paso,	O 12, 13, 14.
Guadalupe Mountains,	O 15, 16, 18.
Eastern base of Guadalupe Mountains,	O 18.
Creek tributary to Pecos,	O 20.
Plains between Guadalupe Mountains and the Pecos,	O 20.
Valley of the Pecos,	O 25, 28, 29, 30, 31, N 2.
Margin of Live Oak Creek.	
Devil's River.	
Spring east of Devil's River (15 miles east of crossing).	
San Felipe Creek,	N 12.
Nueces,	N 13.

List of localities visited in 1851

About El Paso,	Jl 4, 5.
About Frontera,	Jl 9, 18, 19.
Rio Grande bottom above Frontera and at the cottonwoods,	Jl 26.
Valley of the Rio Grande below Doña Ana and at Doña Ana,	Jl 28.
From Doña Ana to San Diego,* the crossing of the river,	Jl 29.
Santa Barbara,*	Jl 30.
From Santa Barbara* to Mule Creek and Cook's Spring,	Jl 31.
From Cook's Spring to Mimbres passing Mimbres Mts.,	Au 1.
From Mimbres to Copper Mine Creek,	Au 2.
Copper Mines (along creek, in mountains and ravines near),	Au 4, 5, 6, 8, 11, 12, 13, 15, 18, 19, 20, 22, 23, 26, 27.
Apache de hoo and Ojo de Vaca, †	Au 28.
Near and at Ojo de Gavilan and on toward Conde's camp,‡	Au 29.
From Ojo de Gavilan to Conde's camp and at the latter,	Au 31.
About Conde's camp,	S 1.
From Conde's camp to Sauz de Cienega, §	S 2.

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* Little Mexican settlements about 25 miles north of Las Cruces.

† Apache de hoo probably is the same as Apache Teju (Tayhoó) near Silver City. The R. R. siding is named Apache Tejo. The correct spelling I am unable to find.

Ojo de Vaca is the present Cow Spring, one of the headquarter ranches of the Victoria Land and Cattle Co. near Silver City.

‡ Ojo de Gavilan is Hawk Spring. Conde's Camp was near the Arizona boundary.

§ Sauz de Cienega should probably be Cienega de Sauz, meaning Willow marsh.

From Sauz de Cienega to the Chiricahui Mts.,*	S 3, 4.
Chiricahui Mts. (sides of),	S 4, 5.
Chiricahui Mts. (pass of and valleys west of),	S 5, 6, 8.
Descending to the San Pedro,	S 8.
San Pedro (on banks and near),	S 9, 10, 11.
Mountain valleys from San Pedro to Santa Cruz, †	S 12.
Valleys of Sonora,	S 13, 14.
Valley of a mountain stream, the Sonoita,	S 14, 15.
On the Sonoita near deserted rancho,	S 15, 16, 17.
Mountains near the San Pedro,	S 18.
Margin of the Barboromori at a deserted rancho,	S 19, 20.
Hillsides from the Barboromori towards Santa Cruz,	S 22, 23.
Valleys near Santa Cruz,	S 23, 24.
About Santa Cruz,	S 24, 25, 26, 27, 28, 29.
Branches of the San Pedro,	S 30, O 1.
Heads of Agua Prieta,	O 1, 2.
San Bernardino,	O 3.
Guadalupe,‡	O 4, 5.
Valley of the Sierra de Las Animas,	O 5, 6, 7.
Las Playas springs,	O 7.
From Las Playas to Copper Mines,	O 8.
Copper Mines (on mountains, hillsides, along the creek, etc.),	O 11, 13, 15, 16, 17, 18, 20, 21, 23.
From Cobre to the Mimbres and along the Mimbres,	O 25, 27.
Cobre, on hills and along creek,	O 28, N 1.
Around the hot springs,	N 2.
Bottom of Mimbres and at Cook's Spring,	N 2.
Mule Creek and "Hole in rock,"	N 3.
Bottom of Rio Grande,	N 4, 5, 6.

List of localities visited in 1852

Prairies of the Rio Grande below San Elezario,	F
Hills, stony and sandy, about San Elezario,	Mr 1–14
Stony hills of cañon leading to San Antonio,	Mr 20–22.
Along Rio Grande,	Mr 22–26.
Hills near Frontera,	Mr 26, 27.
Banks of acequia,§ etc. at El Paso del Norte,	Mr 27–29.
Near Frontera,	Mr 29.
Across river from Frontera (8 numbers in N. M.?)‖	Mr 30.
About Frontera,	Mr 31–Ap 5.
Near El Paso del Norte,	Ap 5.
About Frontera,	Ap 6–15.

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* In Arizona.

† In Sonora, Mexico.

‡ In the extreme southwestern corner of New Mexico.

§ Acequia—irrigating ditch.

‖ Frontera was a ranch or small settlement on the east side of the Rio Grande in what is now Texas, a few miles north of El Paso.

* On road to Chihuahua from near El Paso to Cimieluque Sp. 35 miles south,	Ap 17.
* From Cimieluque Sp. to the Salado,	Ap 18.
* Valley of the Salado,	Ap 18.
* Salado to Lake Santa Maria,	Ap 19.
* Lake Santa Maria,	Ap 20.
* Lake Gusman,	Ap 21.
* Lake Gusman to Frontera,	Ap 23.
About Frontera,	Ap 24–27.
† Camp Filmore,	Ap 29.
† Organ Mts.,	Ap 29, 30.
Rio Grande bottom,	My 2.
Near Frontera,	My 3–10.
About El Paso del Norte,	My 10–15.
At Frontera,	My 15–18.
Near El Paso,	My 19.
Near San Elezario,	My 25, Je 1, 2, 3, 7, 9, 14, 15, and 16.
Rio Grande bottom,	Je 17, 18, 19.
Rio Grande at Eagle Spring,	Je 21.
Eagle Spring to Van Horn's Wells,	Je 22.
Van Horn's Wells to Dead Man's Hole and Rain-Water Creek,	Je 23.
Rain Water Creek to Rock Creek,	Je 24.
Rain Water Creek to Limpio,	Je 25.
Head of the Limpio,	Je 26.
Along the Limpio and to Ojo de Leon,	Je 27.
Leon Spring,	Je 28.
Leon Spring to Comanche Spring,	Je 29.
Comanche Spring to Escondido Spring and along Escondido Creek and on to the Pecos,	Je 30.
Valley of the Pecos,	Jl 1, 2.

AGRICULTURAL COLLEGE, NEW MEXICO.

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* In northern Chihuahua.

† In southern New Mexico.

Tannin cells of persimmons

BURTON JAMES HOWARD

The fact that the tannin in persimmons becomes highly localized during the process of ripening was pointed out by the Japanese investigator Aso * in 1900. He calls the cells "tannin sacs," but all he mentions concerning them is that the tannin is stored in large cells, and he accredits its deposition largely to the action of an oxydase. He also indicates that a browning of the tannin mass also occurs. A still later article upon the subject is that of Tichomirow,† in which certain microchemical characteristics of the bodies are brought out, but apparently this author worked only on ripe fruits, for none of the progressive changes during ripening are noted. Because of the meagerness of some of the facts given it was deemed well to look somewhat further into this phenomenon in connection with chemical work being undertaken by the Bureau of Chemistry, because it was thought it might shed some light on some of the chemical results obtained. Cells of a form somewhat similar to those present in persimmons are present in the Saint John's bread (*Ceratonia Siliqua*) and here also serve for the deposition of tannin. At a recent meeting of the Washington Botanical Society, Mr. Walter Swingle described such cells, occuring in the flesh of the date, which he termed "giant cells" because of their great size.

We have chosen to call these cells tannin cells, for though in some varieties they are very large, yet in others they vary only little from the other parenchyma-cells in their vicinity. In the persimmon the tannin cells occur in the wedge-shaped portions of flesh between the carpels. They appear simply as specialized parenchyma-cells, from which they differ hardly at all excepting in size in the earlier stages of ripening. The shape and size of the

---

* Aso: A physiological function of oxydase in Kaki-fruit. Bot. Mag. Tokyo 14: 179. 1900.

† Tichomirow: Sur les inclusions intracellulaires du parenchyme charnu de certains fruits. Compt. Rendus Acad. Sci. Paris 139: 305. 1904.

tannin cells vary widely in the American, Chinese and Japanese types. In the wild persimmon varieties of eastern North America, the cells are about the same size and shape as the other parenchyma-cells around them, being nearly isometric in shape (FIGURE 1). The Chinese variety, which was kindly sent us by Mr. Taylor of the Office of Pomological Investigations, was found to contain an immense number of these cells, which were not very greatly different from those found in the American type, though commonly somewhat pointed at the ends (FIGURE 2). The most remarkable tannin cells both as regards size and shape occur in the Japanese varieties. In this type the cells are commonly cigar-shaped, in some cases being five or ten times as long as wide and having an actual length of one millimeter or more (FIGURE 3). If a small portion of the soft pulp from a thoroughly ripened fruit is spread upon a slide or allowed to flow down the side of a test tube, the individual cells can easily be seen with the naked eye. These differences as shown in the different kinds are of especial interest in

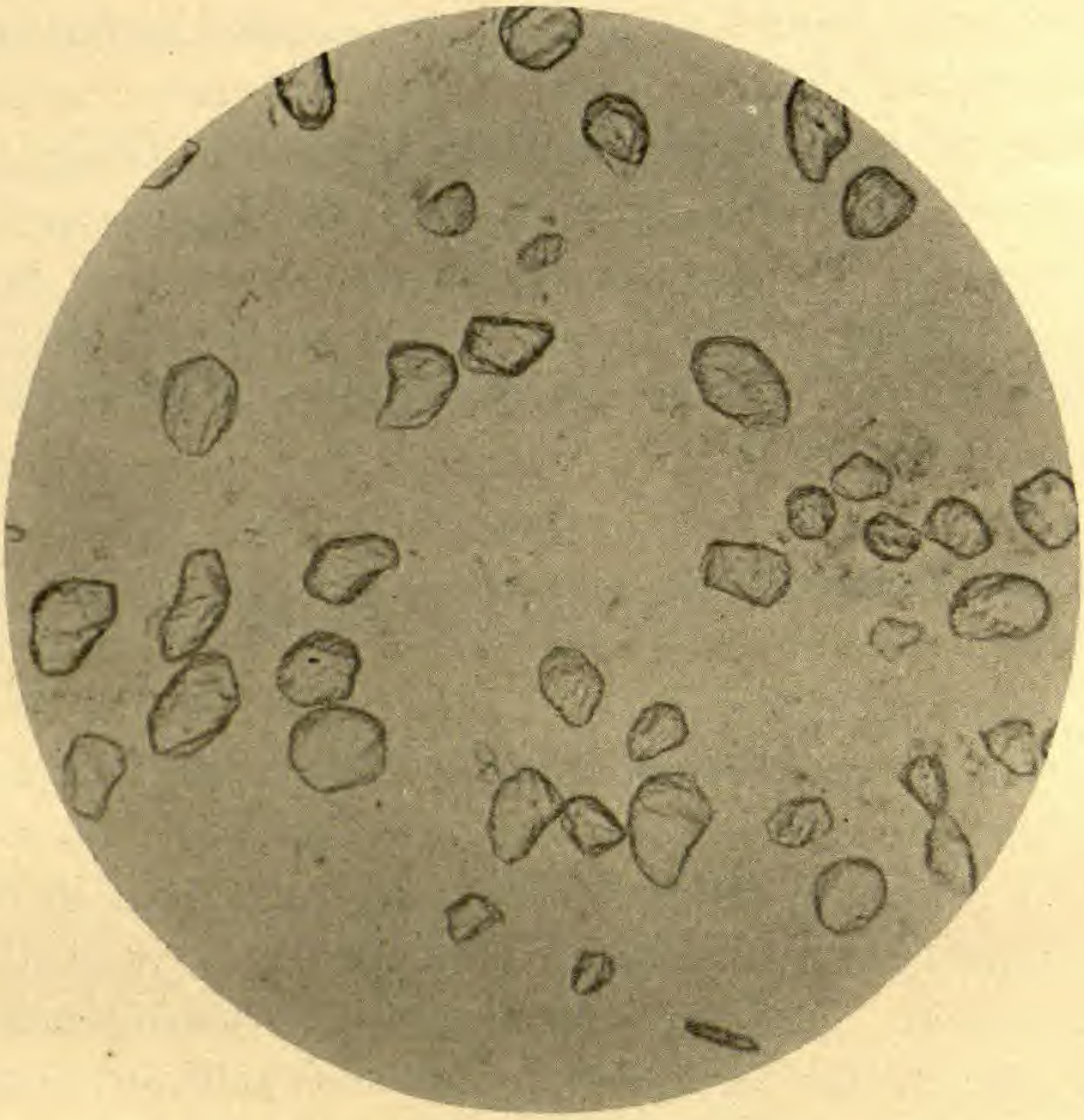

FIGURE 1. Tannin cells from wild American persimmons. × 25.

view of somewhat similar differences occurring in different kinds of dates, as was pointed out by Mr. Swingle.

In portions of the tissue where these cells occur in great abundance there seem to be special modifications in shape by which nearly adjacent tannin cells are in touch with each other. This is accomplished by small protuberances extending from one cell toward another of like character meeting similar projections from the other cell midway. This is shown in FIGURE 4. Such arrangement seems very manifest in the Japanese variety, from which the illustration was made. The actual communication between the cells seems to be no more free than is usual among parenchyma-cells, inasmuch as only pore-like perforations appear to be present.

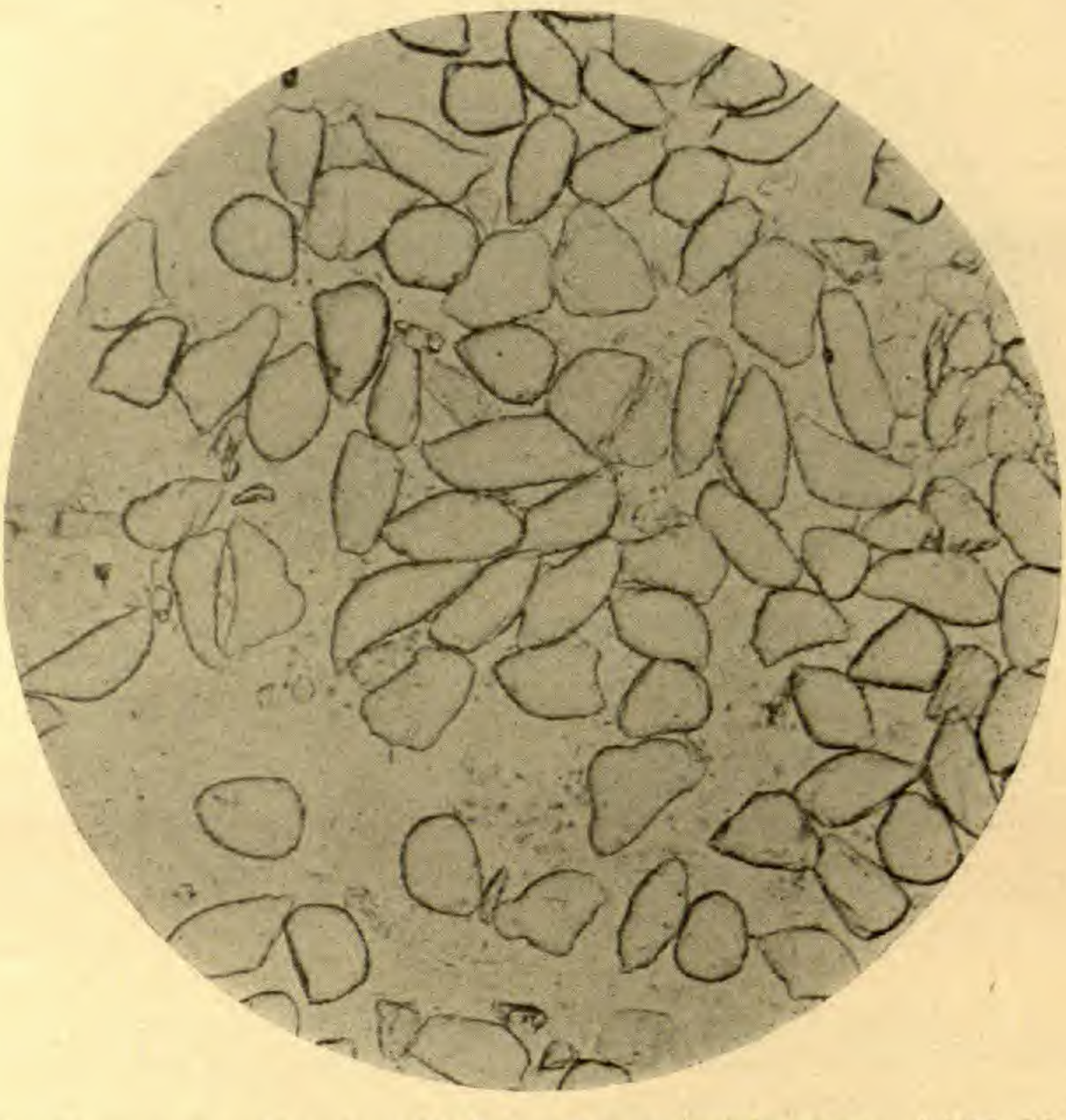

FIGURE 2. Tannin cells from Chinese persimmons. × 25.

For the sake of convenience of description, the ripening process of persimmons may be divided into three stages which shade off by imperceptible degrees from one into the other, viz: the green, the transitory, and the ripe.

In the green stage the tannin does not appear to be strongly localized, for though it appears most abundantly in the loose parenchyma-tissue where the tannin cells are located, yet it is not limited to these cells nor even to the region where the cells are most abundant. Microchemical tests show that tannin is abundant in most of the cell-sap of the parenchyma-cells and even in the intercellular portions. In this stage it is somewhat difficult to identify the cells which are afterwards to figure as tannin cells except by means of the size and shape, which as noted above strongly differentiate them in some varieties. At this stage the cell-contents appear to be in as perfectly liquid condition as any other cells around them.

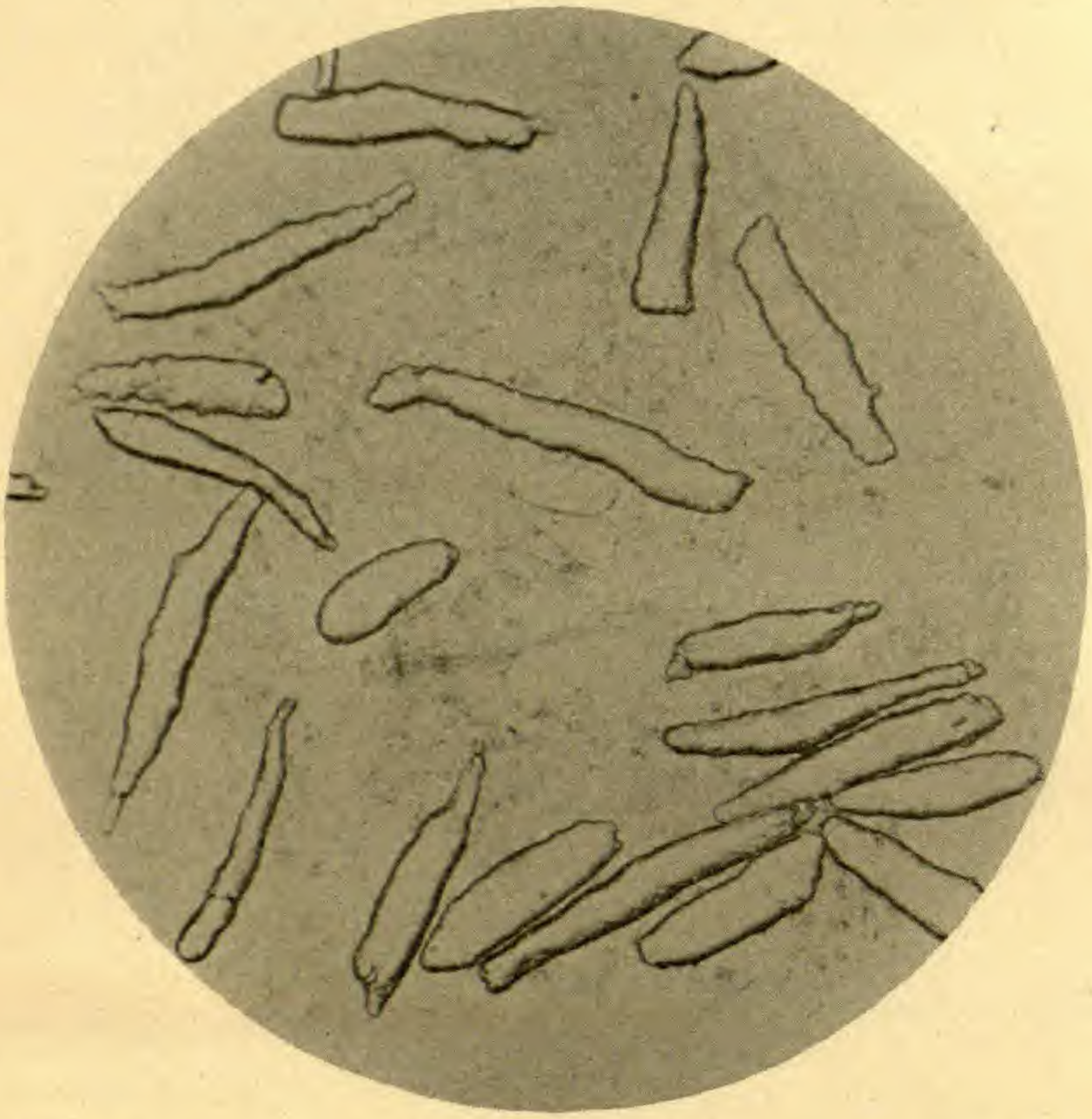

FIGURE 3. Tannin cells from Japanese persimmons (Kaki). × 25.

The second stage of ripening, the transitory, is the one in which the most radical changes occur in the physical and possibly in the chemical constitution of the tannin. This stage in the native American variety is signalized by a slight decrease in the firmness of the fruit, and not long afterward by a marked tendency toward softening. Examination of the tissues in the early part of this stage will show that most of the tannin is being or has been collected into the tannin cells. The contents of the cells are becoming more highly refractive and from this fact the cells can be identified with considerable ease, even without any tannin test. The middle lamellae have softened sufficiently to allow the cells to be separated without rupturing the walls. At about the middle of this stage a large proportion of the tannin cells show vacuoles between the tannin mass of the cell and portions of the cell-wall (FIGURE 5). If the material is mounted in the fruit juice these vacuoles remain unchanged, but if water be added the tannin mass expands, fills out the vacuoles, and, if allowed to continue absorbing, there results a rupturing of the cell-wall. This is then followed by part of the cell-contents being forced out into the surrounding media. In the early part of this stage the contents thus escaping mingle readily with water, but later on the material forms a globular-shaped portion on the sides of the cell. Such a condition is shown in

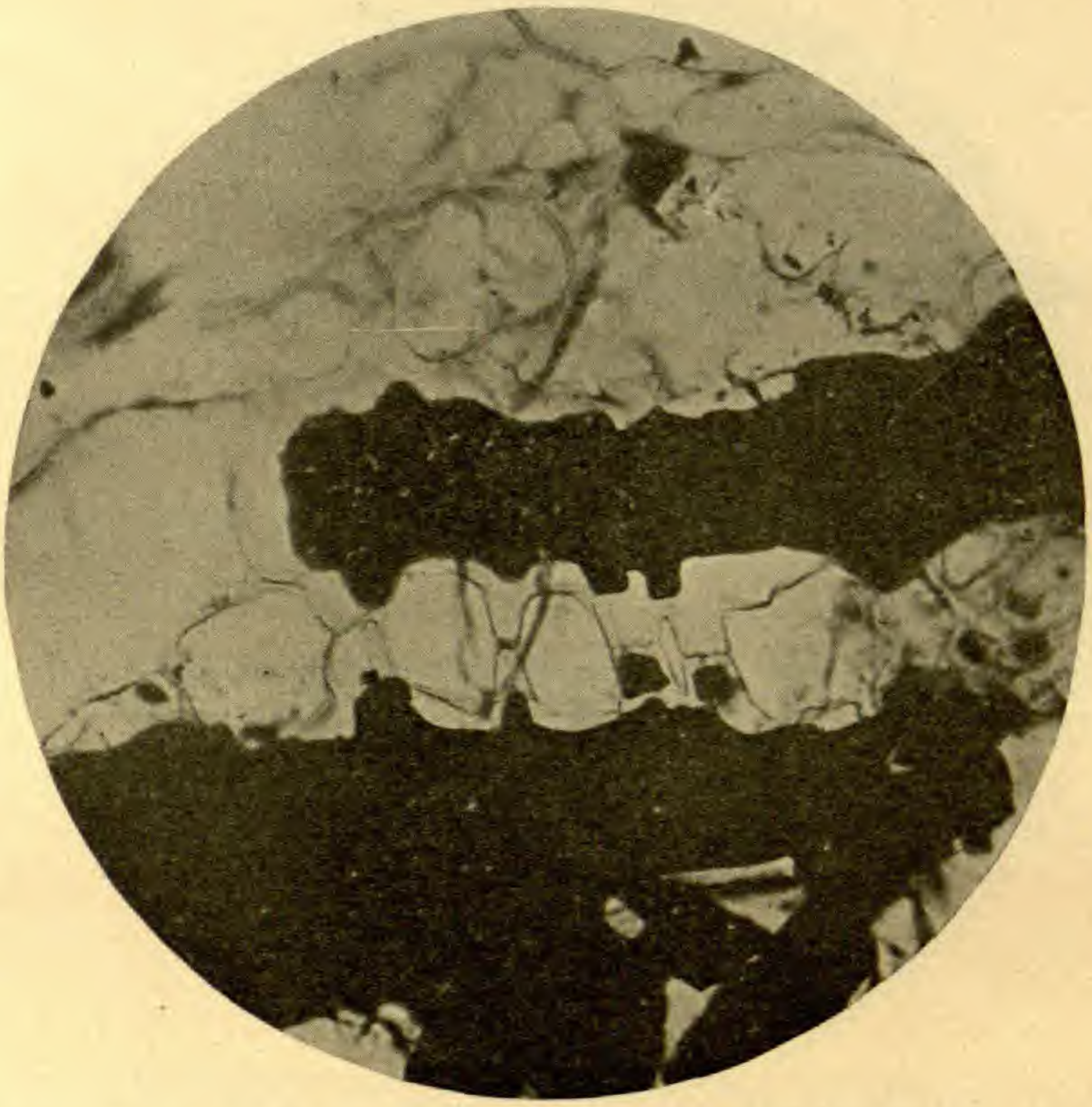

FIGURE 4. Section of Japanese persimmon, showing projections extending between adjacent cells. Tannin cells (masses) dark and somewhat shrunken away from the cell-wall. × 150.

FIGURE 6. There is no definite portion of the cell-wall where rupture occurs; sometimes this happens at one end and at other times at some point along the side of the cell. The form of energy producing the bursting is undoubtedly osmotic pressure, for solutions of fairly strong osmotic power cause no increase in size or bursting when pulp cells are mounted in them. In order to demonstrate this we used glycerine solutions as well as aqueous solutions of sodium chloride, potassium bromide, potassium iodide and sodium sulphite. Even the tannin reaction with fairly strong iron chloride solution proceeds with exceeding slowness where rupture of some kind has not occurred. It appears that if the iron chloride solution is about isotonic with the solution within the cell, sufficient water cannot pass in to produce rupturing and thus bring the cell-contents in contact with the reagent; and furthermore that the iron salts are prevented, except in comparatively few instances, from passing into the cells and producing the color reaction there.

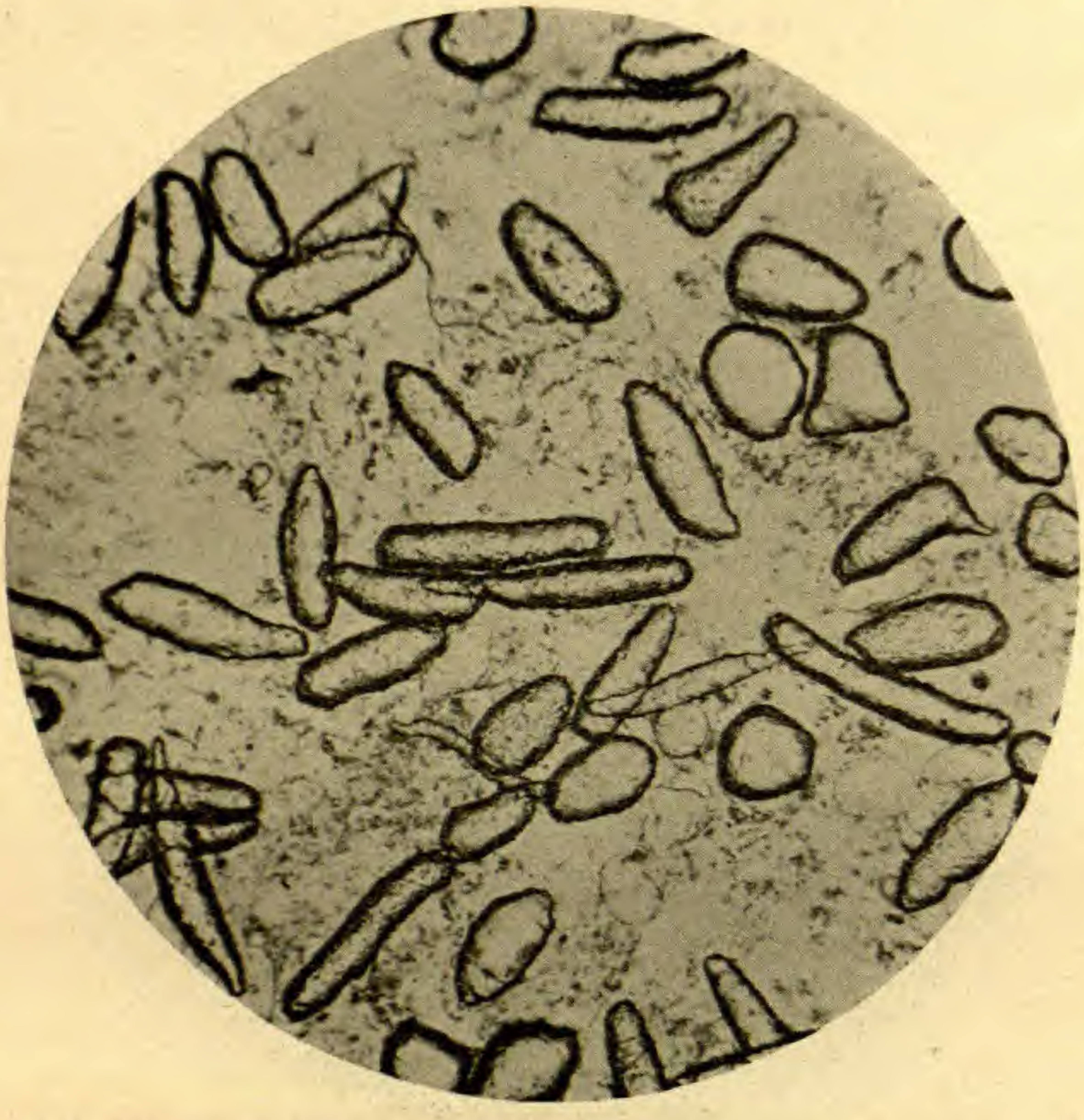

FIGURE 5. Japanese persimmon tannin cells (masses), showing small vacuoles on surface. × 25.

The above facts show very convincingly why it is that in eating partially ripe persimmons they first produce a fine sweet taste, while it usually takes about half a minute for the taste to detect any astringency; this of course being due to the fact that the saliva, being a liquid of low osmotic strength, causes in a few seconds a swelling and rupturing of the tannin cells and finally the consequent development of astringency. Fruit-pulp in this stage of development if mixed with water changes only slowly. When rupturing and contact with water has finally occurred there appear after a short time, even to the naked eye, whitish particles. These on further examination are found to be the expelled cell-contents, which on coming in contact with abundance of water have assumed a white granular condition.

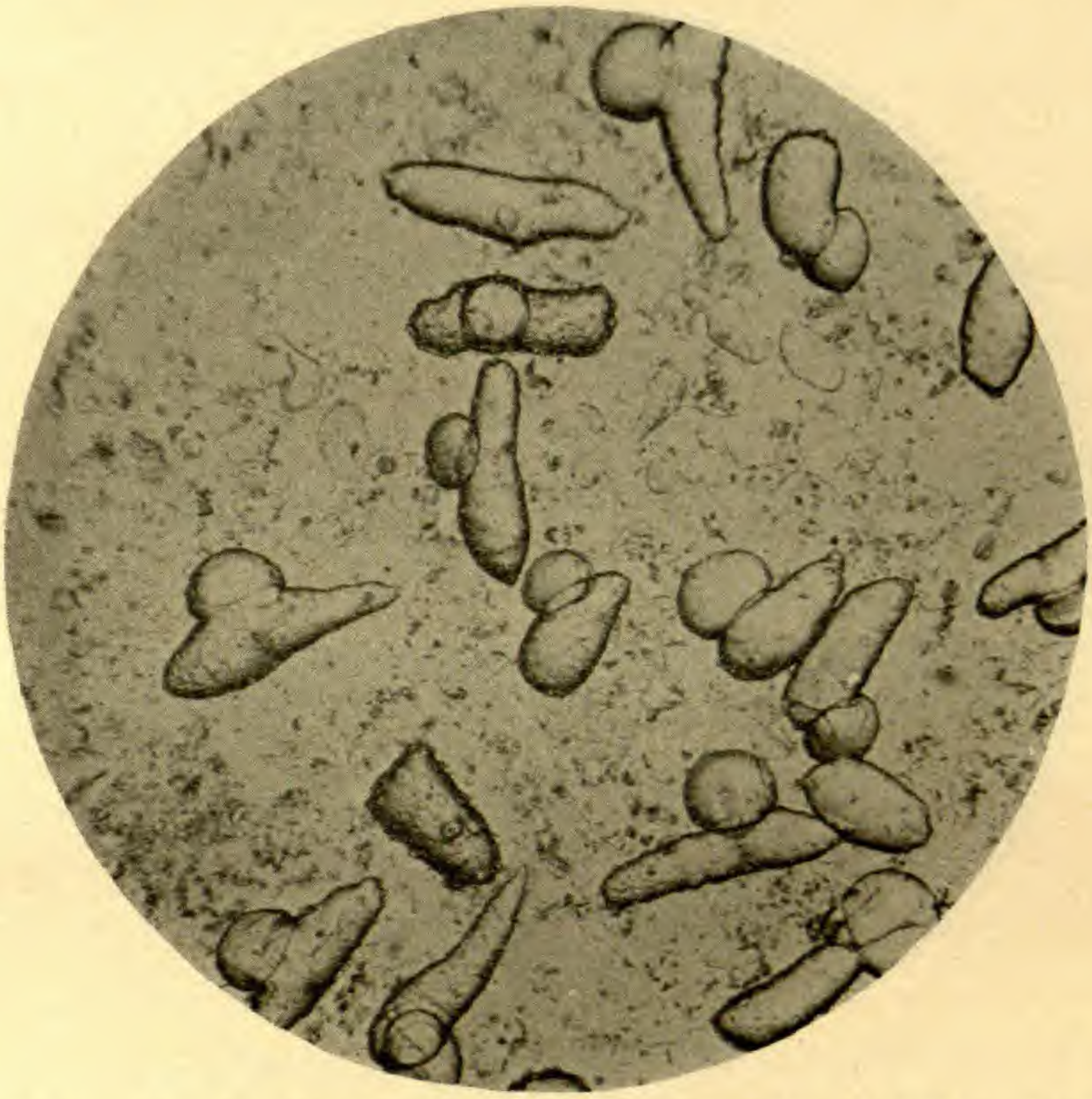

FIGURE 6. Tannin cells after bursting, showing tannin globule on side of cells. × 25.

The writer has also observed that solutions considerably stronger than those necessary to maintain equilibrium will produce a shrinking of the cell-contents. This is of course what might be naturally expected when the cause of the swelling is considered.

When the last stage of the change has been reached the tannin masses have a very high refractive power. The addition of water causes but little, if any, swelling, and the contents are friable, pressure upon the cover slip resulting in the fracturing of the tannin mass into irregular fragments (FIGURE 7). These fragments tested for tannin give strong reactions showing that no fundamental change has taken place in the distinctive character of the tannin radical. This stage of ripening is evident to the taste, for all astringency has now disappeared. Right here it may not be out of place to call attention to the fact that finally the tannin masses may be either of watery clearness in color or else of dark amber-brown color. There is, however, a difference in surface outline of the two kinds, in that the clear form has a fairly even surface with more or less of slight wrinkling while in the brown type hemispherical hollows in the surface seem to be always present in greater or less extent (FIGURE 8). Hollows are very rarely observed in the clear type. The brown type has not been observed

FIGURE 7. Tannin cells in ripe condition, after pressure has been applied, breaking the mass into fragments. × 25.

in any of the wild American fruits. The brown-colored cells are much harder than the clear type, giving in the process of mastication almost the sensation of the stone-cells in some fruits. The reaction with tannin reagents develops more slowly in this than in the clear kind. The brown type of the tannin mass is the only one referred to by Aso, and he considers that it is a result of an oxidation occurring in the tannin during the process of deposition. The present writer, however, fails to see that any such change in color is of necessity connected with the localization of the tannin, but rather thinks that it indicates secondary changes which have occurred after the deposition of the tannin has been completed.

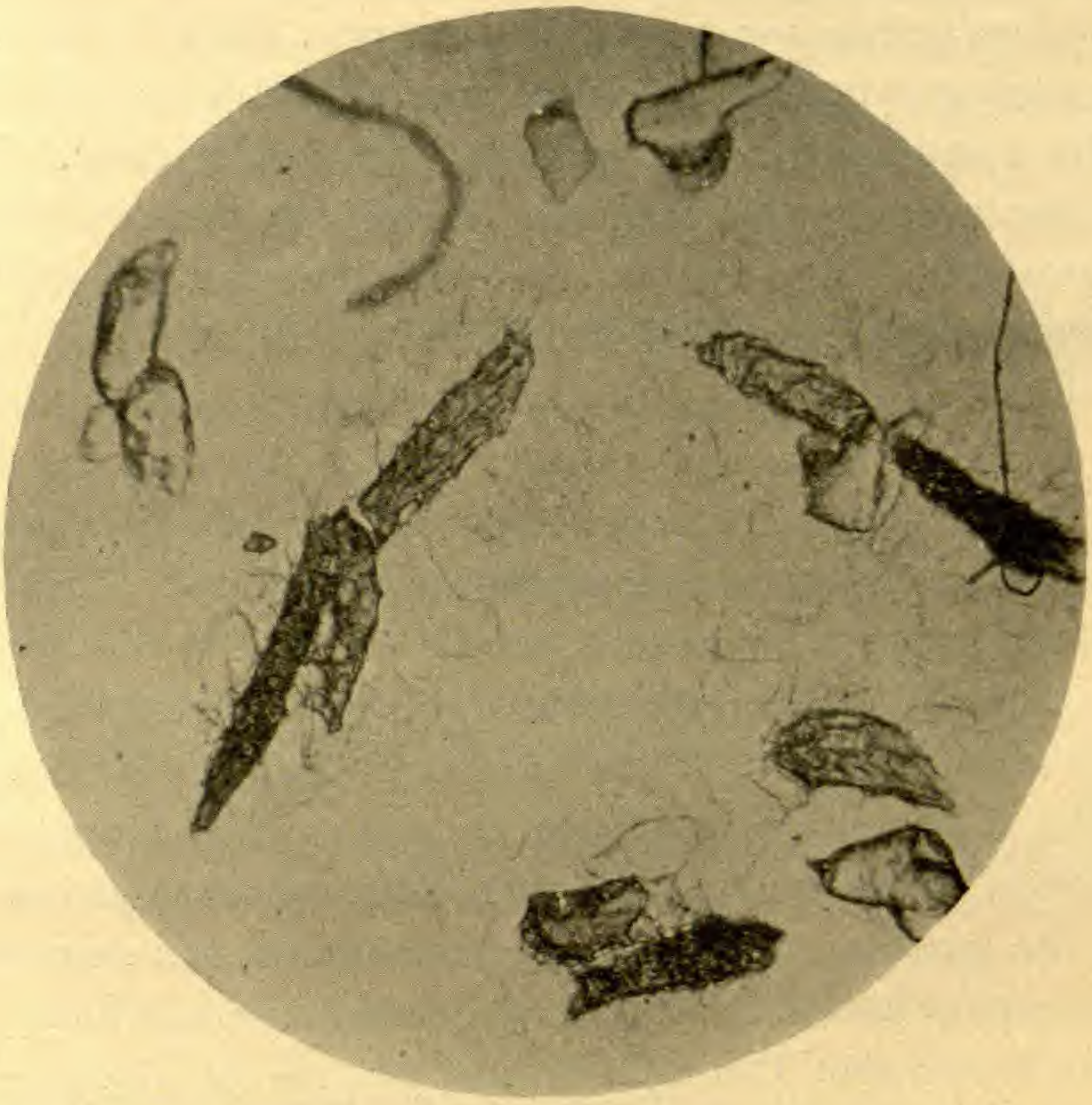

FIGURE 8. Brown tannin masses (cells), showing depressions or hollows. × 25.

In a few Japanese persimmons sent from the Alabama Experiment Station only one showed these brown tannin masses even when the fruit was firm and strongly astringent. They were also present in the sample furnished by Mr. Fairchilds which had been cured in saki barrels, but we are inclined to believe that the saki had nothing to do with their presence there.

Experiment also demonstrated that fruit packed in a container with vapors of chloroform lost its astringency much quicker than those simply kept in a container without the chloroform, but there was developed at the same time a marked increase in the degree of mushiness.

Another feature which is commonly associated in our minds with the ripening of persimmons, is the development of mushiness. This feature, however, does not run parallel, stage for stage, with changes in the tannin, for it not infrequently occurs that mushiness develops before the astringency is gone, while in other cases just the reverse is true. The latter case is notably so in specimens artificially cured by the saki process. In this method, which is largely employed by the Japanese in ripening their varieties, the fruit is stored for a few days in empty saki barrels. At the end of the treatment it is found that the tannin has all been localized and rendered insoluble in water, though the flesh of the fruit is nearly as firm as that of an ordinary apple. From this it seems that the change in the physical characteristics of the tannin is not at all closely related to the development of mushiness. This makes highly improbable a hypothesis, which we at first thought might be true, namely, that as the middle lamella was rendered soluble in the process of ripening it in some way combined with the tannin, producing a compound insoluble in water. Mr. Gore, of these laboratories, in his studies into the chemical changes occurring during the process of ripening of persimmons, has demonstrated that the sum of tannin and marc (pulp less alcohol-soluble matter) is nearly a constant throughout the process of ripening; from which it seems improbable that the tannin combines with any soluble substance, such as sugar, producing an insoluble compound; for, as shown above, the tannin to the end of the ripening process maintains its power of color reaction toward tannin reagents such as iron salts and chromic compounds.

BUREAU OF CHEMISTRY,
UNITED STATES DEPARTMENT OF AGRICULTURE.

Two new coralline algae from Culebra, Porto Rico

M. FOSLIE AND M. A. HOWE

(WITH PLATES 23–26)

Since the publication of our paper on "New American Coralline Algae,"* the island of Culebra, lying between Porto Rico proper and St. Thomas and now occupied by the United States as a naval station, has been visited by a collecting party from the New York Botanical Garden. Several coralline algae were secured there, including two rather large and conspicuous kinds which are quite different from any hitherto reported from the West Indian region and are, we think, entitled to characterization as new species. Descriptions of these two species are herewith given:

Goniolithon acropetum Fosl. & Howe, sp. nov.

Attached by a rather inconspicuous hypothallus and forming cespitose or difform masses mostly 4–12 cm. high, the single clusters usually 6–15 cm. in diameter, but often confluent and apparently larger; branches repeatedly subdichotomous, much anastomosed, compressed or subterete, 1.25–3.10 mm. in diameter, and subtruncate-capitate, or very often much dilated either at apex only or throughout and then forming flabella or foliar laminae 10–25 mm. broad (including anastomoses) and 1–2 mm. thick or commonly thicker in basal parts, the dilated portions often anastomosing in such a way as to form somewhat tubular or subinfundibuliform communicating interstices, the terminal flabella sometimes crested with short subterete or dentiform innovations; younger branches all conspicuously decutescent, the exfoliations papyraceous, revolute, and more or less concentric or zonate: medullary hypothallic cells 14–40 μ × 11–20 μ; perithallic cells 11–21 μ × 9–14 μ, heterocysts numerous; conceptacles of sporangia subconical becoming mammilliform, about 1 mm. in diameter; sporangia 4-parted, 90–168 μ × 40–102 μ. (FIGURE 1 and PLATES 23, 24.)

Growing on corals and on other *Melobesieae* in about 1–4 dm. of water (low tide) in a reef-sheltered cove near the mouth of the

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* Bull. N. Y. Botanical Garden 4: 128–136. *pl. 80–93.* 17 Mr 1906.

main harbor of Culebra Island, Porto Rico (M. A. Howe, 3 March, 1906, *no. 4224*).

Goniolithon acropetum is probably most nearly allied to *Goniolithon frutescens* Fosl. f. *flabelliformis*, of the South Pacific, originally described * from Funafuti, but is evidently quite distinct from that species, being coarser,† more anastomosed, often much more widely dilated, and more conspicuously decutescent; the conceptacles of sporangia are somewhat larger (about 1 mm. diameter *vs.* 500–600 μ in *G. frutescens*) and are rather less abruptly conical, and the sporangia attain larger dimensions (reaching maxima of 168 μ in length and 102 μ in width *vs.* 110 μ and 50 μ in *G. frutescens*); the perithallic layer is thicker, and after decalcification the cells of both perithallium and medullary hypothallium appear more rounded at the angles and firmer-walled than in *G. frutescens.*

Conditions of *Goniolithon acropetum* with subterete branches sometimes bear a slight resemblance to forms of *G. strictum* Fosl., but are coarser, less fragile, and have less tapering branches. A small form of *G. strictum* was found growing within half a mile of *G. acropetum* and was always abundantly distinct.

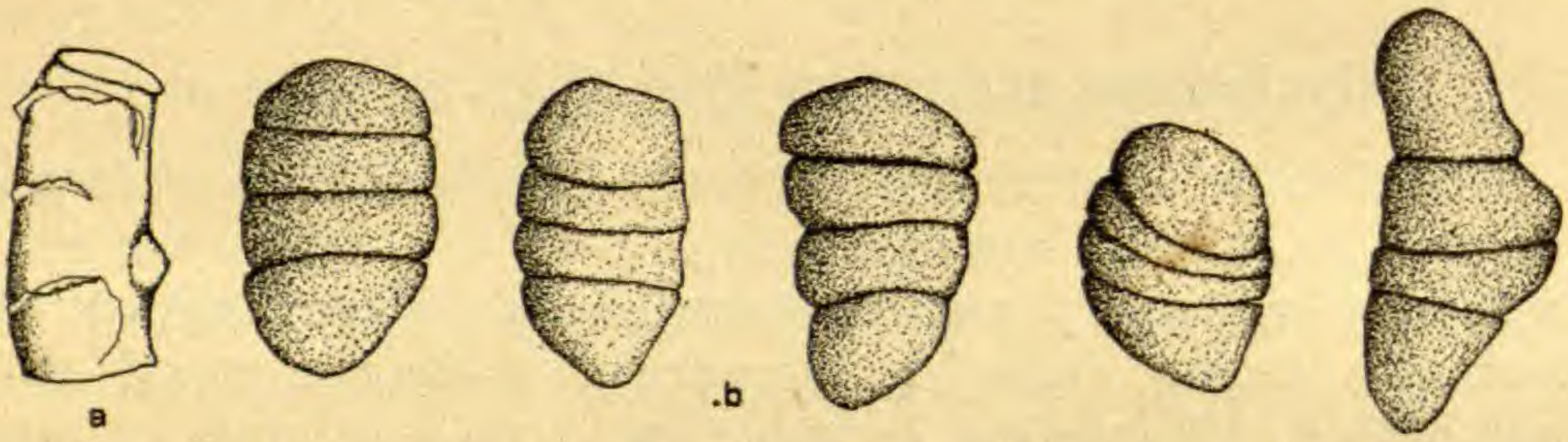

FIGURE 1. *Goniolithon acropetum; a*, end of a terete branch showing tetrasporangial conceptacle and exfoliations, × 5; *b*, tetraspores, × 150.

On the other hand, forms of *Goniolithon acropetum* with dilated, flabelliform branches have a certain superficial resemblance to *Lithophyllum platyphyllum* Fosl. (St. Martin, West Indies) and *Lithophyllum daedaleum pseudodentatum* Fosl. & Howe (Porto Rico), but have really no close affinity with either of these. Both of the last named forms are either not at all decutescent or flake off only minute and irregular scales.

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* Det Kgl. Norske Videnskabers Selskabs Skrifter. No. 1. 1900.

† Compare published photographs of *G. frutescens* f. *typica*, in The Fauna and Geography of the Maldive and Laccadive Archipelagoes 1: *pl. 25. f. 4;* and in Corallinaceae Siboga-Exped. *pl. 10. f. 7–9.* 1904.

Lithophyllum Antillarum Fosl. & Howe, sp. nov.

Thallus grayish-pink or decolorate when living, becoming pallid or greenish-pallescent on drying, forming often somewhat columnar rather flat-topped masses 10–30 cm. high and 8–20 cm. broad; branches much fused, forming in the basal parts an almost solid mass with more or less lacunae, the irregular and somewhat daedaleoid anastomoses extending nearly to the irregularly pyramidal, somewhat prismatic, subconical, compressed or occasionally subterete, often truncate or retuse apices, the free portions mostly 5–25 mm. broad and 3–12 mm. thick, often enlarging upward, the interstices commonly tubular or irregularly infundibuliform; surface smooth or subpulverulent, or, especially at the sides, minutely corrugated or rugulose; medullary hypothallic cells 7–18 μ × 7–10 μ, sometimes forming (in a longitudinal section) irregularly alternating rows of one short and two long cells; perithallic cells subquadrate or roundish, 7–10 μ in diameter; short rows of larger cells (20–33 μ × 14–20 μ) occurring here and there in both medulla and perithallium: conceptacles of sporangia convex, but little prominent, 150–300 μ in diameter: sporangia 4-parted, 38–70 μ × 20–40 μ. (FIGURE 2 and PLATES 25, 26.)

Growing at low-water mark on a coral reef at Flamingo Bay, Culebra Island, Porto Rico (M. A. Howe, 7 March 1906, *no. 4373*).

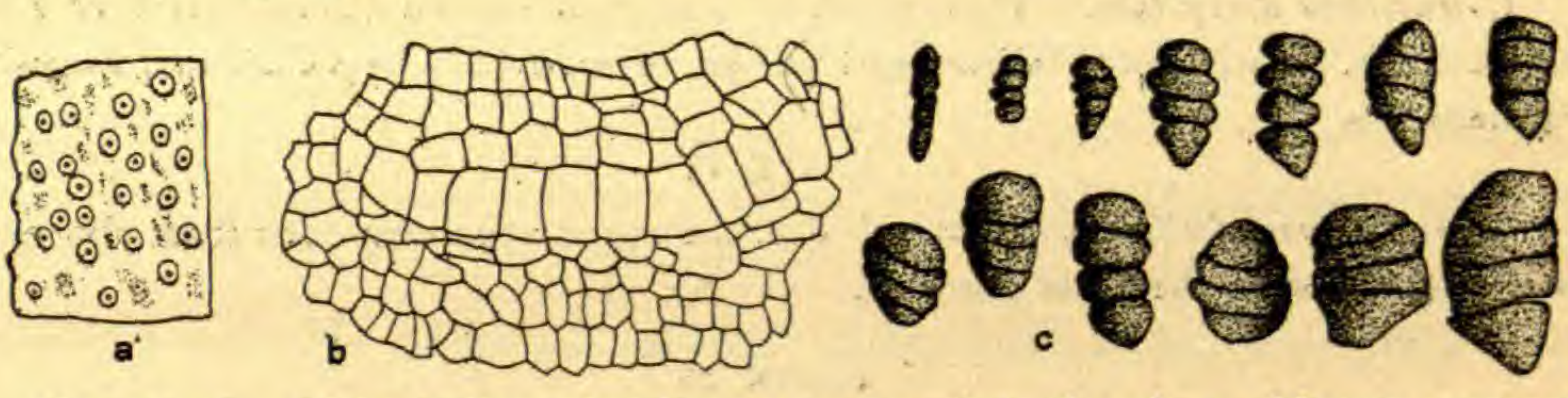

FIGURE 2. *Lithophyllum Antillarum*; *a*, portion of surface with tetrasporangial conceptacles, × 5; *b*, portion of a radio-vertical section, showing row of enlarged cells × 232 (the cells should be more rounded at the angles, as indicated in photomicrograph, PLATE 26); *c*, tetraspores, × 150.

Lithophyllum Antillarum is evidently a reef-builder. In general habit it bears some resemblance to coarse forms of *Lithophyllum africanum* Fosl. (Cape Verde) and to well-developed conditions of *Lithophyllum craspedium* Fosl., a species originally described from specimens brought from Funafuti and since discovered in the Maldives (see Fauna and Geography of the Maldive and Laccadive Archipelagoes, 1: *pl. 25. f. 1*). It is perhaps the more closely related to the latter species, agreeing essentially in structure even to the possession of the peculiar short rows of enlarged cells apparent at frequent intervals in a radio-longitudinal section (FIGURE 2, *b* and PLATE 26; see also Corallinaceae Siboga-Exped. 59), but the West Indian plant is rather coarser and is considerably different in habit as will be seen by comparing our photograph (PLATE 25) with that of *L. craspedium* cited above, the branches being more inclined to increase in size upward and anastomosing in a more gyrose or daedaleoid fashion. We believe it should bear a distinctive specific name, at least until further collections give better grounds for understanding the relationships of West Indian forms to those of the South Pacific and Indian oceans. *Lithophyllum africanum* is less coarse than *L. Antillarum*, its branches are thinner, and more frequently subterete or compressed, though sometimes dilated and rather foliar, its medullary cells after decalcification are firmer-walled and more rounded at the angles, and the short rows of enlarged cells are rare.

Explanation of plates 23-26

PLATE 23

Goniolithon acropetum, natural size; the topmost specimen is the type.

PLATE 24

Goniolithon acropetum. Photograph of a sagittal section (decalcified) of a flattened branch, showing perithallium and portion of medullary hypothallium, magnified 165 diameters.

PLATE 25

Lithophyllum Antillarum, natural size, the upper specimen seen from above, the lower from the side; the latter the type.

PLATE 26

Lithophyllum Antillarum. Photograph of radio-vertical section (decalcified) from the medullary hypothallium, magnified 165 diameters. The direction of growth is towards the upper left-hand corner.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1906)

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

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

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Becker, W. *Violae* andinae. Bot. Jahrb. **37**: 587–592. 30 O 1906.

Descriptions of 7 new species.

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Berry, E. W. The flora of the Cliffwood clays. Ann. Rep. State Geol. N. J. **1905**: 135–172. *pl. 19–26.* 1906.

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Rubus trifrons sp. nov., from Vermont.

Blanchard, W. H. Some Maine *Rubi.* The blackberries of the Kennebunks and Wells. I. Rhodora **8**: 146–157. 3 S 1906; — II. Rhodora **8**: 169–180. 8 O 1906; — III. Rhodora **8**: 212–218. N 1906.

Includes descriptions of 18 new species and several new varieties.

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Native of Mexico.

Charles, V. K. Occurrence of *Lasiodiplodia* on *Theobroma Cacao* and *Mangifera indica.* Jour. Myc. **12**: 145, 146. 29 S 1906.

Clarke, C. B. *Cyperaceae andinae.* Bot. Jahrb. **37**: 517–519. 30 O 1906.

New species in *Cyperus*, *Rynchospora*, *Eleocharis*, and *Carex*.

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Collins, F. S. *Acrochaetium* and *Chantransia* in North America. Rhodora **8**: 189–196. 25 O 1906.

Two new species are described in *Acrochaetium*.

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Copeland, E. B. New Philippine ferns. Philipp. Jour. Sci. Suppl. **1**: 143–167. *pl. 1–28.* 15 Je 1906.

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Includes 13 new species in 8 genera.

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Labatia discolor sp. nov.

Dowell, P. Observations on the occurrence of Boott's fern. Torreya **6**: 205–209. 25 O 1906.

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Gilbert, B. D. *Polypodium vulgare* var. *alatomultifidum*, var. nov. Fern Bull. **14**: 105. [N] 1906.

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With description of a new species in *Malesherbia*.

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Hackel, E. *Panicum* (*Eupanicum*) *Türckheimii* Hack. nov. spec. Allgem. Bot. Zeits. **12**: 60. 15 Ap 1906.

Native of Guatemala.

Harms, H. & Loesener, T. *Staphyleaceae* andinae. Bot. Jahrb. **37**: 575. 30 O 1906.

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The number of species is estimated at about 60: only 45 are mentioned by name, however, of which 19 are described as new.

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Kränzlin, F. *Orchidaceae* andinae, imprimis peruvianae Weberbauerianae. IV. Bot. Jahrb. **37**: 520–528. 30 O 1906.

Includes new species in *Pleurothallis*, *Epidendrum* (3), *Schomburgkia*, and *Chloraea*.

Krause, K. *Borraginaceae* andinae. Bot. Jahrb. **37**: 627–636. 30 O 1906.

New species in *Cordia* (5), *Tournefortia* (3), *Heliotropium* (4) *Cynoglossum* (3), and *Lithospermum*.

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Four new species in *Pilea*.

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Includes four new species in *Mauria*.

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New species in *Trattinickia* and *Pachylobus*.

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Merrill, E. D. New or noteworthy Philippine plants, V. Philipp. Jour. Sci. Suppl. **1**: 169–246. *pl. 1.* 15 Au 1906.

Includes descriptions of 95 new species in 66 genera.

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Osterhout, W. J. V. The rôle of osmotic pressure in marine plants. Univ. Calif. Pub. Bot. **2**: 229, 230. 15 Mr 1906.

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Peck, C. H. A new species of *Galera.* Jour. Myc. **12**: 148. *pl. 89.* 29 S 1906.

G. Kellermani.

Peirce, G. J. Studies of irratability in plants. The formative influence of light. Ann. Bot. **20**: 449–465. *pl. 35.* O 1906.

Pilger, R. *Gramineae* andinae III. Bot. Jahrb. **37**: 504–517. 30 O 1906.

Includes new species in *Sporobolus*, *Trisetum* (2), *Poa* (2), *Festuca* (13), and *Bromus*.

Pilger, R. *Plantaginiaceae* andinae. Bot. Jahrb. **37**: 643–646. 30 O 1906.

Includes 5 new species in *Plantago*.

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Piper, C. V. Notes on *Calochortus*. Bull. Torrey Club **33**: 537–540. 8 N 1906.

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Native of Brazil.

Rolfe, R. A. *Chloraea virescens*. Curt. Bot. Mag. IV. **2**: *pl. 8100*. 1 O 1906.

Native of Chile.

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Native of Peru.

Rolfe, R. A. *Odontoglossum naevium*. Curt. Bot. Mag. IV. **2**: *pl. 8097*. 1 O 1906.

Native of Colombia.

Ruhland, W. *Eriocaulaceae* andinae. Bot. Jahrb. **37**: 519, 520. 30 O 1906.

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The genus of grasses commonly known as *Eatonia.*

Skan, S. A. *Blakea gracilis.* Curt. Bot. Mag. IV. **2**: *pl. 8099.* 1 O 1906.

Native of Costa Rica.

Skan, S. A. *Ribes cruentum.* Curt. Bot. Mag. IV. **2**: *pl. 8105.* 1 N 1906.

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Skan, S. A. *Ribes viburnifolium.* Curt. Bot. Mag. IV. **2**: *pl. 8094.* 1 S 1906.

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Smith, J. D. Undescribed plants from Guatemala and other Central American republics. XXVIII. Bot. Gaz. **42**: 292–300. 23 O 1906.

New species and varieties are described in *Saurauja* (3), *Prunus*, *Tibouchina*, *Monolena*, *Conostegia* (3), *Miconia* (2), *Blakea*, *Passiflora*, *Dendropanax*, *Rondeletia* (3), *Bidens*, and *Hectia.*

Sprague, T. A. *Passiflora punctata.* Curt. Bot. Mag. IV. **2**: *pl. 8101.* 1 O 1906.

Native of South America.

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Ulbrich, E. *Leguminosae* andinae III. Bot. Jahrb. **37**: 541–555. *f. 1.* 30 O 1906.

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Urban, I. Plantae novae andinae imprimis Weberbauerianae. II. Bot. Jahrb. **37**: 503–646. 30 O 1906.

Consists of 27 separate papers, here indexed under their respective authors: Becker, Clarke, Dammer, Diels, Focke, Gilg, Harms, Hill, Knuth, Kränzlin, Krause, Lindau, Loesener, Pilger, Ruhland, Schlechter, Ulbrich.

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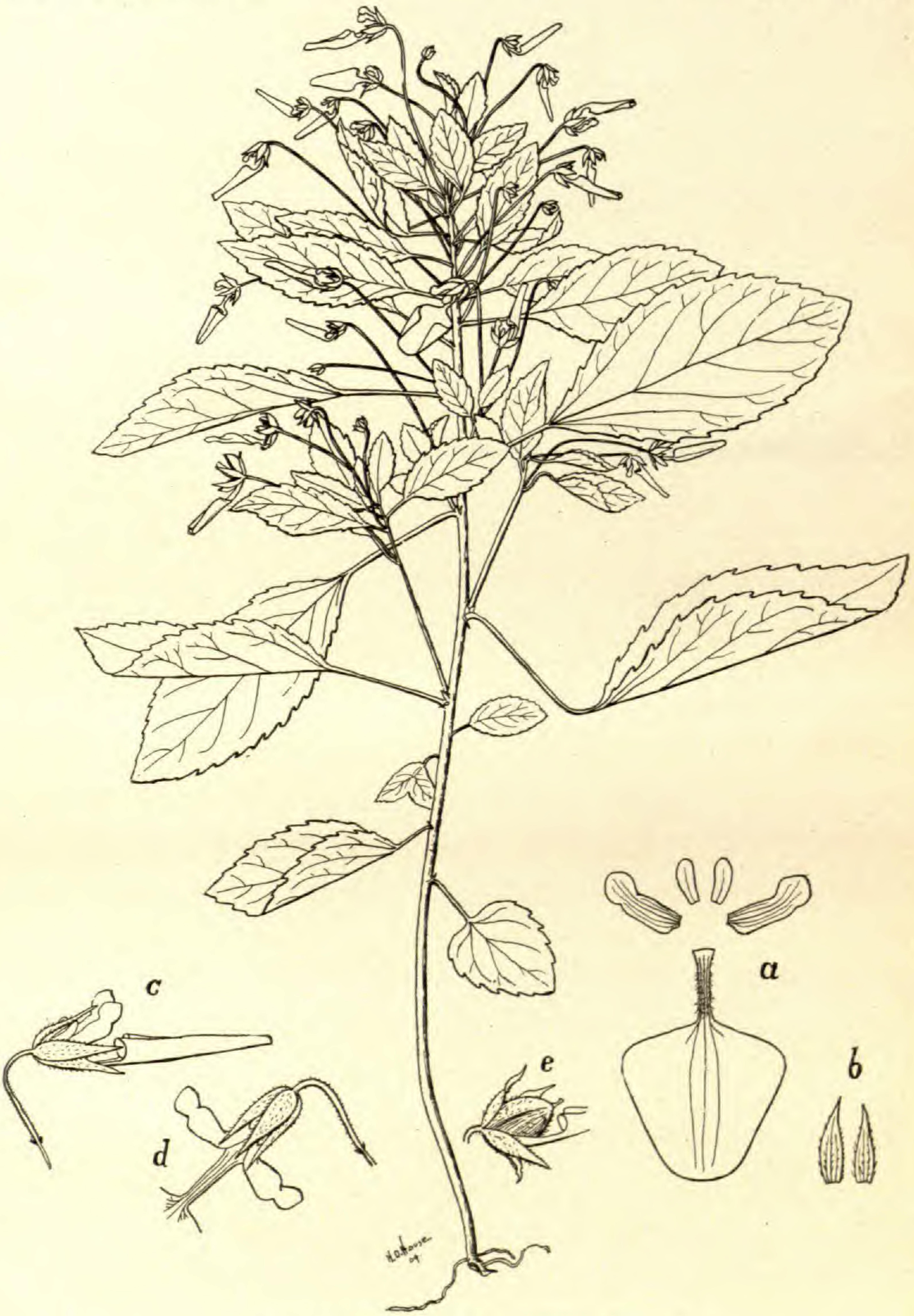
CALCEOLARIA TENUIFOLIA Dowell.



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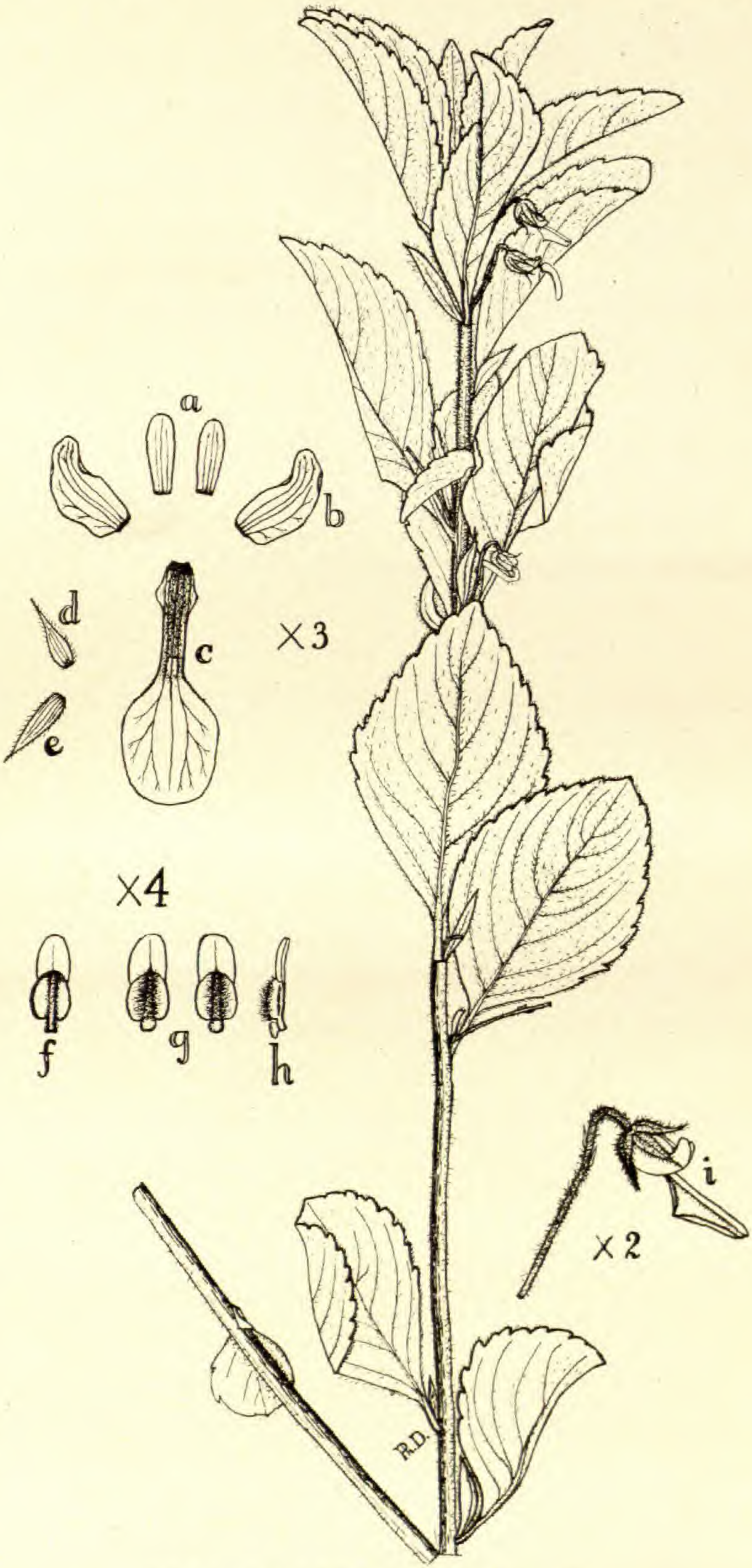
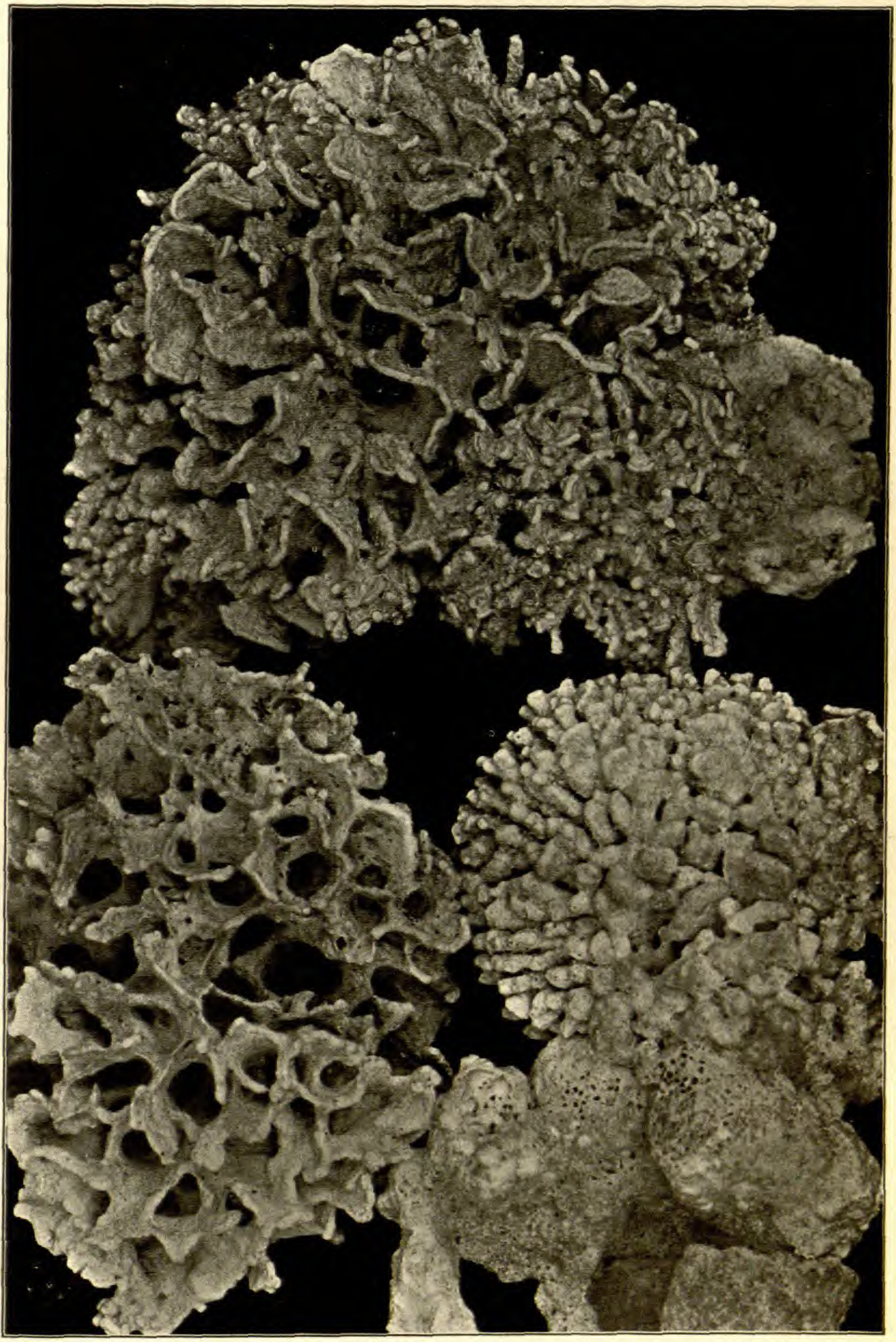
CALCEOLARIA GLABRA Dowell.

CALCEOLARIA BREVIS Dowell.



CALCEOLARIA ROSEI Dowell.



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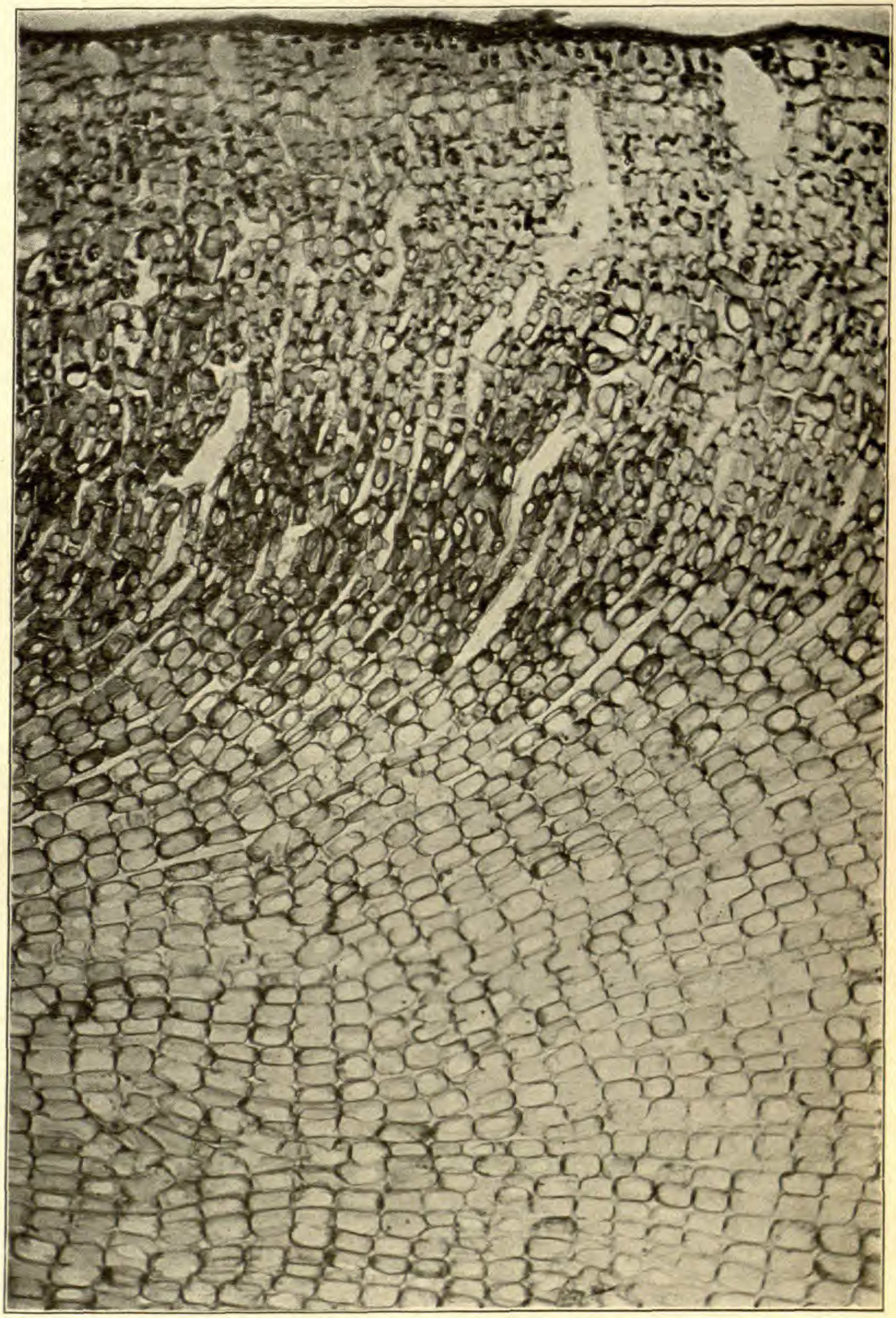

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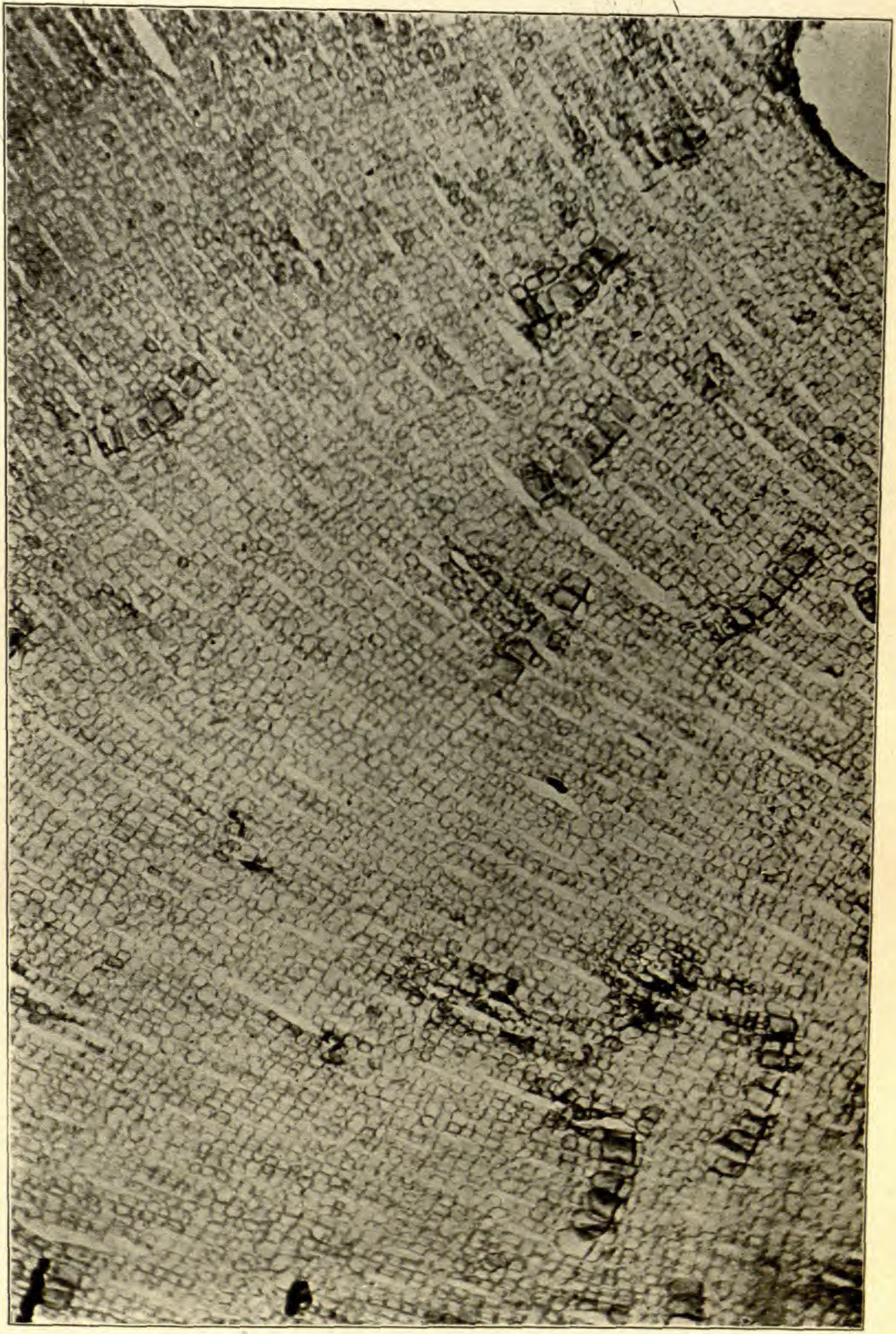
LITHOPHYLLUM ANTILLARUM Fosl. & Howe.



LITHOPHYLLUM ANTILLARUM Fosl. & Howe.

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OF THE

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

DECEMBER, 1906

American ferns — VII

LUCIEN MARCUS UNDERWOOD

A. THE AMERICAN SPECIES OF STENOCHLAENA

A short time since we presented an account of the species of *Stenochlaena* from the Old World,* stating that the American species would form the subject of a later paper. We present herewith a synopsis of the known American species, all of which belong to the section *Lomariopsis*. Instead of ten species as estimated at that time, we are forced to recognize twelve; besides these there are several collections which do not seem to fall within the limits of any of the described species, and we have set these aside for further information dependent on more extended exploration in the regions where they have already been collected a single time. A list of these possible candidates for recognition as species is given at the end of this paper under the *Species inquirendae*. All the following species are included under *Acrostichum sorbifolium* in the *Synopsis Filicum* of Hooker and Baker, as was also the case with the greater part of the species of the Old World as discussed and in part figured in our previous paper. One purpose of binomial names is to enable botanists to refer definitely to some particular well-defined plant. There are some, commencing with Goethe, who maintain that this is the only *raison d'être* of species in the text-books anyway. Now if a single name like *Acrostichum sorbifolium* is allowed to stand for a series of twenty-five distinct and recognizable groups of plants, each found in some definite quarter of the tropical world, somewhere from Florida to Brazil,

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* Bull. Torrey Club 33: 35–50. 1906.

[The BULLETIN for November 1906 (33: 541–590, *pl. 18–26*) was issued 19 D 1906.]

around the world to Sierra Leone and Mauritius, thence to India, Java, the Philippines, New Zealand, and Samoa, each with distinctive characters and each with a well-defined geographic range, how is one to know how to refer *definitely* to any particular group of this series, for example the one figured in this paper (FIGURES 1–3) which has a very limited distribution in eastern Cuba, together with a very pronounced type of leaf that no one would possibly mistake for any other? Or how shall we refer to another very definite plant of the lowlands of Florida and Cuba which we have recently seen fit to describe as *Stenochlaena Kunzeana** and which is figured in this paper (FIGURES 4–6)? It is true they could be referred to as varieties of *Stenochlaena sorbifolia;* so could our species of soft maples be referred to as varieties of the sugar maple, but I believe none of our so-called conservatives has thought of such a course, even though the foliage of the maples is really much closer than the two plants in question. Besides, we do not know which is the parent stock and which is the variation, or better we do know that both have diverged from a common ancestor in the past so that neither one could with accuracy be said to be a variety of the other. Being distinct recognizable entities, we prefer to call these units of classification *species*, the same as we do our well recognized species of maples and other plants of a similar sort.

Linnaeus founded *Acrostichum sorbifolium* on two things that turn out to be distinct. One was a plant figured by Plumier from Martinique (afterwards copied by Petiver), and the other was a plant figured by Sloane from Jamaica. The acquisition of the extensive herbarium of Père Duss from the islands of Martinique and

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* We are gravely informed by the confident editor of the Fern Bulletin (14 : 95) that this species is *Lomaria procera!* and that "the [Florida] plant reported by A. A. Eaton as *Acrostichum sorbifolium* is also omitted" [*i. e.*, in the last number of this series of papers]. *Lomaria procera* was originally described from New Zealand and like its congeners of the mountain regions of the West Indies is a terrestrial fern growing in a crown after the manner of our native Christmas fern, and like other species of *Lomaria* possesses a distinct linear intramarginal sorus covered by an indusium; while *Stenochlaena Kunzeana*, originally designated (but not described) by Presl seventy years ago from the lowlands of Cuba, is a climbing fern with scattered leaves, creeps up the trunks of trees three or four meters, and like other members of its genus possesses no indusium and not even a definite sorus. Mere details (?) of structure, habit, geographic and altitudinal distribution like these, seem to amount to nothing in the mind of the editor of "the only fern magazine in the world."

Guadeloupe places the New York Botanical Garden in possession of the most complete series of plants from those islands that has ever been brought together. Specimens of *Stenochlaena* in this herbarium, as well as older collections from Martinique seen in European herbaria, when compared with the recent extensive collections in the island of Jamaica, have enabled us clearly to differentiate the plant of the Lesser Antilles, which extends also into Porto Rico and Hispaniola, from the Jamaican plant, more or less common in the hill region of that island.

Each one of the species described or recognized in this paper has a very definite geographic area as determined from a study of practically all the material that has yet been collected. The species are most abundantly represented in our own collections, but the materials at Vienna, Prague, Berlin, Paris, Kew, Washington and New Haven have contributed type specimens and additional information.

The American species which we recognize may be separated by the following synopsis :

- Pinnae tapering gradually in the lower third, truncate-acuminate at the apex; sporophyllary pinnae narrow (3–4 mm.). 12. *S. Wrightii.*
- Pinnae blunt or cuneate at base, but never long-tapering below.
  - Pinnae mostly 2–4 cm. wide; sporophyllary pinnae 7–16 mm. wide.
    - Pinnae few (1–5). 8. *S. Prieuriana.*
    - Pinnae more numerous (7–20 or more).
      - Sporophyllary pinnae 12–16 mm. wide; scales of the rootstock and bases of the leaf-stalks brownish-black. 5. *S. japurensis.*
      - Sporophyllary pinnae 7–8 mm. wide.
        - Scales of the rootstock and bases of the leaf-stalks narrowly lanceolate, ferruginous; sporophyllary pinnae mostly 12 cm. long. 2. *S. erythrodes.*
        - Scales of the rootstock and bases of the leaf-stalks broad, ovate, pallid; sporophyllary pinnae shorter, 6–9 cm., stalked. 4. *S. jamaicensis.*
  - Pinnae normally under 2 cm. wide; sporophyllary pinnae under 5 mm. wide (except in no. 7).
    - Pinnae irregularly sharply serrate, not over 1 cm. wide, cuneate at the base. 6. *S. Kunzeana.*
    - Pinnae entire, undulate, or slightly and uniformly serrulate or denticulate.
      - Pinnae truncate at the base.
        - Pinnae 7–8 cm. or more long; sporophyllary pinnae 3 mm. wide. 3. *S. Fendleri.*

Pinnae 4–7 cm. long; sporophyllary pinnae under 2 mm wide. 11. *S. vestita.*
Pinnae cuneate at base (acute or obtuse).
Pinnae 4–8 cm. long.
Pinnae 20–25-jugate; sporophyllary pinnae nearly sessile; scales of the rootstock long-hairy ciliate. 1. *S. angusta.*
Pinnae 10–15-jugate; sporophyllary pinnae stalked; scales of the rootstock smooth. 10. *S. sorbifolia.*
Pinnae 10–15 cm. long, tapering to a long-acuminate apex.
Sporophyllary pinnae 5–6 mm. wide, 9 cm. long, long-stalked. 7. *S. Maxoni.*
Sporophyllary pinnae not over 2 mm. wide, 10–12 cm. long, short-stalked. 9. *S. recurvata.*

1. **Stenochlaena angusta** sp. nov.

Wide-climbing on trees. Roostock rather slender, 4–8 mm. thick, densely covered at the apex with pale, narrowly lanceolate, long-ciliate scales, becoming naked below; leaves scattered, narrow, tapering at both ends, 45–60 cm. long, with a short stalk (6–8 cm.) which is densely covered below with scales like those of the rootstock, and with still narrower scattered fibrils which extend up the rachises; pinnae 20–25-jugate, obtusely cuneate at base forming a very short stalk, 6–7 cm. long, 10–12 mm. wide, the margins finely and deeply undulate, tapering at the more or less falcate apex into an acuminate point; veins simple or once forked, rather close, with 11–15 intercostal spaces to 1 cm.; sporophyls slightly shorter than the leaves, the pinnae 22–25-jugate, 55–8 cm. long, 3–4 mm. wide, obtuse at the base with a short stalk, tapering gradually to the apex. [FIGURE 6.]

COLOMBIA: Jordan, Prov. Santa Marta, *H. H. Smith 1051* (type). "Creeping on tree trunks to 15 feet or more. Rare in deep forest, 1200–1400 feet."

To the same species we should refer *Funck 774* collected in 1845 (P)* and *Spruce 1556* collected at Tarapoto, Peru (K). Also more or less fragmentary recent collections from Bolivia: Lower Rio Cocos, *Williams 1190;* San Raphael, *Williams 1189;* and more doubtfully the juvenile forms, Isapuri, *Williams 1203.*

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* Unless otherwise stated, specimens cited are in the collections in the New York Botanical Garden. For convenience other collections are marked with an initial: K = Kew, B = Berlin, P = Paris, Pr = Prague, V = Vienna, etc.

2. **Stenochlaena erythrodes** (Kunze).

Acrostichum erythrodes Kunze, Flora 22[1]: Beibl. 46. 1839. (Type from Ilheos, Brazil, *Herb. Mart. 366.*)

RANGE: Brazil, Prope Ilheos, *Herb. Mart. 366; Sellow* (B); Organ Mountains, *Gardner* (?) *101* (K).

In *Index Filicum*, Mr. Christensen refers this plant with two other species of the genus to *Stenochlaena marginata* (Schrad.) C. Chr., the original of which was described by Schrader in 1824 in his report on the ferns collected in Brazil by Maximilian, Prince of Neuwied, as follows: "[LOMARIA] MARGINATA: *frondibus pinnatis; sterilium pinnis oblongo-acuminatis subintegerrimis basi superiori cuneatis glabris indusiis crenato-incisis rhachi marginata.*" Goett. Gel. Anz. 871. 1824. In the absence of the type and with such a description it would seem safer to leave this name in the waiting list until more certainty is attainable in regard to its status; if the description is correct, the plant is not even a *Stenochlaena*. In any case the three united species have little in common and can easily be distinguished, when real specimens are at hand.

3. **Stenochlaena Fendleri** (D. C. Eaton).

Lomariopsis Fendleri D. C. Eaton, Mem. Am. Acad. II. 8: 195. 1860. (Type from Venezuela, *Fendler 335.*)

RANGE: Known only from its type locality. [FIGURES 9 and 10.]

4. **Stenochlaena jamaicensis** sp. nov.

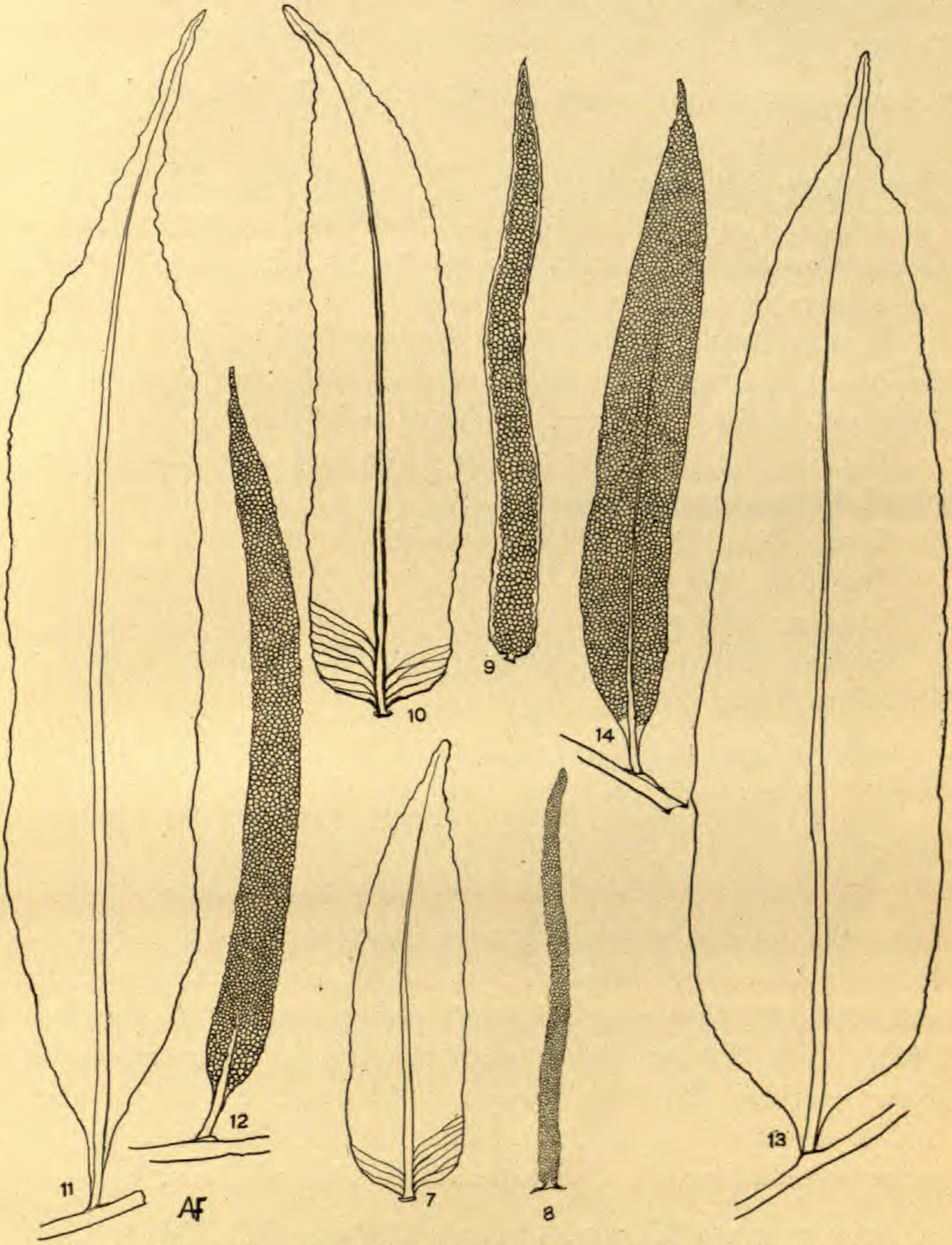
Wide-climbing on tree-trunks. Rootstock 1.5–2 cm. in diameter, densely covered with pallid ciliate scales which are broadly lanceolate to lanceolate-ovate in shape, 2–3 mm. wide; leaves 50 cm. or more long on stramineous stalks 12–14 cm. long, densely covered at the base with scales similar to those of the rootstocks, simply pinnate, 5–10-jugate, the pinnae obtusely cuneate at the base, more or less abruptly tapering at the apex, 8–12 cm. long, 2–2.5 cm. wide, the margins slightly repand and very minutely revolute in drying; veins simple or occasionally forked, inconspicuous, with about 10–11 intercostal spaces to 1 cm.; sporophyls 35 cm. or more long, on similar but shorter (8–10 cm.) leaf-stalks, about 9-jugate; pinnae short-stalked (3–4 mm.), obtuse at base, short-tapering at the apex, 7–8 cm. long by 7–8 mm. wide. [FIGURES 13 and 14.]

JAMAICA: Vicinity of Mandeville, *Maxon 2566* (type, in the United States National Herbarium and the New York Botanical Garden); Manchester, *Day;* no locality, 1884–5, *Balch.*

Normal pinnae of American species of *Stenochlaena:* 1–3, *S. Wrightii.* 4, 5, *S. Kunzeana.* 6, *S. angusta.* All the figures natural size.

Besides the above, the following mostly sterile plants appear to go here: Hollymount, *Maxon 1904, 2217;* Tyre, Cockpit country, *Underwood 3305;* Mansfield, near Bath, *Underwood 2782.*

Young forms collected with the last number seem to indicate a widely different juvenile condition from that which obtains in the



Normal pinnae of American species of *Stenochlaena:* 7, 8, *S. vestita.* 9, 10, *S. Fendleri.* 11, 12, *S. Maxoni.* 13, 14, *S. jamaicensis.* All the figures natural size.

common Windward Island species (*S. sorbifolia*) from which this is a segregation. In the last-named species the juvenile form is so unlike the mature condition as often to be regarded as belonging to an entirely different species. In the present species the juvenile leaves fail to show this strongly dimorphic character. Further material bearing on this point is a desideratum.

5. STENOCHLAENA JAPURENSIS (Mart.) Griseb. Fl. Brit. W. I. 676. 1864.

Acrostichum japurense Mart. Ic. Pl. Crypt. Bras. 86. *pl. 24.* 1834. (Type from Japura River, N. Brazil.)

Lomariopsis phlebodes Kunze, Linnaea **9**: 33. 1835. (Type from Maynas, Peru, *Poeppig*.)

RANGE: Guatemala and Costa Rica to Trinidad, Guiana, and Brazil and down the Andes as far as Bolivia and Peru. Apparently a lowland species. We have specimens as follows:

GUATEMALA: Cubilquitz (Alta Verapaz) *von Tuerckheim* (*J. D. S. 8043*).

COSTA RICA: Turrialba, *Maxon 184.*

TRINIDAD: *Fendler 106.*

PANAMA: *Hayes 4.*

GUIANA: Essequibo, *Jenman 2312;* Mt. Ragwa, *Jenman;* Demerara River, *Jenman.*

COLUMBIA: San Pablo, *Holton 21;* Santa Marta, *H. H. Smith 2697.*

BOLIVIA: Tumupara, *Williams 1192;* San Buena Ventura, *Williams 1196.*

The species does not appear to have been collected much below the Amazon in Brazil, but there are specimens at Kew collected in the Upper Amazon, *Traill 1394*, and Para, *Spruce 27* and *569.* We have seen Poeppig's plant (cotype of *Lomariopsis phlebodes*) at Vienna and it does not appear to be separable from the widely distributed species as listed above. This species and *S. erythrodes* of Southern Brazil are united under a distinct name (noted above) by Christensen in his *Index Filicum.*

6. STENOCHLAENA KUNZEANA (Presl) Underw. Bull. Torrey Club **33**: 196. 1906. (Type from Cuba, *Wright 973.*)

Olfersia Kunzeana Presl, Tent. Pterid. 235. 1836 (*nomen nudum*).

RANGE: Cuba, Hispaniola, and southern Florida. (FIGURES 4 and 5.)

Additional stations to those given with the original description are as follows:

CUBA: El Guama (Prov. Pinar del Rio), *Palmer & Riley 392*; Sevilla Estate near Santiago, *Taylor 473*.

7. **Stenochlaena Maxoni** sp. nov.

Climbing on tree-trunks. Rootstock wide-creeping, 8–10 mm. in diameter, densely covered with pale straw-colored, narrowly lanceolate scales, which are usually less than 1 mm. wide; leaves scattered, 65 cm. or more long, on long, rather stout leaf-stalks, 25 cm. long, which have scattering scales throughout like those of the rootstock intermixed with brown fibrils which extend upwards through the rachises; pinnae about 9-jugate, distant, rather long-stalked (5–7 mm.), acutely cuneate at the base, long-acuminate at the apex, 12–14 cm. long, about 2 cm. wide, the margins irregularly undulate, very slightly reflexed in drying; veins very prominent, converging in pairs at the base when simple, occasionally forked, somewhat spaced, with about 8 intercostal spaces to 1 cm.; sporophyls 55 cm. or more long, with leaf-stalks similar to those of the leaves, about 10-jugate, the pinnae distant, stalked (4–6 mm.), obtuse at base, tapering at apex, 9 cm. long, 5–6 mm. wide. [FIGURES 11 and 12.]

COSTA RICA: La Palma, alt. 1450–1550 m., *Maxon 411*.

It is with pleasure that we name this clearly marked species from Costa Rica for Mr. William Ralph Maxon through whose discriminating and careful field study we know so much of the real characters of the fern flora of Costa Rica. The practice of sending specialists into the field is of the greatest importance if we ever expect to secure accurate information regarding the real characters of plants.

8. **Stenochlaena Prieuriana** (Fée).

Lomariopsis Prieuriana Fée, Mém. Foug. 2: 66. *pl. 25. f. 1.* 1845. (Type from Guiana, *Herb. Richard.*)

RANGE: Known only from Guiana, *Appun 128* (K); Pomeroon River, *Jenman*; Potaro River, *Jenman*; Ragwa, *Jenman*.

This species has been combined with *Stenochlaena japurensis*, with which it has closest alliance; its limited number of pinnae is apparently a constant character, and until this is found to be due to accidental causes it may best remain distinct as Fée left it.

9. **Stenochlaena recurvata** (Fée).

Lomariopsis recurvata Fée, Mém. Foug. **2**: 68. *pl. 28.* 1845. (Type from Teapa, Mexico, *Herb. Delessert et Mus. Paris.*)

RANGE: Known only from its type collection, of which we have seen the specimen preserved at Paris. A very distinct species.

10. STENOCHLAENA SORBIFOLIA (L.) J. Sm. Jour. Bot. **4**: 149. 1841.

Acrostichum sorbifolium L. Sp. Pl. 1069. 1753. (Type from Martinique, based on Plumier *pl. 117.*)

RANGE: Lesser Antilles, Porto Rico, and Hispaniola.

We have seen specimens of this characteristic species, whose distribution has been erroneously supposed to be well-nigh universal, from the following islands:

MARTINIQUE: *Duss 1698.*

GUADELOUPE: *Duss 4139.*

DOMINICA: *Lloyd 344, 743, 744, 869.*

ST. VINCENT: *Guilding* (K), *Chickley* (B).

ST. KITTS: *Hon. J. H. H. Berkley, Britton & Cowell 454.*

PORTO RICO: 1824, *Balbis* (P), *Schwanecke* (K), *Booth* (K), *Underwood & Griggs 843, Britton & Marble 1084.*

HISPANIOLA: Petit Borgne, *Nash 468.*

11. **Stenochlaena vestita** (Fourn.). [FIGURES 7 and 8.]

Lomariopsis vestita Fourn. Bull. Bot. Soc. France **19**: 250. 1872. (Type from Chontales, Nicaragua, *Levy 476.*)

Acrostichum Pittieri Christ, Bull. Soc. Bot. Belg. **35**: 243. 1896. (Type from Costa Rica, *Pittier 6931.*)

Lomariopsis guatemalensis Presl, in herb. (Sterile plant only. "In Guatimala ad ripam occidentalem fluvii S. Juan, *Friedrichsthal.*")

Stenochlaena Pittieri Diels, Die Nat. Pflanzenf. **1**^{4}: 251. 1899.

RANGE: Apparently throughout Central America. We have seen specimens as follows:

GUATEMALA: Alta Verapaz, *von Tuerckheim* (*J. D. S. 8042*), San Juan River,* *Friedrichsthal* (V, Pr).

NICARAGUA: Chontales, *Levy 496* (K, P), *Tate 72* (K, two sheets).

COSTA RICA: La Concepcion, *J. D. S. 6942; Wercklé;* Turrialba, *Maxon 163.*

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* There appears to be some doubt whether this station is in Guatemala or not.

PANAMA: Lion Hill Station, *Hayes 379* (K).

This species, which was first named (though not published) by Presl sixty years or more ago, and twice published since, is rather close to *S. Fendleri*, and the Panama specimen cited above suggests a possible transition between the two. In the absence of any more definite light on this subject it is wiser to keep them separate for the present.

12. STENOCHLAENA WRIGHTII (Mett.) Griseb. Cat. Pl. Cub. 277. 1866.

Lomariopsis Wrightii Mett.; D. C. Eaton, Mem. Am. Acad. II. 8: 195. 1860. (Type from Monte Verde, eastern Cuba, *Wright 787*.)

RANGE: Confined to eastern Cuba. [FIGURES 1–3.]

This most peculiar species has been twice collected since Wright's time at a second station still farther eastward than Monte Verde, *viz.*: at Baracoa, *Pollard & Palmer 220*, and on the slopes of El Yunque, near Baracoa, *Underwood & Earle 948*.

SPECIES INQUIRENDAE

1. We have collected in Jamaica what appears to be a very distinct species with small pinnae (4–5.5 cm. by 1.2–1.5 cm.) which are about 13-jugate on short stalks, acutely tapering at the base, and the rootstocks densely covered with dark ferruginous narrowly lanceolate ciliated scales, 1 mm. wide. The veins are very close (12–15 intercostal spaces to 1 cm.). Unfortunately only immature sporophyls have been found; hence our hesitancy to describe what appears to be distinct. The plants were collected in the Cockpit country near Troy, *Underwood 2866* and *2887* (the latter sterile only).

The present genus illustrates excellently the doubt often occasioned by improper field work. There are in various collections a series of scrappy specimens often consisting of the upper half of a leaf only or sometimes with a similar upper portion of a sporophyl unconnected with the leaf, and neither showing anything of the character of the stem, which in this genus, as in most others, presents most important diagnostic specific characters. To break off the mere tip of a fern as a representative of a species is as idiotic a proceeding as to break off the upper half of a compound leaf of ash or hickory or sumac and expect a botanist to describe a species from this fragment only. And yet a very large number of fern species have been described from just such fragments and their types are often of such a character that after real personal field work in the type locality of a given species, it is only with the greatest uncertainty that we can recognize the elegant and complete specimens of modern collecting as the same as these old fragments, especially after they have been handled for two or three generations. We have a series of these fragments from Jamaica and elsewhere that are now in doubt and will very likely remain in this condition to the end of time. One hesitates to throw away an imperfect specimen after it has once been mounted in a collection, but it might be better except, of course, in the case of old types to commit them to the flames and save succeeding generations from wasting gray matter on them.

2. *Fendler 121*, from Trinidad (distributed by Professor D. C. Eaton as *Acrostichum sorbifolium*), probably represents a distinct species. We had long supposed that this represented *Lomaria longifolia*, a species described by Kaulfuss in 1824, citing: (1) Willdenow's description of *Acrostichum sorbifolium* (Sp. Pl. 5: 115, *excl. syn.*), and (2) a figure of a separate pinna by Plumier on plate 117 (the type of *Acrostichum sorbifolium* L.). An examination of Willdenow's herbarium shows that he had under this species a plant with elongate pinnae, which seems to differ in no other way from the ordinary *Stenochlaena sorbifolia*, and analogous specimens appear in Père Duss' collections both from Martinique and Guadeloupe, as well as in those of Sherring from Grenada, and among those of Lloyd from Dominica.

The Trinidad plants differ more widely (1) in the vestiture of the bases of the leaf-stalks and the rootstocks, the scales being densely long-hairy and ciliate, while they are smooth in *S. sorbifolia;* (2) in the form of the pinnae and their basal characters; (3) in the closeness of the venation, there being 11–12 intercostal spaces to 1 cm. (instead of 7–9 as in *S. sorbifolia*); and in various other characters. Unless further information appears, *Lomaria longifolia* Kaulf. will become a synonym of *S. sorbifolia*, but the Trinidad plants may come to be recognized as a distinct species of *Stenochlaena*.

3. A single specimen from Potrero, Mexico, *Hahn 56*, in herb. Paris, indicates a species distinct from any known. The pinnae are 9 by 2.5 cm., with prominent veins, while the sporophyllary pinnae are narrowly linear, 13 cm. long by 3 mm. wide. The specimens were distributed as *S. erythrodes* but of course have nothing to do with that South Brazilian species. Potrero is in the state of Hidalgo.

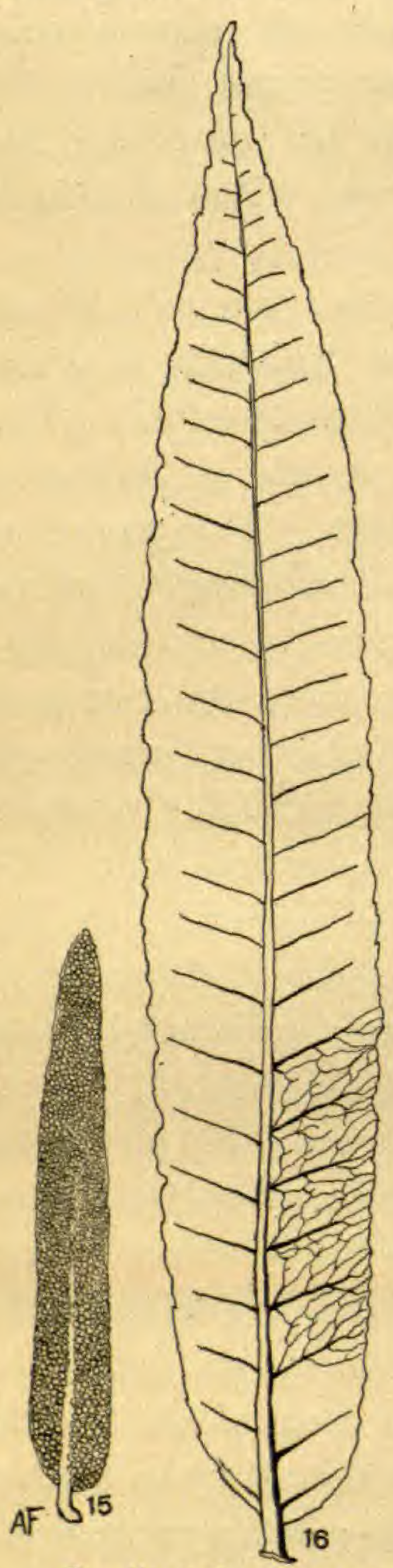
4. Two specimens in herb. Berol.: Bahia, *Luchnath 86*, and *Sellow* (without locality), were marked by Klotzsch as a new species in *Olfersia* but apparently have not been described. They represent a species of *Stenochlaena* which recalls *S. Maxoni* as described above, but have marked differences. The pinnae are acute at base but are sessile, 11–12 by 2 cm., tapering to an acuminate point; the sporophyllary pinnae are 6–7.5 cm. long by 4 mm. wide and also sessile. The two specimens are not quite counterparts of each other, the Luchnath specimen having the sporophyllary pinnae up to 9 cm. long. They probably represent a good species which had best await further exploration in the little-known regions of Brazil.

5. A second specimen from Brazil, collected by Sellow, also in herb. Berol., bears a second unpublished name by Klotzsch under *Olfersia*. It has pinnae rounded at the sessile base, 17 by 2.5 cm., tapering gradually to the apex; the sporophyllary pinnae are 10 cm. long by 6 mm. wide; the veins are close, 12 or more intercostal spaces to 1 cm. This plant is not like any described species and is probably new, as indicated in Klotzsch's herbarium name.

The genus *Olfersia*, containing the common *Olfersia cervina* of the American tropics and a second Brazilian species which is the type of the genus (*O. corcovadensis*), is characterized by its distinct marginal vein with which the other veins unite; its sporophyls are similar to those of *Polybotrya* but simpler. It is not a near ally of *Stenochlaena*.

B. THE STATUS OF POECILOPTERIS CRENATA PRESL

The genus *Leptochilus* was founded by Kaulfuss in 1824, based on *Acrostichum axillare* Cav. This long-known plant possesses a simple leaf with the complex venation of *Drynaria*, *Tectaria*, and *Phymatodes*. Whether all the species with this type of anastomosing veins, formerly associated erroneously under the genus *Gymnopteris* (*Acrostichum* § *Gymnopteris* of *Synopsis Filicum*), will form a single genus, or be differentiated into several, as held by Presl, John Smith and Fée, may well form a later discussion. Suffice it to say that the American species, elaborately treated by Carl Christensen under *Leptochilus* § *Bolbitis*,* in our opinion are not congeneric with *Acrostichum axillare*, and as a coherent group must bear the name *Poikilopteris* † as the oldest name applied to any species included within the present generic limits. Their venation is amply characterized in the illustrations given in Mr. Christensen's admirable paper and may be seen in the accompanying figure (FIGURE 16). We do not purpose a duplication of Mr. Christensen's work, but having seen nearly all the original specimens cited in his paper, and in addition the equally extensive collection at Kew which materially supplements those cited, and particularly the originals of Presl at Prague, we wish to make a correction regarding the status of one of the doubtful species cited at the close of his paper.



Poecilopteris crenata Presl. Drawn from Presl's type material at Prague. 15, Sporophyllary pinna. 16, Normal sterile pinna. Both natural size.

Mr. Christensen says (page 297): "*Poecilopteris crenata* Presl, Epim. bot. 174. 1849.—Rio. After a remark on a sheet in Herb. Berol. (by Mettenius ?) and after the description this is only a common form of *L. serratifolius*."

The above quotation notes the usual European neglect to look up type specimens so easily accessible as those in Presl's herbarium, and also emphasizes the force of a statement that cannot be

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* Bot. Tidsskrift **26**: 283–300. 1904.

† Eschweiler, Linnaea **2**: 117. 1827; afterwards (1836) called *Poecilopteris* by Presl.

reiterated too often, *viz.* : "A species is not a description, but a group of allied individuals," in this case represented by a single well-preserved type specimen. The accompanying figures (15–16) are drawn directly from Presl's *Poecilopteris crenata* and it will be seen to be, not the plant to which it has been erroneously referred by those who have never seen it, but instead a species closely allied to the one described in Mr. Christensen's paper as *Leptochilus contaminoides* (Christ) C. Chr. Having seen the type number of the Paraguay plant both at Berlin and at Kew, and the Brazilian specimens also referred by Mr. Christensen to Christ's species, we are inclined to regard the Paraguay plant as distinct from the others, and refer all the Brazilian plants cited to Presl's species. Otherwise Dr. Christ's species must fall under it in synonymy. We present the following comparisons of *Balansa 2852* and Presl's plant:

Balansa 2852 (Type of *Gymnopteris contaminoides* Christ).	*Poecilopteris crenata* Presl. (*Cf.* FIGURES 15 and 16.)
Pinnae 3.5 cm. wide.	Pinnae 2 cm. wide.
Color bright-green.	Color distinctly red.
Margins regularly crenate-toothed.	Margins irregularly undulate.
Areolae in 5 (4–6) rows between the costae.	Areolae in 4 (3–5) rows between the costae.
Sporophyllary pinnae 8 mm. wide.	Sporophyllary pinnae 6 mm. wide.

At a later time we hope to add something to the series of species so well described by Mr. Christensen, when the other species may be more appropriately transferred to what we regard their correct generic name, *Poikilopteris.*

COLUMBIA UNIVERSITY.

Some desmids from Newfoundland

Joseph Augustine Cushman

During the past year material has been obtained from Newfoundland which has added many species to the few which were previously known to belong to the flora of the island. The greatest number of species were obtained from material collected by Mr. Owen Bryant at St. Anthony in May, 1906. Some of the species were not previously known from North America. In addition to this material a number of species were obtained from *Utricularia* collected by Waghorne at Bay of Islands. This added several species not obtained in any of the other material. Included in the present paper are the species found by the writer in Dr. G. M. Allen's material from Rose au Rue, and published in this journal for November, 1904. In certain cases the synonymy has been altered and in these species the corrections are here made. Material has thus been obtained from three points on the island fairly remote from one another. As a result of the work seventy-two species included in seventeen genera are here noted from Newfoundland. None were recorded from the island previous to the former paper.

MESOTAENIUM Näg. 1849

1. Mesotaenium DeGreyi Turn.
Length 83 μ; breadth 20 μ. Occasional, St. Anthony.

2. Mesotaenium Endlicherianum Näg.
Length 35 μ; breadth 12 μ. Very common, Rose au Rue.

CYLINDROCYSTIS Menegh. 1838

3. Cylindrocystis Brebissonii Menegh.
Length 54 μ; breadth 18 μ. Fairly common, St. Anthony.

4. Cylindrocystis americana minor Cushman.
Length 40 μ; breadth 18 μ. Common, Rose au Rue.

5. CYLINDROCYSTIS DIPLOSPORA Lund.

Length 71 μ; breadth 37 μ; isthmus 33 μ. Occasional, St. Anthony.

NETRIUM Näg. 1849

6. NETRIUM DIGITUS (Ehrenb.) Itzigs. & Rothe.

Length 160–190 μ; breadth 63–80 μ. Common at Rose au Rue and St. Anthony. The prevailing form is short and much swollen at the central portion, thence narrowing fairly rapidly to the apex.

7. NETRIUM NAEGELII (Bréb.) W. & G. S. West.

Length 140–145 μ; breadth 37 μ. Occasional, Bay of Islands and St. Anthony.

PENIUM Bréb. 1844

8. PENIUM LIBELLULA INTERMEDIUM Roy & Biss.

Length 98–110 μ; breadth 24–29 μ. Occasional, Rose au Rue.

CLOSTERIUM Nitzsch. 1817

9. CLOSTERIUM CYNTHIA DeNot.

Length 128 μ; breadth 18 μ; apices 5.2 μ. Occasional, St. Anthony.

10. CLOSTERIUM ANGUSTATUM Kütz.

Length 310–560 μ; breadth 19–23 μ; apices 12 μ. Fairly common at St. Anthony.

Some of the specimens of this species show very interesting conditions of the surface ornamentation. One specimen, for instance, was divided into five nearly equal portions. The central portion was somewhat tumid, a character noted in many of the specimens from this material. The striae on this portion were very distinctly twisted laterally. The end segments show, even more distinctly, the twisting, subspiral arrangement of the striae. This twisting is developed more fully as the ends are approached. The intermediate areas of the membrane which were formed later by division do not keep to the subspiral striae, but have them in the normal, straight form. Nearly all the specimens from this locality show more or less of the subspiral arrangement of the costae.

11. CLOSTERIUM STRIOLATUM Ehrenb.

Length 275 μ; breadth 27 μ; apex 12 μ. Common, St. Anthony.

12. CLOSTERIUM PARVULUM Näg.

Length 115 μ; breadth 10 μ. Common, St. Anthony.

13. CLOSTERIUM TOXON West.

Length 290–325 μ; breadth 9–9.5 μ; apices 6 μ. Fairly common, St. Anthony.

DOCIDIUM Bréb. 1844

14. DOCIDIUM BACULUM Bréb.

Length 340 μ; breadth 21 μ; apex 13.3 μ. Common, St. Anthony.

PLEUROTAENIUM Näg. 1849

15. PLEUROTAENIUM CORONATUM (Bréb.) Rabenh.

Length 558 μ; breadth 60 μ; apex 42 μ. Common, Bay of Islands.

16. PLEUROTAENIUM EHRENBERGII (Bréb.) DeBary.

Length 405 μ; breadth 30 μ; apex 22 μ. Occasional, St. Anthony.

TETMEMORUS Ralfs. 1844

17. TETMEMORUS BREBISSONII TURGIDUS Ralfs.

Length 174–198 μ; breadth 40–44 μ. Abundant, Rose au Rue.

TETMEMORUS BREBISSONII MINOR DeBary.

Length 78 μ; breadth 18 μ; isthmus 13.5 μ. Common, St. Anthony.

TETMEMORUS BREBISSONII MINIMUS W. & G. S. West.

Length 62–65 μ; breadth 15–16 μ. Abundant, Rose au Rue.

On second examination, the form from this locality, reported in the previous paper as *T. minutus* DeBary, should be placed here.

18. TETMEMORUS GRANULATUS (Bréb.) Ralfs.

Length 190–204 μ; breadth 42–53 μ. Common at Bay of Islands and St. Anthony.

19. TETMEMORUS LAEVIS (Kütz.) Ralfs.

Length 133 μ; breadth 25 μ. Common, Rose au Rue.

EUASTRUM Ehrenb. 1832

20. EUASTRUM CRASSUM (Bréb.) Kütz.

Length 170 μ; breadth 85 μ; isthmus 21 μ; breadth of polar lobe 45 μ. Fairly common, St. Anthony.

21. EUASTRUM PINNATUM Ralfs.

Length 120–126 μ; breadth 57–60 μ; isthmus 16–18 μ; polar lobe 31–33 μ. Common, St. Anthony.

22. EUASTRUM OBLONGUM CEPHALOPHORUM West.

Length 170 μ; breadth 105 μ; isthmus 26 μ; polar lobe 75 μ. Occasional, Bay of Islands.

23. EUASTRUM AMPULLACEUM Ralfs.

Length 87–110 μ; breadth 47–72 μ; isthmus 15–20 μ; polar lobe 22–31 μ. Rose au Rue, Bay of Islands, and St. Anthony.

This is the most common species of the genus as far as the material examined shows. It was subject to little variation in form.

24. EUASTRUM OBESUM Josh.

Length 62 μ; breadth 34 μ; isthmus 8.2 μ; polar lobe 16 μ. Rare, St. Anthony. This is the first record for North America for this species. It was typical in its form and size.

25. EUASTRUM DIVARICATUM Lund.

Length 43 μ; breadth 37 μ; isthmus 6 μ; polar lobe 18 μ. Occasional, St. Anthony.

26. EUASTRUM ELEGANS (Bréb.) Kütz.

Length 25 μ; breadth 15 μ; isthmus 4 μ. Rare, Rose au Rue.

27. EUASTRUM BINALE (Turp.) Ehrenb.

Length 18 μ; breadth 15 μ. Rare, Rose au Rue.

28. EUASTRUM DENTICULATUM (Kirchn.) Gay.

Length 31 μ; breadth 23 μ; isthmus 5 μ; polar lobe 18 μ. Common, St. Anthony.

29. EUASTRUM PECTINATUM INEVOLUTUM W. & G. S. West.

Length 60–62 μ; breadth 42–44 μ; isthmus 9–12 μ; polar lobe 23–25 μ; thickness 25–27 μ. Very common, St. Anthony. This is the first North American record for this variety.

30. EUASTRUM FISSUM AMERICANUM Cushman.

Length 38 μ; breadth 23 μ; isthmus 6 μ; polar lobe 16 μ. Occasional, St. Anthony.

31. EUASTRUM ALLENII Cushman.

Length 105 μ; breadth 49 μ; isthmus 18 μ; polar lobe 33 μ. Occasional, Rose au Rue.

MICRASTERIAS Ag. 1827

32. MICRASTERIAS PINNATIFIDA (Kütz.) Ralfs.

Length 66 μ; breadth 75 μ; apical lobe 56 μ. Occasional, Bay of Islands.

33. MICRASTERIAS TRUNCATA (Corda) Bréb.

Length 78 μ; breadth 78 μ; isthmus 16 μ; apical lobe 56 μ. Common, St. Anthony.

34. MICRASTERIAS CONFERTA NOVAE-TERRAE Cushman.

Length 102 μ; breadth 93 μ; isthmus 12 μ; apical lobe 37 μ. Frequent, Rose au Rue.

35. MICRASTERIAS DENTICULATA Bréb.

Length 205 μ; breadth 170 μ; isthmus 30 μ: apical lobe 102 μ. Occasional, Bay of Islands.

MICRASTERIAS DENTICULATA ANGULOSA (Hantzsch.) W. & G. S. West.

Length 330 μ; breadth 210 μ; isthmus 36 μ; apical lobe 58 μ. Occasional, St. Anthony.

COSMARIUM Corda. 1834

36. COSMARIUM SUBUNDULATUM Wille.

Length 58 μ; breadth 41 μ; isthmus 16 μ. Common, St. Anthony.

37. COSMARIUM CUCUMIS (Corda) Ralfs.

Length 70–75 μ; breadth 39–42 μ; isthmus 19–21 μ. Common, St. Anthony.

38. COSMARIUM CONTRACTUM JACOBSENII (Roy) W. & G. S. West.

Length 43 μ; breadth 24 μ; isthmus 6 μ. Occasional, St. Anthony.

COSMARIUM CONTRACTUM ELLIPSOIDEUM (Elfv.) W. & G. S. West.

Length 33.5 μ; breadth 27 μ; isthmus 8 μ. Common, St. Anthony.

39. COSMARIUM HAMMERI Reinsch.

Length 41 μ; breadth 32 μ; isthmus 12 μ. Occasional, Bay of Islands.

40. COSMARIUM NYMANNIANUM Grun.

Length 43 μ; breadth 20 μ; isthmus 8 μ. Common, St. Anthony.

41. COSMARIUM GRANATUM Bréb.

Length 27 μ; breadth 20 μ; isthmus 7 μ. Common, St. Anthony.

42. COSMARIUM PSEUDONITIDULUM Nordst.

Length 53 μ; breadth 42 μ; isthmus 12 μ. Occasional, Bay of Islands.

43. COSMARIUM PYRAMIDATUM Bréb.

Length 87 μ; breadth 56 μ; isthmus 19 μ. Common, St. Anthony.

44. COSMARIUM PSEUDOPYRAMIDATUM Lund.

Length 50–56 μ; breadth 31–33 μ; isthmus 9–10 μ. Very common, Rose au Rue.

45. COSMARIUM VENUSTUM (Bréb.) Arch.

Length 37 μ; breadth 26 μ; isthmus 6.5 μ; apex 15 μ. Common, St. Anthony.

46. COSMARIUM CONNATUM Bréb.

Length 72 μ; breadth 56 μ; isthmus 45 μ. Rare, St. Anthony.

47. COSMARIUM IMPRESSULUM MINOR Turner.

Length 16 μ; breadth 12 μ; isthmus 3.5 μ. Common, Rose au Rue.

48. COSMARIUM SUBSPECIOSUM Nordst.

Length 50 μ; breadth 40 μ; isthmus 18.5 μ. Occasional, St. Anthony.

XANTHIDIUM Ehrenb. 1834

49. XANTHIDIUM ARMATUM (Bréb.) Rabenh.

Length without spines 148 μ; breadth without spines 93 μ, with spines 115 μ; isthmus 45 μ. Fairly common, Rose au Rue.

This species was also common in the material from St. Anthony, but was very much smaller than in that from Rose au Rue. The spines were for the most part simple, those with bifurcate spines being the exception. A considerable variation was noticed in the specimens from Rose au Rue. An average specimen from St. Anthony measures: length without spines 96 μ; breadth without spines 67 μ; with spines 80 μ; isthmus 32 μ.

50. XANTHIDIUM ANTILOPAEUM (Bréb.) Kütz.

Length with spines 96 μ; without 58 μ; breadth with spines 80 μ, without 46 μ; isthmus 15 μ. Occasional, St. Anthony.

XANTHIDIUM ANTILOPAEUM MINNEAPOLIENSE Wolle.

Length with spines 87 μ, without 68 μ; breadth with spines 75 μ; without 53 μ. Occasional, St. Anthony.

The specimens of this variety had the lateral spines below the chain of granules. The cells in the variety were larger than in the preceding but the lateral spines were very much shorter.

51. XANTHIDIUM CRISTATUM Bréb.

Length with spines 72 μ; breadth with spines 56 μ, without spines 40 μ; isthmus 12 μ. Common, St. Anthony.

ARTHRODESMUS Ehrenb. 1838

52. ARTHRODESMUS CONVERGENS Ehrenb.

Length with spines 45 μ, without 32 μ, breadth with spines 45 μ, without 28 μ; isthmus 6.5 μ. Common, St. Anthony.

53. ARTHRODESMUS QUADRIDENS Wood.

Length 34 μ; breadth with spines 50 μ, without 34 μ; isthmus 9 μ. Common, St. Anthony.

54. ARTHRODESMUS INCUS RALFSII W. & G. S. West.

Length 24 μ; breadth with spines 40 μ, without 19 μ; isthmus 7 μ. Common, St. Anthony.

ARTHRODESMUS INCUS LONGISPINUS Eichl. & Racib.

Length with spines 46 μ, without 26 μ; breadth with spines 34 μ, without 14 μ; length of spines 15 μ; isthmus 5 μ. Occasional, St. Anthony.

STAURASTRUM Meyen. 1829

55. STAURASTRUM ARISTIFERUM Ralfs.

Length 40 μ; breadth without spines 68 μ; isthmus 9 μ. Occasional, St. Anthony.

56. STAURASTRUM DUBIUM West.

Length 28 μ; breadth 22 μ; isthmus 10 μ. Very common, Rose au Rue.

57. STAURASTRUM LONGISPINUM BIDENTATUM (Wittr.) Cushman.

Length 90 μ; breadth with spines 108 μ, without 83 μ; isthmus 40 μ. Rare, St. Anthony.

58. STAURASTRUM ARCUATUM Nordst.

Breadth with processes 45–50 μ; isthmus 8.5 μ. Occasional, St. Anthony.

59. STAURASTRUM NANUM Wolle.

Length 25 μ; breadth with spines 31 μ, without 22 μ; isthmus 8 μ. Common, Rose au Rue.

60. STAURASTRUM JOHNSONII W. & G. S. West.

Length 56 μ; breadth 84 μ; isthmus 9.5 μ. Occasional, St. Anthony.

61. STAURASTRUM GRACILE Ralfs.

Length with processes 58 μ, without 15 μ; isthmus 8 μ. Not common, St. Anthony.

62. STAURASTRUM CRENULATUM (Näg.) Delp.

Breadth 25–37 μ; isthmus 9 μ. Rare, Rose au Rue. Frequent, St. Anthony.

63. STAURASTRUM MACROCERUM Wolle.

Length 48 μ; breadth with processes 100 μ; without 28 μ; isthmus 18 μ. Common, St. Anthony.

64. STAURASTRUM ECHINATUM Bréb.

Length without spines 45 μ; breadth with spines 50 μ, without 37 μ; isthmus 16 μ. Occasional, St. Anthony.

65. STAURASTRUM EUSTEPHANUM (Ehrenb.) Ralfs.

Breadth with processes 58 μ; isthmus 13 μ. Occasional, St. Anthony.

66. STAURASTRUM ARCTISCON (Ehrenb.) Lund.

Breadth with processes 100 μ, without 50 μ; isthmus 25 μ. Rare, St. Anthony.

SPHAEROZOSMA Corda. 1835

67. SPHAEROZOSMA EXCAVATUM Ralfs.

Breadth of filament 14 μ; length of cells 12 μ; isthmus 6.5 μ. Rare, St. Anthony.

DESMIDIUM Ag. 1824

68. DESMIDIUM SWARTZII Ag.

Breadth of filament 34 μ; length of cell 18 μ. Rare, St. Anthony.

69. DESMIDIUM COARCTATUM Nordst.

Maximum breadth of filament 43.5 μ, minimum 31 μ; length 26 μ. Rare, St. Anthony.

70. DESMIDIUM QUADRATUM Nordst.

Breadth of filament 27–29 μ; length of cell 21–23 μ. Rare, St. Anthony.

71. DESMIDIUM BAILEYI (Ralfs) DeBary.

Breadth of filament 23–25 μ. Rare, Rose au Rue and St. Anthony.

GYMNOZYGA Ehrenb. 1840

72. GYMNOZYGA MONILIFORMIS Ehrenb.

Breadth of filament 22 μ; length of cell 28 μ. Occasional, Bay of Islands and St. Anthony.

BOSTON SOCIETY OF NATURAL HISTORY.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1906)

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